Resistors for electrical vehicles

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19 juni 2019
1931 Congrescentrum 's-Hertogenbosch
POWER ELECTRONICS 2019

NIBE Industrier - Sweden

Three Business Area's

12.800 employees

Sales € 1973 M

ELEMENT
€ 530 M
8.500 employees
57 units

The leader in Northern Europe and a leading international manufacturer of heating, resistors & control.

CLIMATE SOLUTIONS
€ 1248 M
3.417 employees
25 units

The largest manufacturer of domestic heating products in the Nordic countries and a market leader in Northern Europe in its main focus areas of heat pumps and water heaters.

STOVES
€ 232 M
922 employees
4 units

The market leader of wood-burning stoves in Sweden and a player in the absolute front rank of the European wood stove market.

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Danotherm A/S

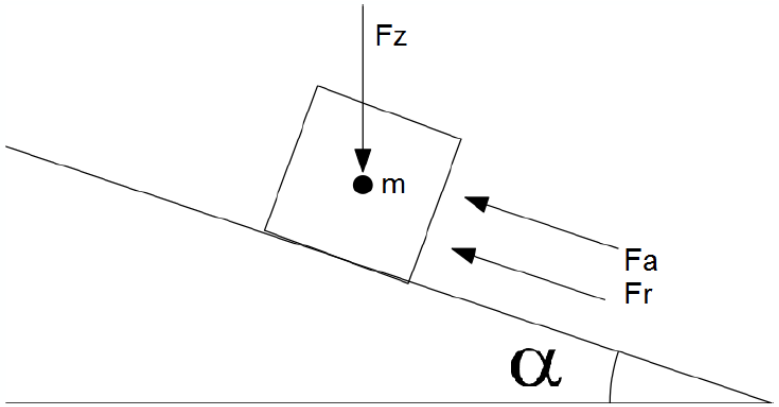
- Copenhagen – DK
- Founded 1919 – Part of **NIBE - Element Division** since 2003
- Manufactures industrial power resistors
- 5 production plants - 165 people - Sales € 24 M

Presentation

- Brake resistors on electric Bus & Truck
- Necessary brake power – range of products
- Additional functionality (heating)

Hybrid / Full Electrical Vehicle Brake resistor

Down hill test



F_z: Gravity force

F_a: Air resistance

F_r: Rolling resistance

Test requirements:

- 7% slope (= 4º)
- 6 km track at constant speed of 30 km/h
- Only using brake resistor

