



Braking resistors for rolling stock



SIMPAX
We make resistors



- one of the largest Polish manufacturers of resistors
- wide range of resistors with power: 50W / Mega W
- high expertise, innovation and quality
- highly experience in replacements resistors production
- delivering resistors for globally respected companies
- low production cost and short lead time

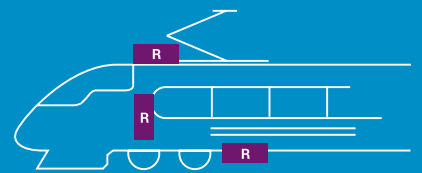
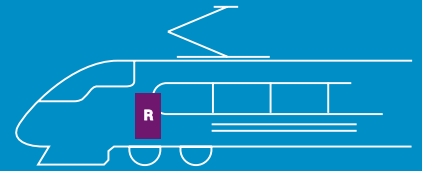
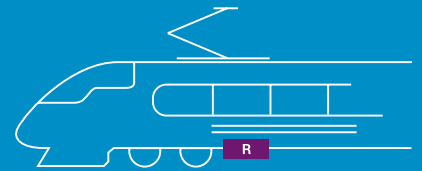
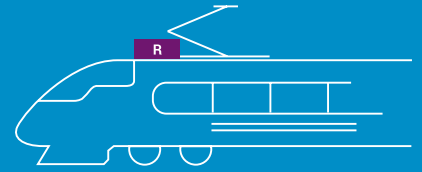


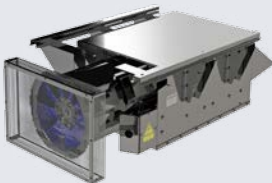
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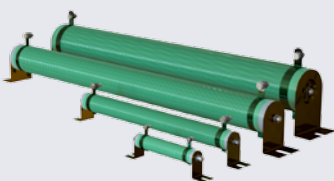
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Traction resistors / replacement resistors

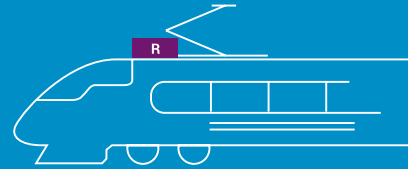
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Roof mounted braking resistors of open construction

Application

Trams • Trains • Hybrid or electric buses



Examples



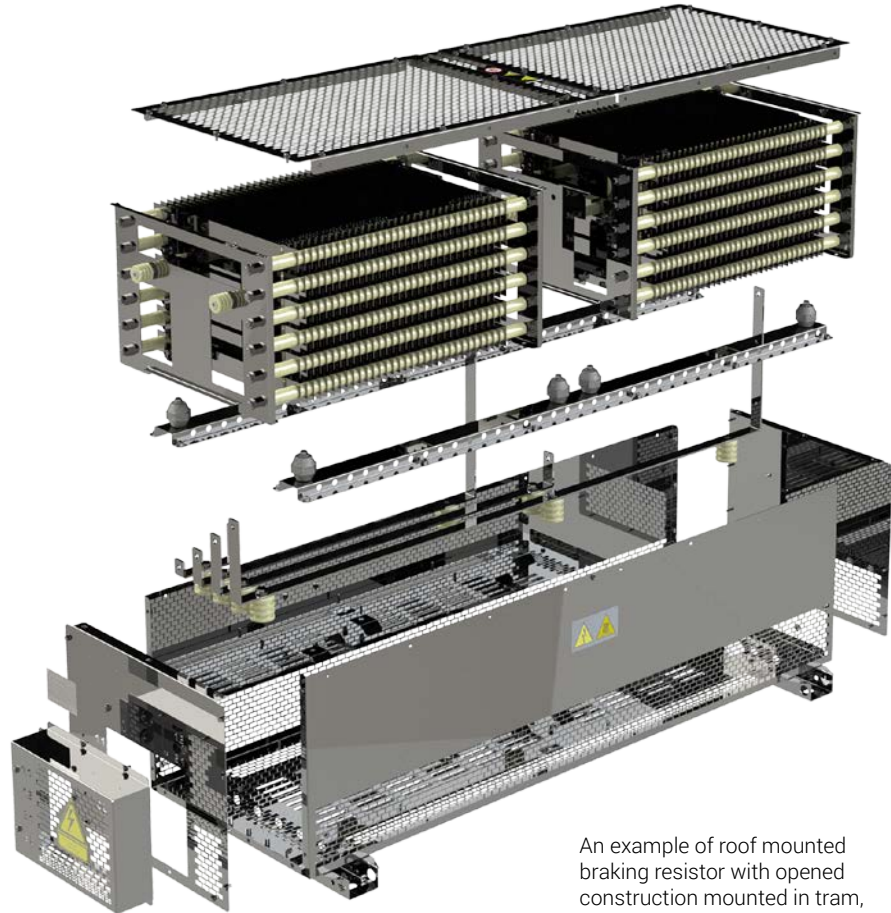
Example of roof resistor used in tram.



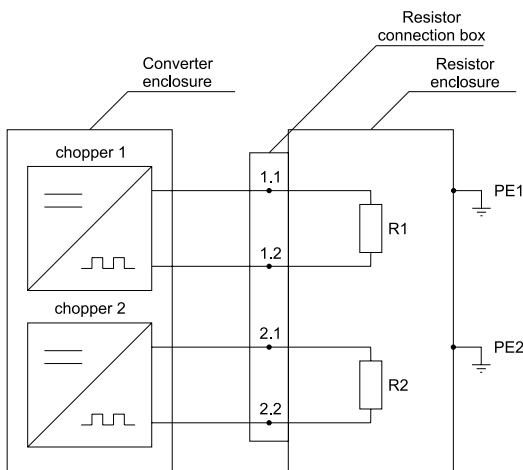
Example of roof resistor used in light train.



Example of roof resistor used in electric bus. Connection by Harting HAM connector.



