

---

# **BRAKE CHOPPER MODULE INSTRUCTION MANUAL**

## **PHOENIX *DX, EX, DS & ES* AC DRIVES**



## OBJECTIVES

The purpose of this manual is to provide the user with the necessary information to install, start-up and maintain the Brake Chopper Module. This manual should be read thoroughly before operating, servicing or setting up the Brake Chopper Module.

This manual is intended for qualified service personnel responsible for setting up and servicing the Brake Chopper Module. You must have previous experience with and a basic understanding of electrical terminology, programming procedures, required equipment and safety precautions before attempting service on the Brake Chopper Module.

## SAFETY

### WARNING

Only personnel familiar with motor drives and the associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the Brake Chopper Module. Failure to comply may result in personnel injury and/or equipment damage.

### WARNING

An incorrectly applied or installed Brake Chopper Module can result in component damage or a reduction in product life. Wiring or application errors such as under-sizing the motor, incorrect or inadequate AC supply or excessive ambient temperatures may result in damage to the Drive or motor.

### WARNING

This Brake Chopper Module contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, please consult with the factory.

### WARNING

**TO AVOID A HAZARD OF ELECTRIC SHOCK, AFTER THE INPUT POWER IS REMOVED FROM THE BRAKE CHOPPER MODULE AND DRIVE CONNECTED TO THE BRAKE CHOPPER MODULE, WAIT FIVE (5) MINUTES FOR BUS CAPACITORS TO FULLY DISCHARGE AND VERIFY THAT THE VOLTAGE ON THE DC BUS CAPACITORS HAS DISCHARGED BY MEASURING AT THE +DC & -DC TERMINALS OF THE DRIVE AND AT THE BRAKE CHOPPER MODULE. THE VOLTAGE MUST BE ZERO.**

## MODEL RATINGS

Tables 1 through 3 show the Brake Chopper Module model ratings.

Table 3 through 6 show recommended resistor assemblies.

Specifications and Features

Drive Voltage		Drive 208/230/240Vac						380/415/480Vac						525/575/600Vac					
Brake Chopper Model Number	BC-2-45	BC-2-60	BC-2-90	BC-2-120	BC-2-180	BC-4-30	BC-4-45	BC-4-60	BC-4-90	BC-4-120	BC-4-180	BC-5-30	BC-5-45	BC-5-60	BC-5-90	BC-5-120	BC-5-180		
Rated DC Current	45 A	60 A	90 A	120 A	180 A	30 A	45 A	60 A	90 A	120 A	180 A	30 A	45 A	60 A	90 A	120 A	180 A		
Maximum Recommended Bus Fuse*	60 A	80 A	125 A	150 A	225 A	40 A	60 A	80 A	125 A	150 A	225 A	40 A	60 A	80 A	125 A	150 A	225 A		
Max Duty Cycle @ Rated DC Current (Cycle time is 60 seconds)	50%	30%	20%	10%	10%	50%	50%	30%	20%	10%	10%	50%	50%	30%	20%	10%	10%		
Duty Cycle is 100% @ rated current when model number is followed by "C"																			
Minimum Brake Resistance	8.3 Ω	6.3 Ω	4.2 Ω	3.1 Ω	2.1 Ω	25 Ω	16.7 Ω	12.5 Ω	8.3 Ω	6.3 Ω	4.2 Ω	31.1 Ω	19.7 Ω	15.5 Ω	10.4 Ω	7.8 Ω	5.2 Ω		
Chopper Maximum Heat Loss @ Rated DC Current	90 W	120 W	180 W	240 W	360 W	60 W	90 W	120 W	180 W	240 W	360 W	60 W	90 W	120 W	180 W	240 W	360 W		
Ambient Temperature	-10°C to 55°C (14°F to 131°F)																		
Storage Temperature	-40°C to 70°C (-40°F to 158°F)																		
Environmental Specification	Sea level to 3000 Feet [1000m] without derating																		
	5% to 95% relative humidity non-condensing																		
	Non-corrosive & non-hazardous dust vapor or gas																		
	9.8m/sec <sup>2</sup> (1.0G) peak																		
Physical Attribute	Panel Mount																		
	IP00 (Open)																		
Protective Feature	<ul style="list-style-type: none"> <li>• Heatsink over-temperature monitoring</li> <li>• DC bus voltage indication</li> <li>• Fourth generation IGBT</li> <li>• 55°C ambient</li> <li>• High voltage Application: 250Vac+10%, 500Vac+10%, and 600Vac+10%</li> <li>• DC bus Power ON light</li> <li>• Brake ON light</li> <li>• Heatsink over-temperature light</li> <li>• Form C dry contacts rated 115Vac @ 5A; 30Vdc @ 3.5A</li> <li>• No programming or hardware jumpers for all models</li> <li>• No programming or hardware jumpers for parallel operation</li> <li>• No mis-operation due to changing plant voltage</li> <li>• No external control power supply required</li> </ul>																		
Standard Features	<p>*Semiconductor Fuse: Ferraz Shawmut: A50P type for 208/230/240Vac application A70P type for 380/415/480Vac application A70P type for 525/575/600Vac application</p> <p>Bussmann: FWH type for 208/230/240Vac application FWP type for 380/415/480Vac application FWP type for 525/575/600Vac application</p>																		

## OVERVIEW

The Brake Chopper Module is an open style assembly together with customer-supplied resistors can increase the braking torque capability of the Phoenix DX and EX drives. When the drive detects a regeneration condition, a control signal is sent to the Brake Chopper. The Brake Chopper is controlled using a pulse width modulated signal to optimize the resistor power dissipation capability. The drive controls the chopper turn-on pulse width based on the regeneration level thus increasing the utilization of the brake resistor and providing smooth speed control. Other brake choppers in the market use a dc bus voltage threshold (bang-bang controller) to turn-on the brake. Bang-bang control method creates rough speed control and torque pulsations and could mis-operate when plant voltage increases during light load conditions. The control method used in US Drives brake prevents mis-operation due to changing plant voltage. The Brake Chopper is designed to operate only when regeneration is required. The brake chopper modules can be operated in parallel with no jumper programming. The same control signal is repeated to all brake choppers to insure that all paralleled brake choppers operate at the same duty. There are no jumpers or pots to move or adjust on all models.

## INSTALLATION AND WIRING

This Section provides the information needed to properly mount and wire the Brake Chopper Module. Since most start-up difficulties are the result of incorrect wiring, it is essential that the wiring is done as instructed. Read and understand this section in its entirety before actual installation begins.

## WARNINGS

### WARNING

Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate or service this equipment.

### WARNING

The control and its associated motors and operator control devices must be installed and grounded in accordance with all national and local codes (NEC, VDE 0160, BSI, etc.). To reduce the potential for electric shock, disconnect all power sources before initiating any maintenance or repairs. Keep fingers and foreign objects away from ventilation and other openings. Keep air passages clear. Potentially lethal voltages exist within the Brake Chopper Module its and connections. Use extreme caution during installation and start-up.

### WARNING

The following information is only a guide for proper installation. US Drives cannot assume responsibility for the compliance or noncompliance to any code, national, local or otherwise for the proper installation of this Brake Chopper Module or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during the installation.

## INITIAL CHECKS

Before installing the Brake Chopper Module, check the unit for physical damage sustained during shipment. If damaged, file a claim with the shipper and return for repair following the procedures outlined on the back cover. If no damage is observed, remove all shipping restraints and padding. Check Brake Chopper Module nameplate data for conformance with the AC power source and motor.

## DETERMINING CONTROL LOCATION

The Brake Chopper Module should be mounted inside a protected enclosure. Locations subject to steam vapors or excessive moisture, oil vapors, flammable or combustible vapors, chemical fumes, corrosive gases or liquids, or excessive dirt, dust or lint should be avoided unless an appropriate enclosure has been supplied or a source of clean air is supplied to the enclosure. The location should be dry and the ambient temperature should not exceed 131°F (55°C). If the mounting location is subject to vibration, the unit should be shock mounted.

**Input Fusing**

**WARNING**

The Brake Chopper Module does not provide input power short circuit fusing. Maximum Recommended DC Bus Fuse is shown in the Specifications and Features table. Note that branch circuit breakers or disconnect switches cannot respond fast enough to provide the level of protection that the Brake Chopper Module components require.

