Boston Gear®
Ratiotrol®
DC Motor Speed Control

Installation and Operation

Doc. No. 83721

RG1 and RG2 Models
1/6 - 1 HP

Boston Gear

GENERAL INFORMATION

DESCRIPTION

Series RG Controllers statically convert single-phase AC line power to regulated half-wave DC for adjustable-speed, four-quadrant armature control of shunt-wound and permanent magnet motors. Series RG Controllers control the speed and direction of motor rotation and also the direction of motor torque. Applications include those which require controllable bidirectional speed and torque for overhauling loads, contactorless reversing, and static braking.

MODEL TYPES

Motor RG Controllers are offered in two standard models as shown in Table 1.

TABLE 1. MODEL TYPES

MODEL	HP RANGE	POWER SOURCE (single-phase)	OUTPUT VDC	
			Armature	Field
RG1	1/6-1/2	115V 50 or 60 Hz	0-90	50/100
RG2	1/3-1	230V 50 or 60 Hz	0-180	100/200

MOTOR SELECTION

Motor may be shunt-wound or permanent-magnet DC type. Since the controller output is half-wave, and since motors are normally designed for full-wave current, the motor horsepower rating must be greater than that of the controller. See Table 2.

CAUTION **FAILURE TO USE A MOTOR WITH HP RATING GREATER THAN THAT OF THE CONTROLLER CAN CAUSE MOTOR DAMAGE RESULTING FROM OVERHEATING.**

ENCLOSURE

Non-ventilated, dust resistant, NEMA Type 1, constructed of die cast aluminum alloy. The enclosure forms an integral heat sink with the power control devices electrically isolated from the enclosure. Complete controller is attached to the front cover, which can be removed from the enclosure by removing four screws.

OPERATOR CONTROLS

The operator controls are integrally mounted on the front cover. Included are:

1. **POWER ON/OFF Toggle Switch** - Provides motor start and stop functions. Switch is maintained in ON and OFF positions.
2. **MOTOR SPEED Potentiometer** - Provides speed and direction control. Pot may be reconnected for unidirectional operation.

RATINGS

1. Service Factor 1.0
2. Duty . . . . . .Continuous
3. Overload Capacity . . . . . .150% for 1 minute
4. Motor Speed Potentiometer . . . . . .1 00K, 1/2 W

OPERATING CONDITIONS

1. Line Voltage VariatioN. . . . . .-0 to + 10% of rated (1)
2. Line Frequency Variation . . . . . .2 Hertz
3. Ambient Temperature . . . . . 0 to 40°C
. . . . . .(32°F to 104°F)
4. Altitude (standard) . . . . . 1000 meters (3300 feet) maximum

NOTE: (1) Low line voltage may prevent the motor from attaining rated speed under full-load conditions, or may cause fuse blowing or controller damage. See "Adjustment Instructions," note 2.

FIGURE 1. SERIES RG REGENERATIVE CONTROLLER

TABLE 2. MODEL TYPES

Component			Ratings					
Rated Horsepower (HP)			1/6	1/4	1/3	1/3	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	4.7	6.0	7.1	10.0	-	-
		230V Unit	-	-	3.6	4.9	6.8	10.2
	Controller KVA.58		.69	.83	1.15	1.64	2.35	
	Transformer KVA(1)		.75	1.00	1.00	1.50	2.00	3.00
DC Output (Full Load)	Full Load Motor Amps	90V	2.0	2.8	3.5	5.4	-	-
		180V	-	-	1.8	2.6	3.8	5.5
	Maximum Motor Amps	90V	3.0	4.2	5.3	7.1	-	-
		180V	-	-	2.7	3.9	5.7	7.2
	Motor Field Amps	50V/100V	1.0	1.0	1.0	1.0	1.0	1.0
		100V/200V	1.0	1.0	1.0	1.0	1.0	1.0
Recommended Motor Nameplate Horsepower Rating (KW) (2) (3)			1/2 (0.373)	1/2 (0.373)	3/4 (0.560)	3/4 (0.560)	1 1/2 (1.12)	1 1/2 (1.12)
Full-load torque (lb-ft) with 1750 RPM base speed motors			0.50	0.75	1.0	1.5	2.2	3.0
Controller Weight			2.0 lbs. (0.9) Kg					

NOTES (1) If a line isolation transformer is used, half-wave DC flows in the transformer secondary, which may cause transformer saturation and overheating. Therefore, the transformer KVA rating must be greater than the controller KVA rating, as shown in the table.
(2) Since the controller is a half-wave converter, the motor HP rating must be greater than the controller HP rating because motor heating will be greater for any given load or speed than with a full-wave converter.
(3) Motor HP ratings less than recommended may prevent the motor from attaining rated torque.

