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## 1 Introduction

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The Braking Unit controls the dissipation of regenerated power developed when the motor is being braked by the Drive module(s). The power is dissipated in a *braking resistor bank* which is supplied by the user and mounted separately from the Braking Unit.



**Warning**

**The Braking Unit is intended to be installed only with the following Drive modules in complete systems:**

**High-Power CDE  
Unidrive model size 5**

High-voltage power connections are made to the DC bus of the Drive and to the braking resistor bank.

A 10-way ribbon cable is used for making signal connections from the Drive module to the Braking Unit.

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## 2 Safety Information

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Persons supervising and performing the electrical installation or maintenance of a Drive and/or its external Option Unit must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the Drive and external Option Units are capable of inflicting a severe electric shock and may be lethal. The Stop function of the Drive does not remove dangerous voltages from the terminals of the Drive and external Option Unit. AC supplies should be removed before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the Drive and external Option Unit, and the way in which they are operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the country in which the equipment is used.

The Braking Unit must not be used in a safety-critical application without additional, independent high-integrity protection. When braking is required to ensure the safety of the system, an independent mechanical fail-safe brake must be used.

### 2.1



#### Warnings, Cautions and Notes

A **Warning** indicates information which is essential to avoid a safety hazard.

A **Caution** indicates information which is necessary to avoid a risk of damage to the product or other equipment.

A **Note** indicates information which is helpful to ensure the correct operation of the product.

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## 3 Data

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### 3.1 Environmental

Ingress protection: IP00 (in accordance with IEC529)

The unit may be operated in an ambient temperature of 0°C to +50°C (32°F to 104°F)

Power may be applied in an ambient temperature of –10°C to +50°C (14°F to 104°F)

Humidity: Non-condensing

### 3.2 Electromagnetic Compatibility

Refer to the *Declaration of Conformity* for the Drive.

### 3.3 Electrical ratings

#### Braking current

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Maximum peak	250A
Maximum continuous	125A RMS (see Power-limit protection system in Chapter 3)

#### DC bus

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Voltage	850VDC maximum
Connections	Two single-core power cables plus one ground cable to the Drive Maximum cable length: 1.5 m (4 feet)

#### Power dissipation in the Braking Unit

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Power dissipation	110W maximum
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## Braking resistor bank

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Recommended resistance	3Ω (this is also the minimum permissible value)
Maximum tolerance	–10%
Continuous power rating	5kW ~ 40kW nominal
Voltage	Factory-set proportional control Braking starts at 37V above nominal dc voltage Full braking at 69V above nominal dc voltage
Peak current	250A nominal
Electrical time constant	30μsec maximum
Inductance	100μH maximum
Connections	2-wire plus ground to the Braking Unit Maximum cable length: 100m (300 feet) Cable type: shielded

**Warning****Access to the Braking Unit**

**The Braking Unit is designed to be fitted into an enclosure which prevents access by untrained personnel.**

**Fire enclosure**

**Where local regulations require electrical equipment to be mounted in a fire enclosure, the Braking Unit must be installed in a fire enclosure. When the Braking Unit is mounted on a Drive, the Drive must be installed in a fire enclosure.**

**Hazardous areas**

**Do not locate the Braking Unit in a classified hazardous area unless the Braking Unit is installed in an approved enclosure and the installation is certified.**

## 4.1

**Environment**

In accordance with the IP00 rating of the Braking Unit, the Braking Unit must be located in an environment that is free from dust, corrosive vapours, gases and all liquids, including condensation of atmospheric moisture (ie. pollution degree-2 as required by UL840 and IEC664-1).

If condensation is likely to occur when the Braking Unit is not in use, install an anti-condensation heater. This heater must be switched off when the Braking Unit is in use; automatic switching is recommended.

