REO Braking- and charging resistors

REOHM - Resistors are our business

Compact Braking Resistors • Compact braking resistor combination • Liquid-cooled braking resistors • Register braking resistors • Charging and

Pure|Power|Perfection

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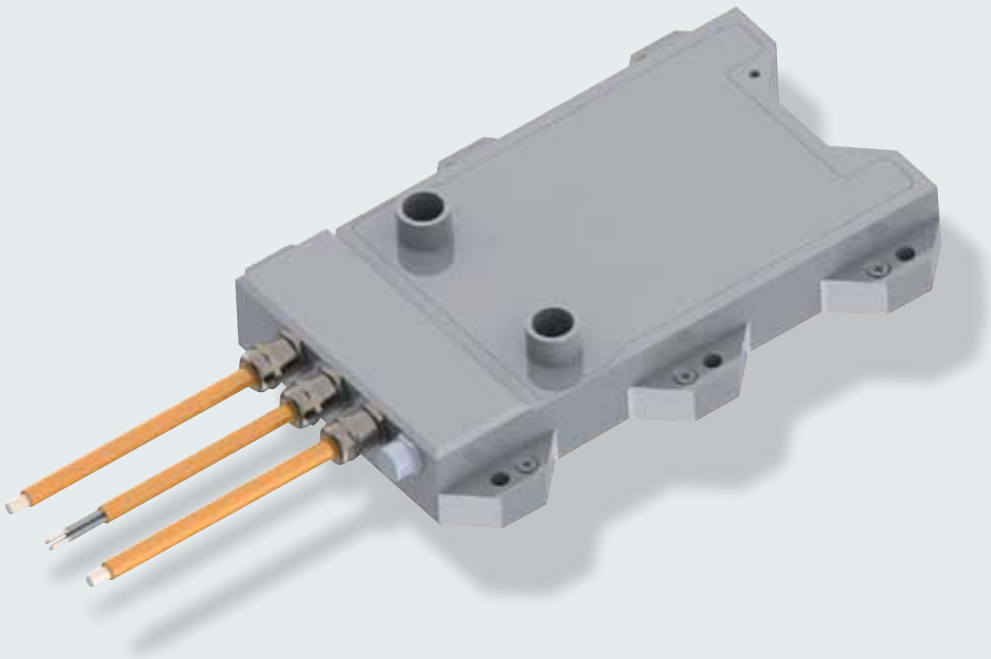
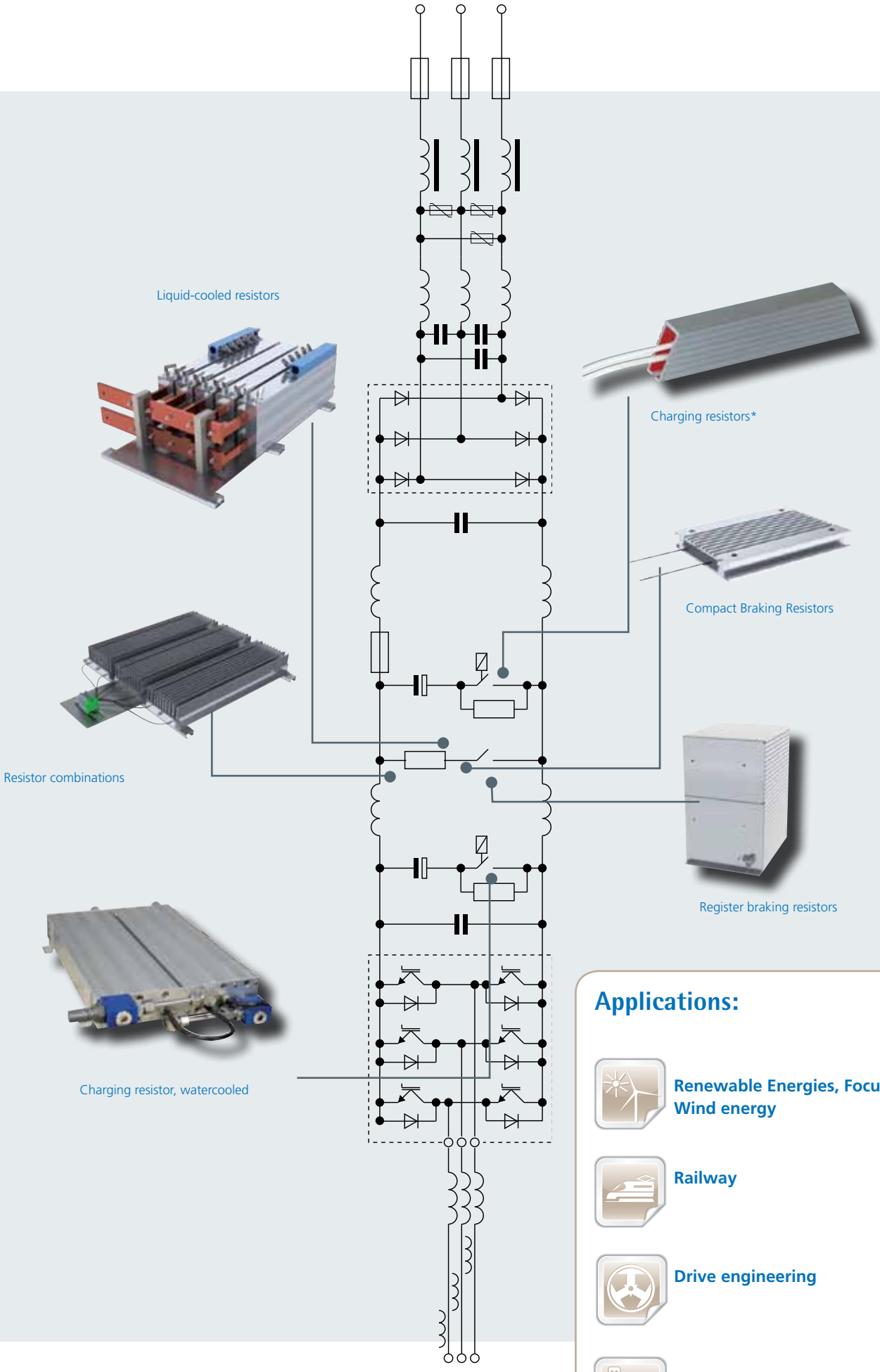
Reliable partner for drive engineering

For many years, REO has been continuously developing and improving the technology and manufacturing processes of high power resistors, which are typically used in electrical drive technology applications such as lifts, cranes and also in railway engineering.

Not all braking resistors are the same -
REOhm is the answer for modern inverter technology.



Use in inverters



Liquid-cooled resistors

Charging resistors*

Compact Braking Resistors

Resistor combinations

Register braking resistors

Charging resistor, watercooled

Applications:

- Renewable Energies, Focus: Wind energy
- Railway
- Drive engineering
- E-Mobility

Braking resistors from REO

REO has been manufacturing resistors for more than 75 years. Its wide experience and application knowledge of high-capacity braking resistors that are wound on tubes or ceramic cores has led it to develop more modern technologies. The Kyritz subsidary has been producing braking resistors in profile construction for more than 20 years. Better heat dissipation and better dynamic behaviour of the resistors have been achieved by filling heat conducting material surrounding the wound body. Impressive temperature reductions are possible due to efficient power dissipation.

REO can provide resistors for inverters that can offer the following advantages:

- the resistor can be directly matched to the requirements (Output; peak output; cycle duration);
- the braking resistor can also be installed outside the control cabinet, and therefore, the heat energy of the resistor is not generated inside the control cabinet any more;
- Large variety for cooling, e.g., (active and passive) air cooling and water cooling are possible;
- upon overloading the braking resistor, there is no overheating of electronic components; for water cooled and externally mounted units.
- resistors are short-circuit resistant and are self-extinguishing

REO's aim is to always integrate new technologies in development of its resistor range, especially with regard to the dimensions, heat evolution, dynamic behaviour and not least, design and layout. Moreover, innovations are promoted and the technological compositions of various new products are presented to the market in the form of systems, such as, e.g.

- Water cooling > see page 27
- Ecoload Technology > see page 45

From these developments emerged the series of REOHM resistors BW 150 in 9 different versions for:

- Lift technology
- Robotics
- Wind power engineering
- Railway engineering
- Automobile engineering
- Handling systems and
- so-called Stop motors
- Frequency converter and DC drives
- Load resistors for power supplies, batteries, UPS systems
- Resistors for testing and measurement stations

REO resistors are typically used in conjunction with brake choppers, which are either located in frequency converters, or – particularly with large systems, are present as stand-alone units - braking resistors are connected and disconnected and thus consume the excess voltage at the capacitors of the DC intermediate circuit.
Together with the braking resistors, REO will also supply you the corresponding brake chopper or resistors with integrated brake chopper.

Distinction braking resistor – Load/precharging resistor

Braking resistor (REOhm BW):

When an electric motor works as a generator (electromotive brake), the braking resistor protects the machine from a voltage rise in the DC link. At the same time, the reduction of current leads to a speed reduction of the engine and helps to brake the machine.

Load resistor / precharging resistor (REOhm R):

The precharging resistor is a current limiting resistor for the charging and discharging of capacitors, It limits the inrush current which flows into the DC link capacitor, this requires the device to be designed for a high impulse energy and nominal voltage.
The inductance of the resistor contributes to the limitation of the inrush current,
Wirewound resistors are the right choice are often used for this reason.

When selecting a suitable braking resistor, it is necessary to know how powerfully and how often the motors have to brake. Ideally systems with excess energy (emf) could be used for other components that require it. However, technology has not reached the level where this requirement can be easily met. In high power systems feeding the energy back to the grid can be cost effective but a good solution is not realistic for smaller systems. Moreover, for safety reasons, braking resistors cannot be done away with in many applications. Therefore, REOhm braking resistors remain the most effective option.

Designing braking resistors

Determining the braking resistor value

The braking resistor depends on the intermediate circuit voltage. When the intermediate circuit voltage exceeds a certain voltage value, the braking resistor is connected. UDC is the value of the intermediate circuit voltage at which the brake is activated. The resistance value is calculated on the basis of the intermediate circuit voltage UDC and the peak braking power Pmax.

$$\text{The following applies: } R_{BR} = U_{DC}^2/P_{max}$$

In order to prevent a protective interruption of the frequency converter, the resistance value must be calculated on the basis of this formula.

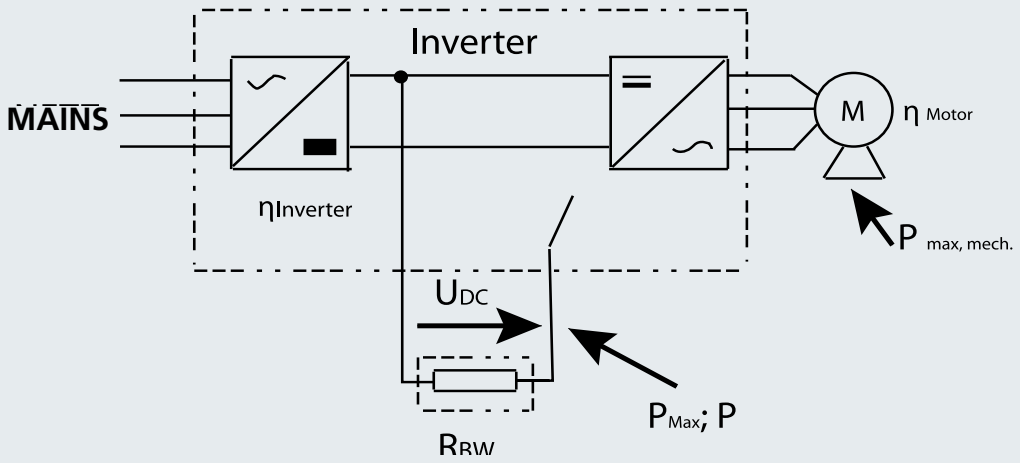
Calculation of the braking power

In the calculation of the braking power, we consider the continuous output (P) and the maximum peak pulse output (Pmax). The braking resistor must be suitable for both outputs. The max. pulse output is the output that is fed back during the duration of the braking process, and is determined by the braking torque. This output is only emitted during the period of braking. As against that, the continuous output is determined using the cycle time. What is involved here is the length of the braking duration in relation to the cycle time (SD).

Calculation of the max. pulse output

Pmax,mech. is the maximum power with which the motor brakes on the motor shaft, and is calculated from the motor rating PMotor and the braking torque MBR.

$$P_{max,mech.} = P_{Motor} \times M_{BR}(\%)$$



The power that is dissipated at the braking resistor when braking, Pmax, is smaller than Pmax,mech. The reason is the efficiency of the motor and the frequency converter, which reduces the output.

$$P_{max} = P_{Motor} \times M_{BR}(\%) \times \eta_{Motor} \times \eta_{Inverter}$$

Calculation of the continuous output

If the kinetic energy emitted during the braking at the braking resistor, Ekin, is known, the continuous output can be directly determined with the magnitude of the energies and the cycle time.

$P = E_{kin.} / SD$

P = continuous output
Ekin. = kinetic energy
SD = cycle time

If the kinetic energy is not known, we need the switching time ED and the cycle time SD.
ED = switching time
SD = cycle time

$$ED[\%] = \frac{ED[s]}{SD[s]} * 100$$

The continuous output for a switching time of 10% can be calculated as follows:

$P = P_{max}$ x 10%

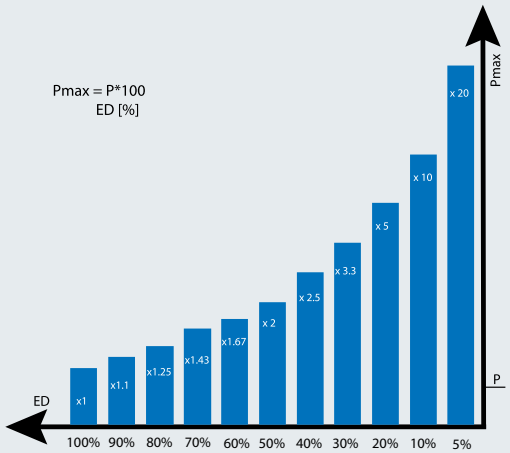
With a switching time of 50%, the following is obtained:

$P = P_{max}$ x 50%

The continuous output (P) is also smaller than the maximum pulse output (Pmax) by a corresponding factor. The calculations at REO refer to intermittent braking at a cycle time of 120 seconds.