**ELECTRICAL INTERFERENCE (EMI/RFI)**

**Brake Chopper Module Immunity**

The immunity of the Brake Chopper Module to externally generated interference is outstanding. No special precautions other than following the procedures outlined in this manual are required.

It is recommended that the coils of AC and DC energized contactors interfaced with the Brake Chopper Module be suppressed with RC networks and diodes respectively or with similar devices. This is because non-suppressed coils (inductors) can generate high electrical transients.

In areas prone to frequent lightning strikes, the standard MOV's (Metal Oxide Varistors) supplied with the drive may need to be supplemented with additional surge suppression MOV's on the AC line feeding the drive.

**Brake Chopper Module Emissions**

Care must be used in the routing of power and ground connections to the Brake Chopper Module to avoid interference with sensitive equipment that may be nearby. The cable from the drive to the Brake Chopper Module carries switched voltages and should be routed well clear of sensitive equipment. The ground conductor of the motor cable should be connected to the drive ground stud directly. Connecting this ground conductor to a cabinet ground point or ground bus bar may cause high frequency current to circulate in the ground system of Brake Chopper Module enclosure.

**GROUNDING**

Refer to the "Recommended Power Wiring" in the AC drive instruction manual for grounding instructions. The Brake Chopper Module frame must be connected to AC system ground screw provided.

**Power Cabling**

Input and output power connections are made through the power terminal screws and power ground screw. The actual Brake Chopper Module label markings are shown in the table below.

**Power Signal Description**

Terminal		Description
GND		Power Earth Ground Stud
R1	R2	Resistor Terminals
DC-	DC+	DC Bus Terminals

**SIZING THE BRAKE CHOPPER MODULE**

The following calculations can be used to size the Brake Chopper Module.

**Step 1: Determine the Total Inertia**

$$wk^2_T = wk^2_M + [wk^2_L \times (GR)^2] \quad \text{in (lb-ft}^2\text{)}$$

$wk^2_M$  = Motor inertia in (lb-ft<sup>2</sup>)  
 $wk^2_L$  = Load inertia in (lb-ft<sup>2</sup>)  
 $GR$  = Speed reduction ratio:  $\frac{\text{Output RPM}}{\text{Input RPM}}$

**Step 2: Determine the Required Braking Torque**

$$TQ_B = \frac{wk^2_T \times [N_2 - N_1]}{308 \times t_d} \quad \text{in (lb-ft)}$$

$wk^2_T$  = Total inertia in (lb-ft<sup>2</sup>)  
 $N_1$  = Motor minimum speed in (RPM)  
 $N_2$  = Motor maximum speed in (RPM)  
 $t_d$  = Motor deceleration time in (sec)

**Step 3: Determine the Rated Motor Torque**

$$TQ_M = \frac{5250 \times HP}{N} \quad \text{in (lb-ft)}$$

$HP$  = The nameplate horsepower of the motor  
 $N$  = The nameplate base speed of the motor in (RPM)

**Step 4: Determine the Required Percent of Braking Torque**

$$TQ\% = \frac{TQ_B}{TQ_M} \times 100 \quad \text{in (\%)}$$

$TQ_M$  = The rated motor torque

$TQ_B$  = The required braking torque

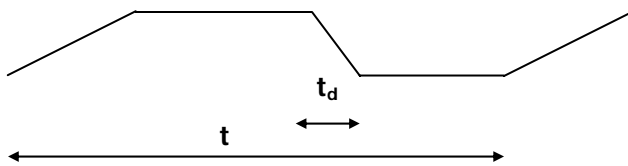
If  $TQ\%$  is between 20% and 150% dynamic braking is required

**Step 5: Determine the Duty Cycle of the Dynamic Brake**

$$\text{Duty Cycle} = \frac{t_d}{t} \times 100 \quad \text{in (\%)}$$

$t_d$  = The motor deceleration time in (sec)

$t$  = The motor cycle time in (sec)



Duty Cycle	Maximum Brake ON $t_d$	Brake OFF $t_{off}$
10%	6 sec.	54 sec.
20%	12 sec.	48 sec.
30%	18 sec.	42 sec.
50%	30 sec.	30 sec
100%	Continuous	-

**Important:** The selection of chopper and resistor are limited to a Maximum Brake On Time defined by the table above.

When ordering resistors, specify if the brake application is overhauling or deceleration type.

Overhauling loads: are those that require resistive braking to prevent speed increase.

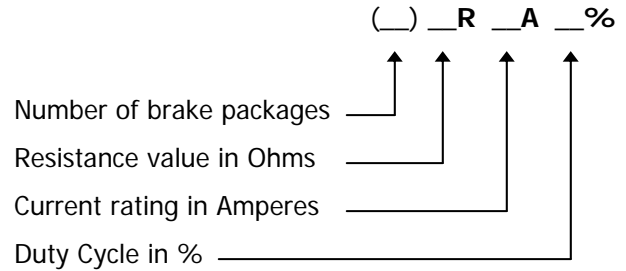
Deceleration Braking: is for those loads that require resistive braking to reduce speed or stop.

**Step 6: Select a Brake Chopper Module and a resistor package from table 1 through 6:**

Using the motor horsepower, percent braking torque, brake duty cycle, the brake chopper can be selected using table 1 through 3.

Recommended resistor assembly should include an normally-closed over-temperature switch (see Recommended Power Wiring Diagram 1 & 2)

Specify the Resistor package using the following:



Example:

- Motor horsepower = 100HP
- Drive voltage = 480VAC
- Required braking torque = 100%
- Required duty cycle = 20% deceleration

Using table 4 through 6 the resistor package for the above example is: 7.5R100A20%

Ordering specifications are: 7.5 Ohms resistor package rated at 100A for 20% duty cycle (Braking time 12 sec for deceleration braking). The resistor assembly should include a normally-closed over-temperature switch (see Recommended Power Wiring Diagram 1). Specify enclosure type.

**Resistor Assemblies Can be Purchased from:**

POWEROHM Resistors, Inc.  
5713 13<sup>th</sup> Street  
Katy, Texas 77493  
Tel: 281-391-6800 Fax: 281-391-6810  
www.powerohm.com

Or  
IPC Power Resistors Int'l, Inc.  
7453 Empire Drive, Unit 105  
Florence, Kentucky 41042-2923  
Tel: 606-282-2900 Fax: 606-282-2904  
www.ipcresistors.com

**If a different resistor choice is desired, the following formulas can be used:**

$$R = \frac{V_p^2}{TQ\% \times HP \times 7.5} \quad \text{Brake resistance in (Ohms)}$$

$$I = \frac{V_p}{R} \quad \text{Brake resistance current in (A)}$$

$V_p$  = \*DC bus peak voltage:

For 240Vac drive  $V_p = 375$

For 480Vac drive  $V_p = 750$

For 575Vac drive  $V_p = 935$

$TQ\%$  = The required braking torque in (%)

$HP$  = Motor horsepower

Using the brake current calculated in the above equation and brake duty cycle required by the application, select a brake-chopper using table 1 through 3. The chopper current rating should be at least equal or greater than the calculated required current.

Example:

- Motor Horsepower = 50HP
- Drive Voltage = 480VAC
- Required braking torque = 100 %
- Brake duty cycle = 10% deceleration

$$R = \frac{750^2}{100 \times 50 \times 7.5} = 15 \text{ Ohms}$$

$$I = \frac{750}{15} = 50A$$

Using table 2 the braking chopper is BC4-60

The resistor specifications are: 10 Ohms at 50A with 10% duty cycle (Maximum braking time 6 sec for deceleration braking). The resistor assembly should include a normally-closed over-temperature switch (see wiring diagram 1). Specify enclosure type.

\*  $V_p$  is not the turn-on brake voltage.  $V_p$  is just a level to calculate the resistor value. The turn-on of the Brake Chopper occurs only when a regeneration condition is detected. The Brake Chopper is controlled using a pulse width modulated signal to optimize the resistor power dissipation capability. The drive controls the chopper turn-on pulse width based on the regeneration level thus increasing the utilization of the brake resistor. This control method prevents mis-operation due to changing plant voltage. Other brake choppers in the market use a dc bus voltage threshold (bang-bang controller) to turn-on the brake. This bang-bang control method creates rough speed control and torque pulsations and the brake could mis-operate when plant voltage increases during light load conditions. The control method used in US Drives brake prevents mis-operation due to changing plant voltage.

