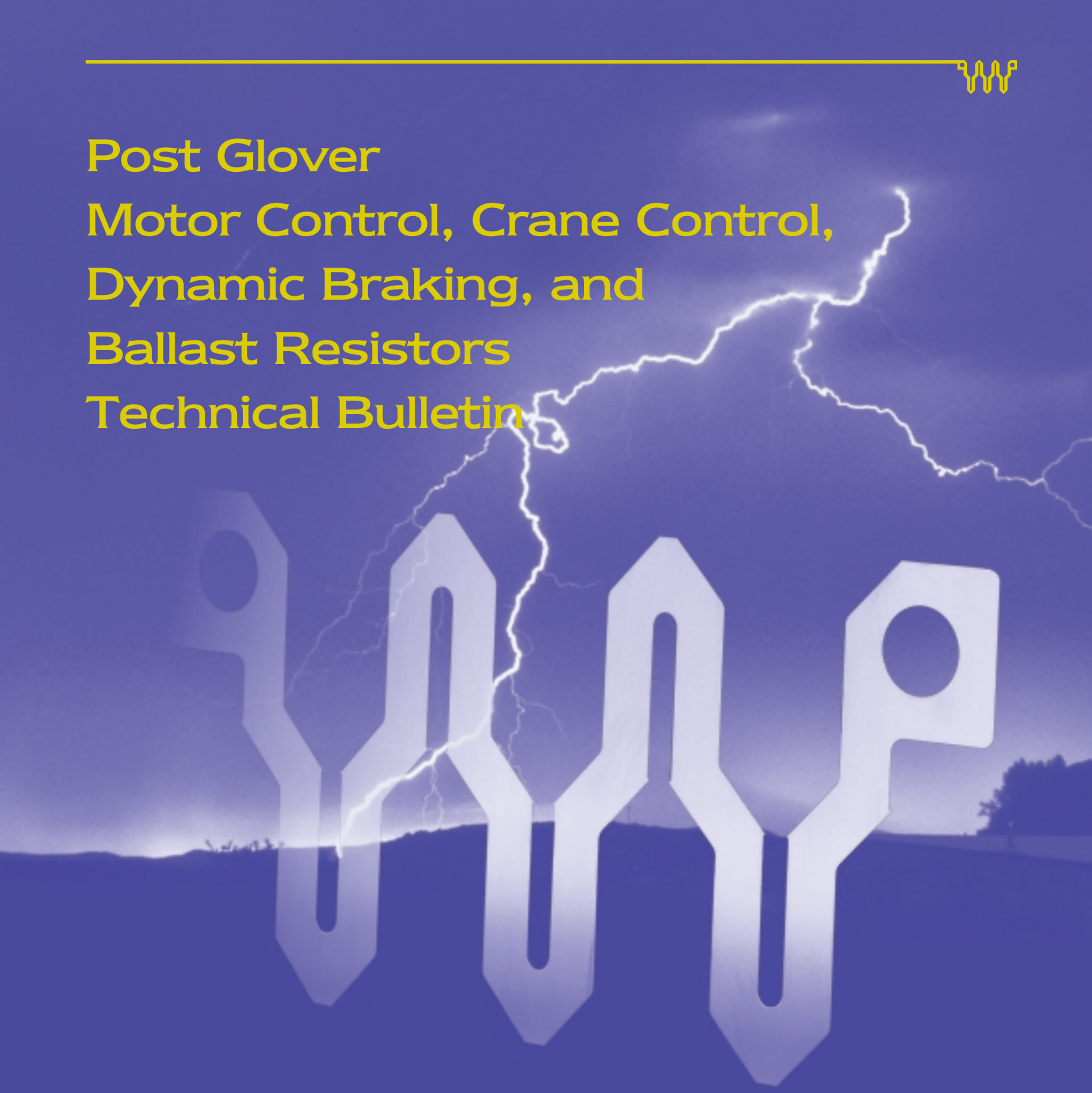
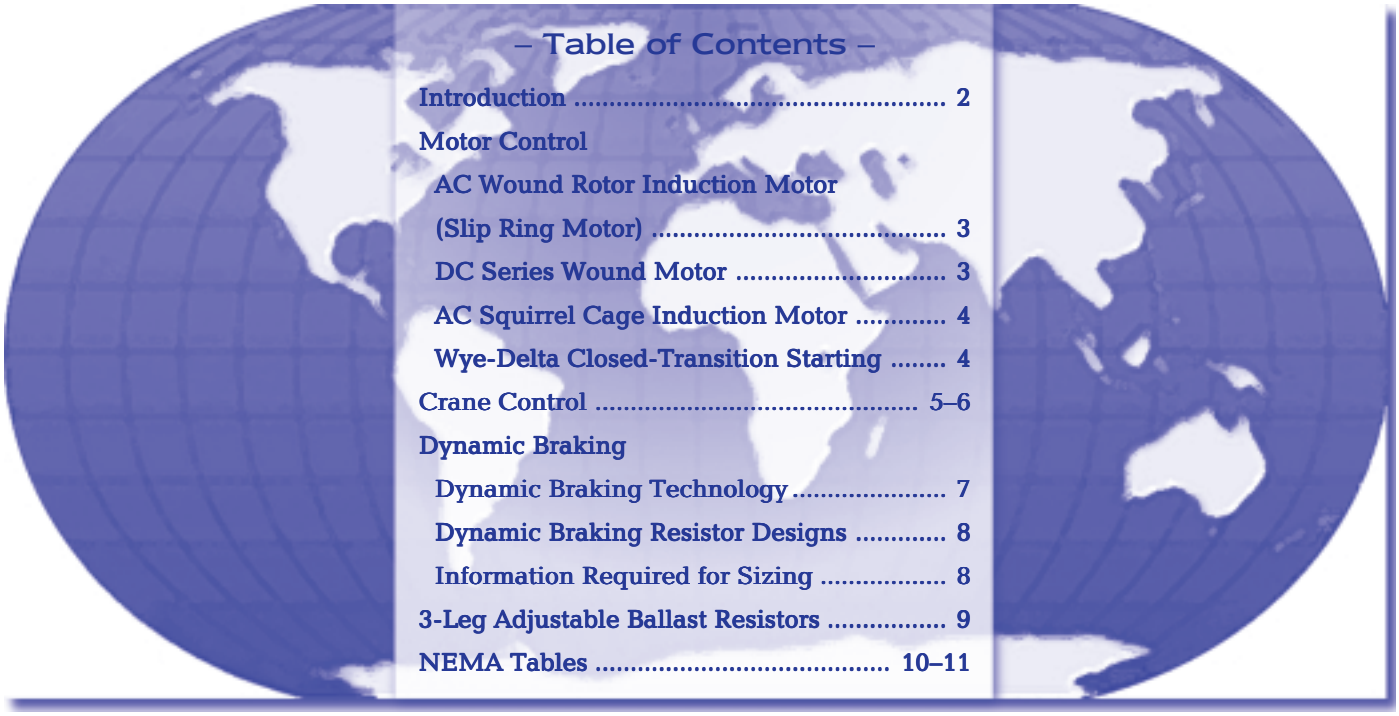
Post Glover
Motor Control, Crane Control, Dynamic Braking, and Ballast Resistors
Technical Bulletin



