

KBIC® SCR DC Motor Speed Controls

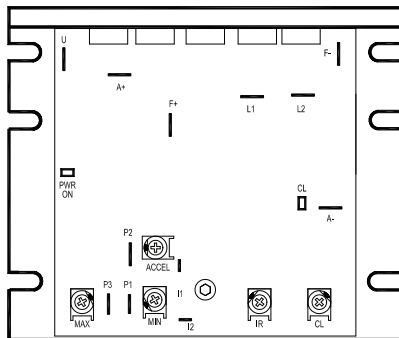
Ultra Fast
CL Circuit Prevents
Demagnetization in
PM Motors

Installation and
Operation Manual



See **SAFETY WARNING**

* See CE information on page 5



BASIC KBIC®



**This Manual Covers Models
KBIC-120, 125, 240, 225, 240D, 240DS**

PENTA  POWER™

A COMPLETE LINE OF MOTOR DRIVES

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(See back cover)

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1 QUICK-START INSTRUCTIONS

Important: You must read these simplified instructions before proceeding. These instructions are to be used as a reference only and are not intended to replace the details provided herein. You must read the Safety Warning on, page 5, before proceeding.

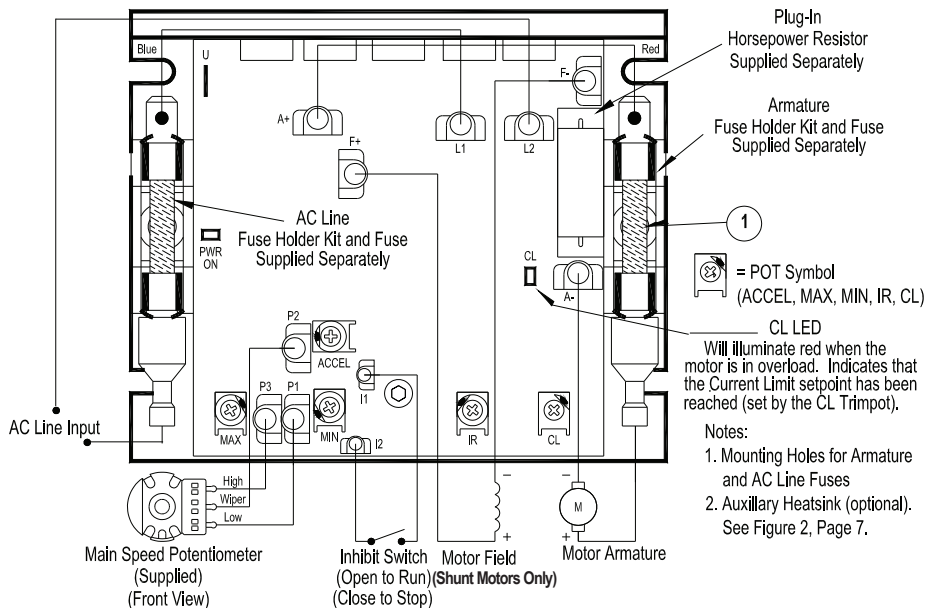
See Figure 1, on page 4. Also see Section 3 - Application Information, on pages 6 and 7.



WARNING! Disconnect main power before making connections to the speed control.

- 1.1 Be sure the AC input line voltage corresponds to the control voltage. See Table 2, on page 8.
- 1.2 Install the correct Plug-In Horsepower Resistor[®] according to armature voltage and motor horsepower. See Table 6, on page 11.
- 1.3 Recheck connections: AC line to L1 and L2, armature to A+ and A- and Field (Shunt motors only) to F+ and F-. (Note: If motor runs in improper direction, interchange armature leads with Main Power disconnected.) See Figure 1, on page 4.
- 1.4 It is recommended that both AC line and armature fuses be installed. See Table 4, on page 9.

FIGURE 1. GENERAL CONNECTION DIAGRAM



2 SAFETY WARNING

Definition of Safety Warning Symbols



Electrical Hazard Warning Symbol: Failure to observe this warning could result in electrical shock or electrocution.



Operational Hazard Warning Symbol: Failure to observe this warning could result in serious injury or death.



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 electrical connections, fusing or other current protection, and grounding, can reduce the chance of electrical shocks, and/or fires, in this product or products used with this product, such as electric motors, switches, coils, solenoids, and/or relays. Do not use this drive in an explosion-proof application. Eye protection must be worn and insulated adjustment tools must be used when working with drive 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. It is the responsibility of the equipment manufacturer and individual installer to supply this Safety Warning to the ultimate end user of this product. (SW 1/2006)

This drive contains electronic Start/Stop circuits, which can be used to start and stop the drive. 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.

