INSTALLATION AND OPERATING INSTRUCTIONS

REGENERATIVE DRIVE

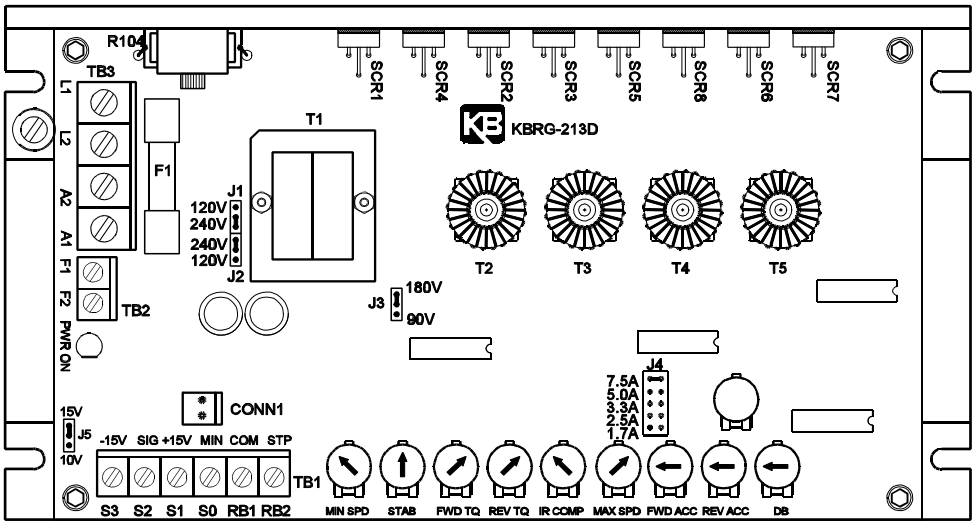
MODEL KBRG-213D

KB Part No. 8826

VARIABLE SPEED SCR CONTROL

DESIGNED FOR SHUNT WOUND
and PM DC MOTORS

FULL WAVE • 4 QUADRANT



See Safety Warning on Page 1

See Page 1

PENTA KB POWER™

A COMPLETE LINE OF MOTOR DRIVES

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i. SAFETY WARNING! — PLEASE READ CAREFULLY

This product should be installed and serviced by a qualified technician, electrician or electrical maintenance person familiar with its operation and the hazards involved. Proper installation, which includes wiring, mounting in proper enclosure, fusing or other overcurrent protection and grounding, can reduce the chance of electric shocks, fires or explosion in this product or products used with this product, such as electric motors, switches, coils, solenoids and/or relays. Eye protection must be worn and insulated adjustment tools must be used when working with control under power. This product is constructed of materials (plastics, metals, carbon, silicon, etc.) which may be a potential hazard. Proper shielding, grounding and filtering of this product can reduce the emission of radio frequency interference (RFI) which may adversely affect sensitive electronic equipment. If information is required on this product, contact our factory. It is the responsibility of the equipment manufacturer and individual installer to supply this safety warning to the ultimate user of this product. (SW effective 11/92)

This control contains electronic Start/Stop and Inhibit circuits that can be used to start and stop the control. However, these circuits are never to be used as safety disconnects since they are not fail-safe. Use only the AC line for this purpose.

The input circuits of this control (potentiometer, start/stop, Inhibit) are not isolated from AC line. **Be sure to follow all instructions carefully. Fire and/or electrocution can result due to improper use of this product.**

CE This product complies with all CE directives pertinent at the time of manufacture. Contact factory for detailed installation instructions and Declaration of Conformity. Installation of a CE approved RFI filter (KBRF-200A, KB P/N 9945A or equivalent) is required. Additional shielded motor cable and/or AC line cables may be required along with a signal isolator (SI-4X, KB P/N 8801 or equivalent).

I. GENERAL INFORMATION.

The KBRG-213D is a full-wave regenerative control, capable of operating a DC motor (Permanent Magnet or Shunt) in a bidirectional mode. It provides 4-quadrant operation which allows forward and reverse torque in both speed directions. The drive provides dynamic response, which closely approximates the performance of servo-type drives. Ratings and specifications are presented in tables 1 and 3. Be sure the drive is used within these ratings and specifications. **(Note: Regenerative drives normally produce more motor heating than standard unidirectional SCR speed controls, especially under low speed operation. This should be taken into consideration when specifying motor rating.)**

WARNING! Be sure to follow all instructions carefully. Fire or electrocution can result due to improper use of this product. Read Safety Warning.

TABLE 1 – ELECTRICAL RATINGS

Model	Input Voltage (VAC)	Max. AC Current (RMS)	Output Voltage (VDC)	Max. DC Output Current (ADC)	Max. Horsepower HP, (KW)
KBRG-213D	115	12	0 – ±90	7.5	3/4, (.5)
	230	12	0 – ±180	7.5	1, (1)

II. OPERATION.

The KBRG will vary the motor speed as a function of the signal voltage on input terminals “S2" (signal) and “RB1” (common). The input voltage can be derived from the wiper of the main speed potentiometer or from an isolated analog input (voltage following mode). Since the KBRG is a 4-quadrant regenerative drive, the motor speed will follow both a positive and negative signal voltage and drive the motor in both the forward direction and reverse direction. In addition , it will apply both forward and reverse torque in order to stabilize motor speed.

