GE Consumer & Industrial
Electrical Distribution

AF-650 GP™
General Purpose Drive

Brake Resistor Design Guide

imagination at work

Contents

1 How to Read this Design Guide

1.1.1 How to Read this Design Guide

This Design Guide will introduce all aspects of Brake Resistors for your AF-650 GP; From choosing the right Brake Resistor for the application to instructions about how to install it and how to programme the Frequency converter.

GE technical literature is also available online at www.geelectrical.com/drives

1.1.2 Symbols

Symbols used in this manual:

NB!
Indicates something to be noted by the reader.

Indicates a general warning.

Indicates a high-voltage warning.

*	Indicates default setting

1.1.3 Abbreviations

Alternating current	AC
American wire gauge	AWG
Ampere/AMP	A
Current limit	I_{LIM}
Degrees Celsius	°C
Direct current	DC
Drive Control Tool PC Software	DCT 10
Drive Dependent	D-TYPE
Electro Magnetic Compatibility	EMC
Electronic Thermal Overload	Elec. OL
Gram	g
Hertz	Hz
Kilohertz	kHz
Meter	m
Millihenry Inductance	mH
Milliampere	mA
Millisecond	ms
Minute	min
Nanofarad	nF
Newton Meters	Nm
Nominal motor current	$I_{M,N}$
Nominal motor frequency	$f_{M,N}$
Nominal motor power	$P_{M,N}$
Nominal motor voltage	$U_{M,N}$
Parameter	par.
Protective Extra Low Voltage	PELV
Printed Circuit Board	PCB
Rated Inverter Output Current	I_{INV}
Revolutions Per Minute	RPM
Regenerative terminals	Regen
Second	s
Synchronous Motor Speed	n_s
Torque limit	T_{LIM}
Volts	V

2 Safety and Conformity

2.1 Safety Precautions

Equipment containing electrical components may not be disposed of together with domestic waste.
It must be separately collected with electrical and electronic waste according to local and currently valid legislation.

AF-650 GP

Design Guide

2.1.1 CE Conformity and Labelling

What is CE Conformity and Labelling?

The purpose of CE labelling is to avoid technical trade obstacles within EFTA and the EU. The EU has introduced the CE label as a simple way of showing whether a product complies with the relevant EU directives. The CE label says nothing about the specifications or quality of the product. Frequency converters are regulated by three EU directives:

The low-voltage directive (73/23/EEC)

Frequency converters must be CE labelled in accordance with the low-voltage directive of January 1, 1997. The directive applies to all electrical equipment and appliances used in the 50 - 1000 V AC and the 75 - 1500 V DC voltage ranges. GE CE-labels in accordance with the directive and issues a declaration of conformity upon request.

Warnings

When in use the brake resistor surface temperature rises. DO NOT touch the brake resistor during operation.

Never work on a brake resistor in operation.

NB!

Never attempt to repair a defective brake resistor.

3 Introduction

3.1.1 Description of the Brake System

When the speed reference of a frequency converter is reduced, the motor acts as a generator and brakes. When a motor acts as a generator, it supplies energy to the frequency converter which is collected in the intermediate circuit. The function of the brake resistor is to provide a load on the intermediate circuit during braking, thereby ensuring that the braking power is absorbed by the brake resistor.

If a brake resistor was not used, the intermediate circuit voltage of the frequency converter would continue to increase, until it cuts out for protection. The advantage of using a brake resistor is it enables braking of a heavy load quickly, e.g. on a conveyor belt.

GE has chosen a solution in which the brake resistor does not form an integral part of the frequency converter.
This offers the user the following advantages:

- The resistor time cycle can be selected as required
- The heat developed during braking can be conveyed beyond the panel cabinet to allow the energy to be used
- There is no overheating of the electronic components, even if the brake resistor is overloaded

GE offers a range of brake resistors for AF-650 GP.

This Design Guide describes how to choose the right brake resistor for an application. Alternative to using a brake resistor there are other braking methods which can be applied depending on the braking profile of the application. The alternative braking methods can be found in the chapter *Alternative Braking Methods*.

4 How to Choose a Brake Resistor

The GE brake resistor programme consists of two types of resistors, flat packs and wire wound - see pictures below.

Illustration 4.1: Wire Wound

Illustration 4.2: Flat Pack

4.1.1 Flat Packs

The flat pack brake resistors (see Illustration 4.2) for the AF-650 GP series is a safe and compact solution for the customer. At a constant load and free convection the resistor is self protecting as a fuse. This means short circuit proof, no fault to frame, no melting of casing and self extinguishing. The casing is made of anodized aluminum and is IP65 tight.
With the compact flat pack resistor, it is possible to mount the resistor on the rear of a AF-650 GP frequency converter.

The flat pack resistor portfolio covers the lower power range from 0.75 - 7.5 kW (200 - 240 V & 380 - 480 V) - and intended for horizontal applications (conveyors).