## LED DESCRIPTIONS

### Brake ON LED

The Brake ON LED becomes lit when the chopper module is turn on.

### Heatsink Over-temperature LED

The Heatsink Over-temperature light will be lit if the IGBT transistor overheats.

### DC Bus Power ON LED

The DC Bus Power ON LED is lit when DC bus voltage is present.

**To avoid a hazard of electric shock, after the input power is removed from the Brake Chopper Module and drive connected to the Brake Chopper Module, wait five (5) minutes for bus capacitors to fully discharge and verify that the voltage on the DC bus capacitors has discharged by measuring at the +DC & -DC terminals of the drive and at the Brake Chopper Module. The voltage must be zero.**

**Brake Chopper Selection Table 1**

**Brake Chopper Module Selection Table**

**208/230/240VAC Drive Voltage**

HP	Chopper Catalog Number 100% Braking Torque					Chopper Catalog Number 150% Braking Torque				
	Duty Cycle Rating					Duty Cycle Rating				
	10%	20%	30%	50%	100%	10%	20%	30%	50%	100%
3	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45
5	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45
7.5	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45
10	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45-C	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45-C
15	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45-C	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45-C
20	BC2-45	BC2-45	BC2-45	BC2-45	BC2-45-C	BC2-60	BC2-60	BC2-60	BC2-60-C	BC2-60-C
25	BC2-60	BC2-60	BC2-60	BC2-60-C	BC2-60-C	BC2-90	BC2-90	BC2-90	BC2-90-C	BC2-90-C
30	BC2-60	BC2-60	BC2-60	BC2-60-C	BC2-60-C	BC2-90	BC2-90	BC2-90-C	BC2-90-C	BC2-90-C
40	BC2-90	BC2-90	BC2-90	BC2-90-C	BC2-90-C	BC2-120	BC2-120	BC2-120-C	BC2-120-C	BC2-120-C
50	BC2-120	BC2-120	BC2-120-C	BC2-120-C	BC2-120-C	BC2-180	BC2-180	BC2-180-C	BC2-180-C	BC2-180-C
60	BC2-120	BC2-120	BC2-120-C	BC2-120-C	BC2-120-C	BC2-180	BC2-180	BC2-180-C	BC2-180-C	BC2-180-C
75	BC2-180	BC2-180-C	BC2-180-C	BC2-180-C	BC2-180-C	2 x BC2-120	2 x BC2-120	2 x BC2-120-C	2 x BC2-120-C	2 x BC2-120-C
100	2 x BC2-120	2 x BC2-120	2 x BC2-120-C	2 x BC2-120-C	2 x BC2-120-C	2 x BC2-180	2 x BC2-180	2 x BC2-180-C	2 x BC2-180-C	2 x BC2-180-C
125	2 x BC2-120	2 x BC2-120	2 x BC2-120-C	2 x BC2-120-C	2 x BC2-120-C	2 x BC2-180	2 x BC2-180	2 x BC2-180-C	2 x BC2-180-C	2 x BC2-180-C
150	2 x BC2-180	2 x BC2-180-C	2 x BC2-180-C	2 x BC2-180-C	2 x BC2-180-C	3 x BC2-180	3 x BC2-180	3 x BC2-180-C	3 x BC2-180-C	3 x BC2-180-C
200	3 x BC2-180	3 x BC2-180-C	3 x BC2-180-C	3 x BC2-180-C	3 x BC2-180-C					
250	3 x BC2-180	3 x BC2-180-C	3 x BC2-180-C	3 x BC2-180-C	3 x BC2-180-C					

Drive Horsepower Rating is Based on the NEC Rated Full Load Current for 230Vac Motors



**Brake Chopper Selection Table 2**

**Brake Chopper Module Selection Table**  
**380/415/480VAC Drive Voltage**

HP	Chopper Catalog Number 100% Braking Torque				Chopper Catalog Number 150% Braking Torque					
	Duty Cycle Rating				Duty Cycle Rating					
	10%	20%	30%	50%	100%	10%	20%	30%	50%	100%
5	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30
7.5	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30
10	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30
15	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30
20	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30-C
25	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30-C	BC4-45	BC4-45	BC4-45	BC4-45	BC4-45-C
30	BC4-30	BC4-30	BC4-30	BC4-30	BC4-30-C	BC4-45	BC4-45	BC4-45	BC4-45	BC4-45-C
40	BC4-45	BC4-45	BC4-45	BC4-45	BC4-45-C	BC4-60	BC4-60	BC4-60	BC4-60-C	BC4-60-C
50	BC4-60	BC4-60	BC4-60	BC4-60	BC4-60-C	BC4-90	BC4-90	BC4-90	BC4-90-C	BC4-90-C
60	BC4-60	BC4-60	BC4-60	BC4-60-C	BC4-60-C	BC4-90	BC4-90	BC4-90-C	BC4-90-C	BC4-90-C
75	BC4-90	BC4-90	BC4-90	BC4-90-C	BC4-90-C	BC4-120	BC4-120	BC4-120-C	BC4-120-C	BC4-120-C
100	BC4-120	BC4-120	BC4-120-C	BC4-120-C	BC4-120-C	BC4-180	BC4-180-C	BC4-180-C	BC4-180-C	BC4-180-C
125	BC4-120	BC4-120	BC4-120-C	BC4-120-C	BC4-120-C	BC4-180	BC4-180-C	BC4-180-C	BC4-180-C	BC4-180-C
B150	BC4-180	BC4-180-C	BC4-180-C	BC4-180-C	BC4-180-C	2 x BC4-120	2 x BC4-120	2 x BC4-120-C	2 x BC4-120-C	2 x BC4-120-C
200	2 x BC4-120	2 x BC4-120	2 x BC4-120-C	2 x BC4-120-C	2 x BC4-120-C	2 x BC4-180	2 x BC4-180	2 x BC4-180-C	2 x BC4-180-C	2 x BC4-180-C
250	2 x BC4-120	2 x BC4-120	2 x BC4-120-C	2 x BC4-120-C	2 x BC4-120-C	2 x BC4-180	2 x BC4-180	2 x BC4-180-C	2 x BC4-180-C	2 x BC4-180-C
300	2 x BC4-180	2 x BC4-180-C	2 x BC4-180-C	2 x BC4-180-C	2 x BC4-180-C	3 x BC4-180	3 x BC4-180	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C
350	2 x BC4-180	2 x BC4-180-C	2 x BC4-180-C	2 x BC4-180-C	2 x BC4-180-C	3 x BC4-180	3 x BC4-180	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C
400	3 x BC4-180	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C					
450	3 x BC4-180	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C					
500	3 x BC4-180	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C	3 x BC4-180-C					

Drive Horsepower Rating is Based on the NEC Rated Full Load Current for 230Vac Motors.