An example of roof mounted braking resistor with opened construction mounted in tram, or light train



Construction

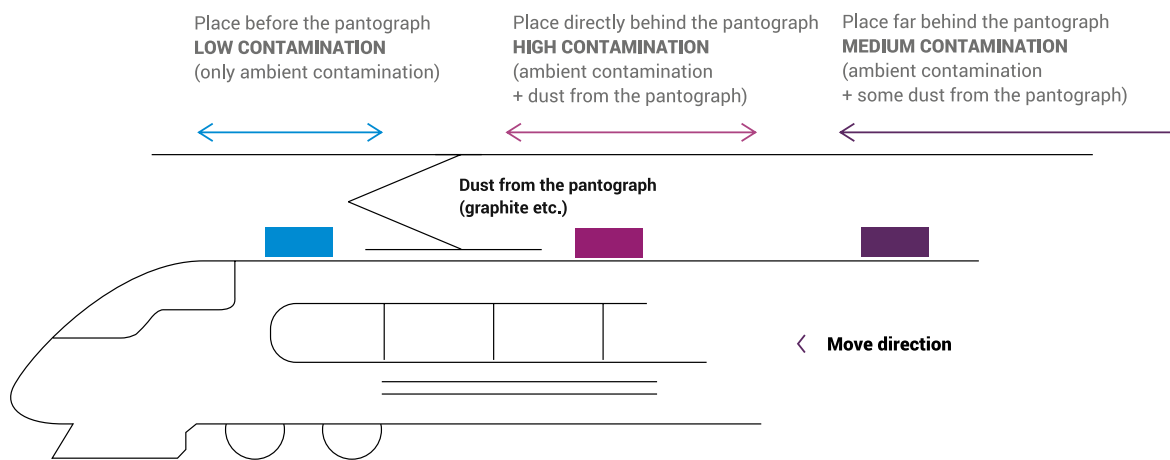
Roof resistors are built from steel grid or ribbon resistance elements. They are put in to opened enclosure with protection degree IP20.

Such resistor complied with the standard IEC 60322:2001 Railway applications - Electric equipment for rolling stock - Rules for power resistors of open construction.

The resistor consist of 2 resistance modules (R1; R2) which are connected to braking chopper.

Place of installation on the roof of vehicle

Resistors are mounted on the roof of the vehicle. Due to the fact that the resistor is an open construction (IP20), contaminants can settle on its post insulators. To avoid possible damage (short circuit), it is not recommended to install them directly behind the pantograph, because the pantograph graphite can get into the resistor enclosure. Its accumulation on insulators can lead to short-circuits. In such place is necessary to clean the resistor more frequently.



Main features of the resistor construction

Design resistant to ambient conditions

The resistor is open construction compliant with the EN-60322 standard with IP20 protection degree, where active elements of the resistor (being under voltage) are exposed to atmospheric conditions such as rain, snow, dirt etc. All parts of the resistor are made of stainless steel or covered with anti-corrosion layers (copper conductors). It has a rainwater drainage system.

Vibration resistant construction

The individual connections of the resistor parts are made with special screw connections (no welding). Particular attention is paid to the proper selection of the type of screw connections and the tightening torque. This solution guarantees that the connections will not spin during operation on the vehicle. Additionally, for the prototype resistors, vibration resistance tests are carried out in accordance with EN-61373.

High temperature resistant construction

The resistance elements of the resistors warm up during operation to temperatures around 600°C, which causes their elongation and the possibility of contact with each other by making an internal short-circuit of the resistor. Therefore, their construction is made in such a way as to compensate for the thermal expansion of the resistance steel.

Resistor housings are made of stainless steel resistant to high temperatures. Its construction includes the following aspects:

- The most efficient air exchange possible, resulting in better cooling of the resistor
- Special construction of the bottom of the casing to protect the vehicle roof from heating above 80°C, ensuring adequate water drainage.
- Protection against heating elements located directly after the resistor while the vehicle is moving - heat is only discharged upwards
- Special orientation of the upper flaps of the housing, thanks to which they deform in a controlled way during heating, without reducing the clearances from the supporting elements
- connection terminals are paced in a place where there are no high temperatures.

Detailed technical parameters of resistor

Bellow you can find many detailed parameters of the resistor. Please remember that some of them are optional and don't need to give them during the first contact.

Number of resistance modules	2	Or according to requirements
Rated Resistance: Rn	Please specify. Standard for trams: 1,5Ω-2,0Ω	[Ω] +7%/-5% according to EN-60322
Min. resistance in min. ambient temperature: Rmin	Please specify	[Ω] It can not be lower than the value causing a higher braking current than the max. Chopper current
Max resistance in max temperature of resistor: Rmax	Please specify Standard Rn + 15% – 40%	[Ω] It can not rise above the value causing too low braking power
Rated Energy for one cycle of braking (worst case)	Please specify	[J]
Rated Energy for Emergency braking	Please specify	[J]
Rated braking power	Result of braking energy	[kW]
Rated working cycle	Please specify For example: 15s. braking, 60s. break. Time of cycle: 75s.	
Rated working voltage: Un	Please specify	[V] according EN-50163
Peak voltage	Please specify	[V] for example during emergency braking
Pollution degree	PD4	According EN-50124-1
Over voltage category	OV2	According EN-50124-1
Rated insulation voltage: Unm	Depends on Un	According EN-50124-1
Impulse voltage: Uni	Depends on Un, PD, OV	According EN-50124-1
Insulation test voltage	Depends on Un	According EN-60322
Protection degree	IP20	For enclosure and connection box
Cooling	Natural	
Max working temperature of resistor	Standard 600°C or according to requirements	
Max peak temperature	Standard 800°C or according to requirements	
Max. allowed dimensions	Please specify	

Detailed technical parameters of resistor

Working conditions

Ambient temperature	Please specify	Standard: -25°C; 40°C
Max operating altitude	Please specify	Standard < 1000m
Shock and vibration	Cat. 1 / Class A all directions	According EN-61373
Roof load for walking section	Please specify	Standard: 0 kg no walking allowed
Environment corrosivity category	C5-I	According ISO12944-2