POST GLOVER RESISTORS INC. A HALMA GROUP COMPANY

Post Glover
Motor Control, Crane Control, Dynamic Braking, and Ballast Resistors



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Introduction

Post Glover specializes in motor control resistors—the most popular use of our resistors—for severe duty applications. Our resistors make it possible to start and stop extremely powerful electric motors—such as those on cranes, compressors, and pumps—with safety and precision.

The resistor functions to control the torque and/or speed of an electrical motor or limit the initial current inrush to an acceptable level. This is accomplished through the use of manual or magnetic controls, or with solid-state controls.

In harsh environments, such as foundries and steel mills, motors and resistors must be able to withstand "plugging"—a type of motor braking provided by reversing the voltage polarity or phase sequence so that the motor develops a counter-torque and brakes the load.

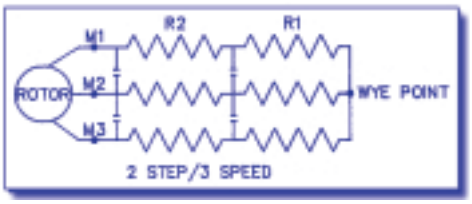
They must also withstand dynamic braking, fast acceleration of heavy loads, large amounts of dust and dirt, and occasional operator abuse. In these instances, Post Glover's stainless steel stamped grid resistors offer excellent service and cost efficiency.

