Altivar 68
Telemecanique

Guide d’exploitation
User's manual
Bedienungsanleitung
Guía de explotación

Unités de freinage
Braking units
Bremsmodule
Módulos de frenado

VW3A687537
VW3A687575

Merlin Gerin
Modicon
Square D
Telemecanique

Schneider Electric

Altivar 68

FRANÇAIS

ENGLISH

DEUTSCH

ESPAÑOL

When the drive is powered up, the power components and some of the control components are connected to the line supply. *It is extremely dangerous to touch them. The unit cover must be kept closed.*

After the ALTIVAR has been switched off, *wait for at least 5 minutes before working on the equipment.* This is the time required for the capacitors to discharge. The voltage at the + and – terminals must always be measured. This should be less than 60 V DC.

The voltage at the terminals may be as high as 900 V.

As a rule, *the drive power supply must be disconnected* before any operation on either the electrical or mechanical parts of the installation or machine.

CAUTION

The products and equipment described in this document may be changed or modified at any time, either from a technical point of view or in the way they are operated. Their description can in no way be considered contractual.

NOTE

Contents

Receipt

Ensure that the equipment reference marked on the label conforms to the delivery note corresponding to the order form.
Open the packaging and check that the goods have not been damaged in transit.

For successful setup, it is important to check that the braking unit, protection devices and mounting are correct. For more information, please contact your local representative.

Capacitor discharge!

Before any operation on or in the braking unit, disconnect the power line supply and wait 5 minutes for the DC bus to discharge completely. Measure the voltage on the DC bus before any intervention. This should be less than 60 V DC.

Automatic restart!

In certain cases, depending on its parameter setting, the drive may restart automatically when the power is restored. The safety of nearby equipment and people must be assured.

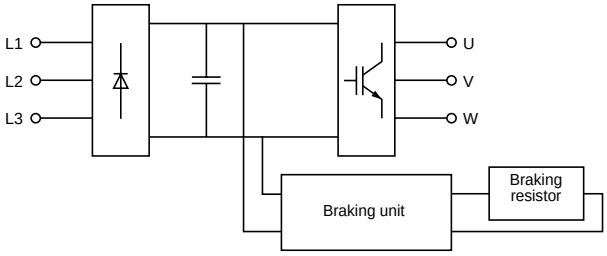
General

If a motor slows down on a deceleration ramp, it is working as a generator. A drive uses a rectifier and cannot restore electrical energy onto the distributor network.
During operation as a generator, the voltage at the terminals of the DC bus increases due to the regeneration of energy from the motor to the drive. This disables the drive on a DC bus overvoltage fault.

The regenerated power in the drive depends on the inertia of the load to be braked and the desired braking time.

The drive protects itself against being disabled due to DC bus overvoltage by auto-adapting its deceleration ramp. If a shorter deceleration time is required, a BRAKING UNIT must be used.

The braking unit is an external module controlled by the drive. If the voltage at the DC bus terminals exceeds a preset value, an external resistor is connected in the DC circuit to dissipate the energy.
The min. resistor should be chosen in relation to the braking unit characteristics tables, its power rating depends on the application.



The braking circuit is not protected against earth currents.

A short-circuit on the DC bus or on PA – PB may cause irreparable damage to the drive.

The voltage at the DC bus terminals may be as high as 900 V DC.

The braking resistors should be installed in a non-flammable atmosphere free of humidity.

Ensure that the braking unit is connected with the correct polarity.

Recommendations

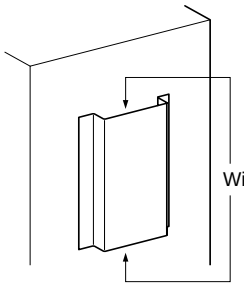
The distance between the drive and the braking unit is limited by the control cable. This distance should be respected for reasons to do with the level of control and interference.
The distance between the braking unit(s) and braking resistor(s) should be respected (50 meters max.).
Otherwise, there is a risk of irreparable damage to the braking unit due to the dv/dt.

Parameter C1.03 should be adjusted in order to activate control of the braking unit.
Select “5… U.F control 1” to use one braking unit.
Select “6… U.F control 2” to use two braking units in parallel on the drive.

With the exception of the ATV68C10N4, all other drives should be fitted with the DC bus connection kit.

The DC bus connection kit is not supplied with the braking unit. It should be ordered separately.

The DC bus connection kit can only be used with sizes 3, 4 and 5.
It includes a protective plastic panel.



Braking unit

The external braking unit is used with a drive on an application operating in all four quadrants.
Depending on which drive, braking unit and braking resistor are chosen, the max. power and permanent braking torque can be optimized.

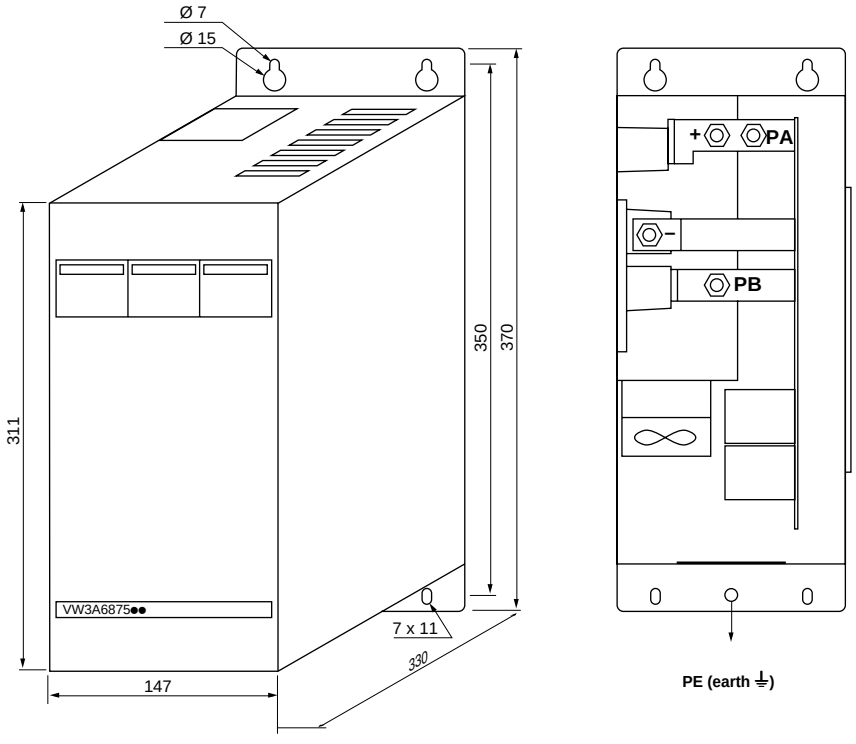
The braking unit is controlled by the drive.
By setting parameters for the braking resistor values, its use can be monitored.

The connection between the braking unit and the drive should not exceed 0,9 meter and is attached as follows:

Size 2 (C10)	: under the drive
Size 3 and 4 (C13 to C33)	: on the left of the drive
Size 5 (C43 to C63)	: on the right of the drive

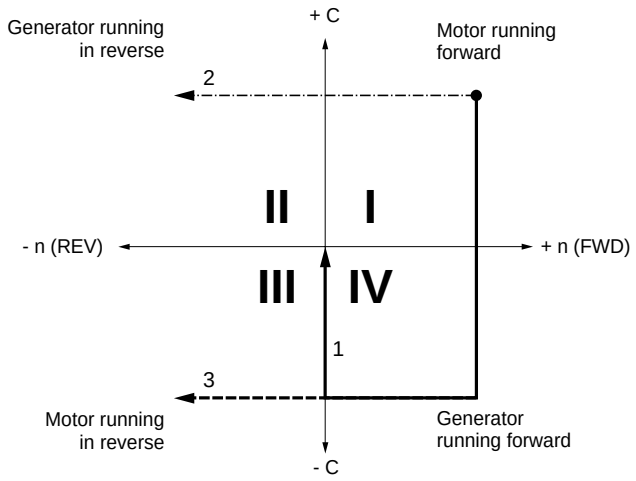
Connect the braking unit as follows :
- Connect the braking module control cable (the braking unit has a factory-fitted 0,9-meter cable for connection to the drive)
- Use the + and – terminals to make the connection between the drive and the braking unit.
- Use the PA and PB terminals to make the connection between the braking unit and the braking resistor.