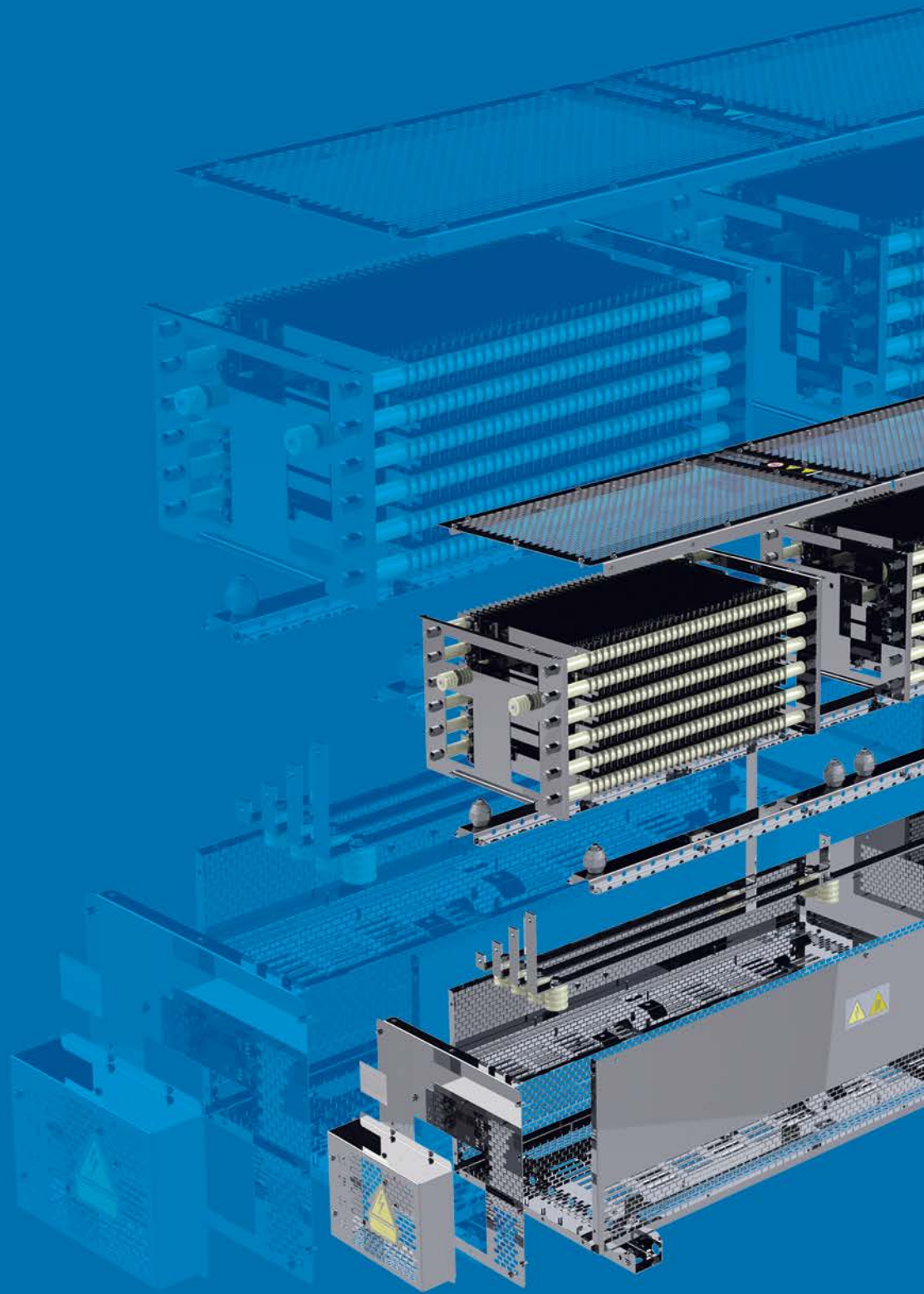
Other

Max. Temp below the resistor	Standard < 80°C	
Sound power level	≤70dB	According IEC 60076-10 at 1 m distance
Fire protection	Category A1	All materials used in the resistor construction are non-flammable

Kinds of test

Kind of test	Type test (for prototype)	Routine test (each unit)	Standard
Visual inspection	S	S	IEC 61287-1
Dimensions measurements	S	S	IEC 61287-1
Weighing	S	O	IEC 61287-1
Marking control	S	S	IEC 61287-1
Resistance measurement	S	S	EN 60322
Inductance measurement	O	N	EN 60322
Temperature rise test	O / S	N	EN 60322
Shock and vibration test	O / S	N	EN 61373
Dielectric high voltage test	S	S	EN 60322
Test for performance in rain	O	N	EN 60322
Other on request	O	O	

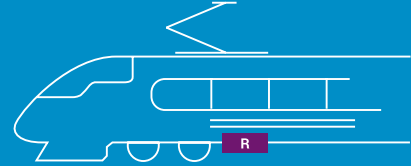
S – Standard, O – Option, N – Not applicable



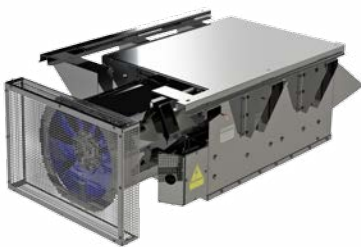
Braking resistors mounted under the vehicle

Application

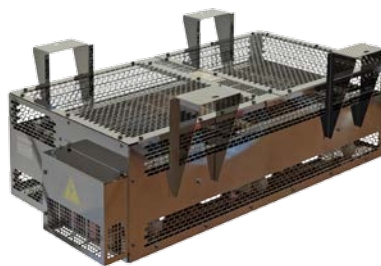
Metro vehicles • Old types of trams • Other



