Motor Control Applications

INTRODUCTION

Motor control is one of the most common applications of power resistors. Resistors are used to control the torque and speed characteristics of AC and DC motors, and to limit inrush currents.

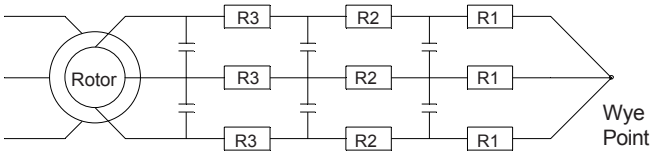
This section provides a basic understanding of how resistors are used for motor control, and the information required to design a resistor configuration. To order a resistor assembly, simply obtain the data needed for your motor type and call the factory. Our engineers will design a package that best suits your needs.

AC WOUND ROTOR INDUCTION MOTOR

In wound rotor motors, the conductors in the rotor (or secondary) are connected to slip rings. The internal brushes make electrical contact with the slip rings and are connected to an external resistor circuit. By varying the external resistance, the rotor current can be changed to control the starting torque and speed of the motor to meet the requirements of any installation.

Data Requirements:

- Application
- Horsepower
- Secondary Volts
- Secondary Amps
- NEMA Class
- Number of Speeds



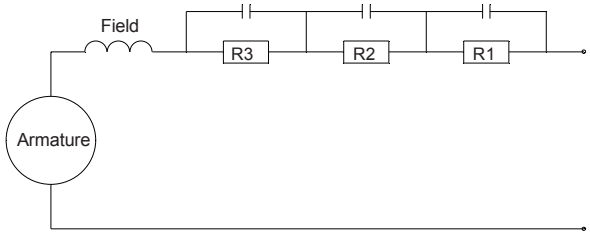
Typical Resistor Control Schematic for an AC Wound Rotor Motor 3 Step/ 4 Speed

DC SERIES WOUND MOTOR

Conductor current in DC motors is produced by an applied voltage to the armature coils (in DC motors the rotating part is called the armature, in AC motors it is called the rotor). Resistors are used to limit the current flow to the motor to control torque and speed characteristics.

Data Requirements:

- Application
- Horsepower
- Normal Line Voltage
- Full Load Amps
- NEMA Class
- Number of Speeds



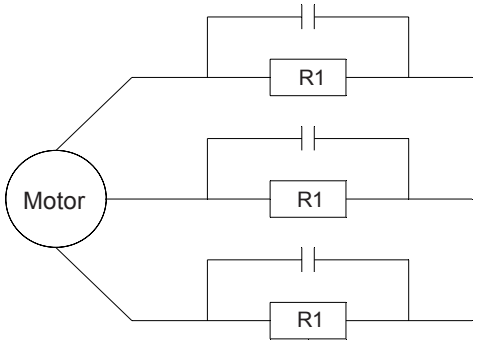
Typical Resistor Control Schematic for a DC Series Wound Motor 3 Step/ 4 Speed

AC SQUIRREL CAGE MOTOR

In squirrel cage motors, the conductors in the rotor slots are shorted at the ends. Therefore, the resistance of the conductors is fixed and cannot be changed. However, resistors can be connected in-line with the motor to reduce the starting voltage. During the acceleration period at the moment a motor is started, it draws a high "inrush" current. Resistors can be used to reduce the full line, starting voltage applied to the motor. Commonly known as a ballast resistor, the resistor acts as a voltage divider and reduces the inrush current, providing a "soft start." Standard designs for small horsepower motors can be found on the following page.

Data Requirements:

- Application
- Horsepower
- Normal Line Voltage
- Full Load Amps
- NEMA Class



Typical Resistor Control Schematic for an AC Squirrel Cage Motor

POWEROHM RESISTORS, INC.

