REO Braking- and charging resistors
REOHM – Resistors are our business
Introduction 3

Compact Braking Resistors 16

Compact braking resistor combination 25
By combining individual resistors, ratings of up to 30,000 W can be achieved.

Liquid-cooled braking resistors 27
Resistors with ratings up to 100 kW with direct liquid cooling or as a cold-plate version.

Register braking resistors 34
For drives with frequency converters or for railway engineering with ratings up to 20,000 W.

Charging and damping resistors 37
Charging and damping resistors (air- or water-cooled), versions for railway engineering.

Resistors for aggressive environments 42
Charging, damping, absorption and braking resistors for use e.g. in wind power engineering.

Special solutions 45
Special models, such as ecological braking resistors
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

Applications:

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

* for a definition of Charging-/Braking resistors, see page 5.
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 subsidiary 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.
Facts about REOhm-Resistors

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 P_max.

\[ R_{BR} = \frac{U_{DC}^2}{P_{max}} \]

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 (P_max). 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
P_max, 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, P_max, is smaller than P_max, 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, $E_{\text{kin}}$, is known, the continuous output can be directly determined with the magnitude of the energies and the cycle time.

$$P = \frac{E_{\text{kin}}}{SD}$$

$P$ = continuous output  
$E_{\text{kin}}$ = kinetic energy  
$SD$ = cycle time

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

$$ED(\%) = \frac{ED(s)}{SD(s)} \times 100$$

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

$$P = P_{\text{max}} \times 10\%$$

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

$$P = P_{\text{max}} \times 50\%$$

The continuous output ($P$) is also smaller than the maximum pulse output ($P_{\text{max}}$) 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.
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

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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.
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.
# 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

<table>
<thead>
<tr>
<th><strong>Conformity</strong></th>
<th>Conformity with the CE Low voltage directive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vibration resistance</strong></td>
<td>acceleration-resistant up to 0.7 g; EN50178, IEC61800-5-1 and Germanischer Loyd, General conditions</td>
</tr>
<tr>
<td><strong>Temperature switch</strong></td>
<td>version NC contactor, 200°C</td>
</tr>
<tr>
<td><strong>Switching capacity</strong></td>
<td>250 V AC / 0,5 A</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>EN 60204.1</td>
<td>The <strong>EN 60204-1</strong> 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.</td>
</tr>
</tbody>
</table>
| EN 60664-1        | Insulation coordination for equipment within low-voltage systems -Part 1: Principles, requirements and tests  
| VDE 0113          | 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        | Insulation coordination - Railway applications Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment (German version) EN 50124-1 |
| VDE 0115          |                                                                                                                                               |
| EN 50155          | Railway applications - Electronic equipment used on rolling stock;  
| VDE 0115          | German version EN 50155                                                                                                                                 |
| UL 94             | Flammability according to UL 94                                                                                                                                 |
Overview of compact resistors

**BW 151**
Output range: 50 - 200 W
Protection class: IP 20 - 54

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

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

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

**BW 155**
Single resistor: 1.000 - 3.000 W
Protection class: IP 20 - 65

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

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

**BW 155 combination**
Output range: 4000 - 30.000 W
Protection class: IP 20 - 65
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 be dealt with. Pollutants 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 encapsulated. 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%.
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. (All 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.
Compact Braking Resistors

BW 151 series
(max continuous output: 250 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.

**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

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance values R [Ohm]</th>
<th>Continuous output at 25°C and surface overtemperature of 200K/220K</th>
<th>max. operating voltage U [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 151 / 50</td>
<td>10 - 120</td>
<td>50/70</td>
<td>900</td>
</tr>
<tr>
<td>BW 151 / 100</td>
<td>10 - 150</td>
<td>100/140</td>
<td></td>
</tr>
<tr>
<td>BW 151 / 150</td>
<td>10 - 250</td>
<td>130/180</td>
<td></td>
</tr>
<tr>
<td>BW 151 / 200</td>
<td>8 – 300</td>
<td>180/250</td>
<td></td>
</tr>
</tbody>
</table>

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!
**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