Examples



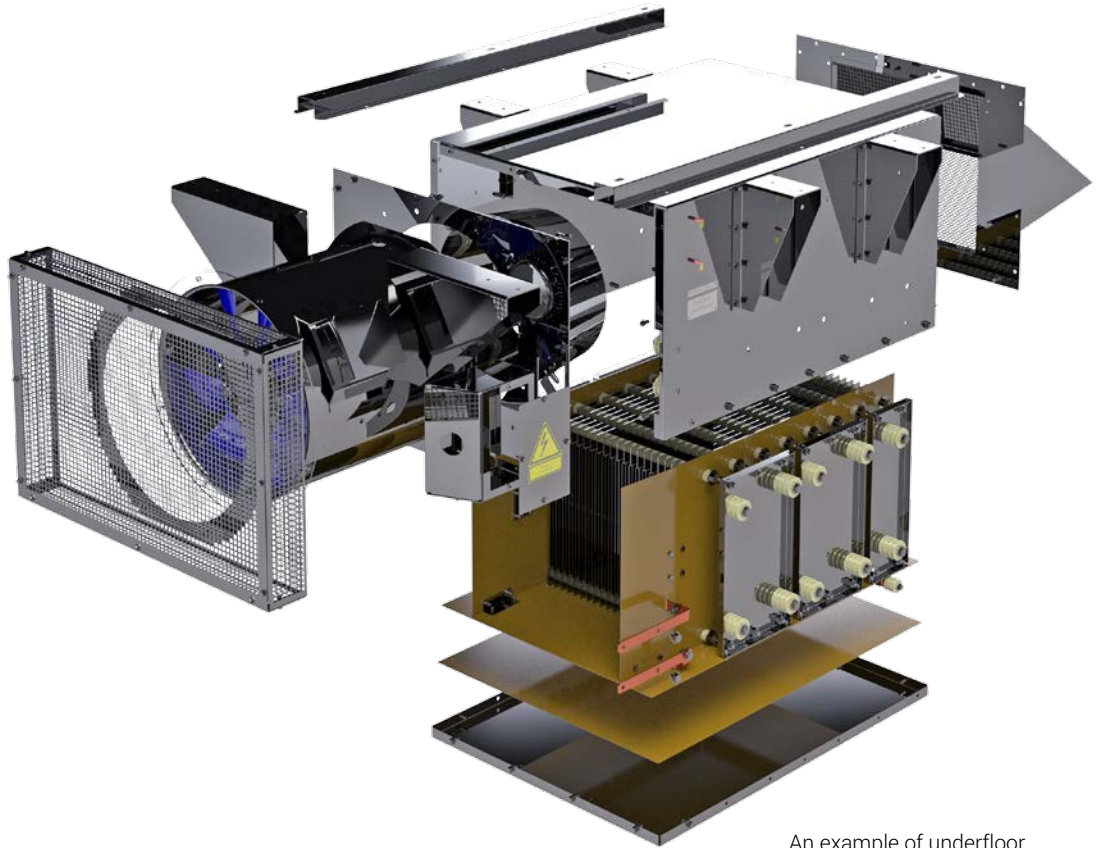
Example of braking resistor with forced cooling mounted underfloor in metro vehicle.



Example of braking resistor with natural cooling mounted underfloor in metro vehicle.



Example of braking resistor mounted underfloor in converter enclosure. Forced cooling from converter cooling system.



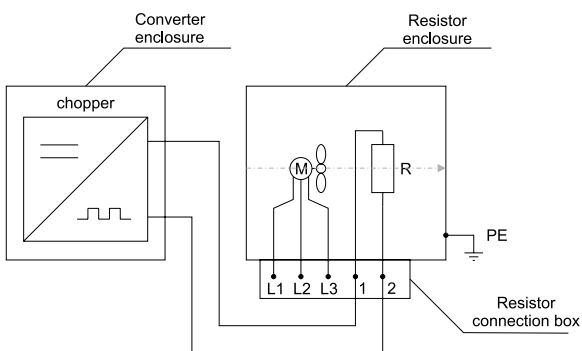
An example of underfloor braking resistor with forced cooling used in metro vehicles

Construction

Resistors mounted under the vehicle are usually constructions with forced cooling in a horizontal arrangement. In some cases, resistors with natural cooling are also used, or cooling air is supplied externally - e.g. a chopper cooling system.

Such a resistor is made of ribbon resistance elements mounted in a channel through which cooling air flows. In addition, in most cases it is also equipped with a cooling fan, or it is mounted in a housing where the cooling air is supplied from the outside - the fan is not then included in the scope of delivery of the resistor.

The resistor consists of one or two resistance modules that are connected to the braking chopper. In case of one module resistor, to the chopper are connected 2 such resistors.



Main features of the resistor construction

Moisture resistant construction

Such resistor is a construction with IP20 protection degree, where active elements of the resistor (being under voltage) are exposed to moisture and pollution. It is made entirely of stainless materials, or covered with anti-corrosive layers (copper busbars). It has a hot air outlet orientation system

Vibration resistant construction

The individual connections of the resistor construction parts are made with screw connections (no welding), which pays special attention to the appropriate selection of the screw connection type and the tightening torque. This solution guarantees that the connections will not spin during operation on the vehicle. Additionally, for the prototype resistors, vibration resistance tests are carried out in accordance with EN-61373. Resistors equipped with a cooling fan have in some cases welded parts for the fan structure (eg mounting elements). It is in accordance to EN-15085 standard, Class CP-C2

High temperature resistant construction

During operation the resistance elements of the resistor warm up to temperatures of around 600 - 800°C. It cause their elongation and the possibility of contact with each other by making an internal short circuit of the resistor. Therefore, their construction is made in such a way, to compensate for the thermal expansion of the steel. Resistor housing is made of stainless steel resistant to high temperatures. Its construction includes the following aspects:

- The most efficient air exchange possible, thanks to using resistance elements that cause low resistance to cooling air flow.
- Protection against heating of elements placed directly behind the resistor. During the movement of the vehicle, heat from the resistor is directed to given side, e.g. down.
- Use of efficient cooling fans made in railway standards. Thanks to this, the resistance module can be smaller than with natural cooling.
- Placing of resistor connection terminals in a place where there are no high temperatures.

