REO Braking- and charging resistors
Liquid-cooled braking resistors
### Overview of liquid-cooled braking resistors

<table>
<thead>
<tr>
<th>Model</th>
<th>Output range</th>
<th>Protection class</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BW D158/BWD 160</strong></td>
<td>5,000 - 60,000 W</td>
<td>IP 20 - 65</td>
<td><img src="30" alt="Image" /></td>
</tr>
<tr>
<td><strong>NTT RD 158</strong></td>
<td>2,600 W</td>
<td>IP 00 - 65</td>
<td><img src="31" alt="Image" /></td>
</tr>
<tr>
<td><strong>BW D 158 CP</strong></td>
<td>2,000 - 10,000 W</td>
<td>IP 20 - 65</td>
<td><img src="32" alt="Image" /></td>
</tr>
<tr>
<td><strong>BW D 330</strong></td>
<td>15,000 - 60,000 VA</td>
<td>IP 20 - 65</td>
<td><img src="33" alt="Image" /></td>
</tr>
</tbody>
</table>
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></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>
<td></td>
</tr>
<tr>
<td>BW D 158 /45000 / …</td>
<td>2,1 - 800</td>
<td>45.000</td>
<td></td>
</tr>
<tr>
<td>BW D 158 /60000 / …</td>
<td>2 - 850</td>
<td>60.000</td>
<td></td>
</tr>
</tbody>
</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></td>
<td>L1 [mm]</td>
<td>L2 [mm]</td>
<td>L3 [mm]</td>
</tr>
<tr>
<td>BW D 158 / 3000 / …</td>
<td>320</td>
<td>213</td>
<td>500</td>
</tr>
<tr>
<td>BW D 158 / 5000 / …</td>
<td>450</td>
<td>343</td>
<td>500</td>
</tr>
<tr>
<td>BW D 158 / 6000 / …</td>
<td>550</td>
<td>443</td>
<td>500</td>
</tr>
<tr>
<td>BW D 158 / 10000 / …</td>
<td>680</td>
<td>343</td>
<td>265</td>
</tr>
<tr>
<td>BW D 158 / 15000 / …</td>
<td>680</td>
<td>343</td>
<td>265</td>
</tr>
<tr>
<td>BW D 158 / 20000 / …</td>
<td>680</td>
<td>343</td>
<td>265</td>
</tr>
<tr>
<td>BW D 158 / 30000 / …</td>
<td>680</td>
<td>343</td>
<td>265</td>
</tr>
<tr>
<td>BW D 158 / 45000 / …</td>
<td>680</td>
<td>343</td>
<td>265</td>
</tr>
<tr>
<td>BW D 158 / 60000 / …</td>
<td>680</td>
<td>343</td>
<td>265</td>
</tr>
</tbody>
</table>
Liquid-cooled braking resistors

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 D 158 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance values R [Ohm]</th>
<th>Rated current I [A]</th>
<th>Rated power P [W]</th>
<th>max. operating voltage U [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTT RD 158 / 2600</td>
<td>0,1 - 1,0</td>
<td>2-110</td>
<td>2600</td>
<td>4200</td>
</tr>
</tbody>
</table>

Values of the single resistors

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance values R [Ohm]</th>
<th>Rated current I [A]</th>
<th>max. operating voltage U [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTT R D 158</td>
<td>1,0</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>R1</td>
<td>1,0</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>NTT R D 158</td>
<td>0,1</td>
<td>70</td>
<td>490</td>
</tr>
<tr>
<td>R2</td>
<td>0,1</td>
<td>70</td>
<td>490</td>
</tr>
<tr>
<td>NTT R D 158</td>
<td>0,5</td>
<td>40</td>
<td>800</td>
</tr>
<tr>
<td>R3</td>
<td>0,5</td>
<td>40</td>
<td>800</td>
</tr>
<tr>
<td>NTT R D 158</td>
<td>0,1</td>
<td>110</td>
<td>1210</td>
</tr>
<tr>
<td>R4</td>
<td>0,1</td>
<td>110</td>
<td>1210</td>
</tr>
</tbody>
</table>