Be sure to read and follow all instructions carefully. Fire and/or electrocution can result due to improper use of this product.



This product complies with all CE directives pertinent at the time of manufacture. Contact the Sales Department for Declaration of Conformity. Installation of a CE approved RFI filter is required (see Table 7, on page 24). Additional shielded cable and/or AC line cables may be required along with a signal isolator (SI-5 (Part No. 9443)).

3 INTRODUCTION

Thank you for purchasing the KBIC® "Standard of the Industry" DC motor speed controls. The speed controls are designed for applications demanding good performance, high reliability and low cost. The controls are fabricated with components that have proven reliability, including MOV transient protection, which is used to protect the Power Bridge. Integrated circuitry is used to provide an uncomplicated design with superior load and line voltage regulation. The Direct-Fed™ current limit circuit protects the motor and control against overloads by limiting the maximum level of output current. It also prevents motor failure due to demagnetization of the magnets of PM motors. Acceleration start (adjustable from 0.5 to 4 seconds) provides a smooth start each time the AC power is applied.

A unique feature of the KBIC® control is the Plug-in Horsepower Resistor®. It eliminates the need to recalibrate IR Comp. and CL when the control is used over a wide range of motor horsepower. Additional versatility is achieved by using the Auxiliary Heat Sink (optional) which is used to double the horsepower rating of each model. The output of the control is a linear function of potentiometer rotation. The KBIC® can also be operated in a voltage following mode by supplying an isolated analog signal (0-7 VDC) to the input terminals P2 (+) and F-. If an isolated input signal is not available, the optional Barrier Terminal Board Signal Isolator (SI-5) can be used. The controls are terminated as standard with Q-D terminals provided. A Barrier Terminal Board is available, which includes both line and armature fuse holders.

The Inhibit™ circuit (Terminals I1 and I2) are provided to electronically disconnect the armature output voltage. Another standard feature is Auto Inhibit. This circuit prevents false starts and high surge currents when cycling the KBIC® control with the AC line. All models are UL Listed for the USA and Canada and are CE approved.

4 APPLICATION INFORMATION

4.1 Motor Type – The KBIC® is designed for Permanent Magnet (PM), Shunt Wound and Universal (AC/DC) motors. Controls operated on 115 volt AC inputs are designed for 90 volt SCR rated motors. Controls operated on 230 volt AC inputs are designed for 180 volt SCR rated motors. Use of higher voltage motors will result in reduction of available maximum (MAX) speed (Trimpot Adjustment). Also, if motor is not an SCR rated type, the actual AC line amperage at full load should not exceed the motor's DC nameplate rating.

4.2 Torque Requirements – When replacing an AC induction motor with a DC motor and speed control, consideration must be given to the maximum torque requirements. The full load torque rating of the DC motor must be equal to, or greater than, that of the AC motor.

4.3 Acceleration Start – The KBIC[®] contains an adjustable acceleration start feature that allows the motor to smoothly accelerate from 0-full speed over a time period of 0.5-4 seconds. The "ACCEL" is factory set at 2 seconds.

4.4 Limitation in Use – The KBIC[®] controls are designed for use on machine applications.

4.5 Armature Switching – Do not switch the armature without taking proper precautions. (Refer to Armature Switching and Dynamic Braking, Section 9.2 on page 20).

CAUTION! Consult factory before using on constant horsepower applications such as saws or drill presses. Do not use in explosive atmosphere. Be sure the KBIC[®] is used within its maximum ratings. Follow all installation instructions carefully (Refer to Section 5, on page 12).

FIGURE 2. MECHANICAL SPECIFICATIONS

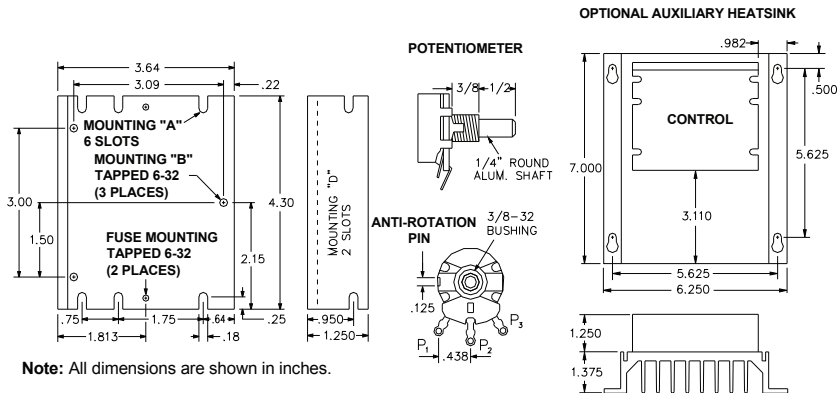


TABLE 1. FIELD CONNECTIONS (SHUNT-WOUND MOTORS ONLY)

