

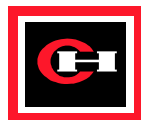
ADJUSTABLE FREQUENCY DRIVES

SERIES 9000 AF DRIVES

SVG17ED Series

Dynamic Braking Resistors

- **Instruction Sheet**



Cutler-Hammer

EAT•N

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WARNING:

All electrical installation and maintenance work on the Brake Chopper and Dynamic Braking units should only be carried out by qualified electricians.



WARNING:

Do not attempt any work on powered units. Components and component boards inside the variable frequency drive and braking unit may be at incoming voltage potential when the AFD is connected to supply voltage. Coming in contact with live components is extremely dangerous and may cause death or serious injury.



WARNING:

In normal heavy loading, the temperature of the wall attachment may reach +194°F (90°C). Contact with exposed surfaces may cause fire or injury.

Because of the variety of uses for this equipment and because of the differences between this solid-state equipment and electromechanical equipment, the user of and those responsible for applying this equipment must satisfy themselves as to the acceptability of each application and use of the equipment. In no event will Eaton Cutler-Hammer be responsible or liable for indirect or consequential damages from the use or application of this equipment.

1. Introduction

1.1 Dynamic Braking Application Basics

When a motor is rapidly decelerated, it may become a generator, feeding energy back into the Adjustable Frequency Drive (AFD). The absorbed energy will increase the DC link voltage in the AFD.

The rate of deceleration, the load and motor inertia, the power losses of the motor, and the power loss of the AFD determine what energy level will be fed back into the AFD.

In general, the braking magnitude for a standard motor and AFD is about 15% of the AFD rated power, primarily due to the power losses in both the motor and the AFD. This is usually sufficient in many applications such as pumps, mixers and conveyors, etc., where the kinetic energy stored in the load is small and the braking time is not critical.

When the motor and its load must be braked more quickly than the losses will allow, an external brake resistor must be used in conjunction with a factory installed brake chopper. The extra energy is dissipated as heat in the brake resistor.

Applications where dynamic braking is usually needed include centrifuges, cranes, some conveyors, fans, and drives requiring rapid reversing. Typical applications require periodic braking of either a cyclical or random nature.

Dynamic braking is not recommended for applications that require continuous braking.

1.2 Operation

The brake chopper consists of an IGBT assembly and logic function, factory mounted internally to the AFD. The chopper controls the DC link voltage by connecting the resistor across the link when the voltage reaches a predetermined level. Excessive energy is dissipated in the brake resistor.

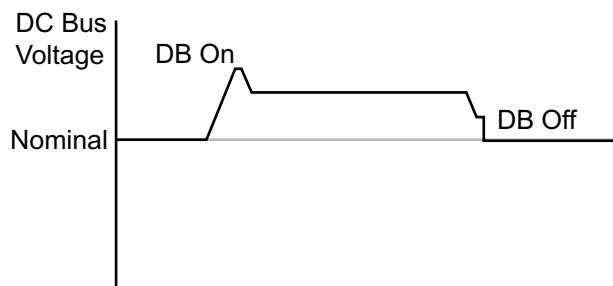


Figure 1: Brake Chopper Operation

Brake chopper size is fixed by the drive rating. The brake resistor is selected on the basis of the AFD rating, the magnitude of the energy to be dissipated, and the braking duty cycle.

1.3 Resistor Rating

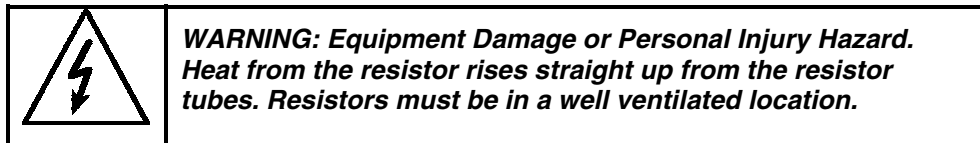
Cutler-Hammer has pre-selected resistor assemblies for Dynamic Braking based on two common braking levels.