**BW 152 series**  
(max continuous 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

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

**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!
**Compact Braking Resistors**

**BW 153 series**  
(max continuous 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

### Performance Values

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance R [Ohm]</th>
<th>Continuous output at 25°C and surface overtemperature of 200K/220K</th>
<th>max. operating voltage U [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 153 / 100</td>
<td>7 - 400</td>
<td>160</td>
<td>240</td>
</tr>
<tr>
<td>BW 153 / 200</td>
<td>10 - 500</td>
<td>160</td>
<td>240</td>
</tr>
<tr>
<td>BW 153 / 300</td>
<td>8 - 620</td>
<td>200</td>
<td>280</td>
</tr>
<tr>
<td>BW 153 / 400</td>
<td>10 - 310</td>
<td>250</td>
<td>360</td>
</tr>
</tbody>
</table>

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 154 series
(max continuous 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

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

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 continuous 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
- 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
- protection class up to IP 65

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

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1 [mm]</td>
</tr>
<tr>
<td>BW 155 / 1000 /...</td>
<td>470</td>
</tr>
<tr>
<td>BW 155 / 1200 /...</td>
<td>530</td>
</tr>
<tr>
<td>BW 155 / 1500 /...</td>
<td>630</td>
</tr>
<tr>
<td>BW 155 / 2000 /...</td>
<td>830</td>
</tr>
<tr>
<td>BW 155 / 2500 /...</td>
<td>960</td>
</tr>
<tr>
<td>BW 155 / 3000 /...</td>
<td>1050</td>
</tr>
</tbody>
</table>

BW 155
**Compact Braking Resistors**

**BW 156 series**

*(max continuous 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 40 / IP 54 / IP 64
- higher protection classes upon request
- test voltage 4 kV DC
- other ratings upon request
- other fastening dimensions upon request
- installation also possible outside the control cabinet
- compact

**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
- installation also possible outside the control cabinet
- compact

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

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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

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1 [mm]</td>
</tr>
<tr>
<td>BW 156 / 400 /...</td>
<td>300</td>
</tr>
<tr>
<td>BW 156 / 600 /...</td>
<td>360</td>
</tr>
<tr>
<td>BW 156 / 800 /...</td>
<td>430</td>
</tr>
<tr>
<td>BW 156 / 1000 /...</td>
<td>500</td>
</tr>
<tr>
<td>BW 156 / 1200 /...</td>
<td>580</td>
</tr>
<tr>
<td>BW 156 / 1500 /...</td>
<td>730</td>
</tr>
</tbody>
</table>

**BW 156**

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Compact Braking Resistors
**Compact Braking Resistors**

**BW 402 series**
(max continuous 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...+40ºC
- 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**

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

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!
Compact Braking Resistors

Series BW 155 – Combination
(max continuous output: 30,000 W)

Braking resistor for drives with frequency converters of high output, 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

