

Inverter System Accessories

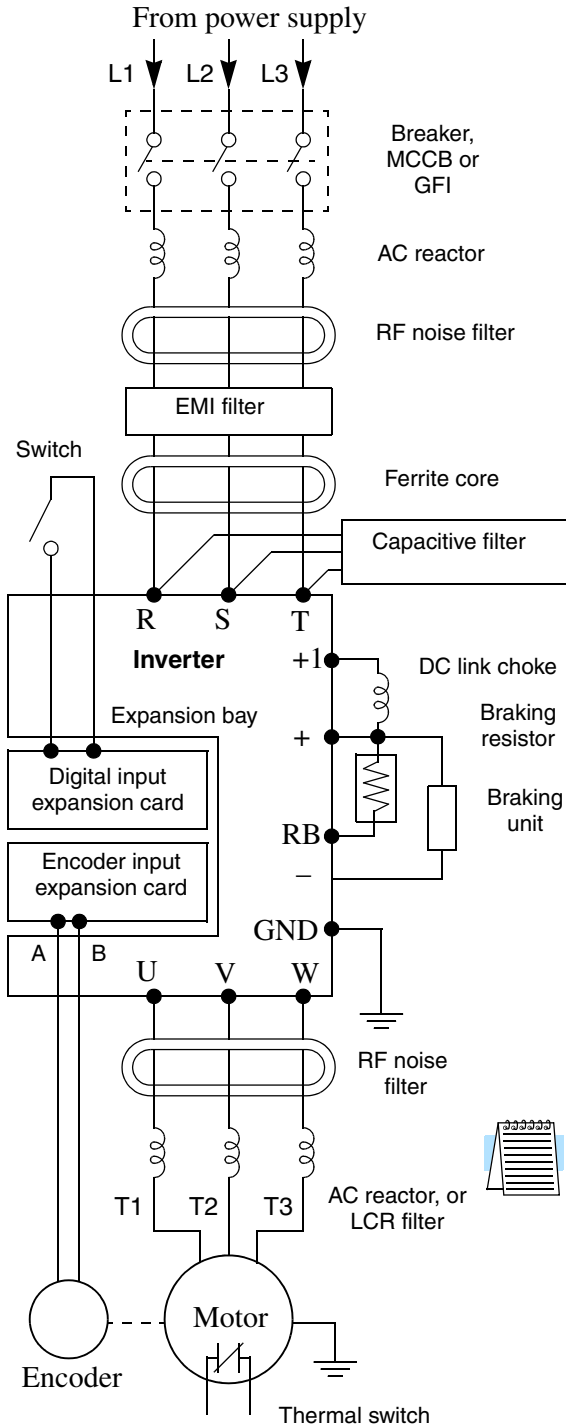


5

In This Chapter....	page
— Introduction	2
— Component Descriptions	3
— Dynamic Braking.....	6

Introduction

A motor speed control system will obviously include a motor and inverter, as well as fuses for safety. If you are connecting a motor to the inverter on a test bench just to get started, that's all you may need for now. But a fully developed system can also have a variety of additional components. Some can be for noise suppression, while others may enhance the inverter's braking performance. The figure below shows a system with several possible optional components, and the table gives part number information.



Name	Part No. Series		See page
	Europe, Japan	USA	
AC reactor, input side	ALI-xxx	HRL-x	5-3
RF noise filter, input side	ZCL-x	ZCL-x	5-4
EMI filter (EMC Class A)	NF-CEHx	NF-CEHxx	5-4
EMI filter (EMC Class B)	NF-CEHx, with FC-Hx	NF-CEHxx, with FC-Hx	5-4
Capacitive filter	CFI-x	CFI-x	5-4
DC link choke	—	HDC-xxx	5-4
Braking resistor	JRB-xxx-x, SRB-xxx-x	JRB-xxx, SRB-xxx	5-9
Braking resistor, NEMA-rated	—	HRB1-x, HRB2-x, HRB3-x	5-9
Resistance braking unit	BRD-xxx	BRD-xxx	5-8
RF noise filter, output side	ZCL-xxx	ZCL-xxx	5-4
AC reactor, output side	ALI-xxx	HRL-xxx	5-3
LCR filter	—	HRL-xxxC	5-3
Encoder feed-back expansion	SJ-FB		5-5
Digital input expansion card	SJ-DG		5-5

NOTE: The Hitachi part number series for accessories includes different sizes of each part type, specified by the -x suffix. Hitachi product literature can help match size and rating of your inverter to the proper accessory size.

