INFRANOR

Braking resistor

Braking resistor types
for
Infranor drives

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WARNING

This is a general manual describing various braking resistor types for servo drives having output capability suitable for driving AC brushless sinusoidal servo motors.

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the drives operational.

Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the drive manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.

Any contact with electrical parts, even after power down, may involve physical damage.
Wait for at least 10 minutes after power down before handling the drives (a residual voltage of several hundreds of volts may remain during a few minutes).

ESD INFORMATION (ElectroStatic Discharge)
INFRANOR drives are designed for being best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the drives are not properly stored and handled.

STORAGE

- The drives must be stored in their original packaging.
- When taken out of their packaging, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the drive connectors and material with electrostatic potential (plastic film, polyester, carpet…).

HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the drives must be handled via their metal housing.
- Never get in contact with the connectors.

WASTE DISPOSAL
In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all INFRANOR devices are labelled with a sticker symbolizing a crossed-out dustbin as shown in Appendix IV of the 2002/96/EC Directive.
This symbol indicates that INFRANOR devices shall be eliminated by selective disposal and not with household waste.

INFRANOR does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.
Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

INFRANOR reserves the right to change any information contained in this manual without notice.

Issue: **1.5**

Content

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Chapter 1 - General description

1.1 - POWER FEEDBACK SYSTEM VIA A BRAKING RESISTOR

All Infranor drives are equipped with the power feedback system. When the motor is decelerating, especially with high inertia and high speed, the mechanical braking energy is reflected to the drive. This energy is dissipated inside a resistor called "braking resistor".
In order to avoid over-heating in the drive cabinet, particular care must be given to the thermal aspect.
It **MUST** be mounted out of range of heat sensitive and inflammable elements (plastic, cable sleeves, etc.).

For an optimum power feedback by the drives in a multiaxis application, the DC bus (DC+ and DC-) can be parallel connected (see application note "*DC bus interfacing*").
In this case, the mains input must also be parallel wired in order to balance the current load inside the AC/DC converters.

It is recommended to mount the braking resistor on the drive with highest current rating.

An electronic control of the dissipated power avoids the overloading of the braking resistor. So, if the energy reflected to the drives with parallel mounted DC busses is too high, the DC bus voltage will rise up to the triggering of the "**Overvoltage**" fault. A second resistor must then be mounted on the second axis.

Chapter 2 - Specifications

2.1 - BRAKING RESISTOR TYPES

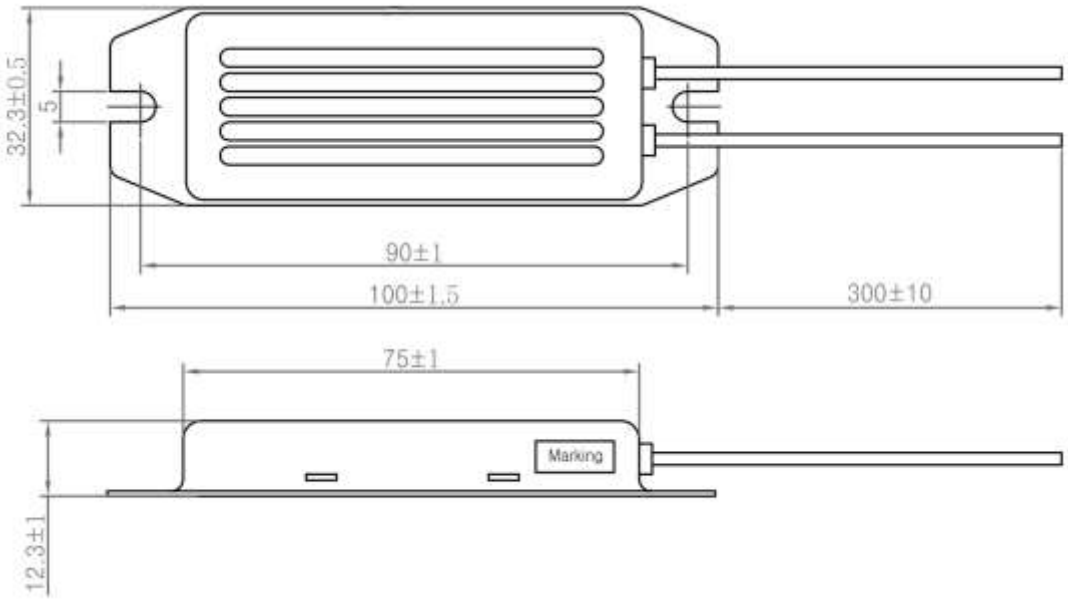
Ordering code	Ohmic value	Rated power	Case size	Compatible Devices (non exhaustive list)	Equivalent Ordering code
dp 1/35	1 Ω	35 W	Case 35	- XtrapulsEasy 60 V / 60 A & 120 A	
dp 7.5/560	7.5 Ω	560 W	Case 560	- XtrapulsGDPS-400/64	
dp 15/280	15 Ω	280 W	Case 280	- For legacy products only	
dp 16.5/560	16.5 Ω	560 W	Case 560	- XtrapulsCD1 400/70 to 90 A - XtrapulsGDPS-400/32	
dp 33/280	33 Ω	280 W	Case 280	- XtrapulsCD1 400 V / 30 to 45 A - XtrapulsGDPS-400/16 - XtrapulsGem 400 V / 5 to 20 A	D2
dp 50/200	50 Ω	200 W	Case 200	- XtrapulsCD1 230 V - XtrapulsCD1 400 V / 14 A - XtrapulsPac 230 V - XtrapulsPac 400 V / 20 A - XtrapulsGem 230 V - XtrapulsGem 400 V / 5 to 20 A - XtrapulsEasy 230 V / 17 A	
dp 100/35	100 Ω	35 W	Case 35	- XtrapulsCD1 230 V - XtrapulsPac 230 V - XtrapulsPac 400 V / 8 A - XtrapulsGem 230 V / 5 to 17 A - XtrapulsEasy 230 V / 17 A	
dp 100/100	100 Ω	100 W	Case 200	- XtrapulsCD1 230 V - XtrapulsPac 230 V - XtrapulsPac 400 V / 8 A - XtrapulsGem 230 V / 5 to 17 A - XtrapulsEasy 230 V / 17 A	
dp 200/100	200 Ω	100 W	Case 200	- XtrapulsCD1 400 / 1.8 to 7.2 A - XtrapulsPac 400 V / 08 A - XtrapulsGem 400 V / 5 to 20 A - XtrapulsEasy 230 V / 17 A	
				-	
dp 400/35	400 Ω	35 W	Case 35	- XtrapulsCD1 400 /1.8 to 7.2 A - XtrapulsPac 400 V / 08 A - XtrapulsGem 400 V / 5 to 20 A - XtrapulsEasy 230 V / 17 A	