Connect the braking unit to earth on the M8 nut marked PE using a cable of 10 mm^2 minimum.
It is advisable to use a line contactor which should open when a fault appears on the braking unit. The “contact. line” function in parameter C6.00 can be used for this purpose.



Braking principle and calculation

To obtain a good operating ratio between a drive and a braking unit, the exact motor torque and speed must be known in the different operating quadrants.
If both these values have an opposing sign, we get the following speed-torque diagram:



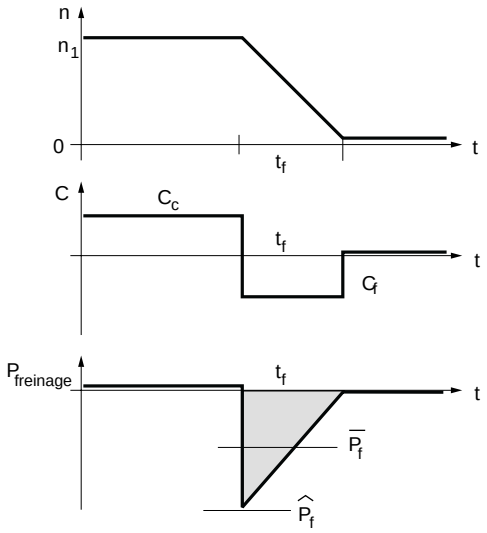
1 Motor slowing down to zero speed with constant torque
2 Transient state in a hoisting movement during inversion of up/down direction
3 Slowdown and change of direction for a motor at constant torque

As a general rule, the power is: $P = \frac{C \cdot n}{9{,}55}$

Hence, the motor power (+P) is expressed in quadrant I (+C, +n) and III (-C, -n).
The generator power (-P) is expressed in quadrant II (+C, -n) and IV (-C, +n).

In principle, examples of a generating load are separated into two groups:

1 Braking power during deceleration

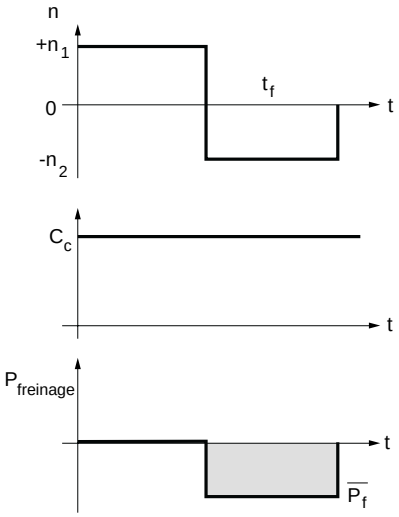


n_1 Motor speed
C_c Load torque
C_f Braking torque
$\hat{P}_f$ Max. braking power
$\overline{P}_f$ Average braking power during t_f
t_f Braking time

The braking power is characterized by a peak power $\hat{P}_f$ obtained at the start of deceleration, which decreases to 0 in proportion with the speed.

Example : Stopping centrifuges, travel, change of direction, etc

2 Braking at constant speed



At constant speed, the braking power is constant throughout braking.
With fast dynamic braking (deceleration ramp < 2 s) the peak power lasts longer due to the inertia of the load.

Example : Vertical downward movement, motor/generator test bench, gravity conveyors, etc

Using a drive

Using an asynchronous machine in quadrants II and IV makes the motor work as a generator and restores the electrical energy to the drive DC bus via its inverter bridge.
The drive DC voltage cannot be restored to the line supply.
This is why the DC bus voltage increases when the motor is acting as a generator.

If the energy restored to the DC bus during braking exceeds the losses generated in the motor and the drive, then the DC bus voltage increases. To deal with this problem, it is necessary to increase the deceleration time or to use a braking unit.

The regenerated power depends on the inertia of the load and the duration of the deceleration ramp.

The drive prevents itself from being disabled due to overvoltage by auto-adapting the duration of its deceleration ramp. To maintain a short ramp duration (or follow the deceleration ramp) or to work with a driving load, it is necessary to use a braking option such as the braking unit.

Calculating the braking power

1) Calculating the braking time from the inertia

$$t_f = \frac{J \cdot \omega}{C_f + C_r}$$

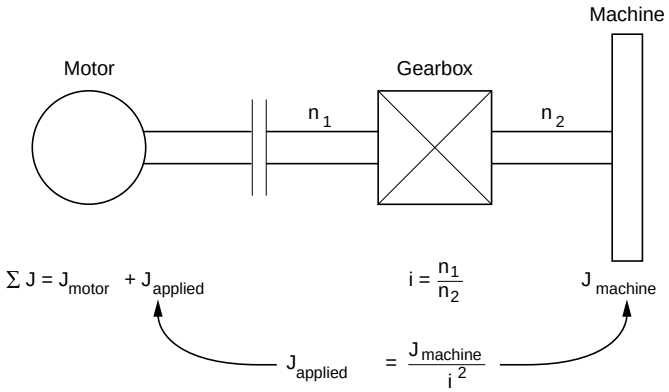
$$\omega = \frac{2\pi \cdot n}{60}$$

$$C_f = \frac{\Sigma J \cdot (n_1 - n_2)}{9{,}55 \cdot t_f}$$

$$\hat{P}_f = \frac{C_f \cdot n_1}{9{,}55}$$

$$\bar{P}_f = \frac{\hat{P}_f}{2}$$

C_f	Motor braking torque	[Nm]
ΣJ	Total inertia applied to the motor	[kgm^2]
n_1	Motor speed ahead of gearbox	[r/min]
n_2	Motor speed after gearbox	[r/min]
t_f	Braking time	[s]
$\hat{P}_f$	Peak braking power	[W]
$\bar{P}_f$	Average braking power during time t_f	[W]



2) Braking a load moving horizontally with constant deceleration (eg : carriage)

$$W = \frac{m \cdot v^2}{2} \qquad \bar{P}_f = \frac{W}{t_f} \qquad \hat{P}_f = \bar{P}_f \cdot 2$$

W	Kinetic energy	[Joule]
m	Mass	[kg]
v	Speed	[m/s]
t_f	Braking time	[s]
$\hat{P}_f$	Peak braking power	[W]
$\bar{P}_f$	Average braking power during time t_f	[W]

3) Braking an active load (eg : test bench)

$$\bar{P}_f = \frac{C_f \cdot n}{9{,}55}$$

$\bar{P}_f$	Average braking power during time t_f	[W]
C_f	Braking torque	[Nm]
n	Motor braking speed	[r/min]

4) Braking a downward vertical movement

$$\bar{P}_f = m \cdot g \cdot v \qquad \hat{P}_f = m \cdot (g + a) \cdot v + \frac{J \cdot \omega^2}{t_f} \qquad \omega = \frac{2\pi \cdot n}{60}$$

$\bar{P}_f$	Average braking power during time t_f	[W]
$\hat{P}_f$	Peak braking power	[W]
m	Mass	[kg]
g	Acceleration	9.81 m/s^2
a	Deceleration	[m/s^2]
v	Linear downward speed	[m/s]
J	Moment of inertia	[kgms^2]
w	Angular speed	[rad/s]
t_f	Downward stopping time	[s]
n	Downward motor speed	[r/min]

All the braking power calculations are only true if it is assumed that there are no losses ($\eta = 1$) and that there is no resistive torque.