Each inverter accessory comes with its own printed instruction manual. Please refer to those manuals for complete installation details. This chapter gives only an overview of these optional system devices. For more information on Hitachi inverter system accessories, please contact your Hitachi sales office or distributor.

Motor Control Accessories

Component Descriptions

AC Reactors, Input Side

This is useful in suppressing harmonics induced on the power supply lines, or when the main power voltage imbalance exceeds 3% (and power source capacity is more than 500 kVA), or to smooth out line fluctuations. It also improves the power factor.

In the following cases for a general-purpose inverter, a large peak current flows on the main power supply side, and is able to destroy the inverter module:

- If the unbalanced factor of the power supply is 3% or higher
- If the power supply capacity is at least 10 times greater than the inverter capacity (the power supply capacity is 500 kVA or more)
- If abrupt power supply changes are expected

Examples of these situations include:

1. Several inverters are connected in parallel, sharing the same power bus
2. A thyristor converter and an inverter are connected in parallel, sharing the same power bus
3. An installed phase-advance (power factor correction) capacitor opens and closes

Where these conditions exist or when the connected equipment must be highly reliable, install an AC reactor between the power supply and the inverter. Also, where the effects of an indirect lightning strike is possible, install a lightning conductor.

Example calculation:

$V_{RS} = 205V$, $V_{ST} = 203V$, $V_{TR} = 197V$,

where V_{RS} is R-S line voltage, V_{ST} is S-T line voltage, V_{TR} is T-R line voltage

$$\text{Unbalance factor of voltage} = \frac{\text{Max. line voltage (min.)} - \text{Mean line voltage}}{\text{Meanline voltage}} \times 100$$

$$= \frac{V_{RS} - (V_{RS} + V_{ST} + V_{TR})/3}{(V_{RS} + V_{ST} + V_{TR})/3} \times 100 = \frac{205 - 202}{202} \times 100 = 1.5\%$$

Please refer to the documentation that comes with the AC reactor for installation instructions.

AC Reactor or LCR Filter, Output Side

This reactor reduces the vibrations in the motor caused by the inverter's switching waveforms, by smoothing the waveforms to approximate commercial power quality. It is also useful to reduce the reflected voltage wave phenomenon when wiring from the inverter to the motor is more than 10m in length. Please refer to the documentation that comes with the AC reactor for installation instructions.

Zero-phase Reactor (RF Noise Filter)

Electrical noise interference may occur on nearby equipment such as a radio receiver. The zero-phase reactor helps reduce radiated noise from the inverter wiring. It can be used on the input or output side of the inverter. The example zero-phase reactor shown to the right comes with a mounting bracket. The wiring must go through the opening to reduce the RF component of the electrical noise. Loop the wires three times (four turns) to attain the full RF filtering effect. For larger wire sizes, place multiple zero-phase reactors (up to four) side-by-side for a greater filtering effect.



ZCL-x

EMI Filter

The EMI filter reduces the conducted noise on the power supply wiring generated by the inverter. Connect the EMI filter to the inverter primary (input side). The NF-CEH-x series filter is required for compliance to the EMC Class A directive (Europe) and C-TICK (Australia). See “CE-EMC Installation Guidelines” on page D-2.



WARNING: The EMI filter has high internal leakage current from power wiring to the chassis. Therefore, connect the chassis ground of the EMI filter before making the power connections to avoid danger of shock or injury.



NF-CEHxx

Ferrite Core

To meet EMC Class B limit an optional ferrite core (FC-Hx) must be inserted between the NF-CEHx filter (above) and the inverter.

RF Noise Filter (Capacitive)

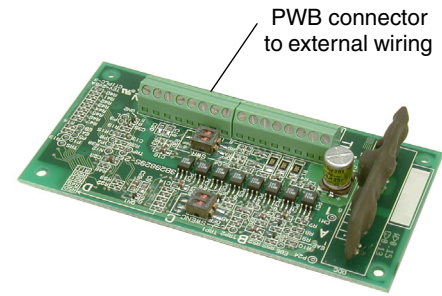
This capacitive filter reduces radiated noise from the main power wires in the inverter input side. This filter is not for achieving CE compliance and is applicable only to the input side only of the inverter. It comes in two versions—for 200V class inverters or 400V class inverters. Please refer to the documentation that comes with the radio noise filter for installation instructions.