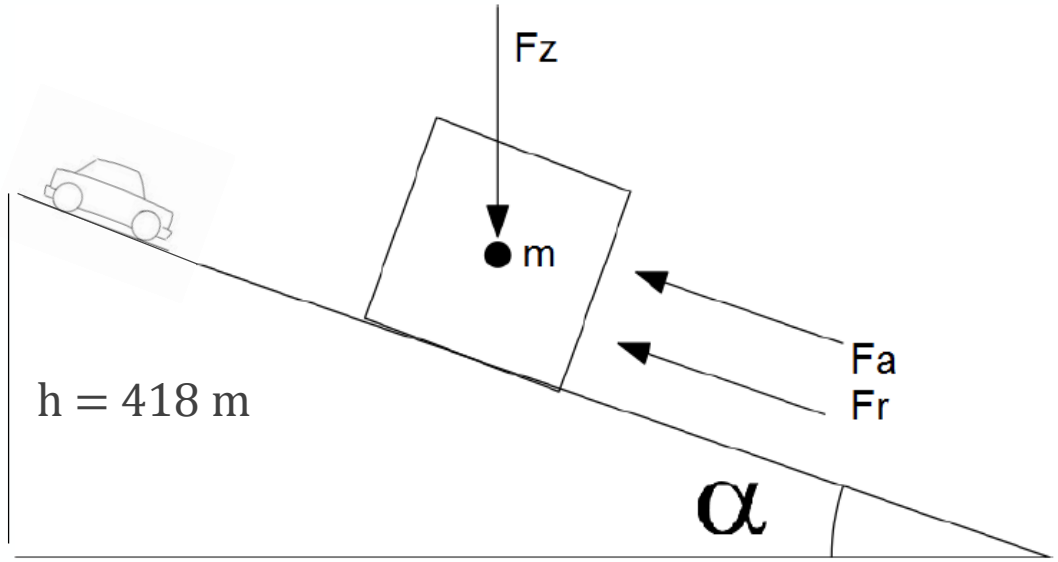
Example

$$E_{pot} = m * g * h$$

$$E_{pot} = \mathbf{20.000\ kg} * 9.81 \frac{m}{s^2} * 418\ m$$

$$E_{pot} = 82\ MJ$$

$$P = \frac{82\ MJ}{\mathbf{720\ s}} = \mathbf{114\ kW}$$



v = 30 km/h
d = 6 km

α = 4°
m = 20.000 kg

→ H = 418 m
→ t = 12 min = 720 sec

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Rolling resistance

ISO 18164:2005

$$F_R = m * g * Cmr$$

$$F_R = \boxed{20.000} * 9.81 . 0.006$$

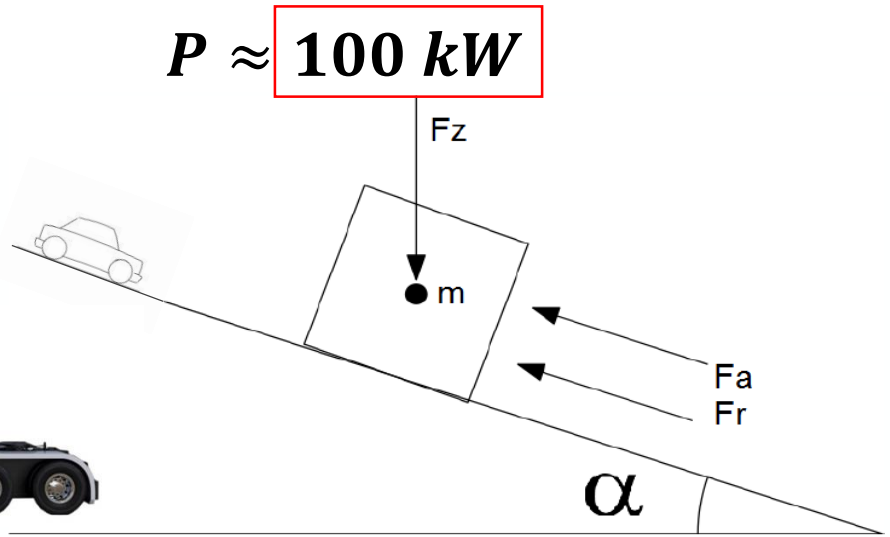
$$F_R = 1.177\ N$$

$$P_R = F * v$$

$$\boldsymbol{P_R = 9.8\ kW}$$

$$P = 114 - 10 - 1.2kW$$

$$\boldsymbol{P \approx \boxed{100\ kW}}$$



Air resistance

$$F_A = \frac{1}{2}\delta * v^2 * A * Cw$$

$$F_A = \frac{1}{2}1.155 * 8.33^2 * 6 * 0.6$$