5713 13th Street
Katy, Texas 77493
Phone: (281) 391-6800, Fax: (281) 391-6810
Please visit our website at www.powerohm.com

Standard Motor Control Designs

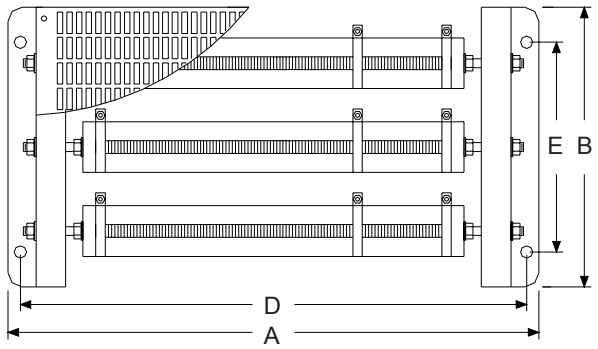
The following table contains standard designs for three-phase adjustable ballast resistors. Contact the factory for information on motors not listed in the table.

3-PHASE ADJUSTABLE BALLASTS FOR SMALL SQUIRREL CAGE MOTORS

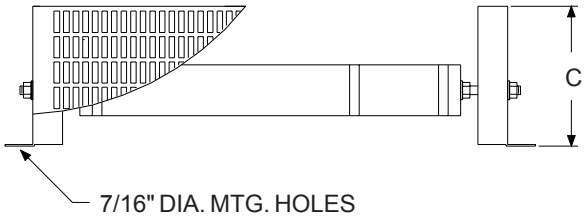
CATALOG NUMBER	MOTOR H.P.	MOTOR AMPS	OHMS PER PHASE	DIMENSIONS IN INCHES				
				A	B	C	D	E
230 VOLTS								
BR230-50	1/2	2.0	19.9	12	10	5	11-1/8	7-1/2
BR230-75	3/4	2.8	14.2	12	10	5	11-1/8	7-1/2
BR230-100	1	3.6	11.1	12	10	5	11-1/8	7-1/2
BR230-150	1-1/2	5.2	7.7	12	10	5	11-1/8	7-1/2
BR230-200	2	6.8	5.9	12	10	5	11-1/8	7-1/2
BR230-300	3	9.6	4.1	12	10	5	11-1/8	7-1/2
BR230-500	5	15.2	2.6	19	10	5	18-1/8	7-1/2
BR230-750	7-1/2	22.0	1.8	19	10	5	18-1/8	7-1/2
BR230-1000	10	28.0	1.4	19	10	5	18-1/8	7-1/2
460 VOLTS								
BR460-50	1/2	1.0	79.9	12	10	5	11-1/8	7-1/2
BR460-75	3/4	1.4	56.9	12	10	5	11-1/8	7-1/2
BR460-100	1	1.8	44.3	12	10	5	11-1/8	7-1/2
BR460-150	1-1/2	2.6	30.6	12	10	5	11-1/8	7-1/2
BR460-200	2	3.4	23.4	12	10	5	11-1/8	7-1/2
BR460-300	3	4.8	16.6	12	10	5	11-1/8	7-1/2
BR460-500	5	7.6	10.5	19	10	5	18-1/8	7-1/2
BR460-750	7-1/2	11.0	7.2	19	10	5	18-1/8	7-1/2
BR460-1000	10	14.0	5.7	19	10	5	18-1/8	7-1/2
575 VOLTS								
BR575-50	1/2	0.8	124.5	12	10	5	11-1/8	7-1/2
BR575-75	3/4	1.1	90.5	12	10	5	11-1/8	7-1/2
BR575-100	1	1.4	71.1	12	10	5	11-1/8	7-1/2
BR575-150	1-1/2	2.1	47.4	12	10	5	11-1/8	7-1/2
BR575-200	2	2.7	36.9	12	10	5	11-1/8	7-1/2
BR575-300	3	3.9	25.5	12	10	5	11-1/8	7-1/2
BR575-500	5	6.1	16.3	19	10	5	18-1/8	7-1/2
BR575-750	7-1/2	9.0	11.1	19	10	5	18-1/8	7-1/2
BR575-1000	10	11.0	9.1	19	10	5	18-1/8	7-1/2

CONSTRUCTION: Powerohm's three-phase adjustable ballast resistors feature our quality resistor elements assembled in our GLE enclosures. Our durable GLE enclosures have a mill galvanized finish. Contact the factory for special space constraints, etc.