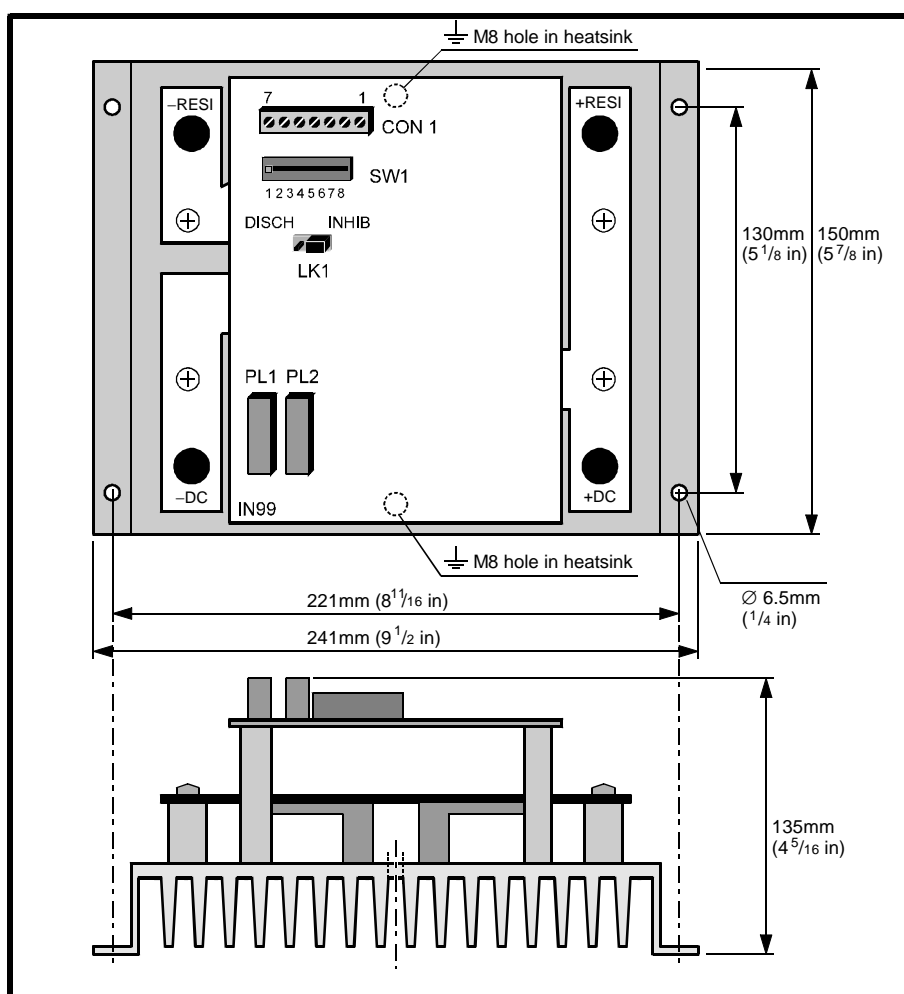
Install the Braking Unit vertically for best flow of cooling air. When the Braking Unit is installed in an enclosure, install the Drive as low as possible (without contravening EMC requirements).

Observe the requirements for ambient temperature if the Braking Unit is to be mounted directly above any heat generating equipment (such as a Drive or another Braking Unit).

## 4.2 Mounting instructions

### Note

Dimensions given in inches are equivalent to the metric values and are to the nearest  $\frac{1}{16}$  inch.