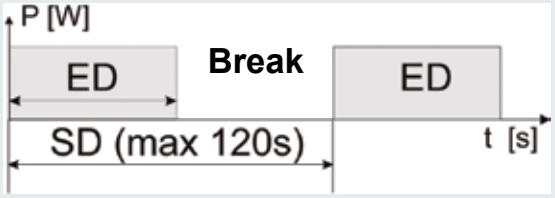
Load diagram

The REOhm braking resistor can absorb energy in the short term, and store it due to a special type of winding. Thanks to special materials and impregnation processes this energy is released as heat which is quickly dissipated to the resistors surface, over a long period. However, because the winding cools so quickly, pulses can always be absorbed and do not result in the destruction of the winding. The REOhm braking resistors are typically designed for a switching time of 5% -100%. Upon request, smaller switching times are also possible.



SD = Cycle time max. 120 sec.

ED = duty cycle



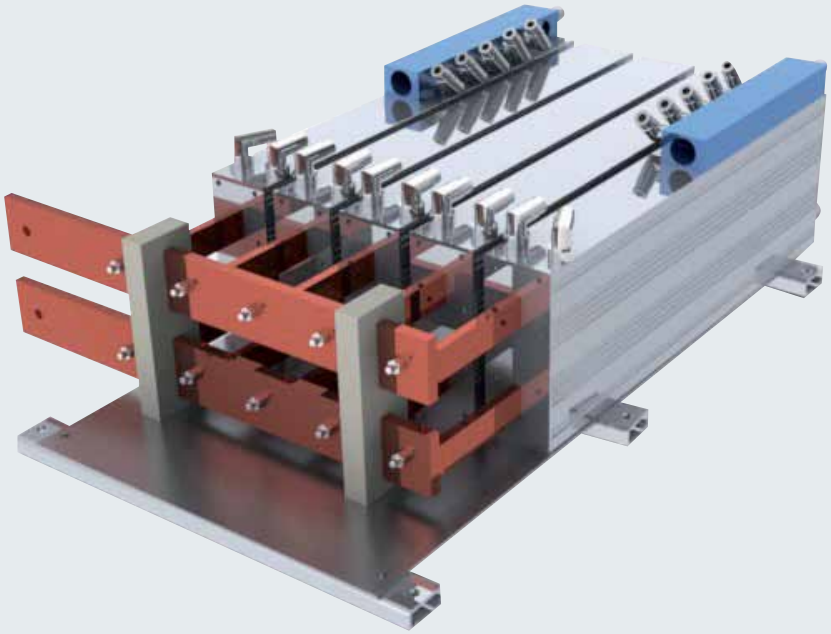
Facts about REOhm-Resistors

Our experiences, show that you have to assume a continuous load with escalators and elevators, because it is not possible to evaluate for how long, how often and how many persons would have to be carried by an escalator or elevator.

Here, REO has developed solutions for application based problems and supplied a solution which can provide resistors for protection class IP 64 or IP 65. Most lifts still are not designed with regenerative control systems, so here too, the energy during the downward movement has to be consumed. Since the control solutions are becoming smaller and the protection classes ever higher, traditional brake resistors cannot be used. The requirements specified here can only be met by specially impregnated resistors in an aluminium profile.

REO braking resistors have the following advantages:

- the resistor can be directly matched to the requirements (output; peak output; cycle duration);
- for industrial applications, the braking resistor can also be installed outside the control cabinet and thus, the heat energy of the resistor is not generated in the control cabinet any more;
- the most varied possibilities for cooling, e.g., (active and passive) air cooling and water cooling are possible;
- upon overloading the braking resistor, there is no overheating of electronic components;
- resistors are short-circuit proof and self-extinguishing



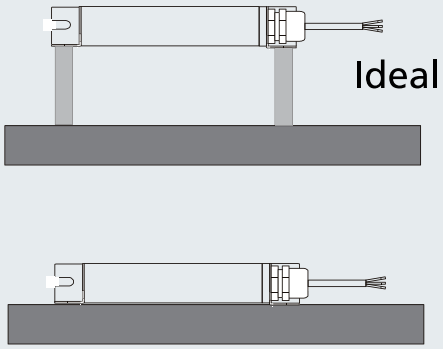
Caution!!! Insufficient cooling or wrong installation can result in overheating or destruction of the resistor. If the braking resistor is overloaded, there is no overheating of electronic components. Continuous temperature values of > 200 K result in a degradation of the protection class.

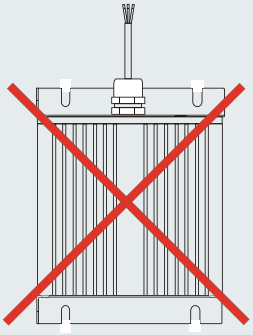

RECOHM BW D 330/7000/8
BV: 96xxxx.xx-xx
7.0 kW / 8 Ω
IP 67
Serien Nr.: 0001

If installed on a surface that is not a good conductor of heat, the application should be checked because of the reduced heat conduction. When the resistors are vertically mounted it is essential that the connections or terminals be on the bottom side of the resistor.

An assembly position with connections on the top should not be undertaken!

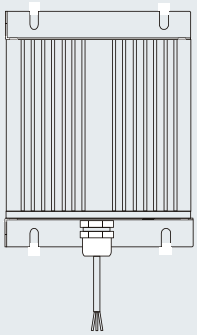
If several resistors are fitted on top one another, their mutual heating must be taken into account. Here, attention must be paid to compliance with the ambient conditions given above, and the installation conditions at the site must be ascertained. With direct installation on a heat sink or a cooling surface, the continuous output of the resistor can be increased and the surface temperature can be reduced. Depending on the type and size of the cooling surface/ heat sink, the output can be increased by a factor of 1.5 - 4. But this must be checked in each individual case, with the given ambient conditions.





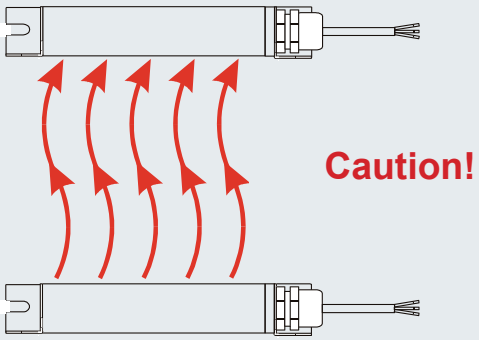
not permissible

connection on top



permissible

connection at bottom



Caution!
Mutual influencing

With cold plate, a possible rating increase by a factor of 1.5 - 4

Usage conditions

Ambient temperature	-15°C ... +70°C above 40°C, reduce continuous output Pd by 5 %/10K
Installation height	0 ... 4000 m above sea level above 1000 m continuous output, reduce Pd by 5 %/1000 m
Installation site	• The installation site must conform to the device properties specified in the „General data". • There must not be any flammable material or substances in the vicinity of the braking resistor. • The heat generated by the braking resistor must be dissipated without any hindrance.
Assembly position	vertically suspended, with connections at the bottom, or horizontal installation
Installation clearances	top > 200mm below > 100mm to the side > 25mm

General Data

Conformity	Conformity with the CE Low voltage directive
Vibration resistance	acceleration-resistant up to 0.7 g; EN50178, IEC61800-5-1 and Germanischer Loyd, General conditions
Temperature switch	version NC contactor, 200°C
Switching capacity	250 V AC / 0,5 A

Standards

Standard	Description
EN 60204.1 VDE 0113	The **EN 60204-1** with the Title Safety of machinery - Electrical equipment of machines, - Part 1: General requirements, governs the general determinations and recommendations for the safety, functionality, and maintenance of the electrical equipment of machines.
EN 60664-1 VDE 0110	Insulation coordination for equipment within low-voltage systems -Part 1: Principles, requirements and tests German version EN 60664
DIN 17471	Resistance alloys ; properties
EN 60529	These have been treated in DIN EN 60529 with the title Protection classes through housing (IP codes). With regard to their suitability for various ambient conditions, the systems are sub-divided into the corresponding protection classes, the so-called IP codes. The abbreviation IP, according to DIN, stands for International Protection, but in the English-speaking world, is considered to be Ingress Protection.
EN 50124-1 VDE 0115	Insulation coordination - Railway applications Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment (German version) EN 50124-1
EN 50155 VDE 0115	Railway applications - Electronic equipment used on rolling stock; German version EN 50155
UL 94	Flammability according to UL 94

Overview of compact resistors

BW 151
Output range: 50 - 300 W
Protection class: IP 20 - 54
16

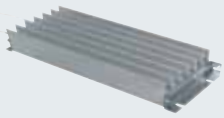
BW 152
Output range: 100 - 330 W
Protection class: IP 20 - 54
17

BW 153
Output range: 100 - 360 W
Protection class: IP 20 - 64
18

BW 154
Output range: 20 - 200 W
Protection class: IP 20 - 54
19

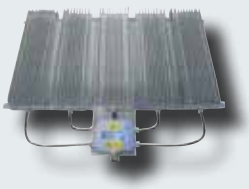
BW 155
Single resistor: 1.000 - 3.000 W
Protection class: IP 20 - 66
20

BW 156
Output range: 400 - 1.500 W
Protection class: IP 20 - 65
22



BW 402
Output range: 100 - 600 W
Protection class: IP 20
24

BW 155 combination
Output range: 4000 - 30.000 W
Protection class: IP 20 - 65
25



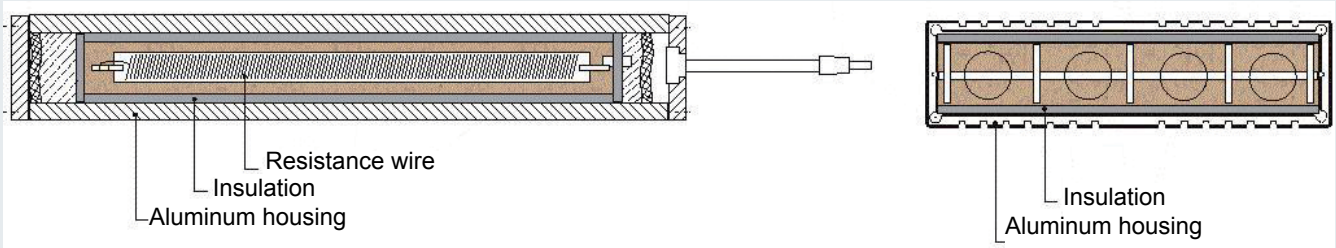
Technical details

In industrial applications, resistors are expected to function safely under difficult ambient conditions for many years. Issues like temperature range, chemical and environmental stress must also dealt with. Polutants like vapours, gases, coal dust, oil or brake abrasion dust and the possible ingress of moisture and foreign bodies such as dust must be prevented for reliable working.

Advantages:

The REOhm resistors of the BW 150 series are characterised by a high degree of functional safety and a long life. The resistor wires are wound on a frame and enscapsulated. This provides a very high degree of mechanical protection and no susceptibility to vibrations and oscillations.

This construction enables the resistor to absorb higher pulse loads and store them temporarily. External environmental influences have only a marginal affect on resistors, i.e. they are less sensitive to moisture and fouling. An added benefit of profile resistors is that they have very low levels of audible noise.



Resistance value / Temperature

The resistance values refer to the standard products with a normal tolerance of +/- 10% at an ambient temperature of 20°C.
The changes in resistance due to winding temperature are relatively small.
The change in resistance from cool to hot are typically +10%.

Technical details

The output data in the data sheets apply under the following usage conditions:

- maximum ambient temperature 40°C
- unhindered entry and outflow of the cooling air
- If the ambient temperature is higher than 40°C,
  the continuous output must be reduced by 5% per 10K increase in temperature.

The resistors are short-circuit proof and self-extinguishing. (Alle types except REOhm R)

The resistors are designed to convert electrical energy into heat and therefore, heating up of the exhaust air and the adjacent housing parts is unavoidable. Unhindered inflow and outflow of cooling air, or a sufficient heat dissipation of the cooling surfaces must be ensured.

Protection classes

For the protection class ≤ IP20, the temperature increase at the hottest point of the surface of the resistor may be max. 300K.
For a higher protection class (> IP20), a maximum temperature increase of 200K at the hottest point of the resistor surface applies.

Temperature switch

There is an option to monitor the temperature of the resistor with a temperature switch.
When nominal temperature is exceeded, the temperature switch opens and triggers a signalling contact.
The temperature switch is fitted with two ready-to-connect leads.