$$F_A = 144\ N$$

$$P_A = F . v$$

$$\boldsymbol{P_A = 1200\ W}$$

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Life time

THEORETICAL

12 years operation

Normal Brake cycle
- 12H per day
- Brake cycle 5s/1min
- 4.380 hours / 12 years

Downhill Brake Cycle
- One time per day
- 876 hours / 12 years

✓ Total 5.000 h

PRACTICAL

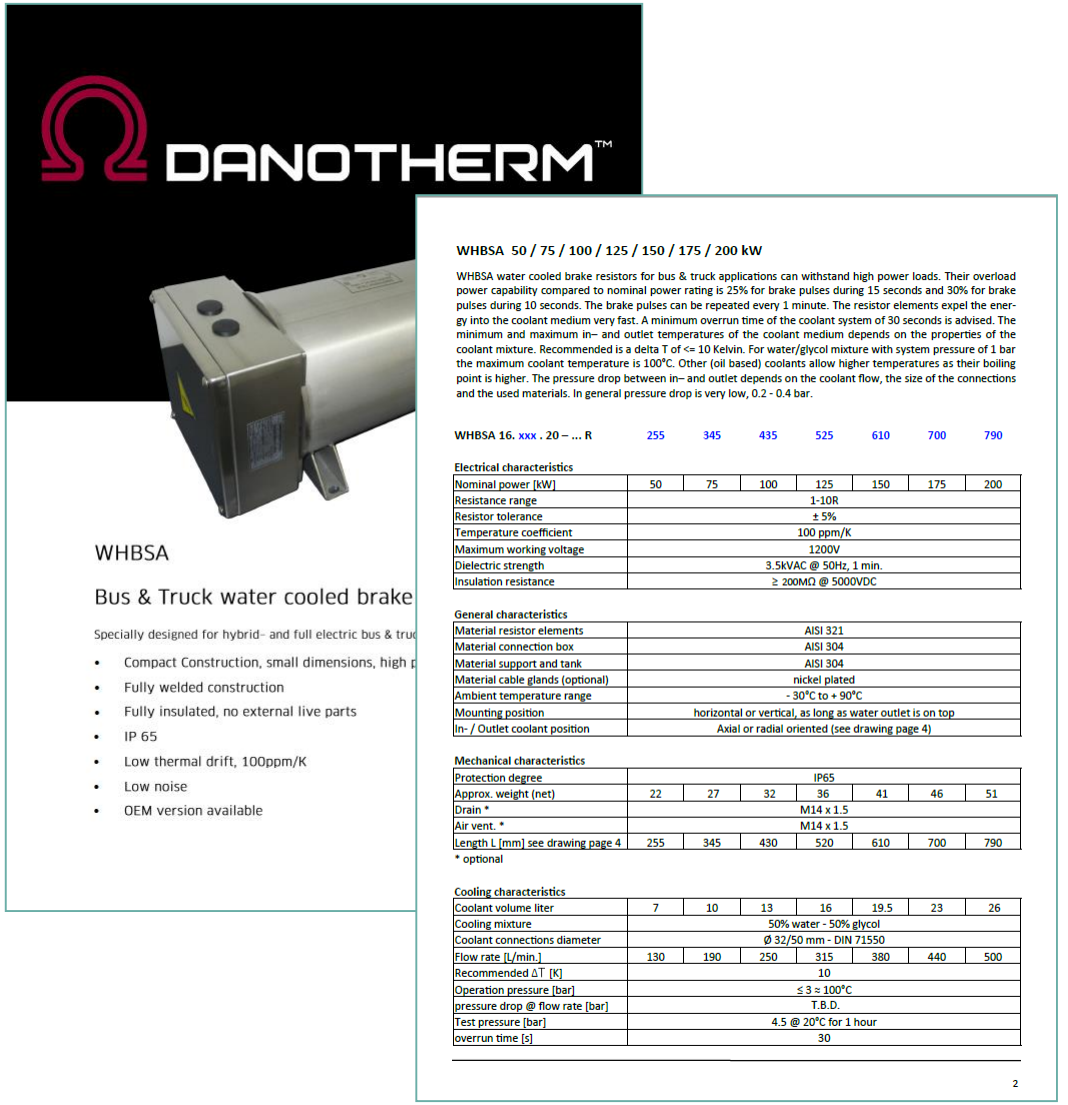
Normal Brake Cycle
- Battery gets charged

Downhill Brake Cycle
- Battery gets charged + some assistance from the resistor

✓ Conclusion:
Resistor to pass homologation test

WHBSA

- Dedicated resistor for hybrid / Full Electric applications.
- High braking power 20 – 250kW
- Supports down hill test
- Outperforms competition



