

RATIOTROL SYSTEMS

*Single-Phase Adjustable Speed
DC Motor Controllers, Nonregenerative*



TABLE OF CONTENTS

SPECIFICATION CHART	8
RATIOPAX	9-10
DCX/DCXplus	11-15
BETA II	16-20
BETAplus	21-25
VEplus	26-30
OPTIONS FOR DC CONTROLLERS	38-46
APPLICATION ENGINEERING	113-127

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

Specification Chart

The purpose of this chart is to provide a general feature comparison of the Boston Gear controllers. When selecting, refer to the specific catalog selection for complete information.

SINGLE PHASE NONREGENERATIVE DC MOTOR CONTROLLER SPECIFICATIONS														
Features		Ratiopax		DCX		DCXplus		BETA II		BETAplus		VEplus		
AC Line	Voltage 50/60 Hz	115	230	115	230	115	230	115	230	115	230	115	230	
Range	Maximum Horsepower	1/2	1	1	3	1/2	1	1	3	1	3	1	5	
Output	Armature Voltage (0 to)	90	180	90	180	90	180	90	180	90	180	90	180	
	Field Voltage	50	100	100	200	100	200	50/ 100	100/ 200	50/ 100	100/ 200	50/ 100	100/ 200	
AC Line Protection	Fuse Circuit Breaker	S		O		S		S		S		S		
Functions	Jog							S		S		S		
	Preset Speeds													
	Armature Contactor													
	Unidirectional W/ D.B.			O				S		S		S		
	Reversing W/DB			O				S		S		S		
Reversing, Switch	S				S		S		S		S			
Constant Torque Operation	S		S		S		S		S		S			
Enclosure	Angle Bracket Chassis			S				S		S		S		
	Open Chassis					S		S		S		S		
	NEMA 1	S												
	NEMA 3							S		S		S		
	NEMA 4 NEMA 12					S		S		S		S		
Adjustments	Acceleration (Seconds)			0.8-10		0.8-10		0.2-40		0.2-30		0.2-30		
	Deceleration (Seconds)			0.8-10		0.8-10		0.2-40		0.2-30		0.2-30		
	IR Compensation (%)			0-100		0-100		0-100		0-100		0-100		
	Maximum Speed (%)	75-100		60-100		60-100		50-100		50-100		50-100		
	Minimum Speed (%)			0-40		0-40		0-40		0-40		0-40		
	Current Limit (%)	150		0-150		0-150		0-150		0-150		0-150		
Horsepower/ Voltage Calibration	Trim Pot Adjustments			S		S								
	Resistance Wire	S												
	Reconnectable Jumpers							S		S		S		
	Dip Switches							S		S		S		
Isolated Regulator			O				S		S		S			
Load Monitor									S		S			
Speed Regulation	Standard IR Feedback													
	Percentage	5%		2%		2%		2%		2%		2%		
	Speed Range	20:1		30:1		30:1		50:1		50:1		50:1		
Input	Tachometer Feedback													
	Percentage			1%		1%		0.5%		0.5%		0.5%		
	Speed Range			100:1		100:1		200:1		200:1		200:1		
Tachometer Feedback	Analog	S		S		S		S		S		S		
	Unidirectional			S		S		S		S		S		
Modifiable Features	Bidirectional							O		O		O		
	DC Tachometer Feedback			S		S		S		S		S		
	AC Line Starting			S		S		S		S		S		
	Torque Regulator							S		S		S		
	External DC Signal Follower							S		S		S		
Limit Switch Reversing							S		S		S			
Options	Field Installed			O				O		O		O		
	Factory Installed			O								O		
UL/cUL			S		S		S		S		S			
Pages			9-10		11-15		11-15		16-20		21-25		26-30	

S-Standard O-Optional

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

RATIO PAX Series
1/12-1 Horsepower



Ratiopax Controllers are economical, **non-modifiable**, general purpose controllers featuring static conversion of AC line power to regulated DC for nonregenerative, adjustable speed armature control of shunt-wound and permanent-magnet DC motors. Their lightweight and compact design makes these units an ideal choice for a broad range of industrial applications.

Motors suitable for application with these controllers are listed in the DC motor section.

DESIGN FEATURES AND FUNCTIONS

1. **Enclosure** – All models are furnished in a rugged die cast enclosure. Complete control assembly is attached to the front cover which can be removed from the enclosure by removing four (4) screws.
2. **Operator Controls** – Mounted on the front cover. Included is a calibrated SPEED control potentiometer and a RUN-STOP toggle switch. A Forward-Stop-Reverse maintained switch is standard on the RP1R & RP2R. This switch includes a no pass through center detent which provides anti-plug protection.
3. **AC Line Protection** – AC line fuse provides instantaneous protection from peak loads and fault currents. The fuse is front panel mounted, and can be replaced without removing the cover.
4. **Voltage Transient Protection** – Suppression network to minimize the effect of high voltage or high frequency spikes.
5. **Full-Wave Power Conversion** – 2 SCRs 2 diodes and a free-wheeling diode provide optimum form factor for best motor performance and longevity. NEMA Code K Converter.
6. **Reference Circuit** – 24 VDC regulated to provide stable performance with changes in line voltage.
7. **Maximum Speed Adjustment** – Adjustable from 75 to 100% of motor base speed.
8. **Trigger Circuit** – Fast rise, hard firing type to minimize di/dt degradation of SCRs.
9. **Counter EMF Voltage Feedback with IR Compensation** – Non-adjustable, factory set.
10. **Quality Features** – FR4 glass printed circuit card • Rugged construction • Conservatively rated components selected for long service life.

RATINGS

1. **Service factor** 1.0
2. **Duty** Continuous
3. **Overload Capacity** 150% for 1 minute
4. **Run Speed Potentiometer** 100K Ohms, 2W
5. **Reference Power Supply** 24 VDC
6. **AC Line Fuse, Interrupting Capacity** 5000 Amps
7. **RP1, RP1R Controllers** 115 VAC, 50 or 60 Hz, Single Phase
8. **RP2, RP2R Controllers** 230 VAC, 50 or 60 Hz, Single Phase

PERFORMANCE CHARACTERISTICS

1. **Controlled Speed Range** – Zero to motor base speed. Speed range with respect to specified regulation is shown below.
2. **Speed Regulation** – Regulation percentages listed are of motor base speed under steady-state conditions. Normal operation will result in performance equal to or better than specifications.

SPEED REGULATION CHARACTERISTICS					
Regulation Method	Variables				Speed Range
	Load Change 95%	Line Voltage $\pm 10\%$	Field Heating Cold/Normal	Temp. $\pm 10^\circ\text{C}$	
Standard Voltage Feedback with IR Compensation	5%	$\pm 1\%$	5–12%	$\pm 2\%$	20:1

3. **Efficiency** (rated speed/rated load)
 - (a) Controller (SCR regulator) 98%
 - (b) Complete drive (controller and motor, typical) 85%
4. **Current Limit** (factory set, nonadjustable) 150% full-load torque (typical)

OPERATING CONDITIONS

1. **Line Voltage Variation** $\pm 10\%$ of rated
2. **Line Frequency Variation** ± 2 Hz
3. **Ambient Temperature** 0°C to 40°C (32°F to 104°F)
4. **Altitude (standard)** 3300 feet (1000 meters) maximum

RATIOTROL SYSTEMS

**Single-Phase Adjustable Speed
DC Motor Controllers, Nonregenerative**

**RATIOPAX Series
1/12-1 Horsepower**

MODEL TYPES

Ratiopax controllers are offered as four standard models. Models RP1 and RP2, are unidirectional packaged controllers and Models RP1R and RP2R, are reversible controllers with Forward-Stop-Reverse switch. All are furnished in a totally-enclosed, non-ventilated, rugged, die-cast aluminum alloy enclosure with integral operator controls.

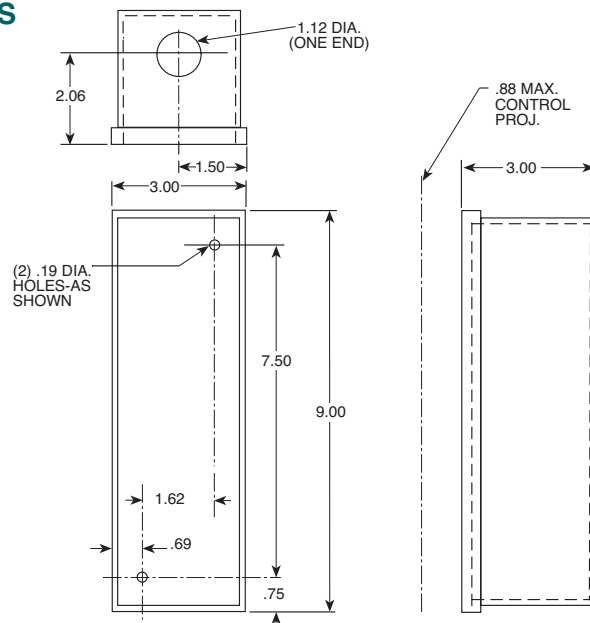
ORDER BY CATALOG NUMBER OR ITEM CODE

NEMA 1 ENCLOSED CONTROLLER WITH INTEGRAL OPERATOR CONTROLS				
Horsepower Range		Catalog Number	Item Code	Function
115 VAC	230 VAC			
1/6 – 1/2	—	RP1	63370	Run/Stop
		RP1R	63372	Armature Switch Reversing
—	1/2 – 1	RP2	63371	Run/Stop
		RP2R	63373	Armature Switch Reversing

TYPICAL APPLICATION DATA								
			Ratings					
Rated Horsepower (HP)			1/6	1/4	1/3	1/2	3/4	1
Rated Kilowatts (kW)			0.124	0.187	0.249	0.373	0.560	0.746
1-Phase AC Input (Full-Load)	Line Amps	115V Unit	3.9	5.0	6.0	8.7	—	—
		230V Unit	—	—	—	4.2	5.9	8.8
	KVA		.48	.58	.71	1.0	1.4	2.0
DC Output (Full-Load)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	—	—
		180V	—	—	—	2.6	3.8	5.5
	Motor ⁽¹⁾ Field Amps	50V	2.0	2.0	2.0	2.0	—	—
		100V	—	—	—	2.0	2.0	2.0
Full-Load Torque (lb-ft) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0

(1) Does not apply to permanent magnet motors.

DIMENSIONS – ALL MODELS



APPROX WEIGHT – 2 LBS

BOSTON GEAR®

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

DCX® Series
DCXplus® Series
1/12-3 Horsepower



Ratiotrol DCX® controllers statically convert single-phase AC line power to regulated DC for nonregenerative adjustable speed armature control of shunt-wound and permanent magnet DC motors. They are ideal for simple MRO modifications of existing drives or for installation in OEM equipment to provide variable speed motor operation with traditional Boston Gear reliability.

These controls feature a number of exclusive advantages. Their built-in adjustment trim pots, for example, offer immediate access to a broad range of horsepower settings.

They completely eliminate the need to stock a variety of components for every horsepower rating.

The dual voltage models can be connected to either 115 VAC or 230 VAC for operation without the use of jumpers or switches.

With a selection of four enclosed models, two panel-front models for installation in OEM control cabinets, and three chassis models with up to 3 horsepower capability and companion optional accessories, Boston Gear has a low-cost controller suitable for virtually any requirement.

Motors suitable for application with these controllers are listed in the DC motor section.

DESIGN FEATURES AND FUNCTIONS

- 1. DCXplus® Enclosed Models** – These units are furnished in a compact, die cast aluminum, non-ventilated NEMA 1 or NEMA 12 rated enclosure. The complete control assembly is mounted on the front panel which can be removed from the enclosure by removing four (4) screws. The unenclosed panel assembly can be mounted through a cut-out in the user's enclosure.
- 2. DCX® Chassis Models** – The units are furnished as a very compact open chassis consisting of the regulator/power conversion circuit board mounted to a formed aluminum chassis. The DCX202C model may be furnished with a supplemental heatsink (DCX-HTSK or DCX-RHTSK) to improve heat dissipation and thereby extend the horsepower range. Chassis units are dimensionally interchangeable with many competitive units.
- 3. Full-Wave Power Conversion** – NEMA Code K converter configuration formed of discrete devices rated 600 PIV. Converter consists of two (2) SCR's, two diodes and a free wheeling diode which provide optimum form factor for best motor performance and long service. Enclosed models use the control enclosure as an integral heatsink with the power control devices electrically isolated from the enclosure.
- 4. Voltage Transient Protection** – Metal oxide suppressor across the AC line minimizes the effect of high voltage spikes from the AC power source.
- 5. Tachometer Feedback** – All standard units except DCX102C accept a 35, 50 or 100 VDC/1000 RPM feedback signal from a motor mounted DC tachometer generator for improved speed regulation. (Unidirectional units only).
- 6. Horsepower Selection** – Easily calibrated by built-in trim pots to suit individual motor horsepower ratings without special instruments, or plug-in shunts.
- 7. Wiring Terminals** – Enclosed models are provided with barrier terminal strips for all external power and signal wires. Chassis models are provided with male tab wiring connectors. A terminal strip is offered as Options DCX-BTB2 or DCX-BTB3.
- 8. AC Line Fuse** – Enclosed models include an AC line fuse mounted on the circuit board. Chassis units do not include a fuse as standard, but a fuse holder may be provided with Options DCX-BTB2, DCX-BTB3 or DCX-FBK.
- 9. Operator Controls** – All enclosed models include integral operator controls consisting of a speed setting potentiometer and an ON-OFF AC line power switch. Switch is maintained in ON and OFF positions. Reversing models additionally include a 3-position FORWARD-STOP-REVERSE maintained switch. Switch includes a no pass through center detent which provides a delay when changing direction.
Chassis units are controlled by external, customer furnished switches, pushbuttons, or control logic. These units include an inhibit circuit for automatic operation by switch, relay or PLC.
Chassis units are furnished with a speed setting potentiometer and female wiring connectors supplied loose.
- 10. Line Voltage Selection** – Line voltage selection is automatic without the use of jumpers or switches.
- 11. Field Supply** – A full-wave, transient protected motor field supply is provided.
- 12. UL Rating** – The DCX Series units are either UL listed or UL recognized.

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

DCX® Series
DCXplus® Series
1/12-3 Horsepower

RATINGS

1. Horsepower. . . See selection chart Page 6
2. Service Factor 1.0
3. Duty Continuous
4. Operating Voltages

OPERATING VOLTAGES		
Power Source (Single-Phase)	Output VDC	
	Armature	Field
115V, 50 or 60 Hz	0-90	100
230V, 50 or 60 Hz	0-180	200

5. Overload Capacity (armature) 150% for 1 minute
6. Run Speed Potentiometer 5K Ohms, 1/2 W
7. Reference Power Supply 10VDC⁽¹⁾
8. Line Fuse⁽²⁾ Provided by others

- (1) Units are optionally adaptable for use with 4-20mA and 0-10 VDC reference voltages by the use of option DCX-25A
 (2) Line fuse is standard on DCXplus models, optional on all others

PERFORMANCE CHARACTERISTICS

1. **Controlled Speed Range** — Zero to motor base speed.
Speed range with respect to specified regulation is shown on right.
2. **Speed Regulation** — Regulation percentages listed are of motor base speed under steady-state conditions. Normal operation will result in performance equal to or better than specifications.

SPEED REGULATION CHARACTERISTICS					
Regulation Method	Variable				Speed Range
	Load Change 95%	Line Voltage ± 10%	Field Heating Cold/Normal	Temp. ±10°C	
Standard Voltage Feedback with IR Compensation	2%	± 1%	5-12%	± 2%	30:1
Tachometer Feedback ⁽¹⁾	1%	± 1%	0.2%	±2%	100:1

(1) Unidirectional models only.