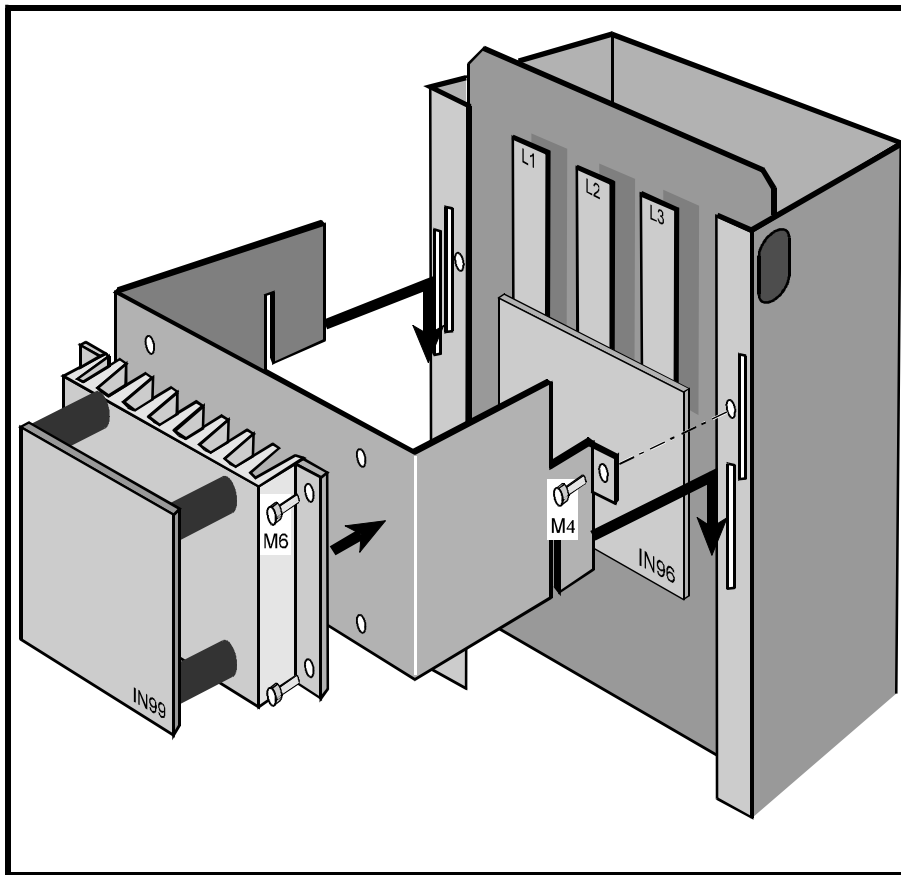


**Figure 1** Dimensions of the Braking Unit, and the locations of the connectors and switch SW1

### Installation with a High-power CDE Drive

- 1 Mount the Braking Unit as close as possible to the Drive so that the cables do not exceed 1.5 metres (5 feet) in length. (The Braking Unit cannot be installed inside the High-power CDE Drive module.)
- 2 Use the four M6 holes to mount the heatsink of the Braking Unit to the back-plate of the enclosure, or to a suitable panel.

### Installation with a Unidrive size 5



**Figure 2**     **Mounting the Braking Unit on a Unidrive size 5**

- 1 Mount the Braking Unit on the mounting bracket using the M6 screws supplied. Note that the hooks at the rear of the brackets will point downward when the Braking Unit is installed.

- 2 Insert the two hooks at the rear of the bracket into the lower pair of vertical slots in the upper part of the front edge of the Drive case. (These slots are in front of the AC supply rectifier section.)
- 3 Fully lower the hooks in the slots.
- 4 Fit an M4 screw into each mounting flange to secure the mounting bracket to the tapped holes in Drive.

### 4.3 Recommended wiring practices



#### **Warning**

#### **Electric shock risk**

**The voltages present in the following locations can cause severe electric shock and may be lethal:**

**DC bus cables and connections**

**Braking resistor cables and connections**

**Certain parts of the Drive**

**Certain parts inside the Braking Unit**

#### **Isolation device**

**The AC supply must be disconnected from the Drive using an approved isolation device before any servicing work is performed on the Braking Unit or the Drive.**

#### **Stored charge**

**The Drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the Drive has been energized, the AC supply must be isolated at least 10 minutes before work may continue.**

#### **STOP function**

**The STOP function of the Drive does not remove dangerous voltages from the Drive or from the Braking Unit.**

For the following power connections...

- To the DC bus
- To the braking resistor bank

...use the following:

- Single-core pvc-insulated cable with copper conductor having a temperature rating not less than 60/75°C and laid in accordance with defined conditions.
- The cables to the braking resistor bank must be shielded.
- The wiring must conform to local regulations and codes of practice.

## Cables

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Minimum cable size: 35mm<sup>2</sup> (2AWG)

This is based on a continuous current of 125A RMS. The cables should be capable of handling 300A for 40 seconds.