DC Link Choke

The DC choke (reactor) suppresses harmonics generated by the inverter. It attenuates the high-frequency components on the inverter’s internal DC bus (link). However, note that it does not protect the diode rectifiers in the inverter input circuit.

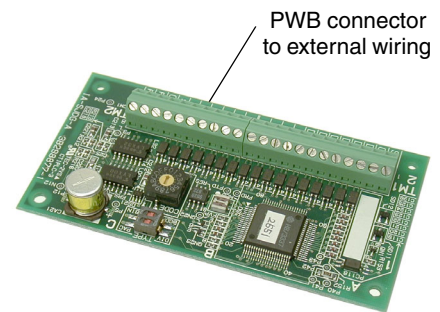
Expansion Cards The SJ-FB Encoder Feedback Board installs in the inverter's expansion bay, which can accept up to two expansion cards. The encoder card accepts two-channel incremental encoder signals. Position feedback is essential for certain torque-control algorithms, and is useful for improving low-speed performance. The card can also generate linear acceleration/deceleration ramps for velocity control.

All wiring associated with this card connects to its PWB connectors as shown. Some related signals may be assigned to the intelligent I/O terminals, as described in Chapter 4. For more information, refer to the SJ-FB manual.



SJ-FB Encoder Feedback Card

The SJ-DG Digital Input Card installs in the inverter's expansion bay. This card accepts up to eight digital input signals, in addition to the intelligent inputs on the inverter's control terminal connector. All wiring associated with card connects to its PWB connectors as shown.



SJ-DG Digital Input Card

The SJ-DN DeviceNet Interface Card (not shown) installs in the inverter's expansion bay. It connects directly to a DeviceNet network. Inverter parameters P044 to P049 configure the card. Only one DeviceNet card may be installed in an inverter. For more information, please refer to the DeviceNet Expansion Card Instruction Manual.

Dynamic Braking

Introduction

The purpose of dynamic braking is to improve the ability of the inverter to stop (decelerate) the motor and load. This becomes necessary when an application has some or all of the following characteristics:

- High load inertia compared to the available motor torque
- The application requires frequent or sudden changes in speed
- System losses are not great enough to slow the motor as needed

When the inverter reduces its output frequency to decelerate the load, the motor can temporarily become a generator. This occurs when the motor rotation frequency is higher than the inverter output frequency. This condition can cause the inverter DC bus voltage to rise, resulting in an over-voltage trip. In many applications, the over-voltage condition serves as a warning signal that we have exceeded the deceleration capabilities of the system. SJ300 inverters rated 15hp (11kW) and below have a built-in braking unit that sends the regenerative energy from the motor during deceleration to the optional braking resistor(s). External braking units may also be used if higher braking torques and/or duty cycles are required. The dynamic braking resistor serves as a load, developing heat to stop the motor just as brakes on an automobile develop heat during braking.

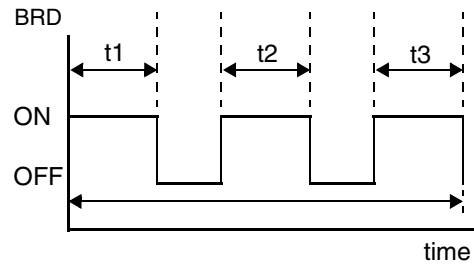
The braking resistor is the main component of a braking resistor assembly, which includes an integral thermal fuse and thermally activated alarm relay for safety. However, be careful to avoid overheating its resistor. The thermal fuse and thermal relay are safeguards for extreme conditions, but the inverter can maintain braking usage in a safe zone.



Braking Resistor

Dynamic Braking Usage Ratio

The inverter controls braking via a duty cycle method (percent of the time braking is ON versus total time). Parameter B090 sets the dynamic braking usage ratio. In the graph to the right, the example shows three uses of dynamic braking in a 100-second period. The inverter calculates the average percentage usage in that time (T%). The percentage of usage is proportional to the heat dissipated. If T% is greater than the B090 parameter setting, the inverter enters the Trip Mode and turns OFF the frequency output.



$$\boxed{\text{B90}} \quad T\% = \frac{(t1 + t2 + t3 + \dots)}{100 \text{ seconds}} \times 100$$

Please note the following (for SJ300-004LF/HF to SJ300-110LF/HF).

