

# Industrial metal Grid Brake Resistors and metal grid resistor blocks

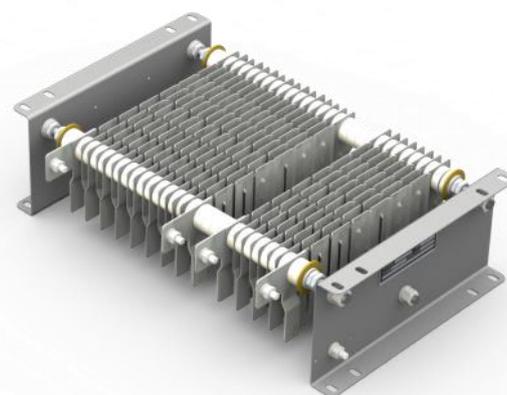
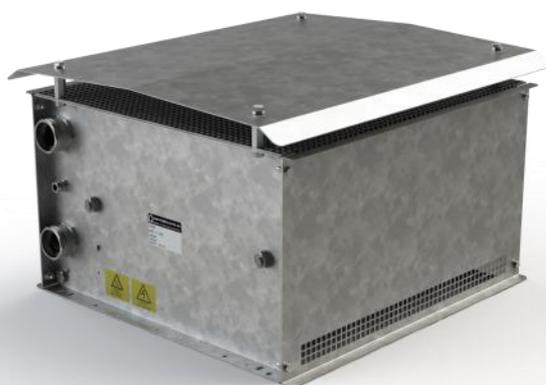
Low voltage

IP00–IP23

For indoor and outdoor use



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## Application

All modern frequency controlled drive systems need to be able to cope with re-generated energy. Typical applications are elevators, escalators, conveyer belts and cranes. Other applications where steel grid brake resistors are used are gas turbines, wind turbines and deck machinery on vessels. In traction applications also brake resistors are necessary. For traction brake resistors, please, consult our separate brochure for railway resistors.

During braking the motor functions as a generator. The electrical energy that automatically is fed back into the frequency drive needs to be dissipated to avoid damage to the frequency inverter. A brake chopper takes care of any excessive energy and dissipates the energy in a brake resistor. Even with active front end inverter systems where re-generated energy is fed back into the mains a brake resistor is needed in case the mains is not available during a fault.

In some applications braking is done once in a very long time where other applications need to brake every few seconds, repeated endlessly. The braking power can be very high compared to the average value. Steel grid brake resistors need to be;

- Reliable
- Robust
- Compact / light
- Limited thermal drift on resistance value
- Cost effective

Backer-Facsa S.L. , Heating Elements Division is located in Aiguafreda, some 50km from Barcelona, Spain. The company FAC S.A. was founded in 1959 and mainly produced heating elements for both industrial and domestic applications. In the '80s, FACSA was the biggest heating-element manufacturer in Spain for washing machines and dish washers. In 2003, NIBE bought Facsa and the name was changed to Backer-Facsa S.L. NIBE is the leading manufacturer of heating elements in northern Europe and has production facilities in 19 countries in Europe, North-America and Asia. The total number of employees world-wide exceeds 10'000 people.

In Llanera, Asturias, in the northern part of Spain, Backer-Facsa has a resistor division that is fully dedicated to the design and production of metal-grid resistors. Backer-Facsa's engineers have a long experience of grid-type resistors as well as their numerous and growing applications. Whether it is in power distribution, renewable energy, industrial drives or public transport, resistors form an essential part of many of these applications.

All resistors are fully tested prior to shipment and where required, they can be tested according to special standards. Standards that are applicable to Traction or Power Distribution are studied during the design phase and tests are carried out to ensure their compliance. Backer-Facsa has its own test equipment but also has access to local external testing facilities where still higher test currents or voltages are needed.

Although resistors are generally seen as 'energy consuming' elements, they do improve overall system performance, simply by minimizing down-times. A good example of this is LVRT by which resistors allow wind turbines to keep producing energy during a grid fault where they would otherwise be switched off.

Backer-Facsa offers grid resistors for both low voltage and high voltage applications. Demands on insulation voltages, load, ingress protection, thermal ohmic drift, vibration withstand-capability, all determine the type of resistor needed. Thanks to a wide range of types and the ease of configuration, standard resistors can be used for most applications with and only minor customization being required for special customer needs.

At Backer-Facsa, all assembly and welding of resistor components and routine tests are performed in-house which ensures short leadtimes and high quality of the grid elements. High material-purchasing volumes ensure competitive pricing in this cost-conscious market.