PERFORMANCE CHARACTERISTICS

1. Controlled Speed Range..... 0 to motor base speed
2. Speed Regulation (See Table 3) - Regulation percentages are of motor base speed under steady-state conditions.

TABLE 3. SPEED REGULATION CHARACTERISTICS

Regulation Method		Variable			
	Load Change	Line Voltage	Field Heating	Temperature	Speed Range
	95%	+/-10%	Cold/Normal	+/-10	
Standard Voltage Feedback with IR Compensation	2%	+/- 1%	5-12%	+/- 2%	50:1

3. Efficiency (at maximum speed and rated load)
   a. Controller 97%
   b. Controller with motor 87%
4. Displacement Power Factor 86%
   (at maximum speed and rated load)
5. Acceleration Control . . . . . .By current limit
6. Bandwidth (1) . . . . . .10 Hz
7. Current Form Factor (2) 2.22
8. Current Ripple Frequency (1) . . . . . .60 Hz.

(1) With a 60 Hz. power source (2) At motor base speed and rated load

ADJUSTMENTS

1. Current Limit . . . . . .50 to 150% of full-load torque
   (Independent forward and reverse circuits)
2. IR Compensation . . . . . .0 to 100% of rated load
3. Maximum Speed . . . . . .60 to 100% of motor base speed
   (Common forward and reverse circuit)

INSTALLATION AND WIRING

1. Report shipping damage immediately to the carrier.
2. Unpack the controller and remove all packing material.
3. Remove the four screws on the front cover, and remove the cover from the enclosure.

4. Check components in the controller. All damaged components must be replaced.
5. Remove the applicable calibration shunt wire(s) with a wire cutter, as shown in Table 4 and Figure 2.

CAUTION **FAILURE TO REMOVE THE CORRECT SHUNT WIRE(S) CAN CAUSE MOTOR DAMAGE.**

6. For 50 Hertz operation, remove the 60 Hz jumper wire from the circuit board with a wire cutter. (See Figure 2.)
7. The controller is designed for surface mounting in a dry location. Never mount the controller immediately beside or above heat-generating equipment, or directly below water or steam pipes.
8. If the controller is subjected to external vibrations, it must be shock mounted. Vibration can cause broken connections and component damage.
9. Mount the enclosure with its 1-1/8 inch diameter conduit hole at the bottom to ensure adequate clearance between the external wiring and controller components. See Figure 3 for dimensions.
10. Be sure the line voltage and frequency are compatible with the rating of the controller.
11. Insert external wiring through the enclosure conduit hole. Use #14 AWG stranded wire. Comply with the National and local electrical codes. Oversized or solid wire, as well as the use of large screw drivers, can break terminal strip barriers.
12. Connect the motor and single-phase power to the controller as shown in Figure 2. If unidirectional operation is desired, rewire the MOTOR SPEED pot as shown. Then, remove the pot's bidirectional dial plate, thereby revealing a unidirectional dial plate.

STARTUP AND OPERATION

1. Recheck the wiring before applying power.

CAUTION **INCORRECT WIRING AND ACCIDENTAL GROUNDS CAN DAMAGE THE CONTROLLER.**

2. Replace the front cover on the enclosure and tighten the four screws.
3. Turn the MOTOR SPEED pot to zero on its dial.
4. Place the POWER ON/OFF switch in OFF position.
5. Apply AC input power to controller Terminals 3 and 4.
6. Place the POWER ON/OFF switch in ON position.
7. Slowly turn the MOTOR SPEED pot until the motor rotates.

NOTE: If motor rotation is opposite to that desired, turn-off the POWER ON/OFF switch and the AC input power, and interchange the motor armature leads at the motor connection box.

