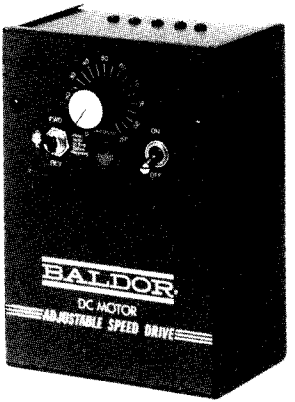
# BC140

# Solid State DC Motor Speed Control

# Installation and Operating Instructions

SEE SAFETY WARNING on page 8.




- Dual Voltage Input (115V or 230V)
- Up to 1HP-115V & 2HP-230V with Auxiliary Heatsink.*
- Multiple Horsepower capability with Plug-In Horsepower Resistor®
- Forward-Brake-Reverse Switch (Optional)
- Rugged NEMA I enclosure
- Current Limit LED Indicator

* Rating without Heatsink is 3/4HP at 115V and 1.5HP at 230V.

BALDOR®
MOTORS AND DRIVES

## IMPORTANT

**You must read these simplified instructions before operating control.**
(Remove (2) 6-32 screws and lift front cover.)

- Set the Dual Voltage Switch to the correct AC line input voltage, "115" or "230".
- If not already installed, install the correct Plug-in Horsepower Resistor® according to input voltage and motor horsepower (see Table 3, page 3).
- Install correct line and armature fuses (see Table 6, page 8).
- Install Auxiliary Heatsink on controls used with motors rated above 3/4 HP on 115 volts and above 1.5 HP on 230 volts.
- Recheck connections: AC line to L1 and L2, armature to A+ and A—, and field (Shunt motor only) to F+ and F— (or to L1 and F+ for low voltage field). Connect ground via ground screw (Note: To reverse motor direction, reverse armature leads).
- Nominal trimpot settings are as follows (expressed in % of full CW rotation):

**TABLE**

| | |
|---|---|
| MIN (minimum speed): | 15% |
| MAX (maximum speed): | 65% |
| IR (IR compensation): | 25% |
| CL (current limit/torque): | 65% |
| ACCEL (acceleration start): | 20% |
| DECEL (deceleration): | 20% |

- (For detailed instructions see Section IV, pages 9 & 10.)

---

## LIMITED WARRANTY

For a period of 2 years from date of original purchase, BALDOR will repair or replace without charge controls 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. This warranty is in lieu of any other warranty or guarantee expressed or implied. BALDOR shall not be held 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 the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, BALDOR's total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. No liability is assumed for expendable items such as fuses.

Goods may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid.

## ersatility

### DUAL AC VOLTAGE

The BC140 has dual AC line voltage input capacity** which provides 0-full speed capacity on DC motors from 1/100th-3/4 HP at 115 VAC and 1/50th-1.5 at 230 VAC (set the Dual Voltage Switch to the corresponding input voltage "115" or "230").

### PART NO. BC143

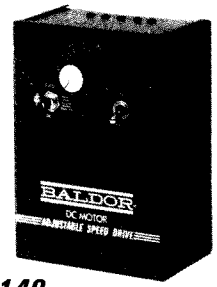
Auxiliary Heatsink capability to 1HP at 115 VAC and 2HP at 230 VAC.

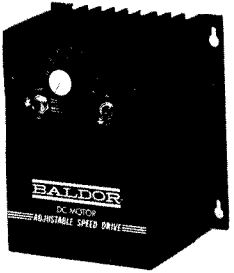
- **ALL MOTOR SIZES**

3. BC140 adapts to a complete range of motor horsepower by selecting and installing the proper Plug-in Horsepower Resistor® (see table).

- **REVERSIBLE**

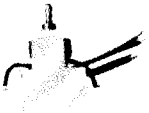
4. A FWD-BRK-REV Switch Kit is available as an option.