The grid elements are manufactured using punching and laser-cutting machines and then assembled into resistor blocks. The stainless-steel stamped grids are fitted on mica insulated steel rods. The grids are spot-welded together. The grid blocks are then mounted into cabinets. The terminals are fitted and the inter-connections are made . Backer-Facsa also uses wire-wound elements for high ohmic resistors.



Backer-Facsa  
Resistor Division  
Llanera– Asturias

## Design

Metal grid brake resistors comply of several plates, fitted on steel rods, separated by ceramic rings. The plates are welded together for electrical connection. Depending on the ohm value and or the topology, cross connections between different plate groups can be made. The resistor block is then fitted into either a rack or fitted to mounting brackets. Different steel materials and alloys with different electrical properties can be chosen from to match customers demands. Thermal low drift alloys outperform stainless steel types. Electrical connections depend on the current rating. Standard values are 40A/ 54A/ 125A / 200A / 320A / 500A / 800A thick coated steel, on request AISI 304. Performance versus cost is an important topic.

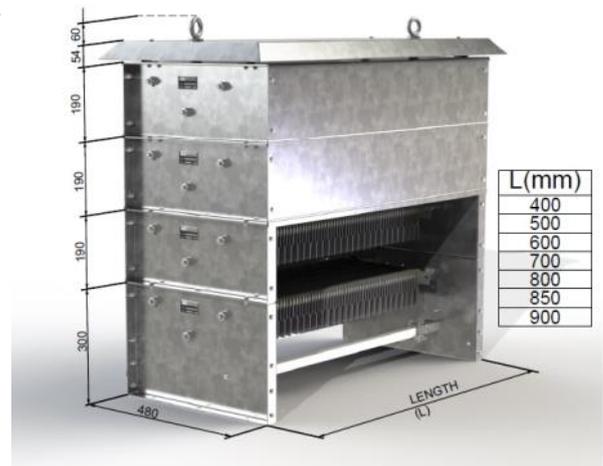
### Enclosures: protection class and materials

Brake resistors are offered as resistor blocks (IP00) and with an enclosure. The standard enclosures are IP10/13/20/23 and designed according IEC60529. IP23 rating is suitable for indoor and outdoor use as it allows sufficient cooling and provides more than adequate protection unless the environmental conditions are extreme (to prevent the ingress of foreign bodies greater than 12mm, and rain falling at any angle up to 60° from the vertical). Standard enclosures are manufactured from unpainted galvanized sheet steel. Enclosures in stainless steel, like AISI 304 and AISI 316, or mild steel painted in any specific color are on request. If required, other enclosure materials and special finishes can be arranged to comply with users specifications.

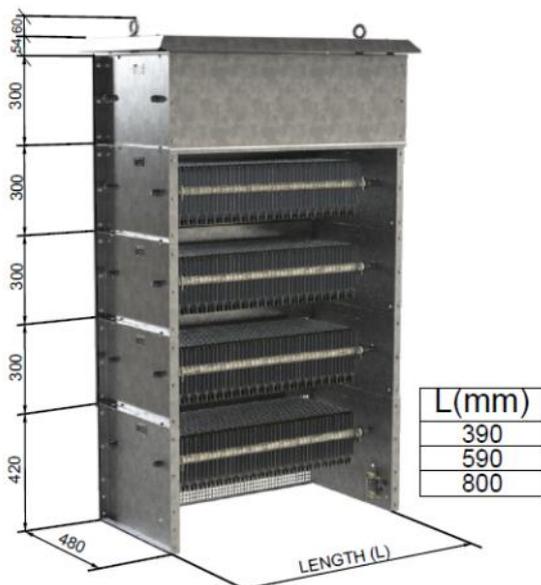
### Main parameters

For selecting a brake resistor the following parameters are necessary:

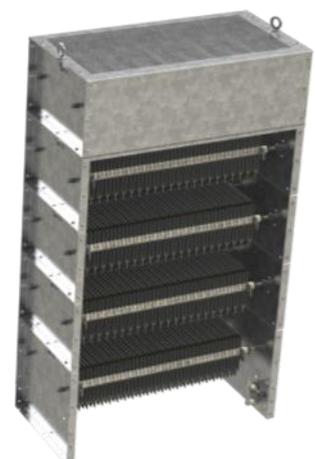
- Resistance value
- Working voltage level / Insulation voltage level
- Brake load pattern (power, duty time and cycle time and shape)
- Protection class