BW 151 series

(max continous output: 300 W)

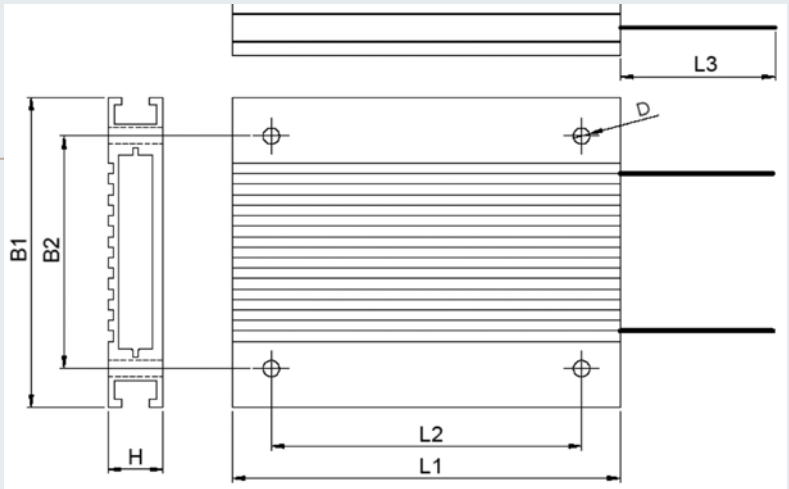
Braking resistor for drives with frequency converters
of small to medium output or usable as a charging resistor; installation close to the frequency converter.

- Protection class IP 20 / IP 40 / IP 54
- higher protection classes upon request
- test voltage 2.5 kV DC
- other ratings and fastening dimensions available on request

Benefits:

- can be easily combined
- short-circuit proof
- very flat and compact shape with grooves for vertical assembly
- matching to any frequency converter
- very good heat dissipation, installation on heat sink possible
- high-resistance at overload
- fast connection
- available with UL certification - see overview UL certified products by REO

Type	Resistance values R [Ohm]	Continous output [W]	max. operating voltage U [V]
BW 151 / 50	1,1 - 200	50	900
BW 151 / 100	3 - 300	100	
BW 151 / 150	4 - 300	150	
BW 151 / 200	5-1000	200	
BW 151 / 250	5-1000	250	
BW 151 / 300	7-2000	300	



Type	B1 [mm]	B2 [mm]	H1 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	D [mm]	Connections
BW 151 / 50 /...	80	60	14	70	50	250	4,2	2 x AWG 18,UL 1659
BW 151 / 100 /...	80	60	14	110	80	250	4,2	2 x AWG 18,UL 1659
BW 151 / 150 /...	80	60	14	160	130	250	4,2	2 x AWG 18,UL 1659
BW 151 / 200 /...	80	60	14	210-216	180	250	4,2	2 x AWG 18,UL 1659
BW 151 / 250 /...	80	60	14	260	230	250	4,2	2 x AWG 18,UL 1659
BW 151 / 300 /...	80	60	14	310	280	250	4,2	2 x AWG 18,UL 1659

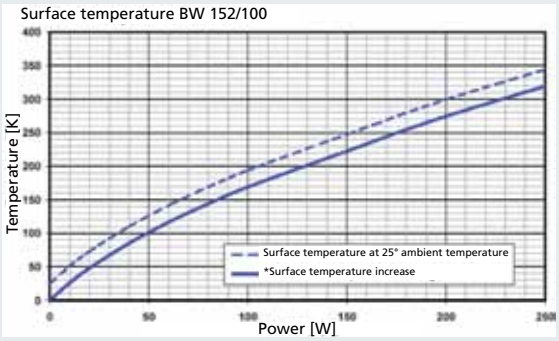
In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

BW 152 series

(max continous output: 330 W)

Braking resistor for drives with frequency converters of small to medium output or usable as a charging resistor; installation close to the frequency converter.

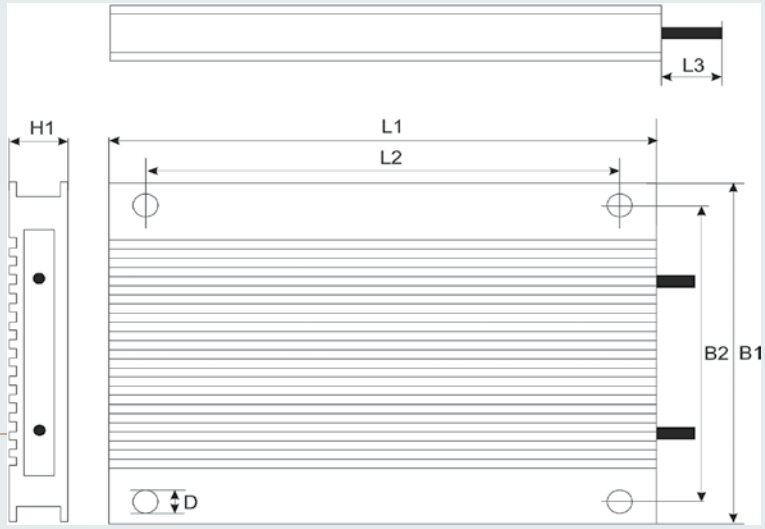
- Protection class IP 20 / IP 40 / IP 54
- higher protection classes upon request
- test voltage 2.5 kV DC
- other ratings and fastening dimensions available on request



Benefits:

- can be easily combined
- short-circuit proof
- very flat and compact shape with grooves for vertical assembly
- matching to any frequency converter
- very good heat dissipation, installation on heat sink possible
- high-resistance at overload
- fast connection

Type	Resistance values R [Ohm]	Continuous output at 25°C and surface overtemperature of ...../P [W] 200K	220K	max. operating voltage U [V]
BW 152 / 100	10 - 620	120	160	900
BW 152 / 150	12 - 500	150	200	
BW 152 / 200	20 - 350	200	280	
BW 152 / 250	3 – 430	250	330	



Type	B1 [mm]	B2 [mm]	H1 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	D [mm]	Connections
BW 152 / 100	100	84	14	100	70	250	4,2	2 x AWG 18,UL 1659
BW 152 / 150	100	84	14	150	120	250	4,2	2 x AWG 18,UL 1659
BW 152 / 200	100	84	14	200	170	250	4,2	2 x AWG 18,UL 1659
BW 152 / 250	100	84	14	250	220	250	4,2	2 x AWG 18,UL 1659

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

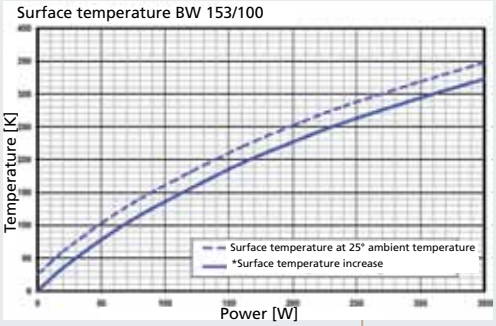
Certified for railway engineering

BW 153 series

(max continous output: 360 W)

Braking resistor for drives with frequency converters of small to medium output, installation close to the frequency converter.

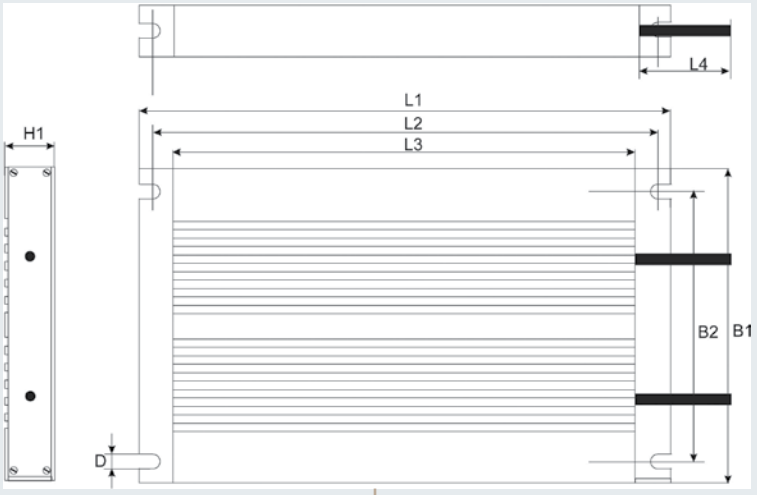
- Protection class IP 20 / IP 40 / IP 54/ IP 65
- higher protection classes upon request
- test voltage 4 kV DC
- other ratings upon request
- other fastening dimensions upon request



Benefits:

- small dimensions, fast connection
- short-circuit proof
- matching to any frequency converter
- can be used under rough conditions
- vertical or horizontal installation possible
- high-resistance at overload
- Protection class up to IP65
- available with UL certification - see overview UL certified products by REO

Type	Resistance R [Ohm]	Continuous output at 25°C and surface overtempera-ture of . ...../P [W] 200K	220K	max. operating voltage U [V]
BW 153 / 100	7 - 400	160	240	900
BW 153 / 200	10 - 500	160	240	
BW 153 / 300	8 - 620	200	280	
BW 153 / 400	10 - 310	250	360	



Type	L1 [mm]	L2 [mm]	L3 [mm]	L4 [mm]	B1 [mm]	B2 [mm]	H [mm]	D [mm]	Connections
BW 153 / 100	160	145	130	250	104	70	29	4,5	IP20/40 PTFE AWG14
BW 153 / 200	160	145	130	250	104	70	29	4,5	
BW 153 / 300	210	195	180	250	104	70	29	4,5	
BW 153 / 400	260	245	230	250	104	70	29	4,5	

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
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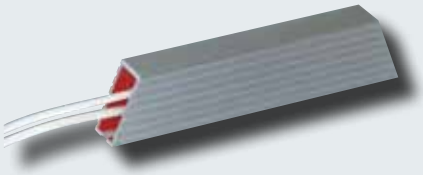
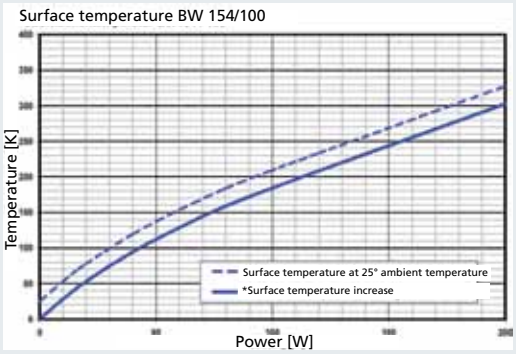


BW 154 series

(max continous output: 200 W)

Braking resistor for drives with frequency converters of small to medium output, installation close to the frequency converter.

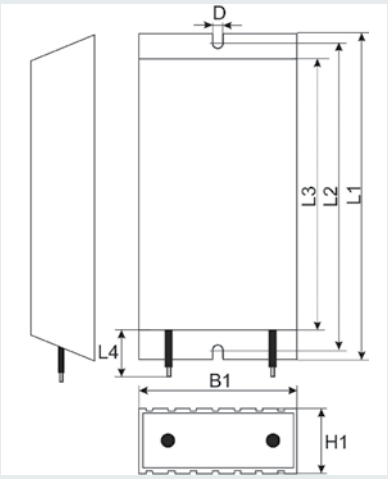
- Protection class IP 20 / IP 40 / IP 54
- higher protection classes upon request
- test voltage 4 kV DC
- other ratings upon request
- other fastening dimensions upon request

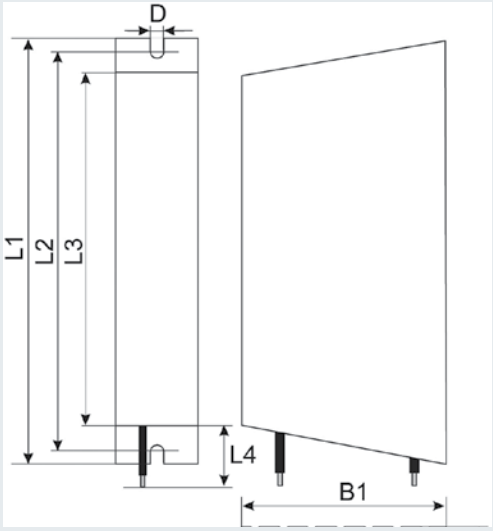


Benefits:

- small dimensions
- fast connection
- short-circuit proof
- matching to any frequency converter
- less additional mounting area
- compact shape
- high-resistance at overload
- vertical and horizontal installation

Type	Resistance R [Ohm]	Continuous output at 25°C and surface overtemperature of . ...../P [W] 200K	220K	max. operating voltage U [V]
BW 154 / 50	10 - 100	50	60	900
BW 154 / 100	3 - 500	100	150	
BW 154 / 150	2,2 -160	120	160	
BW 154 / 200	5 - 200	140	180	
BW 154 / 250	5 - 250	160	200	





Type	B1 [mm]	H1 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	L4 [mm]	D [mm]	Connections
BW 154 / 50	40	21	150	135	120	250	5,5	2 x AWG 14,UL 1659
BW 154 / 100	40	21	170	155	140	250	5,5	2 x AWG 14,UL 1659
BW 154 / 150	40	21	210	195	180	250	5,5	2 x AWG 14,UL 1659
BW 154 / 200	40	21	250	235	220	250	5,5	2 x AWG 14,UL 1659
BW 154 / 250	40	21	290	275	260	250	5,5	2 x AWG 14,UL 1659

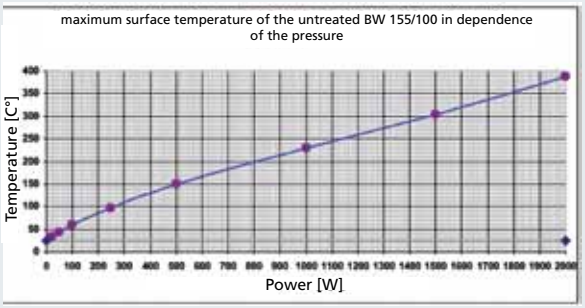
In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

BW 155 series

(max continous output: 3000 W)

Braking resistor for drives with frequency converters of small to medium output, installation close to the frequency converter.