Detailed technical parameters of resistor

Bellow you can find many detailed parameters of the resistor. Please remember that some of them are optional and don't need to give them during the first contact

Number of resistance modules	1 - 2	Or according to requirements
Rated Resistance: Rn	Please specify	[Ω] +7%/-5% according to EN-60322
Min. resistance in min. ambient temperature: Rmin	Please specify	[Ω] It can not be lower than the value causing a higher braking current than the max. Chopper current
Max resistance in max temperature of resistor: Rmax	Please specify Standard Rn + 15% – 40%	[Ω] It can not rise above the value causing too low braking power
Rated continuous power	Please specify	[kW]
Rated Energy for one cycle of braking (worst case)	Please specify	[J]
Rated Energy for Emergency braking	Please specify	[J]
Rated braking power	Result of braking energy	[kW]
Rated working cycle	Please specify For example: 30s. braking, 90s. break. Time of cycle: 120s.	
Rated working voltage: Un	Please specify	[V] according EN-50163
Peak voltage	Please specify	[V] for example during emergency braking
Pollution degree	PD4	According EN-50124-1
Over voltage category	OV2	According EN-50124-1
Rated insulation voltage: Unm	Depends on Un	According EN-50124-1
Impulse voltage: Uni	Depends on Un, PD, OV	According EN-50124-1
Insulation test voltage	Depends on Un	According EN-60322
Protection degree	IP20 for resistor housing	By forced cooling IP65 for motor.
Cooling	Natural or forced	
Max working temperature of resistor	Standard 600°C	
Max peak temperature	Standard 800°C	
Max allowed dimensions	Please specify	

Parameters of cooling fan

Power supply voltage	Please specify	
Other	Air flow, Supply power, Supply frequency,	The other parameters of the cooling fan are discussed during proceed of the project

Working conditions

Ambient temperature	Please specify	Standard -25°C - +40°C
Max operating altitude	Please specify	Standard < 1000m
Shock and vibration	Cat. 1 / Class A all directions	According EN-61373
Environment corrosivity category	C5-I	According ISO12944-2

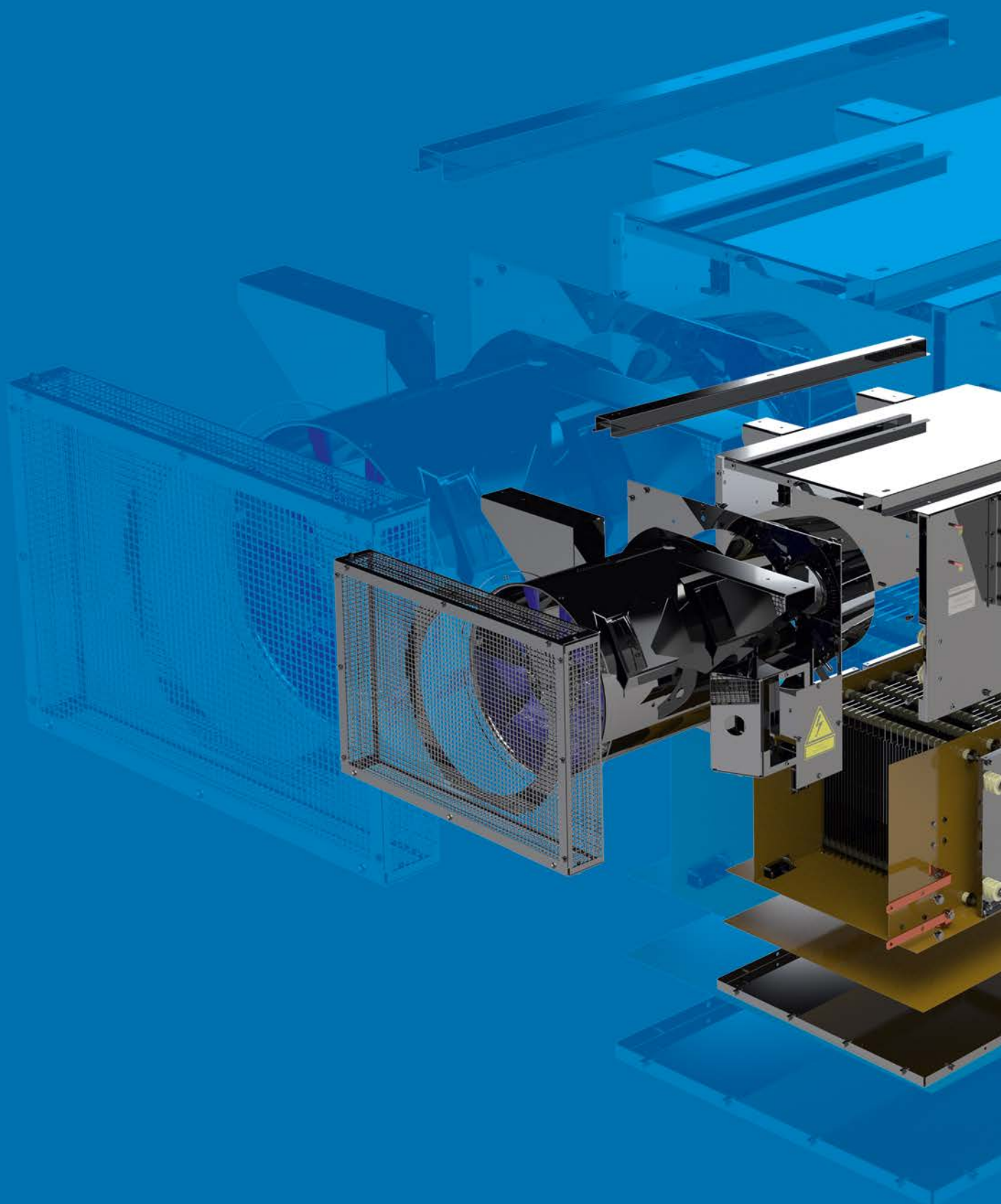
Other

Sound power level	≤70dB	According IEC 60076-10 at 1 m distance
Fire protection	Category A1	All materials used in the resistor construction are non-flammable
Electrical interfaces	Power cables connections, type of socket for cooling fan power supply and other signals	These things are discussed during proceed of the project

Kinds of test

Kind of test	Type test (for prototype)	Routine test (each unit)	Standard
Visual inspection	S	S	IEC 61287-1
Dimensions measurement	S	S	IEC 61287-1
Weighing	S	O	IEC 61287-1
Marking control	S	S	IEC 61287-1
Resistance measurement	S	S	EN 60322
Inductance measurement	O	N	EN 60322
Temperature rise test	O / S	N	EN 60322
Shock and vibration test	O / S	N	EN 61373
Dielectric high voltage test	S	S	EN 60322
Test for performance in rain	O	N	EN 60322
Other on request	O	O	

