AC Drives
Regenerative Energy Solutions

Product Summary

RELIANCE ELECTRIC

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 turns 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

Regenerative Energy Solutions

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.

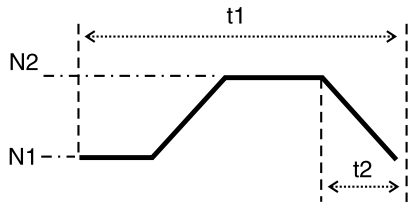
A drive operating on 460 VAC power will have a nominal bus voltage of 650 VDC (325 VDC for 230 VAC drives). 460 VAC drives are typically designed to operate with DC bus voltage levels up to 800 VDC (400 VDC for 230 VAC drives) before tripping. The regenerative energy may be small enough for the DC bus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

$WK^2s = WK^2m + (WK^2L / GR^2)$

Where:

WK^2s = total system inertia
WK^2m = motor rotor inertia
WK^2L = driven load inertia

GR^2 = gear ratio (defined as motor revolutions/driven load revolutions)

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

$$T_R = T_{decel.} - T_f$$

$$T_R = \frac{WK_2 * (N2 - N1) - T_f}{308 * 12}$$

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 M/N	Resistance Value	Cont. Watt Dissipation	Instant. Watt Dissipation	Continuous Duty Cycle	Dimensions (in.)		
						H	W	D
1 HP, 230 V	2SR20400	30	400	4000	50%	18.2	8.25	8.5
2 HP, 230 V	2SR20400	30	400	4000	30%	18.2	8.25	8.5
	2SR20600	20	600	6000	50%	18.2	8.25	8.5
3 HP, 230 V	2SR20400	30	400	4000	20%	18.2	8.25	8.5
	2SR20600	20	600	6000	30%	18.2	8.25	8.5
	2SR21200	10	1200	12000	50%	18.2	8.25	8.5
5 HP, 230 V	2SR20600	20	600	6000	20%	18.2	8.25	8.5
	2SR21200	10	1200	12000	30%	18.2	8.25	8.5
	2SR21800	6	1800	18000	50%	18.2	10.25	10.5
7 1/2 HP, 230 V	2SR21200	10	1200	12000	50%	18.2	8.25	8.5
	2SR21800	6	1800	18000	50%	18.2	10.25	10.5
10 HP, 230 V	2SR21200	10	1200	12000	50%	18.2	8.25	8.5
	2SR21800	6	1800	18000	50%	18.2	10.25	10.5
1 HP, 460 V	2SR40400	120	400	4000	50%	18.2	8.25	8.5
2 HP, 460 V	2SR40400	120	400	4000	30%	18.2	8.25	8.5
	2SR40600	75	600	6000	50%	18.2	8.25	8.5
3 HP, 460 V	2SR40400	120	400	4000	20%	18.2	8.25	8.5
	2SR40600	75	600	6000	30%	18.2	8.25	8.5
	2SR41200	40	1200	12000	50%	18.2	8.25	8.5
5 HP, 460 V	2SR40600	75	600	6000	20%	18.2	8.25	8.5
	2SR41200	40	1200	12000	30%	18.2	8.25	8.5
	2SR41800	25	1800	18000	50%	18.2	10.25	10.5
7 1/2 HP, 460 V	2SR41200	40	1200	12000	50%	18.2	8.25	8.5
	2SR41800	25	1800	18000	50%	18.2	10.25	10.5
10 HP, 460 V	2SR41200	40	1200	12000	50%	18.2	8.25	8.5
	2SR41800	25	1800	18000	50%	18.2	10.25	10.5
15 HP, 460 V	2SR41800	25	1800	18000	50%	18.2	10.25	10.5
20 HP, 460 V	2SR41800	25	1800	18000	50%	18.2	10.25	10.5
5 HP, 575 V	2SR50600	105	600	6000	20%	18.2	8.25	8.5
	2SR51200	52	1200	12000	40%	18.2	8.25	8.5
	2SR51800	35	1800	18000	50%	18.2	10.25	10.5
10 HP, 575 V	2SR51200	52	1200	12000	20%	18.2	8.25	8.5
	2SR51800	35	1800	18000	40%	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 5 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 unit
- 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 M/N	Amps DC RMS	Min. Ohms	Maximum On-time	UL Labeled	Dimensions (in.)		
						H	W	D
230	2ST20019	19	20	120 Sec.	No	15	6	6.75
	2ST20054	54	6	120 Sec.	Yes	15	6	6.75
460	2ST40009	9	75	Continuous	No	15	6	6.75
	2ST40027	27	25	120 Sec.	Yes	15	6	6.75
	2ST40075	75	10	120 Sec.	No	15	12	8
	2ST40125	125	6	120 Sec.	No	15	12	8
	2ST40150	150	5	Continuous	No	16	15	8
	2ST40200	200	3.8	Continuous	No	16	15	8
	2ST40300	300	2.5	Continuous	No	16	15	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 unit
- 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 M/N	Amps DC RMS	Min. Ohms	UL Labeled	Dimensions (in.)		
					H	W	D
230	M3575TL15	15	25	No	12.75	3	8.7
	M3575TL30	30	12.5	No	12.75	3	8.7
	M3575TL60	60	6.25	No	12.75	4	8.7
460	M3575TH15	15	50	No	12.75	3	8.7
	M3575TH30	30	25	No	12.75	3	8.7
	M3575TH75	75	10	No	12.75	4	8.7
	M3575TH125	125	6	No	17.75	4	8.7
	M3575TH150	150	5	No	17.75	4	8.7
	M3575TH200	200	3.75	No	17.75	7	9.2
	M3575TH300	300	2.5	No	17.75	7	9.2

