Snubber Braking Kits for AC Drives
Enclosed Resistor/Transistor Modules
and Chassis Transistor Modules

Model Numbers

2SR20400, 2SR20600, 2SR21200, 2SR21800, 2SR40400, 2SR40600, 2SR41200, 2SR41800, 2SR50600, 2SR51200, 2SR51800, 2ST20019, 2ST20054, 2ST40009, 2ST40027, 2ST40075, 2ST40125, 2ST40150, 2ST40200, 2ST40300, 2ST50023

Instruction Manual D2-3291-2

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, and/or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

Product Description

Snubber Braking Units connect to 230V and 460V GV3000/SE, SP120, SP500, and VSM500 drives, and 575V SP500 drives. The Braking Units dissipate the power regenerated by the motor during rapid deceleration or during overhauling load conditions.

The regenerated energy is normally consumed, as shown in figure 1, by mechanical loss, by the motor, and by the drive. The remaining energy is stored in the drive's DC bus capacitor. If the remaining energy causes the capacitor voltage to rise above the normal operating range, the Braking Unit will discharge the regenerated energy before the drive voltage becomes excessive.

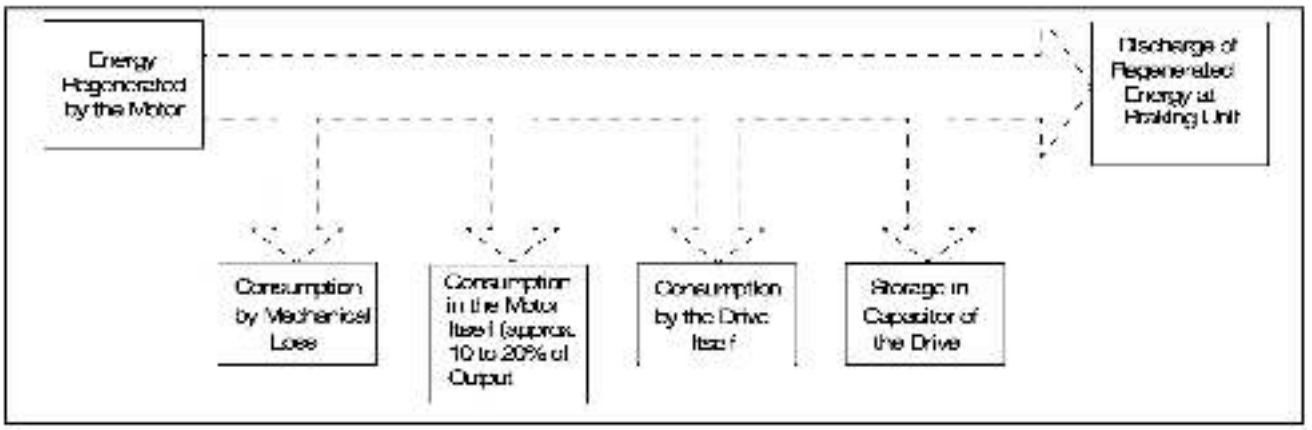


Figure 1 – Dissipation of Energy Regenerated by the Motor

Power resistors are used to dissipate the energy. When the DC bus voltage rises above normal level, the drive automatically switches the dynamic braking resistors on in pulse-width-modulation (PWM) mode to absorb the excess energy. The resistors are turned fully on at 360 VDC for 230 VAC input drives, at 720 VDC for 460 VAC input drives, and at 800 VDC for 575 VAC input drives. The snubber resistors are sized to provide the power dissipating capability required for the duty cycle of the application.

Rockwell

Snubber Braking Units are available:

- as a NEMA 1 enclosed (cabinet styles B and C) resistor/transistor module (M/N 2SRxxxxx)
- as a chassis-style transistor braking module for non-standard applications (chassis style A, E, or F) (M/N 2STxxxxx)

Note that the transistor braking module versions (2STxxxxx) of the Braking Units are intended for either 120 second or continuous duty, non-standard applications (see table 2 for duty cycle). The snubber braking resistors and their required cooling protection must be provided by the user, based upon the requirements of the application. The enclosed resistor/transistor modules are intended for a 60 second maximum on-time.

Refer to tables 1 and 2 to ensure that the braking kit matches your drive. These tables also provide braking unit specifications.

Braking Unit Indicators

Braking units (M/N 2SRxxxxx and 2STxxxxx) have the following indicators, as shown in figures 2, 4, 5 and 6:

- DC BUS: An amber neon lamp that turns on when the DC bus voltage is equal to or greater than 90 VDC.
- CONTROL POWER: A green incandescent lamp that turns on when the Braking Unit has AC control power.
- ACTIVE BRAKING: A red incandescent lamp that turns on when the snubber transistor turns on. Note that if this indicator is on continuously, the AC line voltage may be high. Use an input transformer to reduce the incoming AC line voltage by connecting the AC input of the Braking Unit to the primary side of the input transformer.

Braking Unit Thermal Protection

NEMA 1 enclosed resistor/transistor Braking Units (M/N 2SRxxxxx) are provided with thermal protection via the temperature board. The following limits apply:

- If the temperature of the Braking Unit exceeds the maximum recommended temperature of 40° C (104° F), the fan will turn on to cool the unit.
- If the temperature of the Braking Unit exceeds 70° C (158° F), the IGBT transistor will be turned off and disabled. This indicates that a regenerative condition exists that is in excess of the power rating of the resistors and/or transistor.
- If the temperature of the Braking Unit exceeds 110° C (230° F), the on board fuse will open and cause a drive overvoltage fault. The resistor thermal switches will reset once the temperature falls 5° C (9° F) below their maximum rated temperature.