4.1.2 Wire Wound

The GE wire wound resistor (see Illustration 4.1) consist of fully welded wire wound ceramic resistors. The base material is a very high temperature (up to 700°C) resistant ceramic, called Corderite. This ensures a resistor which is suitable for pulse loads between 10 - 20 times or more compared to the nominal load, which is used in frequent braking applications such as cranes, hoists and elevators.

To simplify the selection of the wire wound brake resistor GE has chosen to offer two sizes for each drive across the power range, from 0.37 kW to 355 kW (380 - 480 V).
The overall sizes are based on the duty cycle (10% and 40%) which is the proportion between the process time and the braking time. Thus if a 10% duty cycle resistor is applied it is able to absorb/brake away the peak power for 10% of the period. The remaining 90% of the period will be used to deflect excess heat. Depending on the size the periods for the wire wound resistors are 120, 300 and 600 seconds.

The following chapter lists the 10% and 40% brake resistors available for the AF-650 GP drives.

If the optimum brake resistor must be selected it is necessary to know how often and how much the motor is to brake. How to calculate this and application examples can be found in chapter 6 and 7.

The enclosures comply with IP20.

As rule of thumb the 10% resistors are used for horizontal loads (e.g. conveyors, gantry cranes) and the 40% for vertical loads (e.g. cranes, hoists and elevators). However to help choose the right sized brake resistor for an application the flow chart (illustration 3) provides guidance. Answer the questions in the diamond shaped boxes and you are guided to either tables for selection of brake resistors or chapters about how to calculate inertia or duty cycle.

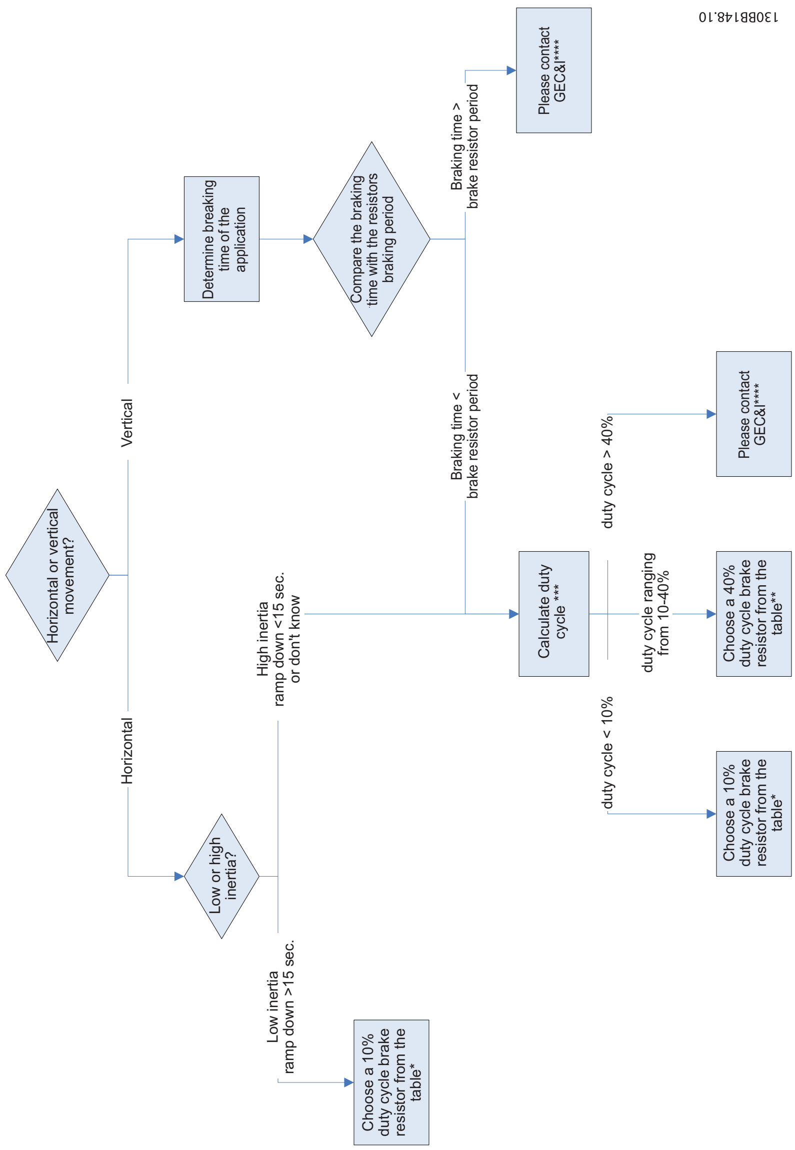


Illustration 4.3: Brake Resistor Selection Flow Chart

*) 40% (same as **)

