AC Drives
Regenerative Energy Solutions

Product Summary

RELIANCE ELECTRIC

AC Drives

Regenerative Energy Solutions

- *Snubber Resistor Braking Kits*
- *Line Regeneration Controls*
- *Synchronous Rectifier Controls*

AC Drives and Regenerative Energy

When the rotating element of an AC motor runs faster than the AC drive's speed command, the motor begins to act as a generator and pumps (regenerates) energy back into the DC bus of the drive. If the drive cannot absorb this excess energy, the DC bus voltage will continue to climb until the drive trips on a high bus fault. These regenerative conditions can occur when:

- quickly decelerating a high inertia load (flywheel, mechanical arm)
- controlling the speed of a load moving vertically downward (hoist, declining conveyor)
- a sudden drop in load torque occurs (machining/drilling operation or an industrial saw)
- the process requires repetitive acceleration and deceleration to a stop (indexing)
- controlling the speed (tension control) of an unwind application

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A 460 VAC drive operating on 460 VAC line power will have a nominal DC bus voltage of 650 VDC (325 VDC for a 230 VAC drive). When the DC bus exceeds 800 VDC (400 VDC for a 230 VAC drive) the drive will trip.

There are three technologies available to prevent the AC drive from reaching the trip level. Each technology has its own advantages and disadvantages. The three technologies are **Snubber Resistor Braking, Line Regeneration Control, and Synchronous Rectifier Control.**

Snubber Resistor Braking kits use a transistor and circuitry that "turns on" at a predetermined DC bus voltage, which is set below the AC drive's trip point. At this voltage level the energy is transferred to a resistor (or group of resistors) where the energy is burned off as heat. Some AC drives already include a built-in braking transistor (such as the GV3000/SE Bookshelf drive) and only require the addition of a resistor kit. Snubber resistor braking kits are a lower cost solution compared to line regeneration controls or synchronous rectifier controls. Snubber braking resistors, however, require cool down time, which make them less suitable for highly cyclical operations such as frequent, repetitive starts and stops. Line regeneration controls or synchronous rectifier controls are more suitable for these applications.

Line Regeneration Controls use a set of transistors, which pulse "on" at a predetermined DC bus voltage set below the AC drive's trip point. At this voltage level the energy is transferred directly back to the AC power source. Line regeneration controls can operate in a continuous mode up to the transistor current rating. Their ability to regenerate power back to the power source also makes them an energy saving device. Over time this energy savings can offset the higher cost of these controls.

Synchronous Rectifier Controls can be used either as line regeneration controls or as AC line voltage to DC voltage converters for powering the DC bus of an AC drive.

In line regeneration control, the synchronous rectifier and the AC drive both receive their input power from the AC line. The AC drive's DC bus terminals are also connected to the DC terminals of the synchronous rectifier. Under regenerative conditions the synchronous rectifier channels the excess DC bus voltage, based on a preset level, back to the AC power line.

In synchronous rectifier control, the AC drive (or a group of AC drives) is connected directly to the DC output of the synchronous rectifier control via the drive DC bus terminals, thus bypassing the AC line and the AC drive's diode bridge front end. With multiple AC drives connected via a "common bus" to the synchronous rectifier, regenerative energy is shared between the motoring and regenerating drives, thus saving power.

When Is External Braking Required?

Not every regenerative situation will require external braking hardware. If the regenerative energy is small enough to be readily absorbed by the DC bus of the drive, then an external brake will not be necessary. A combination of extended deceleration time, reduced change in speed and mechanical system friction will assist in absorbing the excess energy.

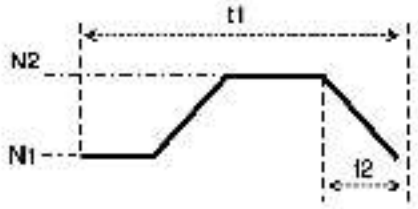
A drive operating on 460 VAC power will have a nominal bus voltage of 650 VDC (325 VDC for 230 VAC drives). 460 VAC drives are typically designed to operate with DC bus voltage levels up to 800 VDC (400 VDC for 230 VAC drives) before tripping. The regenerative energy may be small enough for the DC bus to remain under 800 VDC.