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.

AC Drives

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
M3575RL1M	1	6%	746	50	2	190	12.75	4	8.7
M3575RL1MF		20%		150					
M3575RL2M	2	6%	1492	100	4	95	12.75	4	8.7
M3575RL2MF		20%		300					
M3575RL3B	3	6%	1989	100	5	75	17.75	4	8.7
M3575RL3BF		20%		400					
M3575RL3M	3	6%	2238	150	6	63	12.75	4	8.7
M3575RL3MF		20%		450					
M3575RL4M	4	6%	2984	200	8	48	12.75	7	8.7
M3575RL4MF		20%		600					
M3575RL5B	5	6%	3979	200	10	38	17.75	4	8.7
M3575RL5BF		20%		800					
M3575RL6M	6	6%	4476	300	12	32	12.75	7	8.7
M3575RL6MF		20%		900					
M3575RL8B	8	6%	5968	300	15	25	17.75	4	8.7
M3575RL8BF		20%		1200					
M3575RL9M	9	6%	6714	450	18	21	12.75	10	8.7
M3575RL9MF		20%		1350					
M3575RL11B	11	6%	7967	400	20	19	17.75	7	9.2
M3575RL11BF		20%		1600					
M3575RL16B	16	6%	11936	600	31	13	17.75	7	9.2
M3575RL16BF		20%		2400					
M3575RL24B	24	6%	17904	900	47	8	17.75	10	9.7
M3575RL24BF		20%		3600					