The most popular uses of Post Glover resistors are control of AC wound rotor induction motors (slip ring motors), DC series wound motors, and AC squirrel cage induction motors. Our resistors are also commonly used for wye-delta closed-transition starting applications.

Motor Control

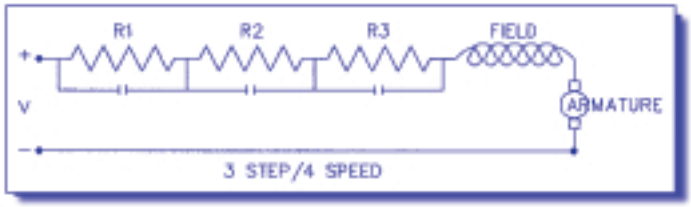
AC Wound Rotor Induction Motor (Slip Ring Motor)

The resistor is wired into the motor secondary slip rings, where it dissipates torque energy in the form of heat. It also provides "soft starting" as resistance is removed in steps.



Initial information needed for sizing your resistor:

- Application
- Horsepower
- Secondary volts
- Secondary amps
- Starting torque
- Number of speeds
- Duty/NEMA class (see tables)



Post Glover sled-mounted motor-starting resistors for the mining industry

DC Series Wound Motor

The resistor limits torque by limiting current flow to the motor. It is used for starting and stopping the motor.

Initial information needed for sizing your resistor:

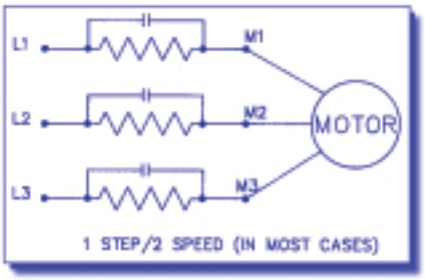
- Application
- Horsepower
- Line voltage
- Full load amps
- Starting torque
- Number of speeds
- Duty/NEMA class (see tables)
- For dynamic lowering applications, include manufacturer of control

AC Squirrel Cage Induction Motor

Commonly known as a "reduced-voltage" or "ballast" resistor, this resistor acts as a voltage divider for soft starting of the motor.

Initial information needed for sizing your resistor:

- Application
- Horsepower
- Line voltage
- Full load amps
- Duty cycle/NEMA class (see tables)

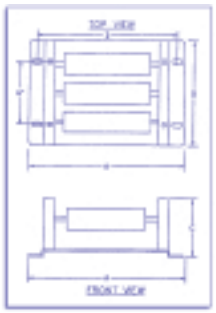


Wye-Delta Closed-Transition Starting

Wye-delta is a reduced-inrush starting method in which 3-phase motor stator coils are initially connected in a wye configuration and switched to delta as the motor's speed increases. The resistor works as a reduced-voltage starting resistor by starting a motor at 58% reduced voltage.

Initial information needed for sizing your resistor:

- Application
- Horsepower
- Line voltage
- Full load amps
- Duty/NEMA class (see tables)



For other applications, such as small horsepower motors, dynamic braking, and field discharge, please give us a call. We offer free engineering assistance to our customers for all motor control applications.

Wye-Delta Closed Transition Starting Resistors

* All units are provided with a mill galvanized louvered cover.

230 VOLTS AC*

HP	FLA	DIMENSIONS A	B	C	D	POST GLOVER P/N
1	4.2	15"	10"	6"	13.5"	YD- 10 -230
1.5	6	15"	10"	6"	13.5"	YD- 15 -230
2	6.8	15"	10"	6"	13.5"	YD- 20 -230
3	9.6	15"	10"	6"	13.5"	YD- 30 -230
5	15.2	15"	10"	6"	13.5"	YD- 50 -230
7.5	22	15"	10"	6"	13.5"	YD- 75 -230
10	28	15"	10"	6"	13.5"	YD- 100 -230
15	42	15"	10"	6"	13.5"	YD- 150 -230
20	54	15"	10"	6"	13.5"	YD- 200 -230
25	68	15"	10"	6"	13.5"	YD- 250 -230
30	80	15"	10"	6"	13.5"	YD- 300 -230
40	104	15"	10"	6"	13.5"	YD- 400 -230
50	130	15"	10"	6"	13.5"	YD- 500 -230
60	154	15"	10"	6"	13.5"	YD- 600 -230
75	192	15"	10"	6"	13.5"	YD- 750 -230
100	248	15"	10"	6"	13.5"	YD-1000 -230
125	312	15"	10"	6"	13.5"	YD-1250 -230
150	360	15"	10"	6"	13.5"	YD-1500 -230
200	480	22"	10"	6"	20.5"	YD-2000 -230
250	600	22"	10"	6"	20.5"	YD-2500 -230
300	720	22"	10"	6"	20.5"	YD-3000 -230
350	840	29.5"	10"	6"	28.0"	YD-3500 -230
400	960	22"	10"	11"	20.5"	YD-4000 -230
450	1080	22"	10"	11"	20.5"	YD-4500 -230
500	1200	22"	10"	11"	20.5"	YD-5000 -230