Typically, if the regenerative horsepower is 10% or less than the drive horsepower rating, external braking hardware will not be required.

Calculating the Regenerative Energy

1) Determine the speed/cycle profile of the application:

N1 = minimum speed
N2 = maximum speed
t1 = total cycle time
t2 = deceleration time



2) Calculate or obtain the system inertia data:

$WK^2_S = WK^2_M + (WK^2_L / GR^2)$

Where:

WK^2_S = total system inertia
WK^2_M = motor rotor inertia
WK^2_L = driven load inertia

GR = gear ratio (defined as motor revolutions/driven load revolutions)

3) Calculate the regeneration or braking torque required to decelerate the load.

$T_R = T_{accel} - T_f$

$$T_R = \frac{WK^2_S * (N2 - N1)}{308 * t2} - T_f$$

Where:

T_R = braking torque in ft lbs
T_f = friction torque

4) Calculate the braking HP required at top speed:

$$HP_{regen} = \frac{T_R * N2}{5250}$$

5) The value of HP_{regen} can now be compared to the drive rating to determine if external braking hardware is needed. If $(HP_{regen} / HP_{drive}) * 100 > 10\%$, external braking hardware is recommended.

Sizing External Braking Hardware

If the results of step 5 indicate the need for external braking hardware, the following additional steps will assist in properly sizing an external brake unit. To determine if the brake unit meets the application's needs, three items must be determined: average power generation, peak power, and peak regeneration current.

6) Average power generation is calculated as follows, assuming the deceleration rate is linear:

$$HP_{regen} = \frac{(T_R * (N2+N1) / 2 * t1}{5250 * t2}$$

7) Convert the regeneration HP in watts (Average Power).

$$Watts_{regen} = HP_{regen} * 746$$

8) Peak regeneration watts can be obtained by using the HP_{regen} calculated in step 4 and converting to watts. This peak regeneration (watts) energy must be less than the peak watt rating of the braking unit.

Determining the Duty Cycle

9) The braking duty cycle (percentage of time during an operating cycle when braking occurs), must be determined. A typical operating cycle consists of an acceleration mode, a running at set speed mode, a deceleration mode and finally a rest or zero speed mode. Braking occurs during the deceleration mode.

$$\text{Duty Cycle} = \frac{\text{Braking time}}{\text{Cycle time}}$$

A lower duty cycle percentage will allow more time for resistor cool-down. This will affect resistor sizing and selection. A duty cycle of 50% or less makes snubber brake control a good solution. For duty cycles near or at 100%, line regeneration control is more suitable.

Calculating the Regenerative Current

10) The regenerative current must be compared to the current rating of the braking unit. The regenerative current must not exceed the rated amps of the braking unit. Using the braking HP from step 4, the following rule-of- thumb formulas can be used to calculate the regenerative current:

460 V Drives $I_{regen} = 1.2 * HP_{regen}$

230 V Drives $I_{regen} = 2.4 * HP_{regen}$

AC Drives

Snubber Braking Kits – Description and Selection Information

Snubber brakes consist of two components – braking transistor circuitry and a resistor or set of resistors. Some AC drives are manufactured with built in snubber transistor circuitry such as the GV3000/SE Bookshelf drive. These drives only require the addition of a properly sized resistor (refer to tables 5 and 6 for resistor kits and sizing information). For drives requiring an external braking transistor, refer to table 1 for complete snubber braking kits or tables 2 through 5 for separate snubber transistor and resistor kits.

Complete Snubber Resistor Braking Units

Contains both a Snubber Transistor and Snubber Resistor

- For 20–50% Duty Cycles
- NEMA 1 Enclosed
- 230 V, 460 V, 575 V

Specifications

- Rated Voltage: 3-phase, +10%, -20%
- Hertz: 50–60 Hz
- Input Current: Rated DC current
- Connections: Drive DC bus, ground, input AC line (single phase, rated voltage –10%, +20%, 50–60 Hz)
- Adjustments: None, automatic voltage level
- Current Limit: To rated DC current
- Maximum On time: 60 seconds
- Operating Temperature: 0–50°C
- Humidity: Below 90%, non-condensing
- Atmosphere: Free of corrosive gas or dust
- Panel Indicators: DC bus lamp, control power lamp, active braking lamp