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

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>BW 155 / 4000</td>
<td>10-200</td>
<td>4000</td>
<td>BW 155 / 12000</td>
<td>2-740</td>
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<td>BW 155 / 5000</td>
<td>6-500</td>
<td>5000</td>
<td>BW 155 / 15000</td>
<td>1.5-700</td>
<td>15.000</td>
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<tr>
<td>BW 155 / 6000</td>
<td>4-600</td>
<td>6000</td>
<td>BW 155 / 18000</td>
<td>1.2-630</td>
<td>18.000</td>
</tr>
<tr>
<td>BW 155 / 7500</td>
<td>3-600</td>
<td>7500</td>
<td>BW 155 / 22000</td>
<td>1.5-600</td>
<td>22.000</td>
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<tr>
<td>BW 155 / 9000</td>
<td>2.1-750</td>
<td>9000</td>
<td>BW 155 / 24000</td>
<td>0.9-580</td>
<td>24.000</td>
</tr>
<tr>
<td>BW 155 / 10000</td>
<td>2.1-820</td>
<td>10000</td>
<td>BW 155 / 27000</td>
<td>0.8-600</td>
<td>27.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BW 155 / 30000</td>
<td>0.8-600</td>
<td>30.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
<th>Cable gland</th>
<th>Connection Clamps</th>
<th>Design</th>
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<tbody>
<tr>
<td>BW 155 / 4000 / ...</td>
<td>L1 [mm] 750, L2 [mm] 500, B1 [mm] 420, B2 [mm] 390, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M25</td>
<td>10 mm²</td>
<td>Design 1</td>
</tr>
<tr>
<td>BW 155 / 5000 / ...</td>
<td>L1 [mm] 880, L2 [mm] 630, B1 [mm] 420, B2 [mm] 390, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M25</td>
<td>10 mm²</td>
<td>Design 1</td>
</tr>
<tr>
<td>BW 155 / 6000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 420, B2 [mm] 390, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M25</td>
<td>10 mm²</td>
<td>Design 1</td>
</tr>
<tr>
<td>BW 155 / 7500 / ...</td>
<td>L1 [mm] 880, L2 [mm] 630, B1 [mm] 590, B2 [mm] 560, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M25</td>
<td>10 mm²</td>
<td>Design 2</td>
</tr>
<tr>
<td>BW 155 / 9000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 590, B2 [mm] 560, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M25</td>
<td>10 mm²</td>
<td>Design 2</td>
</tr>
<tr>
<td>BW 155 / 10000 / ...</td>
<td>L1 [mm] 750, L2 [mm] 500, B1 [mm] 940, B2 [mm] 910, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>16 mm²</td>
<td>Design 4</td>
</tr>
<tr>
<td>BW 155 / 12000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 770, B2 [mm] 740, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>16 mm²</td>
<td>Design 3</td>
</tr>
<tr>
<td>BW 155 / 15000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 940, B2 [mm] 910, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>16 mm²</td>
<td>Design 4</td>
</tr>
<tr>
<td>BW 155 / 18000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 2x590, B2 [mm] 2x560, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>35 mm²</td>
<td>2x Design 2</td>
</tr>
<tr>
<td>BW 155 / 22000 / ...</td>
<td>L1 [mm] 880, L2 [mm] 630, B1 [mm] 3x590, B2 [mm] 3x560, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>35 mm²</td>
<td>3x Design 2</td>
</tr>
<tr>
<td>BW 155 / 24000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 2x770, B2 [mm] 2x740, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>35 mm²</td>
<td>2x Design 3</td>
</tr>
<tr>
<td>BW 155 / 27000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 3x590, B2 [mm] 3x560, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>35 mm²</td>
<td>3x Design 2</td>
</tr>
<tr>
<td>BW 155 / 30000 / ...</td>
<td>L1 [mm] 970, L2 [mm] 720, B1 [mm] 2x940, B2 [mm] 2x910, H1 [mm] 95, H2 [mm] 75, D [mm] 8.5</td>
<td>M32</td>
<td>35 mm²</td>
<td>2x Design 4</td>
</tr>
</tbody>
</table>

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

**Technical data touch protection BW155 Combination**

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1 [mm]</td>
</tr>
<tr>
<td>BW 155 / 4000 / …</td>
<td>700</td>
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<tr>
<td>BW 155 / 5000 / …</td>
<td>800</td>
</tr>
<tr>
<td>BW 155 / 6000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 7500 / …</td>
<td>800</td>
</tr>
<tr>
<td>BW 155 / 9000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 12000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 15000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 18000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 24000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 27000 / …</td>
<td>900</td>
</tr>
<tr>
<td>BW 155 / 30000 / …</td>
<td>900</td>
</tr>
</tbody>
</table>

**BW 155 Combination**

[Diagram of BW 155 Combination]
Overview of liquid-cooled braking resistors

**BW D158/BWD 160**
- Output range: 5,000 - 60,000 W
- Protection class: IP 20 - 65

**RD 158**
- Output range: 100 - 1,210 W
- Protection class: IP 00 - 65

**BW D 158 CP**
- Output range: 2,000 - 10,000 W
- Protection class: IP 20 - 65

**BW D 330**
- Output range: 10 - 10,000 VA
- Protection class: IP 20 - 65
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.

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

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
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.
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)

Series BW D 158 / BW D 160
(max continuous 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

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

Combinations protection class IP65

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
<th>Connections</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 158 / 3000 /...</td>
<td>L1 [mm] 320</td>
<td>L2 [mm] 213</td>
<td>B1 [mm] 190</td>
</tr>
<tr>
<td>BW D 158 / 5000 /...</td>
<td>L1 [mm] 450</td>
<td>L2 [mm] 343</td>
<td>B1 [mm] 190</td>
</tr>
<tr>
<td>BW D 158 / 6000 /...</td>
<td>L1 [mm] 550</td>
<td>L2 [mm] 443</td>
<td>B1 [mm] 190</td>
</tr>
<tr>
<td>BW D 158 / 15000 /...</td>
<td>L1 [mm] 680</td>
<td>L2 [mm] 343</td>
<td>B1 [mm] 245</td>
</tr>
<tr>
<td>BW D 158 / 20000 /...</td>
<td>L1 [mm] 680</td>
<td>L2 [mm] 343</td>
<td>B1 [mm] 2x176</td>
</tr>
<tr>
<td>BW D 158 / 30000 /...</td>
<td>L1 [mm] 680</td>
<td>L2 [mm] 343</td>
<td>B1 [mm] 2x245</td>
</tr>
<tr>
<td>BW D158 / 45000 /...</td>
<td>L1 [mm] 680</td>
<td>L2 [mm] 343</td>
<td>B1 [mm] 3x245</td>
</tr>
<tr>
<td>BW D158 / 60000 /...</td>
<td>L1 [mm] 680</td>
<td>L2 [mm] 343</td>
<td>B1 [mm] 4x245</td>
</tr>
</tbody>
</table>
**Liquid-cooled braking resistors**