Chassis-style transistor Braking Units (M/N 2STxxxxx) are provided with thermal protection via a sensor mounted to the heatsink.

- If the temperature of the Braking Unit exceeds the maximum recommended temperature of 40° C (104° F), the fan will turn on to cool the unit (150 A, 200 A, and 300 A units only).
- If the temperature of the Braking Unit exceeds 70° C (158° F), the IGBT transistor will be turned off and disabled. This indicates that a regenerative condition exists that is in excess of the power rating of the resistors and/or transistor.

Table 1 – Snubber Resistor Braking Unit Specifications

Braking Kit Model Number	AC Drive Rating	Volts AC	Braking Kit Cabinet Style	Resistance Value	Maximum On-time (seconds)	Continuous Watt Dissipation	Instantaneous Watt Dissipation	Maximum Continuous Duty Cycle[1]
2SR20400	1 HP	230	B	30	60	400	4000	0-50%
2SR20400	2 HP	230	B	30	60	400	4000	0-30%
2SR20600			B	20		600	6000	31-50%
2SR20400	3 HP	230	B	30	60	400	4000	0-20%
2SR20600			B	20		600	6000	21-30%
2SR21200			B	10		1200	12000	31-50%
2SR20600	5 HP	230	B	20	60	600	6000	0-20%
2SR21200			B	10		1200	12000	21-30%
2SR21800			C	6		1800	18000	31-50%
2SR21200	7.5 HP	230	B	10	60	1200	12000	0-30%
2SR21800			C	6		1800	18000	31-50%
2SR21200	10 HP	230	B	10	60	1200	12000	0-20%
2SR21800			C	6		1800	18000	21-40%
								41-50%[1]
2SR40400	1 HP	460	B	120	60	400	4000	0-50%
2SR40400	2 HP	460	B	120	60	400	4000	0-30%
2SR40600			B	75		600	6000	31-50%
2SR40400	3 HP	460	B	120	60	400	4000	0-20%
2SR40600			B	75		600	6000	21-30%
2SR41200			B	40		1200	12000	31-50%
2SR40600	5 HP	460	B	75	60	600	6000	0-20%
2SR41200			B	40		1200	12000	21-30%
2SR41800			C	25		1800	18000	31-50%
2SR41200	7.5 HP	460	B	40	60	1200	12000	0-30%
2SR41800			C	25		1800	18000	31-50%
2SR41200	10 HP	460	B	40	60	1200	12000	0-20%
2SR41800			C	25		1800	18000	21-40%
								41-50%[1]
2SR41800	15 HP	460	C	25	60	1800	18000	0-20%
								21-50%[1]
2SR41800	20 HP	460	C	25	60	1800	18000	0-20%
								21-50%[1]
2SR50600	5 HP	575	B	105	60	600	6000	0-20%
2SR51200			B	52		1200	12000	21-40%
2SR51800			C	35		1800	18000	41-50%
2SR51200	10 HP	575	B	52	60	1200	12000	0-20%
2SR51800			C	35		1800	18000	21-40%
								41-50%[1]
2SR51800	20 HP	575	C	35	60	1800	18000	0-20%
								21-50%[1]

[1] A transistor braking module (as listed in table 2) with resistive braking resistors or a regenerative braking module should be used for greater duty cycles and/or higher horsepower applications.

Table 2 – Transistor Braking Modules Only

Braking Kit Model Number	AC Drive Rating (HP)	Volts AC	IGBT Maximum Transistor Amps	Minimum Ohms	Maximum On-time (seconds)	Braking Kit Cabinet Style	Resistor Value	Watts	Maximum Cycle
2ST20019	1 to 7.5	230	19	20	120	A	User-Supplied[1]	User-Supplied[1]	User-Supplied[1]
2ST20054	10 to 20	230	54	6	120	A			
2ST40009	1 to 7.5	460	9	75	continuous	A			
2ST40027	10 to 20	460	27	25	120	A			
2ST40075	25 to 60	460	75	10	120	E			
2ST40125	75 to 100	460	125	6	120	E			
2ST40150	125	460	150	5	continuous	E			
2ST40200	150 to 200	460	200	3.8	continuous	F			
2ST40300	250 to 350	460	300	2.5	continuous	F			
2ST50023	10 to 20	575	23	35	120	A			

[1] Refer to page 11 for sizing snubber braking resistors.

Installing Cabinet B and Cabinet C (NEMA 1 Enclosure) Braking Units

ATTENTION: Equipment is at line voltage when AC power is connected to the drive. The drive's DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the DC bus voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Use the following procedure to install Braking Units housed in NEMA 1 enclosures (cabinets B & C). To install an open enclosure transistor braking unit (styles A, E, or F), refer to the procedure beginning on page 7.

All Braking Unit components must be mounted in a clean, dry environment. The maximum ambient air temperature should not exceed 40° C (104° F).

Step 1. Disconnect, lock out, and tag input power to the drive. Wait five minutes for the DC bus capacitors to discharge.

Step 2. Verify that there is no voltage at the drive's input power terminals.

Step 3. Measure the drive's DC bus potential with a voltmeter to ensure that the DC bus capacitors have fully discharged as described in the drive's instruction manual.