**) See 10% tables in chapter *Brake Resistor Overview*.

***) See the chapter *Calculation of the Brake Resistor*.

****) Please provide the following info:

- Nominal power 100%
- Max. power during brake cycle
- Braking time / Duty cycle
- Supply voltage (max. DC)
- Resistance (Ω-value)
- With or without thermswitch
- IP enclosure rating

5 Application Examples

5.1 Examples

5.1.1 Example 1 - Conveyor Belt

Illustration 6.1 (see next page) shows the relation between the braking power and the acceleration/braking of a conveyor belt. As can be seen, the motor power during braking is negative, since the torque on the motor shaft is negative. The braking power, i.e. the power to be dissipated to the brake resistor, corresponds almost to the negative motor power, taking the losses in the motor and the frequency converter into account. The example also shows that the motor power is time-dependent.

Kinetic energy (E) in conveyor belt + motor:

$$E = 0.5 \times m \times v^2 + 0.5 \times j \times \omega^2 [Ws]$$

m = mass with linear movement [kg]

v = speed of mass with linear movement [m/s]

j = inertia of motor and gear box [kgm^2]

$$\omega = motor\ speed = \frac{n \times 2}{60} [rad / s]$$

This formula may also be expressed as follows:

$$E = 0.50 \times m \times v^2 + 0.0055 \times j \times n^2 [Ws]$$

However, not all of the energy is to be dissipated to the brake resistor. The friction of the conveyor belt and the power loss of the motor also contribute to the braking function. Consequently, the formula for energy dissipation (E_b) to the brake resistor is as follows:

$$E_b = \left(0.5 \times m \times v^2 + 0.5 \times j \times \omega^2 - 0.5 \times M_f \times \omega\right) \times \eta_{MOTOR} [Ws]$$

M_f = Friction torque [Nm]

η_M = Motor efficiency

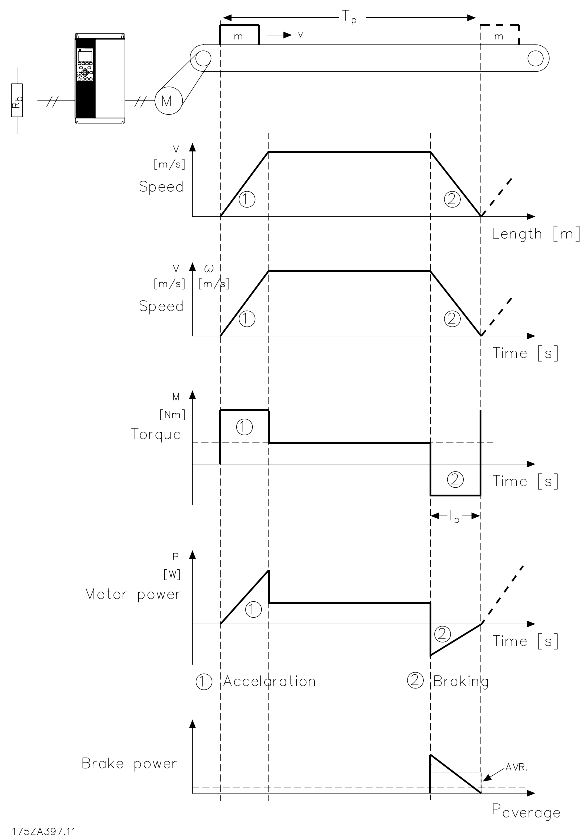
When:

$$\omega = \frac{n \times 2}{60}$$

is inserted, the result is as follows:

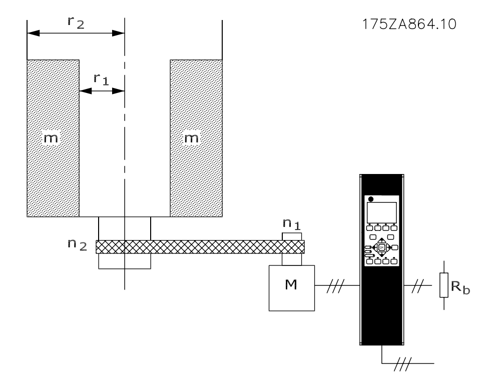
$$E_b = \left(0.5 \times m \times v^2 + 0.0055 \times j \times n^2 - 0.052 \times n \times M_f\right) \times \eta_M [Ws]$$

The relation between braking power and acceleration/braking of a conveyor belt.



5.1.2 Example 2 - Centrifuge

Another typical application in which braking can be required on centrifuges. The weight of the centrifuge content is m.



j_C =	centrifuge inertia = ½ x m x ($r_1{}^2$ + $r_2{}^2$) [kgm²]
j_M =	Gear motor inertia [kgm²]
η_M =	Gear motor efficiency
n_1 =	max. motor speed [rpm]
n_2 =	max. centrifuge speed [rpm]

$$E_b = \left(0.0055 \times j_c \times n2^2 + 0.0055 \times j_M \times n1^2\right) \times \eta_M [Ws]$$

5.1.3 Continuous Braking

For continuous braking, select a brake resistor in which the constant braking power does not exceed the average power P_{avg} of the brake resistor.