Table 1 Complete Snubber Brake Kits Selection Table

Drive Rating	Snubber Brake Kit P/N	Resistance Value	Cont. Watt Dissipation	Instant. Watt Dissipation	Continuous Duty Cycle	Dimensions (in.)		
						H	W	D
1 HP, 230 V	25P20400	40	400	4000	10%	18.2	8.25	8.5
2 HP, 230 V	25P20400	40	400	4000	10%	18.2	8.25	8.5
	75P20600	20	600	6000	10%	18.2	8.25	8.5
3 HP, 230 V	25P20400	40	400	4000	10%	18.2	8.25	8.5
	25P20600	20	600	6000	10%	18.2	8.25	8.5
	75P21200	10	1200	12000	10%	18.2	8.25	8.5
5 HP, 230 V	25P20600	20	600	6000	10%	18.2	8.25	8.5
	75P21200	10	1200	12000	10%	18.2	8.25	8.5
	25P21800	6	1800	18000	10%	18.2	10.25	10.5
7 1/2 HP, 230 V	25P21200	10	1200	12000	10%	18.2	8.25	8.5
	75P21800	6	1800	18000	10%	18.2	10.25	10.5
10 HP, 230 V	25P21200	10	1200	12000	10%	18.2	8.25	8.5
	75P21800	6	1800	18000	10%	18.2	10.25	10.5
1 HP, 460 V	25P40400	160	400	4000	10%	18.2	8.25	8.5
2 HP, 460 V	25P40400	160	400	4000	10%	18.2	8.25	8.5
	25P40600	75	600	6000	10%	18.2	8.25	8.5
3 HP, 460 V	25P40400	160	400	4000	10%	18.2	8.25	8.5
	75P40600	75	600	6000	10%	18.2	8.25	8.5
	25P41200	40	1200	12000	10%	18.2	8.25	8.5
5 HP, 460 V	25P40600	75	600	6000	10%	18.2	8.25	8.5
	75P41200	40	1200	12000	10%	18.2	8.25	8.5
	25P41800	25	1800	18000	10%	18.2	10.25	10.5
7 1/2 HP, 460 V	75P41200	40	1200	12000	10%	18.2	8.25	8.5
	25P41800	25	1800	18000	10%	18.2	10.25	10.5
10 HP, 460 V	75P41200	40	1200	12000	10%	18.2	8.25	8.5
	25P41800	25	1800	18000	10%	18.2	10.25	10.5
15 HP, 460 V	25P41800	25	1800	18000	10%	18.2	10.25	10.5
20 HP, 460 V	75P41800	25	1800	18000	10%	18.2	10.25	10.5
3 HP, 575 V	25P50400	160	400	4000	10%	18.2	8.25	8.5
	75P51200	80	1200	12000	10%	18.2	8.25	8.5
	25P51800	45	1800	18000	10%	18.2	10.25	10.5
10 HP, 575 V	25P51200	80	1200	12000	10%	18.2	8.25	8.5
	75P51800	45	1800	18000	10%	18.2	10.25	8.5

Note: To properly size a complete snubber resistor braking kit, calculate the peak and average regeneration power of the application, as outlined in steps 8 through 9. If the peak and average power cannot be calculated due to unknown values for items such as system inertia, select the braking units above based on the drive horsepower rating and the application duty cycle.

Snubber Transistor Braking Kits

Snubber transistor braking kits provide transistor circuitry for AC drives requiring an external braking transistor. Snubber transistor kits are available in IP20 enclosures or as open chassis construction.