Step 4. Select a location for the Braking Unit within 8 feet of the drive where the heat generated by the snubber resistors will not affect surrounding components. Do not mount the Braking Unit under the drive or where convective air flow is restricted.

Step 5. Mount the Braking Unit vertically with the fan at the bottom. Mounting hardware is not provided. See figure 2 for mounting dimensions.

Step 6. Remove the cover from the Braking Unit by removing the two screws shown in figure 2.

Step 7. Install the wiring between the drive and the Braking Unit. See figure 3. Use wire that is rated at a minimum of 300 volts for 230 VAC Braking Units and 600 volts for 460 / 575 VAC Braking Units.

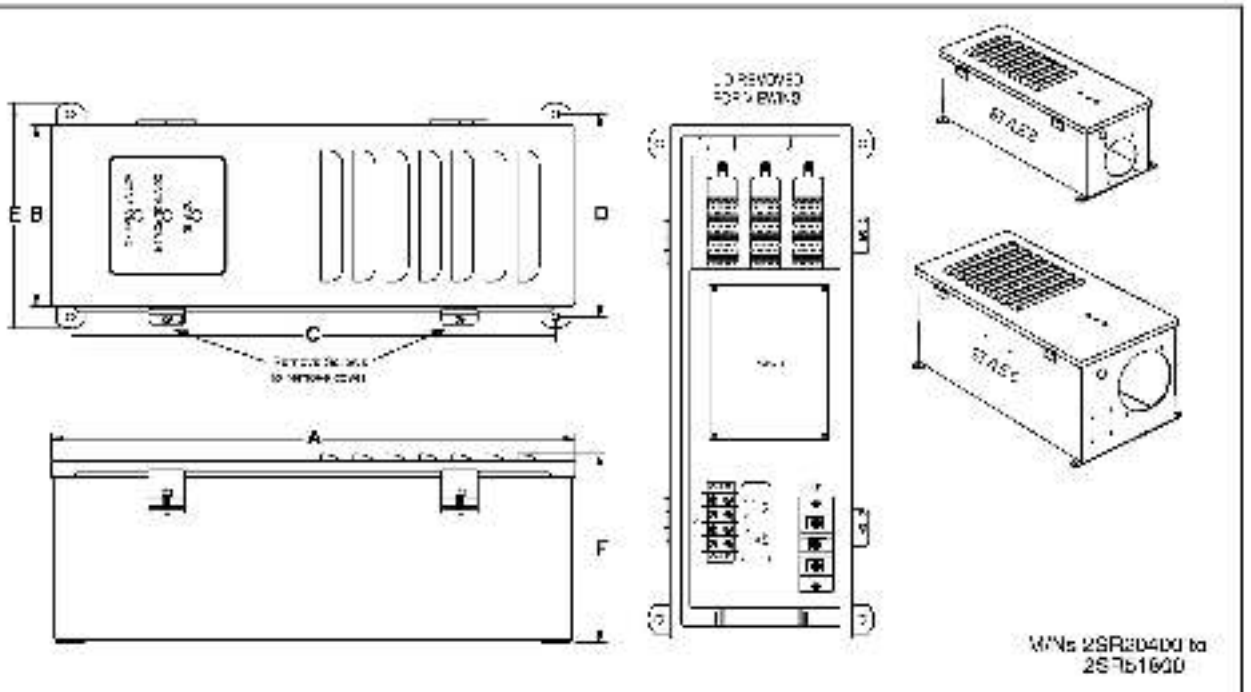
ATTENTION: It is important to use wire rated at 300 volts for 230 VAC Braking Units (600 volts for 460/575 VAC Braking Units) or greater because this wiring may come into contact with uninsulated 230 VAC (or 460/575 VAC) components. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Note that some local codes may require that the AC line field connections for the control voltage be fused. If required, fuse the AC line (connector TS1, terminals 1 and 2, as shown in figure 3). The following Reliance Electric parts are recommended:

- 230 VAC, 0.25A Fuse (P/N 64676-65S)
- 460 VAC, 0.1A Fuse (P/N 64676-65R)
- 575 VAC, 0.1A Fuse (P/N 64676-65R)
- Fuse Block (P/N 49454-6B)

Step 8. Reattach the cover.

Step 9. Reapply input power to the drive. Refer to the drive's instruction manual for complete start-up information.



	A	B	C	D	E	F
Cabinet B	463.5mm 18.25"	209.5mm 8.25"	425.4mm 16.75"	220.7mm 8.69"	241.3mm 9.50"	215.9mm 8.50"
Cabinet C	463.5mm 18.25"	260.3mm 10.25"	425.4mm 16.75"	271.5mm 10.69"	292.1mm 11.50"	266.7mm 10.50"

Figure 2 – Braking Unit Dimensions - Cabinets B and C (NEMA 1 Enclosure)

