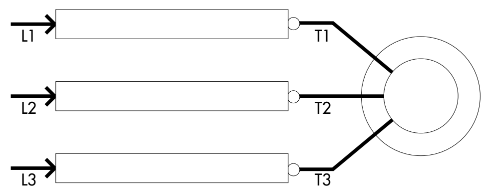
Application Information

Squirrel Cage Motor Starting

NEMA B or NEMA D w/ Ballast Resistors

Hubbell ballast resistors provide an economical and reliable means to limit the starting torque of AC squirrel cage motors. The resistors are designed to remain in the motor circuit permanently, thus eliminating costly accelerating contactors. Standard ballast resistors are designed for use with either NEMA design B or D squirrel cage motors rated 230 or 460 VAC. The NEMA B design resistors are available to limit the motor starting torque to either 70% or 100% of full load starting torque. The NEMA D resistors are set for 150% full load starting torque, field adjustable to 100%.

If special motors or torque limitations are required consult factory and provide motor hp, voltage, locked rotor current, locked rotor power factor and desired torque limit.

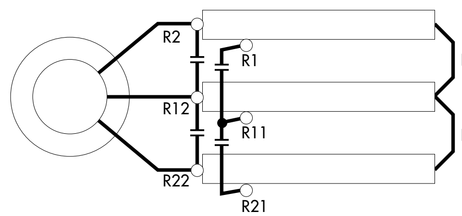


Wound Rotor Motor Starting

Three Speed w/o Permanent Slip Resistance

Step	Res. %	NEMA Class – Capacity % FLC			
	E/I	*152*	*162*	*172*	*92*
1	78	27	30	36	47
2	27.5	47	60	75	100

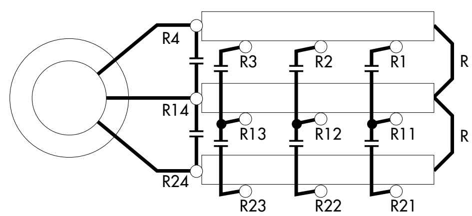
Resistors with permanent slip will have 6.5% permanent slip resistance.



Five Speed w/o Permanent Slip Resistance

Step	Res. %	NEMA Class – Capacity % FLC			
	E/I	*152*	*162*	*172*	*92*
1	*77*	*27*	*30*	*36*	*47*
2	20	40	45	54	70
3	*7*	46	52	62	81
4	6.5	*57*	65	*77*	100

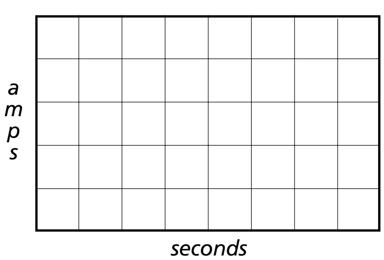
Resistors with permanent slip will have 6.5% permanent slip resistance.



Dynamic Braking

Dynamic Braking resistors are used with AC variable frequency inverter drives or DC adjustable voltage drives. The resistor provides braking torque in the motor to quickly stop the equipment. To determine your needs for this type of application, please complete the following information.

Optional Pulse Waveform



Style Required

- ☐ Best Fit
- ☐ SSR
- ☐ K
- ☐ HHC
- ☐ SSRM (Mill Frame)

Covers Required

- ☐ Open
- ☐ Open with provision for covers
- ☐ Screen
- ☐ Ventilated weatherproof
- ☐ Totally enclosed non-ventilated

Electrical Requirements

Ohms ____________________

Pulse Amps ___________ RMS Pulse Time _________ sec.

Pulse Cycle Rate ______ per______ **or** Off Time __________ sec.

Min Continuous__________amp‡ **or** ______watts‡

Allowable temperature rise if other than 375°C ________°C

‡ Optional, or if other than determined by pulse dissipation.

Resistor Design Information

Hubbell resistors are used on any AC or DC power or control circuit. The resistors are corrosion resistant and built to work in severe environments. Hubbell Resistors can be used on high vibration applications such as traveling cranes or other movable equipment.

Hubbell resistors are manufactured with a resistance tolerance of ±10%. For most applications the coefficient of resistivity has a negligible effect and can be ignored.

Resistors are rated in accordance with NEMA and IEEE standards. Wattage ratings are based upon the assumption that the resistor is operating in free air at altitudes of <6000 feet and at a temperature rise not to exceed 375°C (675°F) in a 40°C (104°F) ambient.

It takes a few steps to properly select the correct Hubbell resistor for a given application:

1. Determine resistance in ohms.
2. Determine the power in watts to be dissipated by the resistor.
3. Determine the proper size resistor — SSR (length 3, 4, 5, 6, 7), K or HHC — based on volts, current, ohms, watts, altitude, grouping, circuit conditions.
4. Select the most suitable unit and the desired mounting.