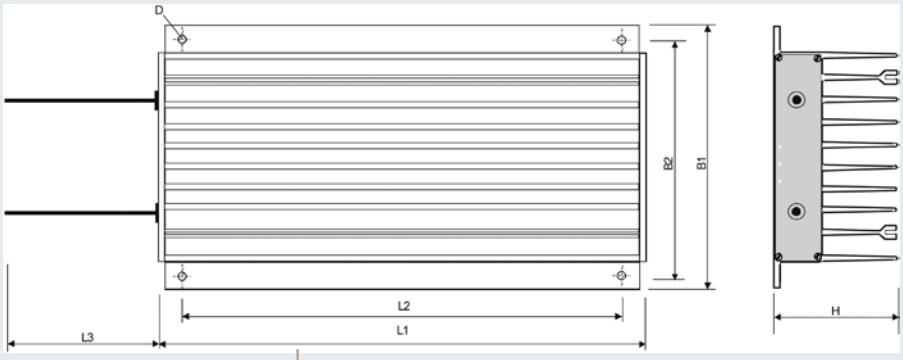
- Protection class: IP20/IP40/IP54/IP64/IP65/IP 66
- Test voltage: 4 kV DC
- Ambient temperature: -10...+40 °C
- other ratings upon request
- other fastening dimensions upon request



Benefits:

- small dimensions
- fast connection
- matching to any frequency converter
- less additional mounting area required
- optionally with cover and temperature switch
- optionally for aggressive environments (e.g. saltwater)
- protection class up to IP 66

Type	Resistance values R [Ohm]	Continuous output P [W]	max. operating voltage U [V]
BW 155 / 1000	1 - 1000	1000	900
BW 155 / 1200	10 - 300	1200	
BW 155 / 1500	0,6 - 280	1500	
BW 155 / 2000	0,5 -1440	2000	
BW 155 / 2500	4 - 600	2500	
BW 155 / 3000	4 - 750	3000	



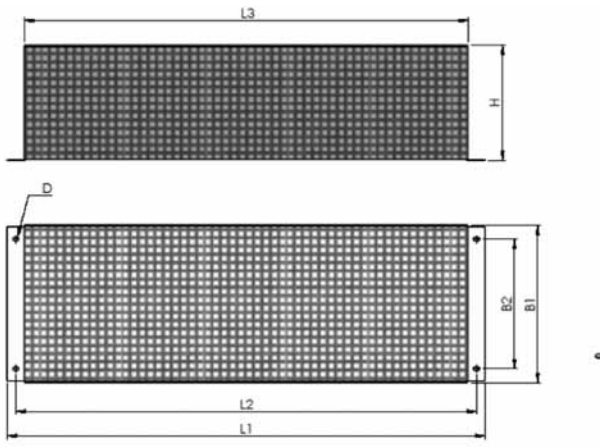
Type	B1 [mm]	B2 [mm]	H [mm]	L1 [mm]	L2 [mm]	L3 [mm]	D [mm]	Connections**
BW 155 / 1000 /...	175	165	75	182	120	250	6,5	IP 40 PTFE AWG14 IP54/64/65 shielded connecting wire 3x1,5mm²
BW 155 / 1200 /...	175	165	75	242	180	250	6,5	
BW 155 / 1500 /...	175	165	75	342	280	250	6,5	
BW 155 / 2000 /...	175	165	75	542	500	250	6,5	
BW 155 / 2500 /...	175	165	75	672	630	250	6,5	IP 40 PTFE AWG12 IP54/64/65 shielded connecting wire 3x2,5mm²
BW 155 / 3000 /...	175	165	75	762	720	250	6,5	

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!
** For small resistance values the conductor cross-section will be adjusted to the current.

Technical data touch protection BW155

Type	Dimensions						
	L1 [mm]	L2 [mm]	L3 [mm]	B1 [mm]	B2 [mm]	H [mm]	D [mm]
BW 155 / 1000 /...	470	440	410	275	225	200	7,0x10,0
BW 155 / 1200 /...	530	500	470	275	225	200	7,0x10,0
BW 155 / 1500 /...	630	600	570	275	225	200	7,0x10,0
BW 155 / 2000 /...	830	800	770	275	225	200	7,0x10,0
BW 155 / 2500 /...	960	930	900	275	225	200	7,0x10,0
BW 155 / 3000 /...	1050	1020	990	275	225	200	7,0x10,0

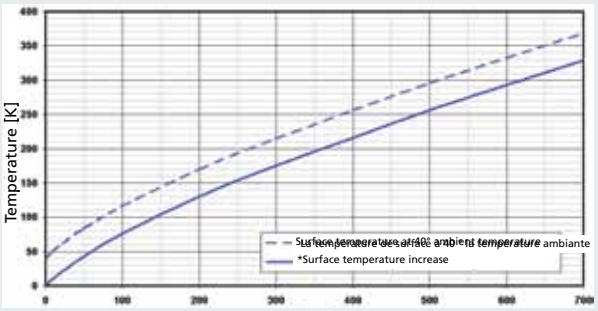
BW 155



BW 156 series

(max continous output: 1500 W)

Braking resistor for drives with frequency converters of small to medium output. Installation in and outside the control cabinet possible.

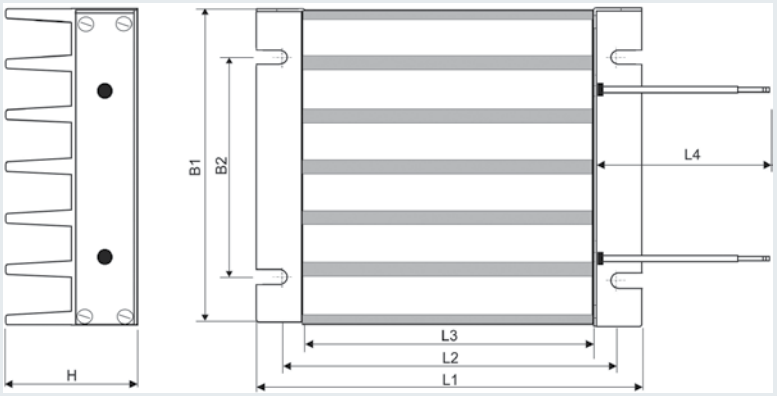


- Protection class IP 20- IP 66
- Test voltage 2,5 kV AC (900V nominal voltage)
- other ratings upon request
- other fastening dimensions upon request

Benefits:

- fast connection
- short-circuit proof
- small dimensions at high output
- very good heat dissipation
- high-resistance at overload
- optionally with contact protection and temperature switch
- optionally for aggressive environements (e.g. salt water)
- installation also possible outside the control cabinet
- compact
- available with UL certification - see overview UL certified products by REO

Type	Resistance values R [Ohm]	Continuous output P [W]	max. operating voltage U [V]
BW 156 / 400 / ...	1 - 1000	400	900
BW 156 / 600 / ...	1 - 250	600	900
BW 156 / 800 /...	3 - 620	800	900
BW 156 / 1000 /...	1 - 500	1000	900
BW 156 / 1200	5 - 400	1200	900
BW 156 / 1500	10 - 300	1500	1000



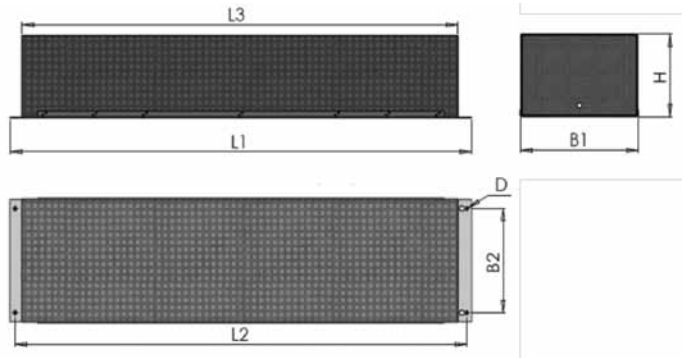
Type	L1 [mm]	L2 [mm]	L3 [mm]	L4 [mm]	B1 [mm]	B2 [mm]	H [mm]	D [mm]	Connections
BW 156 / 400/...	170	155	140	500	104	70	53	4,5	IP 20/40 PTFE AWG14
BW 156 / 600 /...	230	215	200	500	104	70	53	4,5	
BW 156 / 800 /...	300	285	270	500	104	70	53	4,5	
BW 156 / 1000 /...	370	355	340	500	104	70	53	4,5	
BW 156 / 1200 /...	450	435	420	500	104	70	53	4,5	
BW 156 / 1500 /...	600	585	570	500	104	70	53	4,5	
BW 156 / 400/...	174	159	144	500	104	70	53	4,5	IP 54/65 shielded connecting wire 3x1,5mm^2
BW 156 / 600 /...	234	219	204	500	104	70	53	4,5	
BW 156 / 800 /...	304	289	274	500	104	70	53	4,5	
BW 156 / 1000 /...	374	359	344	500	104	70	53	4,5	
BW 156 / 1200 /...	454	439	424	500	104	70	53	4,5	
BW 156 / 1500 /...	604	589	574	500	104	70	53	4,5	

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

Technical data touch protection BW156

Type	Dimensions						
	L1 [mm]	L2 [mm]	L3 [mm]	B1 [mm]	B2 [mm]	H [mm]	D [mm]
BW 156 / 400 /...	300	270	240	200	150	140	7,0x10,0
BW 156 / 600 /...	360	330	300	200	150	140	7,0x10,0
BW 156 / 800 /...	430	400	370	200	150	140	7,0x10,0
BW 156 / 1000 /...	500	470	440	200	150	140	7,0x10,0
BW 156 / 1200 /...	580	550	520	200	150	140	7,0x10,0
BW 156 / 1500 /...	730	700	670	200	150	140	7,0x10,0

BW 156



BW 402 series

(max continous output: 600 W)

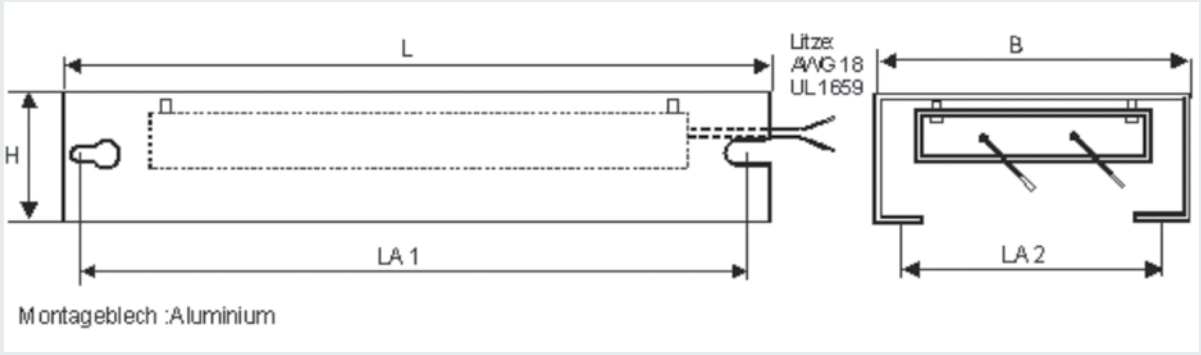
Braking resistor for drives with frequency converters with a smaller output, installation horizontally below the frequency converter, or vertically next to the frequency converter, if desired, with temperature switch.

- Protection class: IP 20
- Test voltage: 4,0 kV DC 1s
- Ambient temperature: -10...+40°C
- other ratings upon request
- other fastening dimensions upon request

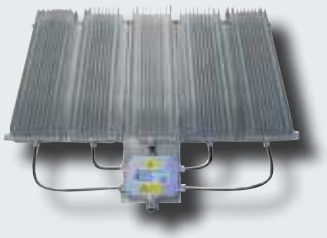
Benefits:

- small dimensions
- fast connection
- galvanised enclosure with mounting plate
- matching to any frequency converter
- additional mounting area not required

Type	Resistance values R [Ohm]	Continuous output P [W]	max. operating voltage U [V]
BW 402 / 100	30 - 2000	100	900
BW 402 / 200	22 - 1200	200	
BW 402 / 300	21 - 1000	300	
BW 402 / 400	20 - 900	400	
BW 402 / 600	18 - 650	600	



Type	L [mm]	B [mm]	H [mm]	LA1 [mm]	LA2 [mm]	Ldm [mm]	Connection
BW 402 / 100	281	121	48	269	100,5	5,5	2 x AWG 18
BW 402 / 200	281	121	48	269	100,5	5,5	
BW 402 / 300	281	121	48	269	100,5	5,5	
BW 402 / 400	281	121	48	269	100,5	5,5	
BW 402 / 600	331	121	48	319	100,5	5,5	



Benefits:

- fast connection
- good heat dissipation
- matching to any frequency converter
- compact, modular construction
- high degree of protection
- assembly-friendly owing to 4-hole fastening
- optionally with cover

Series BW 155 – Combination

(max continous output: 30.000 W)

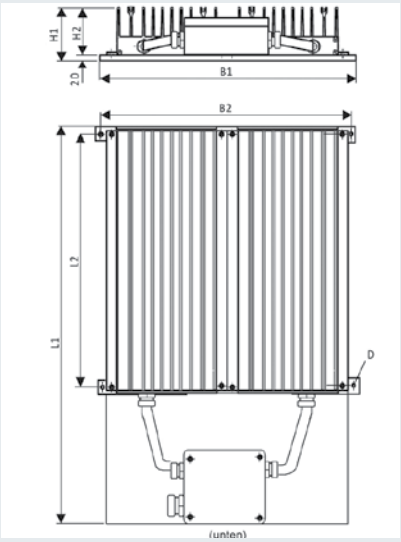
Braking resistor for drives with frequency converters of highoutput, installation close to the frequency converter.