To understand the concept of a regenerative drive, the operation of an elevator can be used. If one were to enter the elevator on the first floor and press 10, the motor and control would have to lift the elevator against gravity. In this mode, the drive would operate like a conventional speed control which is called "motoring" (the applied load is opposite to the direction of motor rotation). When the elevator is at floor 10 and floor 1 is pressed, gravity will try to pull the elevator car down faster than the speed for which it is set. The control will then provide reverse torque to keep the car form falling faster than the set speed. This operation is regeneration (the applied load is in the same direction as the direction of motor rotation).

The table below summarizes the different modes of regen operation.

TABLE 2 – SUMMARY OF CONTROL OPERATION

Quadrant	Type of Operation	Motor Rotation Direction	Motor Torque direction	Applied Load Direction
I	Motoring	CW	CW	CCW
II	Regeneration	CCW	CW	CCW
III	Motoring	CCW	CCW	CW
IV	Regeneration	CW	CCW	CW

TABLE 3 – GENERAL PERFORMANCE SPECIFICATIONS

Parameter	Specification	Factory Setting
AC Line Input Voltage (VAC ±10%,50/60 Hz)	115 or 230	230
AC Line Frequency (Hz), # of Phases	50/60, 1	—
Arm Voltage Range at 115VAC Line (VDC)	0 – ±90	—
Arm Voltage Range at 230VAC Line (VDC)	0 – ±180, 0 – ±90	0 – ±180
Field Voltage at 115VAC Line (VDC)	100/50	—
Field Voltage at 230VAC Line (VDC)	200/100	—
Service Factor	1.0	—
Duty	Continuous	—
Max Load Capacity (% for 2 minutes)	150	—
Ambient Temperature Range (ºC)	0 – 50	—
Speed Range (Ratio)	50:1	—
Arm Feedback Load Regulation (% Base Speed)	±1	—
Line Regulation (% Base Speed)	±0.5	—
Current Ranges (ADC)	1.7, 2.5, 3.3 5.0, 7.5	7.5
FWD and REV Accel Range (Sec.)	0.1 – 15	1
Dead Band Range (% Base Speed)	0 – ±3	0
Max Speed Trimpot Range (% Base Speed)	70 – 110	100
IR Comp Range at 115VAC Line (VDC)	0 – 15	5
IR Comp Range at 230VAC Line (VDC)	0 – 30	10
FWD and REV CL Range (% Range Setting)	0 – 150	150
Voltage Following Input Range (VDC)	0 – ±10, 0 – ±15	0 – ±15
Voltage Following Linearity (% Base Speed)	±0.5	—

III. SETTING SELECTABLE JUMPERS.

The KBRG-213D has customer selectable jumpers which must be set before the control can be used (refer to fig. 1, p. 3). Bold indicates factory setting. See fig. 6, p. 5 for location of jumpers.

A. J1, J2 – Input AC Line Voltage – Select proper input line voltage, 115VAC or 230VAC, by placing both J1 and J2 in the correct corresponding position, "115" or **"230."** (See fig. 1, p. 3.)

B. J3 – Motor Armature Voltage – Select the desired armature voltage by placing J3 in the proper position, "90" or **"180."** Note: For 115 volt AC Line input, the armature voltage must be set to "90." For 230 input, the armature voltage normally is set for "180." However, it is also possible to set the armature voltage to "90" for step-down operation. (See fig. 2 and table 4.)

FIG. 1 – AC LINE VOLTAGE JUMPER SETTING

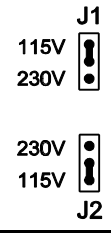
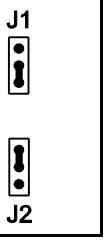
115VAC	230VAC
	

FIG. 2 – MOTOR ARMATURE VOLTAGE JUMPER SETTING

90VDC	180VDC
	

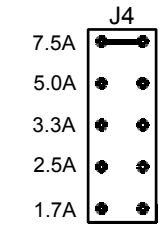
TABLE 4 – RELATIONSHIP of AC LINE INPUT AND MOTOR VOLTAGE with J1, J2 and J3 JUMPER POSITION

AC INPUT VOLTAGE	J1, J2 POSITION	J3 POSITION	MOTOR VOLTAGE
115	115	90	90
230	230	180	180
230	230	90*	90*

*A 90VDC motor can be used with a 230VAC line. However, speed range may be reduced and motor overheating may result.