***BC140*** **with Auxiliary Heatsink & FWD-BRK-REV Switch options.**

***C140***



**Part No. BC144 Forward Brake Reverse Switch**

**Plug-In Horsepower Resistor®**

**OTE:** An optional FORWARD-BRAKE-REVERSE Switch is available for all models.

**BLE 2. ELECTRICAL RATINGS***

| | AC LINE VOLTAGE (VAC)** | MOTOR VOLTAGE (VDC)*** | AC LOAD CURRENT (RMS AMPS) | DC LOAD CURRENT (AVG. AMPS) | MAX. HP |
|---|---|---|---|---|---|
| ***BC140*** thout Auxiliary Heatsink | 115 | 90-130 | 12.0 | 8.0 | 3/4 |
| | 230 | 180 | 12.0 | 8.0 | 1.5 |
| ***BC140*** Vith Auxiliary Heatsink | 115 | 90-130 | 16.0 | 11.0 | 1 |
| | 230 | 180 | 16.0 | 11.0 | 2 |

* The BC140 can be converted to the higher rating by installing the Auxiliary Heatsink

** The BC140 must be set for either 115 V or 230 VAC line voltage input by setting the Dual Voltage Switch to "115" or "230". When the control is set for "115" use only 90-130VDC rated motors. When the control is set for "230" use only 180VDC rated motors.

*** The BC140 also supplies field voltage for shunt motors as follows:

On 115VAC line, field voltage is 100VDC using F—, F+ and 50 VDC using $L_1$, F+
On 230VAC line, field voltage is 200 VDC using F—, F+ and 100VDC using $L_1$, F+.

**TABLE 3. PLUG-IN HORSEPOWER RESISTOR CHART**

| PLUG-IN HORSEPOWER RESISTOR* CHART | | |
|---|---|---|
| AC LINE VOLTAGE | | PLUG-IN HORSEPOWER RESISTOR* (Resistance value-OHMS) ** |
| 115 VAC | 230 VAC | |
| ▲ MOTOR HORSEPOWER RANGE | | |
| ARMATURE VOLTAGE 90-130 VDC | ARMATURE VOLTAGE 180 VDC | |
| 1/100-1/50 | 1/50-1/25 | 1.0 |
| 1/50-1/30 | 1/25-1/15 | .51 |
| 1/30-1/20 | 1/15-1/10 | .35 |
| 1/20-1/12 | 1/10-1/6 | .25 |
| 1/12-1/8 | 1/6-1/4 | .18 |
| 1/8-1/5 | 1/4-1/3 | .1 |
| 1/4 | 1/2 | .05 |
| 1/3 | 3/4 | .035 |
| 1/2 | 1 | .025 |
| 3/4 | 1 1/2 | .015 |
| 1* | 2* | .01 |

▲ Motor horsepower and armature voltage must be specified when ordering so that proper Horsepower Resistor will be supplied.