In the event of conflicting data, local regulations prevail.

## 4.4 Ground connections

Use one of the two M8 tapped holes in the heatsink of the Braking Unit for making a safety ground connection. Make the safety ground connection to the PE terminal of the Drive.

### Braking-resistor cable

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The cable to the braking resistor bank should be shielded or armoured. Use the second M8 tapped hole to connect the shield or armour to the heatsink of the Braking Unit.

### Grounding the braking resistor bank

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The enclosure of the braking resistor bank must be connected to safety ground. Normally this would be achieved locally. If required, an additional ground cable can be connected to the system ground of the Drive.

## 4.5 Power connections

### DC bus connections

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Make the connections between the Braking Unit and the Drive as shown in Figure 3 or 4 as appropriate.

Make the DC bus connections to the Drive at the DC-bus capacitors near the DC-bus fuse. Ensure the cable length does not exceed 1.5 metres (4 feet). For further details, refer to the User Guide for the Drive.

Group the cables together to minimize the space between them. This will minimize the area of the wiring loop.

## Resistor connections



### Warning

**The braking resistor must always be connected in series with a thermal protection device. The thermal protection device is used to avoid the resistor or associated cables causing a fire hazard in the event of the braking transistor becoming permanently switched on or short-circuit. When activated, the thermal protection device must cause the AC supply to be disconnected from the Drive.**

Connect the braking resistor to the +RESI and –RESI terminals using cable not exceeding 100 metres (330 feet) in length.

## 4.6 Control signal connections

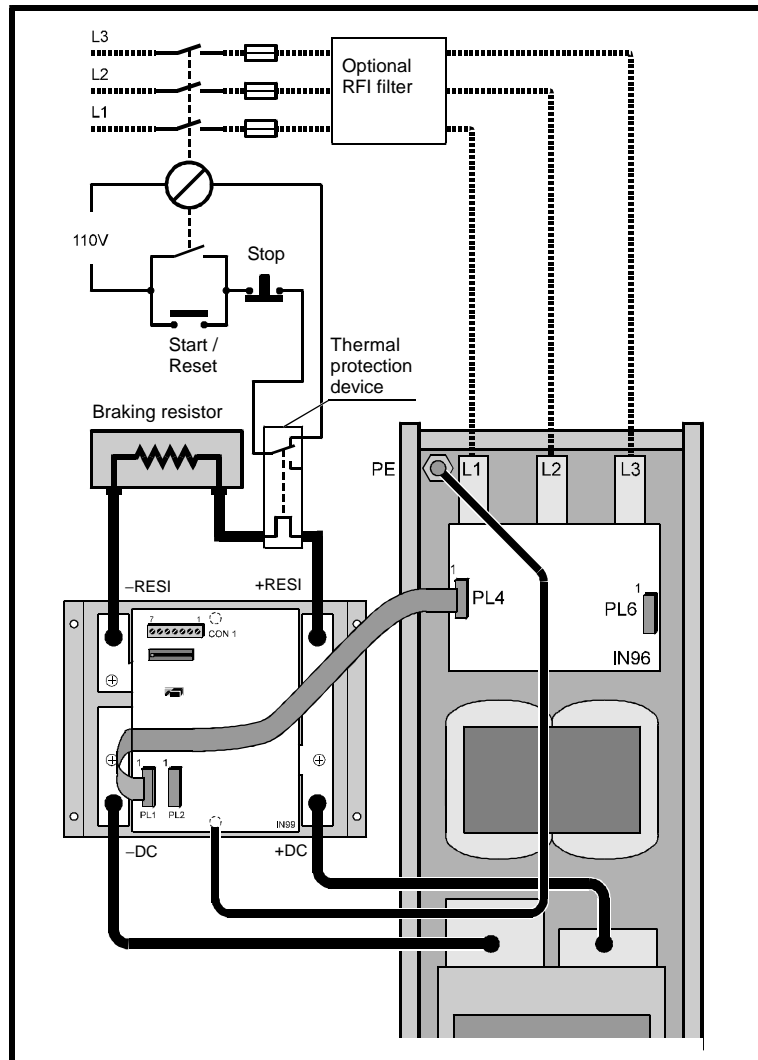
### Ribbon cable

The 10-way ribbon cable is used to carry the following from the IN96 card in the Drive to the IN99 card on the Braking Unit:

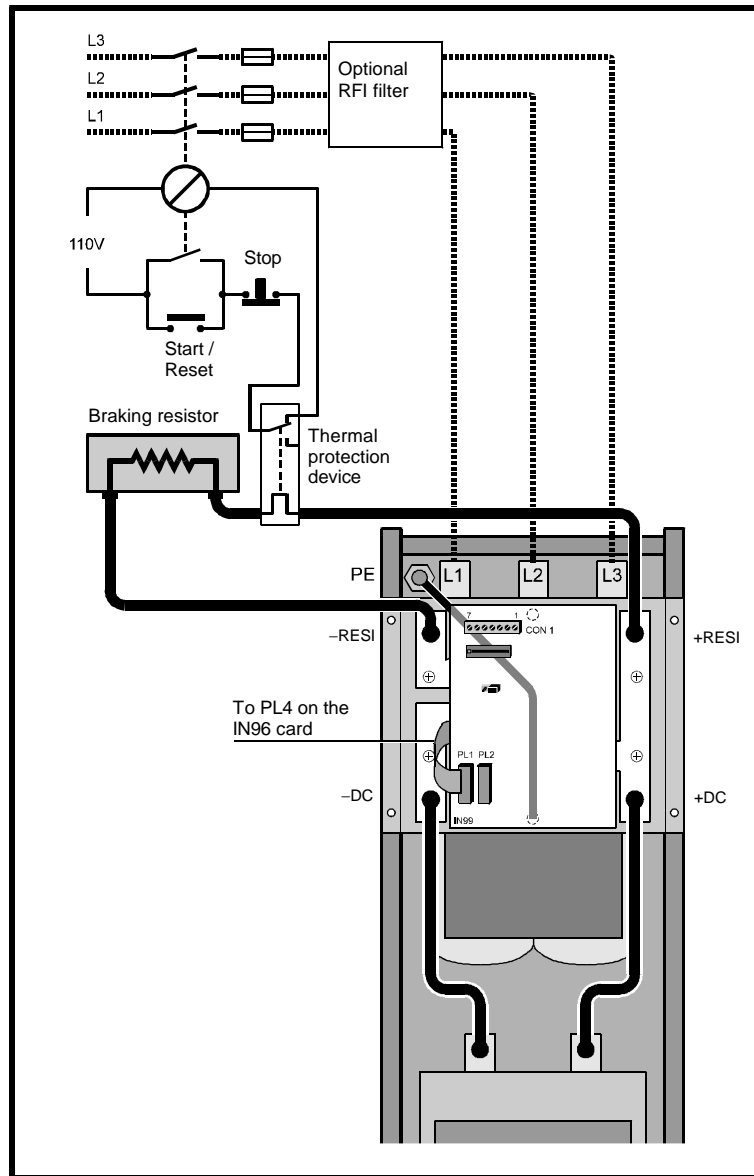
- Auxiliary power
- AC and DC voltage measurements
- Loss of AC supply signal*

Connect the 10-way ribbon cable as follows (see Figure 3):

IN99 card on the Braking Unit	IN96 card on the Drive
PL1 or PL2 (paralleled connectors)	PL4 or PL6 (paralleled connectors)



**Figure 3** *Power, ground and signal connections when connected to a High-power CDE Drive*



**Figure 4** *Power, ground and signal connections when connected to a Unidrive size 5*

## 4.7 User signal connections

Make connections as required to CON 1 on the IN99 card on the Braking Unit. The functions of the terminals are as follows:

CON 1 terminal	Function	Type of I/O
1	0V common	
2, 3	<i>Fault</i> signal output	Normally-closed relay contact
4, 5	<i>Limit</i> signal output	Normally-closed relay contact
6	<i>Sync</i> input or output	In parallel with terminal 7
7	<i>Sync</i> input or output	In parallel with terminal 6

Relay contact rating: 5A at 120VAC, 30VDC

### **Fault signal output**

The relay contact opens when over-temperature is detected in the Braking Unit, or when the instantaneous current flowing through the Braking Unit is excessive. This could be caused by the following:

- Short-circuits in the connections to the braking resistor
- Faulty braking transistor in the Braking Unit

### **Limit signal output**

The relay contact opens when the secondary thermal protection system in the Braking Unit is limiting the duty ratio. See *Power-limit protection system* later in this chapter.