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**Series R D 158**  
(max rated output: 1210 W)

Water-cooled load resistor for high pulse energies.

- 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: IP00-IP65
- other ratings upon request

**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

---

### Type | Resistance values | Rated current | Rated power | max. operating voltage
---|---|---|---|---
R D 158 / 100 | 1,0 | 2 | 100 | 4200
R D 158 / 490 | 0,1 | 70 | 490 |
R D 158 / 800 | 0,5 | 40 | 800 |
R D 158 / 1210 | 0,1 | 110 | 1210 |

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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!
**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

**BW D 158 CP series**

*(Max continuous 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance values R [Ohm]</th>
<th>Continuous output P [W]</th>
<th>max. operating voltage U [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 158 / 2000 /…CP</td>
<td>2 – 800</td>
<td>2.000</td>
<td></td>
</tr>
<tr>
<td>BW D 158 / 3000 /…CP</td>
<td>1 – 600</td>
<td>3.000</td>
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<tr>
<td>BW D 158 / 10000 /…CP</td>
<td>1 – 600</td>
<td>10.000</td>
<td>1.000</td>
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**Type Dimensions Connection Design**

<table>
<thead>
<tr>
<th>Type</th>
<th>L1 [mm]</th>
<th>L2 [mm]</th>
<th>B1 [mm]</th>
<th>B2 [mm]</th>
<th>H [mm]</th>
<th>Cable gland</th>
<th>Clamps</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 158 / 2000 /…CP</td>
<td>232</td>
<td>113</td>
<td>190</td>
<td>175</td>
<td>68</td>
<td>M20</td>
<td>6 mm²</td>
<td>BF1</td>
</tr>
<tr>
<td>BW D 158 / 3000 /…CP</td>
<td>272</td>
<td>163</td>
<td>190</td>
<td>175</td>
<td>68</td>
<td>M20</td>
<td>6 mm²</td>
<td>BF1</td>
</tr>
<tr>
<td>BW D 158 / 5000 /…CP</td>
<td>462</td>
<td>343</td>
<td>190</td>
<td>175</td>
<td>68</td>
<td>M20</td>
<td>10 mm²</td>
<td>BF1</td>
</tr>
<tr>
<td>BW D 158 / 10000 /…CP</td>
<td>462</td>
<td>343</td>
<td>340</td>
<td>325</td>
<td>68</td>
<td>M20</td>
<td>10 mm²</td>
<td>BF2</td>
</tr>
</tbody>
</table>

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!
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.

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

### BW D 330 series
(max continuous output: 25.000 W)

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance values R [Ohm]</th>
<th>Continuous output [VA]</th>
<th>Operating voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 330 /10000</td>
<td>0,1 - 5</td>
<td>10.000 - 25.000</td>
<td>400</td>
</tr>
</tbody>
</table>

#### Type L1

<table>
<thead>
<tr>
<th>Type</th>
<th>L1 [mm]</th>
<th>L2 [mm]</th>
<th>L3 [mm]</th>
<th>B1 [mm]</th>
<th>B2 [mm]</th>
<th>H [mm]</th>
<th>D1 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 330</td>
<td>280</td>
<td>118,5</td>
<td>107,5</td>
<td>190</td>
<td>170</td>
<td>55</td>
<td>9</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Output range</th>
<th>Protection class</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 601 / 602</td>
<td>1.500 - 30.000 W</td>
<td>IP 20 - 22</td>
</tr>
<tr>
<td>BW 605</td>
<td>3.000 - 7.500 W</td>
<td>IP 20</td>
</tr>
</tbody>
</table>
Register resistors

Series BW 601 / BW 602
(max continuous 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

