Warning:
Do not touch the brake resistors during braking. They can be very hot.

Introduction

The flatpack brakeresistors for the VLT 5000 series is a safe and compact solution for the customer.

At a constant load and free convection the resistor is selfprotecting 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 IP54 tight.

With the compact flatpack resistor, it is possible to mount the resistor on the rear of a VLT 5000 bookstyle frequency converter.

Description of the brake system

When the speed 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 intermediate circuit in the frequency converter. The brake resistor loads the intermediate circuit, ensuring that the brake 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 that it enables braking of heavy load quickly, e.g. on a conveyor belt.

In addition, VLT5000 incorporates brake monitoring to ensure that the average power dissipated to the brake resistor does not exceed a given limit. The brake monitor calculates the mean brake power within the last 120 seconds and compares this value with a programmed limit. If the limit is exceeded the drive can give a warning or trip. Monitoring of short circuiting of the brake resistor or brake IGBT and disconnection of the brake resistor is also possible.
Increased performance at low speeds can be achieved by using the DC brake in VLT5000.

Application - conveyor belt

The brake resistor program covered in this instruction is for horizontal conveyor applications. The resistors are chosen for use with small drives, this means up to VLT5011.
The premises for the application is:

- The energy of the system is assumed to be determined by two times the motor inertia.
- Values for braking are calculated at 160% torque.

Figure 1 shows the relation between the braking power and the acceleration/braking of the conveyor belt. During braking the motor power is negative, since the torque on the motor shaft is negative. The braking power is to be dissipated in the brake resistor, and corresponds almost to the negative motor power taking the losses into the motor and VLT frequency converter into account.

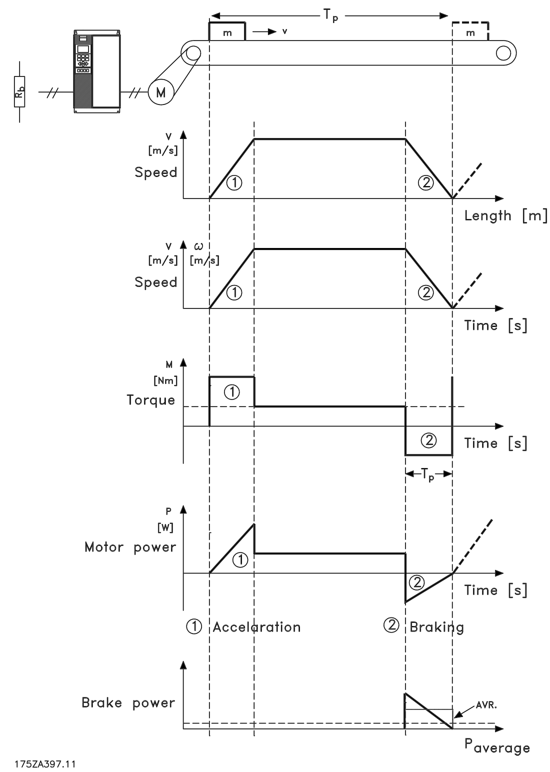


Figure 1
Typical characteristic of a horizontal brake application

General fomulas

The general formulas for calculation of the brake in a system are stated below.

An example is shown with the following values:

Motor inertia: $j = 0.0021$ kgm2
Motor speed (at 50 Hz): $n = 1500$ rpm
Average power dissipated in resistor: $P_{average} = 120$ W
Nominal motor power: $P_{motor} = 750$ W

The kinetic energy in the system is:

$E = ½ \times j' \times \omega^2 = j \times \omega^2 = 0.011 \times j \times n^2$ [Ws]
$E = 0.011 \times 0.0021 \times 1500 \times 1500 = 52$ Ws

j = inertia of motor and gear box (kgm²)
j' = inertia of the system ≈ 2 × j
ω = motor speed = (n × 2 × π)/60 [rad/s]
n = motor speed [rpm]

The maximum number of stops per time unit for the resistor is calculated as:

$f_{stop} = P_{resistor}/E_{system}$ [s^{-1}]
$f_{stop} = 120/52 = 2.3\ s^{-1} = 138,5\ min^{-1}$

$P_{resistor}$ = Average power dissipated in the resistor [W]

The minimum time for stop is calculated as:

$t_{stop} = E_{system} / P_{motor}$ [s]
$t_{stop} = 52/750 = 0.069$ s

P_{motor} = nominal motor power (100% torque)

The maximum duty cycle of the system is:

Duty cycle = $t_{stop} \times f_{stop} \times 100$ [%]
Duty cycle = $0.069 \times 2.3 \times 100 = 16\%$

The resistor values must be calculated using the formulas from the general brake instruction (resistance based on minimum acceptable resistance). When choosing a standard resistor, it is necessary to choose a value higher than the calculated t_{rec}.