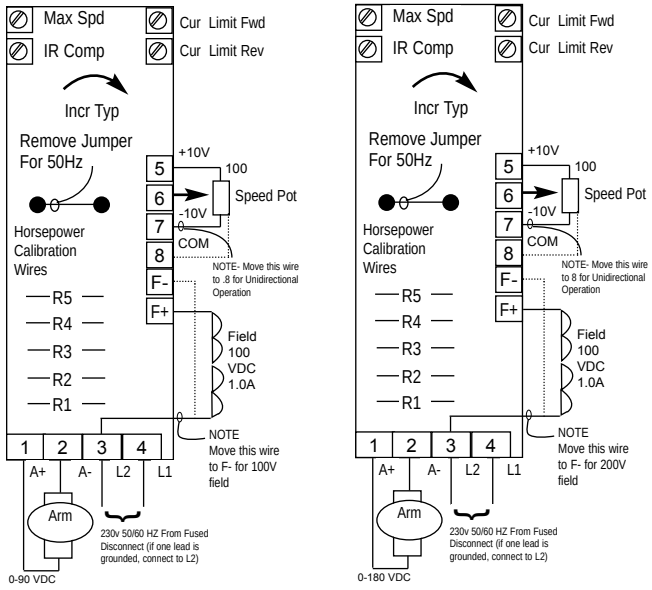
WARNING **WHENEVER AC POWER IS APPLIED TO THE CONTROLLER, POTENTIALLY HAZARDOUS VOLTAGE IS PRESENT ON THE ARMATURE AND FIELD TERMINALS. THIS VOLTAGE CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.**

8. To obtain top speed, turn the MOTOR SPEED pot to 100 on its dial.
9. If the controller is wired for bidirectional operation, turning the MOTOR SPEED pot clockwise from zero rotates the motor in the forward direct tion, and turning it counterclockwise from zero results in reverse rotation. When the pot is in center position (0), motor speed is zero.

NOTE: If motor base speed cannot be reached or speed regulation is inadequate, refer to Table 5.

Table 4. Calibration Wires

Controller HP Rating		Remove Shunt Wires
Model RG1	Model RG2	
1/5	1/3	R3, R4, R5
1/4	1/2	R4, R5
1/3	3/4	R5
1/2	1	None



MODEL RG1 **MODEL RG2**

FIGURE 2. CONNECTION DIAGRAM

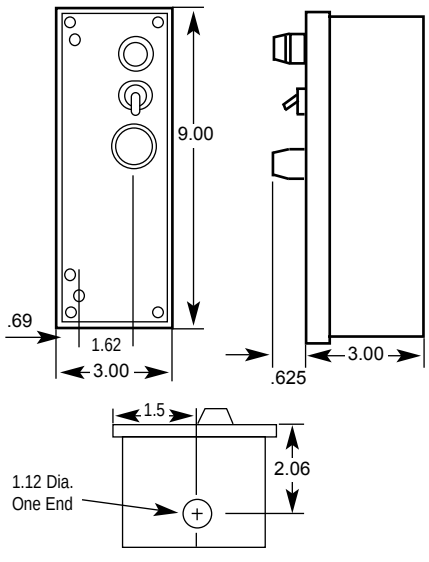


FIGURE 3. SERIES RG DIMENSION

10. To stop the motor, either turn the MOTOR SPEED pot to zero for regenerative braking, or place the POWER ON/OFF switch in OFF position, thereby allowing the motor to coast to a stop.

NOTE: Whenever the AC input power to Terminals 3 and 4 is interrupted (turned-off), the controller must be reset when the AC power is restored by placing the POWER ON/OFF switch in OFF position, then in ON position, thereby preventing accidental restarting.

MAINTENANCE

Maintenance consists of keeping the controller clean and dry. Refer to maintenance instructions supplied by the motor manufacturer. A fuse is located on the front cover. If the motor doesn't rotate, turn-off the AC input power and check the fuse. Remove the fuse by unscrewing the plastic fuse holder cap. If the fuse is blown, replace it with an exact replacement.

CAUTION **SUBSTITUTE FUSES CAN CAUSE CONTROLLER DAMAGE.**

If the replacement fuse blows, turn-off the AC input power and refer to Table 5. Most controller failures are caused by incorrect connections, overload, or the accumulation of dirt, dust, or moisture. If motor operation becomes faulty, proceed as follows:

WARNING **BE SURE THE AC INPUT POWER IS TURNED-OFF BEFORE WORKING ON THE CONTROLLER. High voltage within the controller can cause electric shock resulting in personal injury or loss of life.**

1. Check for: a. Blown fuse. b. Loose or missing terminal screws. c. Unattached wires. d. Charred, darkened, or punctured components and wires.
2. If the MOTOR SPEED pot feels rough or stiff when rotated, an open or shorted pot is indicated.
3. Measure the AC input voltage to the controller on Terminals 3 and 4, and compare with controller rating.