The rated power is the value given by the resistor manufacturer.
At this power, the rise in temperature of the resistor reaches 350°C in free air cooling.

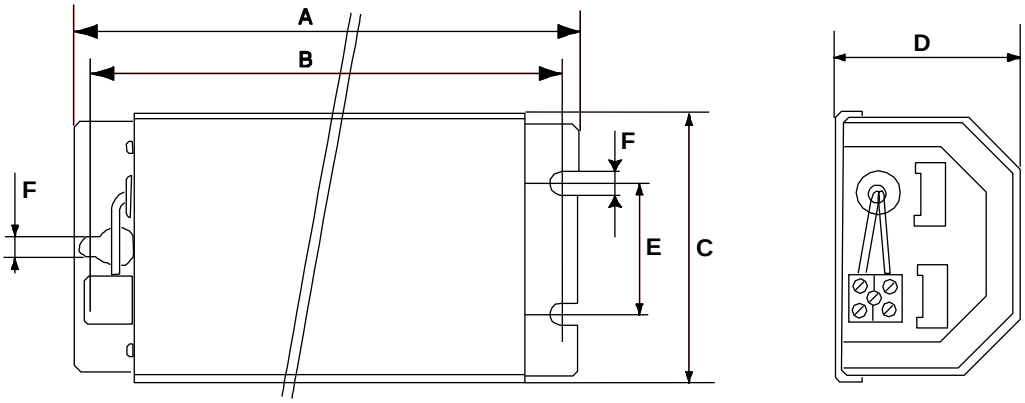
2.2 - DIMENSIONS

VERTICAL MOUNTING IS MANDATORY

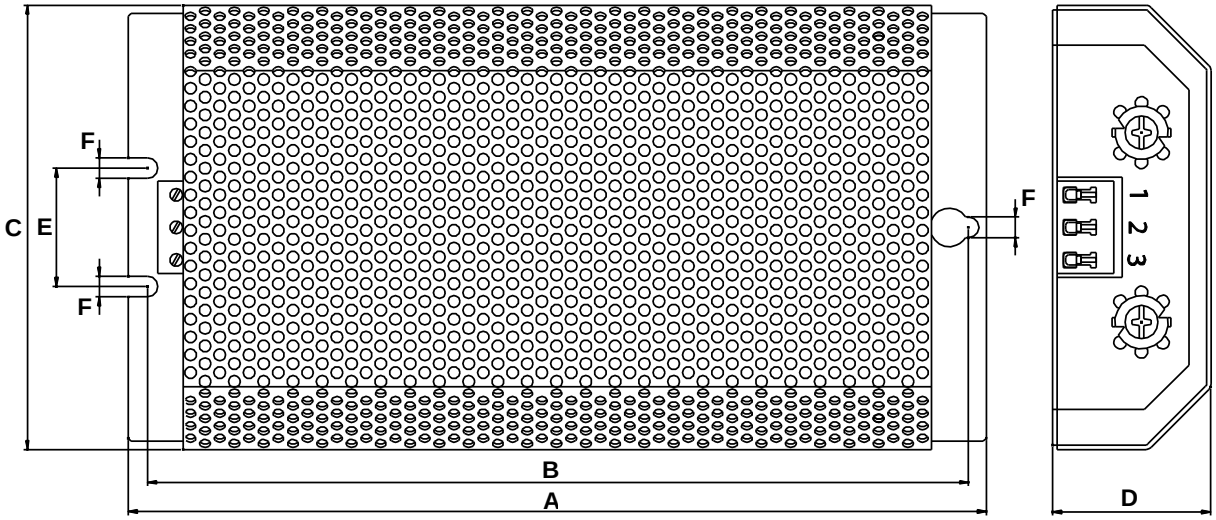
CASE 35



CASE 200



CASE 560



DIMENSIONS (mm)	CASE 200	CASE 280	CASE 560
A	157	290	290
B	145	278	278
C	83	83	150
D	52	57	57
E	40	40	40
F	7	7	7

2.3 - CONNECTION OF THE BRAKING RESISTOR

The braking resistor MUST be mounted out of range of heat sensitive and inflammable elements (plastic, cable sleeves, etc.).

In order to avoid any EMC or electrical problem, some rules must be observed:

- heat must be evacuated,
- shielded cable or at least twisted wires must be used,
- wires must bear high voltage and high temperature (recommended type: UL1015, AWG 14)
- wires must be as short as possible (max. 1 m).

Connection example:

2.4 - OPTIMIZING THE BRAKING RESISTOR

The braking resistor can be chosen according to the drive reference.
However, this choice is not optimized for a lot of applications.
The following method allows the designer to optimize the braking resistor.

Two different quantities are necessary to completely define a braking system:

- The peak power:
  - It defines the deceleration energy,
  - It is limited by the braking transistor current.

- The average power:
  - It defines the heat dissipation

2.4.1- Estimation of the regenerative power

The regenerative power must be calculated for each deceleration phase of each motor.

$$P_{LOAD} = \frac{J_{TOTAL}.(n_1^{\ 2} - n_2^{\ 2})}{180.t_{DEC}} - \frac{T_{LOAD}.(n_1 + n_2)}{19}$$

$$P_{MOTOR} = P_{LOAD}.\eta_{COUPLING}$$

$$P_{JOULE} = \frac{3}{2} R_{MOTOR}.I_{MOTOR}^{\ 2}$$

$$P_{ELEC} = P_{MOTOR} - P_{JOULE}$$

With:
- P_{LOAD}: Power regenerated by the load during the deceleration phase, in W
- J_{TOTAL}: motor + load inertia of the axis reflected to the motor shaft, in kg.m²