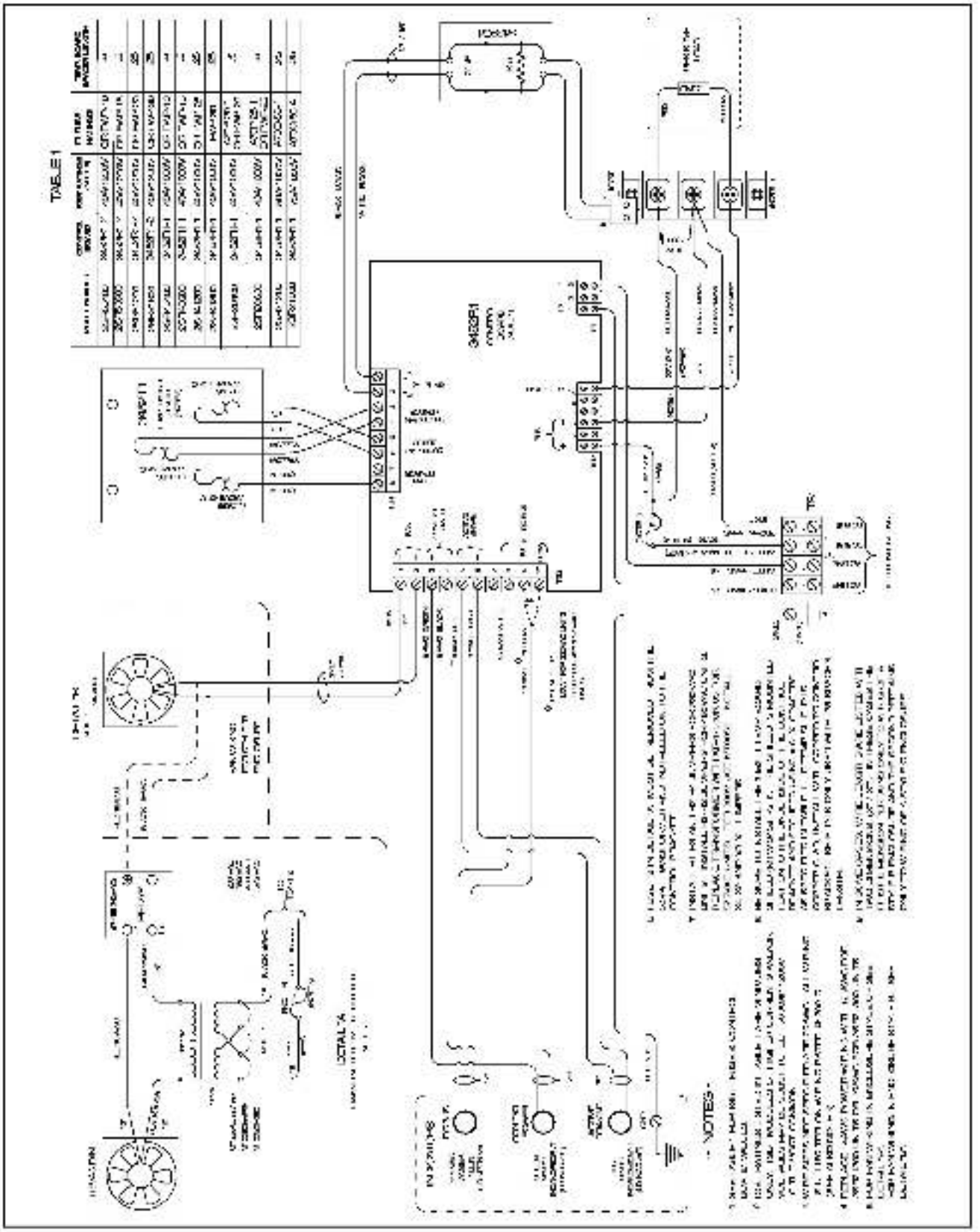


Figure 3 — Electrical Connections – Cabinet Styles B and D

Installing the Transistor Braking Module (Styles A, E, & F)

ATTENTION: Equipment is at line voltage when AC power is connected to the drive. The drive's DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the DC bus voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Use the following procedure to install the transistor braking module (open enclosure style A, E, or F). All transistor braking modules must be mounted in a clean, dry environment. The maximum ambient air temperature should not exceed 40° C (104° F). To install Braking Units housed in NEMA 1 enclosures (cabinets B & C), refer to the procedure on page 4.

Step 1. Disconnect, lock out, and tag input power to the drive. Wait five minutes for the DC bus capacitors to discharge.

Step 2. Verify that there is no voltage at the drive's input power terminals.

Step 3. Measure the drive's DC bus potential with a voltmeter to ensure that the DC bus capacitors have fully discharged as described in the drive's instruction manual.

Step 4. Choose the snubber braking resistors as described in the following section. The output voltage on the bus is 640 VDC nominal (760 VDC maximum).

Note that the sizing and protection of the snubber resistors is the responsibility of the user based upon the application.

Step 5. Select a location for the Braking Unit within 6 feet of the drive where the heat generated by the snubber resistors will not affect surrounding components. Do not mount the Braking Unit under the drive or where convective airflow is restricted.

Step 6. Mount the Braking Unit vertically, with the fan at the bottom (a fan is standard on the 150 A to 300 A units). Refer to figure 4 (style A), figure 5 (style E), or figure 6 (style F) for mounting dimensions. Mounting hardware is not provided.

Step 7. Install the wiring between the drive, the Transistor Braking Unit, and the snubber resistors, as shown in figure 7. Use wire rated at a minimum of 300 volts for 230 VAC Units and 600 volts for 460 / 575 VAC Units.

ATTENTION: It is important to use wire rated at 300 volts for 230 VAC Braking Units (600 volts for 460/575 VAC Braking Units) or greater because this wiring may come into contact with uninsulated 230 VAC (or 460/575 VAC) components. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Note that some local codes may require that the AC line field connections for the control voltage be fused. If required, fuse the AC line (connector TS1, terminals 6 and 7, as shown in figure 7). The following Reliance Electric parts are recommended:

- 230 VAC, 0.25A Fuse (P/N 64676-65S)
- 460/575 VAC, 0.1A Fuse (P/N 64676-65H)
- Fuse Block (P/N 49454-6B)

Step 8. Reapply input power to the drive. Refer to the drive's instruction manual for complete start-up information.