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

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>
<td></td>
</tr>
<tr>
<td>BW D 158 / 5000 /…CP</td>
<td>1 – 600</td>
<td>5.000</td>
<td></td>
</tr>
<tr>
<td>BW D 158 / 10000 /…CP</td>
<td>1 – 600</td>
<td>10.000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
<th>Connection</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1 [mm]</td>
<td>L2 [mm]</td>
<td>B1 [mm]</td>
</tr>
<tr>
<td>BW D 158 / 2000 /…CP</td>
<td>232</td>
<td>113</td>
<td>190</td>
</tr>
<tr>
<td>BW D 158 / 3000 /…CP</td>
<td>272</td>
<td>163</td>
<td>190</td>
</tr>
<tr>
<td>BW D 158 / 5000 /…CP</td>
<td>462</td>
<td>343</td>
<td>190</td>
</tr>
<tr>
<td>BW D 158 / 10000 /…CP</td>
<td>462</td>
<td>343</td>
<td>340</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 D 330 series**
*(max continuous 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance values [Ohm]</th>
<th>Continuous output [W]</th>
<th>Operating voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 330 / 15.000</td>
<td>1 - 100</td>
<td>15000</td>
<td>800</td>
</tr>
<tr>
<td>BW D 330 / 30.000</td>
<td></td>
<td>30000</td>
<td></td>
</tr>
<tr>
<td>BW D 330 / 45.000</td>
<td></td>
<td>45000</td>
<td></td>
</tr>
<tr>
<td>BW D 330 / 60.000</td>
<td></td>
<td>60000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>L1 [mm]</th>
<th>L2 [mm]</th>
<th>B1 [mm]</th>
<th>B2 [mm]</th>
<th>D1 Ø [mm]</th>
<th>D2 Ø [mm]</th>
<th>H1 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW D 330 / 15.000</td>
<td>390</td>
<td>250</td>
<td>315</td>
<td>285</td>
<td>12,5</td>
<td>G3/4</td>
<td>57</td>
</tr>
<tr>
<td>BW D 330 / 30.000</td>
<td>390</td>
<td>250</td>
<td>315</td>
<td>285</td>
<td>12,5</td>
<td>G3/4</td>
<td>87</td>
</tr>
<tr>
<td>BW D 330 / 45.000</td>
<td>390</td>
<td>250</td>
<td>315</td>
<td>285</td>
<td>12,5</td>
<td>G3/4</td>
<td>117</td>
</tr>
<tr>
<td>BW D 330 / 60.000</td>
<td>390</td>
<td>250</td>
<td>315</td>
<td>285</td>
<td>12,5</td>
<td>G3/4</td>
<td>147</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

**BW 601 / 602**
Output range: 1,500 - 30,000 W
Protection class: IP 20 - 22

**BW 605**
Output range: 3,000 - 7,500 W
Protection class: IP 20
**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>Type</th>
<th>Continuous output [W]</th>
<th>Resistance values [Ohm]</th>
<th>max. operating voltage U [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 601/1/R</td>
<td>1000</td>
<td>BW 602/1,5/R</td>
<td>1500</td>
<td>1,6 - 660</td>
<td></td>
</tr>
<tr>
<td>BW 601/2/R</td>
<td>2000</td>
<td>BW 602/3/R</td>
<td>3000</td>
<td>0,8 - 330</td>
<td></td>
</tr>
<tr>
<td>BW 601/3/R</td>
<td>3000</td>
<td>BW 602/4,5/R</td>
<td>4500</td>
<td>0,6 - 220</td>
<td></td>
</tr>
<tr>
<td>BW 601/4/R</td>
<td>4000</td>
<td>BW 602/6/R</td>
<td>6000</td>
<td>0,4 - 160</td>
<td></td>
</tr>
<tr>
<td>BW 601/5/R</td>
<td>5000</td>
<td>BW 602/7,5/R</td>
<td>7500</td>
<td>0,33 - 130</td>
<td></td>
</tr>
<tr>
<td>BW 601/7,5/R</td>
<td>7500</td>
<td>BW 602/11/R</td>
<td>11000</td>
<td>0,23 - 90</td>
<td></td>
</tr>
<tr>
<td>BW 601/10/R</td>
<td>10000</td>
<td>BW 602/15/R</td>
<td>15000</td>
<td>0,17 - 65</td>
<td></td>
</tr>
<tr>
<td>BW 601/12,5/R</td>
<td>12500</td>
<td>BW 602/19/R</td>
<td>19000</td>
<td>0,13 - 50</td>
<td></td>
</tr>
<tr>
<td>BW 601/15/R</td>
<td>15000</td>
<td>BW 602/22,5/R</td>
<td>22500</td>
<td>0,11 - 44</td>
<td></td>
</tr>
<tr>
<td>BW 601/17,5/R</td>
<td>17500</td>
<td>BW 602/26/R</td>
<td>26000</td>
<td>0,1 - 38</td>
<td></td>
</tr>
<tr>
<td>BW 601/20/R</td>
<td>20000</td>
<td>BW 602/30/R</td>
<td>30000</td>
<td>0,09 - 33</td>
<td></td>
</tr>
</tbody>
</table>