CAUTION Shunt-wound motors may be damaged if field remains energized with the motor stopped for an extended period of time, unless provided with external cooling.	AC LINE VOLTAGE	FIELD VOLTAGE (VDC)	FIELD CONNECTION	FIELD TYPE
	115	100	F+, F-	Full Voltage
	115	50	F+, L1	Half Voltage
	230	200	F+, F-	Full Voltage
	230	100	F+, L1	Half Voltage

TABLE 2. ELECTRICAL RATINGS

Model No.	Part No.	AC Line Voltage (VAC) +/- 15% 50/60 Hz	Motor Voltage (VDC) (3)	RATING WITHOUT AUXILIARY HEAT SINK			RATING WITH AUXILIARY HEAT SINK			Field Voltage (Shunt Wound Motor Only) (VDC)
				Max. AC Load Current (RMS Amps)	Max. DC Load Current (Avg. Amps)	Max. HP	Max. AC Load Current (RMS Amps)	Max. DC Load Current (Avg. Amps)	Max. HP	
KBIC-120	9429	115	0 – 90	9.0	6.0	0.5	18.0	12.0	1	50, 100
KBIC-125	9433	115	0 – 90	12.0	8.0	0.75	24.0	16.0	1.5	50, 100
KBIC-240	9428	208/230	0 – 180	9.0	6.0	1	18.0	12.0	2	100, 200
KBIC-225	9432	208/230	0 – 180	12.0	8.0	1.5	24.0	16.0	3	100, 200
KBIC-240D (1)	9464	115	0 – 90	9.0	6.0	0.5	18.0	12.0	1	50, 100
		208/230	0 – 180			1			2	100, 200
KBIC-240DS (2)	9423	115, 208/230	0 – 90	9.0	6.0	0.5	18.0	12.0	1	100

Notes: (1) Model KBIC-240D is designed to accept 115 or 230 VAC line input to provide 0 - 130 VDC with a 115 or 230 VAC line and 0 - 220 VDC with a 208/230 VAC line. (2) Model KBIC-240DS is designed to accept 115 or 208/230 VAC line input to provide 0-130 VDC with a 115 or 208/230 VAC line. (3) A higher output voltage can be reached by increasing MAX trimpot setting.

TABLE 3. MINIMUM SUPPLY WIRE SIZE REQUIREMENTS

Maximum Motor Current (DC Amps)	Maximum Motor HP 90 V	Maximum Motor HP 180 V	Minimum Size Wire (AWG) Cu Only	
			Max 50 Foot Run	Max 100 Foot Run
6	0.5	1	16	14
12	1	2	14	12*
16	1.5	3	12	12

*Minimum recommended wire size.

TABLE 4. FUSE SELECTION CHART*

HORSEPOWER		Approx. Motor Current (DC Amps)	Fuse Rating (AC Amps)
90 VDC Motor	180 VDC Motor		
1/100	1/50	0.1	2/10
1/50	1/25	0.2	3/10
1/30	1/15	0.3	1/2
1/20	1/10	0.5	3/4
1/15	1/8	0.7	1
1/10	1/5	1.0	1 – 1/2
1/8	1/4	1.3	2
1/6	1/3	1.7	3
1/4	1/2	2.5	4
1/3	3/4	3.3	5
1/2	1	5.0	8
3/4	1 – 1/2	7.5	12
1	2	10.0	15
1 – 1/2	3	15.0	25

***Note:** Specific applications may require a different fuse value than indicated. This is based on several factors such as ambient temperatures, duty cycle, motor form factor and CL setpoint.

TABLE 5. GENERAL PERFORMANCE SPECIFICATIONS

Speed Range (ratio)	50:1
Load Regulation (% base speed) (0 - full load; 50:1 speed range)	1 *
Line Voltage Regulation (% base speed at full load; 100 - 130 VAC)	1/2 *
Control Linearity (% speed vs. dial rotation)	2
CL/Torque Range (% full load).	0 - 300
ACCEL Time Period (0 - full speed) (seconds)	0.5 - 4.0
MIN Speed Trimpot Range (% full speed)	0 - 30 *
MAX Speed Trimpot Range (% full speed)	50 - 140 *
IR Compensation Trimpot Range (at specified full load) (volts)	0 - 24
Maximum Allowable Ambient Temperature at full rating (° C/° F)	45/113
Maximum Inrush Start Current (Peak DC amps)	3 times CL Setting
Note: * Performance is for the SCR rated PM motors only. Lower performance can be expected with other motor types. Factory setting is for 3% load regulation. To obtain superior regulation. See Section 7, paragraph 7.5 on page 19.	