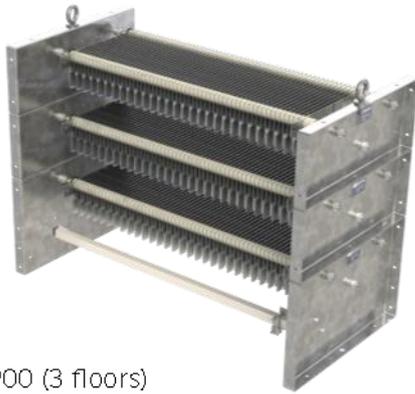
Cut Grid cabinet (CGC-LV), up to 4 levels



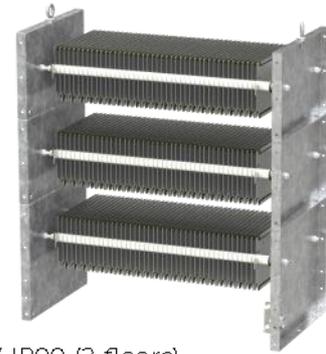
LAGC-LV IP23



IP20  
Laser Grid Cabinet (LAGC-LV), up to 5 levels



CGC-LV IP00 (3 floors)



LAGC-LV IP00 (3 floors)

**Routine tests**

- Measurement of insulation resistance between enclosure and resistor
  - Dielectric test 50Hz/1 minute between active part en housing (voltage levels up to 120kV) conform directive IEC 60298: 1990
  - Dimensional check according relevant drawings
- optional
- Measurement of inductance value
  - Measurement of DC resistance
  - Measurement of metal surface thickness (galvanized or painted)

**Standards / directives**

- IEC 60071-1 Insulation coordination
  - IEC 60529. IP Protection degree.
- All manufacture takes place in our factory operating to ISO 9001 quality standard.



Table 1

GENERAL DATA		
Reference	CGC-LV	LAGC-LV
working voltage	1000VAC / 1400VDC	
dielectric test	3kV 50Hz, 1 min.	
Power (kW)	3kW - 29kW	5kW - 55kW
Grid size	275 x 105 x 1 mm	350 x 190 x 1mm
Thermal coefficient (1/°C)		
AISI 304	0.0011	
Cr-AL	0.000145	
Length (mm)	400/500/600/700/800/850/900	390/590/800
Width (mm)	480	480
Height (mm)	300 - 870	420 - 1620
No. Floors	4	5
Standards reference	IEC 60071-1 Insulation co-ordination IEC 60529. IP Protection degree	
Cooling method	Self cooling	
De-rating at altitude	According IEE Std 32	
Resistor tolerance	± 10 % as standard, other on request	
Resistor active part materials	AISI-304 / AISI-310 / Cr-Al / AISI-430	
Enclosure materials	Galvanized steel as standard, other on request	
Ingress Protection IEC 60529	00 / 10 / 13 / 20 / 23	
Connections	40A/ 54A/ 125A / 200A / 320A / 500A / 800A	

## Nominal power and maximum overload power

In table 2 the maximum power for duty times from 10 seconds to 80 seconds is given at a cycle time of 120 seconds. As can be seen the resistors can endure a high overload during relative short time (on-time). The energy from the overload heats up the active material to its maximum grid surface temperature. During the resting period (off-time) the energy is further released into the air. The cycle time is the on-time plus the off-time and taken here as 120 seconds. For other load patterns and or cycle times, please consult Backer-Facsa for support.

## Thermal Coefficient

Depending on the customers requirement different materials can be used for the grids; steel AISI 304 with 0.0011/°C or Cr-AL alloy with 0.000145/°C. The maximum grid temperature is 500°C. However, the average temperature is lower. The thermal drift should be based on the average temperature increase. To calculate the ohm value at elevated temperature the following formula applies:

$$R_{hot} = R_{cold} \cdot (1 + K_{th} \cdot \Delta T)$$

$R_{cold}$  is the nominal ohm value at 25°C

$R_{hot}$  is the ohm value at elevated temperature

$K_{th}$  is the thermal coefficient, here 0.0011 for AISI 304 or 0.00014 for Cr-AL

Underneath table 2 give the maximum overload value per duty time (from 10 to 80 seconds), the maximum ohm value, the number of floors (for Laser grid box the maximum is 5) and the number of laser cut grid plates. The maximum ohmic values given are based on our standard available metal sheet material. Other values are very well possible. Please, consult Backer-Facsa.