- Protection class: IP 20, IP 54; IP 64; IP 65
- Test voltage: 2,5 kV AC
- Ambient temperature: -10...+40°C
- other ratings upon request
- other fastening dimensions upon request

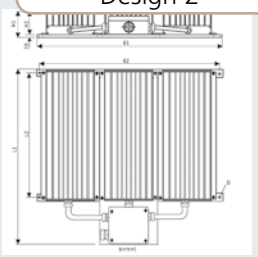
Type	Resis-tance values R [Ohm]	Conti-nuous output P [W]	Type	Resis-tance values R [Ohm]	Conti-nuous output P [W]	max. Voltage U [V]
BW 155 / 4000	10-200	4000	BW 155 / 15000	1,5-700	15.000	900
BW 155 / 5000	6-500	5000	BW 155 / 18000	1,2-630	18.000	
BW 155 / 6000	4-600	6000	BW 155 / 24000	0,9-580	24.000	
BW 155 / 7500	3-600	7500	BW 155 / 27000	0,8-600	27.000	
BW 155 / 9000	2,1-750	9000	BW 155 / 30000	0,8-600	30.000	
BW 155 / 12000	2-740	12.000				

The designs below show the resistors as IP54 / 64/ 65 with a terminal box and cable gland. With IP20 they are provided with terminal and wire (s. next page)

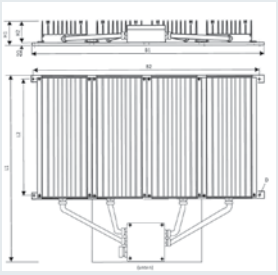
Design 1



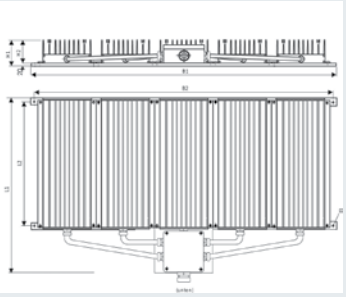
Design 2



Design 3



Design 4



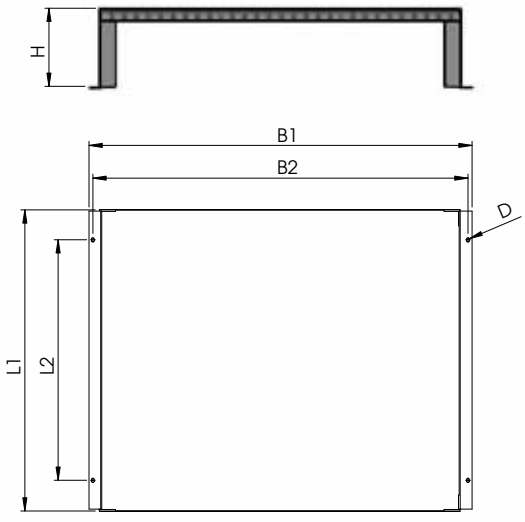
Type	Dimensions							Cable gland	Connection Clamps	Design
	L1 [mm]	L2 [mm]	B1 [mm]	B2 [mm]	H1 [mm]	H2 [mm]	D [mm]		Terminal	
BW 155 / 4000 / ...	750	500	420	390	95	75	8,5	M25	10 mm²	Design 1
BW 155 / 5000 / ...	880	630	420	390	95	75	8,5	M25	10 mm²	Design 1
BW 155 / 6000 / ...	970	720	420	390	95	75	8,5	M25	10 mm²	Design 1
BW 155 / 7500 / ...	880	630	590	560	95	75	8,5	M25	10 mm²	Design 2
BW 155 / 9000 / ...	970	720	590	560	95	75	8,5	M25	10 mm²	Design 2
BW 155 / 12000 / ...	970	720	770	740	95	75	8,5	M32	16 mm²	Design 3
BW 155 / 15000 / ...	970	720	940	910	95	75	8,5	M32	16 mm²	Design 4
BW 155 / 18000 / ...	970	720	2x590	2x560	95	75	8,5	M32	35 mm²	2x Design 2
BW 155 / 24000 / ...	970	720	2x770	2x740	95	75	8,5	M32	35 mm²	2x Design 3
BW 155 / 27000 / ...	970	720	3x590	3x560	95	75	8,5	M32	35 mm²	3x Design 2
BW 155 / 30000 / ...	970	720	2x940	2x910	95	75	8,5	M32	35 mm²	2x Design 4

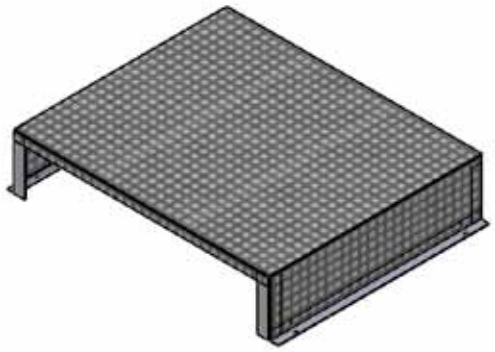
For small resistance values the conductor cross-section will be adjusted to the current.

Technical data touch protection BW155 Combination

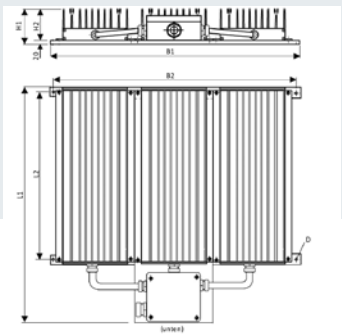
Type	Dimensions						
	L1 [mm]	L2 [mm]	B1 [mm]	B2 [mm]	H [mm]	D [mm]	Quantity
BW 155 / 4000 / …	700	620	520	500	200	7,0x10,0	1
BW 155 / 5000 / …	800	720	520	500	200	7,0x10,0	1
BW 155 / 6000 / …	900	820	520	500	200	7,0x10,0	1
BW 155 / 7500 / …	800	720	690	670	200	7,0x10,0	1
BW 155 / 9000 / …	900	820	690	670	200	7,0x10,0	1
BW 155 / 12000 / …	900	820	870	850	200	7,0x10,0	1
BW 155 / 15000 / …	900	820	1040	1020	200	7,0x10,0	1
BW 155 / 18000 / …	900	820	2 x 690	2 x 670	200	7,0x10,0	2
BW 155 / 24000 / …	900	820	2 x 870	2 x 850	200	7,0x10,0	2
BW 155 / 27000 / …	900	820	3 x 690	3 x 670	200	7,0x10,0	3
BW 155 / 30000 / …	900	820	2 x 1040	2 x 1020	200	7,0x10,0	2

BW 155 Combination

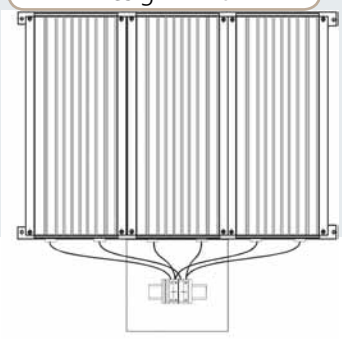




Design IP 54/IP64/IP65



Design IP 20



Overview of liquid-cooled braking resistors

BW D158/BWD 160
Output range: 5.000 - 60.000 W
Protection class: IP 20 - 65
30

NTT RD 158
Output range: 2600 W
Protection class: IP 00 - 65
31

BW D 158 CP
Output range: 2.000 - 10.000 W
Protection class: IP 20 - 65
32

BW D 330
Output range: 15.000 - 60.000 VA
Protection class: IP 20 - 65
33

Facts about liquid cooling

The water cooling (liquid cooling) method is a very efficient option for drawing heat away from a heat source. The heat is transported with the high heat capacity and density of the coolant.
This makes this type of cooling more efficient than traditional air cooling. Very high cooling power densities are possible.

As an example, we will consider a comparison between air cooling and water cooling:

- assumed power loss: 3200 W
- temperature difference to be reached: 5K

Calculation of the coolant volume required:
In order to achieve a cooling of 5K with power dissipation of 3200W, 655 l/s air is required or only 0.1557 l/s water.
This illustrates a significant advantage.

$$Luft: \quad \dot{V} = \frac{Q}{\Delta t * \rho * c_p} = \frac{3200}{5\,K * 1 * 1007} = 0{,}65555 \frac{m^3}{s} = 655\,l/s$$

$$Wasser: \quad \dot{V} = \frac{Q}{\Delta t * \rho * c_p} = \frac{3200}{5\,K * 983 * 4179} = 0{,}0001557 \frac{m^3}{s} = 0{,}1557\,l/s$$

Benefits of liquid cooling

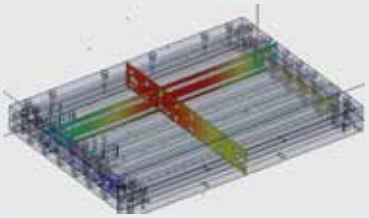
- High efficiency and low audible noise levels
- Reduction of construction sizes up to 80% with resistors
- Effective cooling with high ambient temperatures
- Very low excess surface temperature
- Increase of lifetime with normal operation
- Constant, high performance, as temperature is directly dissipated
- Only cooling type during which the temperature may fall below the ambient temperature
- Very well suited for industrial applications in which components with low surface temperatures are required (wood and textile industries or in explosion-protected environments, wind turbines)

Design of liquid-cooled components

To develop liquid-cooled components, simulation plays a decisive role - with the help of various simulation techniques, cooling and coolant flow can be tested and optimized early during development and construction.
This prevents later problems during construction or with the client.

Possibilities of simulation with REO:

- Simulation of gas and fluid flows
- Calculation of pressure, radiation, solid state temperature, fluid temperature, velocity, and density
- Thermal effect on the environment



Using simulation procedures, the thermal effect on the environment can be reviewed among other things.

There are many cooling channel options

Generally, connections made of brass-plated nickel or stainless steel. What is important here is a discussion concerning the materials for the cooling channels. All hoses, seals, and components have a sufficient temperature resistance of > 100 °C.

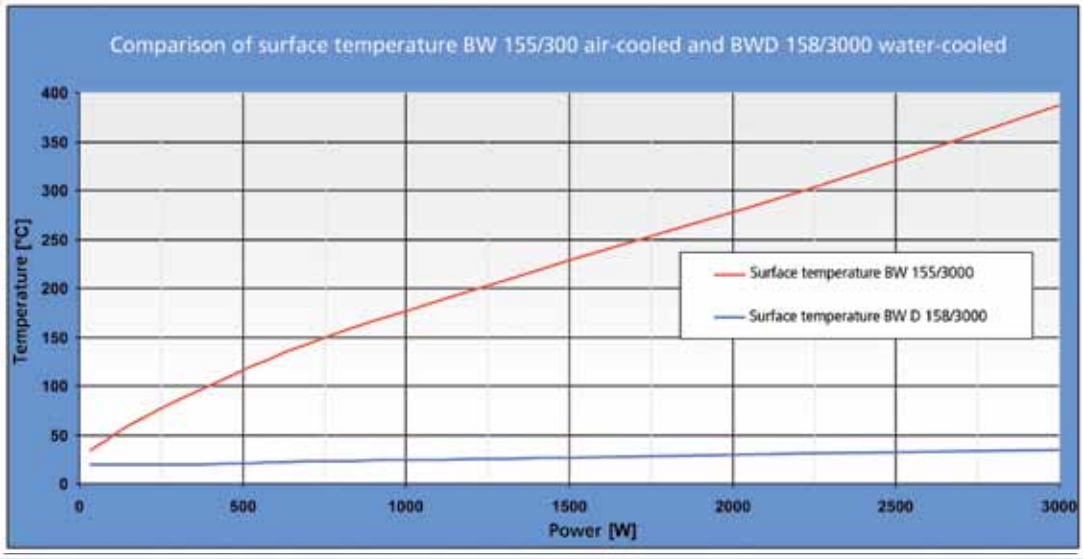
The performance data in the data sheets are valid under the following conditions:

Maximum ambient temperature:	40°C
Max. inlet coolant temperature:	25°C
Max. coolant discharge temperature:	45°C
Operating pressure:	4 bar
Test pressure:	6 bar

Facts about liquid cooling

Liquid-cooled REOHM-Braking resistors

Available with power levels from 1 to 100 kW. Cooling channels fixed into the heat sink enable efficient cooling and the spatial separation of the electricity- and liquid-carrying lines - enabling safe application. In addition to the general advantages of the REOHM braking resistors, such as modular construction for higher power levels or the compact design, the braking resistors have an optimal structure and power consumption, enabling them to withstand vibration and shock tests. REOHM braking resistors are an optimized combination of proven and innovative techniques. So for applications which have demanding requirements, water cooling is a viable option.



The diagram illustrates the efficiency of water cooling using a measurement carried out on an air-cooled and a water-cooled REOHM braking resistor. If the air-cooled resistor with a power level of 3000 W has a surface temperature of 387°C, the surface temperature for a water-cooled resistor is 35°C at the same power level.

Series BW D 158 / BW D 160

(max continous output: 60.000 W)

for use as braking or load resistor for drive technology, industrial applications, test beds and railway engineering with integrated water cooling. Thanks to localised, optimised cooling, high outputs can be generated in the smallest space with low heat generation. It is also possible to deploy it in areas with high ambient temperatures.