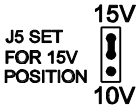
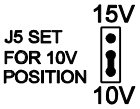
C. J4 – Armature Current – Select the J4 position (1.7, 2.5, 3.3, 5, **7.5**) closest to the rated motor current. (Note the maximum output current is set to 150% of the J4 position, which may be readjusted using the FWD CL and REV CL trimpots.)

TABLE 5 – JUMPER J4 POSITION vs MOTOR HORSEPOWER

	Jumper J4 Position Motor Current (DC Amps)	Motor Horsepower	
		90VDC	180VDC
	7.5A	3/4	1
	5.0A	1/2	1
	3.3A	1/3	3/4
	2.5A	1/4	1/2
	1.7A	1/6	1/3

D. J5 – Analog Input Voltage – Jumper J5 is set to the "15V" position for potentiometer operation. If the control is to be operated from an ***isolated*** 0 – ±10VDC signal, set J5 to the "10V" position. (See sec. V, F, p. 7.) (See fig. 3.)

FIG. 3 – JUMPER J5 SETTING

Potentiometer Operation	Signal Following
	

IV. MOUNTING.

Mount the KBRG-213D on a flat surface free of moisture, metal chips, or corrosive atmosphere. See Mechanical Specifications fig. 7, p. 6. A 5K ohm remote speed potentiometer is provided with each control. Install potentiometer using hardware provided. Be sure to install insulating disk between potentiometer and inside of front panel.

Enclosure – When mounting the KBRG-213D in an enclosure, it must be large enough to allow the proper heat dissipation. A 12"12"24" enclosure is suitable at full rating. Smaller enclosures may be used if full rating is not required.

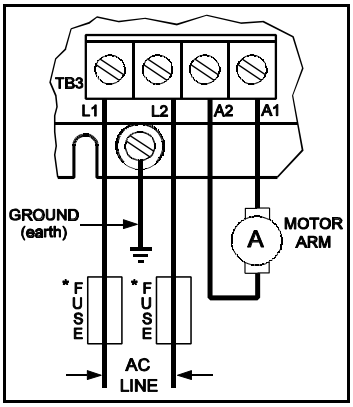
V. WIRING.

Warning! Read Safety Warning before attempting to use this

Warning! To avoid erratic operation do not bundle AC Line and motor wires with potentiometer, voltage following, enable, inhibit or other signal wiring. Use shielded cables on all signal wiring over 12" (30 cm) – Do not ground shield.

Wire control in accordance with National Electric Code require-ments and other local codes that apply. A “normal blo” 15 amp fuse or circuit breaker should be used on each AC line conductor which is not at ground potential (do not fuse neutral or grounded conductors). (See section VI, p. 8 for fuse information.) Wire control in accordance with connection diagram (see fig. 6, p. 5). A separate AC Line switch or contactor must be wired as a disconnect switch so that contacts open each ungrounded conductor of the control.

FIG. 4 – AC LINE AND ARMATURE CONNECTION



A. AC Line – Connect AC Line to terminals L1 and L2. (Be sure jumpers J1 and J2 are set to match the AC Line voltage used.) (See table 4, p. 3.)

B. Motor Armature – Connect motor armature to terminal A1 and A2. (Be sure jumper J3 is set to match motor voltage.) (See table 4, p. 3.)

C. Field – [For Shunt Wound motors **only.** Do not use F1 and F2 terminals for any other motor type.] Connect motor shunt field to terminals F1 and F2 for 90VDC motors with 100VDC fields and 180VDC motors with 200VDC fields. For motors with half voltage fields, 90VDC motors with 50VDC fields and 180VDC motors with 100VDC fields, connect field to terminals F1 and L1. See table 6 for summary of field connections.

FIG. 5A – FULL VOLTAGE FIELD

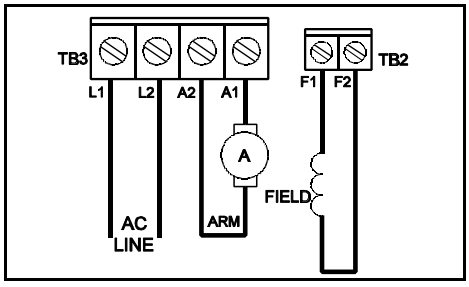


FIG. 5B – HALF VOLTAGE FIELD

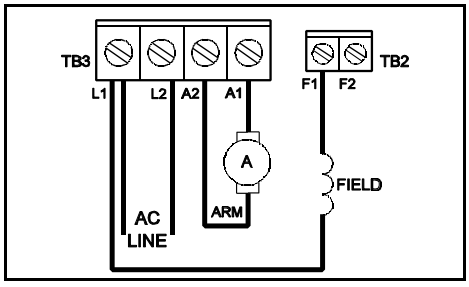


TABLE 6 – FIELD CONNECTIONS (Shunt Wound Motors Only)