Determine Resistance in Ohms

a. The resistance can be determined by Ohm's Law

$$\mathbf{R} \textit{ in ohms} = \frac{\mathbf{E} \textit{ in volts}}{\mathbf{I} \textit{ in amperes}}$$

b. This formula can be used to determine the required current if the voltage and resistance are known.

$$\mathbf{I} = \frac{\mathbf{E}}{\mathbf{R}}$$

c. In addition, E = IR

Determine Power in Watts to be Dissipated

Power can be determined from several formulas all of which derive from Ohm's Law.

a. When resistance and current are known,

$$\mathbf{P} \textit{ in watts} = \mathbf{I^2R}$$

b. When resistance and voltage are known,

$$\mathbf{P} \textit{ in watts} = \frac{\mathbf{E^2} \textit{ in volts}}{\mathbf{R} \textit{ in ohms}}$$

c. When current and voltage across the resistor are known,

$$\mathbf{P} \textit{ in watts} = \mathbf{IE}$$

In all cases, current is in amperes and voltage is in volts.

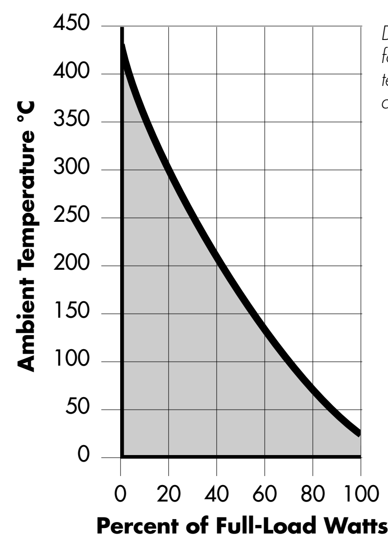
Determine proper size resistor based on volts, current, ohms, watts, altitude, grouping, circuit conditions.

The previous discussion has assumed that a single resistor was to be used within its voltage ratings, with power applied continuously and that it was located in free air at 40°C at sea level. The following takes into account variations of these factors. For further help contact the factory directly.

a. Hubbell resistors are designed for a maximum of 600 volts (except Z length HHC coils are rated 1000 volts) between terminals. For higher voltages connect two or more resistor units in series so voltage drop across any one resistor unit is 600 volts or less.

b. Altitude — For applications at altitudes up to 6000 feet, the listed ratings are applicable. Between 6000–15000 feet derate to 75% of the standard watt ratings, or derate to 86% of the current rating.

c. Ambient Temperature — For ambient temperatures above 40°C, derate resistors in accordance with chart below.



Derating curve for ambient temperatures above 40°C

NEMA Class Rating

Class Numbers of Resistors for Nonreversing Service and Reversing Nonplugging Service Without Armature Shunt or Dynamic Braking

Approximate Percent of Full-Load Current on First Point Starting From Rest	Duty Cycles						
	5 Seconds On 75 Seconds Off	*10 Seconds On 70 Seconds Off*	*15 Seconds On 75 Seconds Off*	*15 Seconds On 45 Seconds Off*	*15 Seconds On 30 Seconds Off*	*15 Seconds On 15 Seconds Off*	*Continuous Duty*
25	111	131	141	151	161	171	91
50	112	132	142	152	162	172	92
70	113	133	143	153	163	173	93
100	114	134	144	154	164	174	94
150	115	135	145	155	165	175	95
200+	116	136	146	156	166	176	96

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

Class Numbers of Resistors for Continuous Duty Speed Regulating Services with Direct Current Shunt Motors and AC Wound Rotor Motors

Percent Speed Reduction	Percent of Rated Motor Torque at Reduced Speed						
	40	*50*	*60*	*70*	*80*	*90*	*100*
5	405	505	605	705	805	905	1005
10	410	510	610	710	810	910	1010
15	415	515	615	715	815	915	1015
20	420	520	620	720	820	920	1020
25	425	525	625	725	825	925	1025
30	430	530	630	730	830	930	1030
35	435	535	635	735	835	935	1035
40	440	540	640	740	840	940	1040
45	445	545	645	745	845	945	1045
50	450	550	650	750	850	950	1050

The stability of the motor speed obtained by simple rheostatic control is dependent upon the stability of the load on the motor. The degree of instability is directly proportional to the amount of speed reduction. Variations in load have a greater proportional effect on the speed when the load is light. For these reasons, the table has not been carried beyond a speed reduction of 50% and a load torque of 40%.

With a direct current shunt motor, the percent of rated motor current which obtained at the reduced speed is assumed to be the same as the percent of rated torque. With a direct current series motor operating at less than 100% current, the percent of torque is less than the percent of current. With a wound rotor motor and resistor in the motor circuit, the percent of rated rotor (secondary) current which is obtained at the reduced speed is assumed to be the same as the percent of rated torque.