### **Sync input/output**

When the **Sync** input/output is connected to 0V common, the braking transistor is made to switch on, connecting the braking resistor across the DC bus. In addition, when the braking transistor is automatically switched on, the **Sync** terminal becomes an output that pulls down to 0V common.

The **Sync** terminals can be used for ensuring all Braking Units in a parallel system switch on in synchronism (see *Using Braking Units with parallel Drives*) by chain connecting the **Sync** terminals on all the Braking Units. The first Braking Unit to switch on will cause the remaining Braking Units to switch on.



**Warning**

**When the *Sync* input is activated, the braking transistor can discharge the DC bus of the Drive. Do not rely on the *Sync* input to remove dangerous voltages from the Drive or Braking Unit.**

## 4.8 Using Braking Units with parallel Drives

When a number of Drive modules are connected in parallel, normally use one Braking Unit for each Drive module. In this case, it is not necessary to connect the DC buses of the Drive modules in parallel.



**Warning**

**When a system consists of multiple Drives, use a separate braking resistor bank for each Braking Unit.**

If the regenerated power is small compared with the total power rating of the Drive modules, it is possible to use fewer Braking Units than Drives. In this case, the DC buses of the Drive modules must be connected in parallel. The Braking Units must then be connected to this common DC bus.

The terminals of connectors PL1 and PL2 on the Braking Unit (and PL4 and PL6 on the IN96 card of the Drive modules) are connected in parallel to allow a chain of connections to be made.

When more than one Braking Unit is used in a parallel system, spreads in component tolerances will cause the Braking Units to operate at slightly different power levels. This should not normally be a problem and can give a progressive braking action which causes less disturbance to the DC bus. Conversely, when all the braking resistors are required to switch on at the same time, chain connect terminals 6 and 7 (**Sync**) of CON1 to all the Braking Units.

## 4.9 Control during loss of AC supply

Use jumper LK1 to select the required operation of the Braking Unit when AC supply is lost, as follows:

### **INHIB (default)**

Use this setting when the fastest possible recovery from a temporary loss of supply is required or where the *AC supply loss ride-through* facility is being used on the Drive module(s).

The Braking Unit is then de-activated when loss of AC supply is detected.

### **DISCH**

Use this setting to reduce the DC-bus voltage rapidly to a safe level when the AC supply is lost or removed.

When the AC supply is lost or the voltage temporarily reduces, the Braking Unit is activated to reduce the DC-bus voltage in accordance with the AC-supply voltage.

## 4.10 Power-limit protection system



### Warning

**The *Power-limit protection system* is designed to give secondary protection only. For reasons of safety and fire protection, the braking resistor must always be connected in series with a thermal protection device. The thermal protection device is used to avoid the resistor causing a fire hazard in the event of the braking transistor becoming permanently switched on or short-circuit. When activated, the thermal protection device must cause the AC supply to be disconnected from the Drive module(s).**

The *Power-limit protection system* gives secondary protection to the braking resistor bank to protect it from abnormal or excessive dissipation by reducing the duty ratio.

The Braking Unit initially operates at the maximum duty ratio required. If the average power reaches the limit set using selector switch SW1 on the IN99 card, the secondary protection system progressively reduces the duty ratio.

When power limiting occurs, an LED on the Braking Unit IN99 card is illuminated, and the **Limit** relay contact at terminals 4 and 5 of CON 1 opens.