3. **Efficiency (Rated speed/rated load)**
Controller 99%
Controller and Motor (typical) 85%

ADJUSTMENTS

1. **Current Limit** 0-150% full-load torque (typical)
2. **Maximum Speed** 60-100% of motor base speed
3. **Minimum Speed** 0-40% of motor base speed
4. **IR (load) Compensation** 0-100% of rated load
5. **Acceleration/Deceleration⁽¹⁾** 0.8-10 seconds

NOTE: (1) DCX102C acceleration/deceleration is 1.0 second fixed rate.

OPERATING CONDITIONS

1. **Line Voltage Variation** ±10% of rated
2. **Line Frequency Variation** ±2 Hz
3. **Ambient Temperature**
Chassis 0°C to 50°C (32°F to 122°F)
Enclosed 0°C to 40°C (32°F to 104°F)
4. **Altitude (Standard)**.... 3300 Feet (1000 meters) maximum
5. **Relative Humidity** 95% non-condensing

TYPICAL APPLICATION DATA												
			Ratings									
Rated Horsepower (HP)			1/12	1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
Rated Kilowatts (kW)			0.062	0.124	0.187	0.249	0.373	0.560	0.746	1.129	1.492	2.238
1-Phase AC Input (Full-Load)	Line Amps	115V Unit	2.0	3.9	5.0	6.0	8.7	12.4	15.0	—	—	—
		230V Unit	—	—	—	—	4.8	5.9	8.8	12.6	15.8	24.0
	KVA		.30	.48	.58	.71	1.0	1.4	2.0	3.0	4.0	6.0
DC Output (Full-Load)	Motor Armature Amps	90V	0.9	2.0	2.8	3.5	5.4	8.1	10.5	—	—	—
		180V	—	—	—	—	2.5	3.8	5.5	8.2	11.6	16.0
	Motor ⁽¹⁾ Field Amps	100V	1.0	1.0	1.0	1.0	1.0	1.0	1.0	—	—	—
		200V	—	—	—	—	1.0	1.0	1.0	1.0	1.0	1.0
Full-Load Torque (lb-ft) with 1750 RPM Base Speed Motors			.25	0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0

(1) Does not apply to permanent magnet motors.

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

DCX® Series
DCXplus® Series
1/12-3 Horsepower

MODEL TYPES

DCX and DCXplus Series controllers are offered as open chassis or enclosed configurations in nine (9) standard models in four (4) functional groups. The DCX® Series chassis units are ideal for the OEM or panel builder who may want to build a custom system by integrating the controller in an enclosure with special logic or auxiliary control devices. The DCXplus® Series enclosed units are offered as complete self-contained functional packages which include power conversion and regulator electronics, AC line protection and integral operator controls.

DCX® AND DCXplus® SERIES SELECTION CHART

ORDER BY CATALOG NUMBER OR ITEM CODE

Horsepower Range ⁽⁴⁾		Catalog Number	Item Code	Function
115 VAC	230 VAC			
DCX ANGLE BRACKET CHASSIS CONTROLLERS				
1/12 – 1/2	—	DCX102C	65984	Run/Stop ⁽³⁾⁽²⁾
1/12 – 1/2	1/2 – 1	DCX202C	65985	Run/Stop ⁽³⁾⁽²⁾
1/12 – 1 ⁽¹⁾	1/2 – 2 ⁽¹⁾			
1/12 – 1	1/2 – 3	DCX302C	65986	Run/Stop ⁽³⁾⁽²⁾
DCXplus FRONT PANEL ASSEMBLY WITH INTEGRAL OPERATOR CONTROLS				
1/12 – 1/2	1/2 – 1	DCX202EP	65987	Run/Stop
		DCX202ERP	65991	Run/Stop, Armature Switch Reversing
DCXplus NEMA 1 ENCLOSED CONTROLLER WITH INTEGRAL OPERATOR CONTROLS				
1/12 – 1/2	1/2 – 1	DCX202E	65988	Run/Stop
		DCX202ER	65992	Run/Stop, Armature Switch Reversing
DCXplus NEMA 12 ENCLOSED CONTROLLER WITH INTEGRAL OPERATOR CONTROLS				
1/12 – 1/2	1/2 – 1	DCX202EN12	65990	Run/Stop
		DCX202ERN12	65995	Run/Stop, Armature Switch Reversing

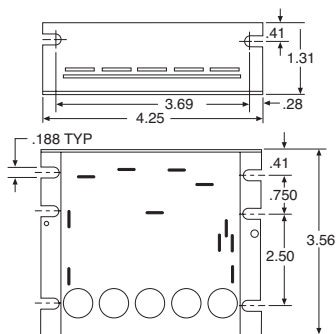
(1) Requires either Option DC-RHTSK for 1 HP on 115 VAC and 2 HP on 230 VAC or Option DCX-HTSK for 3/4 HP on 115 VAC and 1-1/2 HP on 230 VAC.

(2) DC units are furnished with a potentiometer rated 5K ohms, 1/2 watt for separate mounting.

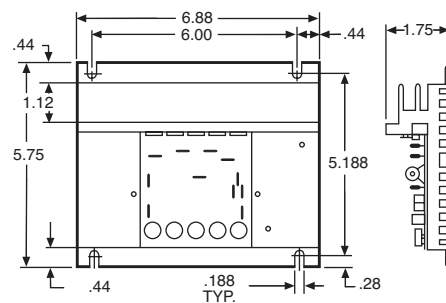
(3) Armature contactor Run-Stop-DB, and contactor reversing and dynamic braking are provided by Options DCX-DA and DCX-RA

(4) Units may be easily recalibrated for any standard rating within the range of the product using trim pots.

DIMENSIONS - DCX CHASSIS



DCX102C, DCX202C



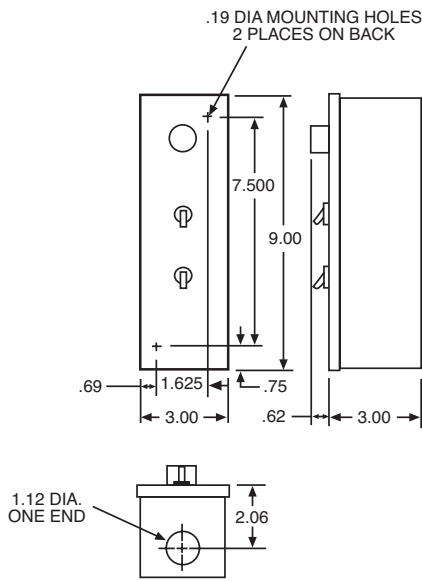
DCX302C

RATIOTROL SYSTEMS

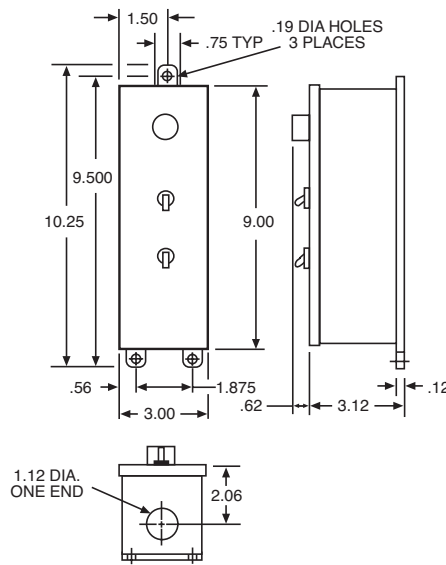
Single-Phase Adjustable Speed
DC Motor Controllers, Nonregenerative

DCX® Series
DCXplus® Series
1/12-3 Horsepower

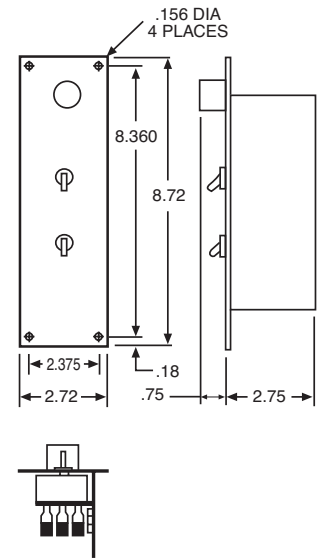
DIMENSIONS - DCXplus ENCLOSED



DCXplus NEMA 1

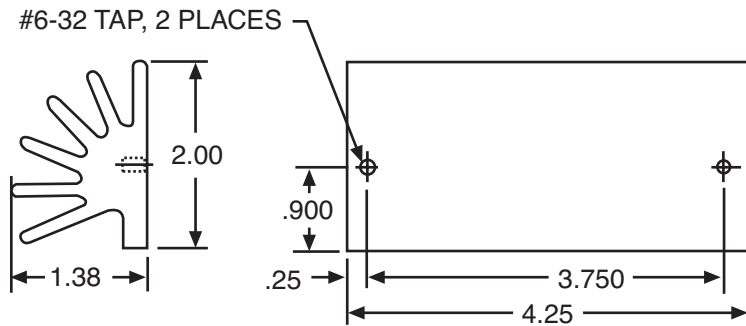


DCXplus NEMA12

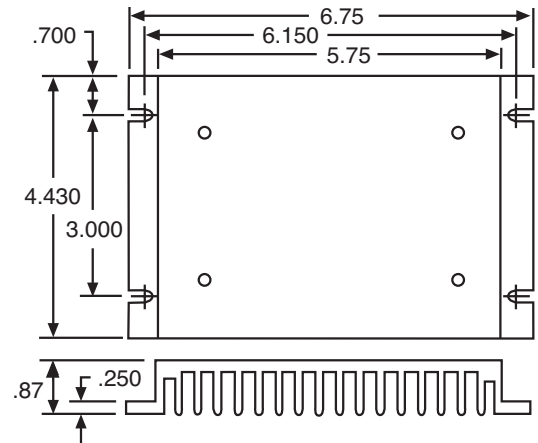


DCXplus Panel-Front

DIMENSIONS - HEATSINKS



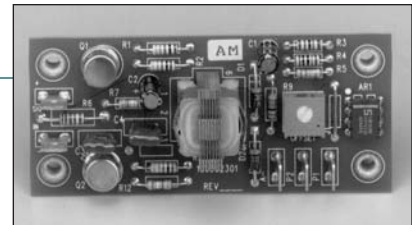
DCX RHTSK



DCX HTSK

OPTIONS FOR DCX SERIES CHASSIS UNITS

ORDER BY CATALOG NUMBER OR ITEM CODE																																																																							
<p>Barrier Terminal Board DCX-BTB-2 (68249) DCX-BTB-3 (68254)</p>	<p>Kit includes screw terminals for all external wiring, one line fuse holder, and an LED power on indicator in an assembly that plugs piggy-back onto chassis model units. (fuse not included) Total height when assembled to DCX102C or DCX202C is 2.12 inches</p> <table border="1" style="float: right;"> <thead> <tr> <th>OPTION</th> <th>INPUT VOLTAGE</th> <th>HP RATING</th> </tr> </thead> <tbody> <tr> <td>DCXBTB-2</td> <td>115 VAC</td> <td>1</td> </tr> <tr> <td>DCXBTB-3</td> <td>115/230 VAC</td> <td>3</td> </tr> </tbody> </table>	OPTION	INPUT VOLTAGE	HP RATING	DCXBTB-2	115 VAC	1	DCXBTB-3	115/230 VAC	3																																																													
OPTION	INPUT VOLTAGE	HP RATING																																																																					
DCXBTB-2	115 VAC	1																																																																					
DCXBTB-3	115/230 VAC	3																																																																					
<p>Contactor, Two-Pole with Dynamic Braking DCX-DA (65996)</p>	<p>The basic DCX Series chassis controller is designed for Run-Stop unidirectional operation without an armature contactor. This option provides a two-pole armature contactor which is necessary whenever the application requires a positive disconnection of the rectified armature power source from the motor on a stop command. Action of the contactor is sequenced with the SCR regulator to ensure that the DC power circuit is "phased off" before the contactor is opened. This results in "dry switching" for improved contactor longevity. This option also includes dynamic braking which provides exponential rate braking of the DC motor armature. Included is a DB resistor with an anti-plug circuit to prevent restarting the controller until the braking cycle is complete, thereby preventing a potentially damaging electrical surge and mechanical stress.</p> <p style="text-align: center;">DYNAMIC BRAKING RESISTOR RATINGS</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th rowspan="2">COMPONENT</th> <th rowspan="2">UNIT</th> <th colspan="10">RATED HORSEPOWER</th> </tr> <tr> <th>1/12</th> <th>1/6</th> <th>1/4</th> <th>1/3</th> <th>1/2</th> <th>3/4</th> <th>1</th> <th>1-1/2</th> <th>2</th> <th>3</th> </tr> </thead> <tbody> <tr> <td>Braking</td> <td>115V</td> <td>250</td> <td>180</td> <td>129</td> <td>103</td> <td>66</td> <td>44</td> <td>34</td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td>Torque %</td> <td>230V</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>278</td> <td>190</td> <td>130</td> <td>88</td> <td>62</td> <td>44</td> </tr> <tr> <td>Stops Per Minute</td> <td>115V</td> <td>18</td> <td>15</td> <td>12</td> <td>11</td> <td>8</td> <td>6</td> <td>2</td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td></td> <td>230V</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>8</td> <td>6</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table> <p>This option permits motor Start/Stop operation by pushbuttons or external logic in 115 or 230 VAC applications.</p> <p>Dimensions 4.3" x 4.6" x 1.9"</p>	COMPONENT	UNIT	RATED HORSEPOWER										1/12	1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	Braking	115V	250	180	129	103	66	44	34	-	-	-	Torque %	230V	-	-	-	-	278	190	130	88	62	44	Stops Per Minute	115V	18	15	12	11	8	6	2	-	-	-		230V	-	-	-	-	8	6	1	1	1	1
COMPONENT	UNIT			RATED HORSEPOWER																																																																			
		1/12	1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3																																																												
Braking	115V	250	180	129	103	66	44	34	-	-	-																																																												
Torque %	230V	-	-	-	-	278	190	130	88	62	44																																																												
Stops Per Minute	115V	18	15	12	11	8	6	2	-	-	-																																																												
	230V	-	-	-	-	8	6	1	1	1	1																																																												
<p>Reversing, Armature with Dynamic Braking DCX-RA (65998)</p>	<p>This option is the same as DCX-DA except two double pole contactors are provided for reversing the DC motor armature rated 1 HP at 90 VDC armature or 3 HP at 180 VDC maximum. Anti-plug protection is provided to prevent armature reversal until a safe minimum speed is attained. The direction of motor rotation is controlled by external RUN/FORWARD-REVERSE pushbuttons, switches or logic. Braking times are same as DCX-DA above. Dimensions 4.3" x 4.6" x 1.9"</p>																																																																						
<p>Fuse Block Kit DCX-FBK (67114)</p>	<p>Kit includes a fuse block, lead wire with spade connectors, and mounting screw. This option provides external line fuse protection for DCX Series chassis controllers (fuse not included).</p>																																																																						
<p>Heatsink Kit (Flat) DCX-HTSK (67106)</p>	<p>This option consists of an extruded aluminum heatsink and hardware to mount a Model DCX202C controller. This heatsink is intended for use only with Model DCX202C where its greater heat dissipation permits increasing the units original rated horsepower. Dimensions: 4.44"x6.75"x.88"</p>																																																																						
<p>Heatsink Kit (Radial) DCX-RHTSK (67098)</p>	<p>This option provides the same function as Option DCX-HTSK except it is a unique space saving radial design and offers a greater horsepower rating. Dimensions: 2"x1.38"x4.25"</p>																																																																						
<p>Dual Connector Terminal Adapter DCX-DP (67118)</p>	<p>This option provides a two (male) into one (female) push-on terminal to facilitate connection of DCX Series units for tachometer feedback and/or inhibit.</p>																																																																						
<p>Knob and Dial Plate Kit DCX-KDP (67109)</p>	<p>This option provides a knob and a dial face graduated 0-100% for use with the potentiometer provided with DCX Series units.</p>																																																																						
<p>Follower, External Signal DCX-25A (68342)</p>	<p>This option is intended as a low cost alternative which offers greater accuracy and flexibility. The option is capable of operating from the following isolated or nonisolated signals: 4-20 DC ma, 0-10 VDC. <i>This option includes a scaling potentiometer for offset adjustment.</i> Dimensions 1.5" x 3.38" x .75"</p>																																																																						



RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETA II Series
1/6-3 Horsepower



BETA II series controllers are high quality, economically priced, general purpose controllers that feature static conversion of AC line power to regulated DC for nonregenerative adjustable speed armature control of shunt wound and permanent magnet DC motors. The combination of a rugged compact design, mechanical flexibility, with many standard and field modifiable features, make these units an ideal choice for a broad range of industrial applications.