Open Chassis - Snubber Transistors Kits

- For 20-100% Duty Cycles
- 230 V, 460 V

Specifications

- Input Power: 1-phase (based on rating)
- Fan Input Voltage: Derived internally
- Hertz: 50-60 Hz
- Input Current: Rated DC current
- Connections: Drive DC bus, ground, input AC line (single phase, rated volts +10, -20% 50-60 Hz), resistor pair
- Adjustments: None, automatic voltage level
- Current Limit: To rated DC current
- Maximum On-time: See selection table 2
- Operating Temperature: 0-50°C
- Humidity: Below 90%, non-condensing
- Atmosphere: Free of corrosive gas or dust
- Panel Indicators: DC bus lamp, control power lamp, active braking lamp

Table 2 Chassis Snubber Transistor Kits

AC Line Voltage	Snubber Transistor Kit P/N	Amps DC RMS	Min. Ohms	Maximum On-time	UL Labeled	Dimensions (in.) H	W	D
230	2S12301	10	20	120 Sec.	No	12	5	6.75
	2S12304	24	8	120 Sec.	Yes	12	5	6.75
460	2S14300	9	75	Continuous	No	12	5	6.75
	2S14302	27	25	120 Sec.	Yes	12	5	6.75
	2S14307	75	10	120 Sec.	No	12	12	8
	2S14312	125	6	120 Sec.	No	12	12	8
	2S14316	150	5	Continuous	No	16	16	8
	2S14320	200	3.8	Continuous	No	16	16	8
	2S14330	300	2.5	Continuous	No	16	16	8

IP20 Enclosed - Snubber Transistors Kits

- For 6-20% Duty Cycles
- 230 V, 460 V

Specifications

- Input Power: Derived from DC bus
- Fan Input Voltage: 1-phase, 115 VAC
- Hertz: 50-60 Hz
- Input Current: Rated DC current
- Connections: Drive DC bus, ground, input AC line (single phase, 115 VAC, 50-60 Hz), resistor pair
- Adjustments: None, automatic voltage level
- Current Limit: To rated DC current
- Maximum On-time: 60 seconds maximum
- Operating Temperature: 0-50°C
- Humidity: Below 90%, non-condensing
- Atmosphere: Free of corrosive gas or dust
- Panel Indicators: DC bus lamp, active braking lamp

Table 3 IP20 Snubber Transistor Kits

AC Line Voltage	Snubber Transistor Kit P/N	Amps DC RMS	Min. Ohms	UL Labeled	Dimensions (in.) H	W	D
230	[illegible]	10	25	No	12.75	5	6.7
	[illegible]	30	16.2	No	12.75	5	6.7
	[illegible]	60	6.25	No	12.75	8	6.7
460	[illegible]	12	50	No	12.75	5	6.7
	[illegible]	30	25	No	12.75	5	6.7
	[illegible]	75	10	No	12.75	4	6.7
	[illegible]	125	6	No	17.75	4	6.7
	[illegible]	150	5	No	17.75	4	6.7
	[illegible]	[illegible]	[illegible]	No	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	No	[illegible]	[illegible]	[illegible]

Note: When matching a transistor kit with resistors, it is important to select a resistor with the proper ohmage. The ohmage must be equal to or greater than the ohmage rating of the transistor. If the resistor ohmage is too low, a short of the drive DC bus may occur which can result in damage to the braking transistor or the drive. If the resistor ohmage is too high, little or no braking will occur.

To properly size a snubber transistor kit, calculate the regenerative current of the application as outlined in steps 5 through 10. If the regenerative current cannot be calculated due to unknown values for items such as system inertia, the drive horsepower can be multiplied by the rule-of-thumb formulas in step 10.

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Snubber Resistor Braking Kits

Snubber resistor braking kits consist of a resistor, or a combination of resistors, packaged in an IP20 enclosure for easy mounting and matching with a snubber transistor kit. Tables 4 and 5 list the snubber resistor kits available in IP20 enclosures, rated for 6 to 20% duty cycles. Loose resistors or resistors with ratings not listed in tables 4 or 5 (i.e., greater than 20% duty cycle) must be obtained directly from a third party vendor.

IP20 Snubber Resistor Brake Kits

- For 6-20% Duty Cycles
- 230 V, 460 V

Specifications

- Optional Fan Input Voltage: 1-phase, 60 Hz, 115 VAC
- Connections: Drive DC bus, fault contacts, optional fan AC input line input (single phase, 60 Hz, 115 VAC)
- Adjustments: None
- Maximum On-time: 60 seconds
- Operating Temperature: 0-50°C
- Humidity: Below 90%, non-condensing
- Atmosphere: Free of corrosive gas or dust
- Fault Indicator: 1 N.C. contact rated for 1 A @ 24 VDC or 0.5 A @ 115 VAC. Contact opens on over-temperature condition (85°C or higher).