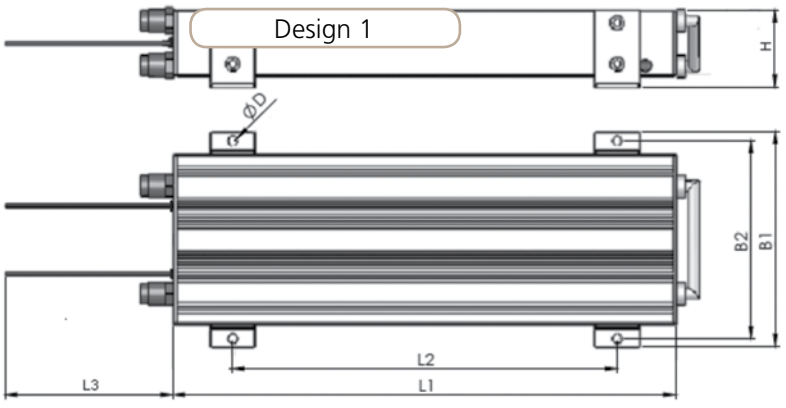
- Protection class: IP 20 to IP 65
- Test voltage: 2.5kV AC
- Enclosure overtemperature max.: 50k
- Ambient temperature: -15 to +40°C
- Other fastening dimensions and ratings upon request

Benefits:

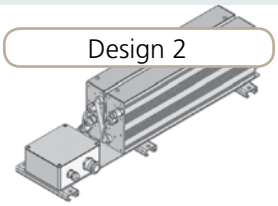
- very compact construction
- high protection class up to IP65
- use also possible at higher ambient temperatures
- optimised cooling for high ratings
- very low enclosure overtemperature
- suitable for standard cooling fluids (water/glycol)
- operating pressure of the cooling circuit up to 4bar (test pressure 10bar)
- also as BW D 160 with cooling channels of Cu or Cu-Ni alloy (then, even salt water can be used as coolant)

Type	Resistance values R [Ohm]	Continuous output P [W]	max. operating voltage U [V]
BW D 158 /3000 / ...	10 - 200	3.000	1000
BW D 158 /5000 / ...	10 - 200	5.000	
BW D 158 /6000 / ...	10 - 200	6.000	
BW D 158 /10000 / ...	6 - 500	10.000	
BW D 158 /15000 / ...	4 - 600	15.000	
BW D 158 /20000 / ...	3 - 600	20.000	
BW D 158 /30000 / ...	2,1 - 750	30.000	
BW D 158 /45000 / ...	2,1 - 800	45.000	
BW D 158 /60000 / ...	2 - 850	60.000	

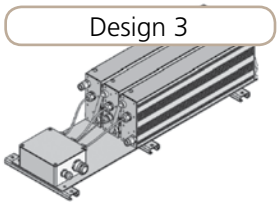
Design 1



Design 2



Design 3



Combinations protection class IP65

Type	Dimensions						Connections		Design
	L1 [mm]	L2 [mm]	L3 [mm]	B1 [mm]	B2 [mm]	H [mm]	Cable gland	Clamps	
BW D 158 / 3000 /...	320	213	500	190	175	68	M20	6 mm²	Design1
BW D 158 / 5000 /...	450	343	500	190	175	68	M20	6 mm²	Design1
BW D 158 / 6000 /...	550	443	500	190	175	68	M20	6 mm²	Design1
BW D 158 / 10000 /...	680	343	265	176	156	170	M25	10 mm²	Design2
BW D 158 / 15000 /...	680	343	265	245	225	170	M32	10 mm²	Design3
BW D 158 / 20000 /...	680	343	265	2x176	2x156	170	M32	10 mm²	2 x Design2
BW D 158 / 30000 /...	680	343	265	2x245	2x225	170	M32	10 mm²	2 x Design3
BW D158 / 45000 /...	680	343	265	3x245	3x225	170	M32	16 mm²	3 x Design3
BW D158 / 60000 /...	680	343	265	4x245	4x225	170	M32	16 mm²	4 x Design3

Benefits:

- higher mechanical protection
- low-noise
- high functional safety and service life
- protection class IP00 to IP65
- wires are spatially separated thanks to a special winding technology, i.e. higher dielectric strength
- the resistor can absorb higher pulse loads and store them temporarily
- low susceptibility to vibrations and oscillations
- many years of experience in the railway field with profile filters

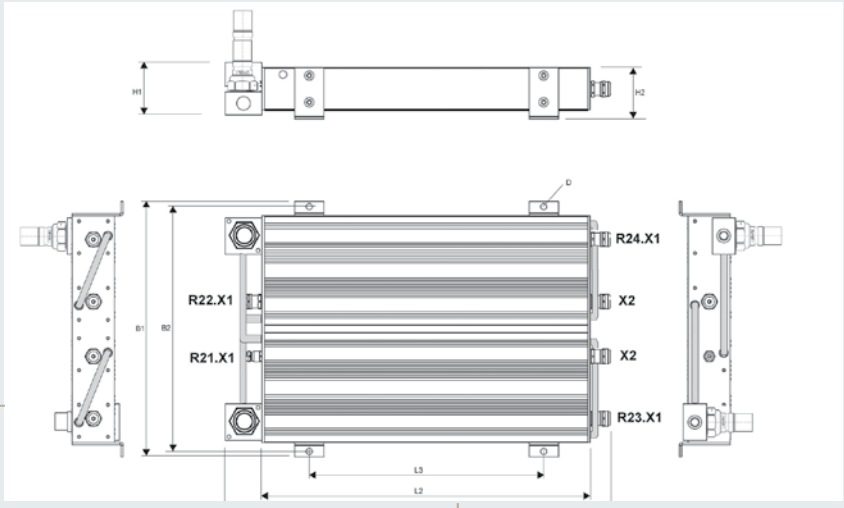
Series NTT RD 158

(max rated output: 1210 W)

Water-cooled load resistor for high pulse energies.The advantage of the resistance unit NTT R D158 is that 4 damping resistors are housed in one unit. This means a compact construction and low cost when connecting the resistor.

- Continuous output: 2600 W
- max. operating voltage: 4200V
- resistance value: 0,1 -1 Ohm
- average pulse load: 1x per hour 20kWs - within 100ms
- Maximum pulse load: 20x per year 120kWs -within 20ms
- Protection class: IP00-IP65
- other ratings upon request

Type	Resistance values R [Ohm]	Rated current I [A]	Rated power P [W]	max. operating voltage U [V]
NTT RD 158 / 2600	0,1- 1,0	2-110	2600	4200
Values of the single resistors				
NTT R D 158 R1	1,0	2	100	4200
NTT R D 158 R2	0,1	70	490	
NTT R D 158 R3	0,5	40	800	
NTT R D 158 R4	0,1	110	1210	



Type	L1 [mm]	L2 [mm]	L3 [mm]	B1 [mm]	B2 [mm]	B3 [mm]	H1 [mm]	H2 [mm]	H3 [mm]	D [mm]
NTT RD 158 / 2600	556	453	343	350	335	255	136	97	70	8,5

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

BW D 158 CP series

(max continous output: 10.000 W)

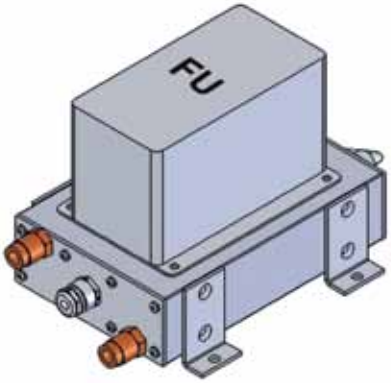
Substructure resistor for cold plate inverters in drive technology, industrial applications, test beds and railway engineering with water cooling. Components such as inverters can be directly fastened on the resistor and be cooled in conjunction with the resistor.

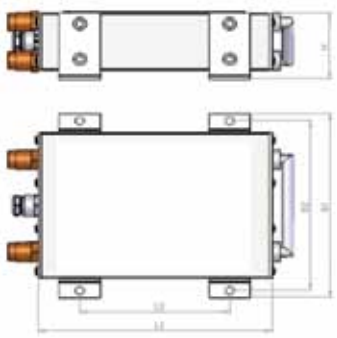
- Protection class: IP 20 to IP 65
- Test voltage: 2.5kV AC
- Enclosure overtemperature max.: 20k
- Ambient temperature: -15 to +80°C
- Other ratings and fastening dimensions available on request

Benefits:

- very compact construction
- high protection class up to IP65
- optimised cooling for high ratings
- very low enclosure overtemperature (20K)
- suitable for standard cooling fluids (water / glycol)
- operating pressure of the cooling circuit up to 4bar (test pressure 10bar)
- customer-specific fastening points

Type	Resistance values R [Ohm]	Continuous output P [W]	max. operating voltage U [V]
BW D 158 / 2000 /... CP	2 – 800	2.000	1.000
BW D 158 / 3000 /...CP	1 – 600	3.000	
BW D 158 / 5000 /...CP	1 – 600	5.000	
BW D 158 / 10000 /...CP	1 – 600	10.000	





Type	Dimensions					Connection		Design
	L1 [mm]	L2 [mm]	B1 [mm]	B2 [mm]	H [mm]	Cable gland	Clamps	
BW D 158 / 2000 / ...CP	232	113	190	175	68	M20	6 mm²	BF1
BW D 158 / 3000 / ...CP	272	163	190	175	68	M20	6 mm²	BF1
BW D 158 / 5000 / ...CP	462	343	190	175	68	M20	10 mm²	BF1
BW D 158 / 10000 / ...CP	462	343	340	325	68	M20	10 mm²	BF2

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
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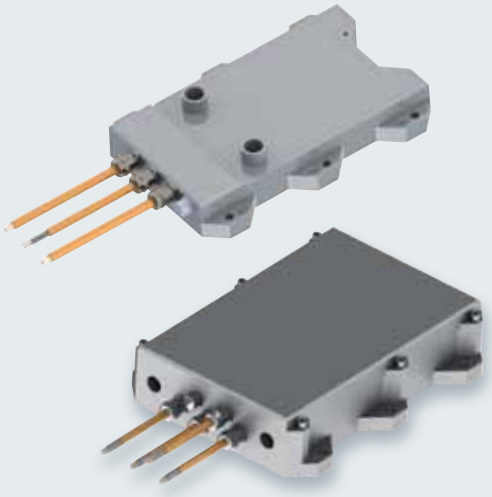


BW D 330 series

(max continous output: 70.000 W)

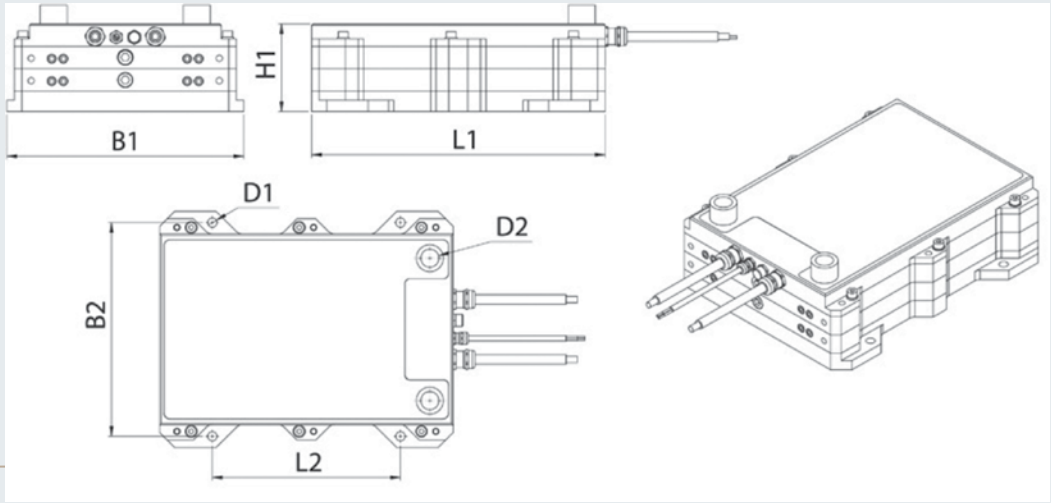
The REO braking resistor converts excess braking energy into useful heat and is thus ideally suitable for electrical or hybrid drives. The water cooling makes an additional space saving of up to 88% possible as compared to a traditional air-cooled braking resistor. As an extra feature, the resistor can easily be connected with drip-free quick fasteners.

- 88% space saving
- drip-free quick fasteners
- water cooling
- electronic controller

Benefits:

- 88% space saving
- Non-drip quick-release connectors
- Water-cooled
- Optional with electronic control (chopper)
- Low weight
- Low surface temperature

Type	Resistance values [Ohm]	Continuous output [W]	Operating voltage [V]
BW D 330 / 15.000	1 - 100	15000	800
BW D 330 / 30.000		30000	
BW D 330 / 45.000		45000	
BW D 330 / 60.000		60000	



Type	L1 [mm]	L2 [mm]	B1 [mm]	B2 [mm]	D1∅ [mm]	D2 ∅ [mm]	H1 [mm]
BW D 330 / 15.000	390	250	315	285	12,5	G3/4	57
BW D 330 / 30.000	390	250	315	285	12,5	G3/4	87
BW D 330 / 45.000	390	250	315	285	12,5	G3/4	117
BW D 330 / 60.000	390	250	315	285	12,5	G3/4	147

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

Overview Register resistors

BW 601 / 602
Output range: 1.500 - 30.000 W
Protection class: IP 20 - 22
35

BW 605
Output range: 3.000 - 7.500 W
Protection class: IP 20
36

Benefits:

- high loading capacity
- simple assembly
- very high short-term load withstanding ability
- increased output through forced cooling
- good corrosion resistance

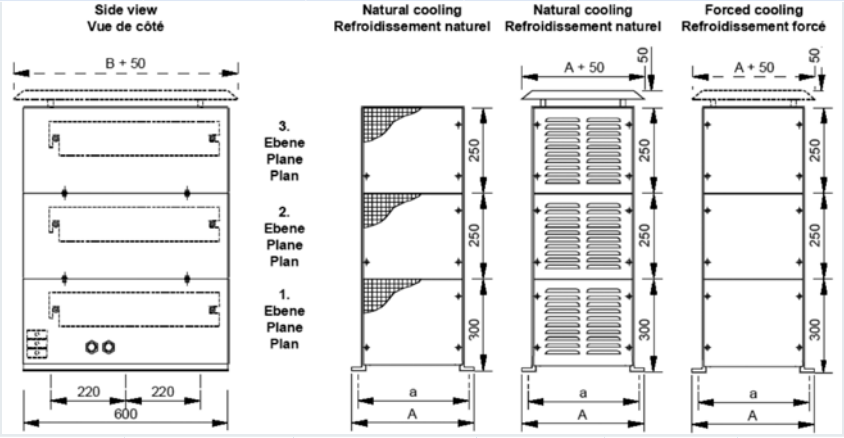
Series BW 601 / BW 602

(max continous output: 30.000 W)