460 VOLTS AC*

HP	FLA	DIMENSIONS A	B	C	D	POST GLOVER P/N
1	2.1	15"	10"	6"	13.5"	YD- 10 460
1.5	3	15"	10"	6"	13.5"	YD- 15 460
2	3.4	15"	10"	6"	13.5"	YD- 20 460
3	4.8	15"	10"	6"	13.5"	YD- 30 460
5	7.6	15"	10"	6"	13.5"	YD- 50 460
7.5	11	15"	10"	6"	13.5"	YD- 75 460
10	14	15"	10"	6"	13.5"	YD- 100 460
15	21	15"	10"	6"	13.5"	YD- 150 460
20	27	15"	10"	6"	13.5"	YD- 200 460
25	34	15"	10"	6"	13.5"	YD- 250 460
30	40	15"	10"	6"	13.5"	YD- 300 460
40	52	15"	10"	6"	13.5"	YD- 400 460
50	65	15"	10"	6"	13.5"	YD- 500 460
60	77	15"	10"	6"	13.5"	YD- 600 460
75	96	15"	10"	6"	13.5"	YD- 750 460
100	124	15"	10"	6"	13.5"	YD-1000 460
125	156	15"	10"	6"	13.5"	YD-1250 460
150	180	15"	10"	6"	13.5"	YD-1500 460
200	240	22"	10"	6"	20.5"	YD-2000 460
250	300	22"	10"	6"	20.5"	YD-2500 460
300	360	22"	10"	6"	20.5"	YD-3000 460
350	420	29.5"	10"	6"	28"	YD-3500 460
400	480	29.5"	10"	6"	28"	YD-4000 460
450	540	29.5"	10"	6"	28"	YD-4500 460
500	600	29.5"	10"	6"	28"	YD-5000 460

575 VOLTS AC*

HP	FLA	DIMENSIONS A	B	C	D	POST GLOVER P/N
3	3.9	15"	10"	6"	13.5"	YD- 30 575
5	6.1	15"	10"	6"	13.5"	YD- 50 575
7.5	9	15"	10"	6"	13.5"	YD- 75 575
10	11	15"	10"	6"	13.5"	YD-100 575
15	17	15"	10"	6"	13.5"	YD-150 575
20	22	15"	10"	6"	13.5"	YD-200 575
25	27	15"	10"	6"	13.5"	YD-250 575
30	32	15"	10"	6"	13.5"	YD-300 575
40	41	15"	10"	6"	13.5"	YD-400 575
50	52	15"	10"	6"	13.5"	YD-500 575
60	62	15"	10"	6"	13.5"	YD-600 575
75	77	15"	10"	6"	13.5"	YD-750 575
100	99	15"	10"	6"	13.5"	YD-1000 575
125	125	15"	10"	6"	13.5"	YD-1250 575
150	144	15"	10"	6"	13.5"	YD-1500 575
200	192	22"	10"	6"	20.5"	YD-2000 575
250	240	22"	10"	6"	20.5"	YD-2500 575
300	288	29.5"	10"	6"	28"	YD-3000 575
350	336	29.5"	10"	6"	28"	YD-3500 575
400	384	29.5"	10"	6"	28"	YD-4000 575
450	432	29.5"	10"	6"	28"	YD-4500 575
500	480	29.5"	10"	6"	28"	YD-5000 575

Crane Control

When overhead cranes are used in industrial facilities, resistor banks are frequently used for control of hoisting and lowering speeds, as well as positioning the crane itself. Resistors are usually mounted in, or on top of, the bridge structure.

Many steel mills use DC motors because, in the past, DC power was the best way to hoist heavy loads. Newer plants are increasingly utilizing more readily available three-phase power, and wound rotor motors are often employed.