The BETA II controllers are designed and manufactured to comply with applicable standards established by the National Electric Code and NEMA for industrial motor and control equipment. The units are UL and cUL Listed.

Motors suitable for Application with these controllers are listed in the DC motor section.

DESIGN FEATURES AND FUNCTIONS

1. Construction

- a) **Angle Bracket Chassis** – Circuit board and power devices are mounted to a formed metal bracket which allows a smaller footprint than the conventional basic chassis. The optional contactor assemblies may also be mounted on the same bracket.
- b) **Basic Chassis** – Open chassis constructed of a rugged die-cast aluminum alloy with provisions for conduit entry at the top and bottom by two (2) 3/4-14 NPSC tapped holes with knockout plugs. The optional contactor boards may also be mounted in the basic chassis.
- c) **Enclosed** – Basic chassis unit with an aluminum die-cast cover added. The cover has a recessed area to guard the local operator control from accidental operation. All units use an oil resistant synthetic gasket to meet the provisions for NEMA 4/12, making them suitable for a wide range of wet and dirty industrial environments. All models with integral operator controls include flexible boots to seal the operator control switches, and a seal for the motor speed potentiometer.
- d) **Washdown Duty** – Basic Chassis unit and aluminum die-cast cover painted with a durable white epoxy paint. All units are furnished with stainless steel hardware, oil resistant synthetic gasket and flexible boots for sealing the operator controls to meet the provisions of NEMA 4X.

2. **Full-Wave Conversion** – NEMA Code K converter configuration consisting of two (2) SCRs, two (2) diodes and a free wheeling diode provides optimum form factor for best motor performance and long service. The units have 600 PIV devices. The controller base or metal bracket forms an integral heatsink with the power control devices and is electrically isolated from the rest of the control.

3. **Voltage Transient Protection** – Metal oxide suppresser across the AC line minimizes the effect of high voltage spikes from the AC power source.

4. **AC Line Protection** – AC line fuse provides instantaneous protection from peak loads and fault currents. The AC line fuse and holder are located on the main circuit board of the controller.

5. **Motor Contactor** – Models with a M or U in the catalog number include DC magnetic armature contactors. This provides a positive, two-pole disconnection of the motor armature from the rectified power source. Action of the

contactor is sequenced with the SCR regulator to ensure that the DC power circuit is “phased-off” before the contactor is opened. This results in “dry-switching” for improved contactor life. Anti-plug protection is provided to prevent armature reversal until a safe minimum speed is reached. Two types of contactor assemblies are available; Unidirectional (U suffix) which adds contactors to disconnect the motor armature when the control is stopped and Reversing (M suffix) which adds additional contactors to disconnect and reverse the motor armature when the unit is reversed.

6. **Dynamic Braking** – A standard feature of the controllers when supplied with the motor contactor. Dynamic braking provides exponential rate braking of the DC motor armature. Included is a DB resistor with an anti-plug circuit to prevent restarting the controller until the braking cycle is complete, thereby preventing a potentially damaging electrical surge and mechanical stress.

The DB resistor is rated for stopping a typical load, when the external machine inertia does not exceed that of the motor armature, as shown in the chart below. The DB resistor may be disconnected when braking is not desired.

		DB RESISTOR RATINGS									
Model	Component	Voltage	Rated Horsepower								
			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
RBA2	Braking	115V	180	129	103	66	44	34	—	—	—
	Torque (%)	230V	—	—	—	278	190	130	88	62	—
	Stops Per Minute	115V	15	12	11	8	6	2	—	—	—
RBA3	Braking	115V	300	215	170	110	75	60	—	—	—
	Torque (%)	230V	—	—	—	400	320	220	145	105	85
	Stops Per Minute	115V	9	6	5	5	4	4	—	—	—
		230V	—	—	—	5	4	4	3	3	2

7. **Operator Controls** – All enclosed models with integral operator controls include a speed setting potentiometer and a multi-position switch providing RUN-STOP-JOG functions. The switch is maintained in RUN and STOP positions and a spring return to the center stop position from the momentary JOG position. Jog speed is set by the RUN speed potentiometer. The reversing models, when supplied without a contactor assembly, have an armature reversing power switch which is maintained in the FORWARD or REVERSE run positions. This switch

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETA II Series
1/6-3 Horsepower

DESIGN FEATURES AND FUNCTIONS (Continued)

- includes a no pass through center detent which provides a delay when changing direction for anti-plug protection.
- Reversing models with a contactor assembly include a momentary contact FORWARD-REVERSE run switch with a spring return to the center position. This switch controls only low control power since armature switching is accomplished by magnetic contactors. The unit is jogged forward or reverse by the momentary FORWARD-REVERSE switch after selecting the JOG position on the RUN-STOP-JOG switch (the JOG position is maintained on this unit).
8. **Control Transformer** – All models include a control transformer which provides internal reference and power supply voltages, and a low voltage source for the magnetic controls, control logic and operator controls.
 9. **Counter EMF Voltage Feedback with IR Compensation** – Adjustable to suit individual motor characteristics.
 10. **Trigger Circuit** – Fast rise, hard firing to ensure reliable conduction and minimize di/dt degradation of SCRs.
 11. **Field Supply** – Transient protected. Selectable for either half-wave or full-wave output. See Table for operating voltages.
 12. **Control Relay** – Enables remote control of all models and provides an interlock to prevent a restart after a power outage. This may be defeated when an external customer furnished AC line contactor is used to control the unit.
 13. **Customer Use Run Relay Contact** – Form A normally open contact rated five (5) amps at 115 VAC or 30 VDC coordinating with a run command. May be used for external control and indicating devices. May also be applied as a pushbutton seal-in or a drive OK contact.
 14. **Hybrid Circuitry** – Miniature components in custom surface mount assemblies improve reliability and make available more features in the smallest possible mechanical configuration.
 15. **Selectable Capabilities** –
 - a) **DC Tachometer Feedback** – Provided is impedance matching, voltage scaling and terminals for accepting a

signal from a DC tachometer generator directly coupled to the drive motor armature. The tachometer signal makes the controller directly sensitive to motor speed. This results in an expanded speed range, improved speed regulation with load changes, motor field heating and other operating variables. The controller will automatically transfer to counter EMF voltage feedback to prevent a runaway motor if the tachometer circuit is opened. (A broken tachometer drive coupling will cause the motor to run at maximum speed.) Tachometers producing 7 to 150 VDC at maximum motor speed may be used. *This feature is suitable for use only with unidirectional units using DC tachometers.*

- b) **AC Line Starting** – A provision is included to defeat the no-restart-on-power-failure feature to permit run-stop control of unidirectional models by an external AC line contactor. Included is circuitry to assure smooth motor starting.
- c) **Torque Regulator** – These units may be easily reconfigured to function as torque regulators. In this mode, the speed setting potentiometer is used to set and regulate the maximum motor armature current over a range of 0 to 150% of rated current. Accordingly motor speed is unregulated and will go to a level of 0 to 100% of rated speed, depending upon the application load torque.
16. **Mechanical Flexibility** – The same basic unit can be used as an open chassis or an enclosed package controller. Enclosed units may be mounted under or through a console surface as shown on page 20. The angle bracket chassis offers the same controller in a smaller footprint and is designed for use in the customer's own panel.
17. **Horsepower and Voltage Calibration** – Units are shipped calibrated for the maximum horsepower rating and 230V operation. They may be easily recalibrated for 115V operation by reconfigurable jumpers and any standard horsepower rating within the design range by clipping shunt wires.
18. **Safety Features** – UL, cUL listed, low voltage operator control. Requires mandatory restart after power interruption, NEMA 4/12.

RATINGS

1. Horsepower Range:

Enclosed	1/6 thru 1 HP @ 115 VAC
	1/2 thru 2 HP @ 230 VAC
Chassis	1/6 thru 1 HP @ 115 VAC
	1/2 thru 3 HP @ 230 VAC

2. Operating Voltages

OPERATING VOLTAGES				
Power Source (Single-Phase)	Output VDC		Control Reference Voltage	Magnetic Control Voltage
	Armature	Field ⁽¹⁾		
115V, 50 or 60 Hz	0–90	50/100	0-10 VDC 4-20 MA	24 VDC
230V, 50 or 60 Hz	0–180	100/200		

(1) Selectable

3. **Service Factor** 1.0
4. **Duty** Continuous
5. **Overload Capacity** (Armature circuit) . 150% for 1 minute
6. **Run Speed Potentiometer** 5K ohms, 1/2 W
7. **Reference Power Supply** 10 VDC
8. **AC Line Fuse, Interrupting Capacity** 100,000 Amps

ADJUSTMENTS

Potentiometer adjustments are provided for:

1. **Acceleration Time**..... 0.2–40 seconds
2. **Deceleration Time**..... 0.2–40 seconds
3. **Minimum Speed**..... 0–40% of base speed
4. **Maximum Speed**..... 50–100% of base speed
5. **IR (Load) Compensation**0–100% of rated load
6. **Current Limit**.....0–150% of full load torque

BOSTON GEAR®

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETA II Series
1/6-3 Horsepower

PERFORMANCE CHARACTERISTICS

- Controlled Speed Range** — Zero to motor base speed. Speed range with respect to specified regulation is shown below.
- Speed Regulation** — Regulation percentages listed are of motor base speed under steady-state conditions. Normal operation will result in performance equal to or better than specifications.

SPEED REGULATION CHARACTERISTICS					
Regulation Method	Variable				Speed Range
	Load Change 95%	Line Voltage $\pm 10\%$	Field Heating Cold/Normal	Temp. $\pm 10^\circ\text{C}$	
Standard Voltage Feedback with IR Compensation	2%	$\pm 1\%$	5-12%	$\pm 2\%$	50:1
Optional Tachometer Feedback ⁽¹⁾	0.5%	$\pm 1\%$	0.2%	$\pm 2\%$	200:1

(1) Unidirectional Models Only

- Efficiency** — (rated speed/rated load)
 - (a) Controller (SCR regulator).....99%
 - (b) Complete drive (Controller and motor, typical).....85%

OPERATING CONDITIONS

- Line Voltage**..... 115/230 VAC, 50/60 Hz, Single Phase
- Line Voltage Variation**..... $\pm 10\%$ of rated⁽¹⁾
- Line Frequency Variation**..... ± 2 Hz
- Ambient Temperature**..... Enclosed: 0° to 40°C (32° to 104°F)
Chassis: 0° to 55°C (32° to 131°F)
- Altitude**..... 3300 ft. (1000 meters) maximum
- Relative Humidity** 0–95%, noncondensing

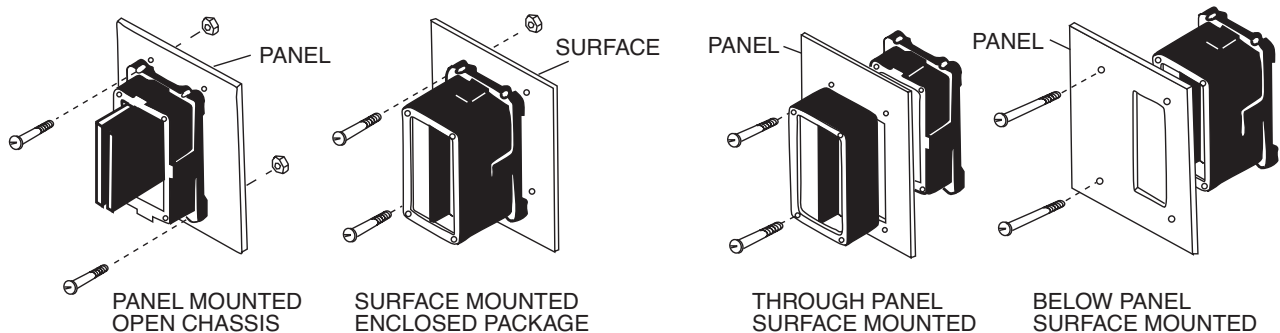
(1) Unit will operate down to -15% of rated voltage although this may prevent rated speed with rated load.

TYPICAL APPLICATION DATA

Rated Horsepower (HP)		Ratings									
		1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	
Rated Kilowatts (kW)		0.124	0.187	0.249	0.373	0.560	0.746	1.120	1.492	2.238	
1-Phase AC Input (Full-Load)	Line Amps	115 VAC	3.9	5.0	6.0	8.7	12.4	15.8	—	—	—
		230 VAC	—	—	—	4.2	5.9	8.8	12.6	15.8	22.0
	KVA	0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00	5.00	
DC Output (Full-Load)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	—	—	—
		180V	—	—	—	2.7	4.0	5.5	8.2	11.6	14.4
	Motor ⁽¹⁾ Field Amps (Maximum)	50V	1.0	1.0	1.0	1.0	1.0	1.0	—	—	—
		100V	—	—	—	1.0	1.0	1.0	1.0	1.0	1.0
200V		—	—	—	1.0	1.0	1.0	1.0	1.0	1.0	
Full-Load Torque (lb-ft) with 1750 RPM Base Speed Motors		0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0	
Minimum Transformer KVA for Voltage Matching or Isolation		0.5	0.75	0.75	1.0	1.5	2.0	3.0	5.0	7.5	

(1) Does not apply to Permanent Magnet Motors

MOUNTING CONFIGURATIONS



RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETA II Series
1/6-3 Horsepower

MODEL TYPES

BETA II controllers are offered in twenty three (23) standard models in six functional groups. The basic chassis models are the nucleus of all the enclosed models; standard covers and contactor assemblies can be added to the basic chassis to make an enclosed controller or the enclosed unit may be ordered complete as shown below.