TABLE 6. PLUG-IN HORSEPOWER RESISTOR CHART (1)

Motor Horsepower (2)		Approx. Motor Current (DC Amps)	Plug-In Horsepower Resistor® Value (Ohms)	Individual Plug-In Horsepower Resistor® P/N
Armature Voltage (90 VDC)	Armature Voltage (180 VDC)			
1/100	1/50	0.1	1.0	9833
1/50	1/25	0.2	0.51	9834
1/30, 1/25	1/15	0.35	0.35	9835
1/20	1/10	0.5	0.25	9836
1/15, 1/12	1/6	0.8	0.18	9837
1/10, 1/8, 1/6	1/4	1.3	0.1	9838
1/4	1/2	2.5	0.05	9839
1/3	3/4	3.3	0.035	9840
1/2	1	5.0	0.025	9841
3/4	1 – 1/2	7.5	0.015	9842
1	2	10.0	0.01	9843
1 – 1/2	3	15.0	0.006	9850
Notes: 1. Motor horsepower and armature voltage must be specified in order to select correct Plug-In Horsepower Resistor®. 2. For motor horsepower not indicated, use lower value Plug-In Horsepower Resistor®.				

A Plug-In Horsepower Resistor®, must be installed to match the KBIC® to the motor horsepower and voltage. See Table 6, above for the correct value. Plug-In Horsepower Resistors® are stocked by your distributor.



Plug-In Horsepower Resistor®

CAUTION – Be sure Plug-In Horsepower Resistor® is inserted completely into the mating socket.

5 INSTALLATION, MOUNTING INSTRUCTIONS AND ELECTRICAL CONNECTIONS



WARNING! DO NOT USE THIS DRIVE IN EXPLOSION-PROOF APPLICATIONS. BE SURE THE DRIVE IS SECURELY MOUNTED.

5.1 Location and Mounting – The KBIC[®] controls should be mounted on a flat surface and located in an area where it will not be exposed to contaminants such as water, metal chips, solvents or excessive vibration. When mounting in an enclosure, the air space should be large enough to provide adequate heat dissipation. The maximum allowable ambient temperature at full rating is 45 °C/113 ° F. Consult factory if more information is required.

5.2 Initial Setup and Wiring.

- a. Install proper size Plug-in Horsepower Resistor[®]. (See Table 6, on page 11).
 - b. The KBIC can be connected to a standard 115V or 230V ($\pm 15\%$) 50/60 Hz AC line based on model selected [Be sure the AC input voltage corresponds to the control voltage rating and the motor rating (e.g. 90-130VDC motor on 115VAC and 180VDC motor on 230VAC)].
 - c. Follow the recommended supply wire sizes as per Table 3, on page 9.
 - d. Follow the NEC and other electrical codes that apply.
- CAUTION:** Separate branch protection must be provided on 230V circuits. Do not fuse neutral or grounded conductors.
- e. Connect control in accordance to connection diagram. (See Figure 1, on page 4).
 - f. When using a step-down transformer (440 VAC to 230 VAC) be sure the VA rating of the transformer is at least 3 times the VA rating of the motor.



WARNING! READ SAFETY WARNING, ON PAGE 5, BEFORE USING THE DRIVE. DISCONNECT MAIN POWER BEFORE MAKING CONNECTIONS TO THE DRIVE. TO AVOID ELECTRIC SHOCK, BE SURE THE DRIVE AND MOTOR ARE PROPERLY GROUNDED.



WARNING! IF CONTROL IS WIRED TO A TRANSFORMER, DO NOT SWITCH THE PRIMARY SIDE OF TRANSFORMER TO DISCONNECT POWER OR CATASTROPHIC FAILURE CAN RESULT. ALWAYS DISCONNECT CONTROL FROM SECONDARY SIDE OF TRANSFORMER.



WARNING! ARMATURE SWITCHING. DO NOT SWITCH THE ARMATURE IN AND OUT OF CIRCUIT OR CATASTROPHIC FAILURE WILL RESULT. IF ARMATURE SWITCHING IS REQUIRED FOR DYNAMIC BRAKE OR REVERSING, USE MODEL KBRG, KBPB OR KBCC-R SUFFIX CONTROLS.

CAUTION: Do not bundle potentiometer connections (P1, P2, P3) and Inhibit™ connections (I1, I2) with AC line or motor wires.