Since all these points are important, an accurate assumption must be made :

1 Losses in the system
The losses generated in the motor (working as a generator, quadrants II and IV) are of some help during the braking phase. Without exception, efficiency must be calculated to the braking power squared.
2 Resistive torque
There may sometimes be resistive torque related to mechanical friction, air and opposing quadratic torque of the fans.
These phenomena, which are rarely taken into consideration, reduce the braking power. The resistive torque or the power should be deduced from the calculated braking power.
3 Driving torque
Additional phenomena, such as the wind, may cause an increase in the braking power. These phenomena should be taken into consideration.

The required braking power is calculated as follows :

$$\hat{P}_{fR} = (\hat{P} - P_{charge}) \times \eta^2_{total} \qquad \bar{P}_{fR} = (\bar{P} - P_{charge}) \times \eta^2_{total} \qquad \eta_{total} = \eta_{mec} \times \eta_{mot} \times 0{,}98$$

$\hat{P}_{fR}$	Max. actual braking power	[W]
$\bar{P}_{fR}$	Max. actual continuous braking power	[W]
η_{total}	Total efficiency	
P_{load}	Braking power relating to the resistive torque	[W]
η_{drive}	Drive efficiency = 0.98	

Selecting the braking unit

The first criterion for selecting the braking unit is the braking power ($\hat{P}_f$, $\bar{P}_f$), but it is also necessary to consider the following points when selecting the braking option :

- Type of installation and protection of the braking resistors
- Wiring conditions
- Problems with heat dissipation (air conditioning)
- Cost and possibility of depreciation of the installation due to the reduced costs of electrical energy

For braking, the braking resistor is selected to match the required power and the braking cycle.

In general :

$$\hat{P}_{max} = \frac{U^2_d}{R}$$

$\hat{P}_{max}$	Maximum braking power available with the braking unit	[W]
P_{contin}	Permanent thermal braking power	[W]
U_d	Braking unit control level	[V]
I	Braking resistor thermal current (see the TH setting)	[A]

P_{Cycle} See the braking cycle diagram

The drive has a protection device inside the braking resistor. See parameters E3.06, E3.07 and E3.08.
The protection curve and other advice is given in the programming guide.
If this protection curve is suitable for your braking resistors, then it is possible to use the internal protection. If not, external protection must be provided by a thermal overload relay.

Thermal overload relay
P = nominal braking resistor power
R = value of the resistor

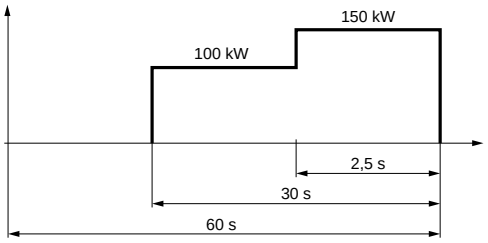
$P = R\,I^2 \Rightarrow I = \sqrt{\frac{P}{R}}$ = thermal overload relay rated value

In the formula, we have : $\hat{P}_{max} = \frac{U^2 d}{R}$

$\hat{P}_{max}$ = Braking unit power + R
Pcontinuous = I^2R (Resistor P)

Example of selection of a braking resistance for a hoisting application :

Cycle :



Customer data : Raising/lowering cyclee = **1 minute**
Cd/Cn = **1,38**
Raising with rated load at steady state : **106 kW**
η_{total} = **0,85**

Calculations : 106 kW leads to selection of a 120kW motor
120 kW x 0,85 = 102 kW ⇒ 100 kW braking at steady state
102 kW x 1,38 = 140 kW ⇒ selection of 150 kW max braking power

The speed controller used is a 132 kW ATV68C19N4 (min. braking resistance = 3 Ω)

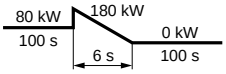
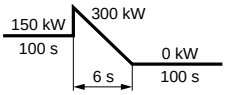
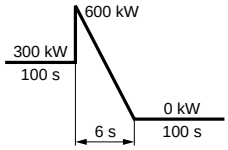
With the aid of the braking unit characteristics table a VW3A687575 braking unit is selected.

The minimum resistance to be used is determined as a function of the speed controller used and the braking unit selected, and with the aid of braking resistance cycle curves.

Braking cycle: 60 s = 150 kW max. for 2.5 s and 100 kW for 30 s.

Braking resistance VW3A68716 can be used since it accepts 100 kW for more than 30 s and 150 kW for 2.5 s.

Braking unit characteristics

Descriptions		Braking unit VW3A687537	Braking unit VW3A687575	2 x Braking unit VW3A687575
Max. braking power (790 V factory setting)	At 790 V DC	180 kW	300 kW	600 kW
	At 680 V DC	140 kW	220 kW	440 kW
% of conduction time at constant power at 690 V DC		6% at 180 kW	6% at 300 kW	6% at 600 kW
		15 % at 140 kW	15 % at 250 kW	15 % at 500 kW
		50 % at 80 kW	50 % at 150 kW	50 % at 300 kW
Cycle time		≤ 200 s		
Max. continuous power		37 kW	75 kW	150 kW
Braking power cycle on a vertical movement (values given for a cycle time of 200 s)				
Adjustable braking engage threshold (Parameter C1.04)		660...820 V DC ±1%		
Degree of protection		IP 20		
Mounting		Vertical mounting		
Ambient temperature		0... + 45 ° C		
Storage temperature		-25... + 65 ° C		
Cooling		Ventilated 45 m^3/hr (1 fan)	Ventilated 90 m^3/hr (2 fans)	Ventilated 2 x 90 m^3/hr
Losses (approx.)		250 W	500 W	2 x 500 W
Degree of pollution		2 according to standard EN 50178		
Humidity		class 3K3 without condensation		
Altitude		≤ 2000 m		
Weight		9 kg	10 kg	2 x 10 kg
Power connections		M8		
Cable cross-section (max.) between drive and braking unit		2 x 1 x 50 mm^2	2 x 1 x 95 mm^2	2 x 1 x 95 mm^2 per braking unit
Cable cross-section (max.) between resistor and braking unit		2 x 1 x 50 mm^2 or 2 x 2 x 35 mm^2	2 x 1 x 95 mm^2 or 2 x 2 x 50 mm^2	2 x 1 x 95 mm^2 or 2 x 2 x 50 mm^2

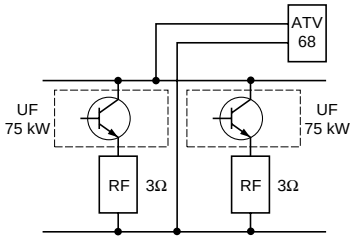
Braking resistor minimum value

Drive		Minimum resistor value		
Type	Power HT/ST (3)	VW3A687537 37 kW unit	VW3A687575 75 kW unit	Two 75 kW units (1)
	kW	Ohm	Ohm	Ohm
ATV68C10N4	75/90	4.2	4.2	-
ATV68C13N4	90/110	3.3	3	3
ATV68C15N4	110/132	3.3	3	3
ATV68C19N4	132/160	3.3	3	3
ATV68C23N4	160/200	3.3	2.1	1.5
ATV68C28N4	200/250	3.3 (2)	2.1	1.5
ATV68C33N4	250/315	3.3 (2)	2.1	1.5
ATV68C43N4	315/400	3.3 (2)	2.1 (2)	1.05
ATV68C53N4	400/500	3.3 (2)	2.1 (2)	1.05
ATV68C63N4	500/630	3.3 (2)	2.1 (2)	1.05

(2) Use possible, but not recommended (max. braking unit power < max. drive power).
(3) HT = High torque; ST = Standard torque

(1) For 2 braking units (BU) in parallel, the value indicated corresponds to the equivalent resistance as seen by the drive.
1.5 = 2 x 3 Ω in parallel

3 Ω = 6 Ω on each BU
1.5 Ω = 3 Ω on each BU
1.05 Ω = 2.1 Ω on each BU



Resistance seen by the drive = 1.5 Ω

Drive adjustment parameters

C1.03 set to value 5 "…UF control 1" controls one braking unit.
or
C1.03 set to value 6 "…UF control 2", if two braking units are connected to the drive.