ORDER BY CATALOG NUMBER OR ITEM CODE

Horsepower Range ⁽¹⁾		Catalog Number	Item Code	Function
115 VAC	230 VAC			
ANGLE BRACKET CHASSIS CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6 – 1	1/2 – 2	RBA2C	57854	Run/Stop ⁽²⁾
		RBA2CU	57855	Armature Contactor Run/Stop and DB
		RBA2CM	57856	Armature Contactor Forward/Reverse and DB
BASIC CHASSIS CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6 – 1	1/2 – 2	RBA2	64801	Run/Stop ⁽²⁾
		RBA2U	57831	Armature Contactor Run/Stop and DB
		RBA2M	64821	Armature Contactor Forward/Reverse and DB
1/6 – 1	1/2 – 3	RBA3	64865	Run/Stop ⁽²⁾
		RBA3U	57889	Armature Contactor Run/Stop and DB
		RBA3M	64873	Armature Contactor Forward/Reverse and DB
NEMA 4/12 ENCLOSED CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6 – 1	1/2 – 2	RBA2B	64805	Run/Stop ⁽²⁾
		RBA2UB	57852	Armature Contactor Run/Stop and DB
		RBA2MB	64855	Armature Contactor Forward/Reverse and DB
NEMA 4/12 ENCLOSED CONTROLLERS WITH INTEGRAL OPERATOR CONTROLS				
1/6 – 1	1/2 – 2	RBA2S	64814	Run/Stop/Jog ^{(2) (4)}
		RBA2R	64820	Run/Stop/Jog, Armature Switch Reversing ^{(3) (4)}
		RBA2US	57853	Run/Stop/Jog, Armature Contactor Run and DB ⁽⁴⁾
		RBA2MR	64863	Run/Stop/Jog, Armature Contactor Forward/Reverse and DB ⁽⁵⁾
WASHDOWN DUTY ENCLOSED CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6 – 1	1/2 – 2	RBA2B-WD	13048	Run/Stop ⁽²⁾
		RBA2UB-WD	13050	Armature Contactor Run/Stop and DB
		RBA2MB-WD	13100	Armature Contactor Forward/Reverse and DB
WASHDOWN DUTY ENCLOSED CONTROLLERS WITH INTEGRAL OPERATOR CONTROLS				
1/6 – 1	1/2 – 2	RBA2S-WD	13102	Run/Stop/Jog ^{(2) (4)}
		RBA2R-WD	13104	Run/Stop/Jog, Armature Switch Reversing ^{(3) (4)}
		RBA2US-WD	13106	Run/Stop/Jog, Armature Contactor Run and DB ⁽⁴⁾
		RBA2MR-WD	13108	Run/Stop/Jog, Armature Contactor Forward/Reverse and DB ⁽⁵⁾

*Refer to Remote Operator Control Stations on Pages 47 and 48.

(1) Units are shipped calibrated for the maximum horsepower ratings shown. Units may be calibrated for other standard ratings by the removal of appropriate resistance wires. Units are connected for 230 VAC and are easily reconnected for 115 VAC input.

(2) Contactorless Run-Stop Operation

(3) Contactorless Reversing Operation

(4) Jog Speed is set by the Run Speed Potentiometer. Maintained in RUN position, JOG position is momentary with a spring return to STOP.

(5) Jog Speed is set by the Run Speed Potentiometer. Maintained JOG position, Forward/Reverse are momentary.

CONTROLLER WEIGHTS

Model	RBA2C	RBA2CU RBA2CM	RBA2 RBA3	RBA2U RBA2M RBA3U RBA3M	RBA2B, RBA2S RBA2R, RBA2BWD RBA2SWD RBA2RWD	RBA2UB, RBA2MB RBA2US, RBA2MR RBA2UB-WD RBA2MB-WD RBA2US-WD RBA2MR-WD
Weight (Lbs)	2.0	2.3	3.3	3.8	5.5	6.1

BOSTON GEAR®

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed
DC Motor Controllers, Nonregenerative

BETA II Series
1/6-3 Horsepower

ORDER BY CATALOG NUMBER OR ITEM CODE

REMOTE OPERATOR CONTROL STATIONS BETA II

Catalog Number	Item Code	Control Elements			Use With Controller Models
		Pushbuttons	Switches	Pots	
RCS1	69362	Run, Stop	—	Motor Speed	ALL
RCS3C	58098	Run, Stop	Run/Jog	Motor Speed Jog Speed	RBA2U, RBA3U, RBA2UB
RCS3D	58099	Run, Stop	Run/Jog	Motor Speed Jog Speed	RBA2, RBA3, RBA2B
RCS6	60239	Fwd, Rev, Stop	—	Motor Speed	RBA2M, RBA3M, RBA2MB
RCS16	58102	—	Run/Stop/Jog	Motor Speed	RBA2U, RBA3U, RBA2UB
RCS17	58103	—	Run/Stop/Jog, Fwd/Rev	Motor Speed	RBA2M, RBA3M, RBA2MB

Remote Operator Station dimensions shown on page 48.

OPTIONS

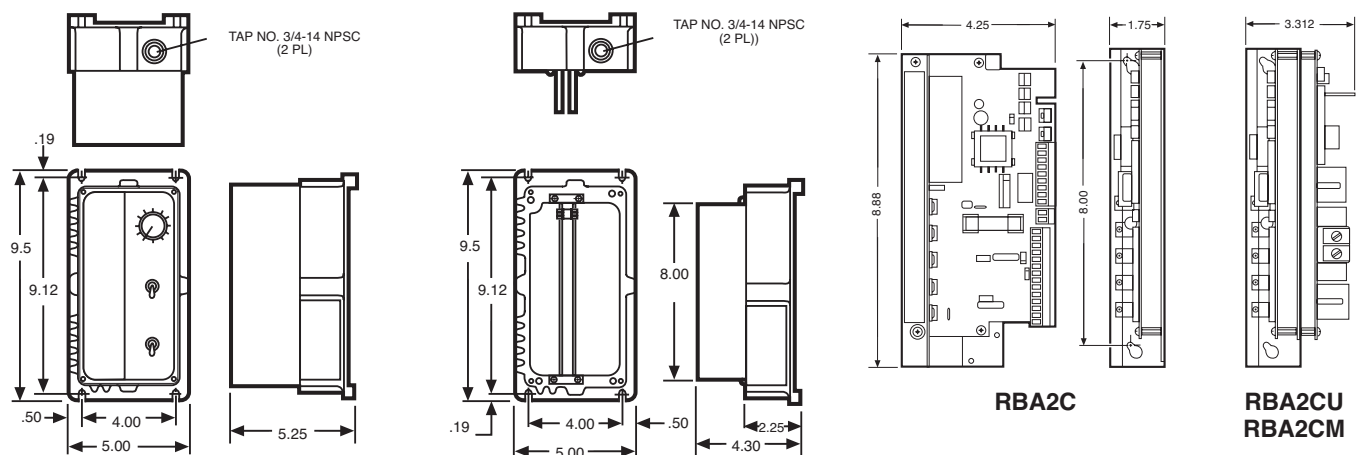
Options and modifications are listed alpha-numerically within each group. Complete option descriptions are listed in the DC option section. To order a controller with the option installed or the modification made, add the option number or letter as a suffix to the controller catalog number, e.g. RBA2B-21. To order a kit for field installation, order by item code.

Group	Option	No.	Kit Item Code	Notes
Feedback	Torque (Current) Reference	18E	—	(1)
	DC Tachometer Feedback	24	—	(1)
External	Line Starting	LS	—	(1)
	Motor Speed Potentiometer, One Turn	21	—	(2)
	Motor Speed Potentiometer, Ten Turn (Analog)	21A	60168	(3)
	Motor Speed Potentiometer, Ten Turn (Digital)	21B	66103	(3)

Notes:

- (1) Modifiable feature of controller
- (2) Unit will not be rated NEMA 4/12 unless factory installed.
- (3) Unit will not be rated NEMA 4/12

DIMENSIONS



ENCLOSED

CHASSIS

ANGLE BRACKET CHASSIS

BOSTON GEAR®

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETAplus Series
1/6-3 Horsepower



BETAplus series controllers are high performance, high quality, general purpose units which feature static conversion of AC line power to regulated DC for nonregenerative, adjustable speed armature control of shunt-wound or permanent magnet DC motors. The BETAplus series features an *isolated speed reference circuit* and uses miniature component hybrid assemblies which provide many standard features in a compact package. This series incorporates the use of *DIP switches and reconnectable jumpers* to configure the voltage, horsepower and selectable features of the controller. The combination of a rugged compact design with standard features and field modifications make this controller an ideal choice for a broad range of industrial applications.

These controllers are designed and manufactured to comply with applicable standards established by the National Electric Code and NEMA pertaining to motor and industrial control equipment. The controllers are UL and cUL Listed.

Motors suitable for application with these controllers are listed in the DC motor section.

DESIGN FEATURES AND FUNCTIONS

1. Construction

- a) **Angle Bracket Chassis** – Circuit board and power devices are mounted to formed metal bracket which allows a smaller footprint than the conventional basic chassis. The optional contactor assemblies may also be mounted on the same bracket.
- b) **Basic Chassis** – Open chassis constructed of a rugged die-cast aluminum alloy with provisions for conduit entry at the top and bottom by two (2) 3/4-14 NPSC tapped holes with knockout plugs. The optional contactor assemblies may also be mounted in the basic chassis.
- c) **Enclosed** – Basic chassis unit with an aluminum die-cast cover added. The cover has a recessed area to guard the local operator control from accidental operation. All units use an oil resistant synthetic gasket to meet the provisions for NEMA 4/12, making them suitable for a wide range of wet and dirty environments. All models with integral operator controls include flexible boots to seal the operator control switches, and a seal for the motor speed potentiometer.
- d) **Washdown Duty** – Basic chassis unit and aluminum die-cast cover painted with a durable white epoxy paint. All units are furnished with stainless steel hardware, oil resistant synthetic gasket and flexible boots for sealing the operator controls to meet the provisions of NEMA 4X.

- 2. **Full-Wave Power Conversion** – Full-wave converter configuration consisting of four SCR's and a freewheeling diode provide benefits for optimum motor performance and long service. Power bridge is composed of 600PIV, discrete, encapsulated and electrically isolated devices. The alloy base forms an integral heatsink with the power control devices electrically isolated from the base.

The "full-bridge" configuration offers important benefits over the conventional two SCR semiconductor commonly used. Smoother operation results since two SCR's in series must fire to enable conduction as opposed to one SCR in conventional single-phase converters. This provides broad band immunity to inadvertent SCR firing due to line noise, and contributes to operating safety since the failure of one SCR will not initiate undesired motor rotation when the armature is at rest.

The freewheeling diode improves the form factor which lowers rms currents resulting in reduced motor temperatures by minimizing power dissipation at low speeds. This enhances both motor performance and life.

- 3. **Voltage Transient Protection** – Metal oxide suppressor across the AC line is combined with RC snubbers across the power bridge to limit potentially damaging high voltage spikes from the AC power source.
- 4. **AC Line Protection** – A high (100K amp) interrupting capacity AC line fuse provides instantaneous protection from peak loads and fault currents. This fuse holder is mounted on the main circuit board of the controller.
- 5. **Isolated Regulator** – Internal DC circuits are isolated from the AC power source for operator and equipment safety and for simplified application. The control reference input common may be grounded or connected without additional isolation to other drive units or grounded external signal sources. Isolation eliminates the common condition of line voltage to ground potentials being present on the speed control potentiometer.
- 6. **Feedback Isolation** –
 - (a) Current Feedback – Isolation by optical coupler.
 - (b) Voltage Feedback – High impedance circuit (two megohms).
- 7. **Feedback** – Two selectable modes of analog feedback are provided. See table for speed regulation characteristics.
 - (a) Armature Feedback – Counter EMF voltage feedback with IR compensation. IR compensation is adjustable to suit individual motor characteristics and optimize speed regulation in this mode.
 - (b) DC Tachometer Feedback – Provides impedance matching, voltage scaling and terminals for accepting a signal from a DC tachometer generator mechanically coupled to the drive motor armature. This results in expanded speed range, improved speed regulation with load changes and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor field heating and other operating variables. The controller will automatically transfer to counter EMF voltage feedback to prevent runaway if the tachometer circuit is open. (A broken tachometer drive coupling will cause the motor to run at maximum speed.) Tachometers producing 7 VDC to 150 VDC at maximum motor speed may be used.

This feature is suitable for use with unidirectional units using DC tachometers.

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETAplus Series
1/6-3 Horsepower

DESIGN FEATURES AND FUNCTIONS (Continued)

8. **Control Voltage** – A transformer coupled 24 VDC power supply isolates all magnetic pushbutton control and logic from the AC power source for operator protection.
9. **Field Supply** – Transient protected, half-wave or full-wave. See table for operating voltages.
10. **Contactorless Design** – Unit is designed for reliable solid state, run-stop operation without an armature contactor. Logic includes a provision to prevent an involuntary restart after a power failure. This feature may be defeated when an external customer furnished AC line contactor is used to control the unit.
11. **Motor Contactor** – Models with a M or U in the catalog number include DC magnetic armature contactors. This provides a positive, two-pole disconnection of the motor armature from the rectified power source. Action of the contactor is sequenced with the SCR regulator to ensure that the DC power circuit is “phased-off” before the contactor is opened. This results in “dry-switching” for improved contactor life. Anti-plug protection is provided to prevent armature reversal until a safe minimum speed is reached. Two types of contactor assemblies are available; Unidirectional (U suffix) which adds contactors to disconnect the motor armature when the control is stopped and Reversing (M suffix) which adds additional contactors to disconnect and reverse the motor armature when the unit is reversed.
12. **Dynamic Braking** – Standard feature of models with a motor contactor. Dynamic braking provides exponential rate braking of the DC motor armature. Included is a DB resistor with an anti-plug circuit to prevent restarting the controller until the braking cycle is complete, thereby preventing a potentially damaging electrical surge and mechanical stress. The DB resistor is rated for stopping a typical load, when the external machine inertia does not exceed that of the motor armature, as shown below.

DB RESISTOR RATINGS											
Model	Component	Voltage	Rated Horsepower								
			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
RBS2	Braking	115V	180	129	103	66	44	34	—	—	—
	Torque (%)	230V	—	—	—	278	190	130	88	62	—
	Stops Per	115V	15	12	11	8	6	2	—	—	—
	Minute	230V	—	—	—	8	6	1	1	1	—
RBS3	Braking	115V	300	215	170	110	75	60	—	—	—
	Torque (%)	230V	—	—	—	400	320	220	145	105	85
	Stops Per	115V	9	6	5	5	4	4	—	—	—
	Minute	230V	—	—	—	5	4	4	3	3	2

13. **Motor Overload** – A nonadjustable electronic circuit continuously monitors motor armature current and shuts down the drive whenever the load exceeds 120% for 80 seconds.
14. **Operator Controls** – All enclosed models with integral operator controls include a speed setting potentiometer and a multi-position switch providing RUN-STOP-JOG functions. The switch is maintained in RUN and STOP positions and a spring return to the center stop position from the momentary JOG position. Jog speed is set by the RUN speed potentiometer. The reversing models, when supplied without a contactor assembly, have an armature reversing power switch which is maintained in the FORWARD or REVERSE run positions. This switch includes a no pass through center position detent which provides a delay when changing

direction. Reversing models with a contactor assembly include a momentary contact FORWARD-REVERSE run switch with a spring return to the center position. This switch controls only low control power since armature switching is accomplished by magnetic contactors. The unit is jogged forward or reverse by the momentary FORWARD-REVERSE switch after selecting the JOG position on the RUN-STOP-JOG switch (the JOG position is maintained on this unit).