NB!

Please contact your GE distributor for further information.

6 Calculation of the Brake Resistor

To ensure the optimal choice of the brake resistor for a given application, its inertia and braking profile, some calculations must be carried out.
This chapter (along with examples in the previous) provides guidance through the necessary calculations to determine the values needed for GE to design the optimal brake resistor for a given application.

6.1.1 Brake Setup

Illustration 7.1 shows a brake set-up using a frequency converter.

The following sections use expressions and abbreviations with respect to a brake set-up that can be seen from illustration 7.1.

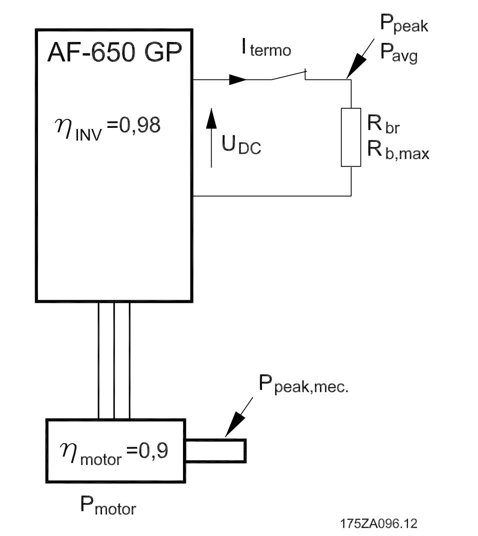


Illustration 6.1: Brake Setup

6.1.2 Calculation of Brake Resistor Values

To keep the frequency converter from cutting out for protection when the motor brakes, the resistor values are to be selected on the basis of the peak braking power and the intermediate circuit voltage:

$$R_{br} = \frac{Udc^2}{P_{peak}} [\Omega]$$

As can be seen, the brake resistor depends on the intermediate circuit voltage (Udc).

Udc is the voltage, where the brake is activated. The Drive-Series brake function is settled in 5 areas of mains:

Size	Brake active	Warning before cut out	Cut out (trip)
AF-650 GP 3 x 200-240 V	390 V	405 V	410 V
AF-650 GP 3 x 380-500 V	810 V	840 V/ 828 V*	855 V
AF-650 GP 3 x 525-600 V	943 V	965 V	975 V
AF-650 GP 3 x 525-690 V	1099 V	1109 V	1130 V
*) 840 V Unit Size 1x, 2x, 3x 828 V Unit Size 4x, 5x, 6x			

NB!
Check that the brake resistor can handle voltages of 410 V, 850 V, 975 V or 1130 V.

GE recommends the brake resistance R_{rec}, i.e. one that guarantees that the frequency converter is able to brake at the highest braking torque ($M_{br(\%)}$) of 160%. The formula can be written as:

$$R_{rec}\,[\Omega] = \frac{U_{dc}^2 \times 100}{P_{motor} \times M_{br\,(\%)} \times \eta_{DRIVE} \times \eta_{motor}}$$

η_{motor} is typically at 0.90

η_{DRIVE} is typically at 0.98

For 200 V, 480 V, 500 V and 600 V frequency converters, R_{rec} at 160% braking torque is written as:

$$200V\ :\ R_{rec} = \frac{107780}{P_{motor}}\,[\Omega]$$

$$480V\ :\ R_{rec} = \frac{375300}{P_{motor}}\,[\Omega]\ 1)$$

$$480V\ :\ R_{rec} = \frac{428914}{P_{motor}}\,[\Omega]\ 2)$$

$$500V\ :\ R_{rec} = \frac{464923}{P_{motor}}\,[\Omega]$$

$$600V\ :\ R_{rec} = \frac{630137}{P_{motor}}\,[\Omega]$$

$$690V\ :\ R_{rec} = \frac{832664}{P_{motor}}\,[\Omega]$$

1) For frequency converters Unit Size 1x

2) For frequency converters Unit Size 2x + 3x

If a higher brake resistor resistanse is selected, 160% / 150% / 110% braking torque cannot be obtained, and there is a risk that the frequency converter will cut out for protection.

If braking is only e.g. at 80% torque, it is possible to install a smaller brake resistor, the size of which can be calculated using the formula R_{rec}, no. 1.

NB!
The resistor brake resistance selected should not be higher than that recommended by GE. If a brake resistor with a higher ohmic value is selected, the 160% braking torque may not be achieved because there is a risk that the frequency converter cuts out for safety reasons.