*Use with Auxiliary Heatsink

**For overlapping motor horsepower range use lower value Plug-in Horsepower Resistor®

## TABLE OF CONTENTS



### LIST OF ILLUSTRATIONS



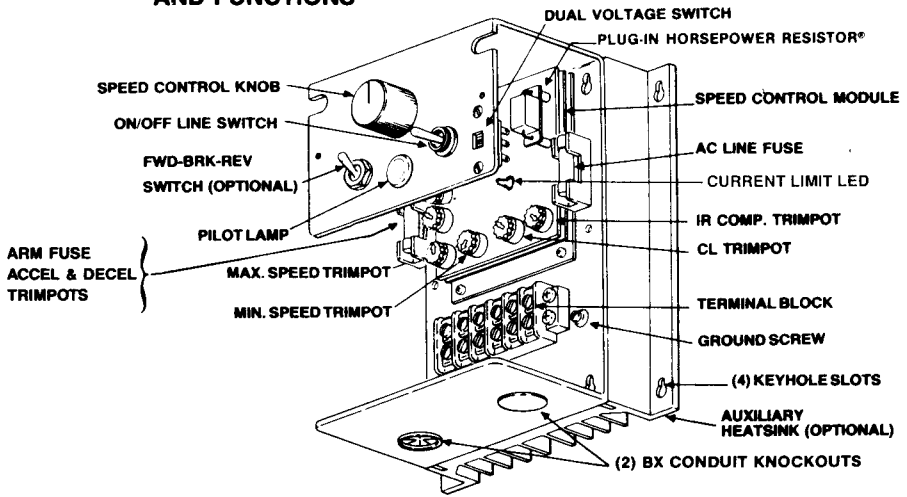
### LIST OF TABLES

## TABLE 4. 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; ±10% line variation) | 1/2* |
| Control linearity (% speed vs. dial rotation) | 2 |
| CL/torque range (% full load) | 0-200 |
| ACCEL/DECEL time period (secs.) | 0.2-10 |
| Min. speed trimpot range (% full speed) | 0-30* |
| Max. speed trimpot range (% full speed) | 50-110* |
| IR compensation trimpot range (at specified full load) (volts) | 0-24 |
| Maximum allowable ambient temperature at full rating (°C/°F) | 50/122 |

*Performance is for 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 Sec. IV E. (page 10). Other factory trimpot settings are as follows: CL-150% FL, ACCEL-2 secs., DECEL-2 secs., MIN-(0)-speed, MAX-full speed & IR-6 volts.

## FIG. 2 LOCATION OF FEATURES AND FUNCTIONS



# INTRODUCTION

The BC140 Full Wave Solid State DC Motor Speed Control represents the latest state-of-the-art design achievable through modern technology.

**Features Include:**

- **Integrated Circuitry**
  Used to control and amplify command and reference levels with both closed and open loop feedback to provide superior motor regulation. (Speed changes due to load, line voltage, or temperature variations are held to minimum levels).
- **High Quality Components**
  Selected and tested for proven dependability.
- **Transient Protection**
  Used to prevent failure of the power bridge circuit caused by voltage spikes on the AC line.
- **High Reliability**
  When used in accordance with the instructions included in this manual, the BC140 will provide years of trouble-free operation.

## SECTION 1. APPLICATION INFORMATION

**A. *Motor Type.*** BC140 is designed for Permanent Magnet (PM) and Shunt Wound D.C. 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 degradation of full speed performance. 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.

**B. *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.

**C. *Acceleration Start.*** The BC140 contains an adjustable acceleration start feature which allows the motor to smoothly accelerate from zero to full speed over a time period of 0.2-10 seconds. The "ACCEL" is factory set at 2 seconds.

**D. *Limitations in Use.*** BC140 control is designed for use on machine applications.

**E. *Armature Switching.*** For Armature switching use the optional Forward-Brake Reverse switch kit.

**WARNING!** Do not incorporate separate armature switching circuits or catastrophic failure will result.

CAUTION: Consult us before using on constant horsepower applications such as saws or drill presses. Do not use in explosive atmosphere.

CAUTION: be sure the BC140 is used within its max. ratings. Follow all installation instructions carefully. (Refer to Section II.)

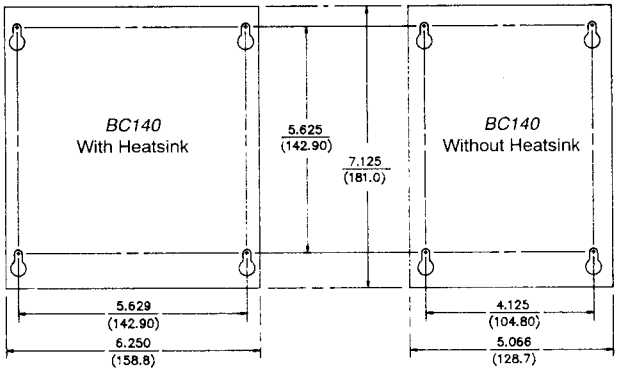
## SECTION II. INSTALLATION INSTRUCTIONS

**A.** *Location and Mounting.* The BC140 control 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 airtight enclosure, the air space should be large enough to provide adequate heat dissipation. The maximum allowable ambient temperature at full rating is 40°C/104°F. Consult us if more information is required.