TOP VIEW



FRONT VIEW



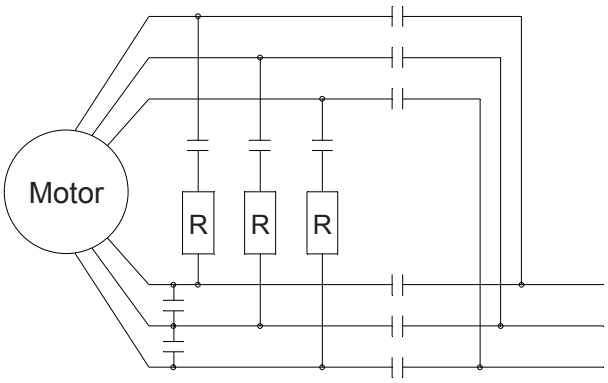
Standard Motor Control Designs

WYE-DELTA STARTING RESISTORS

WYE-DELTA TYPE STARTERS (CLOSED TRANSITION): In the case of a wye-delta closed transition type starter, a set of resistors is connected to the motor winding before the delta contactor is closed. These resistors are used to balance the back EMF of the motor and the line voltage before closing the delta contactor. Closed transition eliminates the surge current that occurs when transferring the motor from wye to delta connection, thus providing a smoother acceleration of the motor from reduced voltage to full voltage.

Data Requirements:

- Horsepower
- Normal Line Voltage
- Full Load Amps



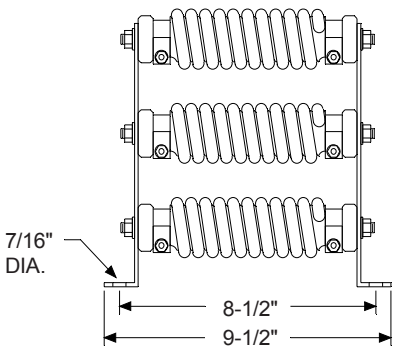
Typical Control Schematic for a Wye-Delta Starter (Closed Transition)

RESISTOR DESIGNS FOR WYE-DELTA STARTERS (CLOSED TRANSITION)

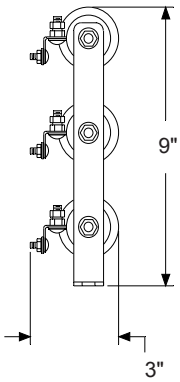
CATALOG NUMBER	MOTOR H.P.	MOTOR AMPS	OHMS PER PHASE	CATALOG NUMBER	MOTOR H.P.	MOTOR AMPS	OHMS PER PHASE
230 VOLTS				380 VOLTS			
WD230-10	10	28	4.70	WD380-10	10	17	13.00
WD230-15	15	42	3.20	WD380-15	15	25	8.60
WD230-20	20	54	2.50	WD380-20	20	33	6.70
WD230-25	25	68	1.90	WD380-25	25	41	5.30
WD230-30	30	80	1.70	WD380-30	30	48	4.50
WD230-40	40	104	1.30	WD380-40	40	63	3.50
WD230-50	50	130	1.00	WD380-50	50	79	2.80
WD230-60	60	154	0.85	WD380-60	60	93	2.40
WD230-75	75	192	0.70	WD380-75	75	116	1.90
WD230-100	100	248	0.55	WD380-100	100	150	1.50
460 VOLTS				575 VOLTS			
WD460-10	10	14	19.00	WD575-10	10	11	30.00
WD460-15	15	21	12.70	WD575-15	15	17	19.50
WD460-20	20	27	9.90	WD575-20	20	22	15.00
WD460-25	25	34	7.80	WD575-25	25	27	12.30
WD460-30	30	40	6.60	WD575-30	30	32	10.40
WD460-40	40	52	5.10	WD575-40	40	41	8.10
WD460-50	50	65	4.00	WD575-50	50	52	6.40
WD460-60	60	77	3.50	WD575-60	60	62	5.40
WD460-75	75	96	2.80	WD575-75	75	77	4.30
WD460-100	100	124	2.10	WD575-100	100	99	3.40

CONSTRUCTION: For most applications, the resistors are mounted in the upper section of the motor control cabinet. Therefore, all of the above standard designs consist of three WR Type resistor coils mounted on open style Type B3 brackets. These brackets have a mill galvanized finish.