240 Volt units: $R_{rec} = 111684 / P_{motor}$ [Ω]
$R_{rec} = 111684 / 750 = 149\ \Omega$

500 Volt units: $R_{rec} = 478801 / P_{motor}$ [Ω]
$R_{rec} = 478801 / 750 = 638\ \Omega$

Brake performance examples

The figures below show typical data for a horizontal application. At other frequencies please use the formulas above to calculate the values.

All are calculated at a nominal motor speed of 1500 rpm at 50 Hz.

$P_{average}$, 120 W

VLT type	Motor 4 pol.	Motor inertia kg × m × m	System inertia kg × m × m	E (50Hz) Ws	Number of stops 1/min from 50 Hz.	E (100 Hz) Ws	Number of stops 1/min from 100 Hz.	Stop time [s] (50 Hz) 160 % torque	Stop time [s] (100 Hz) 160% torque
5001	0.75	0.00210	0.00420	52.0	138.5	207.9	34.6	0.069	0.277
5002	1.1	0.00320	0.00640	79.2	90.9	316.8	22.7	0.072	0.288
5003	1.5	0.00430	0.00860	106.4	67.7	425.7	16.9	0.071	0.284
5004	2.2	0.00690	0.01380	170.8	42.2	683.1	10.5	0.078	0.311
5005	3	0.00820	0.01640	203.0	35.5	811.8	8.9	0.068	0.271
5006	4	0.01200	0.02400	297.0	24.2	1188.0	6.1	0.074	0.297
5008	5.5	0.01800	0.03600	445.5	16.2	1782.0	4.0	0.081	0.324
5011	7.5	0.02300	0.04600	569.3	12.6	2277.0	3.2	0.076	0.304

$P_{average}$, 250 W

VLT type	Motor 4 pol.	Motor inertia kg × m × m	System inertia kg × m × m	E (50Hz) Ws	Number of stops 1/min from 50 Hz.	E (100 Hz) Ws	Number of stops 1/min from 100 Hz.	Stop time [s] (50 Hz) 160 % torque	Stop time [s] (100 Hz) 160% torque
5001	0.75	0.00210	0.00420	52.0	254.0	207.9	63.5	0.069	0.277
5002	1.1	0.00320	0.00640	79.2	166.7	316.8	41.7	0.072	0.288
5003	1.5	0.00430	0.00860	106.4	124.0	425.7	31.0	0.071	0.284
5004	2.2	0.00690	0.01380	170.8	77.3	683.1	19.3	0.078	0.311
5005	3	0.00820	0.01640	203.0	65.0	811.8	16.3	0.068	0.271
5006	4	0.01200	0.02400	297.0	44.4	1188.0	11.1	0.074	0.297
5008	5.5	0.01800	0.03600	445.5	29.6	1782.0	7.4	0.081	0.324
5011	7.5	0.02300	0.04600	569.3	23.2	2277.0	5.8	0.076	0.304

Selection of a brake resistor

Danfoss brake resistors for horizontal applications are rated to the performance mentioned in the table below.

In parameter 402 the brake power limit is set. It is calculated as described in the manual for the VLT 5000 series. The maximum values to put in must be calculated as follows:

For 200-240 V units: $P = 397^2 \times$ Max. dutycycle / R

For 380-500 V units: $P = 822^2 \times$ Max. dutycycle / R

Units for supply 200 to 240 VAC

VLT Type	Motor [kW]	Resistor [ohm]	Size	Ordernumber	Max. duty cycle [%]	Max. limit in par. 402 [kW]
5001	0.75	150	150 Ω 100 W	175U1005	14.0	0.15
5001	0.75	150	150 Ω 200 W	175U0989	40.0	0.43
5002	1.1	100	100 Ω 100 W	175U1006	8.0	0.13
5002	1.1	100	100 Ω 200 W	175U0991	20.0	0.32
5003	1.5	72	72 Ω 200 W	175U0992	16.0	0.36
5004	2.2	47	50 Ω 200 W	175U0993	9.0	0.31
5005	3	35	35 Ω 200 W	175U0994	5.5	0.25
5005	3	35	72 Ω 200 W	2 x 175U0992 *1	12.0	0.55
5006	4	25	50 Ω 200 W	2 x 175U0993 *1	11.0	0.70
5008	5.5	20	40 Ω 200 W	2 x 175U0996 *1	6.5	0.52
5011	7.5	13	27 Ω 200 W	2 x 175U0995 *1	4.0	0.49