C1.04 Adjusts the control threshold of the braking unit
- For a 400 V 3-phase supply, the braking unit control threshold is between 660 VDC and 820 VDC
- For a 440 V 3-phase supply, the braking unit control threshold is between 720 VDC and 820 VDC
- For a 460 V 3-phase supply, the braking unit control threshold is between 750 VDC and 820 VDC
- For a 500 V 3-phase supply, the braking unit control threshold is between 790 VDC and 820 VDC

Recommended value : 790 V for all types of mains supply (factory setting).

C1.05 Activates automatic optimization of the level of braking control during use of two braking units in parallel.
Should only be adjusted if a number of braking units are connected on the same DC bus. Do not adjust this parameter if only two braking units are controlled by the drive.

E3.06 Activates the "braking resistor overload" function
- In position "0" no overload monitoring
- In position "1" an overload will disable the drive
- In position "2" an alarm 1 is activated in the event of an overload, without disabling the drive. A configurable message is displayed and a configurable logic output changes state. In this case, a protection circuit must be provided for the braking resistor (see the alarm configuration section in the ATV68 programming guide).
- In position "3" an alarm 2 is activated in the event of an overload, without disabling the drive. A configurable message is displayed and a configurable logic output changes state. In this case, a protection circuit must be provided for the braking resistor (see the alarm configuration section in the ATV68 programming guide).

Positions 1, 2 and 3 : adjust parameters E3.07 and E3.08.

E3.07 Used to adjust the installed braking resistor power (0.1…1000.0 kW)

E3.08 Used to adjust the ohmic value of the installed braking resistor (0.1…200.0 Ω)

Testing the braking functions

The braking unit performs a self-test whenever a command is received from the motor and every 100 s in the form of a short braking test.
If the braking unit is not connected or is short-circuited, an error message appears on the drive.
All the energy reinjected into the drive causes the DC bus voltage to increase. The DC bus voltage is limited by a command from the braking unit at the threshold configured in parameter C1.04.

During braking, a noise may be heard in the braking resistor.
The DC bus voltage can be displayed via parameter A3.02.
The displayed power, parameter A2.04, is negative.

Parameter A3.12 "thermal state" displays the present thermal state calculated for the braking resistor.
When the result reaches 100%, the drive is disabled or sends an alarm, depending on the configuration of E3.06.

Drive display

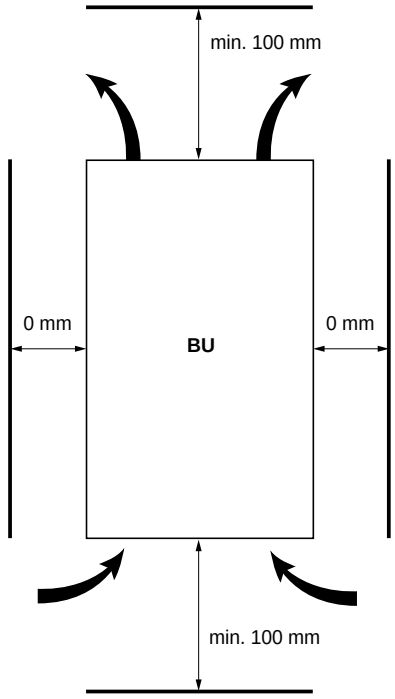
If parameter A6.03 "view limitations" is set to value 1 "visible";
the "braking active" message is displayed in the drive status zone as soon as the braking unit receives a command.

Fault message on the drive

The "Braking unit faulty" fault message indicates that the braking unit controlled by the drive has been disabled.
There are several possible reasons for this error message :
- braking unit short-circuit
- braking resistor short-circuit
- braking unit overheating
- if the braking resistor is missing or the circuit open
- if parameter C1.03 is set to 5 or 6 and no braking unit is connected
- if parameter C1.03 is set to 6 and only one braking unit is connected

Braking unit characteristics

Recommended installation



The braking unit is designed for installation in the vertical position. The braking unit is connected from below. If the wiring is performed correctly, the braking unit meets degree of protection IP20.

The braking unit is cooled by a built-in fan. For this purpose, it is important that air can circulate freely around the braking unit.
The cooling air should be free of dust, gas, or moisture.

Install the unit vertically +/- 10°.
Avoid placing it near radiators. It is especially important to ensure there are no radiators under the drive or braking unit.
Allow sufficient space around the unit to ensure the necessary circulation of cooling air.

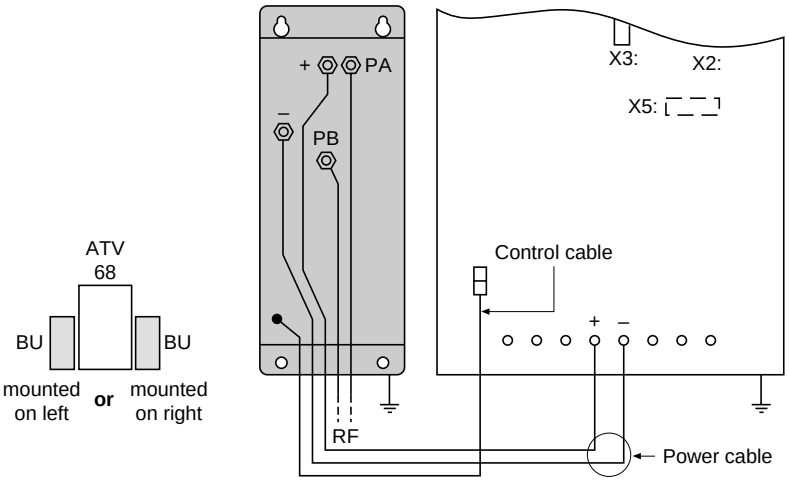
The side distance only applies to mounting and maintenance. It is not imperative.

Mounting recommendation for braking resistors.

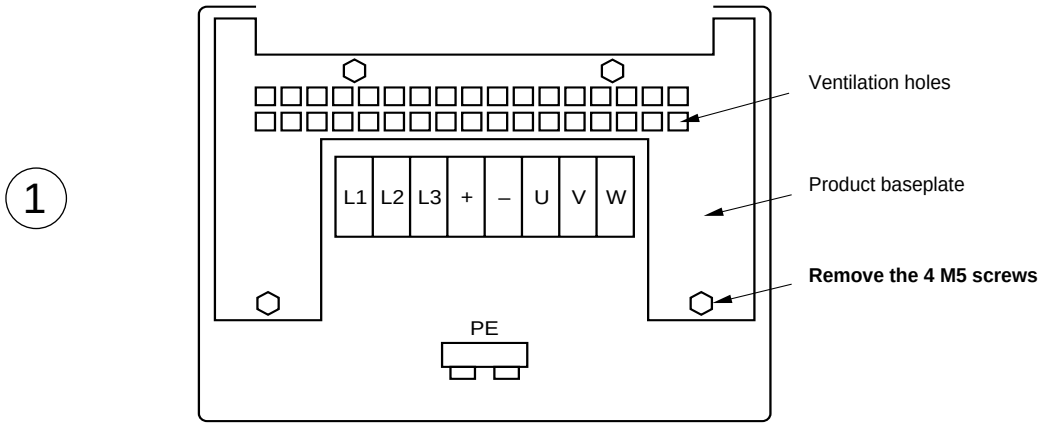
The resistor body (degree of protection IP23) can reach a temperature of 350 °C.
These resistors must be placed where there is no risk of direct contact and kept away from any equipment.
Ventilation must be provided in order for the dissipated energy to disperse.