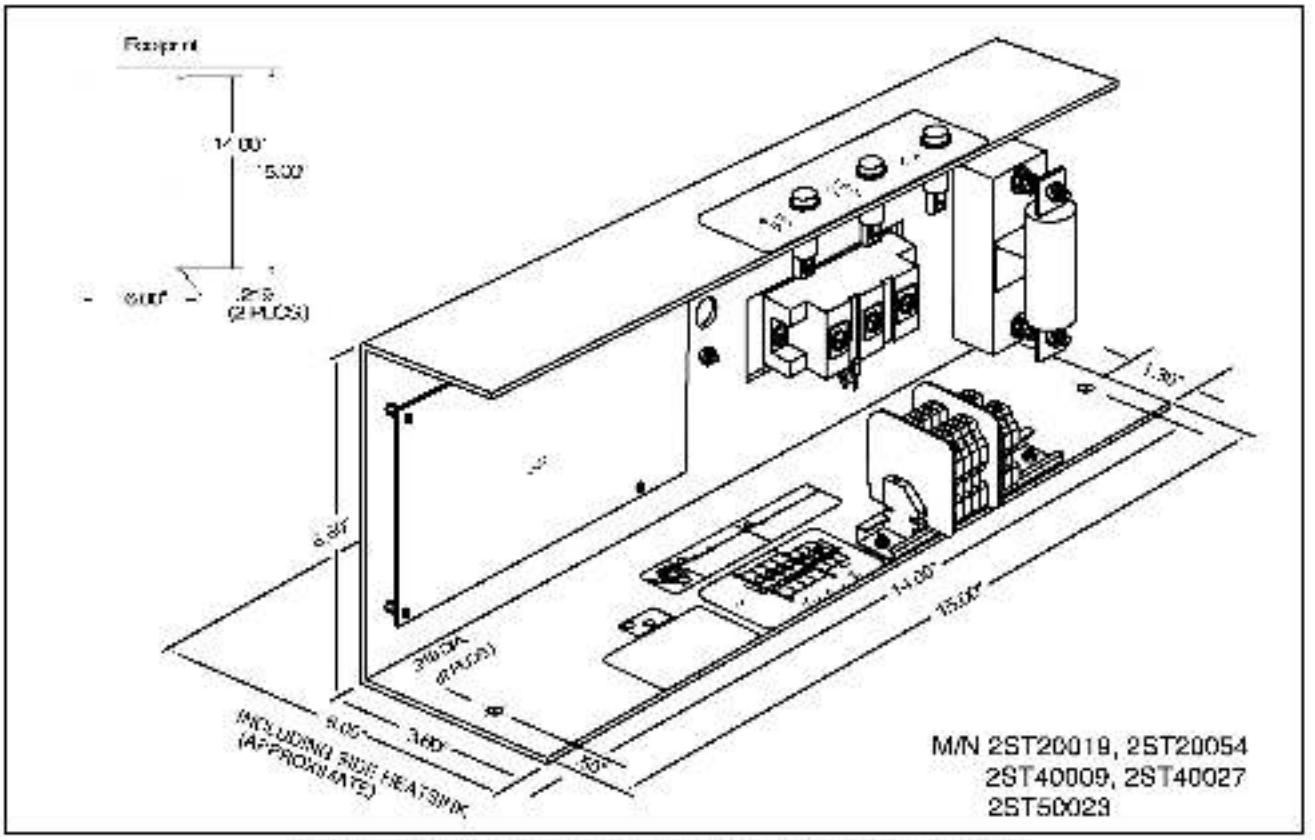


Figure 4 – Transistor Braking Module Dimensions - Style A (Open Enclosure)