15. Selectable Capabilities –

- (a) **DC Tachometer Feedback** – See description under Feedback 7(b).
- (b) **AC Line Starting** – Provision is included to defeat the no-restart-after-power-failure feature to permit run-stop control of unidirectional models by an external AC line contactor. Included is circuitry to assure smooth starting.
- (c) **Torque Regulator** – BETAplus units may be easily reconfigured to function as a torque regulator. In this mode the speed setting potentiometer is used to set and regulate the motor maximum armature current over a range of 0–150% of rated. Accordingly, motor speed is unregulated and will go to a level of 0–100% of rated, depending upon the application load torque.
- (d) **External DC Signal Follower** – These units include isolation and impedance matching circuitry to interface an externally supplied grounded or ungrounded, isolated or non-isolated 0–5 VDC, 0–10 VDC or 4–20 mA DC signal source with the motor controller reference input. This provides a linear transfer of the external signal to motor speed. Typical applications include those where motor speed must be controlled as a function of a process variable such as temperature, weight, flow, pressure, etc. In many applications, the reference signal is obtained from a process instrument controller, or other commercially available transducers with a DC output.
16. **Mechanical Flexibility** – BETAplus units offer outstanding application flexibility. The same basic unit can be used as an open chassis or enclosed package controller.
17. **Horsepower and Voltage Calibration** – Units are shipped calibrated for the maximum horsepower rating and 230V operation. They may be easily recalibrated for any standard horsepower rating within the design range and 115V operation by reconfigurable jumpers.
18. **Customer Use Run Contact** – Form A normally open contact rated five amps at 115 VAC or 30 VDC coordinated with run command may be used for external control and indicating devices.
19. **Visual Status Indicator** – Bicolor LED glows green to show normal operation with the armature current at 100% of rated or less, glows red to show current limit operation.
20. **Control Relay** – Enables remote control of all models and provides an interlock to prevent a restart after a power outage.
21. **Hybrid Circuitry** – Extensive use of surface mount miniature components expands flexibility, enhances reliability, and results in a significant reduction in the size of the controller.
22. **Safety Features** – UL and cUL Listed. Low Voltage Operator Control. Requires reset for restart after power interruption. TENV enclosure. Isolated regulator. High Interrupting Capacity AC Line Fuse.

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

RATINGS

- Horsepower:**
Enclosed 1/6 thru 1 HP @ 115 VAC
 1/2 thru 2 HP @ 230 VAC
Chassis 1/6 thru 1 HP @ 115 VAC
 1/2 thru 3 HP @ 230 VAC
- Service Factor** 1.0
- Duty** Continuous
- Operating Voltages**

OPERATING VOLTAGES				
Power Source (Single-Phase)	Output VDC		Control Reference Voltage ⁽²⁾	Magnetic Control Voltage
	Armature	Field ⁽¹⁾		
115V, 50 or 60 Hz	0-90	50/100	0-5 VDC 0-10 VDC	24 VDC
230V, 50 or 60 Hz	0-180	100/200	4-20 mA	

(1) Unidirectional Models Only

(2) Grounded or Ungrounded. Choice of one reference voltage.

- Overload Capacity** (Armature circuit) . 150% for 1 minute
- Run Speed Potentiometer** 5K ohms, 1/2 W
- Reference Power Supply** 10 VDC
- AC Line Fuse, Interrupting Capacity** 100,000 Amps

ADJUSTMENTS

Potentiometer adjustments are provided for:

- Acceleration Time** 0.2-30 seconds
- Deceleration Time** 0.2-30 seconds
- Minimum Speed** 0-40% of Base Speed
- Maximum Speed** 50-100% of Base Speed
- IR (Load) Compensation** 0-100% of Rated Load
- Torque (Current) Limit** 0-150% of Full Load

ELECTRICAL DATA

TYPICAL APPLICATION DATA											
Component			Ratings								
Rated Horsepower (HP)			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
Rated Kilowatts (kW)			0.124	0.187	0.249	0.373	0.560	0.746	1.120	1.492	2.238
1-Phase AC Input (Full-Load)	Line Amps	115 VAC	3.9	5.0	6.0	8.7	12.4	15.8	—	—	—
		230 VAC	—	—	—	4.2	5.9	8.8	12.6	15.8	22.0
	KVA			0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00
DC Output (Full-Load)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	—	—	—
		180V	—	—	—	2.6	3.8	5.5	8.2	11.6	15.1
	Motor ⁽¹⁾ Field Amps (Maximum)	50V	1.0	1.0	1.0	1.0	1.0	1.0	—	—	—
		100V	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5
		200V	—	—	—	1.0	1.0	1.0	1.0	1.0	1.5
Full-Load Torque (lb-ft) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0
Minimum Transformer KVA for Voltage Matching or Isolation			0.5	0.75	0.75	1.0	1.5	2.0	3.0	5.0	7.5

(1) Does not apply to Permanent Magnet Motors

OPERATING CONDITIONS

- Line Voltage** 115/230 VAC, 50/60 Hz,
Single Phase
- Line Voltage Variation** ±10%⁽¹⁾
- Line Frequency Variation** ±2 Hz
- Ambient Temperature** Enclosed: 0° to 40°C
(32° to 104°F)
Chassis: 0° to 55°C
(32° to 131°F)
- Altitude** 3300 ft. (1000 meters) maximum
- Relative Humidity** 0-95%, noncondensing

(1) Unit will operate down to -15% of rated voltage, although this may prevent rated speed with rated load.

PERFORMANCE CHARACTERISTICS

- Controlled Speed Range** — Zero to motor base speed.
Speed range with respect to specified regulation is shown below.
- Speed Regulation** — Regulation percentages listed are of motor base speed under steady-state conditions.
Normal operation will result in performance equal to or better than specifications.

SPEED REGULATION CHARACTERISTICS					
Regulation Method	Variable				Speed Range
	Load Change 95%	Line Voltage ±10%	Field Heating Cold/ Normal	Temp. ±10°C	
Standard Voltage Feedback with IR Compensation	2%	±1%	5-12%	±2%	50:1
Optional Tachometer Feedback ⁽¹⁾	0.5%	±1%	0.2%	±2%	200:1

(1) Unidirectional Models Only

- Efficiency** — (rated speed/rated load)
 (a) Controller (SCR regulator) 98%
 (b) Complete drive (Controller and motor, typical) 85%

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETAplus Series
1/6-3 Horsepower

MODEL TYPES

BETAplus controllers are offered in twenty-three (23) standard models in six functional groups. The basic chassis models are the nucleus of all the enclosed models; standard covers

can be added to the basic chassis to make an enclosed controller or the enclosed unit may be ordered complete as shown below.

ORDER BY CATALOG NUMBER OR ITEM CODE

Horsepower Range ⁽¹⁾		Catalog Number	Item Code	Function
115 VAC	230 VAC			
ANGLE BRACKET CHASSIS CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-2	RBS2C	57898	Run/Stop ⁽²⁾
		RBS2CU	57899	Armature Contactor Run/Stop and DB
		RBS2CM	57903	Armature Contactor Forward/Reverse and DB
BASIC CHASSIS CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-2	RBS2	64874	Run/Stop ⁽²⁾
		RBS2U	57894	Armature Contactor Run/Stop and DB
		RBS2M	64878	Armature Contactor Forward/Reverse and DB
1/6-1	1/2-3	RBS3	64881	Run/Stop ⁽²⁾
		RBS3U	57895	Armature Contactor Run/Stop and DB
		RBS3M	64882	Armature Contactor Forward/Reverse and DB
NEMA 4/12 ENCLOSED CONTROLLERS WITHOUT OPERATOR CONTROLS				
1/6-1	1/2-2	RBS2B	64875	Run/Stop ⁽²⁾
		RBS2UB	57896	Armature Contactor Run/Stop and DB
		RBS2MB	64879	Armature Contactor Forward/Reverse and DB
NEMA 4/12 ENCLOSED CONTROLLERS WITH INTEGRAL OPERATOR CONTROLS				
1/6-1	1/2-2	RBS2S	64876	Run/Stop/Jog ^{(2) (4)}
		RBS2R	64877	Run/Stop/Jog, Armature Switch Reversing ^{(3) (4)}
		RBS2US	57897	Run/Stop/Jog, Armature Contactor Run and DB ⁽⁴⁾
		RBS2MR	64880	Run/Stop/Jog, Armature Contactor Forward/Reverse and DB ⁽⁵⁾
WASHDOWN DUTY ENCLOSED CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-2	RBS2B-WD	13184	Run/Stop ⁽²⁾
		RBS2UB-WD	13280	Armature Contactor Run/Stop and DB
		RBS2MB-WD	13324	Armature Contactor Forward/Reverse and DB
WASHDOWN DUTY ENCLOSED CONTROLLERS WITH INTEGRAL OPERATOR CONTROLS				
1/6-1	1/2-2	RBS2S-WD	13350	Run/Stop/Jog ^{(2) (4)}
		RBS2R-WD	13362	Run/Stop/Jog, Armature Switch Reversing ^{(3) (4)}
		RBS2US-WD	13364	Run/Stop/Jog, Armature Contactor Run and DB ⁽⁴⁾
		RBS2MR-WD	13378	Run/Stop/Jog, Armature Contactor Forward/Reverse and DB ⁽⁵⁾

*Refer to Remote Operator Stations, Pages 47 and 48.

(1) Units are shipped calibrated for the maximum horsepower ratings shown. Units may be calibrated for other standard ratings by the changing of a Jumper. Units are connected for 230 VAC and are easily reconnected for 115VAC input.

(2) Contactorless Run-Stop Operation

(3) Contactorless Reversing Operation

(4) Jog Speed is set by the Run Speed Potentiometer. Maintained in RUN position, JOG position is momentary with a spring return to STOP.

(5) Jog Speed is set by the Run Speed Potentiometer. Maintained JOG position, Forward/Reverse are momentary.

CONTROLLER WEIGHTS

Model	RBS2C	RBS2CU RBS2CM	RBS2 RBS3	RBS2U RBS2M RBS3U RBS3M	RBS2B, RBS2S RBS2R, RBS2BWD RBS2SWD RBS2RWD	RBS2UB, RBS2MB RBS2US, RBS2MR RBS2UB-WD RBS2MB-WD RBS2US-WD RBS2MR-WD
Weight (Lbs.)	2.0	2.3	3.3	3.8	5.5	6.1

BOSTON GEAR®

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

BETAplus Series
1/6-3 Horsepower

REMOTE STATIONS

ORDER BY CATALOG NUMBER OR ITEM CODE

REMOTE OPERATOR CONTROL STATIONS BETAplus					
Catalog Number	Item Code	Control Elements			Use With Controller Models
		Pushbuttons	Switches	Pots	
RCS1	69362	Run, Stop	—	Motor Speed	ALL
RCS3C	58098	Run, Stop	Run/Jog	Motor Speed Jog Speed	RBS2U, RBS3U, RBS2UB
RCS3D	58099	Run, Stop	Run/Jog	Motor Speed Jog Speed	RBS2, RBS3, RBS2B
RCS6	60239	Fwd, Rev, Stop	—	Motor Speed	RBS2M, RBS3M, RBS2MB
RCS16	58102	—	Run/Stop/Jog	Motor Speed	RBS2U, RBS3U, RBS2UB
RCS17	58103	—	Run/Stop/Jog, Fwd/Stop/Rev	Motor Speed	RBS2M, RBS3M, RBS2MB

Remote Operator Station dimensions shown on Page 48.

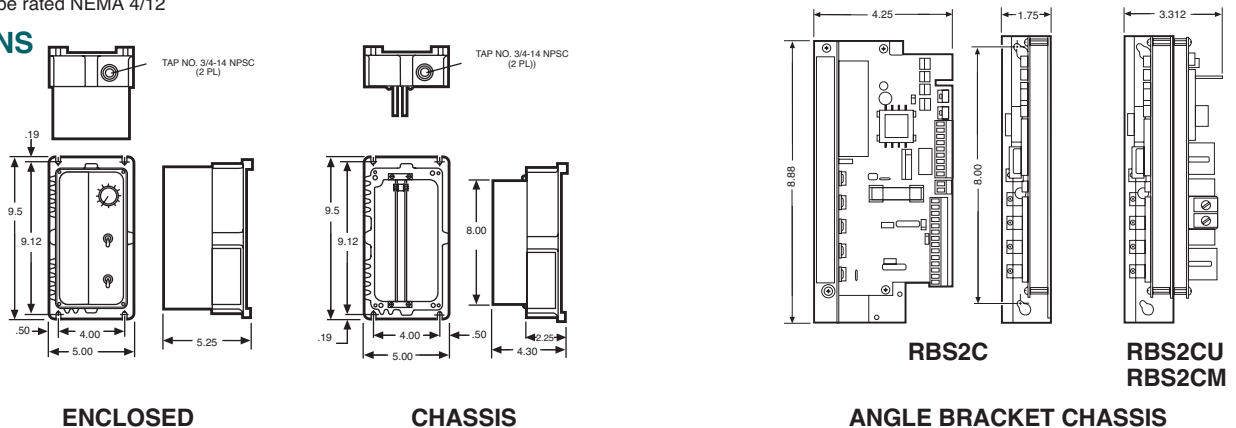
OPTIONS

Options are listed alpha-numerically within each group. Complete option descriptions are listed in the DC option section. To order a controller with the option installed or the modification made, add the option number or letter as a suffix to the controller catalog number e.g. RBS2B-21. To order a kit for field installation, order by item code.

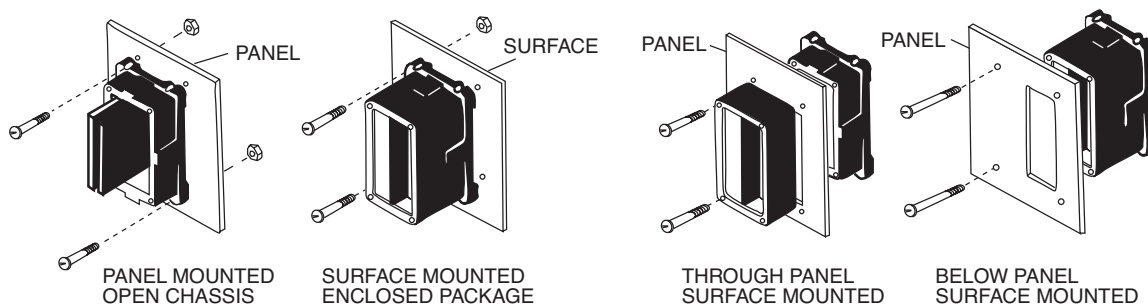
Group	Option	No.	Kit Item Code	Notes
Feedback	Torque (Current) Reference	18E	—	(1)
	DC Tachometer Feedback	24	—	(1)
External	Motor Speed Potentiometer, One Turn	21	—	(2)
	Motor Speed Potentiometer, Ten Turn (Analog)	21A	60168	(3)
	Motor Speed Potentiometer, Ten Turn (Digital)	21B	66103	(3)
	Follower/Manual Mode Selector Switch	38	—	(2)
	Line Starting	LS	—	(1)

- (1) Modifiable Feature of controller
- (2) Unit will not be NEMA 4/12 unless factory installed.
- (3) Unit will not be rated NEMA 4/12

DIMENSIONS



MOUNTING CONFIGURATIONS



BOSTON GEAR®

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

VEplus Series
1/6-5 Horsepower



VEplus series of controllers are a high performance, high quality, general purpose unit which features static conversion of AC line power to regulated DC for nonregenerative, adjustable speed armature control of shunt-wound or permanent magnet DC motors. The VEplus series features an isolated speed reference circuit and use miniature component hybrid assemblies which provide an additional number of standard features and field modifications. This series also incorporates the use of DIP switches and reconnectable jumpers to configure the voltage, horsepower and selectable features of the controller. Supplied in a larger chassis to allow the addition of pre-engineered options and extending the horsepower range to 5 HP make this an ideal choice for your more demanding requirements.

These controllers are designed and manufactured to comply with applicable standards established by the National Electric Code and NEMA pertaining to motor and industrial control equipment. The controllers are UL and cUL Listed.