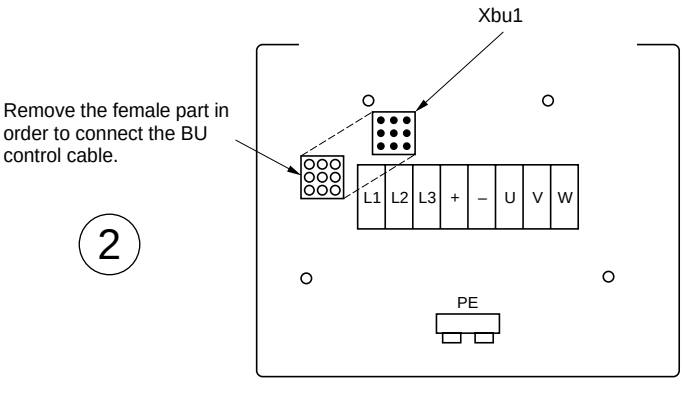
Braking unit connection and position

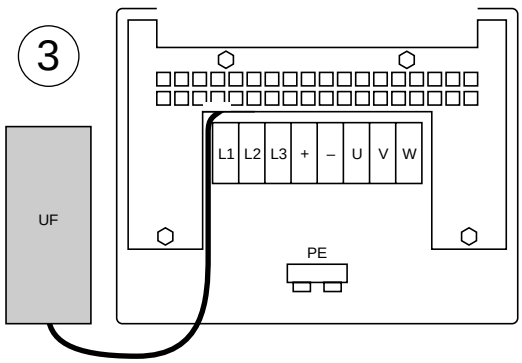
ATV68C10N4



Connecting the braking unit control cable to the ATV68C10N4







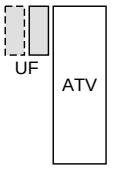
Reposition the baseplate and pass the control cable between the terminals and the baseplate.

On the C10 rating, only one braking unit can be mounted (37 kW or 75 kW) on the right or left of the drive. On the other ratings, two braking units can be mounted.

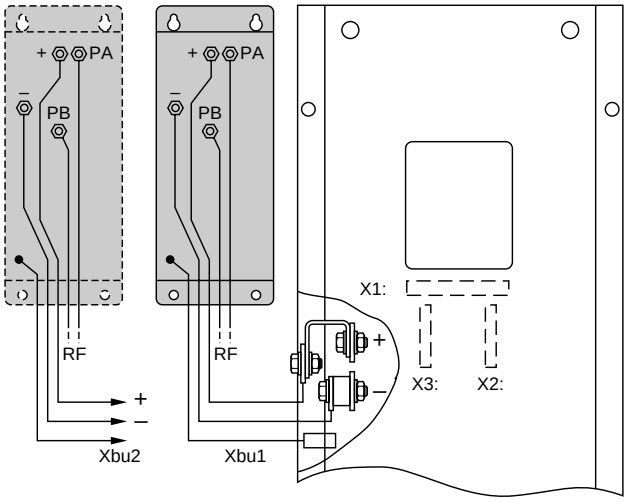
- Length of control cable : 90 cm (maximum).
- Length of + and - power cable limited by the 90 cm of control cable.

Connecting the braking unit

ATV68C13N4 to C33N4



The braking unit(s) can only be mounted on the left of the drive.



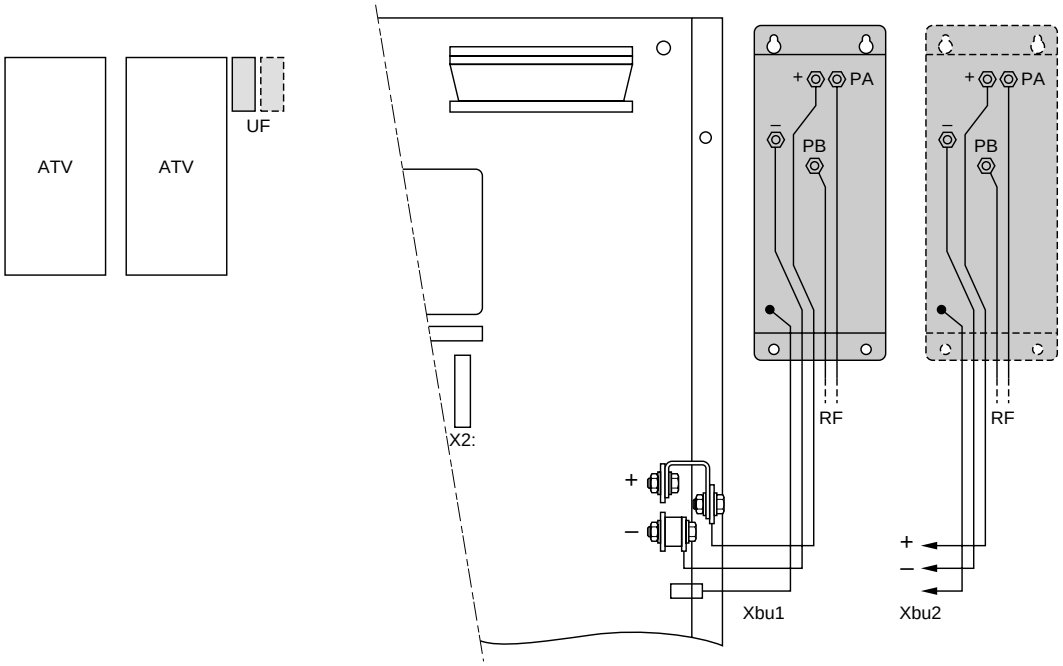
+ Cable connecting the power part
–

Xbu1 or 2 : Control cable. See connection of the control cable on the next page.

Connecting braking units in parallel :
- Connection in parallel of **two 37 kW braking units** is **not possible**.
- Connection in parallel of **two 75 kW braking units** is **possible**.

When the BUs are connected in parallel, the + and - are connected on the drive.

ATV68C43N4 to C63N4



+ Cable connecting the power part
–

Xbu1 or 2 : Control cable. See connection of the control cable on the next page.

Connecting braking units in parallel :
- Connection in parallel of **two 37 kW braking units** is **not possible**.
- Connection in parallel of **two 75 kW braking units** is **possible**.

When the BUs are connected in parallel, the + and - are connected on the drive.

Connecting the braking unit

Connecting the control cable (Xbu1 and/or Xbu2) on sizes 3 and 4 (left), 5 (right)

On sizes 3, 4 and 5, two connectors are available for connecting 2 braking units.

Length of control cable : 90 cm (maximum).

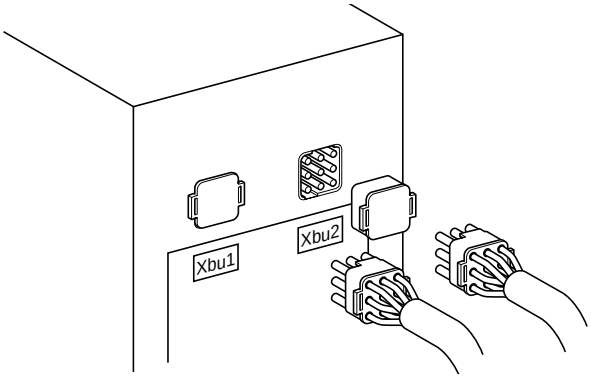
Length of + and - power cable limited by the 90 cm of control cable.