In hoisting and lowering operations, some special considerations are involved. Hoisting is straightforward—the load is resisting the motor, and positive torque against gravity is required. In lowering an empty hook, it may be necessary to drive the hook down, since gravity may be insufficient to lower it at the desired speed.

But, when the hook is loaded, the load may tend to overhaul the motor, which then may have to apply a retarding torque as if it were hoisting. Dynamic braking ensures the load won't run away and crash instead of making a soft landing.

Steel mill ore bridge using DC motor control resistors

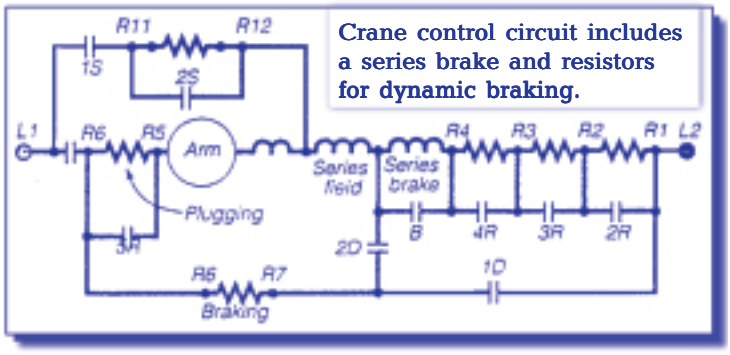
All of these conditions require modifications of the speed-torque curve of the hoist motor. This is readily achieved by applying the proper amount of external armature and field resistance.

A resistor bank is the practical device available for the purpose. Operators effect changes in motor speed with various loads and operate a bank of magnetic contactors to achieve the desired operation. The contactors change taps on the resistor banks as required to maintain appropriate rotor circuit resistance.

Post Glover's stainless steel grid resistors are an excellent choice for heavy industrial applications because of their durability and dependability in severe environments.

Initial information needed for sizing your resistor:

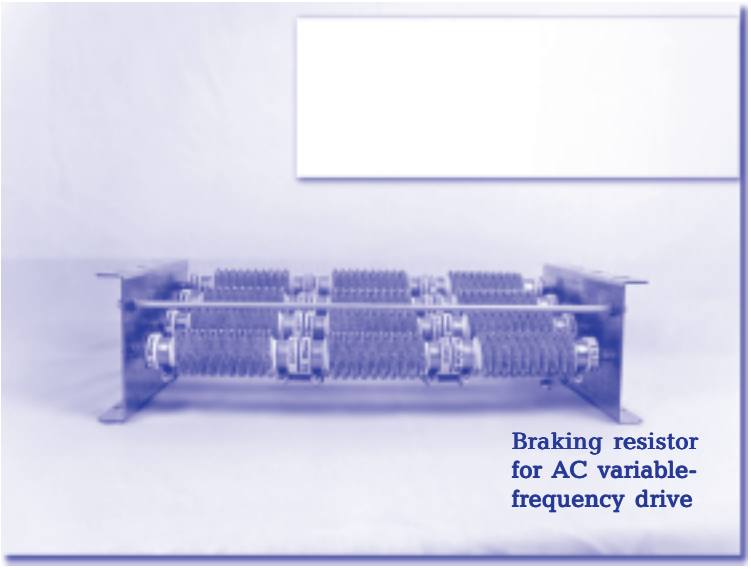
- Application
- Horsepower
- Line voltage
- Full load amps
- Starting torque
- Number of speeds
- Duty/NEMA class (see tables)
- For dynamic lowering applications, include maufacturer of control package.



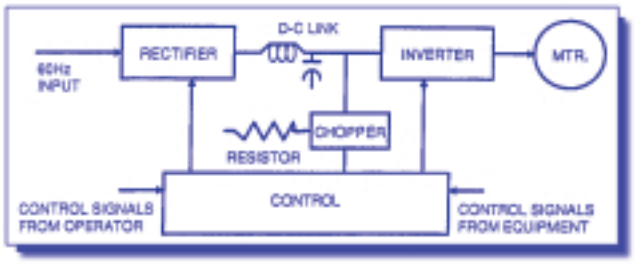
Crane control circuit includes a series brake and resistors for dynamic braking.

Dynamic Braking

Dynamic braking resistors are used on AC variable frequency drives (VFDs) to dissipate energy that is produced in the motor as the drive provides braking torque to stop the motor. The resistors are either used alone for decelerating or in conjunction with compressed-air brakes for stopping. The excitation voltage of the traction motors generally comes from a static converter powered by the overhead catenary and operates as a DC voltage transformer.