Motors suitable for application with these controllers are listed in the DC motor section.

DESIGN FEATURES AND FUNCTIONS

1. Construction

- a) **Basic Chassis** – Open chassis constructed of a rugged die-cast aluminum alloy which features a heatsink design consisting of a unique pin configuration with omnidirectional heat dissipation characteristics. This allows the unit to be wall mounted in either a vertical or horizontal position. Conduit entry is provided top and bottom by two (2) 3/4-14 NPSC tapped holes. All open chassis are cooled by natural convection. Additional space is provided in the base for the addition of the optional contactor assemblies and pre-engineered options.
- b) **Enclosed** – Basic chassis unit with the addition of a screw fixed cover which is gasketed with an oil resistant synthetic rubber gasket to meet the provisions for NEMA 4/12, making them suitable for a wide range of wet and dirty industrial environments. The covers are molded of high strength Noryl® engineering plastic. The cover is designed to accept either a blank panel or various local control panels. All models with integral operator controls include flexible boots to seal the operator control switches, and a seal for the motor speed potentiometer. 5 HP units require the use of a fan assembly mounted to the bottom of the heatsink.

2. **Full-Wave Power Conversion** – Full-wave converter configuration consisting of four SCR's and a freewheeling diode provide benefits for optimum motor performance and long service. Power bridge is composed of 600PIV, discrete, encapsulated and electrically isolated devices. The alloy base forms an integral heatsink with the power control devices electrically isolated from the base.

The "full-bridge" configuration offers important benefits over the conventional two SCR semiconductor commonly used. Smoother operation results since two SCR's in series must fire to enable conduction as opposed to one SCR in conventional single-phase converters. This provides broad band immunity to inadvertent SCR firing due to line noise, and contributes to operating safety since the failure of one SCR will not initiate undesired motor rotation when the armature is at rest.

The freewheeling diode improves the form factor which lowers rms currents resulting in reduced motor temperatures by minimizing power dissipation at low speeds. This enhances both motor performance and life.

3. **Voltage Transient Protection** – Metal oxide suppressors across the AC line is combined with RC snubbers across the power bridge to limit potentially damaging high voltage spikes from the AC power source.
4. **AC Line Protection** – A high (100K amp) interrupting capacity AC line fuse provides instantaneous protection

from peak loads and fault currents. The fuse holder is mounted on the main circuit board of the controller. The optional circuit breaker (30) is a two-pole, molded case, magnetic trip circuit breaker which provides a means of manually disconnecting the AC power to the controller and motor and automatic, instantaneous trip protection from a peak load.

5. **Isolated Regulator** – Internal DC circuits are isolated from the AC power source for operator and equipment safety and for simplified application. The control reference input common may be grounded or connected without additional isolation to other drive units or grounded external signal sources. Isolation eliminates the common condition of line voltage to ground potentials being present on the speed control potentiometer.
6. **Feedback Isolation** –
 - (a) **Current Feedback** – Isolation by optical coupler.
 - (b) **Voltage Feedback** – High impedance circuit (two megohms).
7. **Feedback** – Two selectable modes of analog feedback are provided. See Table for speed regulation characteristics.
 - (a) **Armature Feedback** – Counter EMF voltage feedback with IR compensation. IR compensation is adjustable to suit individual motor characteristics and optimize speed regulation in this mode.
 - (b) **DC Tachometer Feedback** – Provides impedance matching, voltage scaling and terminals for accepting a signal from a DC tachometer generator mechanically coupled to the drive motor armature. This results in expanded speed range, improved speed regulation with load changes and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor field heating and other operating variables. The controller will automatically transfer to counter EMF voltage feedback to prevent run away if the tachometer circuit is open. (A broken Tachometer drive coupling will cause the motor to run at maximum speed). Tachometers producing 7 VDC to 150 VDC at maximum motor speed may be used.

This feature is suitable for use with unidirectional units using DC tachometers.

8. **Control Voltage** – A transformer coupled 24 VDC power supply isolates all magnetic pushbutton control and logic from the AC power source for operator protection.
9. **Field Supply** – Transient protected, half-wave or full-wave. See Table for output voltages.
10. **Contactless Design** – Unit is designed for reliable solid state, run-stop operation without an armature contactor.

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

VEplus Series
1/6-5 Horsepower

DESIGN FEATURES AND FUNCTIONS (Continued)

Logic includes a provision to prevent an involuntary restart after a power failure. This feature may be defeated when an external customer furnished AC line contactor is used to control the unit.

- 11. Motor Contactor** – Models with M or U in the catalog number include DC magnetic armature contactors. This provides a positive, two-pole disconnection of the motor armature from the rectified power source. Action of the contactor is sequenced with the SCR regulator to ensure that the DC power circuit is “phased-off” before the contactor is opened. This results in “dry-switching” for improved contactor life. Anti-plug protection is provided to prevent armature reversal until a safe minimum speed is reached. Two types of contactor assemblies are available; Unidirectional (U suffix) which adds contactors to disconnect the motor armature when the control is stopped and Reversing (M suffix) which adds additional contactors to disconnect and reverse the motor armature when the unit is reversed.
- 12. Dynamic Braking** – Standard feature of models with a motor contactor. Dynamic braking provides exponential rate braking of the DC motor armature. Included is a DB resistor with an anti-plug circuit to prevent restarting the controller until the braking cycle is complete, thereby preventing a potentially damaging electrical surge and mechanical stress. The DB resistor is rated for stopping a typical load, when the external machine inertia does not exceed that of the motor armature, as shown below.

DB RESISTOR RATINGS

Model	Component	Voltage	Rated Horsepower										
			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	5	
VES3	Braking Torque (%)	115V	300	215	170	110	75	60	—	—	—	—	
		230V	—	—	—	400	320	220	145	105	85	—	
	Stops Per Minute	115V	9	6	5	5	4	4	—	—	—	—	
		230V	—	—	—	5	4	4	3	3	2	—	
VES5	Braking Torque (%)	115V	1000	960	660	460	320	220	150	100	—	—	
		230V	—	—	—	920	640	440	300	200	160	100	
	Stops Per Minute	115V	15	12	11	8	6	4	3	3	—	—	
		230V	—	—	—	8	6	4	3	3	2	2	

- 13. Motor Overload** – A nonadjustable electronic circuit continuously monitors motor armature current and shuts down the drive whenever the load exceeds 120% for 80 seconds.
- 14. Operator Controls** – All enclosed models with integral operator controls include a speed setting potentiometer and a multi-position switch providing RUN-STOP-JOG functions. The switch is maintained in RUN and STOP positions and a spring return to the center stop position from the momentary JOG position. Jog speed is set by the RUN speed potentiometer. Reversing models with a contactor assembly include a momentary contact FORWARD-REVERSE run switch with a spring return to the center position. This switch controls only low control power since armature switching is accomplished by magnetic contactors. The unit is jogged forward or reverse by the momentary FORWARD-REVERSE switch after selecting the JOG position on the RUN-STOP-JOG switch (the JOG position is maintained on this unit).

15. Selectable Capabilities –

- DC Tachometer Feedback – See description under Feedback 7(b)
- AC Line Starting – Provision is included to defeat the no-restart-after-power-failure feature to permit run-stop control of unidirectional models by an external AC line contactor. Included is circuitry to assure smooth starting.
- Torque Regulator – VEplus units may be easily reconfigured to function as a torque regulator. In this mode the speed setting potentiometer is used to set and regulate the motor maximum armature current over a range of 0–150% of rated. Accordingly, motor speed is unregulated and will go to a level of 0–100% of rated, depending upon the application load torque.
- External DC Signal Follower – These units include isolation and impedance matching circuitry to interface an externally supplied grounded or ungrounded, isolated or non-isolated 0–5 VDC, 0–10 VDC or 4–20 mA DC signal source with the motor controller reference input. This provides a linear transfer of the external signal to motor speed. Typical applications include those where motor speed must be controlled as a function of a process variable such as temperature, weight, flow, pressure, etc. In many applications, the reference signal is obtained from a process instrument controller, or other commercially available transducers with a DC output.

- 16. Mechanical Flexibility** – VEplus series units offer outstanding application flexibility. The same basic unit can be used as an open chassis or enclosed package controller.

- 17. Horsepower and Voltage Calibration** – Units are shipped calibrated for the maximum horsepower rating and 230V operation. They may be easily recalibrated for any standard horsepower rating within the design range and 115V operation by reconfigurable jumpers.

- 18. Customer Use Run Contact** – Form A normally open contact rated five amps at 115 VAC or 30 VDC coordinated with run command may be used for external control and indicating devices.

- 19. Visual Status Indicator** – Bicolor LED glows green to show normal operation with the armature current at 100% of rated or less, glows red to show current limit operation.

- 20. Control Relay** – Enables remote control of all models and provides an interlock to prevent a restart after a power outage.

- 21. Hybrid Circuitry** – Extensive use of surface mount miniature components expands flexibility, enhances reliability, and results in a significant reduction in the size of controllers over competitive models.

- 22. Safety Features** – UL and cUL Listed. Low Voltage Operator Control. Requires reset for restart after power interruption. TENV enclosure. Isolated regulator. High Interrupting Capacity AC Line Fuse.

- 23. Quality Features** – FR4 glass circuit cards. Rugged die-cast aluminum alloy chassis base. High strength Noryl® covers. Conservatively rated components selected for long service life.

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

VEplus Series
1/6-5 Horsepower

RATINGS

- Horsepower:**
Enclosed or Chassis..... 1/6 thru 1 HP @ 115 VAC
..... 1/2 thru 5 HP @ 230 VAC
- Service Factor** 1.0
- Duty** Continuous
- Operating Voltages**

OPERATING VOLTAGES				
Power Source (single-phase)	Output VDC		Control Reference Voltage ⁽²⁾	Magnetic Control Voltage
	Armature	Field ⁽¹⁾		
115V, 50 or 60 Hz	0-90	50/100	0-5 VDC 0-10 VDC 4-20 mA	24 VDC
230V, 50 or 60 Hz	0-180	100/200		

(1) Selectable

(2) Grounded or Ungrounded, choice of one Reference Voltage

- Overload Capacity** (Armature circuit) . 150% for 1 minute
- Run Speed Potentiometer** 5K ohms, 1/2 W
- Reference Power Supply** 10 VDC
- AC Line Fuse, Interrupting Capacity** 100,000 Amps

ADJUSTMENTS

Potentiometer adjustments are provided for:

- Acceleration Time** 0.2-30 seconds
- Deceleration Time** 0.2-30 seconds
- Minimum Speed** 0-40% of base speed
- Maximum Speed** 50-100% of base speed
- IR (Load) Compensation** 0-100% of rated load
- Torque (Current) Limit** 0-150% of full load

PERFORMANCE CHARACTERISTICS

- Controlled Speed Range** — Zero to motor base speed.
Speed range with respect to specified regulation is shown below.
- Speed Regulation** — Regulation percentages listed are of motor base speed under steady-state conditions.
Normal operation will result in performance equal to or better than specifications.

SPEED REGULATION CHARACTERISTICS					
Regulation Method	Variable				Speed Range
	Load Change 95%	Line Voltage ±10%	Field Heating Cold/Normal	Temp. ±10°C	
Standard Voltage Feedback with IR Compensation	2%	±1%	5-12%	±2%	50:1
Optional Tachometer Feedback ⁽¹⁾	0.5%	±1%	0.2%	±2%	200:1

(1) Unidirectional Models Only

- Efficiency (rated speed/rated load)**
(a) Controller (SCR regulator) 98%
(b) Complete drive (Controller and motor, typical) 85%

OPERATING CONDITIONS

- Line Voltage⁽¹⁾** 115/230 VAC, 50/60 Hz, Single Phase
- Line Voltage Variation** ±10%
- Line Frequency Variation** ±2 Hz
- Ambient Temperature** 0° to 40°C (32° to 104°F)
Chassis: 0° to 55°C (32° to 131°F)
- Altitude** 3300 ft. (1000 meters) maximum
- Relative Humidity** 0-95%, noncondensing

(1) Unit will operate down to -15% of rated voltage, although this may prevent rated speed with rated load.

TYPICAL APPLICATION DATA												
			Ratings									
Rated Horsepower (HP)			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	5
Rated Kilowatts (kW)			0.124	0.187	0.249	0.373	0.560	0.746	1.120	1.492	2.238	3.730
1-Phase AC Input (Full-Load)	Line Amps	115 VAC	3.9	5.0	6.0	8.7	12.4	15.8	—	—	—	—
		230 VAC	—	—	—	4.2	5.9	8.8	12.6	15.8	22.0	32.0
	KVA		0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00	5.00	8.00
DC Output (Full-Load)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	—	—	—	—
		180V	—	—	—	2.6	3.8	5.5	8.2	11.6	15.1	25.0
	Motor ⁽¹⁾ Field Amps (Maximum)	50V	1.0	1.0	1.0	1.0	1.0	1.0	—	—	—	—
		100V	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	2.0
200V		—	—	—	1.0	1.0	1.0	1.0	1.0	1.0	1.5	2.0
Full-Load Torque (lb-ft) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0	15.0
Minimum Transformer KVA for Voltage Matching or Isolation			0.5	0.75	0.75	1.0	1.5	2.0	3.0	5.0	7.5	10.0

(1) Does not apply to Permanent Magnet Motors

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

VEplus Series
1/6-5 Horsepower

MODEL TYPES

VEplus controllers are offered in eighteen (18) standard models in three functional groups. The basic chassis models are the nucleus of all the enclosed models.

Standard covers can be added to the basic chassis to make an enclosed controller (a fan assembly must also be added to the VES5 models) or the enclosed model may be ordered complete as shown below.

ORDER BY CATALOG NUMBER OR ITEM CODE

Horsepower Range ⁽¹⁾		Catalog Number	Item Code	Functions
115 VAC	230 VAC			
BASIC CHASSIS CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-3	VES3	64883	Run/Stop ⁽²⁾
		VES3U	57904	Armature Contactor Run/Stop and DB
		VES3M	64884	Armature Contactor Forward/Reverse and DB
1/6-1	1/2-5	VES5	64890	Run/Stop ⁽²⁾
		VES5U	57909	Armature Contactor Run/Stop and DB
		VES5M	64891	Armature Contactor Forward/Reverse and DB
NEMA 4/12 ENCLOSED CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-3	VES3B	64885	Run/Stop ⁽²⁾
		VES3UB	57910	Armature Contactor Run/Stop and DB
		VES3MB	64887	Armature Contactor Forward/Reverse and DB
1/6-1	1/2-5	VES5B	64892	Run/Stop ⁽²⁾
		VES5UB	57926	Armature Contactor Run/Stop and DB
		VES5MB	64894	Armature Contactor Forward/Reverse and DB
NEMA 4/12 CONTROLLERS WITH INTEGRAL OPERATOR CONTROLS				
1/6-1	1/2-3	VES3S	64886	Run/Stop/Jog ^{(2) (3)}
		VES3US	57930	Run/Stop/Jog, Armature Contactor Run and DB ⁽³⁾
		VES3MR	64889	Run/Stop/Jog, Armature Contactor Forward/Reverse and DB ⁽⁴⁾
1/6-1	1/2-5	VES5S	64893	Run/Stop/Jog ^{(2) (3)}
		VES5US	57935	Run/Stop/Jog, Armature Contactor Run/Stop and DB ⁽³⁾
		VES5MR	64896	Run/Stop/Jog, Armature Contactor Forward/Reverse and DB ⁽⁴⁾

(1) Units are shipped calibrated for the maximum HP ratings shown. Units may be calibrated for other standard HP ratings by changing the position of a jumper. Units are connected for 230VAC and are easily reconnected for 115VAC input.