- A 20 percent duty cycle at 100 percent braking torque
- A 50 percent duty cycle at 150 percent braking torque

Duty cycle is based on a 60-second period. For example, the 20 percent duty cycle resistor can carry 100 percent current for 12 seconds out of every 60 seconds, while the 50 percent duty cycle resistor can carry 150 percent current for 30 seconds out of every 60 seconds.

1.4 Environmental Issues

The surface temperature of the resistor assembly can reach 194°F (90°C). Care must be exercised in selecting a suitable location with adequate ventilation. The maximum allowable operation ambient temperature for the resistor assembly is 122°F (50°C).



2. General Installation Information

Dynamic braking resistors consist of through-rod mounted resistor tubes installed into ANSI-61, gray, powder coated, indoor enclosures (for outdoor applications, please consult your EATON Cutler-Hammer Sales or your local authorized distributor). All resistor tubes are factory mounted in the enclosure using stainless steel hardware.

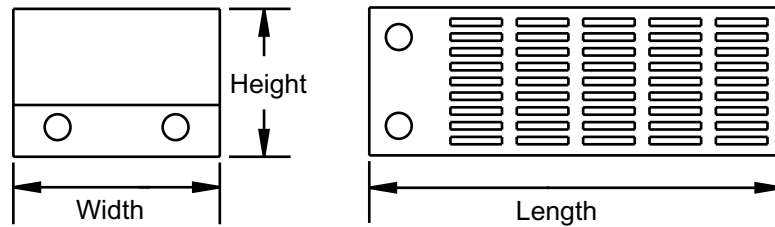
3. Mounting

3.1 Mounting Location Considerations

- Resistor tubes must be mounted horizontally for proper cooling
- There should be at least 24" of free space above the resistor enclosure
- The mounting surface and area should be free of any combustible materials, fire sprinklers or other materials affected by heat
- There should be at least 6" of space between the solid ends of the resistor enclosure and adjacent components
- There should be at least 12" of space between the ventilated sides of the resistor enclosure and any nearby components

3.2 Dimensions

Small Enclosures (Less than 10 HP)



29 in. Width Enclosures (10 HP and Larger)

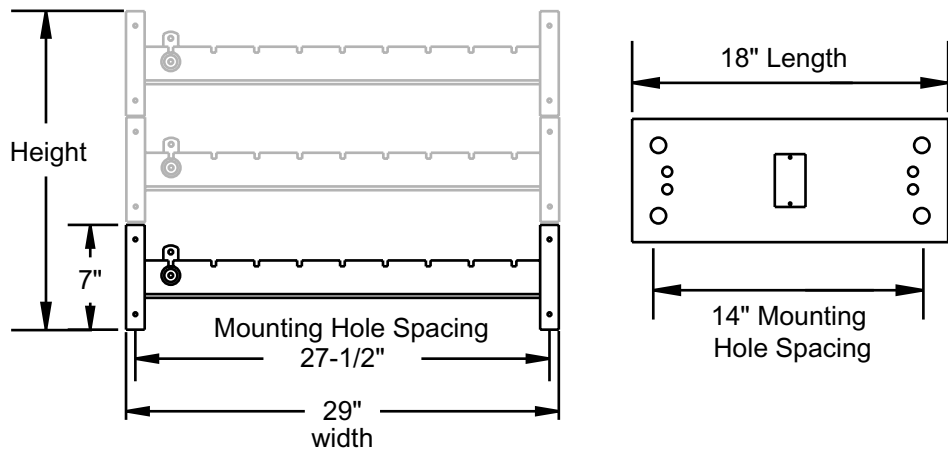


Figure 2: Dynamic Braking Resistor Enclosure

Table 1: Enclosure Dimensions and Mounting Hole Spacing

Enclosure Size	Length in. (mm)	Width in. (mm)	Height in. (mm)	Mounting Hole Spacing	
				Length	Width
A	14 (356)	4 (102)	5 (127)	13	NA
B	14 (356)	7 (178)	5 (127)	12	5
C	14 (356)	10 (254)	5 (127)	12	8
D	14 (356)	13 (330)	5 (127)	12	11
E	21 (533)	10 (254)	5 (127)	19	8
F	21 (533)	13 (330)	5 (127)	19	11
G	28 (711)	13 (330)	5 (127)	26	11
H	29 (737)	18 (457)	7 (178)	27.5	14
I	29 (737)	18 (457)	14 (356)	Multiple of Enclosure H (27.5 x 14 mounting)	
J	29 (737)	18 (457)	21 (533)		
K	29 (737)	18 (457)	28 (711)		
L	29 (737)	18 (457)	35 (889)		
M	29 (737)	18 (457)	42 (1067)		
N	29 (737)	32 (813)	49 (1245)		
O	29 (737)	32 (813)	67 (1702)		
P	29 (737)	32 (813)	76 (1930)		