- n_1: Rotation speed at the beginning of the deceleration phase, in RPM
- n_2: Rotation speed at the end of the deceleration phase, in RPM
- t_{DEC}: Deceleration time, in s
- T_{LOAD}: Torque applied by the load on the motor shaft at the beginning of the deceleration phase in Nm
- P_{MOTOR}: Power regenerated on the motor shaft, in W
- $\eta_{COUPLING}$: Efficiency of the mechanical coupling (gearbox). If no gearbox is used $\eta_{COUPLING} \approx 1$
- P_{JOULE}: Losses in the motor windings, in W
- R_{MOTOR}: Winding resistance measured between two phases of the motor, in Ω
- I_{MOTOR}: Average current in one phase of the motor during the deceleration phase, in A
- P_{ELEC}: Average power managed by the drive during the deceleration phase, in W

2.4.2 - Choice of the ohmic value

$$R_{MIN} \leq R_{BRAKING} < \frac{U_{BRAKING}^{\ 2}}{2.\hat{P}_{ELEC}}$$

With:
- R_{MIN}: Minimum braking resistor value in Ohm according to section "Main technical data".
- $U_{BRAKING}$: Triggering threshold of the braking system, in V.
- $R_{BRAKING}$: Braking resistor, in Ω.
- $\hat{P}_{ELEC}$: Maximum of all P_{ELEC} calculated for all motors and for all deceleration phases, in W.

2.4.3 - Average power

The required average power must be calculated to correctly choose the size of the braking resistor and to take into account the heat dissipation effect into the near environment.

$$P_{AVERAGE} = \frac{\sum_{1,1}^{N,P} P_{ELEC}(n,p) \times T_{DEC}(n,p)}{T_{CYCLE}}$$

With: P_{ELEC}: Power managed by the drive axis n during the deceleration phase p, in W

2.4.4 - Braking I²t setup

$$P_{I^2t} = \frac{t_{ON}}{1000} \cdot \frac{U^2_{BRAKING}}{R_{BRAKING}}$$

With: P_{I^2t}: Maximum average power (in W) allowed by the braking I²t function, in W
t_{ON}: Conduction time allowed by the braking I²t function, in ms
$U_{BRAKING}$: Triggering threshold of the braking system, in V
$R_{BRAKING}$: Braking resistor, in Ω