(2) Contactorless Run-Stop operation.

(3) JOG speed is set by the RUN-SPEED potentiometer. Maintained in RUN position, JOG position is momentary with a spring return to STOP.

(4) JOG speed is set by the RUN SPEED potentiometer. Maintained in JOG position. FORWARD/REVERSE are momentary.

*Refer to Remote Operator Station, Pages 47 and 48.

ORDER BY CATALOG NUMBER OR ITEM CODE

REMOTE OPERATOR CONTROL STATIONS VEplus					
Catalog Number	Item Code	Control Elements			Use With Controller Models
		Pushbuttons	Switches	Pots	
RCS1	69362	Run, Stop	—	Motor Speed	ALL
RCS3C	58098	Run, Stop	Run/Jog	Motor Speed Jog Speed	VES3UB VES5UB
RCS3D	58099	Run, Stop	Run/Jog	Motor Speed Jog Speed	VES3, VES5, VES3B, VES5B
RCS6	60239	Fwd, Rev, Stop	—	Motor Speed	VES3MB VES5MB
RCS16	58102	—	Run/Stop/Jog	Motor Speed	VES3UB VES5UB
RCS17	58103	—	Run/Stop/Jog, Fwd/Stop/Rev	Motor Speed	VES3MB VES5MB

Remote Operator Station dimensions shown on Page 48.

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed DC Motor Controllers, Nonregenerative

VEplus Series
1/6-5 Horsepower

OPTIONS

Options and modifications are listed alpha-numerically within each group. Complete option descriptions are listed in the DC option section.

To order a controller with the options installed, add the option number or letter as a suffix to the controller catalog number, e.g. VES3MR-IAB-25A, VES5MB-21A, etc. To order a kit for field installation, order by item code.

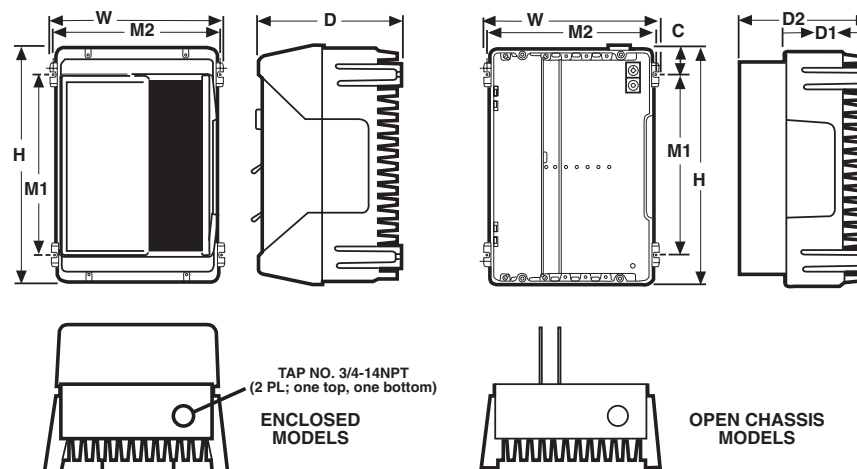
A large number of options, or certain combinations of options may require a larger enclosure or an additional enclosure.

Group	Option	No.	Kit Item Code	Notes
Power	Circuit Breaker (Two-Pole)	30	58091	
Input Signal (plug-in) ⁽²⁾	Follower, Master Override	14	60170	(1, 2)
	Follower, AC or DC Tachometer Generator	22A	60163	(1, 2)
	Follower, Digital Pulse Generator	22B	60270	(1, 2)
	Follower, External DC Signal	25A	60165	(1, 2)
	Follower, AC Current Transducer	25C	—	(1, 2)
	Follower, MIRC	35	60173	(1, 2)
	Precision Reference	47	50390	(1, 2)
Feedback (plug-in) ⁽²⁾	Torque Taper	18A	60164	(1, 2)
	Torque (Current) Limit Control	18B	60164	(1, 2)
	Torque (Current) Reference	18E	—	(6)
	DC Tachometer Feedback	24	—	(6)
	Feedback, AC or DC Tachometer Generator	24A	60162	(1, 2)
	Feedback, Digital Pulse Generator	24B	60269	(1, 2)
Input and Feedback	Centerwind Torque Control	36A	60175	(1, 2, 3)
	Constant Velocity Winder	36B	61285	(1, 2, 3)
Interfaces	Interface Adapter Board	IAB	64907	
External	Line Starting	LS	—	(6)
	Motor Speed Potentiometer, Ten Turn (Analog)	21A	60168	(5)
	Motor Speed Potentiometer, Ten Turn (Digital)	21B	66103	(5)
	Follower/Manual Mode Selector Switch	38	—	(4)
Enclosure	Hinge, Enclosure Cover	50	67539	

Notes: (1) Option IAB (64907) required to use these options
(2) Only one plug-in option in a group is possible
(3) Not to be combined with options from other groups

(4) Will not be NEMA 4/12 unless factory installed
(5) Unit will not be rated NEMA 4/12
(6) Modifiable feature of controller

DIMENSIONS



	H	W	D	D1	D2	M1	M2	C	Weight (lbs.)	
									Chassis	
Enclosed										
VES3	12.1	9.0	7.3	4.1	5.6	9.3	8.6	1.3	9.0	

NOTE: VES5 enclosed models are supplied with a fan assembly.

Single-Phase Adjustable Speed Regenerative DC Motor Controllers



TABLE OF CONTENTS

SPECIFICATION CHART	32
RBA/VEA-RG.....	31-37
OPTIONS FOR DC CONTROLLERS	38-46
APPLICATION ENGINEERING	113-127

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed Regenerative DC Motor Controllers

Specification Chart

The purpose of this chart is to provide a general feature comparison of the Boston Gear controllers. When selecting refer to the specific catalog selection for complete information.

REGENERATIVE DC MOTOR CONTROLLER SPECIFICATIONS			
Features		RBA-RG/VEA-RG	
AC Line (50/60 Hz)	Single-Phase Voltage	115	230
	Three-Phase Voltage	—	—
Range	Maximum Horsepower	1	5
Output	Armature Voltage	90	180
	Field Voltage	50/100	100/200
AC Line Protection	Fuse	S	S
	Circuit Breaker		O
Enclosure	Open Chassis	S	S
	Angle Bracket Chassis	S	S
	NEMA 1	S	
	NEMA 4	S	S
	NEMA 12	S	S
Adjustments	Acceleration (Seconds)	0.2–30	
	Deceleration (Seconds)	0.2–30	
	IR Compensation (%)	10	
	Maximum Speed (%)	50–10	
	Current Limit (%)	10–150	
	Gain		
	Phase Shift		
Horsepower/ Voltage Calibration	Trim Pot Adjustments		
	Resistance Wire	S	
	Plug In Jumpers Switch	S	
Isolated Regulator		O	
Speed Regulation	Standard IR Feedback		
	Percentage	2%	
	Speed Range	50:1	
	Tachometer Feedback		
Input	Percentage	0.5%	
	Speed Range	200:1	
Input	Analog	S	
	Digital		
Tachometer Feedback	Bidirectional	S	
Options	Field Installed	O	
	Factory Installed		
UL/cUL		S	
Pages		33-37	
S-Standard O-Optional			

Single-Phase Adjustable Speed Regenerative DC Motor Controllers

RBA-RG/VEA-RG Series
1/6-5 Horsepower



Boston Gear RBA-RG/VEA-RG regenerative controllers, are economical, general purpose units. The units feature static conversion of AC line power to regulated direct current adjustable speed, four-quadrant armature control of shunt-wound or permanent magnet DC motors. The compact dimensions and design features of the units make this series of controllers an ideal choice for numerous industrial applications which require controllable bidirectional speed and torque for overhauling loads, contactorless reversing and static braking.

RBA-RG & VEA-RG units are identical in standard features and functions and differ only in mechanical configuration and horsepower range. RBA-RG Series units are smaller, are limited to three horsepower maximum and will accept a limited number of options. VEA-RG Series units are physically larger permitting ratings through five horsepower and provide greater available space to facilitate mounting a wide range of optional features. Accordingly, RBA-RG Series units are preferred in space intensive applications where the standard features and functions are adequate for the application. The RBA-RG Series is available as standard in open and enclosed configurations along with the angle bracket chassis style. The VEA-RG Series is available as standard in the open and enclosed configuration.

RBA-RG/VEA-RG controllers are designed and manufactured to comply with applicable standards established by the National Electrical Code and NEMA for industrial motor and control equipment. The units are UL and cUL Listed.

DESIGN FEATURES AND FUNCTIONS

- 1. Construction** – The die-cast aluminum alloy base assembly forms the basic RBA-RG Series open chassis (excluding RBA2C-RG units) which includes regulator electronics, AC line fuse, power conversion and protective circuitry as a totally functional, self-contained unit. The entire back surface of the VEA-RG Series base is a unique, pin configuration heatsink with omni-directional heat dissipation characteristics. This allows vertical or horizontal wall mounting as best suits the available space. All open models are cooled by natural convection. Conduit entry is provided in the base by two 3/4-14 NPT tapped holes, one each on the top and bottom.

Enclosed models consist of the basic chassis with the addition of a screw fixed cover which is gasketed with an oil resistant synthetic rubber gasket to exclude contaminants. Basic enclosed units are TENV, NEMA 4 and 12. All models with integral operator controls also include flexible boots to seal the operator control switches and a seal for the motor speed potentiometer.

RBA3-RG Models, when rated three (3) horsepower as an enclosed unit, requires the use of a stand off kit (Option SK). This is included when an enclosed controller is ordered.

VEA5-RG Models, when rated five (5) horsepower as an enclosed unit, requires the addition of Option VFKT cooling fan assembly. This is included when an enclosed controller is ordered.

VEA-RG Series unit covers are molded of high strength Noryl® engineering plastic. An aperture in the cover permits mounting a blank panel for remote control models or various standard or optional local operator control panels. *Where a hinged cover is desired, Option 50 provides a kit permitting easy field installation.*

RBA-RG Series unit covers are die-cast aluminum alloy. Various cover models are provided. Blank face models include no operator control elements, as they are intended for remote control operation. The local control model provides a motor speed potentiometer and Run/Stop Jog toggle switch.

RBA2C-RG Models are offered only in a special space saving chassis configuration, formed of aluminum into a Right Angle chassis design, which requires only two (2) mounting screws.

- 2. Full-Wave Power Conversion** – Dual full-wave converter configuration, consists of eight (8) SCRs connected in back to back bridges of four (4) SCRs each. The SCR's are rated 600 PIV minimum.
- 3. Voltage Transient Protection** – Metal oxide suppressor with RC snubbers across the AC line input and a second RC snubber across the DC output.
- 4. AC Line Protection** – A 100,000 ampere interrupting capacity AC line fuse provides instantaneous protection from peak loads and fault currents. This line fuse is located inside the controller. A molded-case magnetic-trip circuit breaker (Option 30) is available for VEA-RG Model controllers, which provides a manual disconnection to the controller, and also provides automatic instantaneous trip protection from a peak load.
- 5. AC Line Power** – Controllers are reconnectable for 115 or 230 VAC, single-phase, 50 or 60 Hertz.
- 6. Safety Features** – UL listed and cUL. Requires mandatory restart after power interruption.
- 7. AC Line Starting** – Provision is included to defeat the mandatory restart after power interruption to permit run-stop control of the units by an external AC line contactor.
- 8. Deadband Selection** – This will help to eliminate “creeping” motor speed with zero speed reference signal. It gives a non-adjustable $\pm 2\%$ deadband around zero speed.
- 9. Field Supply** – Transient protected, full-wave and half-wave field supply.
- 10. Operator Controls** – Units with a “S” suffix in the catalog number (example: RBA2S-RG) contain a motor speed potentiometer and a Run-Stop-Jog switch. The speed potentiometer is reconnectable for unidirectional or bidirectional operation.

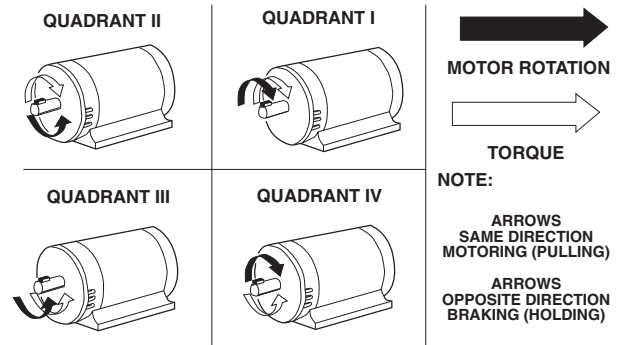
RATIOTROL SYSTEMS

Single-Phase Adjustable Speed Regenerative DC Motor Controllers

RBA-RG/VEA-RG Series
1/6-5 Horsepower

DESIGN FEATURES AND FUNCTIONS (Continued)

11. **Static Reversing** – Solid state, electronic reversal of the motor armature. No reversing contacts to burn, arc or wear.
12. **Static Braking** – Provides smooth regeneration braking of the DC drive motor. Braking is effective whenever the manual speed control potentiometer is reset to command a reduction in speed or change in the direction of motor rotation.
13. **DC Tachometer Feedback** – Unit includes terminals to accept a 5.5 to 100VDC/1000 RPM (1750 RPM maximum) signal from a motor mounted DC tachometer generator for improved speed regulation.
14. **External Current (Torque) Control** – Terminals are provided for external forward and reverse current limit (torque) control.
15. **Diagnostic LED** – A dual color LED, green for power on, red for current limit is provided.
16. **Customer Use Run Contacts** – Form A normally open contact rated five (5) amps at 115 VAC or 30 VDC coordinated with run command may be used for external control and indicating devices. May be applied as pushbutton seal-in or a drive “RUN” contact.
17. **Hybrid Circuitry** – Miniature components in a custom surface mount assembly, improve reliability and make possible more features in the smallest possible mechanical configuration.
18. **Option Connectors** – These connectors are provided for options that fit in a space provided inside the controller.
19. **Dynamic Braking** – Standard feature of model numbers with a “U” suffix. Dynamic braking provides exponential rate braking of the DC motor armature. Included is a Dynamic Braking resistor with an anti-plug circuit to prevent restarting the controller until the braking cycle is complete, thereby preventing a potentially damaging contact arcing. The Dynamic Braking resistor is rated for stopping a typical load, when the external machine inertia does not exceed that of the motor armature, as shown in table.
20. **Control Voltage** – A transformer coupled 24 VDC power supply provides non-isolated control power for all magnetic control logic and operator controls.
21. **DIP Switch Settings** – An 8-position DIP Switch is used to program the controller for various applications and operations.
22. **Motor Contactor** – Controller model numbers with a “U” suffix, e.g., RBA2U-RG, VEA5US-RG, have a DC magnetic armature contactor, which disconnects both motor armature leads from the controller. An antiplug circuit ensures that the contactor does not make or break DC from the SCR bridge.



PRINCIPLES OF OPERATION

Regenerative adjustable speed drives, also known as four-quadrant drives, are capable of controlling not only the speed and direction of motor rotation, but also the direction of motor torque. This is illustrated to the right.

The term regenerative describes the ability of the drive under braking conditions to convert the mechanical energy of the motor and connected load into electrical energy which is returned (or regenerated) to the AC power source.