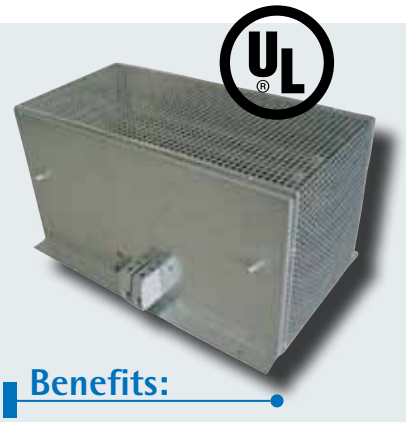
Register resistor for drives with frequency converters

- Protection class: IP 20 to IP 22
- Test voltage: 3.5 kV
- Max. temp.: 300°C
- Ambient temperature: -10 to +40°C
- Resistance values according to E6
- Other ratings upon request
- Optional: Connecting wires, low-induction winding

Natural cooling		Forced cooling			
Type	Continuous output [W]	Type	Continuous output [W]	Resistance values R [Ohm]	max. operating voltage U [V]
BW 601/1/R	1000	BW 602/1,5/R	1500	1,6 - 660	1000
BW 601/2/R	2000	BW 602/3/R	3000	0,8 - 330	
BW 601/3/R	3000	BW 602/4,5/R	4500	0,6 - 220	
BW 601/4/R	4000	BW 602/6/R	6000	0,4 - 160	
BW 601/5/R	5000	BW 602/7,5/R	7500	0,33 - 130	
BW 601/7,5/R	7500	BW 602/11/R	11000	0,23 - 90	
BW 601/10/R	10000	BW 602/15/R	15000	0,17 - 65	
BW 601/12,5/R	12500	BW 602/19/R	19000	0,13 - 50	
BW 601/15/R	15000	BW 602/22,5/R	22500	0,11 - 44	
BW 601/17,5/R	17500	BW 602/26/R	26000	0,1 - 38	
BW 601/20/ R	20000	BW 602/30/R	30000	0,09 - 33	



Type				Dimensions		
Natural cooling	Forced cooling	Number of registers	Number of levels	A [mm]	a [mm]	Total height
BW 601/1/R	BW 602/1,5/R	1	1	270	240	300
BW 601/2/R	BW 602/3/R	2				
BW 601/3/R	BW 602/4,5/R	3		370	340	
BW 601/4/R	BW 602/6/R	4				
BW 601/5/R	BW 602/7,5/R	6		470	440	
BW 601/7,5/R	BW 602/11/R	8		570	540	
BW 601/10/R	BW 602/15/R	12	2	470	440	550
BW 601/12,5/R	BW 602/19/R	15		570	540	
BW 601/15/R	BW 602/22,5/R	18	3	470	440	800
BW 601/17,5/R	BW 602/26/R	21		570	540	
BW 601/20/R	BW 602/30/R	24				



Benefits:

- compact shape
- high loading capacity
- very high short-term load cability
- increased output through forced cooling
- good corrosion resistance
- simple assembly

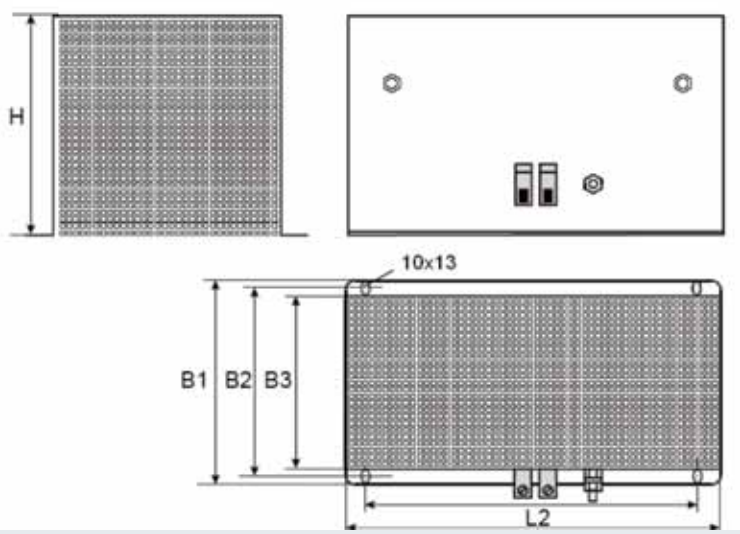
BW 605 series

(max continous output: 7500 W)

Multi-drive technology for large inverters

- Protection class: IP 20 bis IP 22
- Test voltage: 3,5 kV
- max. Temp.: 300°C
- Climatic category: DIN IEC 60068-1
- Resistance values according to E6
- Other ratings upon request
- Connecting wires, low-induction winding

Type	Continuous output [W]	Resistance values R [Ohm]	Continuous output
BW 605/3	3000	3,8 - 330	1000
BW 605/4	4000	1,8 - 250	
BW 605/5,5	5500	1,2 - 181	
BW 605/7,5	7500	0,9 - 130	



Type	B1 [mm]	B2 [mm]	B3 [mm]	H [mm]	L1 [mm]	L2 [mm]	Cable gland [mm²]
BW 605/3	295	270	240	260	490	380	50
BW 605/4	395	370	340	260	490	380	50
BW 605/5,5	395	370	340	260	490	380	50
BW 605/7,5	595	570	540	260	490	380	95

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

Damping and charging resistors

The **REOhm NTT R 150** resistors are used for example in railway engineering, electric vehicles or commercial vehicles as charging or damping resistors (even as braking resistors up to 100 kw power).
They are used to damp over-voltages or to dissipate excess energy that originates, for example, on braking or starting up. This is done by converting the electrical energy into heat in the resistor.
Moreover, the resistor is very well protected against mechanical loads. This ensures a long-term functional reliability.

Only railways-approved, high-quality raw materials are used for the **REOhm NTT R 150** series. The connecting leads and all the other components are specially designed for the railway application. Only materials with railway approval are used.

Charging resistors of the **REOhm series R 150 series** are used for example in the renewable energy sector, in industrial converters or in scientific research.

Advantages:

- air- and water-cooled resistors
- high functional reliability and service life
- classes of protection from IP00 to IP65
- wires are spatially separated thanks to a special winding technology, i.e. higher dielectric strength
- higher mechanical protection
- resistors can absorb higher pulse loads and store them temporarily
- resistors are not sensitive to moisture and fouling
- low susceptibility to vibrations and oscillations
- low-noise
- many years of experience in the railway field with profile filters

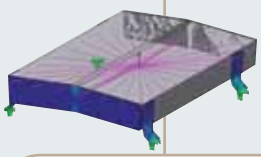
Application

The REOhm NTT 150 resistors are used as charging or damping (even as braking resistors up to 100 kw power). They are used to damp over-voltages or to dissipate excess energy that originates, for example, on braking or starting up. Typical areas of application for the NTT BW 150 series are the use as a resistor for charging the intermediate circuit capacitance, as a braking or load resistor. Another application is as a short-circuiting resistor in traction inverters or as a damping resistor in filter circuits. All applications involve the elimination of very high energies over a short period. To do so, the resistor must be able to absorb higher pulse loads and store them temporarily and have a high dielectric strength.

Service life

The design is normally based on a technical service life of > 30 years or 200,000 operating hours.

Development

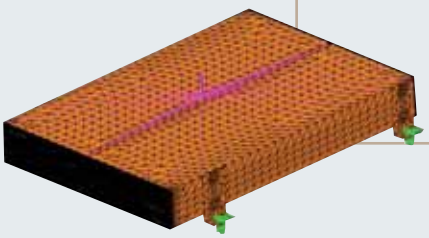


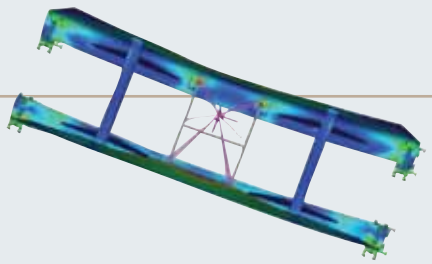
Simulation

Before the production starts, physical factors influencing the component are simulated using the FEM analysis, based on 3D CAD model designed using SolidWorks. This enables the following calculations to be made:

- static and dynamic linear and nonlinear stress analysis
- frequency analysis
- analysis of lifetime
- design calculation of screw strength
- welding seam calculation

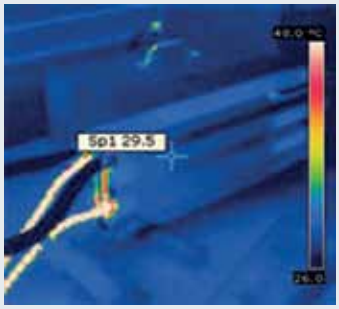
Every produt development is a continuos cycle for REO





Railway Resistors – from development to the finished product

Result



Tests

For use in railway traction applications, the functional capability and the durability under normal railway conditions has to be proven. For this purpose, the following type tests were carried out for the REOhm NTT R D 158 series:

Stresses

- Testing according to BN 411 002 (DIN EN 50155 point 10.2)

Test sequence consisting of:

Climatic testing

Testing Db: moist heat, cyclical (12 + 12 hours cycle) Variant 1 according to DIN EN 60068-2-30
(DIN EN 50155 Point 10.2.5)

Mechanical testing

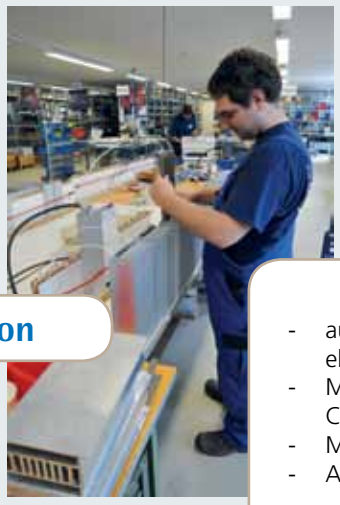
- Tests for vibrations and shocks according to DIN EN 61373 Category 1 Class B
- Testing with undefined assembly position under the most stringent conditions in every axis.
- Simulated service life test through increased broadband noise (Point 9 DIN EN 61373)
- Shock test (point 10 DIN EN 61373)

Corrosion test_

Testing Ka: salt spray according to DIN EN 60068-2-11 (DIN EN 50155 point 10.2.10)

Moreover the type test also includes:

- heating-up measurement
- high-voltage test
- insulation measurement (DIN EN 50155 point 10.2.9)
- measurement of the resistance value
- visual inspection (DIN EN 50155 point 10.2.1)



Production

- automatic winding of resistance elements for different ohmic values
- Mechanical manufacturing with CNC work station
- Metalworking shop
- Automated filling process

Applicable standards

DIN IEC 68 Part 1 und 2 - 6	Environmental testing
IEC 60322 (DIN EN 60322)	Railway applications: -Electric equipment for rolling stock– Rules for power resistors of open construction IEC 61373:1999 Railway applications – Rolling stock equipment – Shock and vibration tests
IEC 61373	Railway applications – Rolling stock equipment – Shock and vibration tests
DIN EN 61373	Railway applications: -Rolling stock equipment - Shock and vibration tests
DIN WDE 0160 und VDE 0535	Electronic equipment for use in power installations
DIN EN 50124	Railway applications – Insulation coordination – Part 1: Basic requirements; Clearances and creepage distances for all electrical and electronic equipment
DIN EN 50125-1	Railway applications - Environmental conditions for equipment – Part 1: Equipment on board rolling stock
DIN EN 50155 BN411002	Railway applications - Electronic equipment used on rolling stock
DIN EN 60068	Environmental testing– Part 2: Tests – Test group A: Coldness
DIN EN 60068	Environmental testing– Part 2: Tests – Test group B: Dry heat
DIN EN 60068	Environmental testing– Part 2: Tests – Testing Ka: Salt spray
DIN EN 60068	Environmental testing– Part 2: Tests – Testing Db: Moist heat, cyclical
DIN EN 60529	Degrees of protection provided by enclosures (IP code)
DIN EN 61140	Protection against electrical shocks
EN 60721-3-5	Classification of environmental conditions – Classification of groups of environmental parameters and their severities. – Ground vehicle installations

Damping and charging resistors, railway

In railway engineering above all others there are requirements for special customized solutions depending on the application. Below are some of the examples and series for railway technology - please contact us for your customized solution!

REOhm NTT R 153 series

Continuous output: 100W
Pulse loading: 34A
Rated voltage: 1000V
Energy storing capacity: 12000Ws
Protection class: IP40
Dimensions lxwxh: 170x25x103mm
Weight: 0.85kg

The application is traction in railway engineering. The resistor is used for pre-charging of the filter capacitor and experiences pulse loads. In doing so, the capacitor is subjected to two-pole charging as in the given circuit. Installation location is the traction container.

REOhm NTT RD - 158 series

Continuous output: 5000W
max. operating voltage: 4200V
Resistance value: 1Ohm
average pulse load: 1x per hour 20kWs within 100ms
Maximum pulse load: 20x per year 120kWs within 20ms
Protection class: IP20-IP6
Other ratings upon request

REOhm damping resistor NTT R 159

Continuous output: 1600W
Rated voltage: up to 4000V
average pulse load:
3x pre-charging processes each 40 kW immediately in 5 s successively possible
Protection class: IP20 – IP65

Air-cooled damping resistor in series with a filter capacitor in a frequency converter.