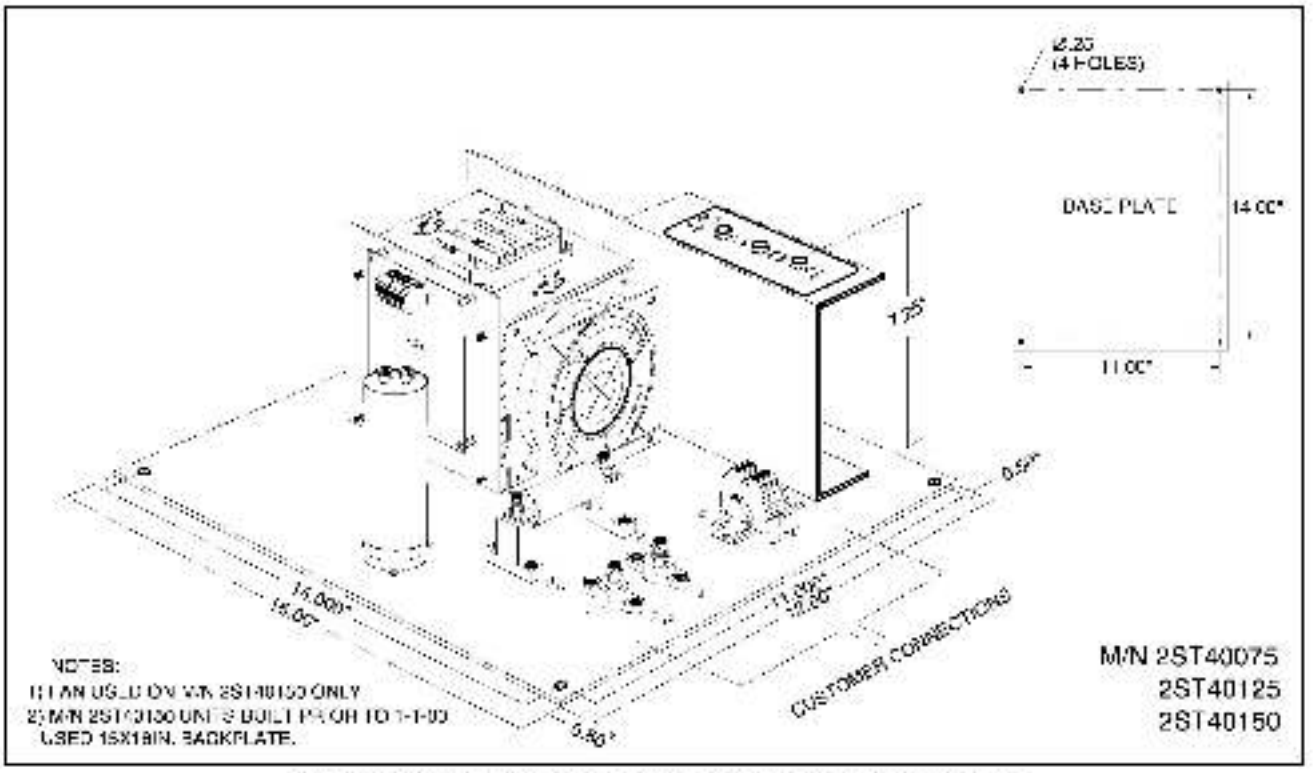


Figure 5 – Transistor Braking Module Dimensions - Style C (Open Enclosure)

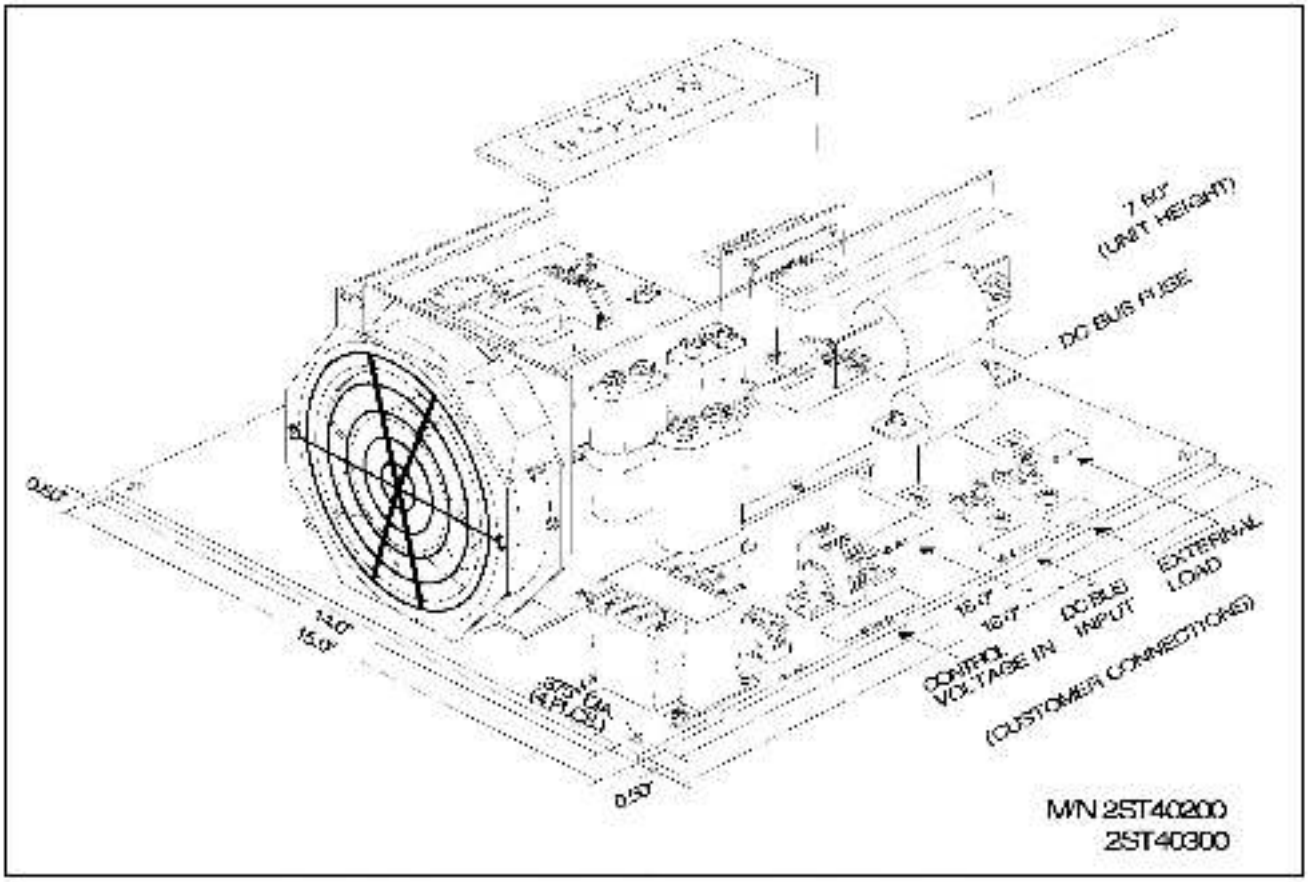


Figure 6. Transistor Braking Module Dimensions - Style F (Open Enclosure)