**Brake Chopper Selection Table 3**

**Brake Chopper Module Selection Table**

**525/575/600VAC Drive Voltage**

HP	Chopper Catalog Number 100% Braking Torque					Chopper Catalog Number 150% Braking Torque				
	Duty Cycle Rating					Duty Cycle Rating				
	10%	20%	30%	50%	100%	10%	20%	30%	50%	100%
5	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30
7.5	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30
10	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30
15	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30
20	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30
25	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30-C
30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30	BC5-45	BC5-45	BC5-45	BC5-45	BC5-45-C
40	BC5-30	BC5-30	BC5-30	BC5-30	BC5-30-C	BC5-45	BC5-45	BC5-45	BC5-45	BC5-45-C
50	BC5-45	BC5-45	BC5-45	BC5-45	BC5-45-C	BC5-60	BC5-60	BC5-60	BC5-60-C	BC5-60-C
60	BC5-60	BC5-60	BC5-60	BC5-60	BC5-60-C	BC5-90	BC5-90	BC5-90	BC5-90-C	BC5-90-C
75	BC5-60	BC5-60	BC5-60	BC5-60-C	BC5-60-C	BC5-90	BC5-90	BC5-90-C	BC5-90-C	BC5-90-C
100	BC5-90	BC5-90	BC5-90	BC5-90-C	BC5-90-C	BC5-120	BC5-120	BC5-120-C	BC5-120-C	BC5-120-C
125	BC5-120	BC5-120	BC5-120-C	BC5-120-C	BC5-120-C	BC5-180	BC5-180	BC5-180-C	BC5-180-C	BC5-180-C
150	BC5-120	BC5-120	BC5-120-C	BC5-120-C	BC5-120-C	BC5-180	BC5-180-C	BC5-180-C	BC5-180-C	BC5-180-C
200	BC5-180	BC5-180-C	BC5-180-C	BC5-180-C	BC5-180-C	2 x BC5-120	2 x BC5-120	2 x BC5-120-C	2 x BC5-120-C	2 x BC5-120-C
250	2 x BC5-120	2 x BC5-120	2 x BC5-120-C	2 x BC5-120-C	2 x BC5-120-C	2 x BC5-180	2 x BC5-180	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C
300	2 x BC5-120	2 x BC5-120	2 x BC5-120-C	2 x BC5-120-C	2 x BC5-120-C	2 x BC5-180	2 x BC5-180	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C
350	2 x BC5-180	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C	3 x BC5-180	3 x BC5-180	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C
400	2 x BC5-180	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C	3 x BC5-180	3 x BC5-180	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C
450	2 x BC5-180	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C	2 x BC5-180-C	3 x BC5-180	3 x BC5-180	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C
500	3 x BC5-180	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C					
600	3 x BC5-180	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C	3 x BC5-180-C					

Drive Horsepower Rating is Based on the NEC Rated Full Load Current for 575Vac Motors.

**Resistor Selection Table 4**

HP		Resistor Package 100% Braking Torque										Resistor Package 150% Braking Torque									
		Duty Cycle Rating					Duty Cycle Rating					Duty Cycle Rating					Duty Cycle Rating				
		10%	20%	30%	50%	100%	10%	20%	30%	50%	100%	10%	20%	30%	50%	100%	10%	20%	30%	50%	100%
3		62.5R6A10%	62.5R6A20%	62.5R6A30%	62.5R6A50%	62.5R6A100%	41.7R9A10%	41.7R9A20%	41.7R9A30%	41.7R9A50%	41.7R9A100%	25R15A10%	25R15A20%	25R15A30%	25R15A50%	25R15A100%	16.7R22.5A10%	16.7R22.5A20%	16.7R22.5A30%	16.7R22.5A50%	16.7R22.5A100%
5		37.5R10A10%	37.5R10A20%	37.5R10A30%	37.5R10A50%	37.5R10A100%	25R15A10%	25R15A20%	25R15A30%	25R15A50%	25R15A100%	16.7R22.5A10%	16.7R22.5A20%	16.7R22.5A30%	16.7R22.5A50%	16.7R22.5A100%	12.5R30A10%	12.5R30A20%	12.5R30A30%	12.5R30A50%	12.5R30A100%
7.5		25R15A10%	25R15A20%	25R15A30%	25R15A50%	25R15A100%	18.8R20A10%	18.8R20A20%	18.8R20A30%	18.8R20A50%	18.8R20A100%	12.5R30A10%	12.5R30A20%	12.5R30A30%	12.5R30A50%	12.5R30A100%	8.3R45A10%	8.3R45A20%	8.3R45A30%	8.3R45A50%	8.3R45A100%
10		18.8R20A10%	18.8R20A20%	18.8R20A30%	18.8R20A50%	18.8R20A100%	9.4R40A10%	9.4R40A20%	9.4R40A30%	9.4R40A50%	9.4R40A100%	7.5R50A10%	7.5R50A20%	7.5R50A30%	7.5R50A50%	7.5R50A100%	6.3R60A10%	6.3R60A20%	6.3R60A30%	6.3R60A50%	6.3R60A100%
15		12.5R30A10%	12.5R30A20%	12.5R30A30%	12.5R30A50%	12.5R30A100%	6.3R60A10%	6.3R60A20%	6.3R60A30%	6.3R60A50%	6.3R60A100%	5R75A10%	5R75A20%	5R75A30%	5R75A50%	5R75A100%	4.2R90A10%	4.2R90A20%	4.2R90A30%	4.2R90A50%	4.2R90A100%
20		9.4R40A10%	9.4R40A20%	9.4R40A30%	9.4R40A50%	9.4R40A100%	4.7R80A10%	4.7R80A20%	4.7R80A30%	4.7R80A50%	4.7R80A100%	3.8R100A10%	3.8R100A20%	3.8R100A30%	3.8R100A50%	3.8R100A100%	3.1R120A10%	3.1R120A20%	3.1R120A30%	3.1R120A50%	3.1R120A100%
25		7.5R50A10%	7.5R50A20%	7.5R50A30%	7.5R50A50%	7.5R50A100%	3.1R120A10%	3.1R120A20%	3.1R120A30%	3.1R120A50%	3.1R120A100%	2.5R150A10%	2.5R150A20%	2.5R150A30%	2.5R150A50%	2.5R150A100%	2.1R180A10%	2.1R180A20%	2.1R180A30%	2.1R180A50%	2.1R180A100%
30		6.3R60A10%	6.3R60A20%	6.3R60A30%	6.3R60A50%	6.3R60A100%	2.5R150A10%	2.5R150A20%	2.5R150A30%	2.5R150A50%	2.5R150A100%	(2) 3.8R100A30%	(2) 3.8R100A50%	(2) 3.8R100A100%	(2) 3.8R100A50%	(2) 3.8R100A100%	(2) 3.3R113A10%	(2) 3.3R113A20%	(2) 3.3R113A30%	(2) 3.3R113A50%	(2) 3.3R113A100%
40		4.7R80A10%	4.7R80A20%	4.7R80A30%	4.7R80A50%	4.7R80A100%	(2) 3.8R100A20%	(2) 3.8R100A50%	(2) 3.8R100A100%	(2) 3.8R100A50%	(2) 3.8R100A100%	(2) 3.8R100A30%	(2) 3.8R100A50%	(2) 3.8R100A100%	(2) 3.8R100A50%	(2) 3.8R100A100%	(2) 2.5R150A10%	(2) 2.5R150A20%	(2) 2.5R150A30%	(2) 2.5R150A50%	(2) 2.5R150A100%
50		3.8R100A10%	3.8R100A20%	3.8R100A30%	3.8R100A50%	3.8R100A100%	(2) 3R125A20%	(2) 3R125A30%	(2) 3R125A50%	(2) 3R125A100%	(2) 3R125A100%	(2) 3R125A10%	(2) 3R125A20%	(2) 3R125A30%	(2) 3R125A50%	(2) 3R125A100%	(2) 2.5R150A10%	(2) 2.5R150A20%	(2) 2.5R150A30%	(2) 2.5R150A50%	(2) 2.5R150A100%
60		3.1R120A10%	3.1R120A20%	3.1R120A30%	3.1R120A50%	3.1R120A100%	(2) 2.5R150A20%	(2) 2.5R150A30%	(2) 2.5R150A50%	(2) 2.5R150A100%	(2) 2.5R150A100%	(2) 2.5R150A10%	(2) 2.5R150A20%	(2) 2.5R150A30%	(2) 2.5R150A50%	(2) 2.5R150A100%	(3) 2.8R133A20%	(3) 2.8R133A30%	(3) 2.8R133A50%	(3) 2.8R133A100%	(3) 2.8R133A100%
75		2.5R150A10%	2.5R150A20%	2.5R150A30%	2.5R150A50%	2.5R150A100%	(3) 2.8R133A10%	(3) 2.8R133A20%	(3) 2.8R133A30%	(3) 2.8R133A50%	(3) 2.8R133A100%	(3) 2.3R167A10%	(3) 2.3R167A20%	(3) 2.3R167A30%	(3) 2.3R167A50%	(3) 2.3R167A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%
100		(2) 3.8R100A10%	(2) 3.8R100A20%	(2) 3.8R100A30%	(2) 3.8R100A50%	(2) 3.8R100A100%	(3) 2.8R133A10%	(3) 2.8R133A20%	(3) 2.8R133A30%	(3) 2.8R133A50%	(3) 2.8R133A100%	(3) 2.3R167A10%	(3) 2.3R167A20%	(3) 2.3R167A30%	(3) 2.3R167A50%	(3) 2.3R167A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%
125		(2) 3R125A10%	(2) 3R125A20%	(2) 3R125A30%	(2) 3R125A50%	(2) 3R125A100%	(3) 2.8R133A10%	(3) 2.8R133A20%	(3) 2.8R133A30%	(3) 2.8R133A50%	(3) 2.8R133A100%	(3) 2.3R167A10%	(3) 2.3R167A20%	(3) 2.3R167A30%	(3) 2.3R167A50%	(3) 2.3R167A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%
150		(2) 2.5R150A10%	(2) 2.5R150A20%	(2) 2.5R150A30%	(2) 2.5R150A50%	(2) 2.5R150A100%	(3) 2.8R133A10%	(3) 2.8R133A20%	(3) 2.8R133A30%	(3) 2.8R133A50%	(3) 2.8R133A100%	(3) 2.3R167A10%	(3) 2.3R167A20%	(3) 2.3R167A30%	(3) 2.3R167A50%	(3) 2.3R167A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%
200		(3) 2.8R133A10%	(3) 2.8R133A20%	(3) 2.8R133A30%	(3) 2.8R133A50%	(3) 2.8R133A100%	(3) 2.3R167A10%	(3) 2.3R167A20%	(3) 2.3R167A30%	(3) 2.3R167A50%	(3) 2.3R167A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%
250		(3) 2.3R167A10%	(3) 2.3R167A20%	(3) 2.3R167A30%	(3) 2.3R167A50%	(3) 2.3R167A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%	(3) 2.5R150A10%	(3) 2.5R150A20%	(3) 2.5R150A30%	(3) 2.5R150A50%	(3) 2.5R150A100%