When the drive is operating in Quadrants I and III, both motor rotation and torque are in the same direction and it functions as a conventional nonregenerative unit. The unique characteristics of a regenerative drive are apparent in Quadrants II and IV. In these quadrants the motor torque opposes the direction of motor rotation which provides a controlled braking or retarding force. A high performance regenerative drive, such as the RBA-RG/VEA-RG Series, is able to switch rapidly from motoring to braking modes while simultaneously controlling the direction of motor rotation.

RATINGS

1. **Horsepower Range** 1/6-5 HP
2. **Power Source** 115 or 230 VAC, Single-Phase, 50 or 60 Hz
3. **Operating Voltages**

OPERATING VOLTAGES

Power Source (Single-Phase)	Output VDC		Control Reference Voltage	Magnetic Control Voltage
	Armature	Field		
115V, 50 or 60 Hz	0-90	50/100	0 to ±10 VDC	24 VDC
230V, 50 or 60 Hz	0-180	100/200		

4. **Service Factor** 1.0
5. **Duty** Continuous
6. **Overload Capacity (Armature Circuit)** 150% for 1 Minute
7. **Line Fuse Interrupting Capacity (Non-Isolated)** 100,000 Amps
8. **Reference Power Supply (Non-Isolated)** ±10VDC
9. **Run Speed Potentiometer** 10K ohms, 1/2 W
10. **Current/Torque Reference Potentiometer** 10K ohms, 1/2 W

DYNAMIC BRAKING CHARACTERISTICS (1) (2)

Rated Component	Rated Model	Rated Horsepower Voltage	Rated Horsepower											
			1/6	1/4	1/3	1/2	3/4	1	1½	2	3	5		
Braking Torque (%)	RBA2-RG 115V	180	129	103	66	44	34	N/A	N/A	N/A	N/A			
	230V	N/A	400	278	200	138	93	66	N/A	N/A				
	RBA3-RG 230V	115V	300	214	171	111	74	57	N/A	N/A	N/A	N/A		
		N/A	N/A	N/A	462	316	218	146	103	79	N/A			
	VEA5-RG 115V	600	429	343	222	148	114	N/A	N/A	N/A	N/A			
	230V	N/A	N/A	923	632	436	293	207	159	96				
Stops Per Minute	RBA2-RG 115V	15	12	11	8	6	2	N/A	N/A	N/A	N/A			
	230V	N/A	12	8	6	2	1	1	N/A	N/A				
	RBA3-RG 230V	115V	9	6	5	5	4	4	N/A	N/A	N/A	N/A		
		N/A	N/A	N/A	5	4	4	3	3	2	N/A			
	VEA5-RG 115V	15	12	10	10	7	7	N/A	N/A	N/A	N/A			
	230V	N/A	N/A	N/A	10	7	7	5	5	3	2			

- Notes:** (1) Ratings shown for units with contactor board (Model number contains “U” suffix, ex RBA3U-RG).
(2) High inertia loads may extend braking time and cause the wattage rating of the dynamic braking resistors to be exceeded.

Single-Phase Adjustable Speed Regenerative DC Motor Controllers

RBA-RG/VEA-RG Series

1/6-5 Horsepower

ADJUSTMENTS

Potentiometer adjustments are provided for:

1. **Current Limit**.....10-150% Full-Load Torque
(Independent forward and reverse circuits)
2. **Maximum Speed**50-100% of Motor Base Speed
3. **IR (Load) Compensation**10% Boost
4. **Acceleration**0.2 to 30 Seconds
5. **Deceleration**0.2 to 30 Seconds
6. **Deadband (Yes or No Adjustment)**0 or $\pm 2\%$
7. **Jog Speed**.....0 to 100% of Motor Base Speed

OPERATING CONDITIONS

1. **Line Voltage Variation** $\pm 10\%$ of rated
2. **Line Frequency Variation**..... ± 2 Hz
3. **Ambient Temperature** (1)0°C to 40°C
(32°F to 104°F)
4. **Altitude (Standard)**.....1000 meters
(3300 feet) Maximum
5. **Relative Humidity**.....95% Noncondensing

(1) 0°C to 55°C (32°F to 131°F) maximum in enclosed areas where chassis models are mounted.

PERFORMANCE CHARACTERISTICS

1. **Controlled Speed Range** – Zero to motor base speed. Speed range with respect to specified regulation is listed in Table. See page I2 for continuous duty application limitations of DC motors.
2. **Speed Regulation** – Regulation percentages shown in Table below are of motor base speed under steady-state conditions.
3. **Efficiency** (Rated speed/Rated load)
 - (a) Controller SCR regulator98%
 - (b) Complete drive with motor (typical)85%
5. **Current Ripple Frequency**120 Hz (60 Hz line)
100 Hz (50 Hz line)
4. **Controller Bandwidth (Speed of Response)**5 Hz

SPEED REGULATION CHARACTERISTICS

Regulation Method	Variable				Speed Range
	Load Change 95%	Line Voltage $\pm 10\%$	Field Heating Cold/Normal	Temp. $\pm 10^\circ\text{C}$	
Standard Voltage Feedback with IR Compensation	2%	$\pm 1\%$	5-12%	$\pm 2\%$	50:1
Tachometer Feedback with 5 PY DC Tach Feedback	0.5%	$\pm 1\%$	0.2%	$\pm 2\%$	200:1

TYPICAL APPLICATION DATA

Component			Ratings									
Rated Horsepower (HP)			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	5
Rated Kilowatts (kW)			0.124	0.187	0.249	0.373	0.560	0.746	1.120	1.492	2.238	3.730
1-Phase AC Input (Full-Load)	Line Amps	115V Unit	3.9	5.0	6.0	8.7	12.4	15.8	—	—	—	—
		230V Unit	—	—	—	4.2	5.9	8.8	12.6	15.8	22.0	32.0
	KVA		0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00	5.00	8.00
DC Output (Full-Load)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	—	—	—	—
		180V	—	—	—	2.6	3.8	5.5	8.2	11.6	15.1	25.0
	Motor Field Amps	RBA-RG	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	—
VEA-RG		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Full Load Torque (lb-ft) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0	15.0
Minimum Transformer KVA for Voltage Matching or Isolation			0.5	0.75	0.75	1.0	1.5	2.0	3.0	5.0	7.5	10.0

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed Regenerative DC Motor Controllers

RBA-RG/VEA-RG Series
1/6-5 Horsepower

MODEL TYPES

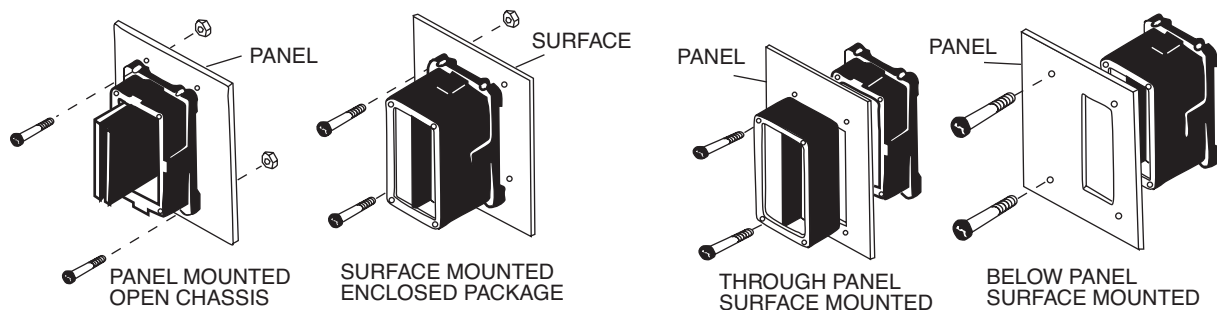
RBA-RG/VEA-RG controllers are offered in eighteen (18) standard models in four (4) functional groups. The basic chassis models are the nucleus of all the enclosed models; standard covers and contactor assemblies can be added to the basic chassis to make an enclosed controller or the enclosed unit may be ordered complete as shown below.

ORDER BY CATALOG NUMBER OR ITEM CODE

Horsepower Range ⁽¹⁾		Catalog Number	Item Code	Function
115 VAC	230 VAC			
ANGLE BRACKET CHASSIS UNITS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-2	RBA2C-RG	68402	Run/Stop(4)
		RBA2CU-RG	68411	Bidirectional with Armature Contactor and DB
BASIC CHASSIS CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-2	RBA2-RG	68385	Run/Stop(4)
		RBA2U-RG	68388	Bidirectional with Armature Contactor and DB
1/6-1	1/2-3	RBA3-RG	68397	Run/Stop(4)
		RBA3U-RG	68400	Bidirectional with Armature Contactor and DB
1/6-1	1/2-5	VEA5-RG	68440	Run/Stop(4)
		VEA5U-RG	68441	Bidirectional with Armature Contactor and DB
NEMA 4/12 ENCLOSED CONTROLLERS WITHOUT OPERATOR CONTROLS*				
1/6-1	1/2-2	RBA2B-RG	68392	Run/Stop(4)
		RBA2UB-RG	68394	Bidirectional with Armature Contactor and DB
1/6-1	1/2-3	RBA3B-RG	68419	Run/Stop(2)(4)
1/6-1	1/2-5	VEA5B-RG	68442	Run/Stop(3)(4)
		VEA5UB-RG	68443	Bidirectional with Armature Contactor and DB(3)
NEMA 4/12 ENCLOSED CONTROLLERS WITH OPERATOR CONTROLS*				
1/6-1	1/2-2	RBA2S-RG	68395	Run/Stop/Jog(4)(5)
		RBA2US-RG	68396	Bidirectional with Armature Contactor and DB
1/6-1	1/2-3	RBA3S-RG	68424	Run/Stop/Jog(2)(4)(5)
1/6-1	1/2-5	VEA5S-RG	68444	Run/Stop/Jog(3)(4)(5)
		VEA5US-RG	68445	Bidirectional with Armature Contactor and DB

*Refer to Remote Operator Stations on Pages 47 and 48

- (1) Units are shipped calibrated for the maximum horsepower ratings shown. Units may be calibrated for other standard ratings by the removal of jumpers. Units are connected for 230 VAC and are easily reconnected for 115 VAC input.
- (2) Includes option SK, Spacer Kit, as standard.
- (3) Includes option VFKT, Cooling Fan, as standard.
- (4) Contactorless Run-Stop Operation.
- (5) Jog Speed is set by the Run Speed potentiometer, maintained in the Run position, Jog position is momentary with a spring return to Stop.



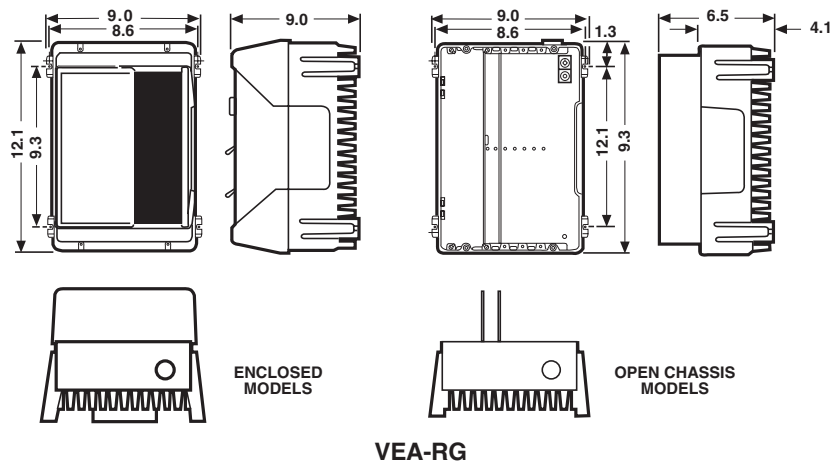
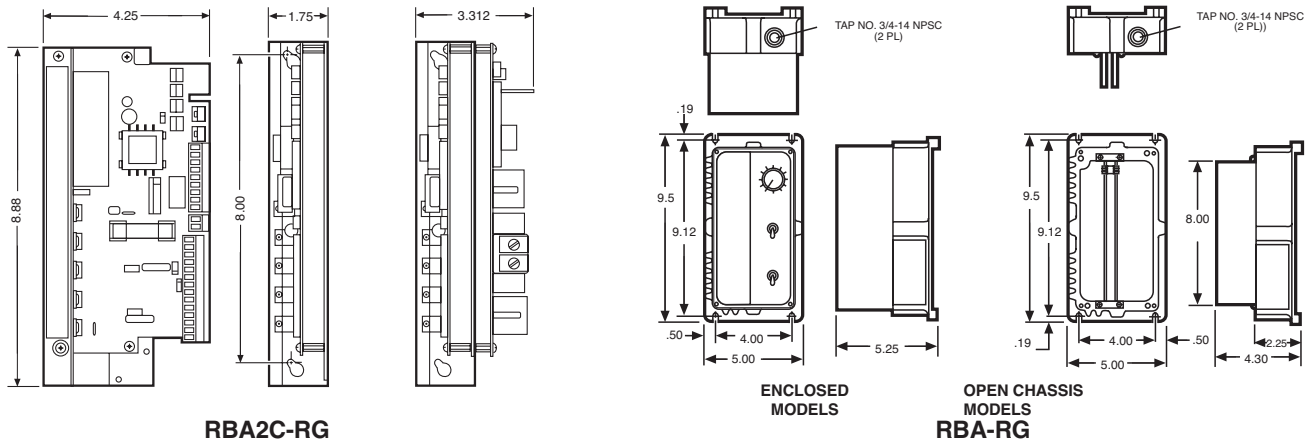
RBA-RG Series Mounting Configurations

RATIOTROL SYSTEMS

Single-Phase Adjustable Speed Regenerative DC Motor Controllers

RBA-RG/VEA-RG Series
1/6-5 Horsepower

DIMENSIONS



CONTROLLER WEIGHTS	
Unit	Weight lbs.
RABA2-RG, RBA3-RG	7.70
RBA2U-RG, RBA3U-RG	8.50
RBA2B-RG, RBA3B-RG RBA2S-RG, RBA3S-RG	11.60
RBA2UB-RG RBA2US-RG	12.40
RBA2C-RG	2.00
RBA2CU-RG	2.25
VEA5-RG	8.20
VEA5U-RG	8.90
VEA5B-RG VEA5S-RG	12.50
VEA5UB-RG VEA5US-RG	13.20

OPTIONS

The versatility of the RBA-RG/VEA-RG Series controllers for various applications can be extended by selecting one (1) or more of the listed options. Most can be easily added in the field via simplified instructions provided. The table below lists the options in functional groups along with information on allowable combinations and installation complexity.

Allowable Option Combinations

Remarks	Option	Catalog Number	Kit Number	Notes
Enclosure Options —Choice of any or all within this group. May be combined with options from any other group.	Hinge kit to allow the cover to swing open	50	67539	
	Spacer kit for RBA3B-RG, RBA3S-RG enclosed controllers	SK	68416	
Power Options	Circuit Breaker—Two Pole (VEA-RG only)	30	68456	
Accel/Decel Option	Four-Quadrant Acceleration/Deceleration	17	68457	
Circuit Board Options — Choice of one within this group	Torque Taper	18	68458	(1)
	Pulse Tachometer Feedback/Follower	24B	68462	(1)
	Isolated Input	25	68478	
	Limit Switch Reversing	RI	68461	(1)
External Options — Choice of any or all within this group	Motor Speed Potentiometer, One-Turn	21	—	(2)
	Motor Speed Potentiometer, Ten-Turn With Analog Dial	21A	66929	(2)
	Option Guide Card Kit	MK	68476	(1)
	Option/Contactor Mounting Kit for RBA2C-RG	SKO	64101	

(1) Option MK is a pre-requisite to enable the use of options in the VEA-RG Series.
(2) Will not be NEMA 4/12 unless factory installed.