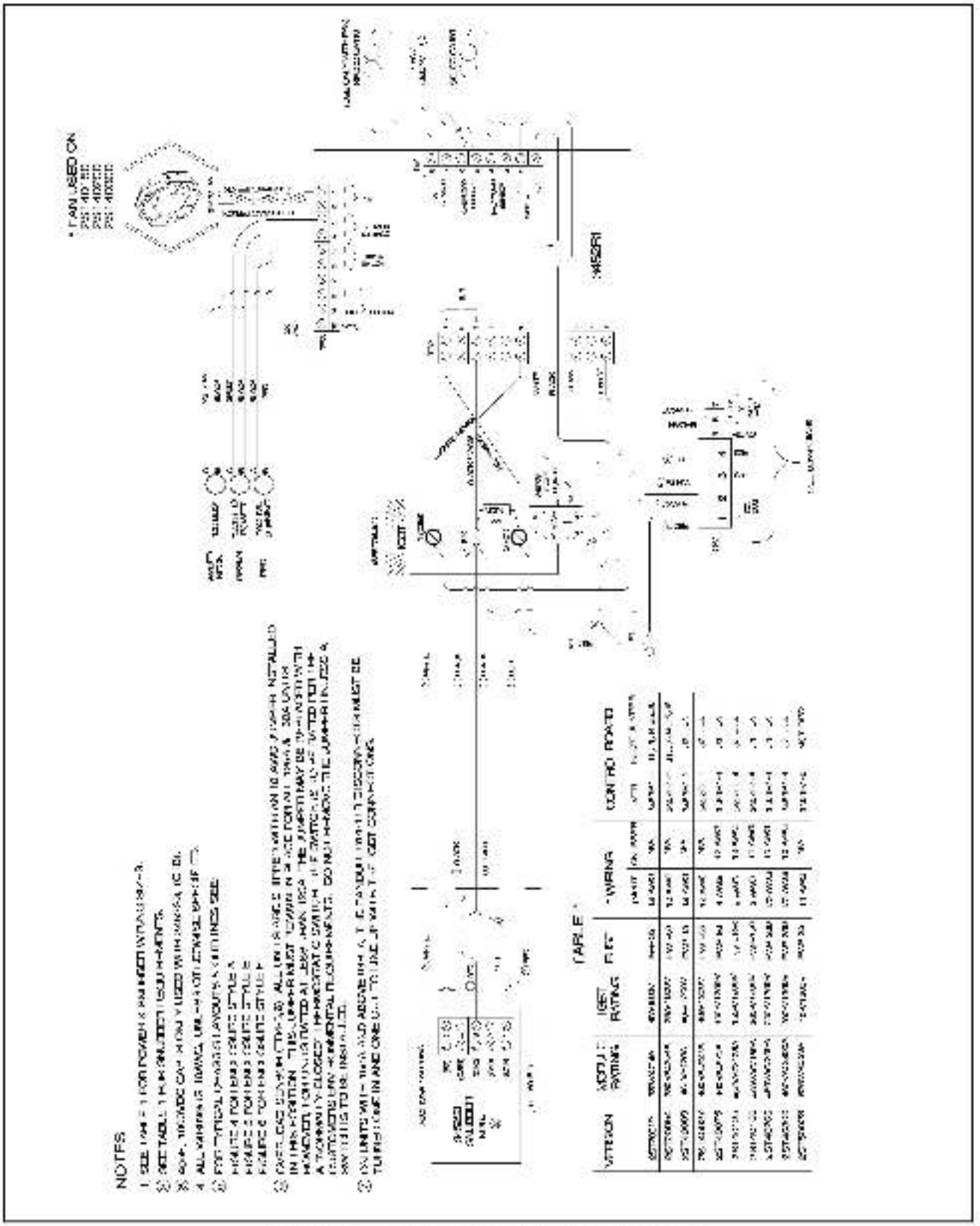


Figure 7 Electrical Connections (Cabinet Styles A, E and F)

Selecting Snubber Braking Resistors

Continuous duty snubber braking resistors must be selected for the transistor braking module versions of the Braking Unit.

Use the following procedure to select the snubber resistors:

Step 1. Calculate the regenerated power (P_{ave}) from the load and the pattern of operation. See figure 8.