## Laser Grid Cabinets

Table 2

floors	# grids	P <sub>nom</sub> [kW]	AISI 304	Cr-Al	Maximum power, cycle time 120 seconds [kW]				
					10 s	20 s	40 s	60 s	80 s
390mm	10	P <sub>nom</sub>	max R	max R	10 s	20 s	40 s	60 s	80 s
1	10	5	31	29	40	19	11	8	7
2	20	9	62	58	65	33	19	14	11
3	30	13	93	86	100	50	28	20	17
4	40	15	125	115	120	60	33	24	20
5	50	17	156	144	130	65	35	27	22
590mm	20	P <sub>nom</sub>	max R	max R	10 s	20 s	40 s	60 s	80 s
1	20	10	62	58	75	40	22	16	13
2	40	17	125	115	130	65	35	27	22
3	60	25	187	173	190	95	55	40	33
4	80	30	249	231	230	120	65	50	40
5	100	33	311	288	260	130	75	55	45
800mm	34	P <sub>nom</sub>	max R	max R	10 s	20 s	40 s	60 s	80 s
1	34	17	106	98	130	65	35	27	22
2	68	29	212	196	220	110	65	45	40
3	102	45	318	294	350	170	100	70	60
4	136	50	424	392	380	190	110	80	65
5	170	55	529	490	420	210	120	90	70

### Cut grid cabinet resistors (CGC-LV)

Cut grids are smaller in size, resulting in a lower maximum power rating per grid. Our standard size is 275 x 105 x 1mm. The maximum power is about 160W and varies slightly on the thickness and the number of cuts the grid has. For higher ohm values more cuts and or a thinner grid is used. Lower ohm values are achieved by using thicker plate material and less number of cuts. The maximum power per cabinet depends on the number of floors (the number of blocks mounted on top of each other) and the IP rating. In the table, the power is listed with a cabinet that has IP23 rating. Lower IP ratings result in a slightly higher permissible maximum power. With cabinets with a lower IP rating the power losses can be expelled easier to the ambient as the air flow is better/faster then with a higher IP rated cabinet.

Underneath table 3 shows the maximum overload value per duty time (from 10 to 80 seconds), the maximum ohm value, the number of floors (for cut grid box the maximum is 4) and the number of cut grid plates. The maximum ohmic values given are based on our standard available metal sheet material. Other values are very well possible.

floors	# grids	Pnom kW	AISI 304 Ω	Cr-Al Ω	Maximum power, cycle time 120 seconds kW				
					10 s	20 s	40 s	60 s	80 s
<b>400mm</b>	<b>18</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	18	3	2.7	4.7	22	11	6	5	4
2	36	5	5.3	9.5	40	19	11	8	6
3	54	7	8.0	14.2	55	28	16	12	10
4	72	9	10.6	19.0	65	33	19	14	11
<b>500mm</b>	<b>24</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	24	4	3.5	6.3	29	15	8	6	5
2	48	7	7.1	12.7	50	25	14	10	9
3	72	10	10.6	19	75	35	21	16	13
4	96	12	14	25	90	45	26	19	15
<b>600mm</b>	<b>34</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	34	5	5.0	9.0	40	21	12	9	7
2	68	9	10	18	70	35	21	15	12
3	102	14	15	27	110	55	30	22	18
4	136	16	20	36	130	65	50	26	21
<b>700mm</b>	<b>42</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	42	7	6.2	11.1	50	26	15	11	9
2	84	11	12	22	90	45	25	18	15
3	126	17	19	33	130	65	40	27	22
4	168	20	25	44	160	80	45	32	26
<b>800mm</b>	<b>50</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	50	8	7.4	13.2	60	31	18	13	10
2	100	14	15	26	100	50	30	22	18
3	150	20	22	40	160	80	45	33	26
4	200	24	30	53	180	90	55	40	31
<b>850mm</b>	<b>56</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	56	9	8.3	14.8	70	35	20	14	12
2	112	15	17	30	120	60	33	24	20
3	168	23	25	44	170	85	50	35	30
4	224	26	33	59	200	100	60	40	34
<b>900mm</b>	<b>60</b>	<b>Pnom</b>	<b>max R</b>	<b>max R</b>	<b>10 s</b>	<b>20 s</b>	<b>40 s</b>	<b>60 s</b>	<b>80 s</b>
1	60	10	8.9	15.8	75	35	21	15	13
2	120	16	18	32	130	65	35	26	21
3	180	24	27	48	190	95	55	40	32
4	240	30	35	63	230	120	65	50	40

**grid resistor blocks (LAGB / CGB)**

Grid resistor blocks are the building blocks for assembling a brake resistor. They can also be used in different applications such as filter, energy dump or crowbars. A grid resistor block is a very open construction. It consists of metal grid elements (plates) fitted on steatite rods. The plates are separated by ceramic beads that can endure high temperatures and have high electrical insulation properties. Each metal plate is welded to the next one, connecting all plates in series. For very low ohmic values it is very well possible to connect copper strips to certain points within the block to arrange a parallel connection.