- When B090 is set for 0%, dynamic braking is not performed.
- When the T% value exceeds the limit set by B090, the inverter will trip (ending the dynamic braking).
- The cable from the external resistor to the inverter must not exceed 5 m (16 ft.) length.
- The individual wires from the resistor to the inverter must not be bundled together.



NOTE: Inverters rated 20hp (15kW) and above (SJ300-150LF/HF to SJ300-550LF/1320HFE/1500HFU) do not include an internal braking unit. Parameters B090, B095, and B096 do not apply to these models.

SJ300 Dynamic Braking Selection Tables

The SJ300 Series 200V and 400V class inverter models in the 1/2 to 15 hp range have internal braking units. Additional stopping torque is available by adding external resistors. The required braking torque depends on your particular application. Other tables in this section will help you choose the proper resistor.

1/2 to 15 hp (0.4 to 11 kW)			Using Internal Resistor		Using Optional Resistor		Performance @ Minimum Resistance		Minimum Resistance @ 100% Braking Duty Cycle, Ohms
Voltage Class	Model Number	Motor hp	Braking Unit	Braking Torque @ 60Hz, (without external resistor), %	External Resistance, Ohms	Braking Torque @60Hz, %	Minimum Resistance, Ohms	Max. Braking Duty Cycle, %	
200V	SJ300-004LFU	1/2	Built-in	50	50	200	50	10	150
	SJ300-007LFU	1	Built-in	50	50	200	50	10	150
	SJ300-015LFU	2	Built-in	50	35	200	35	10	100
	SJ300-022LFU	3	Built-in	20	35	160	35	10	100
	SJ300-037LFU	5	Built-in	20	35	100	35	10	100
	SJ300-055LFU	7.5	Built-in	20	17	80	17	10	50
	SJ300-075LFU	10	Built-in	20	17	80	17	10	50
	SJ300-110LFU	15	Built-in	10	17	70	17	10	50
400V	SJ300-007HFU/E	1	Built-in	50	100	200	100	10	300
	SJ300-015HFU/E	2	Built-in	50	100	200	100	10	300
	SJ300-022HFU/E	3	Built-in	20	100	200	100	10	300
	SJ300-040HFU/E	5	Built-in	20	100	140	70	10	200
	SJ300-055HFU/E	7.5	Built-in	20	70	100	70	10	200
	SJ300-075HFU/E	10	Built-in	20	70	100	50	10	150
	SJ300-110HFU/E	15	Built-in	10	70	70	50	10	150

Choosing a Braking Unit

The SJ300 Series 200V and 400V class inverter models in the 20 to 200 hp range require external braking units to increase their braking torque. Braking units come in sizes corresponding to the power handling requirements for particular resistor selections. Be sure to follow the installation instructions accompanying each braking unit. The following table lists the SJ300 inverter models and their applicable braking units.

20 to 200 hp (15 to 1500 kW)			Performance Versus External Braking Units				
			Without Braking Unit	With Braking Unit			
Voltage Class	Model Number SJ300	Motor hp	Braking Torque, %	Braking Unit Model	Minimum Resistance, Ohms	Max. Braking Duty Cycle, %	Minimum Resistance @ 100% Braking Duty Cycle, Ohms
200V	-150LFU	20	10	BRD-E2	17	10	46
			10	BRD-E2-30K	4	20	6
	-185LFU	25	10	BRD-E2	17	10	46
			10	BRD-E2-30K	4	20	6
	-220LFU	30	10	BRD-E2	17	10	46
			10	BRD-E2-30K	4	20	6
	-300LFU	40	10	BRD-E2-30K	2	20	6
			10	BRD-E2-55K	2	20	4
-370LFU	50	10	BRD-E2-55K	2	20	4	
-450LFU	60	10	BRD-E2-55K	2	20	4	
-550LFU	75	10	BRD-E2-55K	2	20	4	
400V	-150HFU/HFE	20	10	BRD-EZ2	20	10	34
			10	BRD-EZ2-30K	10	10	24
	-185HFU/HFE	25	10	BRD-EZ2	20	10	34
			10	BRD-EZ2-30K	10	10	24
	-220HFU/HFE	30	10	BRD-EZ2	20	10	34
			10	BRD-EZ2-30K	10	10	24
	-300HFU/HFE	40	10	BRD-EZ2-55K	6	20	12
	-370HFU/HFE	50	10	BRD-EZ2-55K	6	20	12
	-450HFU/HFE	60	10	BRD-EZ2-55K	6	20	12
	-550HFU/HFE	75	10	BRD-EZ2-55K	6	20	12
	-750HFU/HFE	100	10	BRD-EZ2-55K	6	20	12
	-900HFU/HFE	125	10	BRD-EZ2-55K	6	20	12
	-1100HFU/HFE	150	10	BRD-EZ2-55K	6	20	12
-1320HFE	175	10	BRD-EZ2-55K	6	20	12	
-1500HFU	200	10	BRD-EZ2-55K	6	20	12	