3.3 Mounting Instructions

1. Unpack and inspect the unit for damage.
2. Remove the screws that attach the ventilation cover to the unit. Most units have four (4) screws, larger units have six (6) screws.
3. Units up to 28" wide may be wall mounted, as shown in **Figure 3**, or roof mounted, as shown in **Figure 4**.
4. Fasten enclosure with (4) 3/8" bolts.

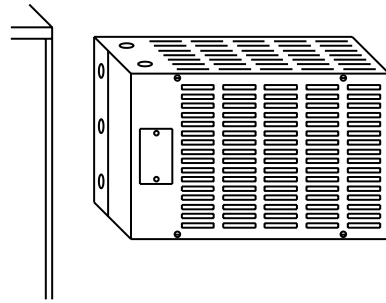


Figure 3: Typical Wall Mounted Unit

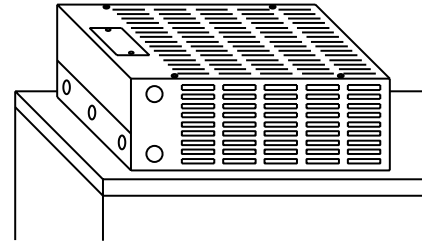


Figure 4: Typical Roof Mounted Unit

5. All larger units (10 Hp and above) are 29" wide and must be roof or floor mounted as shown in **Figure 5**. Fasten enclosure with (4) 1/2" bolts.

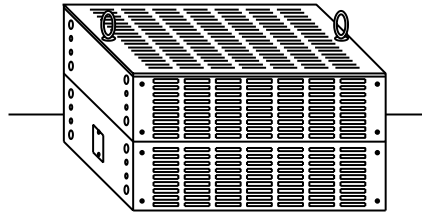


Figure 5: Typical Floor Mounted Unit

6. If there is any concern about the resistor enclosure conducting heat to its mounting surface, then space the unit off its mounting surface approximately 1/4" using flat washers or an extra nut on each mounting bolt. See **Figure 6**.

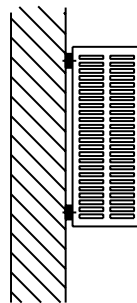


Figure 6: Wall Mounted Unit with Spacers

4. Recommended Protection Devices

4.1 Brake Protection

A failure of the brake chopper or the overheating of a resistor bank can lead to a hazardous condition. Cutler-Hammer highly recommends that an input disconnect with undervoltage trip be installed when using dynamic braking. The wiring diagram is shown below.