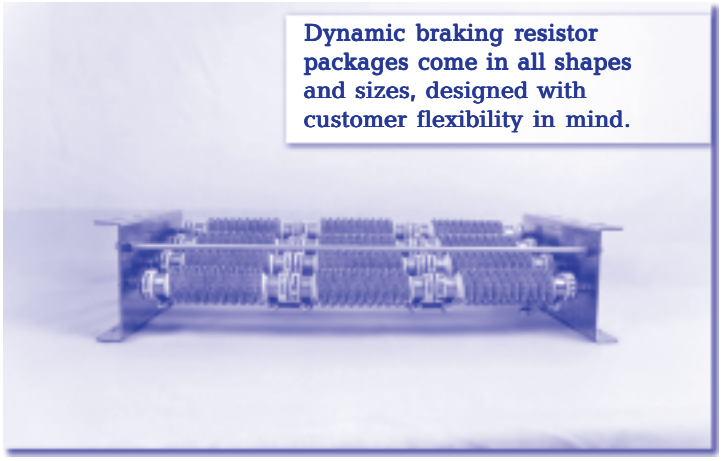


Braking resistor for AC variable-frequency drive



Dynamic Braking Technology

Resistors integrated into the power unit dissipate electrical energy created by electric braking systems. The dynamic braking resistor is connected to the DC bus and will see voltages as high as 800 volts during braking conditions.



Dynamic braking resistor packages come in all shapes and sizes, designed with customer flexibility in mind.

The drive manufacturer normally determines the power rating (watts) needed to prevent overheating during braking duty. The peak braking current is determined by the specified resistance value. Each drive manufacturer specifies a resistance range with a minimum to prevent overcurrent and damage to the drive and a maximum value to give adequate lower dissipation capability.

A three-phase variable frequency drive (VFD) consists of three basic components—rectifier, DC line, and inverter—and a control system to manage these three components as illustrated above. The rectifier converts the three-phase 60Hz AC input to a DC signal.

Depending on the system, an inductor, a capacitor, or combination of these components smoothes the DC signal (reduces voltage ripple) in the DC link part of the VFD. The inverter circuit converts the DC signal into a variable frequency AC voltage to control the speed of the induction motor.

During braking, the VFD ramps the frequency to zero. The rotational energy of the motor and load are driven back through the inverter to the DC bus and the rotational energy is dissipated through the resistor.

Dynamic Braking Resistor Designs

Our LC wirewound resistors are used for most dynamic braking applications. These are conveniently provided on L-shaped mounting brackets or in standard enclosures with louvered or screened covers. For slightly higher wattage applications, our EW-style edgewound resistor is proven highly efficient.

For heavy duty applications that require even higher wattage, we recommend Post Glover stainless steel stamped grid resistor elements. The stamped grid design was developed and patented by Post Glover over 60 years ago and is used around the world for severe-duty applications.

Information Required for Sizing

Three factors must be known for sizing your resistor:

1. Ohms
2. Watts
3. Braking cycle (time on/time off)
4. Drive manufacturer

Ohms are determined by the drive manufacturer and are usually stated as a range or a minimum value.

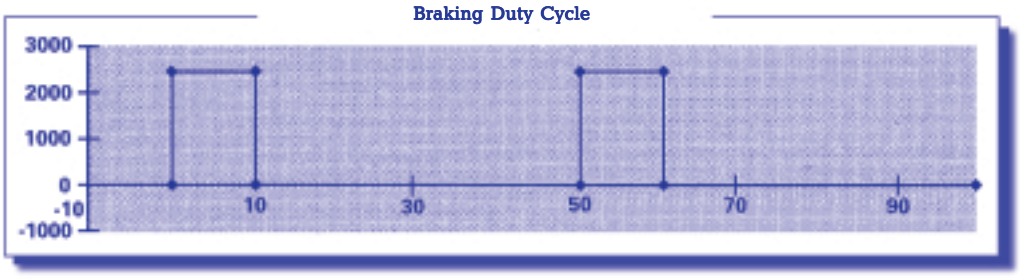
Watts are stated as either a maximum braking power or continuous braking power. In either case, the wattage rating of the resistor is calculated by the braking cycle.

Braking cycle is usually stated as a percentage; however, the actual times on and off are required to offer the optional resistor package while minimizing the size and cost.