DANOTHERM™

WHBSA

Bus & Truck water cooled brake

Specially designed for hybrid- and full electric bus & truc

- Compact Construction, small dimensions, high p
- Fully welded construction
- Fully insulated, no external live parts
- IP 65
- Low thermal drift, 100ppm/K
- Low noise
- OEM version available

WHBSA 50 / 75 / 100 / 125 / 150 / 175 / 200 kW

WHBSA water cooled brake resistors for bus & truck applications can withstand high power loads. Their overload power capability compared to nominal power rating is 25% for brake pulses during 15 seconds and 30% for brake pulses during 10 seconds. The brake pulses can be repeated every 1 minute. The resistor elements expel the energy into the coolant medium very fast. A minimum overrun time of the coolant system of 30 seconds is advised. The minimum and maximum in– and outlet temperatures of the coolant medium depends on the properties of the coolant mixture. Recommended is a delta T of <= 10 Kelvin. For water/glycol mixture with system pressure of 1 bar the maximum coolant temperature is 100°C. Other (oil based) coolants allow higher temperatures as their boiling point is higher. The pressure drop between in– and outlet depends on the coolant flow, the size of the connections and the used materials. In general pressure drop is very low, 0.2 - 0.4 bar.

WHBSA 16. xxx . 20 – ... R	255	345	435	525	610	700	790

Electrical characteristics

Nominal power [kW]	50	75	100	125	150	175	200
Resistance range	1-10R						
Resistor tolerance	± 5%						
Temperature coefficient	100 ppm/K						
Maximum working voltage	1200V						
Dielectric strength	3.5kVAC @ 50Hz, 1 min.						
Insulation resistance	≥ 200MΩ @ 5000VDC						

General characteristics

Material resistor elements	AISI 321
Material connection box	AISI 304
Material support and tank	AISI 304
Material cable glands (optional)	nickel plated
Ambient temperature range	- 30°C to + 90°C
Mounting position	horizontal or vertical, as long as water outlet is on top
In- / Outlet coolant position	Axial or radial oriented (see drawing page 4)

Mechanical characteristics

Protection degree	IP65						
Approx. weight (net)	22	27	32	36	41	46	51
Drain *	M14 x 1.5						
Air vent. *	M14 x 1.5						
Length L [mm] see drawing page 4	255	345	430	520	610	700	790

* optional

Cooling characteristics

Coolant volume liter	7	10	13	16	19.5	23	26
Cooling mixture	50% water - 50% glycol						
Coolant connections diameter	Ø 32/50 mm - DIN 71550						
Flow rate [L/min.]	130	190	250	315	380	440	500
Recommended ΔT [K]	10						
Operation pressure [bar]	≤ 3 ≈ 100°C						
pressure drop @ flow rate [bar]	T.B.D.						
Test pressure [bar]	4.5 @ 20°C for 1 hour						
overrun time [s]	30						

2

ADDITIONAL FUNCTION

- Comfort pre-heating (½ power)
  - Long life time
    - ✓Climatized bus in the morning