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

Resistors for aggressive environments

Charging, damping, absorption (dump resistor) or braking resistors are indispensable components of a modern wind power plant. They are used to filter out over-voltages or to dissipate excess energy, when braking or starting up for example. This is done by converting the electrical energy into heat in the resistor. Resistors in profile design are fully encapsulated in their structure and make very high classes of protection up to IP65 possible. Owing to the construction, external environmental influences have only a very small effect on REO resistors.

The resistors are very well protected against mechanical loads.

This ensures long-term functional reliability and safety. Thanks to the construction, it is possible to operate them in applications where there are high voltage or current peaks, for example pre-charging resistors.

Advantages:

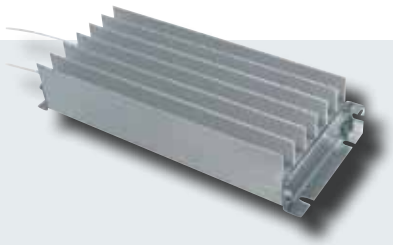
- air- and water-cooled resistors
- high functional reliability and service life
- classes of protection from IP00 to IP65
- wires are wound with spacing and spatially separated, i.e. higher dielectric strength
- higher mechanical protection
- resistors can absorb higher pulse loads and store them temporarily
- resistors are not sensitive to moisture and fouling
- low susceptibility to vibrations and oscillations
- low-noise

Applications

Profile resistors of REOHM Series BW 150 are particularly suitable for aggressive environments, such as in outdoor applications of navigation or in railway technology.

Another major application is the wind power technology - the profile resistors of the REOhm BW 150 series can be used as braking resistors for Azimuth drives (tracker device) or for pitch systems (wing adjustment).
Typical resistors here are the BW 156/ 400 - 1500W series, the BW 155/ 1 – 30 kW series and the water-cooled BW D 158/ 3 - 60 kW series.
These components can be directly mounted on the outside wind turbine and are protected from external environmental influences.

Resistors for aggressive environments



REOhm BW 156 series

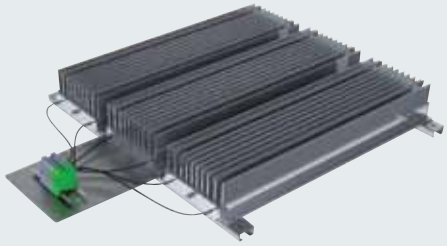
Output range: 400 - 1500W continuous output
Rated voltage: 1000V
Switching time: 5 - 100%
Protection class: IP20 - IP65

Braking resistor of low rating for use in pitch systems and azimuth drives.

REOhm BW 155 series

Output range: 1000 - 3000W continuous output
Rated voltage: 1000V
Switching time: 5 - 100%
Protection class: IP20 - IP65

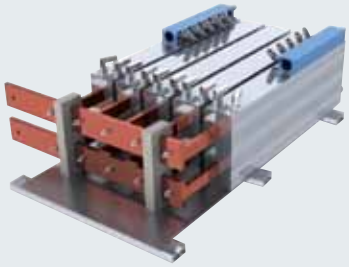
Braking resistor of low to medium rating for use in pitch systems and azimuth drives.



REOhm series combination BW 155

Output range: 4000 - 30000W continuous output
Rated voltage: 1000V
Switching time: 5 - 100%
Protection class: IP20 - IP65

Braking resistor of medium output for use in pitch systems and azimuth drives or as a braking resistor for wind power plants.

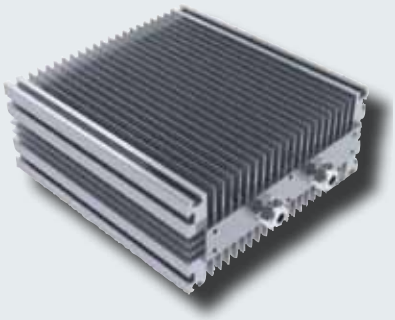


Water-cooled REOhm BW D 158 series

Output range: 3000 - 60000 W continuous output
Rated voltage: 1000V
Switching time: 5 - 100%
Protection class: IP20 - IP65

Water-cooled braking resistor of medium output for use in pitch systems and azimuth drives or as a braking resistor for wind power plants .

Another possible application is the use as a charging resistor, damping resistor or as an absorption resistor (dump resistor). What is involved here is to eliminate very high energies for a short period. For this purpose, the resistor must be able to absorb higher pulse loads and store them temporarily and guarantee a high dielectric strength.



REOhm damping resistor R 159

Output range: 1600 W
Rated voltage: up to 4000 V

Average pulse load:
3x precharge operations each in 40 kWs in 5 seconds
sequentially possible
Protection class: IP20 – IP65

Air cooled damping resistor in series with a filter capacitor in a frequency converter.

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
We are happy to provide customized solutions apart from our standard portfolio - please contact us!

Resistors for aggressive environments

Watercooled REOhm Loading resistor R D 158

Continuous power: 5000 W
Rated voltage: up to 4200 V
Resistance value: 1 Ohm

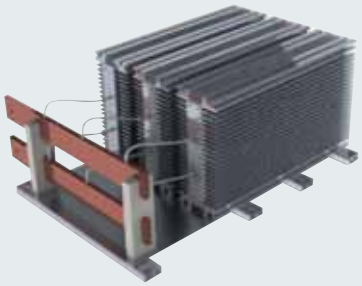
Average pulse load:
1x per hour 20kWs in 100ms

Maximum pulse load:
20x per year 120kWs in 20ms

Protection class: IP20 – IP65

Water-cooled charge-resistance for high pulse energies.

REOhm Dump Resistor R 159



Continuous power: 15000 W
Rated voltage: 1200 V
Impulse load: 750 kW für 2,4 s

Protection class: IP20 – IP65

Air-cooled dump resistor to absorb high
Energies within a short time.

These resistors represent a selection of products. The design is generated according to customer-specific data.

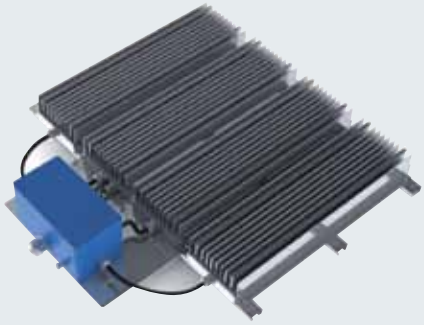
Products for offshore applications

Offshore applications are becoming increasingly important.
In this application the resistors of the material must be specially designed for environment.

For the corresponding REOHM profile resistors, only very high quality materials are used and special production technologies are employed. Protection class tests and salt spray tests were employed to ensure suitability for the application.

Braking resistor BW 155/9000/IP65

Tested for aggressive environments



Continuous output: 9000W
Rated voltage: 1000V
Switching time: 5 - 100%
Protection class: IP65

Braking resistor for use in offshore environments with increased salt-spray resistance and protection class IP.

In the event of a sustained overload, the resistor becomes high-impedance, and therefore, every series can be supplied with a temperature switch, ensuring application safety. The given output values were recorded with a horizontal position of the resistors in the air at a distance of min. 100mm to the substrate.
Performance values refer to the standard products with a standard tolerance of + / - 10% with an ambient temperature of 20 ° C.
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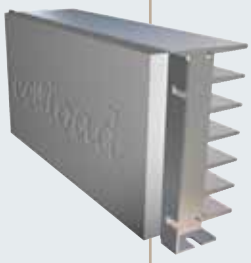
Special solutions

Standard solutions

BWD 158



Due to close cooperation with our customers – whether in the automotive, railway or industrial sector – REO can develop customized solutions, based around our experience and develop-ments in the wider market. This ensures an effective and competitive solution.

NTT BW 158 (Power: 10000 W)

Water-cooled braking resistor combination, used in rolling stock „Coaster".

Electrical data:	
Duty cycle:	100%
Rated current:	I 70 A
Power:	P 10 kW
Pulse voltage:	U 800 V
Resistance:	R 2,2 Ohm
Protection class:	IP 65
Connections:	Cable 25 mm²

BW 159 (ecoload) series (Output: min. 2,000 max. 7,000)

The ecoload resistor can be used as a braking or charging resistor for small wind power plants, in automobile engineering, for alter-native energy generation or for frequency converters.

Electrical data BW 159/2000
Resistance R :10-250 Ohm
Continuous power: 2000 W
Max. pulse load P max [W] at 10%ED : 13000 W
Max. operating voltage : 900 V

BW D 330/40000/4- TS (Power: 40000 W)

Water-cooled resistor with electronic chopper for the use of an electrically driven tractor

Electrical data		
Min. Duty cycle:		10%
Rated power at 100% duty cycle:		PN 40 kW
Rated current at PN:		IN 100 A
Pmax:		180 kW
Current at Pmax:		Imax 212 A
Pulse voltage:		U 850 V
Resistance:	R 4,0 Ohm	
Protection class:		IP 65
Connections:		Litze 16 mm2

Our team Kyritz

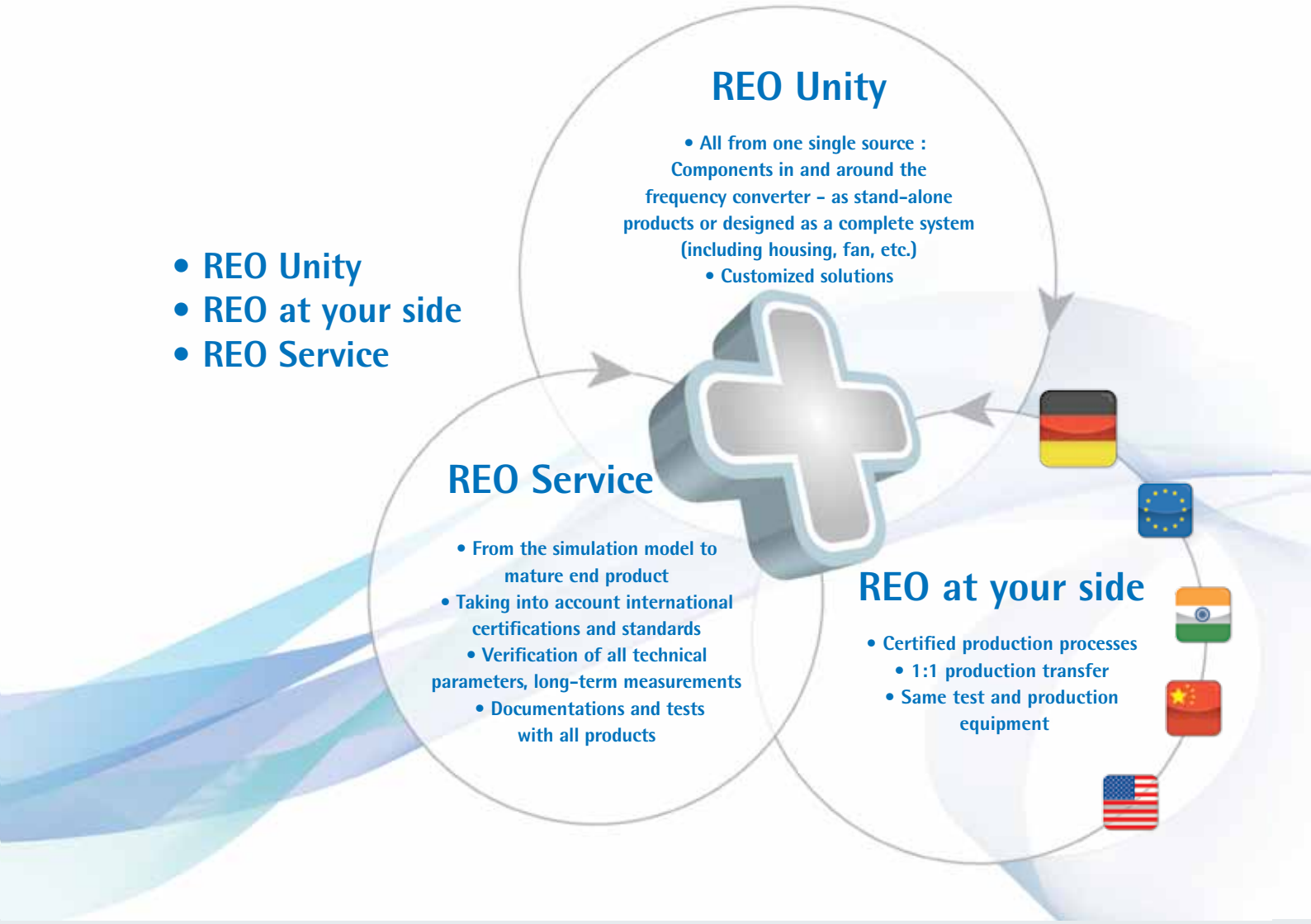
In REO's subsidary in Kyritz we produce resistors for 20 years.
With automatic winding of resistance wires for different ohmic values, CNC machining center or a engineering department we have the capabilties to satisfy every customer.
For the development of resistors there is an experienced team of developers and engineers.
A typical development cycle utilises FEM technologies, SolidWorks and thermal imaging camera etc. This ensures that even at the prototype stage the performance of a product can be optimised to ensure the most efficient solution for the application.

RESISTORS
ARE OUR BUSINESS

Since 80 years the partner on your side

Worldwide presence

- REO Unity
- REO at your side
- REO Service



Worldwide Sales Network

With a worldwide sales network and comprehensive product portfolio, REO can react rapidly to your wishes anywhere in the world - no matter what language you speak. Besides our wide selection of standard products, we can of course offer you tailor-made solutions, developed specially to meet your wishes. Our production facilities in China, India and the USA are equipped in exactly the same way as those in Germany, and designed to provide the same product at the same quality.
Using the same software and with with development and design in Germany we ensure that REO products are always up to the latest state of the art.

Wherever you are, even after the 1000th production run, a REO product always has the same quality.

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