Selecting a Braking Resistor

You can add one or more resistors to your inverter configuration to increase braking torque performance. The number of resistors and their configuration (series or parallel) depends on the desired braking torque. The tables below list the resistor types for inverter models with internal braking units. Tables for inverters with external braking units are on the next two pages.

- Total Ohms – lists the resistance value of the resistor or, if using multiple resistors, their combined resistance
- Total Watts – lists the power dissipation of the resistor or, if using multiple resistors, their combined power dissipation
- Maximum Duty Cycle – the maximum allowable percentage of braking time over any 100-second interval to avoid overheating the resistor(s)
- Maximum braking torque – the maximum braking torque that the inverter / resistor combination can deliver



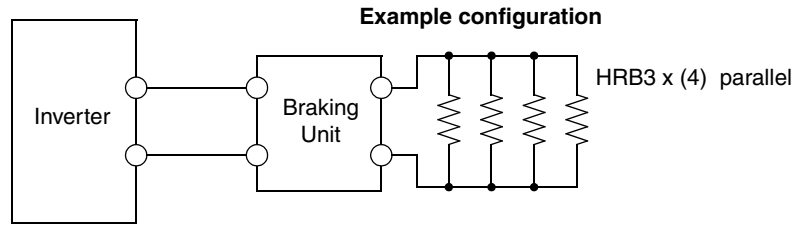
NOTE: If your application requires resistors with NEMA ratings, be sure to use the HRB type.

200V Class	Dynamic Braking Resistor Selection												Max. Braking Torque, %
Model Number SJ300	JRB Series				SRB/NSRB Series				HRB Series				
	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	
-004LFU	120-3	50	120	1.5	300-1	50	300	7.5	HRB1	50	400	10	200
-007LFU	120-3	50	120	1.5	300-1	50	300	7.5	HRB1	50	400	10	200
-015LFU	120-4	35	120	1.0	400-1	35	400	7.5	HRB2	35	600	10	200
-022LFU	120-4	35	120	1.0	400-1	35	400	7.5	HRB2	35	600	10	160
-037LFU	120-4	35	120	1.0	400-1	35	400	7.5	HRB2	35	600	10	100
-055LFU	120-4 x (2) in parallel	17.5	240	1.0	400-1 x (2) in parallel	17.5	800	7.5	HRB3	17	1200	10	80
-075LFU		17.5	240	1.0		17.5	800	7.5	HRB3	17	1200	10	80
-110LFU		17.5	240	1.0		17.5	800	7.5	HRB3	17	1200	10	70

400V Class	Dynamic Braking Resistor Selection												Max. Braking Torque, %
Model Number SJ300	JRB Series				SRB/NSRB Series				HRB Series				
	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	
-007HFU/HFE	120-2	100	120	1.5	200-2	100	200	7.5	HRB1 x (2) in series	100	800	10	200
-015HFU/HFE	120-2	100	120	1.5	200-2	100	200	7.5		100	800	10	200
-022HFU/HFE	120-2	100	120	1.5	200-2	100	200	7.5		100	800	10	200
-040HFU/HFE	120-4 x (2) in series	70	240	1.0	400-1 x (2) in series	70	800	10	HRB2 x (2) in series	70	1200	10	140
-055HFU/HFE		70	240	1.0		70	800	10		70	1200	10	120
-075HFU/HFE		70	240	1.0		70	800	10		70	1200	10	100
-110HFU/HFE		70	240	1.0		70	800	10		70	1200	10	70

Motor Control Accessories

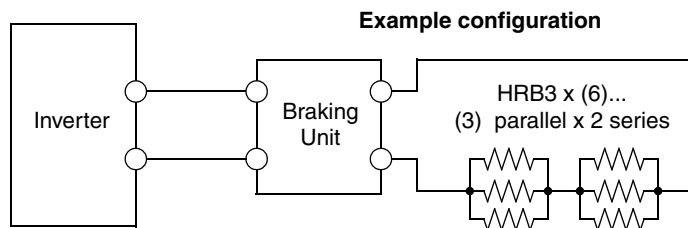
The table below lists the performance of 200V-class inverter models with the optional **external** braking units. In some cases, the resistor selection specifies multiple resistors in a parallel, series, or combination parallel/series configuration. The example diagram shows a parallel configuration. Please refer to the braking resistor documentation for detailed wiring diagrams.