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
M3575RH1M	1	6%	746	50	1	780	12.75	4	8.7
M3575RH1MF		20%		150					
M3575RH2M	2	6%	1492	100	2	390	12.75	4	8.7
M3575RH2MF		20%		300					
M3575RH3M	3	6%	2238	150	3	260	12.75	4	8.7
M3575RH3MF		20%		450					
M3575RH4M	4	6%	2984	200	4	195	12.75	7	8.7
M3575RH4MF		20%		600					
M3575RH5B	5	6%	4000	250	5	150	17.75	4	8.7
M3575RH5BF		20%		800					
M3575RH6M	6	6%	4476	300	6	130	12.75	7	8.7
M3575RH6MF		20%		900					
M3575RH8B	8	6%	6000	350	8	90	17.75	4	8.7
M3575RH8BF		20%		1200					
M3575RH9M	9	6%	6714	450	9	87	12.75	10	8.7
M3575RH9MF		20%		1350					
M3575RH11B	11	6%	8000	450	11	60	17.75	7	9.2
M3575RH11BF		20%		1600					
M3575RH16B	16	6%	12000	700	16	45	17.75	7	9.2
M3575RH16BF		20%		2400					
M3575RH24B	24	6%	18000	1000	24	30	17.75	10	9.7
M3575RH24BF		20%		3600					
M3575RH50G1F	50	20%	40000	8000	53	14	41.25	29	22
M3575RH100G2F	100	20%	80000	16000	106	7	50.25	29	22
M3575RH150G3F	150	20%	24000	24000	159	5	59.25	29	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 infrequently (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.)			Peak Braking Watts	Cont. Braking Watts	Load Ohms	Amp Rating
				H	W	D				
31ER/	1	6%	M3575RH1M	12.75	4	8.7	746	50	780	1
31ET4060	1	20%	M3575RH1MF	12.75	4	8.7	746	150	780	1
38ER/	2	6%	M3575RH2M	12.75	4	8.7	1492	100	390	2
38ET4060	2	20%	M3575RH2MF	12.75	4	8.7	1492	300	390	2
55ER/	3	6%	M3575RH3M	12.75	4	8.7	2238	150	260	3
55ET4060	3	20%	M3575RH3MF	12.75	4	8.7	2238	450	260	3
85ER/	4	6%	M3575RH4M	12.75	7	8.7	2984	200	195	4
85ET4060	4	20%	M3575RH4MF	12.75	7	8.7	2984	600	195	4
	5	6%	M3575RH5B	17.75	4	8.7	4000	250	150	5
	5	20%	M3575RH5BF	17.75	4	8.7	4000	800	150	5
	6	6%	M3575RH6M	12.75	7	8.7	4476	300	130	6
	6	20%	M3575RH6MF	12.75	7	8.7	4476	900	130	6
126ER/	8	6%	M3575RH8B	17.75	4	8.7	6000	350	90	8
126ET4060	8	20%	M3575RH8BF	17.75	4	8.7	6000	1200	90	8
150ER/	9	6%	M3575RH9M	12.75	10	8.7	6714	400	87	9
150ET4060	9	20%	M3575RH9MF	12.75	10	8.7	6714	1350	87	9
240ER/	11	6%	M3575RH11B	17.75	7	9.2	8000	450	60	11
240ET4060	11	20%	M3575RH11BF	17.75	7	9.2	8000	1600	60	11
300ER/	16	6%	M3575RH16B	17.75	7	9.2	12000	700	45	16
300ET4060	16	20%	M3575RH16BF	17.75	7	9.2	12000	2400	45	16
430ER/	24	6%	M3575RH24B	17.75	10	9.7	18000	1000	30	24
430ET4060	24	20%	M3575RH24BF	17.75	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	58	2
	100%	2ST20019	20	35	3.75
7.5 - 10	60%	2ST20019	20	29	3.75
	100%	2ST20054	6	17	7.5
15 - 20	60%	2ST20054	6	14	9
	100%	2ST20054	6	8.5	15
460 V Drive Snubber Resistor Sizing					
1 - 5	60%	2ST40027	25	230	2.5
	100%	2ST40027	25	139	3.75
7.5 - 10	60%	2ST40027	25	116	5
	100%	2ST40027	25	70	7.5
15 - 30	20%	2ST40027	25	116	5
	60%	2ST40027	25	39	13
	100%	2ST40075	10	23	20
40 - 60	20%	2ST40075	10	58	9
	60%	2ST40075	10	20	27
	100%	2ST40075	10	12	45
75 - 100	20%	2ST40075	10	35	15
	60%	2ST40075	10	12	45
	100%	2ST40125	6	7	75
125 - 200	20%	2ST40125	6	17	30
	60%	2ST40150	5	6	90
	100%	2ST40200	3.8	4	150
250	20%	2ST40075	10	14	37
	40%	2ST40125	6	7	75
	60%	2ST40150	5	6	112
	80%	2ST40200	3.8	4	150
	100%	2ST40300	2.5	3	187
300	20%	2ST40075	10	12	45
	40%	2ST40125	6	6.5	90
	50%	2ST40150	5	5.5	112
	60%	2ST40200	3.8	4	135
	100%	2ST40300	2.5	3	224
350	20%	2ST40125	10	11	62
	40%	2ST40150	5	5.5	104
	60%	2ST40200	3.8	4	157
	80%	2ST40300	2.5	3	208
400	20%	2ST40200	3.8	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 in 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 90%
- 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 M/N	RMS DC Amps	w/o Fan Option	
			45 sec. KW	Cont. KW
230V	1RG22008	10	3	3
	1RG22015	20	7	4
	1RG22025	30	10	4
	1RG22045	45	15	4
460V	1RG42008	10	7	4
	1RG42015	20	14	4
	1RG42025	30	20	4
	1RG42045	45	30	4
	1RG42060	60	41	37.5
	1RG42090	90	61	37.5