NB!
If a short circuit in the brake transistor occurs, power dissipation in the brake resistor is only prevented by using a mains switch or contactor to disconnect the mains for the frequency converter. (The contactor can be controlled by the frequency converter).

NB!
Do not touch the brake resistor as it can get very hot while/after braking. The brake resistor must be placed in a secure environment to avoid fire risk

6.1.3 Calculation of Braking Power

When calculating the braking power, it is to be ensured that the brake resistor is able to handle the average power as well as the peak power. The average power is determined by the process period time, i.e. the length of the braking time in relation to the process period time. The peak power is determined by the braking torque, which means that as braking progresses, the brake resistor must be able to dissipate the energy input.

The illustration below shows the relation between the average power and the peak power.

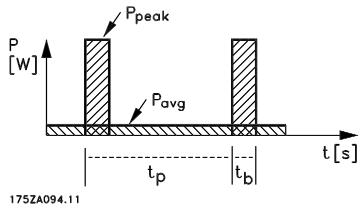


Illustration 6.2: Relation between average power and the peak power.

6

6.1.4 Calculation of the Brake Resistor Peak Power

$P_{peak, mec}$ is the peak power by which the motor brakes on the motor shaft. It is calculated as follows:

$$P_{peak,\ mec} = P_{motor} \times M_{BR(\%)} \quad [W]$$

P_{peak} is the name used for the braking power dissipated to the brake resistor when the motor brakes.

P_{peak} is lower than $P_{peak,mec}$ since the power is reduced by the efficiencies of the motor and the frequency converter.

The peak power is calculated as follows:

$$P_{peak} = P_{motor} \times M_{BR(\%)} \times \eta_{motor} \times \eta_{DRIVE} [W]$$

6.1.5 Calculation of the Brake Resistor Average Power

The average power is determined by the process period time, i.e. the length of the braking time in relation to the process period time.

If the amount of kinetic energy (Eb) transferred to the resistor in each braking sequence (see examples 1 and 2 in the chapter *Application Examples*) is known, the average power of the resistor can be calculated as follows:

$$P_{avg} = \frac{E_b}{T_p} \quad [W]$$

T_p = period time in seconds.

If the amount of kinetic energy transferred to the resistor in each braking sequence is not known, the average power can be calculated on the basis of the process period time and the braking time.

The duty-cycle for the braking sequence is calculated as follows:

6

$$Duty\ cycle = \frac{T_b \times 100}{T_p} \quad [\%]$$

T_b = braking time in seconds.

T_p = process period time in seconds.

GE offers brake resistors with a duty-cycle of max. 10% and 40%, respectively (some drives are only available with a duty-cycle of max. 10%). If a 10% duty-cycle is applied, the brake resistors are able to absorb Ppeak for 10% of the period time. The remaining 90% of the period time will be used on deflecting excess heat.

The average power with 10% duty-cycle can be calculated as follows: $P_{avg} = P_{peak} \times 10\,\% \quad [W]$

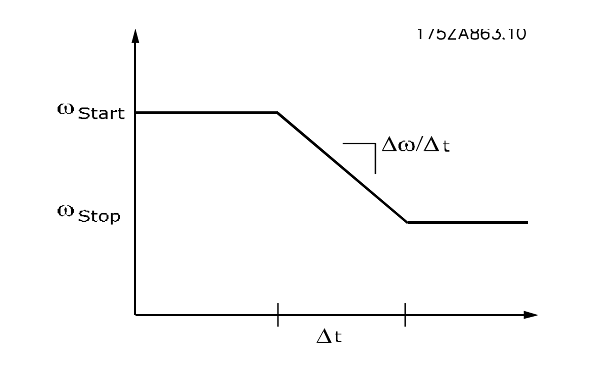
The average power with 40% duty-cycle can be calculated as follows: $P_{avg} = P_{peak} \times 40\,\% \quad [W]$

The calculations apply to intermittent braking using a period time of 120/300/600 seconds.

NB!
Longer time than the specified intermittent braking period time may result in overheating of the resistor.

6.1.6 Braking of Inertia

In the case of braking of high inertia values on the motor shaft, the brake resistor values can be based on the inertia, Δω, Δt. See the illustration below.



Δt is determined by the decel time.

NB!
The decel time goes from the rated motor frequency to 0 Hz.

P_{peak} can be calculated as:

$$P_{peak} = \eta_{motor} \times w_{start} \times j \times \frac{\Delta w}{\Delta t}$$

$$P_{peak} = \eta_{motor} \times \eta_{drive} \times \eta_{start} \times j \times \left(\frac{2 \times \pi}{60}\right)^2 \times \frac{\Delta n}{\Delta t}$$

j is the inertia of the motor shaft.

Calculate the value on the brake resistor as described under the preceding paragraphs.

7 Installation

7.1.1 Brake Cable

Max. length [m]: 20 m screened cable.