Units for supply 380 to 500 VAC

VLT Type	Motor [kW]	Resistor [ohm]	Size	Ordernumber	Max. duty cycle [%]	Max. limit in par. 402 [kW]
5001	0.75	630	620 Ω 100 W	175U1001	14.0	0.15
5001	0.75	630	620 Ω 200 W	175U0982	40.0	0.43
5002	1.1	430	430 Ω 100 W	175U1002	8.0	0.13
5002	1.1	430	430 Ω 200 W	175U0983	20.0	0.32
5003	1.5	320	310 Ω 200 W	175U0984	16.0	0.34
5004	2.2	215	210 Ω 200 W	175U0987	9.0	0.29
5005	3	150	150 Ω 200 W	175U0989	5.5	0.25
5005	3	150	300 Ω 200 W	2 x 175U0985 *1	12.0	0.54
5006	4	120	240 Ω 200 W	2 x 175U0986 *1	11.0	0.62
5008	5.5	82	160 Ω 200 W	2 x 175U0988 *1	6.5	0.54
5011	7.5	65	130 Ω 200 W	2 x 175U0990 *1	4.0	0.42

*1: Connect in parallel.

General technical data:

Max. permissible operating voltage	V_B	≤ 700 VAC ≤ 1000 VDC	always considering the self protection
Insulation voltage	V_{ISO}	≤ 4000 V	
Casing temperature	J_C	≤ 250 °C	free convection
Weight	m	about 280 g about 550 g	Small 100 W Large 200 W
Enclosure		IP54	

Impulseload

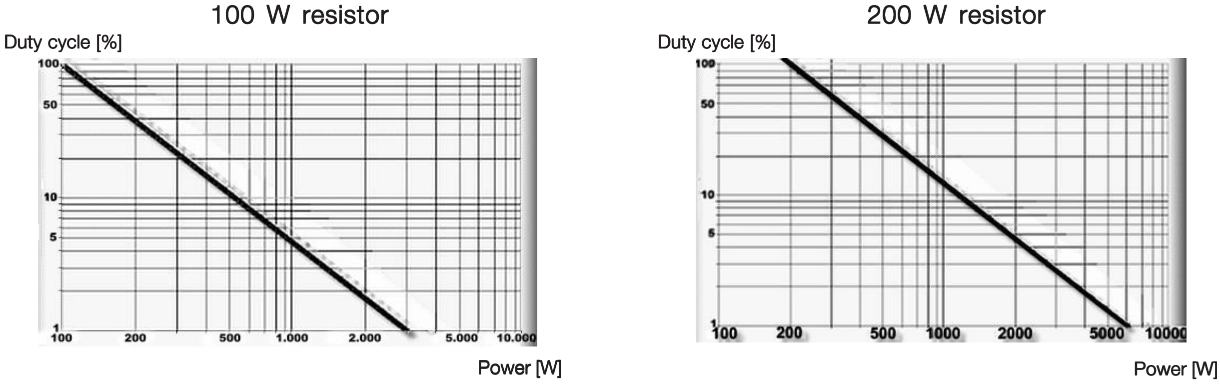


Figure 2

How to setup the brake function

To use the brake function it is necessary to set up some parameters. It is always necessary to perform the Basic Setup. Further settings are available for monitoring the brake power, protection of the brake resistor and brake IGBT and readout of brake power.

Basic setup

To enable the brake function it is necessary to set one parameter.

- Activate the brake function
  - Set parameter 400 (Brake function/overvoltage control) to *Resistor brake* [1].