When **only one braking unit** is **connected** it should be on **Xbu1** and not Xbu 2.

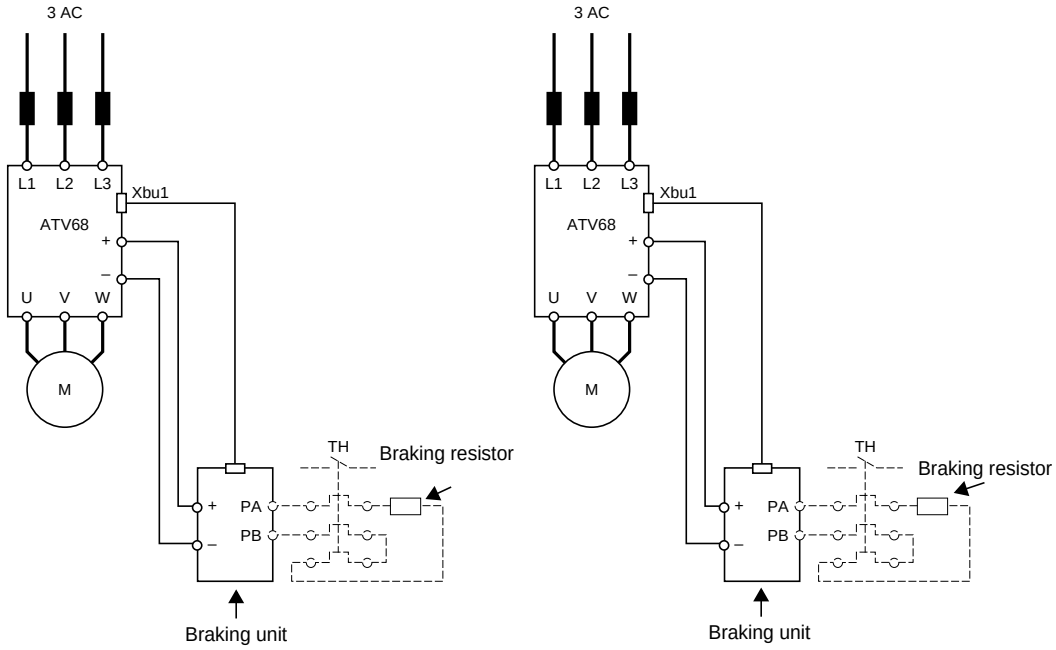
The drive connectors, Xbu 1 and Xbu 2 are male plugs. The drive is supplied with a female connector plugged onto the male.

Remove the female connector to attach the braking unit control connector, and only for this purpose. If the second braking unit is not being used, leave the female connector in place. This plays a role in isolating the contacts.

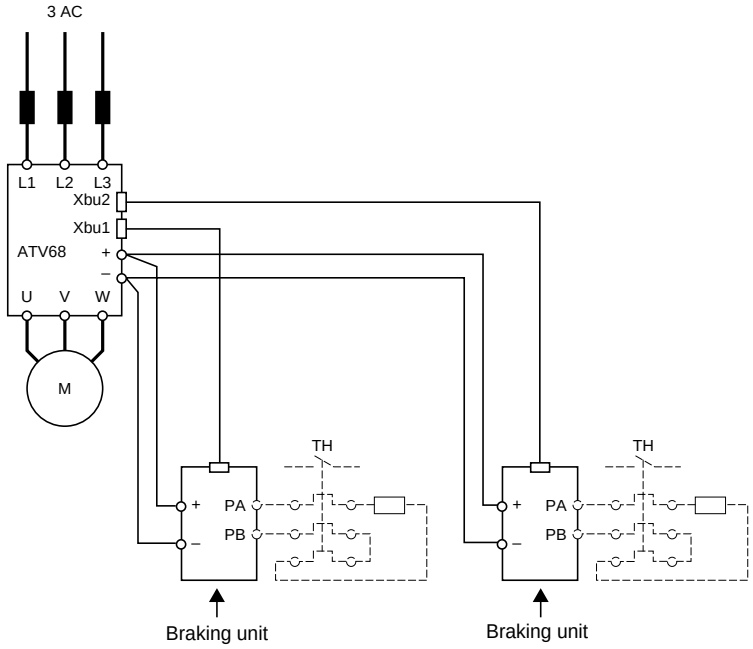
Connecting the control cable



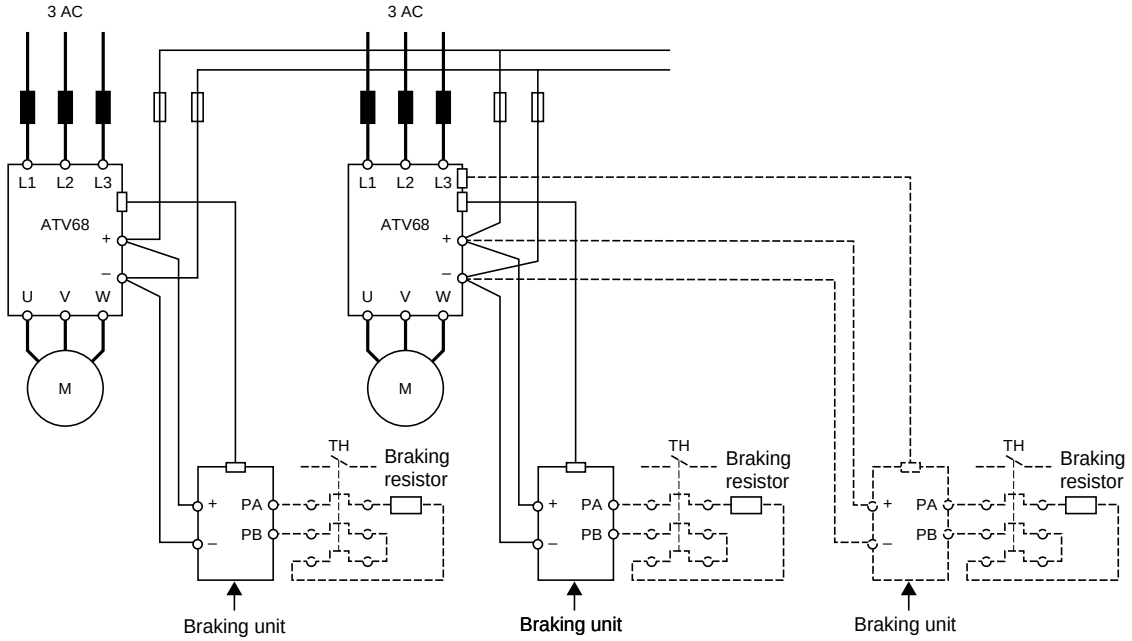
Connecting a drive to a braking unit and a braking resistor



Connecting a drive and two braking units



Connecting two drives, both connected to one braking unit, to a single DC BUS



DC bus
It is possible to have drives of different ratings connected to one DC bus (following the recommendation in the User's Manual to have 1 size maximum between ratings). For BUs it is possible to mix 37 kW and 75 kW.