$$P_{ave} = 0.5 \times P_p \times t/T$$

Where: Pp – Peak Power
t – Rise/Fall Time
T – Period

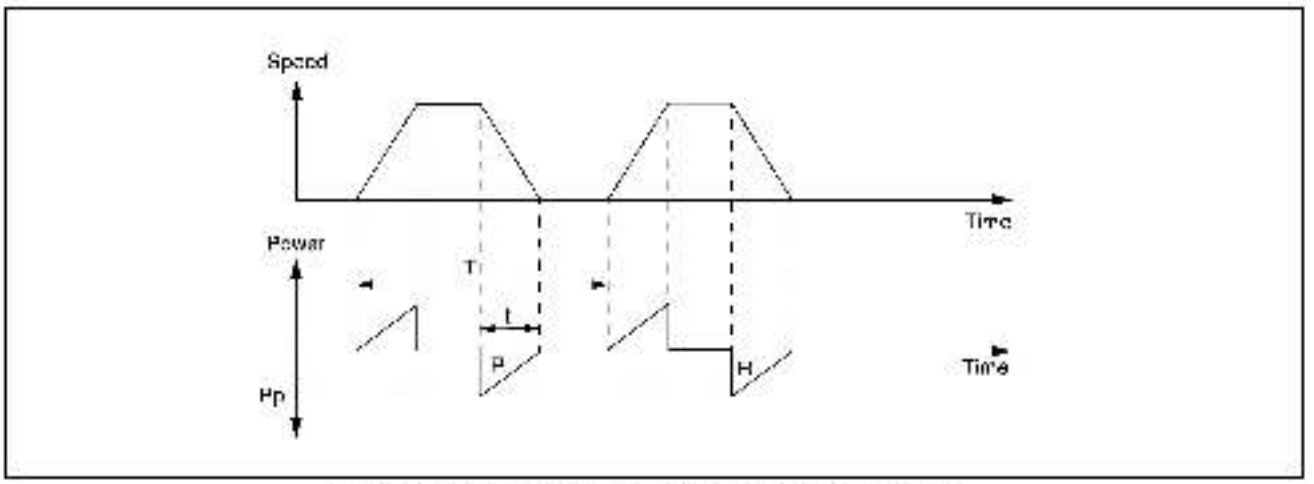


Figure 8 – An Example of Repeated Operation Under Inertial Load

Step 2. Calculate the power dissipation of the resistor (P_d) by deducting 15% of the motor's rated output (energy dissipation by the machine and the motor) from the regenerated power (P_{ave}).

Step 3. Use the following formula to determine the required resistor power rating (Pr) in watts:

$$P_r = (3 \text{ to } 4) \times P_d \text{ watts}$$

Replacing the Internal Braking Unit Fuse

ATTENTION: Equipment is at line voltage when AC power is connected to the drive. The drive's DC bus capacitors retain hazardous voltages after input power has been disconnected. After disconnecting input power, wait five (5) minutes for the DC bus capacitors to discharge and then check the DC bus voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

Use the following procedure to replace the Braking Unit's internal fuse:

Step 1. Disconnect, lock out, and tag input power to the drive. Wait five minutes for the DC bus capacitors to discharge.

Step 2. Verify that there is no voltage at the drive's AC input power terminals.

Step 3. Measure the drive's DC bus potential with a voltmeter to ensure that the DC bus capacitors have fully discharged as described in the drive's instruction manual.

Step 4. Allow adequate Braking Unit cooling time, approximately five to ten minutes.

Step 5. Replace the fuse. Refer to figure 2 (styles B & C), 4 (style A), 5 (style E), or 6 (style F), for fuse location. The fuse is labeled "F1". Table 3 contains a list of the fuse part numbers.

Step 6. Reapply input power to the drive. Refer to the drive's instruction manual for complete start up information.

Table 3 lists the braking kit contents.

Table 3 – Contents of the Snubber Braking Kit

Kit Model Number	IGBT Transistor	DC Fuse	Resistor Array	Control Board	Temperature Board	DC Brushless Fan (24VDC)	AC FAn (115 VAC)
2SR20400	402410-222FAW	402410-516AHX	612180-202J	O-48680-220A	O-48680-221A	402410-907A	---
2SR20600	402410-222HAW	402410-516AJX	612180-202K	O-48680-220A	O-48680-221A	402410-907A	---
2SR21200	402410-222GAW	402410-516ANX	612180-202L	O-48680-220A	O-48680-221A	402410-907A	---
2SR21800	402410-222HAW	402410-516AQX	612180-202M	O-48680-220A	O-48680-221A	---	402410-907B
2SR40400	402410-222HAW	402410-516AHX	612180-202E	O-48680-220B	O-48680-221A	402410-907A	---
2SR40600	402410-222FAW	402410-516AGX	612180-202F	O-48680-220B	O-48680-221A	402410-907A	---
2SR41200	402410-222BAW	402410-516AJX	612180-202G	O-48680-220B	O-48680-221A	402410-907A	---
2SR41800	402410-222GAW	402410-516ALX	612180-202H	O-48680-220B	O-48680-221A	---	402410-907B
2SR50600	402410-222FAW	402410-516AGX	612180-202B	O-48680-220C	O-48680-221A	402410-907A	---
2SR51200	402410-222FAW	402410-516AHX	612180-202C	O-48680-220C	O-48680-221A	402410-907A	---
2SR51800 2ST20009	402410-222FAW	402410-516AKX	612180-202D	O-48680-220C	O-48680-221A	---	402410-907B
2ST20054	402410-222HAW	402410-516AQX	---	O-48680-220A	---	---	---
2ST40009[1]							
2ST40027[1]	402410-222GAW	402410-516ALX	---	O-48680-220B	---	---	---
2ST40075[1] 2ST40125[1]							
2ST40150[1]							
2ST40200[1] 2ST40300[1]							
2ST50023[1]	402410-222FAW	402410-516AKX	---	O-48680-220C	---	---	---

1. Transistor braking module only

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 the talents of authorized partners, distributors and system integrators around the world.

Americas Headquarters, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel (1) 414 382 2000, Fax (1) 414 382 4444
European Headquarters SA/NV, avenue Hermann 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 8040, Fax (216) 266 7295

Publication D2-3251-2 - June 2000