Note: (Shunt motors only) For 90VDC motors with 50VDC fields and 180VDC motors with 100VDC fields, use half voltage field connections F+ and L1. (See Table 1, on page 8).

5.3 Fusing (AC Line and Armature) – The AC line fuse protects the control against catastrophic failure. If the fuse blows, the control is mis-wired, the motor is shorted or grounded, or the KBIC® control is defective. The armature fuse provides overload protection for the motor and control. Choose the proper size armature fuse and AC line fuse by multiplying the maximum DC motor amps by 1.7. (Armature and AC line fuse kits are available from your distributor). On domestic 230 Volt AC lines, separate branch circuit protection for each line must be used. All fuses should be normal blow ceramic 3AG or MDA or equivalent. See Fuse Chart, Table 4, on page 9.

Note: Also available, the Barrier Terminal Kit (optional), which contains pre-wired AC line and armature fuseholders. Contact your distributor.

6 RECOMMENDED HIGH VOLTAGE DIELECTRIC WITHSTAND TESTING (HI-POT)

Testing agencies such as UL, CSA, etc., usually require that equipment undergo a hi-pot test. In order to prevent catastrophic damage to the control, which has been installed in the equipment, it is recommended that the following procedure be followed. A typical HI-POT test setup is shown in Figure 3, on page 15. All controls have been factory hi-pot tested in accordance with UL requirements.



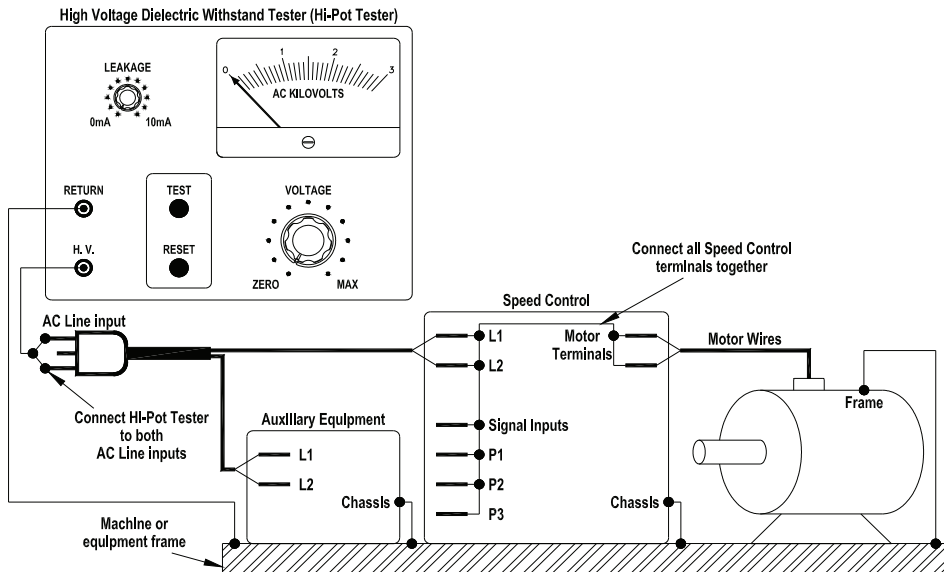
WARNING! WHEN PERFORMING THE HI-POT TEST, DISCONNECT THE AC POWER.

- 6.1** Connect all equipment AC power input lines together and connect them to the H.V. lead of the HI-POT Tester. Connect the RETURN of the HI-POT Tester to the frame on which the control and other auxiliary equipment are mounted. Refer to Figure 3, on page 15, for further information.
- 6.2** The HI-POT Tester must have an automatic ramp-up to the test voltage and an automatic ramp-down to zero voltage.

Note: If the Hi-Pot Tester does not have automatic ramping, then the HI-POT output must be manually increased to the test voltage and then manually reduced to zero. This procedure must be followed for each machine to be tested. A suggested HI-POT Tester is Slaughter Model 2550.

CAUTION! Instantaneously applying the HI-POT voltage will cause irreversible damage to the control.

FIGURE 3. HI-POT TEST SETUP



7 TRIMPOT ADJUSTMENTS AND CONTROL FUNCTIONS

The KBIC® is factory adjusted to provide 0 to full speed range using a 5K potentiometer. Minimum and maximum speed trimpots are provided to change the speed range from other than 0 to full speed. An acceleration (ACCEL) trimpot (located directly behind the MIN trimpot) is factory set to provide motor acceleration from 0 to full speed over a time period of 2 seconds (approx.) each time the AC power is applied. The current limiting (CL, or torque output) adjustment is factory set to approximately one and a half times the motor rating. The IR Compensation (IR) is factory adjusted to provide excellent motor regulation under normal operation. See Figure 1, on page 4, for trimpot locations.