Drive Horsepower Rating is Based on the NEC Rated Full Load Current for 230Vac Motors.

**Resistor Selection Table 5**

HP		Resistor Selection Table 380/415/480VAC Drive Voltage									
		Resistor Package 100% Braking Torque					Resistor Package 150% Braking Torque				
HP		Duty Cycle Rating					Duty Cycle Rating				
		10%	20%	30%	50%	100%	10%	20%	30%	50%	100%
5	150R5A10%	150R5A20%	150R5A30%	150R5A50%	150R5A100%	100R7.5A10%	100R7.5A20%	100R7.5A30%	100R7.5A50%	100R7.5A100%	
7.5	100R7.5A10%	100R7.5A20%	100R7.5A30%	100R7.5A50%	100R7.5A100%	66.7R11.3A10%	66.7R11.3A20%	66.7R11.3A30%	66.7R11.3A50%	66.7R11.3A100%	
10	75R10A10%	75R10A20%	75R10A30%	75R10A50%	75R10A100%	50R15A10%	50R15A20%	50R15A30%	50R15A50%	50R15A100%	
15	50R15A10%	50R15A20%	50R15A30%	50R15A50%	50R15A100%	33.3A22.5A10%	33.3A22.5A20%	33.3A22.5A30%	33.3A22.5A50%	33.3A22.5A100%	
20	37.5R20A10%	37.5R20A20%	37.5R20A30%	37.5R20A50%	37.5R20A100%	25R30A10%	25R30A20%	25R30A30%	25R30A50%	25R30A100%	
25	30R25A10%	30R25A20%	30R25A30%	30R25A50%	30R25A100%	20R37.5A10%	20R37.5A20%	20R37.5A30%	20R37.5A50%	20R37.5A100%	
30	25R30A10%	25R30A20%	25R30A30%	25R30A50%	25R30A100%	16.7R45A10%	16.7R45A20%	16.7R45A30%	16.7R45A50%	16.7R45A100%	
40	18.8R40A10%	18.8R40A20%	18.8R40A30%	18.8R40A50%	18.8R40A100%	12.5R60A10%	12.5R60A20%	12.5R60A30%	12.5R60A50%	12.5R60A100%	
50	15R50A10%	15R50A20%	15R50A30%	15R50A50%	15R50A100%	10R75A10%	10R75A20%	10R75A30%	10R75A50%	10R75A100%	
60	12.5R60A10%	12.5R60A20%	12.5R60A30%	12.5R60A50%	12.5R60A100%	8.3R90A10%	8.3R90A20%	8.3R90A30%	8.3R90A50%	8.3R90A100%	
75	10R75A10%	10R75A20%	10R75A30%	10R75A50%	10R75A100%	6.7R113A10%	6.7R113A20%	6.7R113A30%	6.7R113A50%	6.7R113A100%	
100	7.5R100A10%	7.5R100A20%	7.5R100A30%	7.5R100A50%	7.5R100A100%	5R150A10%	5R150A20%	5R150A30%	5R150A50%	5R150A100%	
125	6R125A10%	6R125A20%	6R125A30%	6R125A50%	6R125A100%	4R188A10%	4R188A20%	4R188A30%	4R188A50%	4R188A100%	
150	5R150A10%	5R150A20%	5R150A30%	5R150A50%	5R150A100%	(2) 6.7R113A10%	(2) 6.7R113A20%	(2) 6.7R113A30%	(2) 6.7R113A50%	(2) 6.7R113A100%	
200	(2) 7.5R100A10%	(2) 7.5R100A20%	(2) 7.5R100A30%	(2) 7.5R100A50%	(2) 7.5R100A100%	(2) 5R150A10%	(2) 5R150A20%	(2) 5R150A30%	(2) 5R150A50%	(2) 5R150A100%	
250	(2) 6R125A10%	(2) 6R125A20%	(2) 6R125A30%	(2) 6R125A50%	(2) 6R125A100%	(2) 4R188A10%	(2) 4R188A20%	(2) 4R188A30%	(2) 4R188A50%	(2) 4R188A100%	
300	(2) 5R150A10%	(2) 5R150A20%	(2) 5R150A30%	(2) 5R150A50%	(2) 5R150A100%	(3) 5R150A10%	(3) 5R150A20%	(3) 5R150A30%	(3) 5R150A50%	(3) 5R150A100%	
350	(2) 4.3R175A10%	(2) 4.3R175A20%	(2) 4.3R175A30%	(2) 4.3R175A50%	(2) 4.3R175A100%	(3) 4.3R175A10%	(3) 4.3R175A20%	(3) 4.3R175A30%	(3) 4.3R175A50%	(3) 4.3R175A100%	
400	(3) 5.6R133A10%	(3) 5.6R133A20%	(3) 5.6R133A30%	(3) 5.6R133A50%	(3) 5.6R133A100%						
450	(3) 5R150A10%	(3) 5R150A20%	(3) 5R150A30%	(3) 5R150A50%	(3) 5R150A100%						
500	(3) 4.5R167A10%	(3) 4.5R167A20%	(3) 4.5R167A30%	(3) 4.5R167A50%	(3) 4.5R167A100%						