Power monitoring

To monitor the power to the brake resistor it is necessary to set the following:

- Set the value of the brake resistor
  - Set parameter 401 to the present resistor value [ohm].
- Set the limit for the power transmitted to the resistor
  - Set parameter 402 to the maximum accept able power [kW] transmitted to the resistor dur ing 120 seconds.
- Choose the power monitoring function
  - Set parameter 403 to *Warning* [1] or *Trip* [2]
  - If the circuit in figure 4 is used, set parameter 323 to *Brakefault* [30]

The monitor function calculates the power transmitted to the brake resistor. The power is calculated on the basis of the resistor ohm value (parameter 401), the intermediate circuit voltage and the resistor run ning time.
If the power transmitted over 120 seconds exceeds 100% of the monitoring limit (parameter 402) and *Warning* [1] (parameter 403) has been selected, a warning will come up on the display. The warning will disappear when the power goes below 80%.
If *Trip* [2] (parameter 403) has been selected, the converter will trip and give an alarm when the power limit is reached.
If the power monitoring is set to *Off* [0]or *Warning* [1], the brake function remains active, even if the monitoring limit has been exceeded. This may lead to thermal overload of the resistor

Brake check

To protect the brake resistor and IGBT during operation, it is possible to activate a brake check function.

- Activate the brake check
  - Set parameter 404 to *Warning* [1] or *Trip* [2], depending on which level of protection You need.

If Off [0] is selected, the brake resistor and brake IGBT will be monitored with respect to short circuiting during operation. In case of short circuit, a warning will be given.
If Warning [1] is selected, the brake resistor and brake IGBT will be monitored with respect to short circuiting and on power-up it will be checked if the brake resistor has been disconnected.
In case of *Trip* [2], the VLT frequency converter will cut out while giving an alarm (trip locked) if the brake resistor has short-circuited or been disconnected or if the brake IGBT has short-circuited.

It is possible to readout the result of the brake check via the outputs 42, 45, 01 (relay) or 04 (relay).

Protective properties

For protection of the installation, one of the outputs from the drive can be used to control a protection circuit. For connections, see page 8 *Electrical*.

- Set one of the outputs 42, 45, 01 (relay) or 04 (relay) (parameters 319, 321, 323 or 326) to *Brake Fault* [30].

If there is a fault on the brake, the output will be activated and activate the protection circuit.

Readout of brake power

To readout the brake power in the display set parameters as follows:

- Mean brake power during the latest 2 minutes.
  - Set parameter 009, 010, 011 or 012 to *Brake energy/2 min* [23].
- Instantaneous brake power
  - Set parameter 009, 010, 011 or 012 to *Brake energy/s* [24].

For large readouts set parameter 009 and for small readout set parameters 010, 011 or 012.

DC braking

To increase brake performance at low speed, the DC brake function can be used.

- The DC brake cuts in when the output frequency is below a set cut-in frequency, and no start signal is present.
  Define a DC brake cut-in frequency.
  Set parameter 127 to the desired DC brake cut-in frequency
- or control the DC brake function by activating digital input 27. Logical low activates the brake.
  Define digital input 27 to DC brake Inverse
  Set parameter 304 to *DC-braking, Inverse* [3]

DC braking can also be controlled via the bus. See parameter 504.
It is possible to optimise the performance of the DC brake by changing the parameters 125 (DC braking current) and 126 (DC braking time).

■ Installation

Mechanical

The brake resistor can be installed beside the drive using different fittings. It is possible to mount the bookstyle drives on the enclosure of the brake resistor. See figure.

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

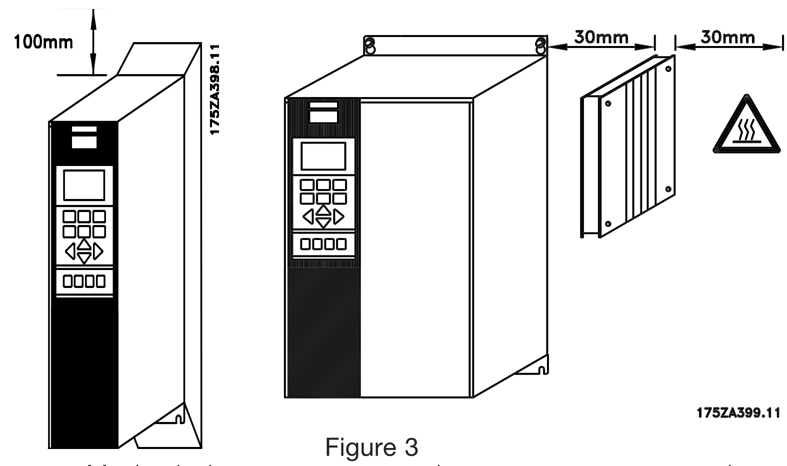


Figure 3
Mechanical measurements and necessary space around

Electrical

The brake resistor must be connected to the terminals 81 and 82.