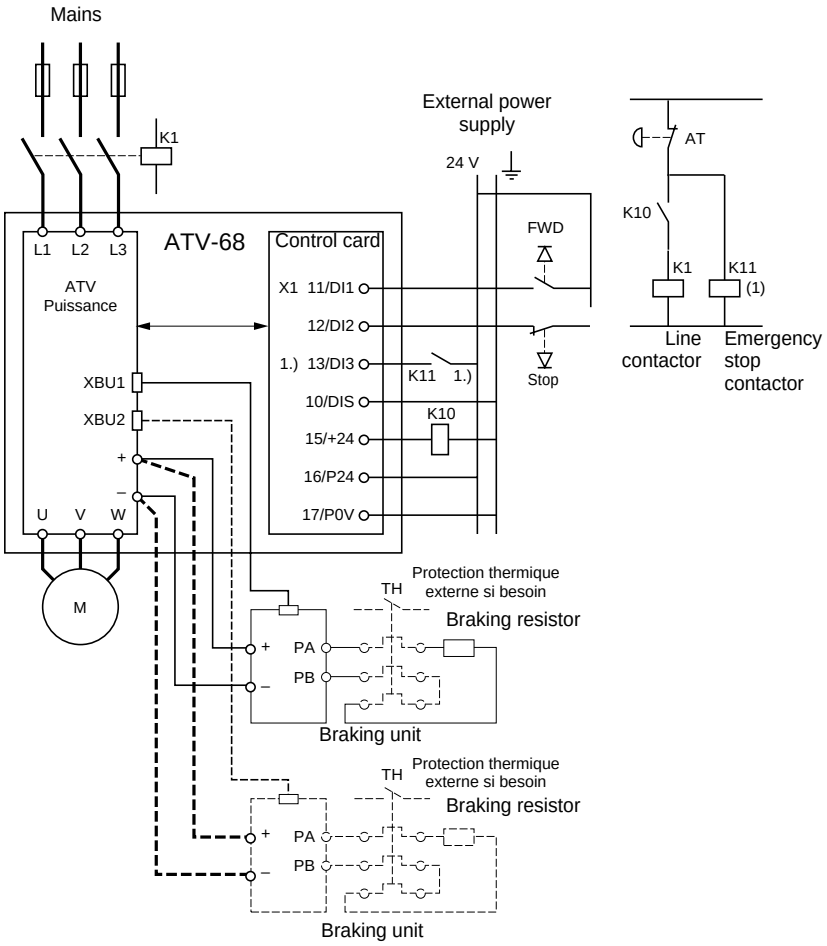
2 possible types of control

1 Controlling braking units in parallel
If the "braking unit balancing" function has been activated using parameter C1.05, the drive will control the braking units in such a way as to divide the braking power correctly (the trip level in C1.04 should be set to the same value for all the drives).

2 Independent control of braking units (for specific applications)
This type of control is chosen in cases where the braking resistors are different and the control parameters in C1.04 "Braking level" are different. A braking unit associated with a resistor with a high ohmic value always produces a low continuous braking power and another braking unit associated with a resistor with a low ohmic value always produces a max. peak braking power.

RECOMMENDATION : Use the same braking units, the same braking resistors and the same adjustment values for C1.04 "Braking level" in the drives.

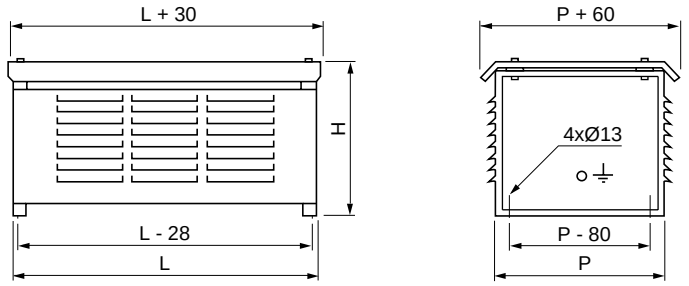
Connecting two braking units in parallel on a single ATV-68 drive with line contactor monitoring.



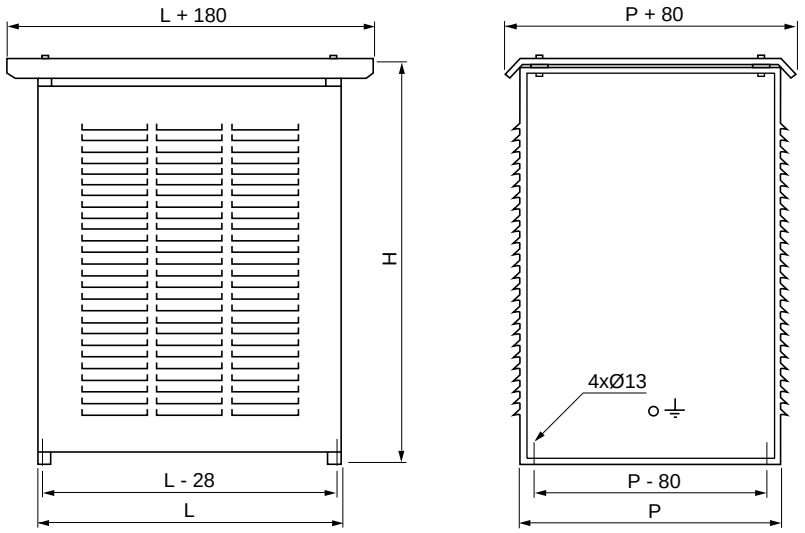
(1) Contact K11 activates a logic input configured for the “32 Mains ON/OFF” function, parameter C6.00.
In the event of an emergency stop, the drive is disabled immediately.

Braking resistance characteristics

Overall dimensions



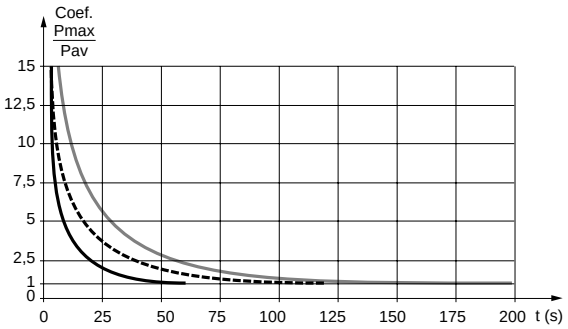
	R° at 20° C	R max hot Ohm(s)	P av (kW)	H (mm)	L (mm)	P (mm)	Weight (kg)
VW3A68706	4.16	5.64	5	440	500	480	28
VW3A68707	3.36	4.57	8	440	580	480	35
VW3A68708	2.16	2.90	10	440	670	480	41
VW3A68709	4.55	6.23	18	440	860	480	53
VW3A68710	3.33	4.50	26	690	860	480	97
VW3A68711	4.26	5.74	28.4	690	860	480	97



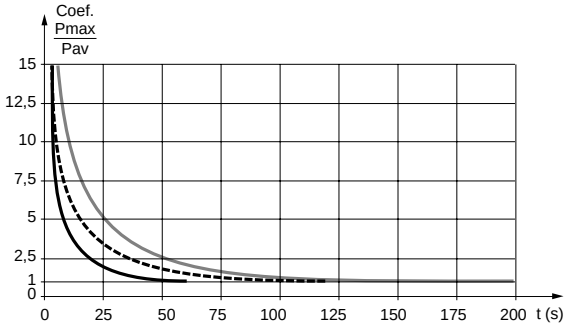
	R° at 20° C	R max hot Ohm(s)	P av (kW)	H (mm)	L (mm)	P (mm)	Weight (kg)
VW3A68712	3.28	3.80	32	1150	960	380	75
VW3A68713	2.20	2.60	47	1150	960	540	90
VW3A68714	2.10	2.44	59	1150	860	740	110
VW3A68715	3.35	4.50	50	1150	960	540	110
VW3A68716	3.10	3.60	70	1150	960	740	120
VW3A68717	2.10	2.87	88	1150	860	540	90
VW3A68718	2.10	2.48	100	1150	960	540	94

Braking resistance characteristics

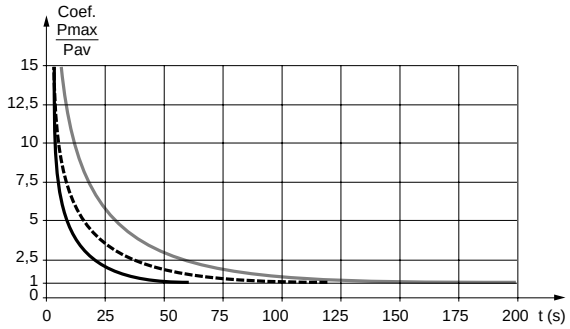
VW3A68706 (P av = 5 kW)