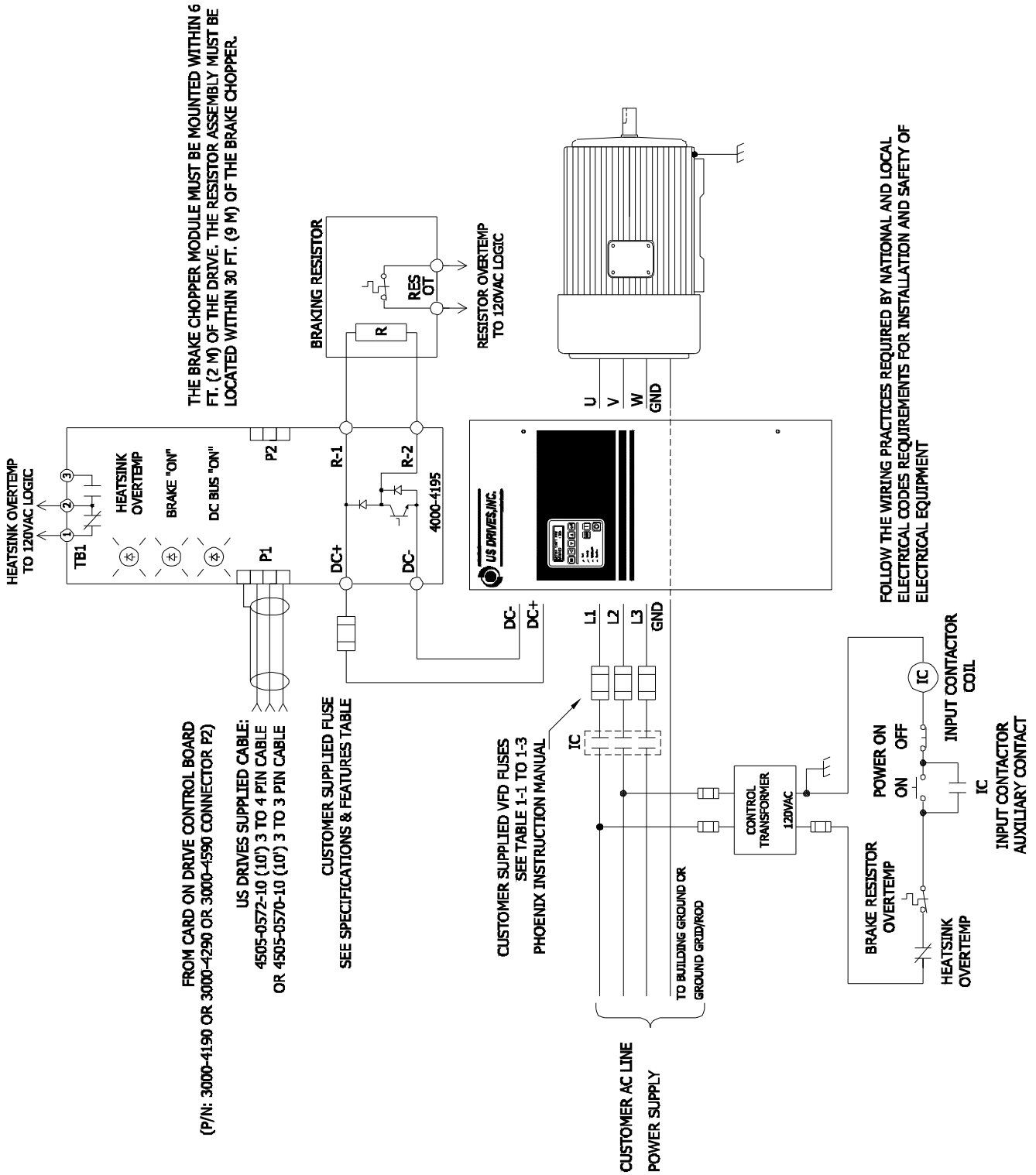
Drive Horsepower Rating is Based on the NEC Rated Full Load Current for 460Vac Motors.

**Resistor Selection Table 6**

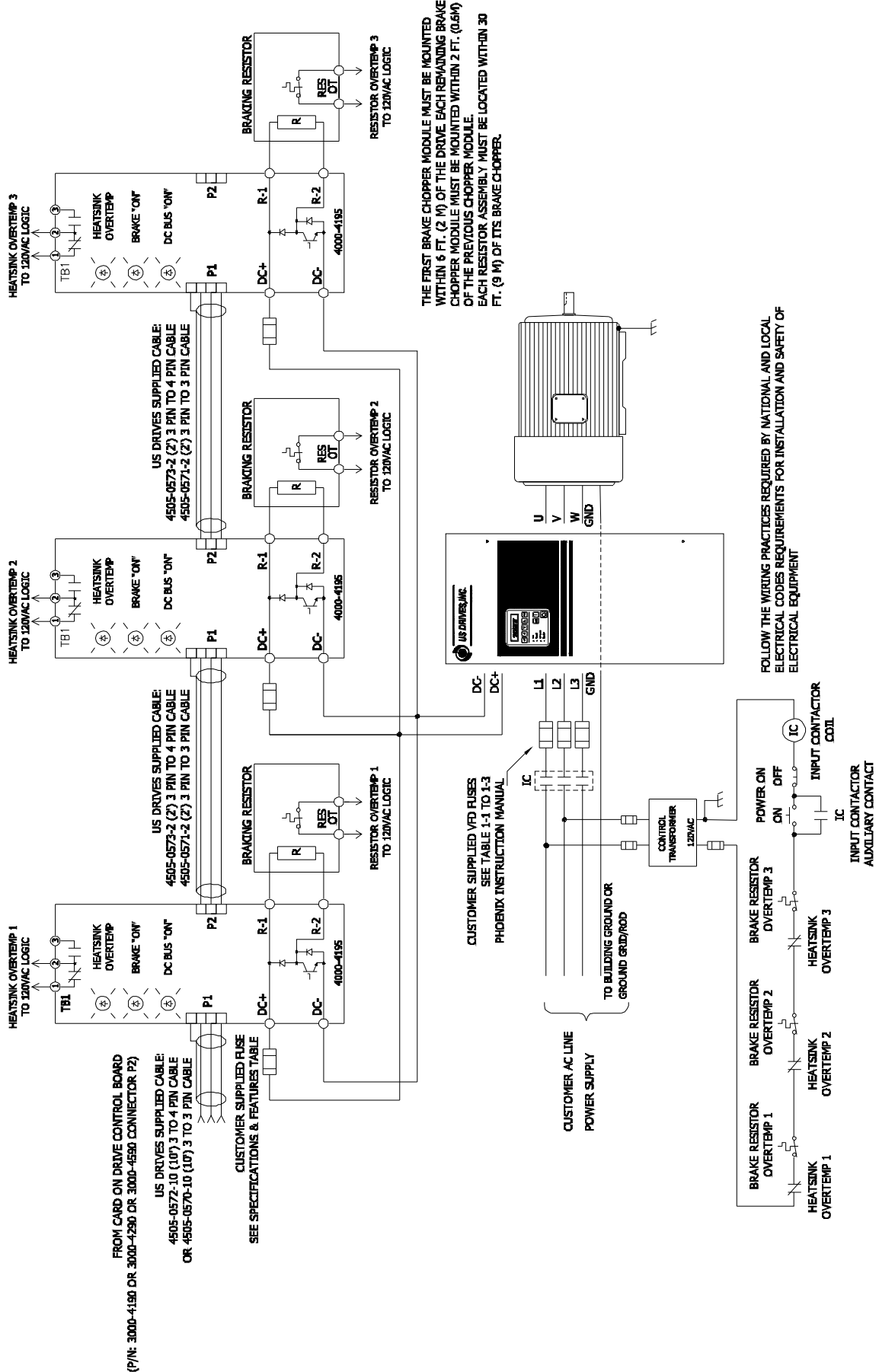
HP		Resistor Selection Table 525/575/600VAC Drive Voltage									
		Resistor Package 100% Braking Torque					Resistor Package 150% Braking Torque				
		Duty Cycle Rating					Duty Cycle Rating				
		10%	20%	30%	50%	100%	10%	20%	30%	50%	100%
5		233R4A10%	233R4A20%	233R4A30%	233R4A50%	233R4A100%	155R6A10%	155R6A20%	155R6A30%	155R6A50%	155R6A100%
7.5		155R6A10%	155R6A20%	155R6A30%	155R6A50%	155R6A100%	104R9A10%	104R9A20%	104R9A30%	104R9A50%	104R9A100%
10		117R8A10%	117R8A20%	117R8A30%	117R8A50%	117R8A100%	77.7R12A10%	77.7R12A20%	77.7R12A30%	77.7R12A50%	77.7R12A100%
15		77.7R12A10%	77.7R12A20%	77.7R12A30%	77.7R12A50%	77.7R12A100%	51.8R18A10%	51.8R18A20%	51.8R18A30%	51.8R18A50%	51.8R18A100%
20		58.3R16A10%	58.3R16A20%	58.3R16A30%	58.3R16A50%	58.3R16A100%	38.9R24A10%	38.9R24A20%	38.9R24A30%	38.9R24A50%	38.9R24A100%
25		46.6R20A10%	46.6R20A20%	46.6R20A30%	46.6R20A50%	46.6R20A100%	31.1R30A10%	31.1R30A20%	31.1R30A30%	31.1R30A50%	31.1R30A100%
30		38.9R24A10%	38.9R24A20%	38.9R24A30%	38.9R24A50%	38.9R24A100%	25.9R36A10%	25.9R36A20%	25.9R36A30%	25.9R36A50%	25.9R36A100%
40		29.1R32A10%	29.1R32A20%	29.1R32A30%	29.1R32A50%	29.1R32A100%	19.4R48A10%	19.4R48A20%	19.4R48A30%	19.4R48A50%	19.4R48A100%
50		23.3R40A10%	23.3R40A20%	23.3R40A30%	23.3R40A50%	23.3R40A100%	15.5R60A10%	15.5R60A20%	15.5R60A30%	15.5R60A50%	15.5R60A100%
60		19.4R48A10%	19.4R48A20%	19.4R48A30%	19.4R48A50%	19.4R48A100%	13R72A10%	13R72A20%	13R72A30%	13R72A50%	13R72A100%