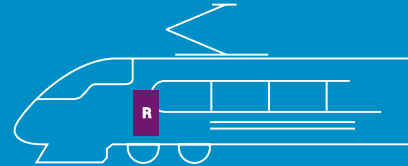
S – Standard, O – Option, N – Not applicable



Braking resistor mounted inside the vehicle

Application

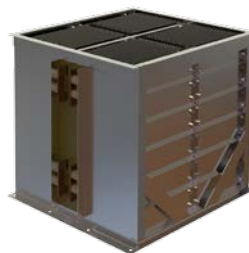
Electric locomotives • Diesel locomotives • Other



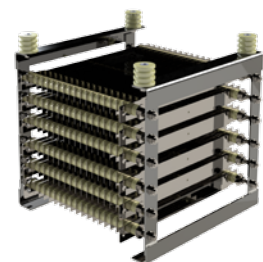
Examples



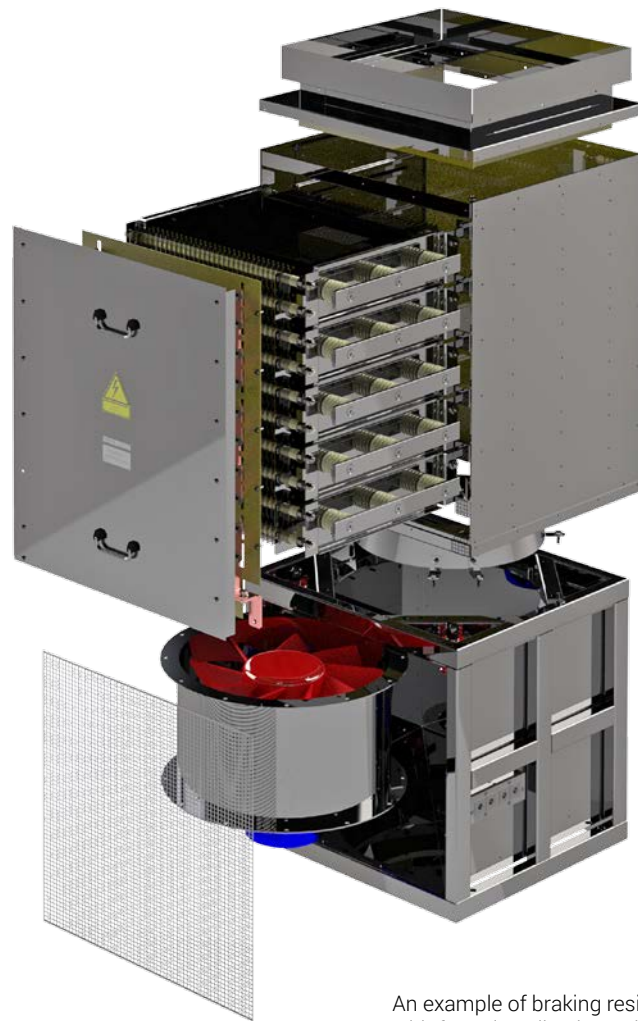
An example of braking resistor with forced cooling mounted inside electric locomotive. (resistor + cooling fan).



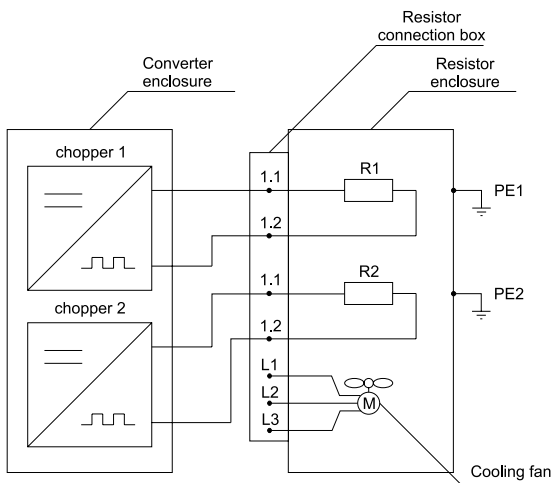
An example of old type braking resistor with forced cooling mounted inside diesel locomotive.



An example of one module with a resistor mounted inside electric locomotive. Resistor without directly forced cooling.



An example of braking resistor with forced cooling in vertical arrangement



Construction

Braking resistors mounted inside the vehicle are usually constructions with forced cooling in a vertical arrangement.

Such a resistor is made of ribbon resistance elements mounted in a channel through which cooling air flows. In addition, in most cases it is also equipped with a cooling fan, or it is mounted in a housing where the cooling air is supplied from the outside - the fan is not then included in the scope of delivery of the resistor.

The resistor consists of one or two resistance modules that are connected to the braking chopper. In case of one module resistor, to the chopper are connected 2 such resistors.

Main features of the resistor construction

Moisture resistant construction

Such resistor is a construction with IP20 protection degree, where active elements of the resistor (being under voltage) are exposed to moisture and pollution. It is made mostly of stainless materials, or covered with anti-corrosive layers: copper busbars covered by CuNi, cooling fan frame is galvanised – it has limited contact with moisture.

Vibration resistant construction

The individual connections of the resistor construction parts are made with screw connections (no welding), which pays special attention to the appropriate selection of the screw connection type and the tightening torque. This solution guarantees that the connections will not spin during operation on the vehicle.

Additionally, for the prototype resistors, vibration resistance tests are carried out in accordance with EN-61373.

Resistors equipped with a cooling fan have welded frame. It is in accordance to EN-15085 standard, Class CP-C2.

High temperature resistant construction

During operation the resistance elements of the resistor warm up to temperatures of around 600 - 800°C. It cause their elongation and the possibility of contact with each other by making an internal short circuit of the resistor.

Therefore, their construction is made in such a way, to compensate for the thermal expansion of the steel.

Resistor housing is made of stainless steel resistant to high temperatures. Its construction includes the following aspects:

- The most efficient air exchange possible, thanks to using resistance elements that cause low resistance to cooling air flow.
- Use of efficient cooling fans made in railway standards. Thanks to this, the resistance module can be smaller than with natural cooling.
- Placing of resistor connection terminals in a place where there are no high temperatures.