Note: In order for the IR comp and CL trimpot settings to be correct, the proper Plug-in Horsepower Resistor® must be installed for the particular motor and input voltage being used. Do not attempt to change the settings of the trimpots unless absolutely necessary since they are factory adjusted to near optimum settings.

IMPORTANT NOTE:

Readjusting the ACCEL time will affect the MAX speed and IR Comp. settings that will have to be readjusted (see this Section). If the ACCEL time is decreased to the minimum time of 0.5 seconds (6 o'clock trimpot position), then increase the IR trimpot 25% CW rotation and decrease the MAX trimpot 20% CCW rotation. If the ACCEL time is increased to the maximum time of 4 seconds (full rotation), then decrease the IR and increase the MAX as per above percentages of rotation.

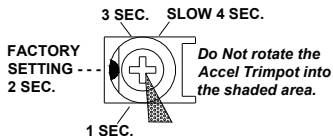
The following procedure is presented in required order of adjustment. It should be followed when readjusting all trimpot functions:

7.1 Acceleration Trimpot (ACCEL)

The ACCEL Trimpot is provided, to allow for a smooth start over an adjustable time period, each time the AC power is applied or the Main Speed Potentiometer is adjusted to a higher speed.

The ACCEL Trimpot has been factory set to 2 seconds, which is the amount of time it will take for the motor to accelerate from zero speed to full speed. To increase the acceleration time, rotate the ACCEL Trimpot clockwise. To decrease the acceleration time, rotate the ACCEL Trimpot counterclockwise. See Figure 4.

FIGURE 4. ACCEL TRIMPOT RANGE



7.2 Maximum Speed Trimpot (MAX)

The MAX Trimpot sets the maximum speed of the motor when the Main Speed Potentiometer is set fully clockwise. The MAX Trimpot is factory set to 100 % of base motor speed. To increase the maximum speed, rotate the MAX Trimpot clockwise. To decrease the maximum speed, rotate the MAX Trimpot counterclockwise. See Figure 5.

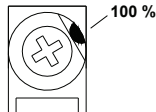
Note: Do not attempt to adjust the MAX speed above the rated motor RPM, since unstable motor operation may occur. For moderate changes in the MAX speed, there will be a slight effect on the MIN speed setting when the MIN speed is set at zero. There may be significant variation in the MIN speed setting if the MIN speed is at a higher than zero setting.

7.3 Minimum Speed Trimpot (MIN)

The MIN speed trimpot sets the minimum speed of the motor when the Main Speed Potentiometer is set fully counterclockwise. The MIN Trimpot is factory set to 0 % of base motor speed. To increase the minimum speed, rotate the MIN Trimpot clockwise. To decrease the minimum speed, rotate the MIN Trimpot counterclockwise. See Figure 6.

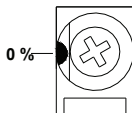
Note: Readjusting the MIN Trimpot will affect the maximum speed setting. Therefore, it is necessary to readjust the MAX Trimpot if readjusting the MIN Trimpot. It may be necessary to repeat these adjustments until both the minimum and maximum speeds are set to the desired levels.

FIGURE 5. MAX TRIMPOT RANGE



(Factory Set to 100% Base Speed)

FIGURE 6. MIN TRIMPOT RANGE



(Factory Set to 0% Base Speed)

7.4 Current Limit Trimpot (CL)

The CL Trimpot sets the current limit (overload), which limits the maximum current (torque) to the motor. The CL also limits the AC line inrush current to a safe level during startup. The CL Trimpot is factory set to 1.5 times the full load rating of the motor. To increase the current limit, rotate the CL Trimpot clockwise (do not exceed 2 times (200%) motor current rating (maximum clockwise position)). To decrease the current limit, rotate the CL Trimpot counterclockwise. See Figure 7.

Note: The correct value Plug-In Horsepower Resistor® must be installed for the CL to operate properly. Calibration of the CL Trimpot is normally not required when the proper Plug-In Horsepower Resistor® is installed.

To Recalibrate the CL Trimpot:

1. Disconnect the AC power and wire a DC ammeter in series with either motor armature lead.

Note: If only an AC ammeter is available, wire it in series with either AC line input lead.

2. Re-Apply power.
3. Set the Main Speed Potentiometer to approximately 30 - 50 % clockwise position.
4. Set the CL Trimpot fully counterclockwise.
5. Lock the motor shaft. The CL LED will illuminate red.