For protection of the installation, a thermal relay should be fitted that cuts off the frequency converter if the brake current becomes too high. See Instruction MI50Dxyy (x is the version and yy is the language).

Alternatively the built in monitoring functions can be used, see page 7 *Protective properties*. To protect the drive and brake resistor from overload, a circuit breaker can be placed in the mains supply. One of the relay outputs on the VLT 5000 are setup as alarm or warning signal and controls a shunt trip. If an alarm or warning occurs, the mains supply will be cut out.

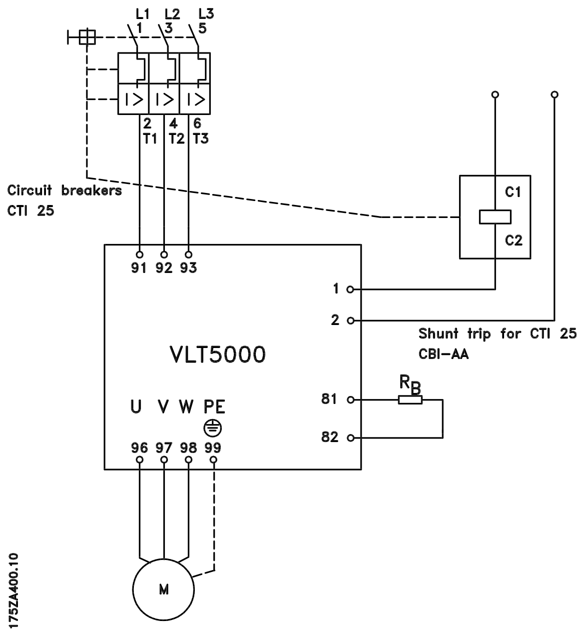


Figure 4
VLT5000 with integrated monitoring

EMC (twisted cables/shielding)

To reduce the electrical noise from the wires between the brake resistor and the VLT frequency converter, the wires must be twisted.

For enhanced EMC performance a metal screen can be used.

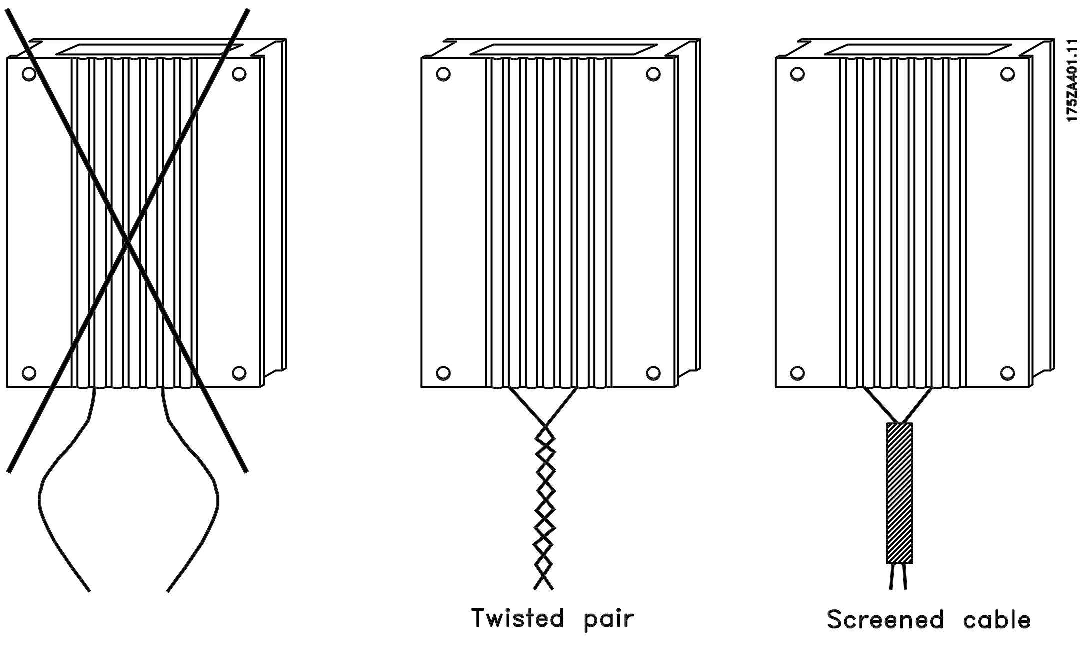


Figure 5

■ Dimensions

All dimensions in mm.