ADJUSTMENT INSTRUCTIONS

The controller is factory tested and adjusted with a motor under simulated operating conditions. Therefore, with the possible exception of maximum speed, internal readjustments are not normally necessary. If the internal pots are changed from the factory settings, or to change the operating characteristics of the controller, the following adjustments can be made.

1. Turn the CUR LIMIT FWD and CUR LIMIT REV pots fully clockwise. If a lower limit of current is required, these pots can be readjusted to limit armature current to as low as 50% of rated.
2. If motor speed is unstable, turn the IR COMP pot counterclockwise until speed stabilizes.

NOTE: If IR COMP pot is turned too far counterclockwise top speed will be reduced.

3. Turn the MAX SPD pot to obtain motor base speed or less when the MOTOR SPEED pot is set at 100 on its dial.

CAUTION **DO NOT EXCEED MOTOR BASE SPEED. Overspeed may cause controller damage.**

NOTES:
1. Line voltage less than rated may prevent the motor from attaining rated base speed when operating with full load.
2. If maximum speed is set too high and line voltage is less than rated, the controller fuse may blow when motor speed is decreased rapidly. If this occurs, perform either one of the following:
   a. Decrease maximum speed with the MAX SPD pot to equal the percentage that the line voltage is below rated. For example, if the line voltage is 10% below rated, decrease maximum speed by 10%. In this case, if the motor base speed is rated at 1750 RPM, set maximum speed at or below 1575 RPM.
   b. Increase line voltage with an autotransformer to equal the controller rating (-0, +10%).