Table 4 230 V Snubber Resistor Kits

Snubber Resistor Kit M/N	Braking HP	Duty Cycle	Braking Watts		Max. Amps	Load Ohms	Dimensions (in.)		
			Peak	Cont.			H	W	D
M3575RL1R M3575RL1RF	1	6% 20%	746	50 150	2	190	17.75	4	8.7
M3575RL2R M3575RL2RF	2	6% 20%	1492	100 300	4	95	17.75	4	8.7
M3575RL3R M3575RL3RF	3	6% 20%	1380	150 400	5	75	17.75	4	8.7
M3575RL3R M3575RL3RF	3	6% 20%	2238	150 450	6	63	17.75	4	8.7
M3575RL4R M3575RL4RF	4	6% 20%	2984	200 600	8	48	17.75	7	8.7
M3575RL5R M3575RL5RF	5	6% 20%	3079	250 750	10	38	17.75	4	8.7
M3575RL6R M3575RL6RF	6	6% 20%	4476	300 900	12	32	17.75	7	8.7
M3575RL8R M3575RL8RF	8	6% 20%	5968	350 1200	13	25	17.75	4	8.7
M3575RL9R M3575RL9RF	9	6% 20%	6714	450 1350	14	21	17.75	10	8.7
M3575RL11R M3575RL11RF	11	6% 20%	7367	450 1600	20	19	17.75	7	9.2
M3575RL16R M3575RL16RF	16	6% 20%	11936	600 2400	31	13	17.75	7	9.2
M3575RL24R M3575RL24RF	24	6% 20%	17904	900 3600	47	8	17.75	10	9.7

Table 5 460 V Snubber Resistor Kits

Snubber Resistor Kit M/N	Braking HP	Duty Cycle	Braking Watts		Max. Amps	Load Ohms	Dimensions (in.)		
			Peak	Cont.			H	W	D
A3575RH1R A3575RH1RF	1	6% 20%	746	50 150	1	780	17.75	4	8.7
A3575RH2R A3575RH2RF	2	6% 20%	1492	100 300	2	390	17.75	4	8.7
A3575RH3R A3575RH3RF	3	6% 20%	2238	150 450	3	260	17.75	4	8.7
A3575RH4R A3575RH4RF	4	6% 20%	2984	200 600	4	190	17.75	7	8.7
A3575RH5R A3575RH5RF	5	6% 20%	4000	250 800	3	150	17.75	4	8.7
A3575RH6R A3575RH6RF	6	6% 20%	4476	300 900	6	130	17.75	7	8.7
A3575RH8R A3575RH8RF	8	6% 20%	6000	350 1100	3	90	17.75	4	8.7
A3575RH9R A3575RH9RF	9	6% 20%	6714	450 1350	9	87	17.75	10	8.7
A3575RH11R A3575RH11RF	11	6% 20%	8000	450 1500	11	60	17.75	7	9.2
A3575RH16R A3575RH16RF	16	6% 20%	8000	700 2400	16	46	17.75	7	9.2
A3575RH24R A3575RH24RF	24	6% 20%	8000	1400 3500	24	30	17.75	10	9.7
A3575RH50R3F	50	20%	10000	3500	23	14	11.25	25	22
A3575RH100R2F	100	10%	20000	18000	105	7	55.75	25	22
A3575RH150R3F	150	10%	24000	20000	150	5	55.75	25	22

Note: When matching a resistor kit with a snubber transistor kit or with a drive that has a built-in braking transistor, it is important to select a resistor with the proper ohmage. The ohmage must be equal to or greater than the ohmage rating of the transistor. If the resistor ohmage is too low, a short of the drive DC bus may occur, resulting in damage to the braking transistor or the drive. If the resistor ohmage is too high, little or no braking will occur.

To determine the proper size snubber resistor kit, calculate the peak and average power regeneration, as well as the braking duty cycle requirement, as outlined in steps 5 through 10. If the regenerative braking condition occurs intermittently (several times a day, with long periods of rest), the resistor kit can be sized using its instantaneous watt rating. If the regenerative braking condition is repetitive and frequent, the resistor kit must be sized according to the kit's duty cycle and continuous watts rating.