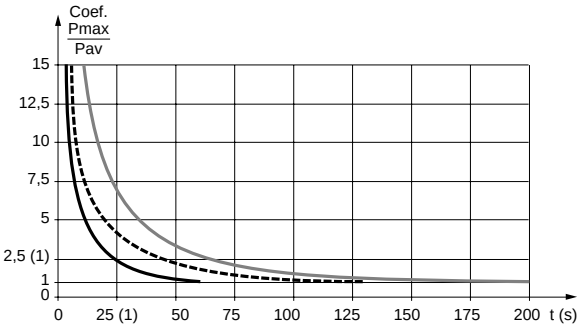
VW3A68707 (P av = 8 kW)



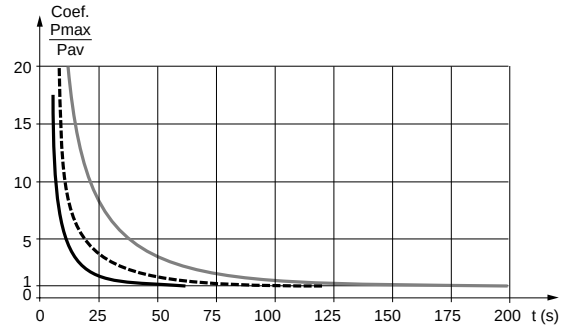
VW3A68708 (P av = 10 kW)



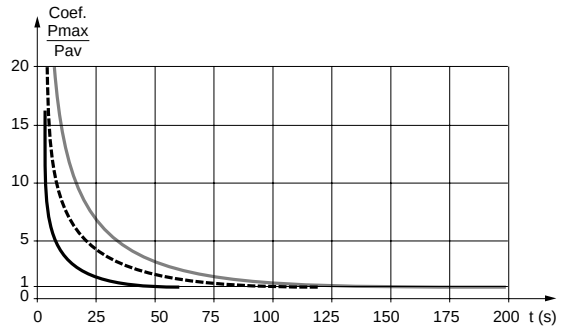
VW3A68709 (P av = 18 kW)



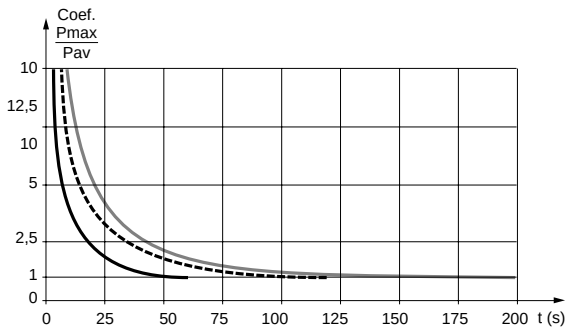
VW3A68710 (P av = 26 kW)



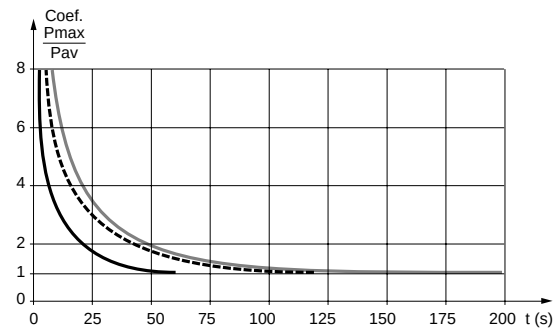
VW3A68711 (P av = 28,4 kW)



VW3A68712 (P av = 32 kW)



VW3A68713 (P av = 47 kW)

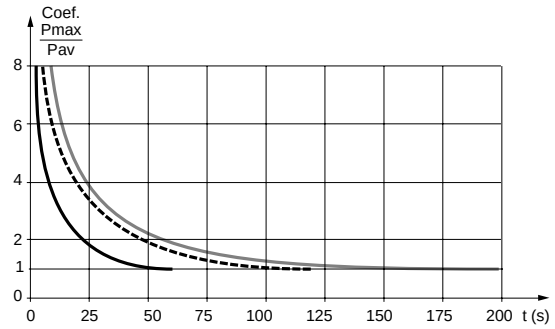


P max/P av (cycle 60 s)
P max/P av (cycle 120 s)
P max/P av (cycle 200 s)

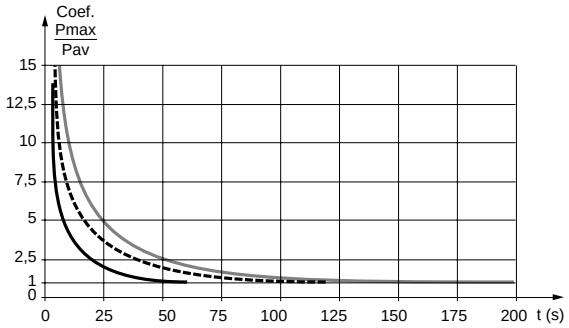
(1) **Example :**
For a cycle of 60 sec the 18kW resistance VW3A68709 accepts an overload of 2.5x18 kW for 25 s. That is 45 kW for 25 s.

Braking resistance characteristics

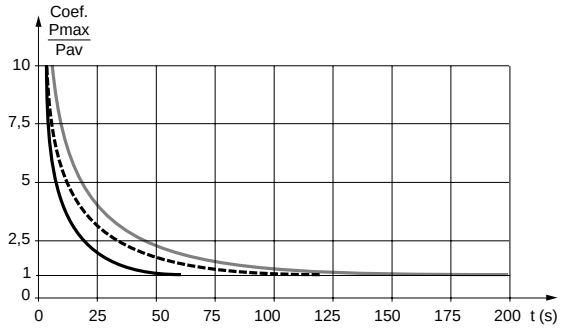
VW3A68714 (P av = 59 kW)



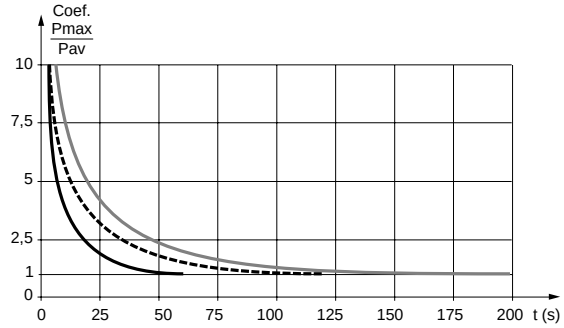
VW3A68715 (P av = 50 kW)



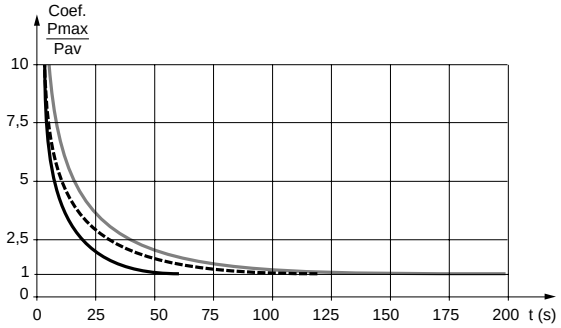
VW3A68716 (P av = 70 kW)



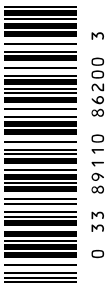
VW3A68717 (P av = 88 kW)



VW3A68718 (P av = 100 kW)



P max/P av (cycle 60 s)
P max/P av (cycle 120 s)
P max/P av (cycle 200 s)



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