MOTOR VOLTAGE	FIELD VOLTAGE (VDC)	FIELD CONNECTION
90	100	F1, F2
90	50	F1, L1
180	200	F1, F2
180	100	F1, L1

FIG. 6 – CONTROL LAYOUT

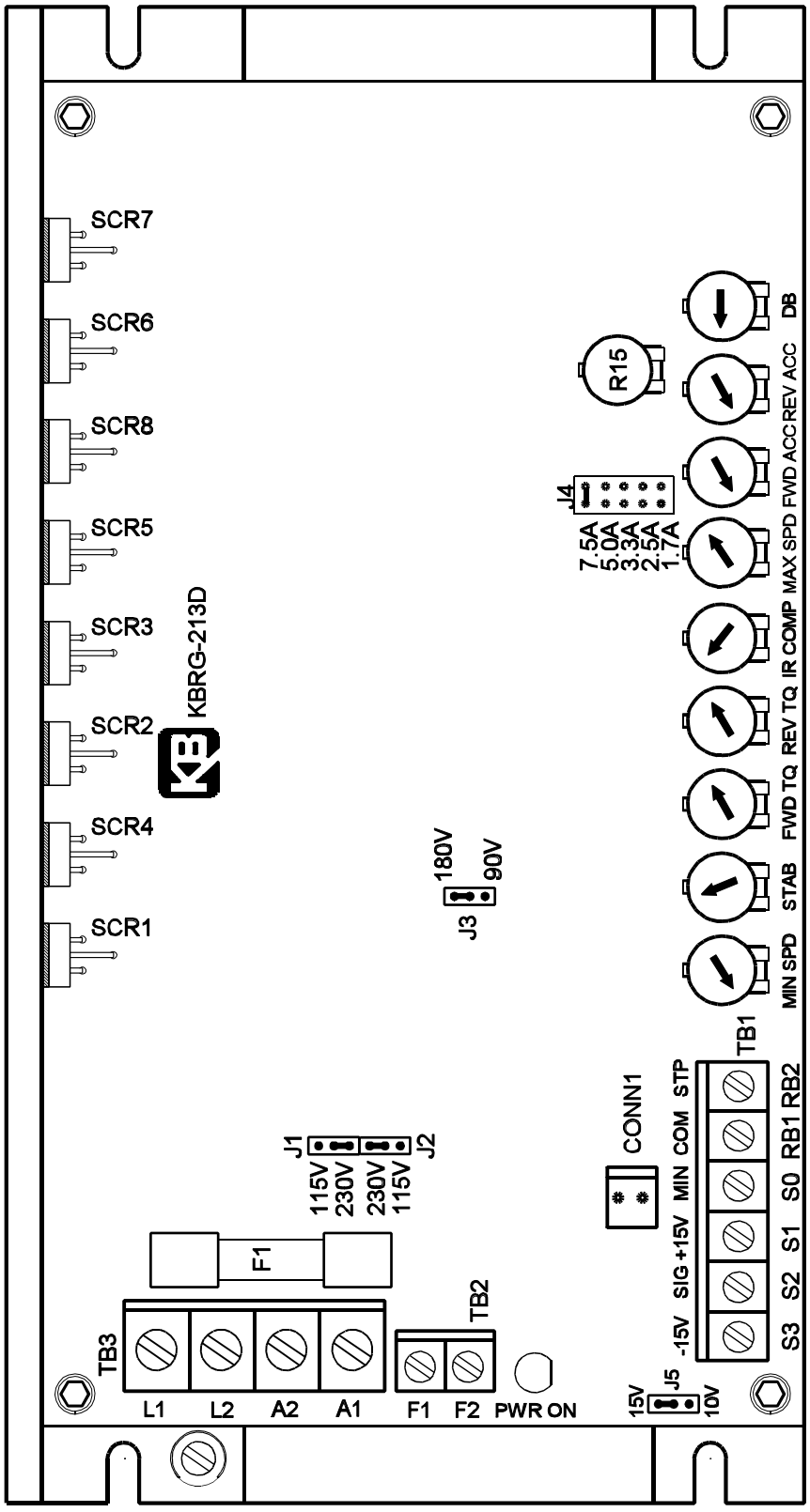
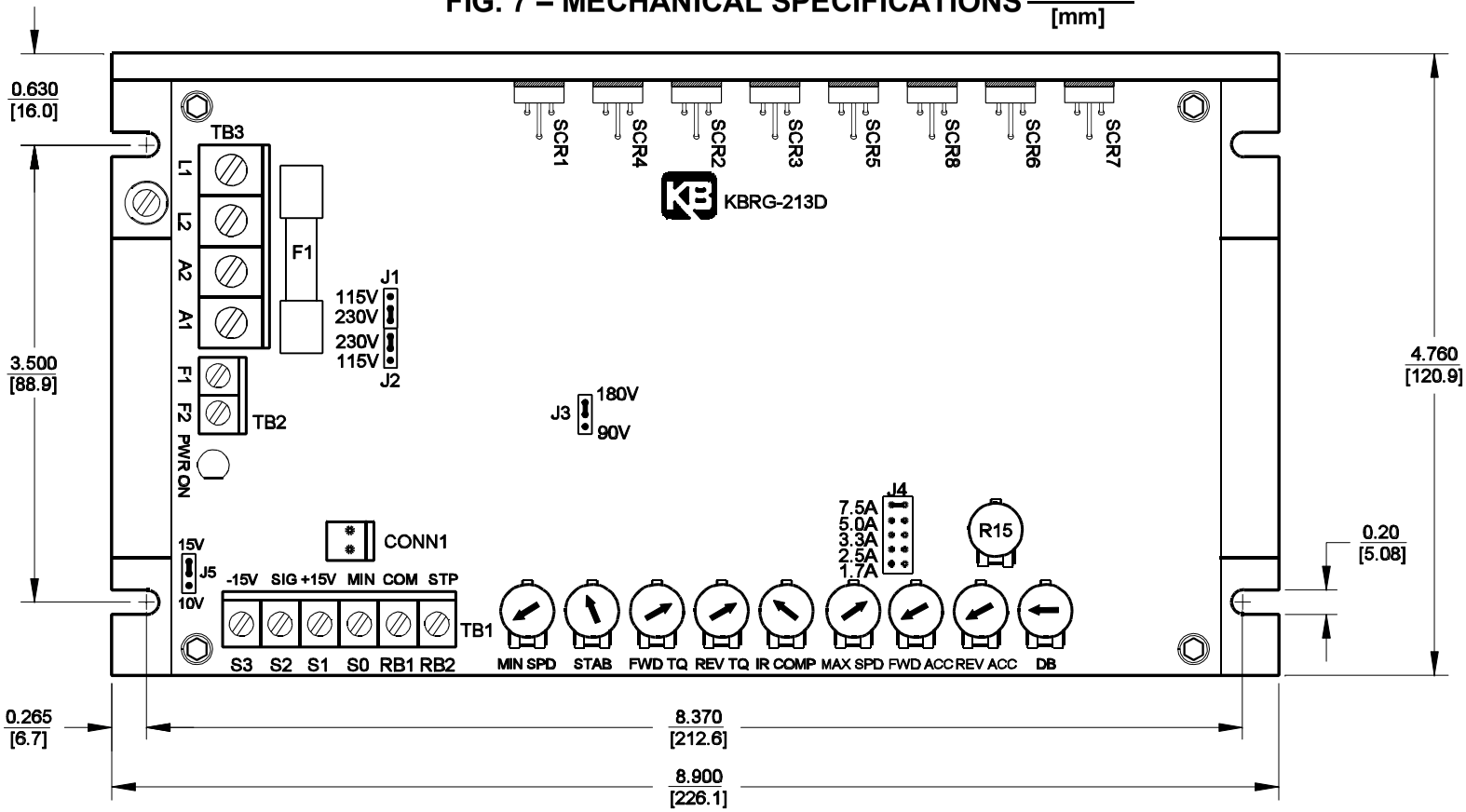