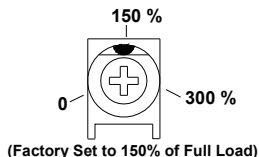


WARNING - DO NOT LEAVE MOTOR SHAFT LOCKED FOR MORE THAN 2-3 SECONDS OR MOTOR DAMAGE MAY RESULT.

6. Rotate the CL Trimpot clockwise until the desired current reading is observed on the DC ammeter. Factory Current Limit setting is 1.5 times the full load rating of the motor (with a DC ammeter wired in series with the motor armature). If using an AC ammeter wired in the AC line input, set the CL 0.75 times the full load rating of the motor. Do not exceed 2 times motor current rating. Refer to Figure 7.

Note: On cyclical loads, it may be normal for the CL LED to momentarily flash.

FIGURE 7. CL TRIMPOT RANGE



7.5 IR Compensation Trimpot (IR):

IR compensation is provided to substantially improve load regulation. If the load presented to the motor does not vary substantially, the IR adjustment may be set at a minimum level (approximately 1/4 of full setting). The control is factory adjusted to approximately 3% regulation. If superior performance is desired (less than 1% speed change of base speed from 0 to full load), then the IR compensation should be adjusted (See Figure 8) as follows:

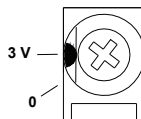
Note: Excessive IR comp. will cause control to become unstable, which causes motor cogging.

Notes: 1. The correct value Plug-In Horsepower Resistor® must be installed for the IR Compensation to operate properly. Calibration of the IR Trimpot is normally not required when the proper Plug-In Horsepower Resistor® is installed. (Actual Comp. voltage depends on the value of the Horsepower Resistor®) 2. Excessive IR Compensation will cause the motor to become unstable, which causes cogging.

To Recalibrate the IR Trimpot:

1. Set the IR Trimpot to approximately 25% rotation.
2. Run the motor unloaded at approximately 1/3 speed and record the RPMs.
3. Run the motor with the maximum load and adjust the IR Trimpot so that the motor speed under load equals the unloaded speed recorded in step 2.
4. Remove the load and recheck the RPMs.
5. If the unloaded RPM has changed, repeat steps 2 - 4 for more exact regulation. The control is now compensated to provide minimal speed change due to changing loads.

FIGURE 8. IR TRIMPOT RANGE



(Factory Set to 3 Volts DC for
Controls with 90 Volt DC Output)
(Factory Set to 6 Volts DC for
Controls with 180 Volt DC Output)

8 DIAGNOSTIC LED'S

The KBIC™ is designed with PC board mounted LEDs to display the control's operational status. See Figure 1, on page 4, for the location of the LEDs.

8.1 Power On (PWR ON):

The PWR ON LED will illuminate green when the AC line is applied to the control.

8.2 Current Limit (CL):

The CL LED will illuminate red when the control goes into current limit, indicating that the current limit set point has been reached (set by the CL Trimpot). See Section 7.4, and Figure 7, on page 18.

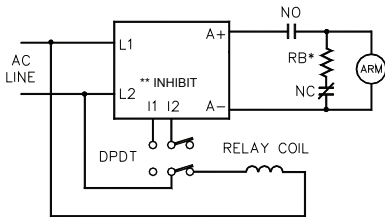
9 CONTROL FUNCTIONS

9.1 AC Line Switching:

The control can be turned "on" and "off" using the AC line (no waiting time is required). Auto-Inhibit® circuitry automatically resets critical components each time the AC line is interrupted. This, along with Acceleration Start and CL, provides a smooth start each time the AC line is applied.

9.2 Armature Switching – If the armature is to be disconnected and reconnected with AC power applied, the Inhibit Circuit™ must be simultaneously activated and deactivated. Connect I1 and I2 together to activate the Inhibit Circuit™. See Figure 9.

FIGURE 9. DYNAMIC BRAKING CIRCUIT



Notes: (Dynamic Brake Circuit)

* Choose RB resistance and wattage according to braking requirements.

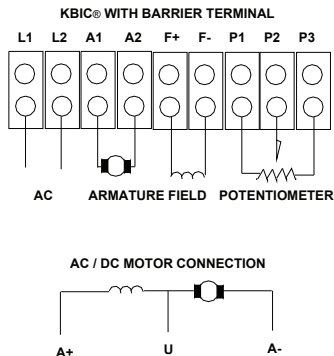
** Inhibit™ circuit extinguishes output of control during brake. When the armature is reenergized, the inhibit™ releases which allows for a smooth start.