**Dimensions**

<table>
<thead>
<tr>
<th>Type</th>
<th>Forced cooling</th>
<th>Number of registers</th>
<th>Number of levels</th>
<th>A [mm]</th>
<th>a [mm]</th>
<th>Total height</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>300</td>
</tr>
<tr>
<td>BW 601/2/R</td>
<td>BW 602/3/R</td>
<td>2</td>
<td>1</td>
<td>370</td>
<td>340</td>
<td>350</td>
</tr>
<tr>
<td>BW 601/3/R</td>
<td>BW 602/4,5/R</td>
<td>3</td>
<td>1</td>
<td>470</td>
<td>440</td>
<td>450</td>
</tr>
<tr>
<td>BW 601/4/R</td>
<td>BW 602/6/R</td>
<td>4</td>
<td>2</td>
<td>570</td>
<td>540</td>
<td>550</td>
</tr>
<tr>
<td>BW 601/5/R</td>
<td>BW 602/7,5/R</td>
<td>6</td>
<td>2</td>
<td>470</td>
<td>440</td>
<td>480</td>
</tr>
<tr>
<td>BW 601/7,5/R</td>
<td>BW 602/11/R</td>
<td>8</td>
<td>2</td>
<td>570</td>
<td>540</td>
<td>550</td>
</tr>
<tr>
<td>BW 601/10/R</td>
<td>BW 602/15/R</td>
<td>12</td>
<td>2</td>
<td>470</td>
<td>440</td>
<td>480</td>
</tr>
<tr>
<td>BW 601/12,5/R</td>
<td>BW 602/19/R</td>
<td>15</td>
<td>3</td>
<td>470</td>
<td>440</td>
<td>480</td>
</tr>
<tr>
<td>BW 601/15/R</td>
<td>BW 602/22,5/R</td>
<td>18</td>
<td>3</td>
<td>570</td>
<td>540</td>
<td>550</td>
</tr>
<tr>
<td>BW 601/17,5/R</td>
<td>BW 602/26/R</td>
<td>21</td>
<td>3</td>
<td>570</td>
<td>540</td>
<td>550</td>
</tr>
<tr>
<td>BW 601/20/R</td>
<td>BW 602/30/R</td>
<td>24</td>
<td>3</td>
<td>570</td>
<td>540</td>
<td>550</td>
</tr>
</tbody>
</table>
Register resistors

**Benefits:**
- compact shape
- high loading capacity
- very high short-term load capacity
- 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></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>1000</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!