200V Class	Braking Unit	Dynamic Braking Resistor Selection					Max. Braking Torque, %
Model Number SJ300	Type	Type x (quantity)	Series or Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %	
-150LFU	BRD-E2	HRB1	—	50	400	10	30
		HRB2	—	35	600	10	35
		HRB3	—	17	1200	10	60
	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	110
		HRB3 x (3)	parallel	5.7	3600	20	150
		HRB3 x (4)	parallel	4.3	4800	20	200
-185LFU	BRD-E2	HRB1	—	50	400	10	25
		HRB2	—	35	600	10	30
		HRB3	—	17	1200	10	50
	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	90
		HRB3 x (3)	parallel	5.7	3600	20	130
		HRB3 x (4)	parallel	4.3	4800	20	170
-220LFU	BRD-E2	HRB1	—	50	400	10	25
		HRB2	—	35	600	10	30
		HRB3	—	17	1200	10	45
	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	80
		HRB3 x (3)	parallel	5.7	3600	20	110
		HRB3 x (4)	parallel	4.3	4800	20	150
-300LFU	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	55
		HRB3 x (3)	parallel	5.7	3600	20	80
		HRB3 x (4)	parallel	4.3	4800	20	110
-370LFU	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	45
		HRB3 x (3)	parallel	5.7	3600	20	65
		HRB3 x (4)	parallel	4.3	4800	20	90
-450LFU	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	35
		HRB3 x (3)	parallel	5.7	3600	20	50
		HRB3 x (4)	parallel	4.3	4800	20	75

200V Class	Braking Unit	Dynamic Braking Resistor Selection					Max. Braking Torque, %
Model Number SJ300	Type	Type x (quantity)	Series or Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %	
-550LFU	BRD-E2-30K	HRB3 x (2)	parallel	8.5	2400	20	30
		HRB3 x (3)	parallel	5.7	3600	20	40
		HRB3 x (4)	parallel	4.3	4800	20	60

The table below lists the performance of 400V-class inverter models with the optional **external** braking units. In some cases, the resistor selection specifies multiple resistors in a parallel, series, or combination parallel/series configuration. The example diagram shows a combination parallel / series configuration. Please refer to the braking unit manual for detailed wiring diagrams.



400V Class	Braking Unit	Dynamic Braking Resistor Selection					Max. Braking Torque, %
Model Number SJ300	Type	Type x (quantity)	Series / Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %	
-150HFU/HFE	BRD-EZ2	HRB1 x (2)	series	100	800	10	40
		HRB2 x (2)	series	70	1200	10	60
		HRB3 x (2)	series	34	2400	10	110
	BRD-EZ2-30K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	190
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	200
-185HFU/HFE	BRD-EZ2	HRB1 x (2)	series	100	800	10	40
		HRB2 x (2)	series	70	1200	10	50
		HRB3 x (2)	series	34	2400	10	90
	BRD-EZ2-30K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	170
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	200
-220HFU/HFE	BRD-EZ2	HRB1 x (2)	series	100	800	10	35
		HRB2 x (2)	series	70	1200	10	45
		HRB3 x (2)	series	34	2400	10	80
	BRD-EZ2-30K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	150
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	200

400V Class	Braking Unit	Dynamic Braking Resistor Selection					Max. Braking Torque, %
Model Number SJ300	Type	Type x (quantity)	Series / Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %	
-300HFU	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	110
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	170
-370HFU/HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	90
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	150
-450HFU/HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	70
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	120
-550HFU/HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	60
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	100
-750HFU/HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	45
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	70
-900HFU/HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	40
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	60
-1100HFU/HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	30
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	50
-1320HFU	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	25
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	40
-1500HFE	BRD-EZ2-55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	20
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	35



NOTE: Other braking units and resistors are also available. For braking requirements beyond those in the tables, contact your Hitachi distributor.