FIG. 7 – MECHANICAL SPECIFICATIONS $\frac{\text{INCHES}}{[\text{mm}]}$



NOTES: MAXIMUM HEIGHT WITH0UT ACCESSORY BOARD IS $\frac{1.700}{[43.2]}$

MAXIMUM HEIGHT WITH ACCESSORY BOARD IS $\frac{3.100}{[78.7]}$

D. Ground – Be sure to ground (earth) control via green screw located on chassis.

E. Main Speed Potentiometer – The main speed potentiometer can be connected in several ways using terminals "S0," "S1," "S3." (A 5K ohm potentiometer is supplied with control. (A 10K potentiometer can also be used.) (Warning! Terminals S0, S1, S2 and S3 are not isolated from AC line.) Note: Jumper J5 must be in the "15V" position.

i. Unidirectional operation only – Connect potentiometer to terminals "S0," "S1," "S2" for forward direction. See fig. 8. To operate in reverse direction, connect to "S0," "S2," and "S3." See fig. 9.

ii. Bidirectional operation using reversing contacts – Connect to terminals "S0," "S1," "S2," and "S3" as per fig. 11.

FIG. 8 – UNIDIRECTIONAL OPERATION (Forward)

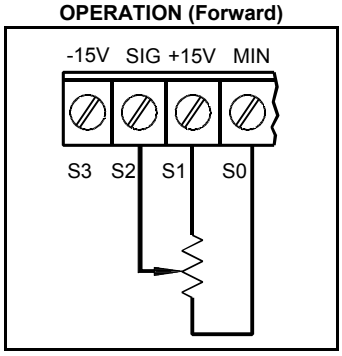


FIG. 9 – UNIDIRECTIONAL OPERATION (Reverse)

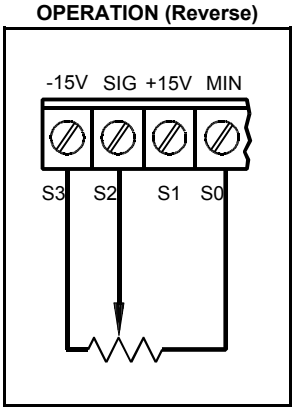


FIG. 10 – BIDIRECTIONAL OPERATION (Reversing Contact)