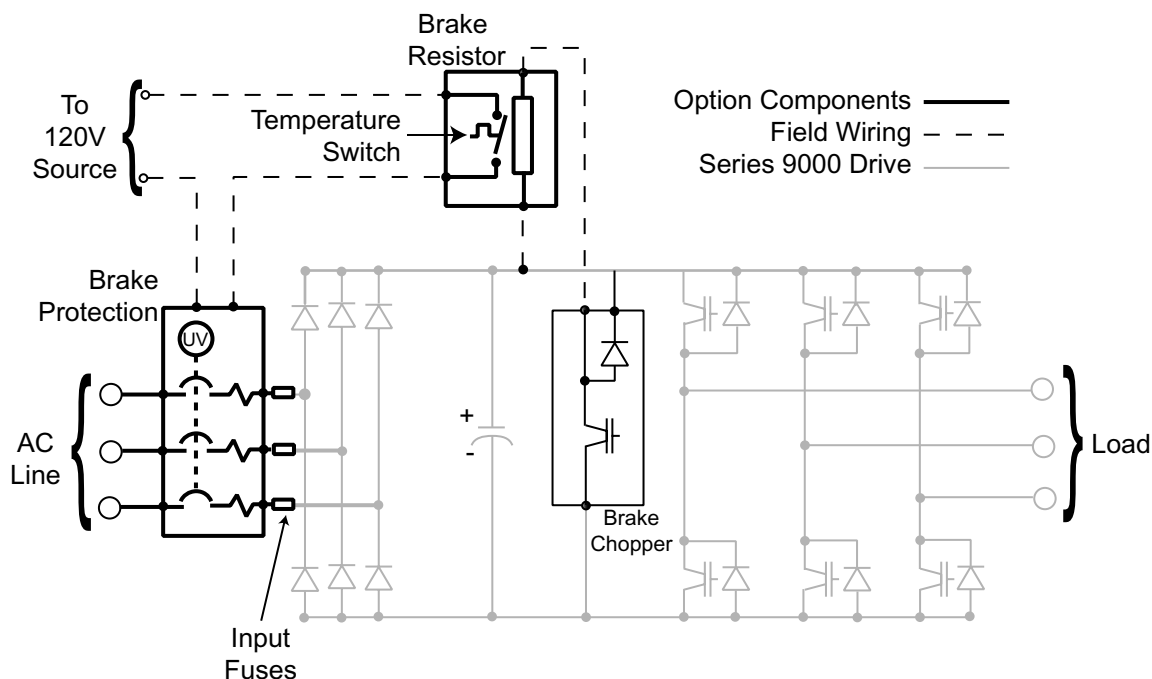



Figure 7: Block Diagram of Protective Device Wiring

The input disconnect with undervoltage trip should be installed to remove input power from the AFD when a hazardous condition occurs. This protective device can be supplied as a factory mounted option or installed in the field. It is available in units with oversized enclosures. If you choose to supply your own disconnect device, Cutler-Hammer recommends a type HMCP disconnect.

	<p>CAUTION: Equipment Damage Hazard. Caution must be practiced to determine the reason for an input disconnect trip and its resolution before the drive is put back into service.</p>
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4.2 Thermal Sensor Operation

The dynamic braking resistor is supplied with a thermal sensor to determine excessive operating temperatures. This thermal sensor is to be wired to the undervoltage trip unit of the drive's input disconnect device. This will provide protection against resistor burnout from excessive operation or high ambient temperature. If the resistor bank is made of multiple units, each with its own thermal sensor, the thermal sensors will need to be connected in series to trip the disconnect.

5. Dynamic Braking Resistor Wiring

5.1 Wiring Guidelines

- Use copper wire with a temperature rating of at least 167°F (75° C).
- Avoid running the wiring on top of, or close to, the hot resistor tubes. It is much cooler underneath the resistors.
- Most units use #10 terminal hardware, but larger ratings use ¼" and even 5/16" terminal hardware.
- **THE RESISTOR SHOULD NOT GLOW RED UNDER NORMAL OPERATING CONDITIONS!**
If the unit glows or seems to run excessively hot, you probably need a higher wattage rated unit (which is available). Please contact your EATON Cutler-Hammer Application Engineering Group or your local authorized distributor for assistance.
- Recommended wire sizes are as follows:

Table 2: 230 VAC Wire Size Recommendations

20% Duty Cycle Wire Sizing	
Hp	Recommended Size
0.75 — 15	14 AWG
20	12 AWG
25 — 30	10 AWG
40 — 50	8 AWG
60	6 AWG
75	3 AWG
100 — 125	2 AWG
150	1/0 AWG
200 — 250	4/0 AWG

50% Duty Cycle Wire Sizing	
Hp	Recommended Size
0.75 — 10	14 AWG
15	12 AWG
20 — 30	10 AWG
40 — 50	6 AWG
60	4 AWG
75	2 AWG
100	1 AWG
125	1/0 AWG
150	3/0 AWG
200	250 MCM
250	300 MCM

Table 3: 380 VAC Wire Size Recommendations

20% Duty Cycle Wire Sizing	
kW	Recommended Size AWG (ISO mm ²)
0.75 — 22	14 AWG
30 — 37	12 AWG
45	10 AWG
55 — 75	8 AWG
90	6 AWG
110	4 AWG
132 — 160	3 AWG
200 — 250	1/0 AWG
315	3/0 AWG
400	4/0 AWG