75		15.5R60A10%	15.5R60A20%	15.5R60A30%	15.5R60A50%	15.5R60A100%	10.4R90A10%	10.4R90A20%	10.4R90A30%	10.4R90A50%	10.4R90A100%
100		11.7R80A10%	11.7R80A20%	11.7R80A30%	11.7R80A50%	11.7R80A100%	7.8R120A10%	7.8R120A20%	7.8R120A30%	7.8R120A50%	7.8R120A100%
125		9.3R100A10%	9.3R100A20%	9.3R100A30%	9.3R100A50%	9.3R100A100%	6.2R150A10%	6.2R150A20%	6.2R150A30%	6.2R150A50%	6.2R150A100%
150		7.8R120A10%	7.8R120A20%	7.8R120A30%	7.8R120A50%	7.8R120A100%	5.2R180A10%	5.2R180A20%	5.2R180A30%	5.2R180A50%	5.2R180A100%
200		5.8R160A10%	5.8R160A20%	5.8R160A30%	5.8R160A50%	5.8R160A100%	(2) 7.8R120A10%	(2) 7.8R120A20%	(2) 7.8R120A30%	(2) 7.8R120A50%	(2) 7.8R120A100%
250		(2) 9.3R100A10%	(2) 9.3R100A20%	(2) 9.3R100A30%	(2) 9.3R100A50%	(2) 9.3R100A100%	(2) 6.2R150A10%	(2) 6.2R150A20%	(2) 6.2R150A30%	(2) 6.2R150A50%	(2) 6.2R150A100%
300		(2) 7.8R120A10%	(2) 7.8R120A20%	(2) 7.8R120A30%	(2) 7.8R120A50%	(2) 7.8R120A100%	(2) 5.2R180A10%	(2) 5.2R180A20%	(2) 5.2R180A30%	(2) 5.2R180A50%	(2) 5.2R180A100%
350		(2) 6.7R140A10%	(2) 6.7R140A20%	(2) 6.7R140A30%	(2) 6.7R140A50%	(2) 6.7R140A100%	(3) 6.7R140A10%	(3) 6.7R140A20%	(3) 6.7R140A30%	(3) 6.7R140A50%	(3) 6.7R140A100%
400		(2) 5.8R160A10%	(2) 5.8R160A20%	(2) 5.8R160A30%	(2) 5.8R160A50%	(2) 5.8R160A100%	(3) 5.8R160A10%	(3) 5.8R160A20%	(3) 5.8R160A30%	(3) 5.8R160A50%	(3) 5.8R160A100%
450		(2) 5.2R180A10%	(2) 5.2R180A20%	(2) 5.2R180A30%	(2) 5.2R180A50%	(2) 5.2R180A100%	(3) 5.2R180A10%	(3) 5.2R180A20%	(3) 5.2R180A30%	(3) 5.2R180A50%	(3) 5.2R180A100%
500		(3) 7R134A10%	(3) 7R134A20%	(3) 7R134A30%	(3) 7R134A50%	(3) 7R134A100%					
600		(3) 5.8R160A10%	(3) 5.8R160A20%	(3) 5.8R160A30%	(3) 5.8R160A50%	(3) 5.8R160A100%					