Snubber Resistor Braking Selection Information

Table 6 provides snubber resistor sizing information for applications using the GV3000/SE Bookshelf drive.

Table 7 provides snubber resistor sizing and appropriately matched chassis style snubber transistor kits for applications with 20% or greater duty cycles.

Table 6 Snubber Resistor Kit Sizing for GV3000/SE Bookshelf Drives

GV3000/SE Bookshelf M/N	Braking HP	Duty Cycle	Snubber Resistor Kit M/N	Cabinet Dim. (in.) H	W	D	Peak Braking Watts	Cont Braking Watts	Load Ohms	Amp Rating
[illegible]	1	6%	[illegible]	12.4	4	8.7	746	50	150	1
[illegible]	1	10%	[illegible]	12.75	4	6.7	746	151	150	1
[illegible]	2	6%	[illegible]	12.75	4	6.7	1492	151	300	2
[illegible]	2	20%	[illegible]	12.4	4	8.7	1492	400	300	2
[illegible]	3	6%	[illegible]	12.75	4	6.7	2238	151	200	3
[illegible]	3	10%	[illegible]	12.75	4	6.7	2238	401	200	3
[illegible]	4	6%	[illegible]	12.4	7	8.7	2984	400	155	4
[illegible]	4	10%	[illegible]	12.75	7	6.7	2984	501	150	4
	5	6%	[illegible]	12.75	4	6.7	3730	251	100	5
	5	20%	[illegible]	12.4	4	8.7	4000	400	150	5
	6	6%	[illegible]	12.75	7	6.7	4476	301	100	5
	6	10%	[illegible]	12.75	7	6.7	4476	501	100	5
[illegible]	6	6%	[illegible]	12.4	4	8.7	4000	250	91	5
[illegible]	6	10%	[illegible]	12.75	4	6.7	4000	1000	91	5
[illegible]	9	6%	[illegible]	12.75	10	6.7	6714	401	67	5
[illegible]	9	20%	[illegible]	12.4	10	8.7	6714	1500	67	5
[illegible]	11	6%	[illegible]	12.75	7	9.2	8000	451	91	11
[illegible]	11	10%	[illegible]	12.75	7	9.2	8000	1000	91	11
[illegible]	15	6%	[illegible]	12.4	7	9.2	12000	700	45	16
[illegible]	16	10%	[illegible]	12.75	7	9.2	12000	2100	45	16
[illegible]	24	6%	[illegible]	12.75	10	9.7	18000	1000	30	24
[illegible]	24	20%	[illegible]	12.4	10	9.7	18000	3600	30	24

Table 7 Snubber Resistor Size for 20-100% Duty Cycles

HP	Duty Cycle	Snubber Transistor Kit M/N	Minimum Ohms	Maximum Ohms	Approx. Resistor KW
230 V Drive Snubber Resistor Sizing					
1 - 5	60%	2ST20019	20	30	2
	100%	2ST20019	20	36	3.75
7.5 - 10	60%	2ST20019	20	29	3.75
	100%	2ST20064	6	17	7.5
15 - 20	60%	2ST20064	6	14	9
	100%	2ST20064	6	8.5	15
460 V Drive Snubber Resistor Sizing					
1 - 5	60%	2ST40027	20	200	2.5
	100%	2ST40027	20	109	3.75
7.5 - 10	60%	2ST40027	20	110	6
	100%	2ST40027	20	70	7.5
15 - 30	20%	2ST40027	20	110	6
	60%	2ST40027	20	39	18
	100%	2ST40070	10	23	20
40 - 60	20%	2ST40070	10	30	9
	60%	2ST40070	10	20	27
	100%	2ST40075	10	12	45
75 - 100	20%	2ST40070	10	35	15
	60%	2ST40070	10	12	45
	100%	2ST40120	6	7	75
125 - 200	20%	2ST40120	6	17	30
	60%	2ST40150	5	6	90
	100%	2ST40200	3.0	4	150
250	20%	2ST40070	10	14	37
	40%	2ST40120	6	7	75
	60%	2ST40150	5	6	112
	80%	2ST40200	3.0	4	150
	100%	2ST40300	2.5	3	187
300	20%	2ST40070	10	12	45
	40%	2ST40120	6	5.5	90
	60%	2ST40150	5	5.5	112
	80%	2ST40200	3.0	4	180
	100%	2ST40300	2.5	3	224
350	20%	2ST40120	10	11	52
	40%	2ST40150	5	5.5	104
	60%	2ST40200	3.0	4	157
	80%	2ST40300	2.5	3	209
400	20%	2ST40200	3.0	9	60
	60%	2ST40300	2.5	3	179