9.4 Voltage Following – All models can be controlled with an isolated analog reference voltage (0 -7 VDC) in lieu of the main speed potentiometer. The voltage is connected to P2 (+) and F-. The control output voltage will linearly follow the input voltage. The source impedance of the input should be 10K ohms or less. The Min and Max trimpots are rendered inoperative in the voltage following mode. Use auxiliary trimpots for scaling and to limit the control range. If the input signal is not isolated, or is a current signal (4 - 20 mA), the KBSI-240D or SI-5 Barrier Terminal Board Signal Isolator must be used. It will allow direct connection to process controllers and microprocessors.

CAUTION: The voltage feeding P2 and F- must be isolated from the AC line. Do not earth ground P2 or F- to setup a zero or ground reference. **2.** Do not bundle signal wires to P2 and F- with AC line or motor connections. If signal wires are over 18 inches, use shielded cables.

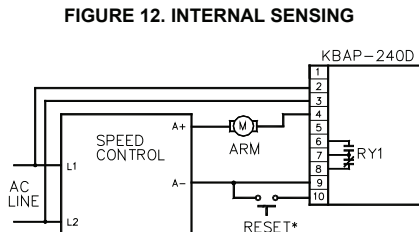
9.5 Connection Methods – Additional methods for motor connections may be used. See Figure 11.

FIGURE 11. CONNECTION METHODS



9.6 Optional Overload Protection with KBAP-240D (Part No. 9106)

The KBAP-240D® is a multipurpose DC Current Sensing Relay and Overload Protector. It is specifically designed for use with DC motors and speed controls from 1/8 - 3 HP. KBAP-240D® operates by sensing current in the armature circuit. When the preset level is reached, the output relay (RY1) trips. An adjustable time delay (0.2 - 15 secs.) is incorporated, which eliminates nuisance tripping. Manual or automatic reset is provided at the user's option along with a LED, which indicates when the preset current level has been reached. When an overload occurs, the KBAP-240D® can be used to shut the system down, sound an alarm, or initiate corrective action before damage occurs. Refer to Figure 12.



Internal Sensing Circuit -

Wire the KBAP® in accordance with this wiring diagram.

10 OPTIONAL ACCESSORIES

- **Auxiliary Heat Sink (Part No. 9861):** Doubles the horsepower rating of the control.
- **Barrier Terminal Accessory Kit (Part No. 9863):** When used with the Auxiliary Heat Sink, it converts the quick-connect terminals of the control to a barrier terminal block.
- **Barrier Terminal Board (Part No. 9884):** Converts the quick-connect terminals of the control to a barrier terminal block. Contains PC board mounted line and armature fuse holders (fuses supplied separately). Plugs onto the quick-connect terminals of the control.
- **SI-5 Signal Isolator (Part No. 9443):** Provides isolation between non-isolated signal sources and the control. Plugs onto the quick-connect terminals of the control.
- **Dial Plate & Knob Kit (Part No. 9832):** Provides indication of the Main Speed Potentiometer position (0 - 100 %).
- **AC Line & Armature Fuse Kit (Part No. 9849):** Provides fusing for the AC line input and armature. Includes wired fuse holders and mounting screws. Fuses supplied separately.

OPTIONAL ACCESSORIES (CONTINUED)

- **DIN Rail Mounting Kit (Part No. 9995).**
- **KBAP-240D Current Sensing Overload Protector (Part No. 9106):** Provides overload current sensing and protection of DC motors and speed controls rated 1/8 - 3 HP by sensing armature current. Operates on 115 or 208/230 Volt AC line input.
- **KBEP-240D Electronic Potentiometer (Part No. 9108):** Provides digital type control of motor speed. Replaces a standard rotary potentiometer with a set of customer supplied momentary push buttons or membrane switches.
- **KBET-240D Electronic Tachometer (Part No. 9469):** Provides an isolated tach-feedback signal and an isolated voltage follower signal from an open collector (Hall, magnetic, inductive, and optical) or 2-wire inductive pickup (encoder). Operates on 115 or 208/230 Volt AC line input.
- **RFI Filters:** Provide RFI and EMI suppression. Rated for 208/230 Volt 50/60 Hz AC. Complies with CE Council Directive 89/336/EEC relating to the Class A Industrial Standard and Class B Residential Standard. Filters are available in remote or undermount types. See Table 7.

TABLE 7. RFI FILTER SELECTION

Model No.	Part No.	Current Rating (RMS Amps)	Mounting	CE Class
KBRF-200A	9945C	24	Remote	A - Industrial
KBRF-250	9509	10	Undermount	A - Industrial
KBRF-300	9484	16	Remote	B – Residential *
KBRF-350	9511	10	Undermount	B – Residential *

* Also meets industrial standard.