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Continuous output [W]</th>
<th>Forced cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Resistance values R [Ohm]</td>
</tr>
<tr>
<td>BW 601/1/R</td>
<td>1000</td>
<td>BW 602/1,5/R</td>
</tr>
<tr>
<td>BW 601/2/R</td>
<td>2000</td>
<td>BW 602/2,5/R</td>
</tr>
<tr>
<td>BW 601/3/R</td>
<td>3000</td>
<td>BW 602/4,5/R</td>
</tr>
<tr>
<td>BW 601/4/R</td>
<td>4000</td>
<td>BW 602/6/R</td>
</tr>
<tr>
<td>BW 601/5/R</td>
<td>5000</td>
<td>BW 602/7,5/R</td>
</tr>
<tr>
<td>BW 601/7,5/R</td>
<td>7500</td>
<td>BW 602/11/R</td>
</tr>
<tr>
<td>BW 601/10/R</td>
<td>10000</td>
<td>BW 602/15/R</td>
</tr>
<tr>
<td>BW 601/12,5/R</td>
<td>12500</td>
<td>BW 602/19/R</td>
</tr>
<tr>
<td>BW 601/15/R</td>
<td>15000</td>
<td>BW 602/22,5/R</td>
</tr>
<tr>
<td>BW 601/17,5/R</td>
<td>17500</td>
<td>BW 602/26/R</td>
</tr>
<tr>
<td>BW 601/20/R</td>
<td>20000</td>
<td>BW 602/30/R</td>
</tr>
</tbody>
</table>

Type | Natural cooling | Forced cooling | Number of registers | Number of levels | a [mm] | Total height |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 601/1/R</td>
<td>BW 602/1,5/R</td>
<td>1</td>
<td>1</td>
<td>270</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>BW 601/2/R</td>
<td>BW 602/2,5/R</td>
<td>2</td>
<td></td>
<td>370</td>
<td>340</td>
<td></td>
</tr>
<tr>
<td>BW 601/3/R</td>
<td>BW 602/4,5/R</td>
<td>3</td>
<td></td>
<td>470</td>
<td>440</td>
<td></td>
</tr>
<tr>
<td>BW 601/4/R</td>
<td>BW 602/6/R</td>
<td>4</td>
<td></td>
<td>570</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>BW 601/5/R</td>
<td>BW 602/7,5/R</td>
<td>6</td>
<td></td>
<td>570</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>BW 601/7,5/R</td>
<td>BW 602/11/R</td>
<td>8</td>
<td></td>
<td>470</td>
<td>440</td>
<td></td>
</tr>
<tr>
<td>BW 601/10/R</td>
<td>BW 602/15/R</td>
<td>12</td>
<td></td>
<td>570</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>BW 601/12,5/R</td>
<td>BW 602/19/R</td>
<td>15</td>
<td></td>
<td>470</td>
<td>440</td>
<td></td>
</tr>
<tr>
<td>BW 601/15/R</td>
<td>BW 602/22,5/R</td>
<td>18</td>
<td></td>
<td>570</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>BW 601/17,5/R</td>
<td>BW 602/26/R</td>
<td>21</td>
<td></td>
<td>470</td>
<td>440</td>
<td></td>
</tr>
<tr>
<td>BW 601/20/R</td>
<td>BW 602/30/R</td>
<td>24</td>
<td></td>
<td>570</td>
<td>540</td>
<td></td>
</tr>
</tbody>
</table>
Register Resistors

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

**BW 605 series**
*(max continuous 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Continuous output [W]</th>
<th>Resistance values R [Ohm]</th>
<th>Continuous output</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 605/3</td>
<td>3000</td>
<td>3.8 - 330</td>
<td>1000</td>
</tr>
<tr>
<td>BW 605/4</td>
<td>4000</td>
<td>1.8 - 250</td>
<td></td>
</tr>
<tr>
<td>BW 605/5,5</td>
<td>5500</td>
<td>1.2 - 181</td>
<td></td>
</tr>
<tr>
<td>BW 605/7,5</td>
<td>7500</td>
<td>0.9 - 130</td>
<td></td>
</tr>
</tbody>
</table>

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!
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 REOhm 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.
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 product development is a continuous cycle for REO
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)
## Applicable standards

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

- 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.
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 developments in the wider market. This ensures an effective and competitive solution.

**NTT BW 158**<br>(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**<br>(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 alternative 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**<br>(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 subsidiary 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 capabilities 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 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 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.
Questions or suggestions? Please contact our team in Kyritz:

+49 (0) 33971 485-0