<table>
<thead>
<tr>
<th>Type</th>
<th>B1 [mm]</th>
<th>B2 [mm]</th>
<th>B3 [mm]</th>
<th>H [mm]</th>
<th>L1 [mm]</th>
<th>L2 [mm]</th>
<th>Cable gland [mm²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW 605/3</td>
<td>295</td>
<td>270</td>
<td>240</td>
<td>260</td>
<td>490</td>
<td>380</td>
<td>50</td>
</tr>
<tr>
<td>BW 605/4</td>
<td>395</td>
<td>370</td>
<td>340</td>
<td>260</td>
<td>490</td>
<td>380</td>
<td>50</td>
</tr>
<tr>
<td>BW 605/5,5</td>
<td>395</td>
<td>370</td>
<td>340</td>
<td>260</td>
<td>490</td>
<td>380</td>
<td>50</td>
</tr>
<tr>
<td>BW 605/7,5</td>
<td>595</td>
<td>570</td>
<td>540</td>
<td>260</td>
<td>490</td>
<td>380</td>
<td>95</td>
</tr>
</tbody>
</table>
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.
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
  - 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>IEC 61373</td>
<td>Railway applications – Shock and vibration tests</td>
</tr>
<tr>
<td>DIN EN 61373</td>
<td>Railway applications – 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; Clearance 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 BN4111002</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 lwxh: 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!
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
(Power: 10000 W)
Water-cooled braking resistor combination, used in rolling stock „Coaster“.

Electrical data:
- Duty cycle: 100%
- Rated current: 170 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 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
(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 an 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 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.
Divisions:

**REO Vibratory Feeding and Power Electronics Division**
REO Vibratory Feeding and Power Electronics Division
Brühler Straße 100 · D-42657 Solingen
Tel.: +49 (0)212 8804 0 · Fax: +49 (0)212 8804 188
E-Mail: info@reo.de

**REO Train Technologies Division**
REO Train Technologies Division
Erasmusstraße 14 · D-10553 Berlin
Tel.: +49 (0)30 3670236 0 · Fax: +49 (0)30 3670236 10
E-Mail: zentrale.berlin@reo.de

**REO Drives Division**
REO Drives Division
Holzhausener Straße 52 · D-16866 Kyritz
Tel.: +49 (0)33971 485 0 · Fax: +49 (0)33971 485 90
E-Mail: zentrale.kyritz@reo.de

**REO Medical and Current Transformer Division**
REO Medical and Current Transformer Division
Schuldholzinger Weg 7 · D-84347 Pfarrkirchen
Tel.: +49 (0)8561 9886 0 · Fax: +49 (0)8561 9886 40
E-Mail: zentrale.pfarrkirchen@reo.de

**REO Test and PowerQuality Division**
REO Test and PowerQuality Division
Brühler Straße 100 · D-42657 Solingen
Tel.: +49 (0)212 8804 0 · Fax: +49 (0)212 8804 188
E-Mail: info@reo.de

**PRODUCTION + SALES:**

- **China**
  REO Shanghai Inductive Components Co., Ltd
  E-Mail: info@reo.cn · Internet: www.reo.cn

- **India**
  REO GPD INDUCTIVE COMPONENTS PVT. LTD
  E-Mail: info@reogpd.com · Internet: www.reo-ag.in

- **USA**
  REO USA, Inc.
  E-Mail: info@reo-usa.com · Internet: www.reo-usa.com

**SALES:**

- **France**
  REO VARIAC S.A.R.L.
  E-Mail: reovariac@reo.fr · Internet: www.reo.fr

- **Great Britain**
  REO UK Ltd.
  E-Mail: main@reo.co.uk · Internet: www.reo.co.uk

- **Italy**
  REO ITALIA S.r.l.
  E-Mail: info@reoitalia.it · Internet: www.reoitalia.it

- **Poland**
  REO CROMA Sp.z.o.o
  E-Mail: croma@croma.com.pl · Internet: www.croma.com.pl

- **Spain**
  REO ESPAÑA 2002 S.A.
  E-Mail: info@reospain.com · Internet: www.reospain.com

- **Switzerland**
  REO ELEKTRONIK AG
  E-Mail: info@reo.ch · Internet: www.reo.ch

- **Turkey**
  REOTURKEY ELEKTRONIK San. ve Tic. Ltd. Şti.
  E-Mail: info@reo-turkey.com · Internet: www.reo-turkey.com