The setting of SW1 determines the following:

- The resulting duty ratio

- The initial time taken to enter limiting (reduction of duty ratio)

Set SW1 for the required average power to be dissipated in the braking resistor bank, as shown in the following table.

### Constant braking power

The braking power will be constant in applications where the speed is maintained during braking (eg. cable laying).

The figures in the following table apply only when the braking power is constant. The table gives the average power, duty ratio and time before limiting occurs for a braking resistor value of  $3\Omega$  and continuous peak power of 200kW (250 A at 800V).

SW1 setting	Braking power when the limit is operating	Duty ratio when the limit is operating	Time to enter limiting
1	4 kW	2 %	5 seconds
2	8 kW	4 %	9 seconds
3	12 kW	6 %	14 seconds
4	16 kW	8 %	19 seconds
5	20 kW	10 %	24 seconds
6	24 kW	12 %	29 seconds
7	28 kW	14 %	34 seconds
8	32 kW	16 %	39 seconds

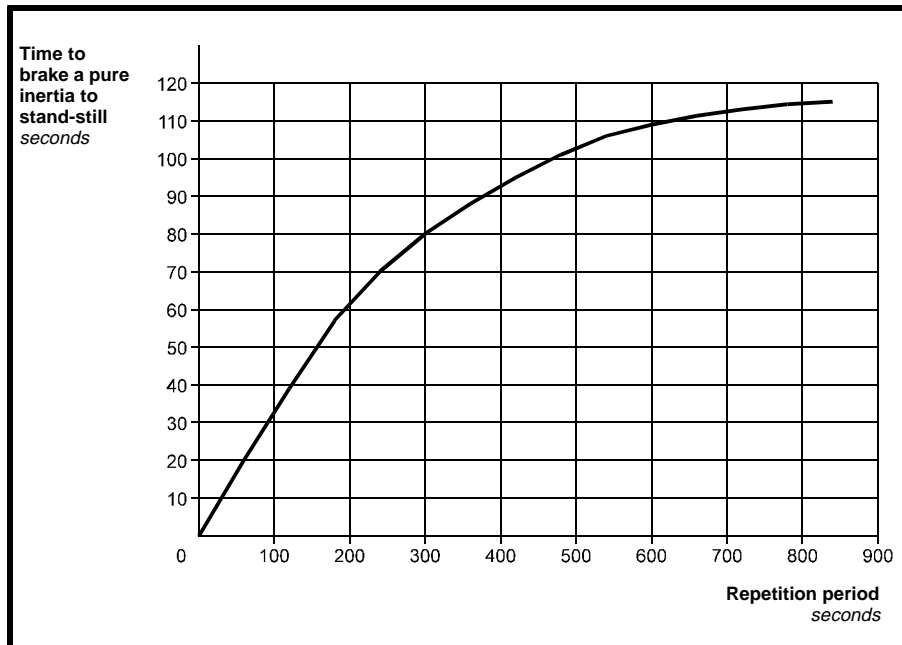
For example, setting 4 causes 200kW of peak power to be absorbed for 19 seconds. Subsequently, the duty ratio is progressively reduced until it settles at 8%. The average power is then 8% of 200kW = 16kW.

### Decelerating pure inertia

The braking power will reduce over a period of time in applications where the motor speed, and hence regenerated energy, is reduced during braking.

The graph in Figure 5 shows the minimum permissible *repetition period* for a range of *braking times* on the assumption that braking starts at peak power, and the power progressively reduces as the load slows down. The graph applies *only* when the braking power reduces in time, and SW1 is set at 8.

If the repetition period exceeds a value defined by the curve, the secondary protection system will not operate so that peak braking power will always be available at the start of each braking duty.



**Figure 5** Relationship between braking time and minimum repetition period when the braking power reduces during braking



**Warning**

The *Power-limit protection system* is automatically reset when the AC supply is disconnected from the Drive, and will not recognize whether the resistor is already hot.

If the AC supply is disconnected from the Drive module(s) when the *Power-limit protection system* is operating, for optimum protection of the braking resistor allow the resistor to cool for up to 20 minutes before re-starting the Drive module(s).