The connection cable to the brake resistor is to be screened/armoured. Connect the screen/armouring to the conductive back plate at the frequency converter and to the brake resistor metal cabinet by means of cable clamps.

NB!
Make sure that the brake resistors used are induction-free.

7.1.2 Protective Functions During Installation

When installing a brake resistor, every measure should be taken to avoid the risk of overloading, since a fire hazard may arise owing to the heat generated in the heat resistor.

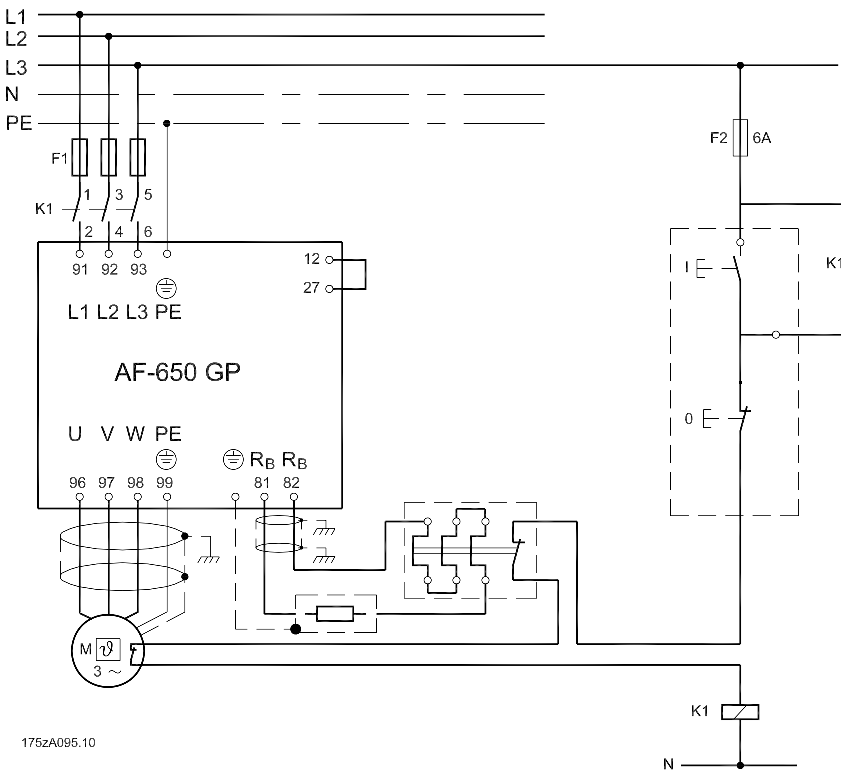
NB!
The brake resistor is to be fitted on a non-flammable material.

For protection of the installation, a thermal relay should be fitted that cuts off the frequency converter if the brake current becomes too high.

Calculate the brake current setting of the thermal relay as follows:

$$\text{Itherm relay} = \sqrt{\frac{P_{brakeresistor\ max}}{R_{brakeresistor}}}$$

R_{br} is the current brake resistor value calculated in the section on "Calculation of brake resistor values". Illustration 7.1 shows an installation with a thermal relay.



Some of the GE Brake resistors contain a thermal switch. This switch is NC (normally closed) and can be used e.g. coasting stop reverse between terminal 12 and 27. The drive will then coast, if the thermal switch is opened.
The thermal switch must comply with PELV.

The brake is protected against short-circuiting of the brake resistor, and the brake transistor is monitored to ensure that short-circuiting of the transistor is detected. A relay/digital output can be used for protecting the brake resistor against overloading in connection with a fault in the frequency converter.
In addition, the brake makes it possible to read out the momentary power and the mean power for the latest 120 seconds. The brake can also monitor the power energizing and make sure it does not exceed a limit selected in par. B-12 *Brake Power Limit (kW)*. In par. B-13 *Braking Thermal Overload*, select the function to carry out when the power transmitted to the brake resistor exceeds the limit set in par. B-12 *Brake Power Limit (kW)*.

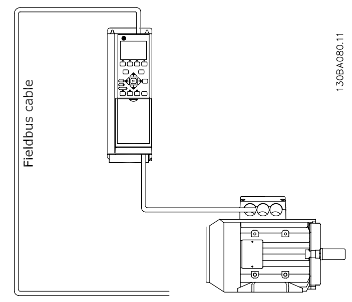
NB!
Monitoring the brake power is not a safety function; a thermal switch is required for that purpose. The brake resistor circuit is not earth leakage protected.

Over voltage control (OVC) (exclusive brake resistor) can be selected as an alternative brake function in par. B-17 *Over-voltage Control*. This function is active for all units. The function ensures that a trip can be avoided if the DC link voltage increases. This is done by increasing the output frequency to limit the voltage from the DC link. It is a very useful function, e.g. if the decel time is too short since tripping of the frequency converter is avoided. In this situation the decel time is extended.