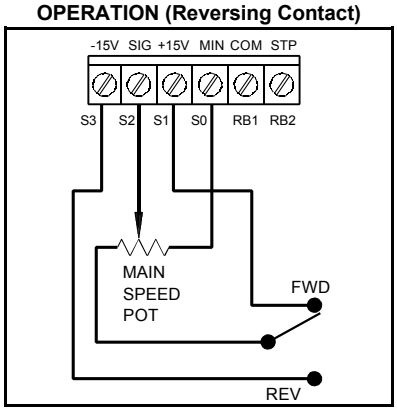
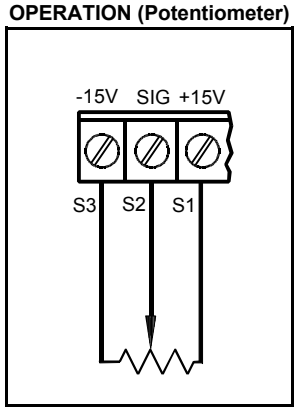
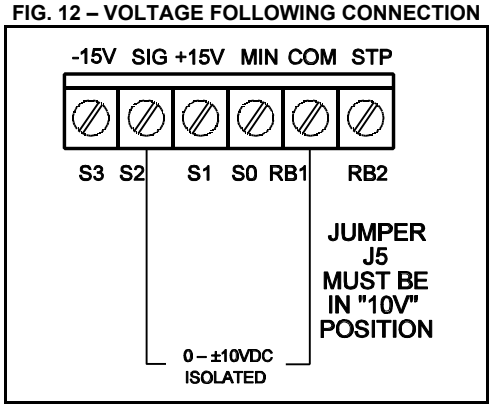


FIG. 11 – BIDIRECTIONAL OPERATION (Potentiometer)



F. Voltage Following – An analog voltage can be used in lieu of main speed potentiometer. Connect signal to terminals "S2" and "RB1." Note: Terminal "RB1" is common. A positive signal with respect to terminal "RB1" will produce a positive output to motor. A negative signal with respect to terminal "RB1" will produce a negative output. A0 to ±10VDC is required to operate control from 0 ± full output. [A bipolar signal isolator, SI-4X (KB P/N 8801), is available as an option from your distributor.] Note: Jumper J5 must be in the "10V" position.

FIG. 12 – VOLTAGE FOLLOWING CONNECTION



⚠ **Note: An isolated signal voltage must be used or catastrophic failure can result.**

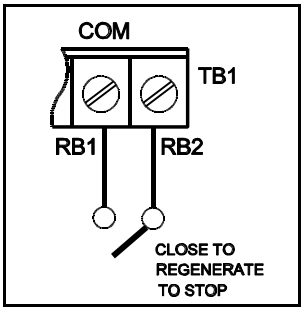
G. Start/Stop Circuits – The KBRG-213D contains two 2-wire stop circuits which are used to electronically bring the motor to a "stop." Both require an ***isolated*** single contact closure. If an isolated contact is not available, it may be necessary to use an isolation relay.

WARNING! Do not use Start/Stop or inhibit functions as a safety disconnect. Use only an AC line disconnect for that purpose.

i. Regen to stop using terminals RB1 and RB2 on terminal block TB3:

When a contact closure is made, the control will use regenerative braking to bring the motor to a rapid stop. In the forward direction the rate of braking can be slowed by increasing the setting of the reverse acceleration trimpot (REV ACC). The rate of braking can be made faster by decreasing the setting of the REV ACC trimpot to its full CCW position. More rapid braking, when required, can be accomplished by increasing the setting of the reverse current limit trimpot (REV CL). Note: Increasing the CL beyond 200% of the motor current rating can lead to premature motor failure. Use an ***isolated*** contact as shown in fig. 13.

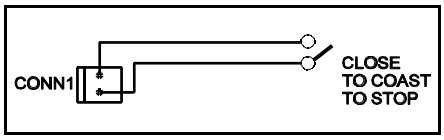
FIG. 13 – REGEN TO STOP



ii. Inhibit – Coast to Stop using Conn 1:

When a contact closure is made on the Conn 1 terminals, the control will cause the motor to coast to a stop. A 2-wire mating connector is supplied. Use an ***isolated*** contact as shown in fig 14.

FIG. 14 – COAST TO STOP



VI. FUSING.

Armature Fuse – An armature fuse (F1) rated 12A is provided with a rating equal to the maximum RMS rating of the control. It is recommended that the correct size armature fuse be installed, depending on the rating of the motor and form factor (RMS/AVG current). Fuse type should be Littlefuse 326 ceramic or Buss ABC, or equivalent. A fuse chart is presented below which suggests appropriate armature fuse ratings. However, the specific application may require larger fuse ratings based on ambient temperature, CL set point and duty cycle of operation (see table 7). Fuses may be purchased from your distributor.