Grid resistor blocks are offered in two materials, AISI 304 and Cr-Al alloy. Please, consult the properties for these different types of grids in table 1. Grid resistor blocks can be fitted with mounting brackets. Because of their open construction the customer must take safety measurements against heat and electric shock. General data on thermal coefficient and other parameters are noted in table 1. Maximum ohmic values, maximum number of grids and power ratings are noted in table 4 and 5.

Laser Grid (LAGB)

Table 4

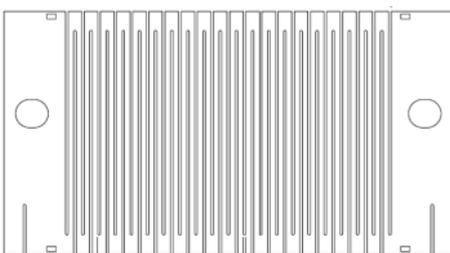
length	# grids	per grid	AISI 304	Cr-Al	Maximum power, cycle time 120 seconds			
length	10	Pnom	max R	max R	10 s	20 s	40 s	80 s
390	10	5 kW	31	29	28 kW	18 kW	11 kW	7 kW
590	20	10 kW	62	58	55 kW	35 kW	22 kW	14 kW
800	34	17 kW	106 kW	98 kW	95 kW	60 kW	35 kW	23 kW

Cut Grid (CGB)

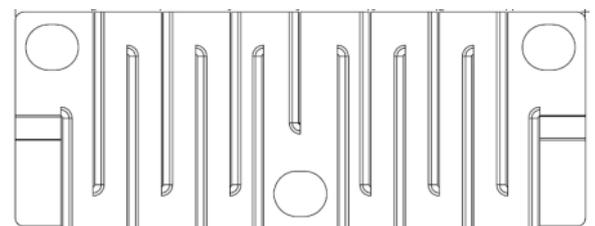
AISI 304 Cr-Al

length	# grids	Pnom	AISI 304	Cr-Al	10 s	20 s	40 s	80 s
length	10	Pnom	max R	max R	10 s	20 s	40 s	80 s
400	18	3 kW	2.7	4.7	16 kW	10 kW	6 kW	4 kW
500	24	4 kW	3.5	6.3	21 kW	13 kW	8 kW	5 kW
600	34	5 kW	5.0	9.0	30 kW	19 kW	12 kW	7 kW
700	42	7 kW	6.2	11.1	40 kW	23 kW	15 kW	9 kW
800	50	8 kW	7.4	13.2	45 kW	28 kW	18 kW	11 kW
850	56	9 kW	8.3	14.8	50 kW	32 kW	20 kW	12 kW
900	60	10 kW	8.9	15.8	55 kW	34 kW	21 kW	13 kW

Table 5



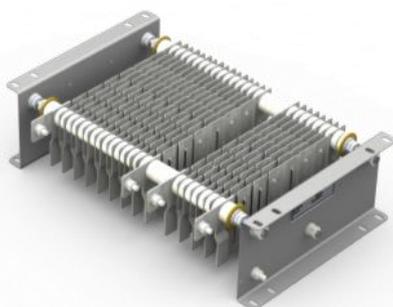
Laser Cut Grid (350 x 190mm)



Cut Grid (275 x 105mm)

**NOMENCLATURE EXAMPLE**

**LAGB-LV-10-39-A-22R-K**



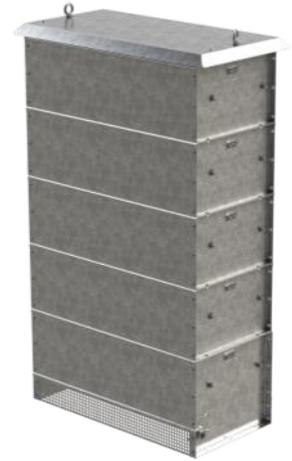
## Backer–Facsas Resistor Division

Brake resistors are necessary to convert kinetic or potential energy into heat. Brake resistors need to be robust, safe and compact. Steel grid resistors have proven to be reliable and cost effective. Brake resistors are used in elevators, escalators, conveyer belts as well as traction and generator applications. In special applications for energy dump, filter or crowbar resistors, grid resistors can very well be used. Please, consult Backer–Facsas Resistor Division when selecting these resistors.

Backer–Facsas offers housed resistors and open style resistor blocks. Backer–Facsas grid resistors are build from standard components, arranged to meet the customers specifications. Special demands on e.g. housing material is very well possible.



CGC-LV, 4 levels



LAGC-LV, 5 levels