AC Drives

Line Regeneration Controls

Line regeneration controls are best suited for applications requiring frequent, repetitive starts and stops or applications requiring the AC drive to hold back on a regenerative load. Line regeneration controls do not radiate the large amounts of heat that can radiate from a snubber resistor. This radiated heat must be considered when applying snubber resistors in small machine rooms or near operating personnel. Finally, line regeneration controls channel the excess regenerative energy back to the AC power line, which provides the additional benefit of energy savings.

Energy Savings Example:

If a drive rated for 20 HP fully regenerates into a snubber resistor grid during 20% of the application duty cycle, the resistor grid actually dissipates 2,984 watts of heat (20 HP x 20% x 746 watts/HP), every time the load is stopped. If the application runs 24 hours a day, 365 days per year, stopping 20% of the time, the wasted energy would total 26,139 KWH (2984 W x 24 Hrs x 365 Days/1000 watts per KW). With an assumed energy cost of $.08 per KWH, this application would save $2,091 per year using a line regeneration control rather than snubber braking resistors.

Line Regeneration Controls

- For 50-100% Duty Cycle
- 230 V, 460 V
- NEMA 12 Enclosure
- DC Ammeter – Door Mounted

Specifications

- Rated Voltage: +/- 10%
- Hertz: 50/60 Hz
- Input Current: 100% of rated DC current, inverse time overload trip
- Connections: Input AC line, drive DC bus, ground
- Power Factor: Greater than 98%
- Fusing: AC input line, DC drive bus
- Adjustments: None, automatic voltage level
- Maximum On-time: Continuous
- Operating Temperature: 0-50°C
- Humidity: Below 90%, non-condensing
- Atmosphere: Free of corrosive gas and dust
- Internal Indicators: Drive active LED, current limit active
- External Indicator: Power indicator lamp, DC bus ammeter

Table 8 Line Regeneration Controls Selection Tables

AC Line Volts	Regeneration Control Unit /kW	RMS DC Amps	w/o Fan Option	
			45 sec. kW	Cont. kW
230V	1R022008	10	7	5
	1R022015	20	7	4
	1R022025	30	10	4
	1R022045	45	15	4
460V	1R042008	10	7	4
	1R042015	20	14	4
	1R042025	30	20	4
	1R042045	45	30	4
	1R042060	60	41	37.5
	1R042090	90	61	37.5

	Regeneration Control Dimensions (in.)			
	Amp Rating	H	W	D
w/o Fan Option	10,20,30,45	7.5	10.2	5.5
with Fan Option	10,20,30,45	7.5	18.6	5.5
	60,90	20	23	10.4

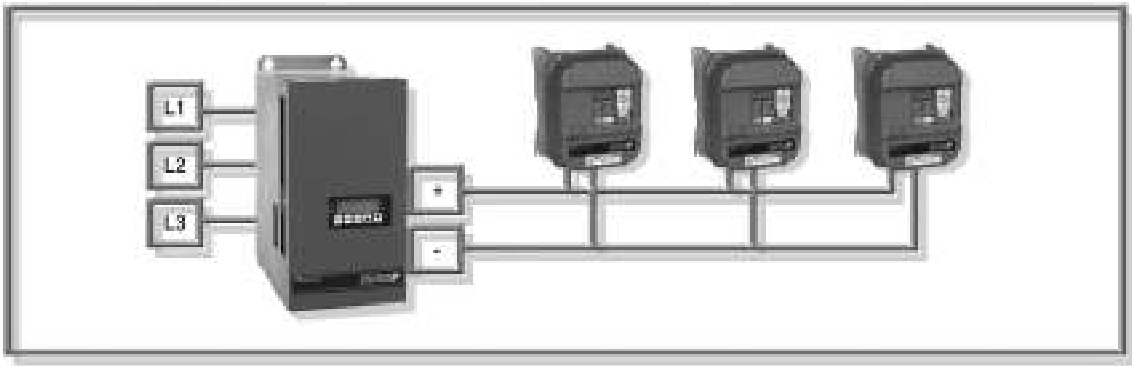
Note: To determine the proper size line regeneration control, calculate the regenerative current of the application, as outlined in steps 5 through 10. If the regenerative current cannot be calculated due to unknown values for items such as system inertia, the drive horsepower can be multiplied by the rule-of-thumb formula in step 10.