TABLE 7 – ARMATURE FUSE CHART

Motor Horsepower		Approx. DC Motor Current Amps	Fuse Rating (AC Amps)
90VDC	180VDC		
1/8	1/4	1.3	2
1/6	1/3	1.7	2
1/4	1/2	2.5	4
1/3	3/4	3.3	5
1/2	1	5.0	8
3/4	1	7.5	12

VII. TRIMPOT ADJUSTMENTS.

The KBRG contains trimpots which have been factory adjusted for most applications. See specifications for factory settings. (Note: fig. 6 p. 5 presents the various trimpots with their location. They are shown in the approximate adjustment position.) Some applications may require readjustment of trimpots in order to tailor control to exact requirements. Readjust trimpots as follows:

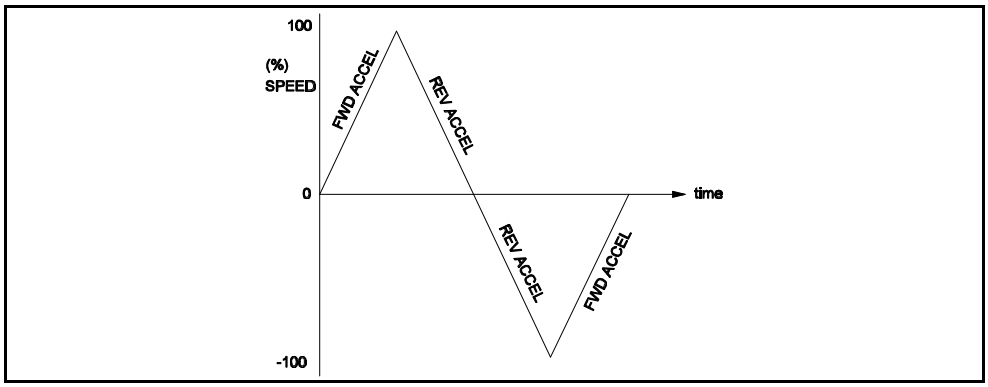
A. Forward Acceleration (FWD ACCEL) and Reverse Acceleration (REV ACCEL) – The FWD ACCEL trimpot determines the amount of time it takes the control voltage to reach full output in the forward direction. It also determines the amount of time it takes for the control voltage, in the reverse direction, to reach zero output. (FWD ACCEL is the Reverse Decel.)

The REV ACCEL trimpot determines the amount of time it takes the control voltage to reach full output in the reverse direction and the time it takes for the control voltage, in the forward direction, to reach zero output. (REV ACCEL is the Forward Decel.)

The FWD and REV ACCEL trimpots are factory adjusted to approximately 1 second. The acceleration times are adjustable over a range of 0.1 to 15 seconds. See fig. 15 for graphical representation of ACCEL.

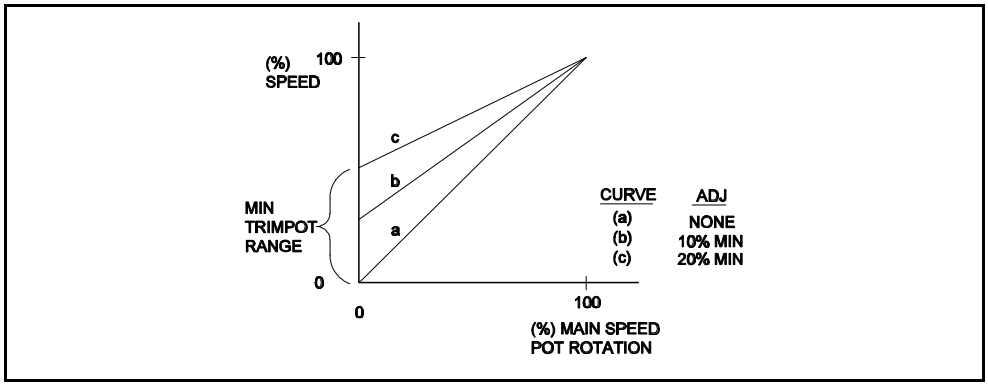
Note: The FWD and REV CL trimpots may override the rapid accel and decel settings.
Note: A 4-quadrant ACCEL/DECEL accessory module is available as an option. It provides separate control of FORWARD acceleration and deceleration and REVERSE acceleration and deceleration. (KB P/N 8803)