7.1.3 EMC Precautions

The following EMC precautions are recommended in order to achieve interference-free operation of the RS-485 network.

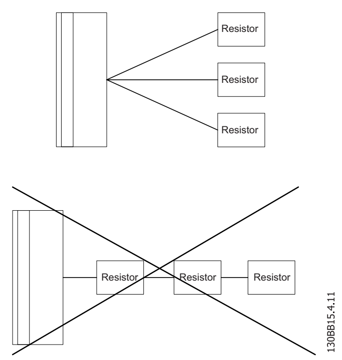
Relevant national and local regulations, for example regarding protective earth connection, must be observed. The RS-485 communication cable must be kept away from motor and brake resistor cables to avoid coupling of high frequency noise from one cable to another. Normally a distance of 200 mm (8 inches) is sufficient, but keeping the greatest possible distance between the cables is generally recommended, especially where cables run in parallel over long distances. When crossing is unavoidable, the RS-485 cable must cross motor and brake resistor cables at an angle of 90 degrees.



7.1.4 Cable Connection

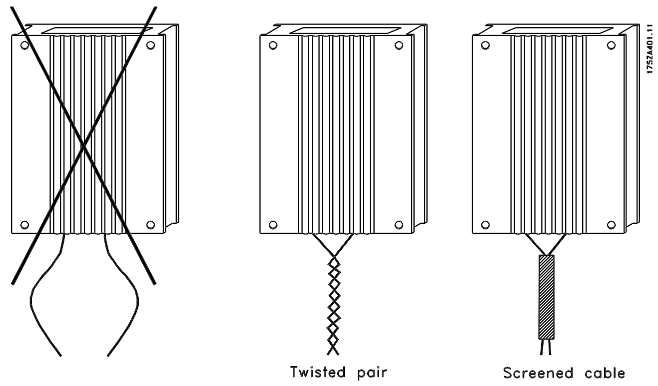
NB!
Cables General: All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper (60/75°C) conductors are recommended.

How to connect more than one resistor
Star parallel connection to ensure load is shared evenly between two or more resistors.



Flat Pack

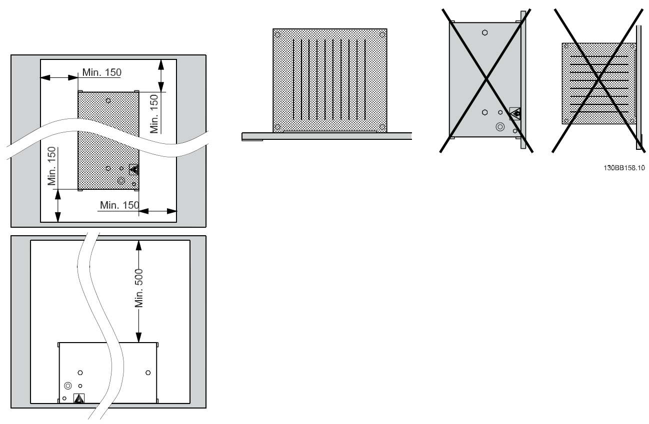
To reduce the electrical noise from the wires between the brake resistor and the frequency converter, the wires must be twisted.
For enhanced EMC performance a metal screen can be used.



7

Wire Wound

Follow the instructions shown in the illustration below to ensure needed cooling of the resistor.



Mounting the resistor so the lamellas are horizontal will course overheating of the resistor.

8 Programming

8.1.1 AF-650 GP Parameters

The following is a list of parameters for the DriveSeries which are important or relevant for braking with a Brake Resistor.

Parameter	Suggestion of settings
Par. B-00 *DC Hold Current*	This parameter holds the motor function (holding torque) or pre-heats the motor.
Par. B-01 *DC Brake Current*	Depends on the desired braking torque
Par. B-02 *DC Braking Time*	Set the desired DC braking time
Par. B-03 *DC Brake Cut In Speed [RPM]*	Set the desired DC Brake Cut In Speed
Par. B-04 *DC Brake Cut In Speed [Hz]*	Set the desired DC brake cut-in frequency

Table 8.1: DC Braking

Parameter	Suggestion of settings
Par. B-10 *Brake Function*	Resistor brake
Par. B-16 *AC brake Max. Current*	Enter the maximum permissible current when using AC brake to avoid overheating of motor windings. The AC brake function is available in Flux mode only (AF-650 GP only).