Example

An application requires a braking resistor rated 25 ohms with an average power during braking of 2500 watts. The duty cycle is 20%—10 seconds on and 40 seconds off—with a cycle time of 50 seconds.

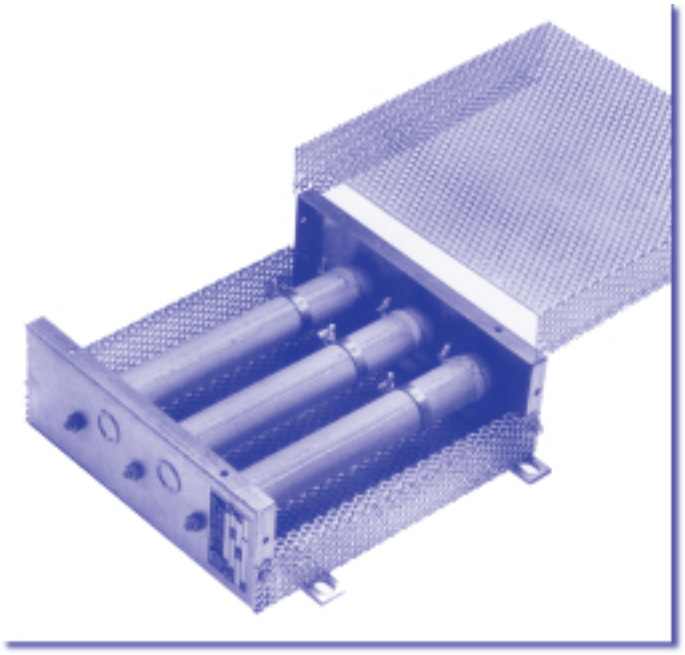
The ohmic value of the resistor is typically between -0% and +5%—therefore, 25.0–26.25 ohms.

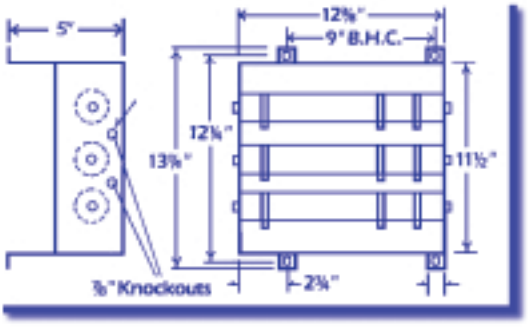


3-Leg Adjustable Ballast Resistors

3-Leg adjustable ballast resistors are used with small horsepower, typically 1/4 to 5 HP, squirrel-cage induction motors for soft strating, reduced speed or two speed control of small cranes. Additional ratings up to 10 horsepower are available.

These resistors are factory set for 70% reduced voltage (50% of normal starting torque) and are available for 230, 460 and 575 volts AC.





Construction

These units consist of three smoothwound adjustable resistors in a ventilated, wall-mount enclosure. Knockouts are provided on both ends for convenient and fast wiring. A removable front cover provides easy access to coils for adjusting the starting torque or speed.

3-LEG ADJUSTABLE BALLAST RESISTORS

Part Number	Horsepower	Ohms‡	Cont. Amps*
230 VAC			
BR-14-230	1/4	46.5	1.4
BR-13-230	1/3	46.5	1.8
BR- 1 2-230	1/2	19.8	2.1
BR-34-230	3/4	15.2	2.8
BR-100-230	1	10.0	3.5
BR-150-230	1 1/2	7.5	4.8
BR-200-230	2	5.5	6.3
BR-300-230	3	3.8	9.0
BR-500-230	5	2.7	14.0
460 VAC			
BR-14-460	1/4	150.0	.7
BR-13-460	1/3	150.0	.9
BR-12-460	1/2	68.0	1.0
BR-34-460	3/4	48.0	1.4
BR-100-460	1	39.0	1.7
BR-150-460	1 1/2	28.0	2.4
BR-200-460	2	19.5	3.2
BR-300-460	3	16.8	4.5
BR-500-460	5	12.4	7.0
575 VAC			
BR-12-575	1/2	106.0	.8
BR-34-575	3/4	75.0	1.1
BR-100-575	1	62.7	1.4
BR-150-575	1 1/2	46.2	1.9
BR-200-575	2	32.5	2.5
BR-300-575	3	23.7	3.5
BR-500-575	5	17.5	5.6

* Continuous Amp capacity at 375° rise.
‡ Resistance in Ohms at 25°C.