Drive Horsepower Rating is Based on the NEC Rated Full Load Current for 575Vac Motors.

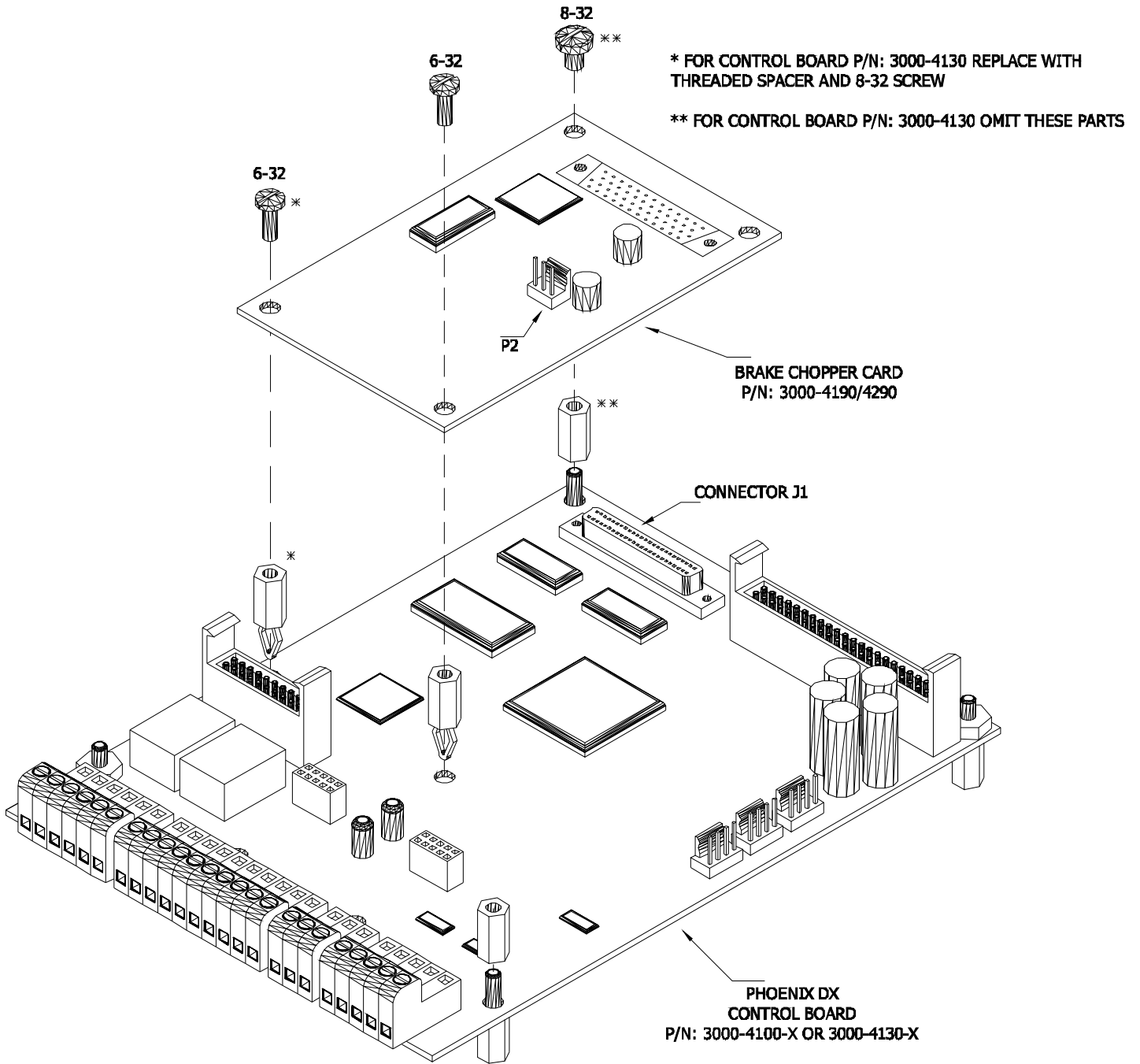
**Recommended Power Wiring 1**



**Recommended Power Wiring 2**



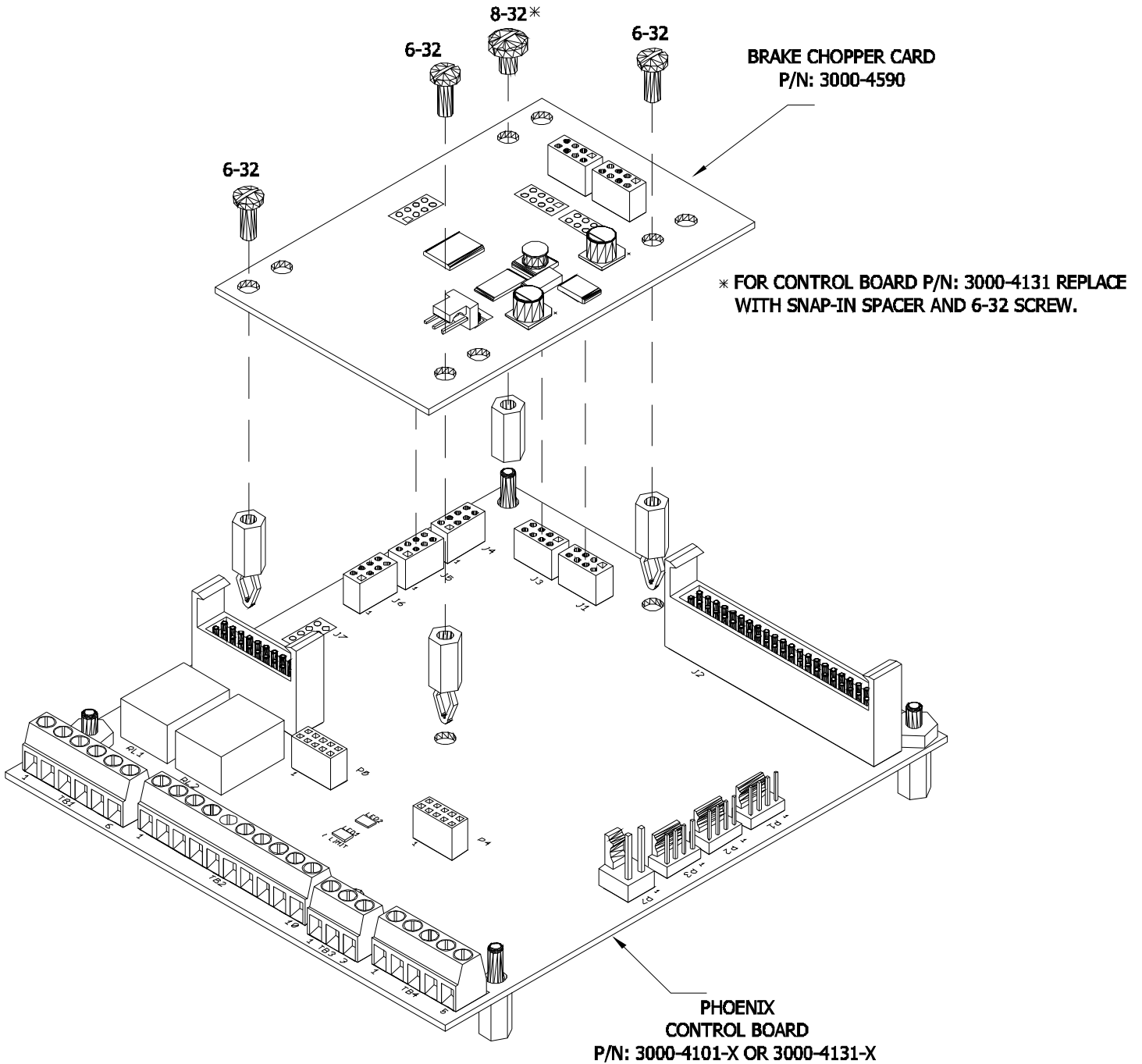
**Brake Chopper Control Card 3000-4190**



**Mounting Diagram**  
**For Control Board 3000-4100 and 3000-4130**

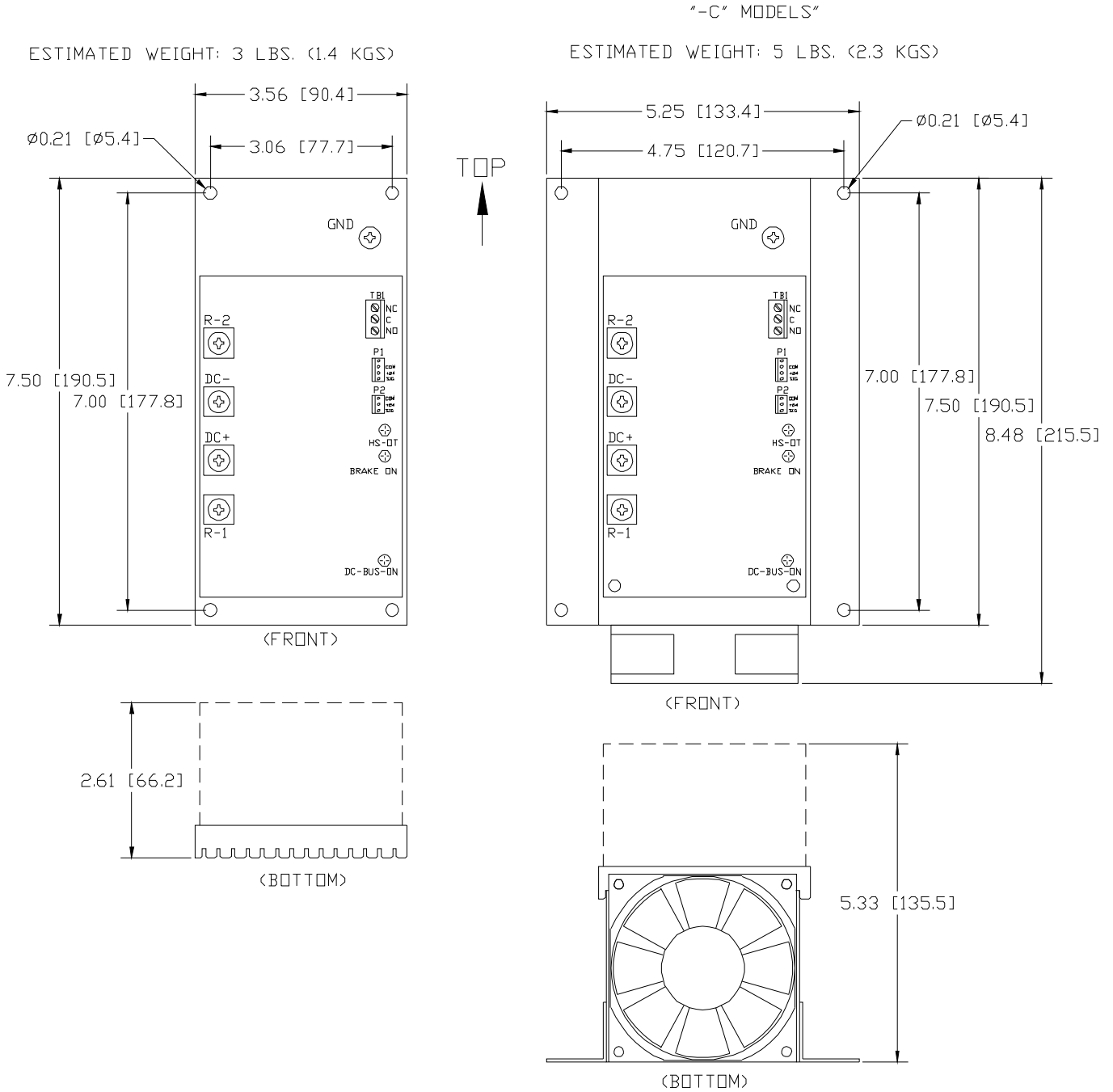


**Brake Chopper Control Card 3000-4590**



**Mounting Diagram  
For Control Board 3000-4101 and 3000-4131**

## Brake Chopper Mounting Information



FOR PROPER HEATSINK COOLING, UNIT  
MUST BE MOUNTED ON FLAT SURFACE  
USING PROVIDED MOUNTING HOLES

***"THE HIGH HORSEPOWER DESIGN EXPERTS"***

---

**US Drives Inc.  
2221 Niagara Falls Boulevard  
P.O. Box 281  
Niagara Falls, NY 14304-0281  
Tel: (716) 731-1606 Fax: (716) 731-1524  
Visit us at [www.usdrivesinc.com](http://www.usdrivesinc.com)**

Products Designed And Manufactured  
In The United States Of America



Rev. 0117 Printed in U.S.A.

---