Detailed technical parameters of resistor

Bellow you can find many detailed parameters of the resistor. Please remember that some of them are optional and don't need to give them during the first contact.

Number of resistance modules	1 - 2	Or according to requirements
Rated Resistance: Rn	Please specify.	[Ω] +7%/-5% according to EN-60322
Min. resistance in min. ambient temperature: Rmin	Please specify	[Ω] It can not be lower than the value causing a higher braking current than the max. Chopper current
Max resistance in max temperature of resistor: Rmax	Please specify Standard Rn + 15% – 40%	[Ω] It can not rise above the value causing too low braking power
Rated continuous power of the resistor	Please specify	[kW]
Rated working cycle	Please specify In many cases for such resistors is specified continuous power or continuous current.	
Rated working voltage: Un	Please specify	[V] according EN-50163
Peak voltage	Please specify	[V] for example during emergency braking
Pollution degree	PD4	According EN-50124-1
Over voltage category	OV2	According EN-50124-1
Rated insulation voltage: Unm	Depends on Un	According EN-50124-1
Impulse voltage: Uni	Depends on Un, PD, OV	According EN-50124-1
Insulation test voltage	Depends on Un	According EN-60322
Protection degree	IP20 for resistor housing	By forced cooling IP65 for motor.
Cooling	Natural or forced	
Max working temperature of resistor	Standard 600°C	
Max peak temperature	Standard 800°C	
Max allowed dimensions	Please specify	

Parameters of cooling fan

Power supply voltage	Please specify	
Other	Air flow, Supply power, Supply frequency,	The other parameters of the cooling fan are discussed during proceed of the project

Working conditions

Ambient temperature	Please specify	Standard -25°C - +40°C
Max operating altitude	Please specify	Standard < 1000m
Shock and vibration	Cat. 1 / Class A all directions	According EN-61373
Environment corrosivity category	C5-I	According ISO12944-2

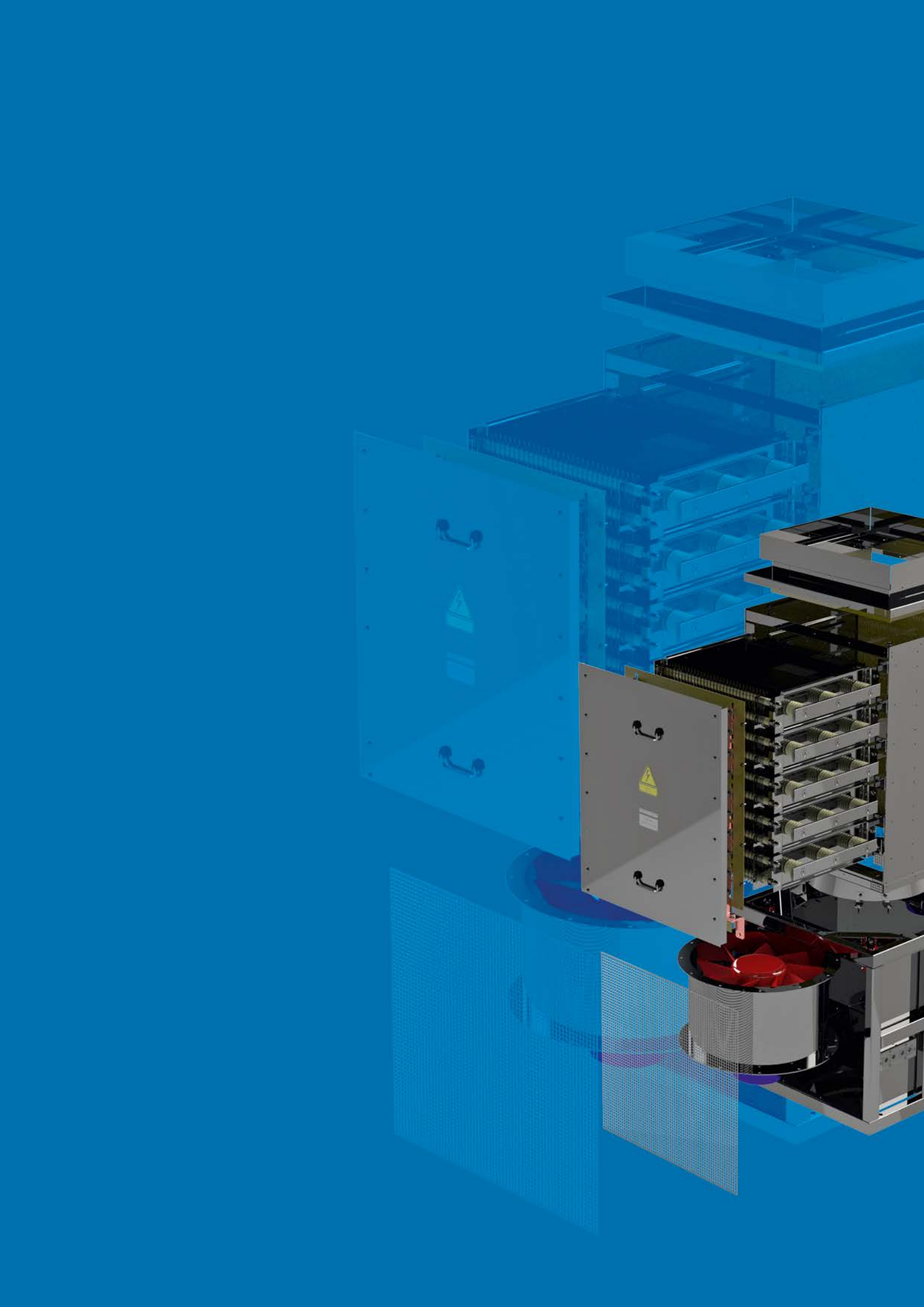
Other

Sound power level	≤70dB	According IEC 60076-10 at 1 m distance
Fire protection	Category A1	All materials used in the resistor construction are non-flammable
Electrical interfaces	Power cables connections, type of socket for cooling fan power supply and other signals	These things are discussed during proceed of the project