Up to four 60 amp or two 90 amp line regeneration control units can be connected in parallel for use with larger amp rated drives. The model numbers listed in table 8, however, cannot be paralleled. Contact Reliance Electric Drives for more information on regenerative controls configured for parallel operation.

Synchronous Rectifier Controls

- Use as line regeneration control
- Use as a DC bus power supply source
  Allows energy to be shared between regenerating and motoring drives
- IP20 enclosures

To function properly, each synchronous rectifier control unit must have a special input line reactor, varistor, and harmonic filter connected at its AC input power terminals. Up to three synchronous rectifiers can be connected in parallel for higher horsepower applications.



Synchronous Rectifier Control used as common DC bus for three GV3000/SE drives

Specifications

- Input Voltage: 200-230 VAC, 380-460 VAC models
- Hertz: 50/60 Hz
- Output Current: Per rated DC current
- Protection Functions: Overcurrent, overload, overvoltage, low voltage, phase loss
- Input Signals: Run, reset, answer-back of main magnetic contactor
- Output Signals: RDY signal, FR signal, instantaneous power loss, main magnetic contactor reference contact
- Monitor Display (four, 7-segment LEDs): Input current, input power voltage, DC bus voltage, power, and load ratio
- Ambient Temperature: 0-55°C
- Humidity: Below 90%, non-condensing
- Atmosphere: Free of corrosive gas and dust

Table 9 Synchronous Rectifier and Accessory Selection Table

AC Line Voltage	Synch. Rectifier Unit M/N	Module Type	KVA	Output Amps	Additional Hardware Required Ahead of Each Synchronous Rectifier			
					AC Line Reactor	Varistor	Harmonic Filter	EMC Filter Unit
200-230V	SS4207	Master	9.5	27	[illegible]	[illegible]	[illegible]	-
	SS4207P	Slave	9.5	27	[illegible]	[illegible]	[illegible]	-
	SS4216	Master	22.5	64	[illegible]	[illegible]	[illegible]	-
	SS4216P	Slave	22.5	64	[illegible]	[illegible]	[illegible]	-
	SS4222	Master	27	76	[illegible]	[illegible]	[illegible]	-
	SS4222P	Slave	27	76	[illegible]	[illegible]	[illegible]	-
	SS4265	Master	75	200	MR-R0025 (qty 2)	-	-	[illegible]
	SS4265P	Slave	75	200	MR-R0025 (qty 2)	-	-	[illegible]
380-460V	SS4415	Master	15	27	[illegible]	[illegible]	[illegible]	-
	SS4415P	Slave	15	27	[illegible]	[illegible]	[illegible]	-
	SS4437	Master	45	64	[illegible]	[illegible]	[illegible]	-
	SS4437P	Slave	45	64	[illegible]	[illegible]	[illegible]	-
	[illegible]	Master	105	[illegible]	MR-R0025 (qty 2)	-	-	[illegible]
	[illegible]	Slave	105	[illegible]	MR-R0025 (qty 2)	-	-	[illegible]

Note: Synchronous Rectifiers SS4265, SS4265P, SS441[illegible], and SS441[illegible]P require two MR-R0025 AC line reactors connected in parallel.
EMC Filter Unit consists of: one EMC Filter, one Main Contactor, one Harmonic Filter, & one Varistor.
Synchronous Rectifiers are only sold through Rockwell Automation Regional Drive Centers.

AC Drives

RELIANCE ELECTRIC

NOTE: This material is not intended to provide operational instructions. Appropriate Reliance Electric Drives instruction manuals precautions should be studied prior to installation, operation, or maintenance of equipment.

This document located at:
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