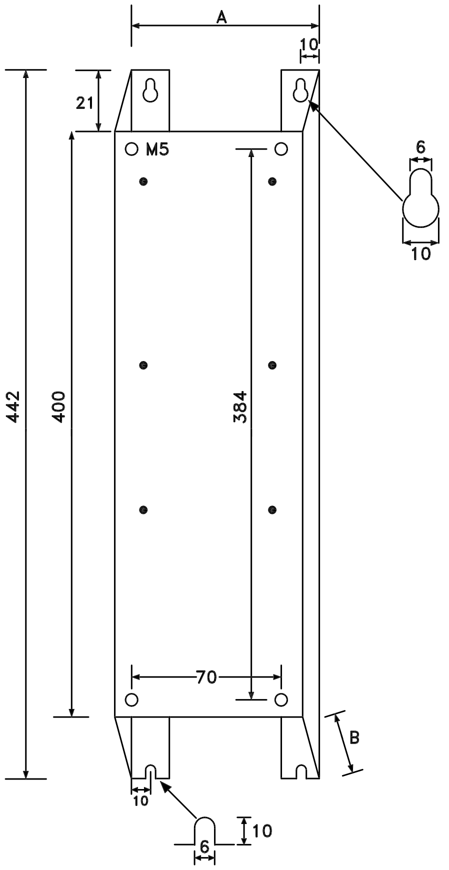


Figure 6

	175U0004 Slim - 2 resistor	175U0003 Wide - 2 resistors	175U0002 Slim - 1 resistors
A	90	130	90
B	65	65	38

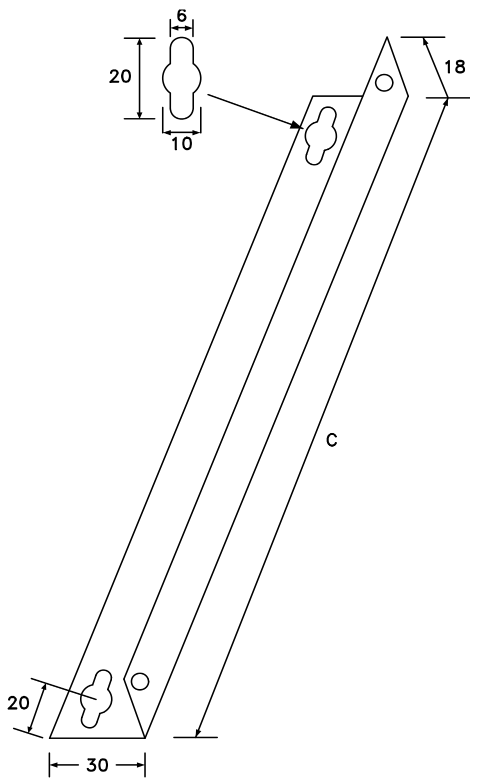
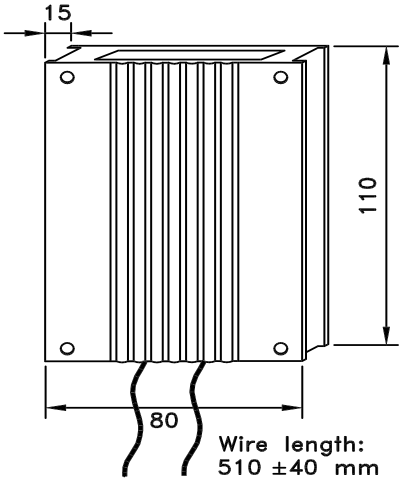


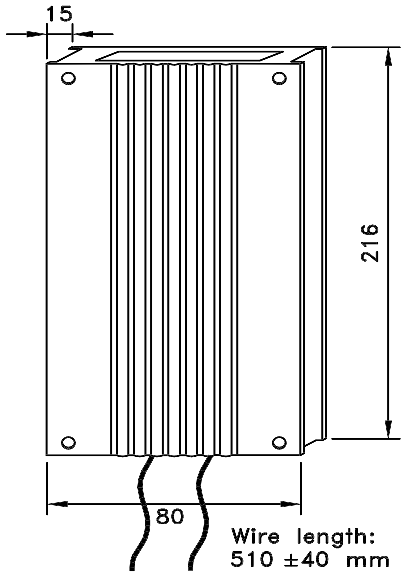
Figure 7

	175U0011 for 100 W resistor	175U0009 for 200 W resistor
C	110	216

Dimensions - 100 W:



Dimensions - 200 W:



175ZA407.10

Figure 8