Types of tests

Kind of test	Type test (for prototype)	Routine test (each unit)	Standard
Visual inspection	S	S	IEC 61287-1
Dimensions measurements	S	S	IEC 61287-1
Weighing	S	O	IEC 61287-1
Marking control	S	S	IEC 61287-1
Resistance measurement	S	S	EN 60322
Inductance measurement	O	N	EN 60322
Temperature rise test	O / S	N	EN 60322
Shock and vibration test	O / S	N	EN 61373
Dielectric high voltage test	S	S	EN 60322
Test for performance in rain	O	N	EN 60322
Other on request	O	O	

S – Standard, O – Option, N – Not applicable



Traction resistors replacement resistors

**New traction resistors, and replacements for older type resistors
(also from other manufacturers)**



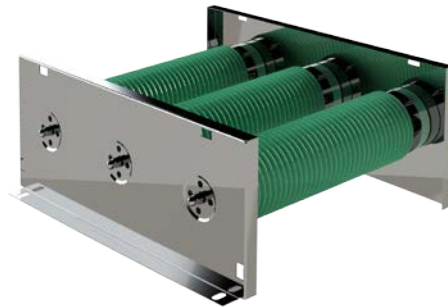
Traction resistors are used in all types of traction vehicles and switchboards. These can be, for example:

- Shunt resistor
- Traction line testing resistors
- Damping resistors
- Starting resistors for older types of vehicles
- Other

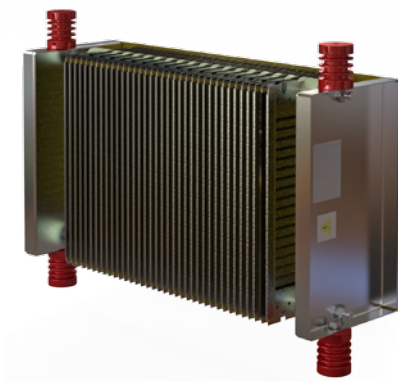
Their construction depends on the application.

Simpax offers resistors consisting of the following types of resistance elements

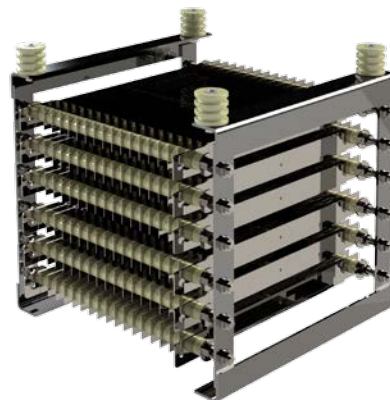
Wirewound resistors



Steel grid resistors



Ribbon resistors



Technical parameters of resistors

Bellow you can find many detailed parameters of the resistor. Please remember that some of them are optional and don't need to give them during the first contact.

Rated Resistance: Rn	Please specify.	[Ω] For replacement resistor with few resistance steps, please provide electric diagram
Allowed resistance increase because temperature	Please specify	[%] if required
Rated continuous power	Please specify	[kW]
Rated cyclic power	Please specify	[kW] if required / if applicable
Energy per event	Please specify	[J] if required / if applicable
Rated working voltage: Un	Please specify	[V] according EN-50163
Peak voltage:	Please specify	[V] if required
Rated insulation voltage: Unm	Depends on Un	According EN-50124-1
Impulse voltage: Uni	Depends on Un, PD, OV	According EN-50124-1
Insulation test voltage	Depends on Un	According EN-60322
Protection degree	Please specify	IP
Cooling	Please specify	Natural or forced cooling

Working conditions

Ambient temperature	Please specify	Standard: -25°C; 40°C
Max operating altitude	Please specify	Standard < 1000m
Shock and vibration	Cat. 1 / Class A all directions	According EN-61373. If concern

Other

Allowed or required dimensions of the resistor	Allowed for new design, required for replacement resistors (if possible, please provide pictures, or drawings of the resistor)	
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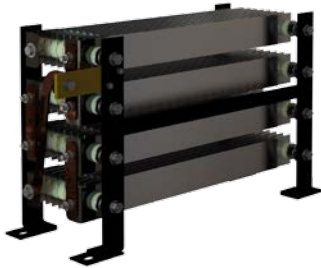
Examples of replacement resistors



Damping resistor used in tram.
Installation in switchgear



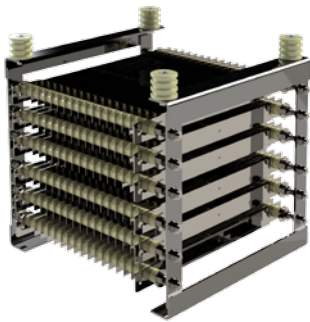
Damping resistor used in switchgear of
traction power supplies



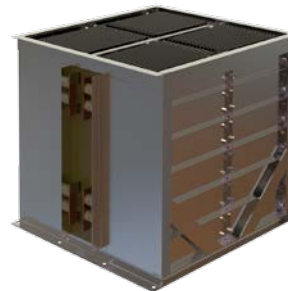
Modules of starting resistor for old type
locomotive. Replacement for old cast iron
resistor. Locomotive ET21 Poland



Traction line testing resistor. Natural cooling.
Installation in traction switchgears located
along the railway tracks



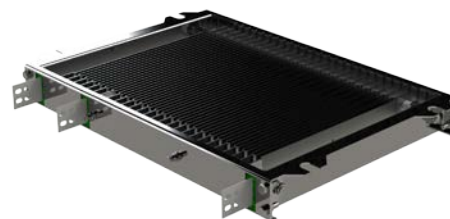
Replacement shunt resistor for Hitachi
locomotive. On picture one of three modules



Replacement braking resistor with forced cooling
used in electric locomotive LE5100



Replacement braking resistor used in old type
tram. Installation in converter enclosure. Forced
cooling from converter cooling system



Replacement resistor for locomotive
EU07 and EP09. On the picture one of 14
modules. Resistor with forced cooling

Braking Resistors
Traction Resistors
Load Resistors
Neutral Earthing &
Grounding Resistors
Starting Resistors



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