	Regeneration Control Dimensions (in.)			
	Amp Rating	H	W	D
w/o Fan Option	10,20,30,45	17.5	16.2	8.3
with Fan Option	10,20,30,45	17.5	18.5	8.3
	60,90	26	23	10.4

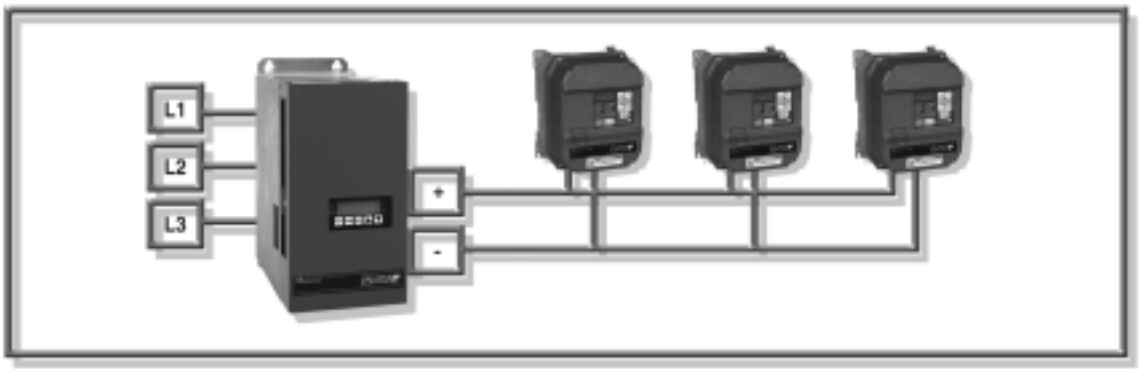
Note: To determine the proper size line regeneration control, calculate the regenerative current of the application, as outlined in steps 5 through 10. If the regenerative current cannot be calculated due to unknown values for items such as system inertia, the drive horsepower can be multiplied by the rule-of-thumb formulas 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	MT-B0023	23SAD431	MC-B0002	-
	SS4207P	Slave	9.5	27	MT-B0023	23SAD431	MC-B0002	-
	SS4218	Master	22.5	64	MT-B0014	23SAD431	MC-B0002	-
	SS4218P	Slave	22.5	64	MT-B0014	23SAD431	MC-B0002	-
	SS4222	Master	27	76	MB-B0025	23SAD431	MC-B0002	-
	SS4222P	Slave	27	76	MB-B0025	23SAD431	MC-B0002	-
	SS4265	Master	75	200	MB-B0025 (qty 2)	-	-	EM441B
	SS4265P	Slave	75	200	MB-B0025 (qty 2)	-	-	EM441B
380-460V	SS4415	Master	19	27	MT-B0023	23SAD102	MC-B0002	-
	SS4415P	Slave	19	27	MT-B0023	23SAD102	MC-B0002	-
	SS4437	Master	45	64	MT-B0013	23SAD102	MC-B0002	-
	SS4437P	Slave	45	64	MT-B0013	23SAD102	MC-B0002	-
	SS441B	Master	135	200	MB-B0025 (qty 2)	-	-	EM441B
	SS441BP	Slave	135	200	MB-B0025 (qty 2)	-	-	EM441B

Note: Synchronous Rectifiers SS4265, SS4265P, SS441B, and SS441BP require two MB-B0025 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

This document located at:
http://www.reliance.com

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.

Reach us now at www.rockwellautomation.com

Wherever you need us, Rockwell Automation brings together leading brands in industrial automation including Allen-Bradley controls, Reliance Electric power transmission products, Dodge mechanical power transmission components, and Rockwell Software. Rockwell Automation's unique, flexible approach to helping customers achieve a competitive advantage is supported by thousands of authorized partners, distributors and system integrators around the world.

Allen-Bradley
RELIANCE ELECTRIC
DODGE
ROCKWELL SOFTWARE
Rockwell Automation

Americas Headquarters, 1201 South Second Street, Milwaukee, WI 53204, USA, Tel: (1) 414 382-2000, Fax: (1) 414 382 4444
European Headquarters SA/NV, avenue Herrmann Debroux, 46, 1160 Brussels, Belgium, Tel: (32) 2 663 06 00, Fax: (32) 2 663 06 40
Asia Pacific Headquarters, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846
Reliance Electric Standard Drives Business, 24800 Tungsten Road, Cleveland, OH 44117, USA, Tel: (1) 888 374 8370, Fax: (216) 266 7095

D-2900-1 - June 2000