Table 8.2: AC Braking

Parameter	Suggestion of settings		
Par. B-10 *Brake Function*	Resistor brake		
Par. B-11 *Brake Resistor (ohm)*	Depends on the unit, see the tables in chapter *Brake Resistor Overview*.		
Par. B-12 *Brake Power Limit (kW)*	Depends on the unit, see the tables in chapter *Brake Resistor Overview*.		
Par. B-13 *Braking Thermal Overload*	Warning or trip		
Par. B-15 *Brake Check*	Warning or trip		
Par. B-17 *Over-voltage Control*	Over-voltage control (OVC) reduces the risk of the drive tripping due to an over voltage on the DC link caused by generative power from the load. - Must not be enabled in hoisting applications.		
Par. F-41 *Torque Limiter (Braking)*	160%		
Par. E-51 *Terminal 27 Mode*	Brake no warning Brake ready no fault or Brake fault		
Par. E-52 *Terminal 29 Mode*	Same as par. E-51 *Terminal 27 Mode*		
Par. E-24 *Output relay*	[21]	Thermal warning	The thermal warning turns on when the temperature exceeds the limit in the motor, the frequency converter, the brake resistor, or the thermistor.
	[28]	Brake, no brake warning	Brake is active and there are no warnings.
	[29]	Brake ready, no fault	Brake is ready for operation and there are no faults.
	[30]	Brake fault (IGBT)	Output is Logic '1' when the brake IGBT is short-circuited. Use this function to protect the frequency converter if there is a fault on the brake modules. Use the output/relay to cut out the main voltage from the frequency converter.

Table 8.3: Dynamic Braking

9 Alternative Braking Methods

9.1.1 DC Injection Braking

If the three-phase winding of the stator is fed with direct current, a stationary magnetic field Φ will be set up in the stator bore causing a voltage to be induced in the bars of the cage rotor as long as the rotor is in motion. Since the electrical resistance of the rotor cage is very low, even small induced voltages can create a high rotor current. This current will produce a strong braking effect on the bars and hence on the rotor. As the speed falls, the frequency of the induced voltage falls and with it the inductive impedance. The ohmic resistance of the rotor gradually becomes dominant and so increases the braking effect as the speed comes down. The braking torque generated falls away steeply just before standstill and finally ceases when there is no further movement. Direct current injection braking is therefore not suitable for actually holding a load at rest.

Drive-Series:
An over-modulated DC current added to the AC current works as an eddy current brake (par. B-02 *DC Braking Time* ≠ 0 s).

9.1.2 AC-braking

When the motor acts as a brake the DC-link voltage will increase because energy is fed back to the DC-link. The principle in AC-brake is to increase the magnetisation during the braking and thereby increase the thermal losses of the motor.

Drive-Series:
The brake energy is distributed in the motor by changing the loss conditions in the motor. The AC brake function cannot be used in applications with high cycling frequency since this will overheat the motor (par. B-10 *Brake Function* = [2]). Using factory settings it is possible to brake with about 50 % of rated torque below 2/3 of rated speed and with about 25 % at rated speed. The function is not working at low speed (below 1/3 of nominal motor speed).

9.1.3 Mechanical Holding Brake

A mechanical holding brake mounted directly on the motor shaft normally performs static braking. In some applications the static holding torque is working as static holding of the motor shaft (usually synchronous permanent motors). A holding brake is either controlled by a PLC or directly by a digital output from the frequency converter (relay or solid state).

NB!
When the holding brake is included in a safety chain:
A frequency converter cannot provide a safe control of a mechanical brake. A redundancy circuitry for the brake control must be included in the total installation.

9.1.4 Optimum Braking

Dynamic braking is useful from max. speed down to a certain frequency. Below this frequency DC braking is to be applied as required. The most efficient way of doing this is to use a combination of dynamic and DC braking. See illustration 11.1. The parameters can be found further on in this instruction in the chapter *Programming*.

For further information about DC Braking see section 11.1.1.

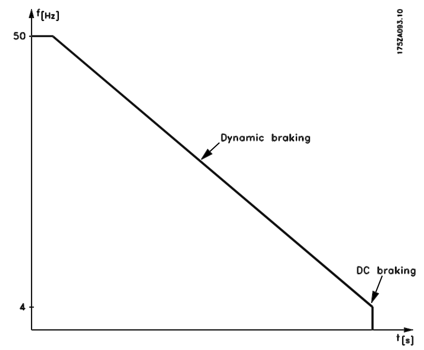


Illustration 9.1:

NB!
When changing from dynamic to DC braking, there will be a short period (2-6 milliseconds) with very low braking torque.

9

How to calculate optimum DC-brake cut in frequency:

Slip $S = \frac{n_O - n_n}{n_O} \times 100 [\%]$

Synchronous speed $n_0 = \frac{f \times 60}{p}$ [1/min]

f = frequency
p = no. of pole pairs
n_n = speed of the rotor

DC-brake cut in frequency = $2 \times \frac{S \times f}{100} [Hz]$

The instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the GE company.

GE Consumer & Industrial
41 Woodford Avenue
Plainville, CT 06062

www.geelectrical.com/drives

imagination at work

130R0373 MG90T102 *MG90T102*

DET-700