FIG. 15 – ACCEL TRIMPOT ADJUSTMENT



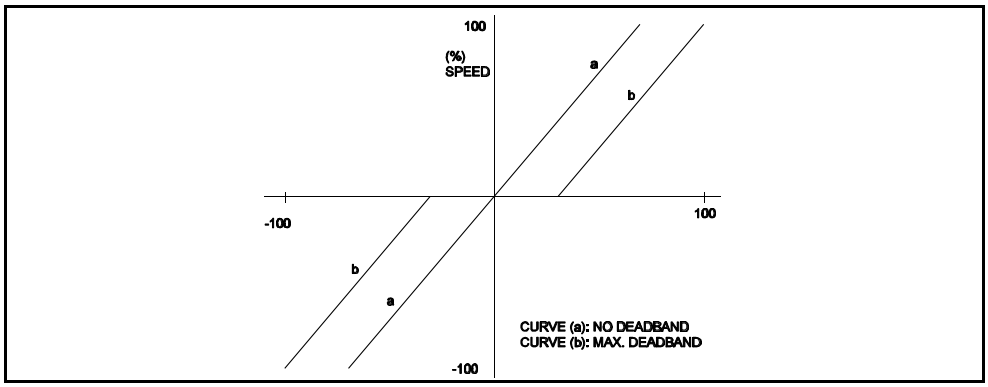
B. Minimum Speed Trimpot (MIN) – The MIN trimpot is used to provide an adjustable minimum speed when the control is used with an external potentiometer. (See section V, E. p. 7.)

FIG. 16 – MINIMUM SPEED TRIMPOT ADJUSTMENT



C. Deadband Trimpot (DB) – The DB trimpot sets the amount of main speed potentiometer rotation required to initiate control voltage output. It is factory adjusted to approximately 25% of rotation.

FIG. 17 – DEADBAND TRIMPOT ADJUSTMENT



The DB trimpot also determines the amount of delay that will occur before regeneration starts. Regeneration occurs when the applied load torque is in the same direction as the motor rotation.

To readjust the DB to factory setting:

i. Set Main Speed pot to zero speed position.

ii. Set DB trimpot to full CCW position.

iii. Adjust DB trimpot CW until motor hum is eliminated. (See fig. 17, p. 9 for graphic illustration of the DB trimpot.) Note: If the deadband trimpot is set too low (CCW direction), the motor may oscillate between forward and reverse. Adjust deadband trimpot CW until the instability disappears. (Oscillation may also occur due to STAB trimpot setting. See sec. VII, G.)

D. Current Limit (FWD CL) and Reverse Current Limit (REV CL) Trimpots – These trimpots are used to set the maximum amount of DC current that the motor can draw in both the forward and reverse directions. The amount of DC current determines the amount of maximum motor torque. They are factory set at 150% of the current established by the jumper J2 setting.

Readjust the CL trimpot as follows:

i. Turn CL trimpot to MIN (CCW) position. Be sure jumper J2 is in the proper position approximately equal to the motor DC ampere rating.

ii. Wire in a DC ammeter in series with armature lead. Lock shaft of motor.

iii. Apply power. Rotate CL trimpot quickly until desired CL setting is reached (factory setting is 1.5 times rated motor current). Be sure control is in forward direction for FWD CL trimpot adjustment and likewise with REV CL.

Warning! Do not leave motor shaft locked for more than 2 – 3 seconds to prevent motor damage.

Caution! Adjusting the CL above 150% of motor rating can cause overheating and demagnetization of some PM motors. Consult motor manufacturer.

E. IR Compensation (IR Comp) – The IR Comp is used to stabilize motor speed under varying loads.

Readjust the IR Comp trimpot as follows:

i. Run motor at approximately 30 – 50% of rated speed under no load and measure actual speed.

ii. Load motor to rated current. Rotate IR Comp trimpot so that loaded speed is the same as the unloaded speed measured in (i).

Control is now compensated so that minimal speed change will occur over a wide range of motor load. Note: Too much IR Comp will cause unstable (oscillatory) operation.

F. Maximum Speed (MAX) – The MAX trimpot is used to set the maximum output voltage of the control which, in turn, sets the maximum speed of the motor.

Adjust the MAX trimpot as follows:

i. Rotate Main Speed potentiometer to full speed (CW).

ii. Adjust MAX trimpot to desired maximum motor speed.

Note: Do not exceed maximum rated RPM of motor since unstable operation may result.

G. Stability Trimpot (STAB) – This trimpot determines the dynamic response of the control. The factory setting is approximately 50% of full rotation. The setting may be increased if a faster response is required. Note: If response is made too fast, unstable operation may result.

VIII. FUNCTION INDICATOR LAMP.

LED 1 Power On (PWR ON) indicates that the drive is energized with the AC line.

IX. – KBRG-213D ACCESSORIES

- Bipolar Signal Isolator KB P/N 8801
- 4-Quad Accel/Decel KB P/N 8803
- Multi Speed Board KB P/N 8814

X – LIMITED WARRANTY

For a period of 18 months from date of original purchase, KB will repair or replace without charge devices which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The foregoing is in lieu of any other warranty or guarantee, expressed or implied, and we are not responsible for any expense, including installation and removal, inconvenience, or consequential damage, including injury to any person, caused by items of our manufacture or sale. Some states do not allow certain exclusions or limitations found in this warranty so that they may not apply to you. In any event, KB's total liability, under all circumstances, shall not exceed the full purchase price of this unit. (rev 4/88)

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