WHBSA

Water cooled resistors ←→ **Air cooled** resistors

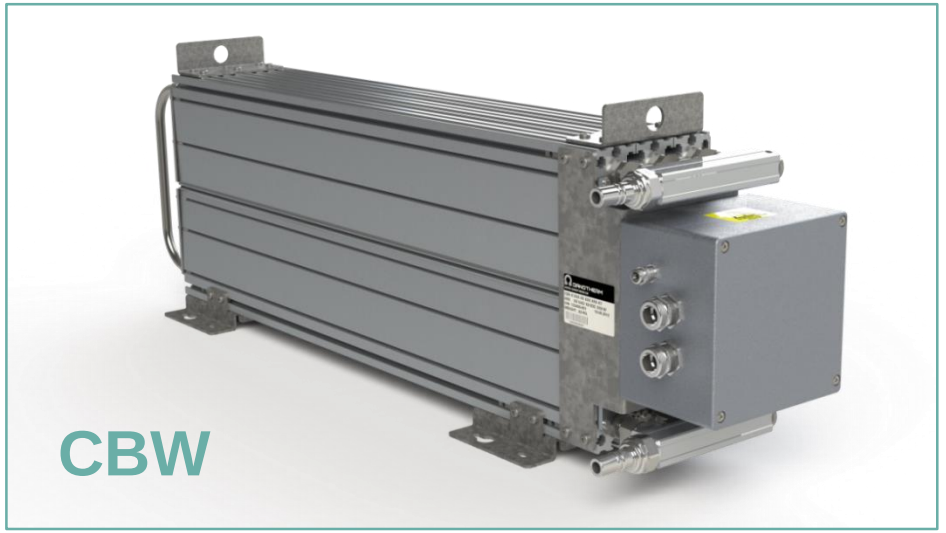
- Need water circuit
- Includes heating function for compartments
- Resistor temp. = cooling water temperature
- Can be installed anywhere
- No live-parts
- Very compact

- No need for water circuit
- Only for braking. Needs separate heating system
- Resistor temp > 400ºC!
- Must be on outside location
- Live-parts / danger for electrocution!
- Large volume

The convertor drive on the vehicle uses water cooling.

ALPHA – CBW type

- Very high pulse load capability
- Average power up to 7kW/housing
- Water flow based on average power
- No down hill test



Ongoing projects for:

WHBSA

- Busses
- Trucks

CBW

- Trams
- Wheel Loaders
- Excavators

Customers

- Spain
- Switzerland
- Germany
- UK
- Sweden

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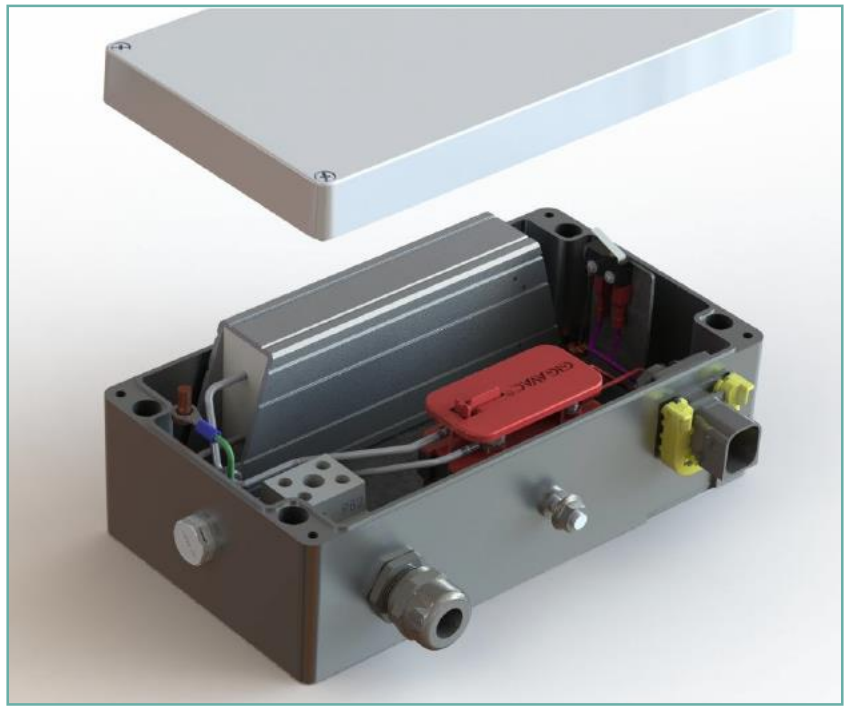
Safety - Discharge

Discharge Resistor System (DRS)

- Fast discharge to reach safe voltage level
- Activated without control signal (NC)
- Gore-Tec air vent
- Different R-values and coil voltages



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