NEMA Classification of Resistors

Table of Classification of Resistors

CLASS NUMBERS APPLYING TO DUTY CYCLES

Apprux. Per Cent of Full Load Current on First Point	30 Sec. on Out of Each 15 Min.	5 Sec. on Out of Each 80 Sec.	10 Sec. on Out of Each 80 Sec.	15 Sec. on Out of Each 90 Sec.	15 Sec. on Out of Each 60 Sec.	15 Sec. on Out of Each 45 Sec.	15 Sec. on Out of Each 30 Sec.	Continuous Duty
25	101	111	131	141	151	161	171	91
50	102	112	132	142	152	162	172	92
70	103	113	133	143	153	163	173	93
100	104	114	134	144	154	164	174	94
150	105	115	135	145	155	165	175	95
200 or over	106	116	136	146	156	166	176	96

When an armature shunt resistor is added, the class number shall include the Suffix-AS. Example: Class 155-AS is a resistor which includes an armature shunt and which will allow an initial inrush of 150 percent with the armature shunt open. When a dynamic braking resistor is added, the class number shall include the suffix-DB.

The following table is intended as a guide in the specifying or designing of resistors. The classifications are those that experience has shown to be correct for the average installation. There will, however, be exceptions. This table is applicable to nonbreakable steel grid resistors, provided that the time-on period does not exceed the values given in the Table of Classification of Resistors.

NEMA Resistor Application Table

Installation	Resistance Class Number
BLOWERS	
Centrifugal	133-93
Constant Pressure	135-95
BRICK PLANTS	
Augers	135
Conveyors	135
Dry Pans	135
Pug Mills	135
BY-PRODUCT COKE PLANTS	
Door Machine	153
Leveler Ram	153
Pusher Bar	153
Valve Reverating Machine	153
CEMENT MILLS	
Conveyors	135
Crushers	145
Elevators	135
Rolary Dryers	145-95
Grinders and Pulverizers	135
Kilns	135-95
COAL AND ORE BRIDGES	
Bridge	153
Closing	162
Holding	162
Trolley	163
COAL MINES	
Car Hauls	162
Conveyors	135-55
Cutters	135
Crushers	145
Fans	134-93
Hoists–	
Slope	172
Vertical	162
Jigs	135
Picking Tables	135
Rotary Car Dumpers	153
Shaker Screens	135
COMPRESSORS	
Constant Speed	135
Varying Speed–	
Centrifugal	93
Plunger Type	95
CONCRETE MIXERS	135
CRANES	
Hoist	153-163
Bridge or Trolley with	
Roller Bearings	152-162
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Gas Valves	155
Gas Washers	155
Hot Metal Mixers	163
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Kickoff	153
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Pickling Machine	153
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Roller Bearings	152
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FLOUR MILLS	
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FOOD PLANTS	
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HOISTS	
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Bending Rolls	163-164
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Gear Cutters	115
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Hobbing Machines	115
Lathes	115
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Presses	135
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Saws	115
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METAL MINING	
Ball, Rod and Tube Mills	135
Car Dumpers–Rotary	153
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Conveyors	135
Crushers	145
Tilting Furnace	153
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Beaters	135
Calenders	154-92
PIPEWORKING	
Cutting and Threading	135
Expanding and Flanging	135-95
POWER PLANTS	
Clinker Grinders	135
Coal Crushers	135
Conveyors–	
Belt	135
Screw	135
Pulverized Fuel Feeders	135
Pulverizers–	
Ball Type	135
Centrifugal	134
Stokers	135-93
PUMPS	
Centrifugal	134-93
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Converters Metal	154
Conveyors	135-155
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Boring Machine	115
Lathe	115
Mortiser	115
Moulder	115
Planers	115
Power Trimmer and Mitre	115
Sanders	115
Saws	115
Shapers	115
Shingle Machine	115

Post Glover makes hundreds of designs of motor control, crane control, dynamic braking, and ballast resistors. For the best value and maximum performance from your resistors, consult with one of our resistor engineering design consultants about your application. Knowledgeable solutions have made Post Glover a leader in heavy-duty resistors, worldwide.

Post Glover: Heavy-Duty Resistors for Tough Applications

- Neutral Grounding Resistors
- High Resistance Grounding Systems
- Harmonic Filtering
- Load Banks
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