FRONT VIEW



SIDE VIEW



NEMA Standards for Motor Control Resistors

The following table is for selecting the NEMA Class for an application in relation to starting torque and duty cycle.

NEMA CLASSIFICATION OF RESISTORS

Approximate Percent of Full-Load Current on First Point Starting @ Rest	CLASS NUMBERS APPLYING TO DUTY CYCLES							
	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

The following table contains standard NEMA Classification Numbers for a variety of applications. Although these classification numbers have been found to be correct for an average installation, there will be exceptions.

NEMA RESISTOR APPLICATION STANDARDS

APPLICATION	NEMA CLASS
Blowers	
Centrifugal	133 - 93
Constant Pressure	135 - 95
Brick Plants	
Augers, Conveyors, Dry Pans, Pug Mills	135
By-product Coke Plants	
Door Machine, Leveler Ram	153
Pusher Bar, Valve Reversing Machines	
Cement Mills	
Conveyors	135
Crushers	145
Elevators	135
Rotary Dryers	145-95
Grinders and Pulverizers	135
Kilns	135-95
Coal and Ore Bridges	
Bridge	153
Closing, Holding	162
Trolley	162 or 163
Coal Mines	
Car Hauls	162
Conveyors	135 or 155
Cutters	135
Crushers	145
Fans	134 or 95
Hoists	
Slope	172
Vertical	162
Jigs, 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-General Purpose	
Hoist	153 - 163
Bridge or Trolley with	
Sleeve Bearings	153-163
Roller Bearings	152-162
Flour Mills	
Line Shafting	135

APPLICATION	NEMA CLASS
Food Plants	
Butter Churns, Dough Mixer	135
Hoists	
Winch	153
Mine Slope	172
Mine Vertical	162
Contractor's Hoists	152
Larry Cars	153
Lift Bridges	152
Machine Tools	
Bending Rolls	163 or 164
Boring Mills	135
Bulldozers	135
Drills, Gear Cutters	115
Grinders	135
Hobbing Machines, Lathes	115
Milling Machines	
Presses, Punches	135
Saws, Shapers	115
Metal Mining	
Ball, Rod and Tube Mills	135
Car Dumpers-Rotary	153
Converters-Copper	154
Conveyors	135
Crushers	145
Tilting Furnace	153
Paper Mills	
Beaters	135
Calenders	154 - 92
Chippers	145
Pipeworking	
Cutting and Threading	135
Expanding and Flanging	135-95
Power Plants	
Clinker Grinders	135
Coal Crushers	135
Conveyors	
Belt, Screw	135
Pulverized Fuel Feeders	135
Pulverizers	
Ball Type	135
Centrifugal	134
Stokers	135 - 93
Pumps	
Centrifugal	134 - 93
Plunger	135 - 95

APPLICATION	NEMA CLASS
Rubber Mills	
Banbury, Crackers	135
Calenders	155
Mixing Mills, Washers	135
Steel Mills	
Accummulators	153
Casting Machines-Pig,	153
Charging Machines	
Bridge	153 or 163
Peel	153 or 163
Trolley	153 or 163
Coiling Machines	135
Converters-Metal	154
Conveyors	135-155
Crushers	145
Furnace Door, Gas Valves, Gas Washers	155
Hot Metal Mixers	163
Ingot Buggy, Kickoff, Levelers	153
Manipulator Fingers	153 or 163
Pickling Machine, Pilars-Slab, Racks	153
Reelers	135
Saws-Hot or Cold	155
Screw Downs	153 or 163
Shears, Shuffle Bars	155
Side Guards	153 or 163
Sizing Rolls, Slab Buggy, Soaking Pit Covers	155
Straighteners	153
Tables	
Approach	153
Lift	153 or 163
Main Roll	153 or 163
Roll	153
Shear Approach	153 or 163
Transfer	153
Tilting Furnace	153
Wire Stranding Machine	153
Woodworking Plants	
Boring Machines, Lathe, Mortiser, Moulder, Planers, Power Trimmer and Mitre, Sanders, Saws, Shapers, Shingle Machine	115