A speed regulating resistor is so designed that it may be operated continuously at any point in the speed regulating range when the load follows its normal speed-torque curve. When additional resistance is required to obtain the starting current specified, the additional portion of the resistor shall be designed for a duty cycle selected from the table above. The resulting resistor may be completely specified by a compound number. For example, 154/850 designates a resistor which is designed for starting and speed regulating duty. The starting section is designed to allow 100% of full-load current on the first point, starting from rest, and a duty cycle of 15 seconds on and 45 seconds off. The regulating section is designed to give 50% speed reduction at 80% of rated torque and for continuous duty when the load follows its normal speed-torque curve.

When used for reversing plugging service add the suffix "P". For example, 162-P. The class numbers apply to the complete resistor, but the duty cycles apply to the accelerating resistor only. Reversing plugging service is not recommended with Class 11x, 13x or 14x.

When used for DC dynamic lowering service add the suffix "DL". For example, 162-DL. Dynamic lowering service is not recommended with Class 11x, 13x or 14x.

Resistor NEMA Class Ratings

Type SSR Resistors

Continuous Amps	NEMA Class Ampere Ratings 90	170	160	150	140	130	110
11	11.0	14.7	17.3	19.6	23.1	26.0	35.0
12	12.0	16.1	18.8	21.4	25.2	28.4	38.1
12.5	12.5	16.7	19.6	22.2	26.2	29.6	39.6
13	13.0	17.4	20.4	23.1	27.3	30.8	41.3
15	15.0	20.1	23.5	26.7	31.5	35.5	47.7
16	16.0	21.2	25.1	28.5	33.6	37.9	50.8
18	18.0	23.1	28.2	32.0	37.8	42.6	57.3
20	20.0	26.8	31.4	35.6	42.0	47.4	63.6
22	22.0	29.5	34.5	39.2	46.2	52.0	70.0
24	24.0	32.2	37.7	42.7	50.4	56.8	76.3
27	27.0	36.2	42.4	49.8	56.7	64.0	85.8
30	30.0	40.2	47.1	53.4	63.0	71.0	95.5
34	34.0	46.6	53.4	60.5	71.5	80.5	108.0
37	37.0	49.6	58.1	65.8	77.6	87.6	117.5
40	40.0	53.5	62.8	71.3	84.0	94.7	127.1
45	45.0	60.3	70.6	80.1	94.5	106.6	143.0
50	50.0	67.0	78.5	89.0	105.0	118.3	159.0
52	52.0	69.7	81.6	92.6	109.2	123.0	165.2
56	56.0	75.0	88.0	99.6	117.5	132.4	178.0
60	60.0	80.5	94.2	106.8	126.0	142.0	190.8
64	64.0	85.8	100.5	114.0	134.5	151.5	203.9
67	67.0	89.8	105.2	119.1	140.7	158.6	213.0
70	70.0	93.8	110.2	124.5	147.0	165.8	222.5
76	76.0	101.9	119.2	135.3	159.5	180.0	241.7
82	82.0	110.0	128.8	146.0	172.1	194.1	260.5
85	85.0	114.0	133.5	151.2	178.5	201.3	270.0
94	94.0	126.0	147.8	167.5	197.5	222.5	299.0
101	101.0	135.5	158.5	180.0	212.1	239.0	321.8

Type K Resistors

Continuous Amps	NEMA Class Ampere Ratings 90	170	160	150	140	130	110
38	38	51	60	67	80	90	121
41	41	54	65	72	87	97	130
48	48	65	77	87	104	118	161
53	53	71	85	96	115	131	177
62	62	85	102	115	140	159	217
66	66	90	109	123	149	170	231
72	72	98	119	134	163	185	253
77	77	105	127	143	174	198	270
80	80	109	132	149	181	206	280
86	86	118	142	160	194	221	302
95	95	130	157	177	215	244	333
98	98	134	162	182	221	252	344
101	101	138	167	188	228	260	355
109	109	149	180	203	247	280	383
117	117	160	193	218	264	301	407
120	120	164	198	223	271	309	421
124	124	170	205	230	280	319	436
139	139	190	229	259	314	357	488
143	143	196	236	266	323	368	502
147	147	201	242	273	332	378	516
156	156	213	257	290	353	401	547
171	171	234	282	318	387	440	600
174	174	238	287	324	393	448	610
178	178	244	294	331	402	457	625
190	190	260	313	353	429	488	667
195	195	267	322	362	441	501	685

Type HHC Resistors

Continuous Amps	NEMA Class Ampere Ratings 90	170	160	150	140	130	110
200	200	270	325	366	443	508	698
225	225	303	365	412	500	572	785
255	255	344	414	467	565	648	890
295	295	403	485	547	662	759	1042
350	350	479	577	651	787	903	1235
395	395	542	653	737	891	1022	1402
445	445	599	722	813	984	1129	1549
500	500	682	821	926	1120	1284	1762
610	610	826	995	1121	1357	1556	2136
695	695	936	1128	1272	1538	1764	2421

Hubbell Industrial Controls, Inc.
a subsidiary of Hubbell Incorporated
4301 Cheyenne Drive, Archdale, NC 27263
Phone (336) 434-2800 | Fax (336) 434-2801
www.hubbell-icd.com
sales@hubbell-icd.com