CAUTION **CONTINUAL FUSE BLOWING CAN CAUSE CONTROLLER DAMAGE.**

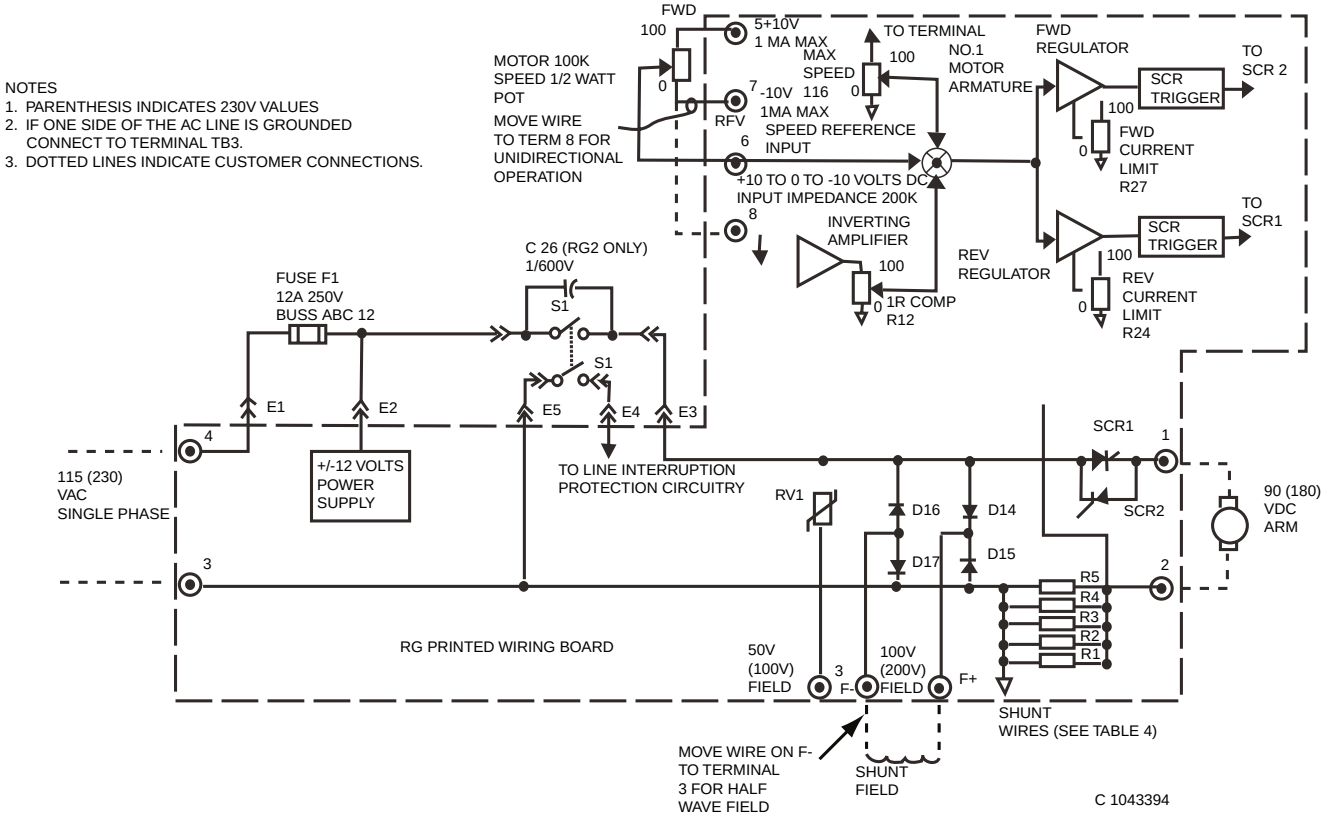


FIGURE 4. SCHEMATIC, RG CONTROLLER

TABLE 5. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. Controller fuse blows when AC input power is applied to the controller.	Wiring faulty, incorrect or grounded	Check all external wiring terminating in the controller
	Motor shunt field shorted or grounded	Repair or replace motor.
	Components shorted	Check Diodes D12, D13, D14. and D15. Varistor RV1, and SCR's SCR1 and SCR2. Replace shorted components or the circuit board.
2. Controller fuse blows when ON/OFF grounded switch is placed in ON position	Motor armature shorted or	Repair or replace motor.
	Shorted SCR SCR1 or SCR2, or circuit board failure	Replace circuit board or shorted SCR.
3. Controller fuse blows while motor is running.	Loose or corroded connection, or wiring faulty, incorrector grounded. Motor overloaded	Check all terminal connections and wiring between the line, controller, and motor. Check motor armature current. If current exceeds controller rating, check for a mechanical overload or faulty motor. Also check shunt field current. Low shunt field current causes excessive armature current.
	Circuit board failure	Replace circuit board.
4. Controller fuse blows when motor speed is decreased	Low line voltage	Increase line voltage to rated, -0 to +10%.
	Maximum speed set too high	See "Adjustment Instructions," note 2.
5. Motor does not rotate	Wiring faulty, incorrect, or grounded Controller not reset	Check all external wiring terminating in the controller. Place the POWER ON/OFF switch in OFF position, then in ON position.
	Too many calibration shunt wires removed	See Table 4 and Figure 2.
	CUR LIMIT pot(s) turned fully counterclockwise	See "Adjustment Instructions," step 1.
6. Motor does not reach base speed	Low line voltage	Check for rated line voltage, -0 to +10%.
	Motor overloaded	See Indication 3.
	MAX SPD pot misadjusted Circuit board failureReplace circuit board.	See "Adjustment Instructions," step 3.
7. Unstable speed, inadequate regulation, or low torque	Wrong shunt wire(s) removed	See Table 4 and Figure 2.
	Motor faulty	Check motor commutator and brushes. Refer to motor manufacturer's instructions.
	IR COMP and/or CUR LIMIT pot(s) misadjusted	See "Adjustment Instructions."
	Circuit board failure	Replace circuit board.

TABLE 6. PARTS LIST

PART	BOSTON GEAR PART NUMBER Model RG1	Model RG2	PART	BOSTON GEAR PART NUMBER Model RG1	Model RG2
Circuit Board	69874	69875	Knob, Motor Speed Pot	60245	60245
Diodes, Shunt Field (D12-D15)	69876	69876	Pot, Motor Speed	63376	63376
			SCR (SCR1, SCR2)	69878	69879
Fuse (F1), 12A 250V	69877	69877	Switch, Power On/Off (S1)	63374	63374
Fuse Holder	63804	63804	Varistor (RV1)	60877	60878

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