50% Duty Cycle Wire Sizing	
kW	Recommended Size AWG (ISO mm ²)
0.75 — 15	14 AWG
18.5 — 22	12 AWG
30 — 45	10 AWG
55	8 AWG
75 — 90	6 AWG
110	3 AWG
132	2 AWG
160	1 AWG
200	2/0 AWG
250	3/0 AWG
315	250 MCM
400	300 MCM

Table 4: 480 VAC Wire Size Recommendations

20% Duty Cycle Wire Sizing	
Hp	Recommended Size
1 — 30	14 AWG
40 — 50	12 AWG
60	10 AWG
75 — 100	8 AWG
125	6 AWG
150 — 200	3 AWG
250 — 300	1/0 AWG
400	3/0 AWG
500	4/0 AWG

50% Duty Cycle Wire Sizing	
Hp	Recommended Size
1 — 15	14 AWG
20	12 AWG
25	10 AWG
30 — 50	8 AWG
60	6 AWG
75	4 AWG
100	3 AWG
125	2 AWG
150	2/0 AWG
200	3/0 AWG
250 — 300	350 MCM
400 — 500	2 x 350 MCM

Table 5: 600 VAC Wire Size Recommendations

20% Duty Cycle Wire Sizing		50% Duty Cycle Wire Sizing	
Hp	Recommended Size	Hp	Recommended Size
2 — 40	14 AWG	2 — 25	14 AWG
50 — 60	12 AWG	30 — 40	12 AWG
75	10 AWG	50 — 75	10 AWG
100 — 125	8 AWG	100 — 150	6 AWG
150	6 AWG	200	3 AWG
200	4 AWG	250 — 300	1 AWG
250	3 AWG		
300	2 AWG		

NOTE: Tighten all connections securely. Loose connections are a major source of resistor failures.

5.2 Wiring Instructions

1. Disconnect power from the drive.
2. Remove the dynamic brake resistor cover.
3. All enclosures feature several convenient conduit “knockouts” for easy wiring. Choose the appropriate locations and remove the knockout.
4. Pull wiring into the resistor enclosure for connection to the resistor.
5. Using an ohmmeter, check the value of the resistor and compare it to the rating shown on the nameplate to ensure you have the proper resistor. Connecting a resistor with too low of an ohm rating can damage the dynamic braking transistor (chopper) or the adjustable frequency drive.



Figure 8: Dynamic Brake Resistor Terminal Locations

6. Connect the two dynamic braking transistor (chopper) wires from the drive terminals indicated in Table 6 to the two screw terminals on the square terminal block in the resistor enclosure. (See **Figure 8** for terminal locations). Resistor wiring is not polarity sensitive.

Table 6: Series 9000 Drive Terminal Designations

Frame Size	Connect Dynamic Braking Resistor to the Series 9000 Drive Terminals Below		Notes
	R+	R-	
M3 through M7	R+	R-	
M8	DC+	R1* or R- *	Jumper drive terminals R1 and R2
M9	DC+	R1* or R- *	Jumper drive terminals R1, R2 and R3
M10	DC+	R1* or R- *	Jumper drive terminals R1, R2, R3 and R4
M11 through M13	DC+	R-	

* *Note: Terminal designation depends on type of drive.*

7. Connect the thermal switch to the brake protection input terminals with the two #8, screw-type terminals on the thermal switch terminal. (See **Figure 8** for terminal locations). Thermal switch wiring is not polarity sensitive.
8. Check the continuity of the thermal switch to confirm that it is either normally closed or normally open as required. Both types are available.
9. Install the ventilated cover and secure with the screws provided. **TIGHTEN SCREWS SECURELY.**
10. The dynamic braking resistor should not require any maintenance, but should be checked periodically for loose connections to the drive and for the accumulation of dust and dirt. Excess dust or dirt on the unit should be removed, as it could prevent proper cooling or cause tracking to ground.

For technical support contact your Cutler-Hammer distributor or the Cutler-Hammer AF Drives Product Integrity Center at 1-800-322-4986