> NOTE: Adequate clearance must be allowed to permit motor and power cables to enter through knockouts on bottom of control.

**FIG. 3 MOUNTING DIMENSIONS IN INCHES (MM).**




B. *Initial Setup.*-***Warning: To prevent electrical shock turn power off before wiring.***

(1) Slide open front cover by removing two 6-32 screw.
(2) Install Plug-in Horsepower Resistor® corresponding to motor voltage and horsepower. (See Chart **Table 3** page 3)
(3) Set the Dual Voltage Switch to proper position "115" or "230" which corresponds to the nominal AC input line voltage 115 or 230 VAC.
(4) Trimpots have been factory adjusted. If readjustment is required see section IV pages 9 & 10.
(5) Install Auxiliary Heatsink if motor is larger than 3/4 HP on115VAC and 1.5 HP on 230VAC.(Use (6) No. 10-32 screws)-unless already installed.

C. *Wiring.* (See Fig. 4 for terminal arrangement and wiring information.)

(1) Connect the BC140 to a standard 115V or 230V 50/60 Hz power source. [Be sure the DVS is set to the proper voltage "115" or "230" and motor voltage corresponds to the line voltage. (e.g. 90-130VDC motor on 115-120VAC and 180DC motor on 230-240VAC)].
(2) Follow the recommended supply wire sizes as per Table 5.
(3) Follow the NEC and other appropriate electrical codes. CAUTION: Separate branch protection must be provided on 230V circuits.
(4) Replace front cover and the two 6-32 screws.

## TABLE 5. MINIMUM SUPPLY WIRE SIZE REQUIREMENTS

| MAX. MOTOR AMPS (DC AMPS) | MAX. MOTOR HP 90 V | MAX. MOTOR HP 180 V | MINIMUM WIRE SIZE (AWG) Cu Only | |
|---|---|---|---|---|
| | | | MAX. 50 FOOT RUN | MAX. 100 FOOT RUN |
| 6.0 | 1/2 | 1 | 16 | 14 |
| 11.0 | 1 | 2 | 14 | 12* |

* Maximum recommended wire size.

**SAFETY WARNING:** This product must be installed and serviced by qualified electrical maintenance personnel familiar with SCR control and the hazards involved. Failure to disconnect power before wiring and servicing and to connect proper ground wire may result in an electrical shock. If adjustments are made with the control under power, insulated adjustment tools must be used and eye protection must be worn.

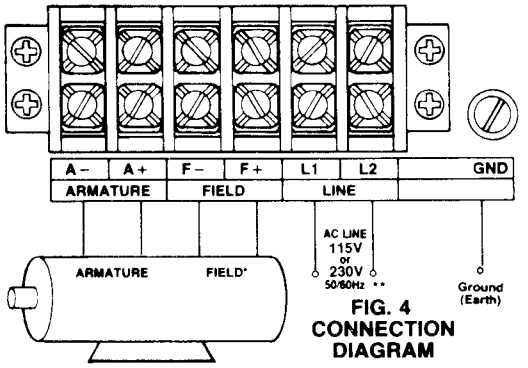



**FIG. 4 CONNECTION DIAGRAM**

*Use F– & F+ for shunt motors only. On motors with half voltage fields (e.g. 50 V field with 100 V rated armature) use $L_1$ & F+ terminals.

**Be sure to set the Dual Voltage Switch to the proper position "115" or "230".

### TABLE 6. FUSE SELECTION CHART

| 90VDC MOTOR HORSEPOWER | 180VDC MOTOR HORSEPOWER | APPROX. DC MOTOR CURRENT (AMPS) | FUSE RATING (AC AMPS) ARM | RECOM. RATING (AC AMPS) LINE |
|---|---|---|---|---|
| 1/30 | 1/15 | .33 | 1/2 | 12 |
| 1/20 | 1/10 | .5 | 3/4 | 12 |
| 1/15 | 1/8 | .65 | 1 | 12 |
| 1/12 | 1/6 | .85 | 1-1/4 | 12 |
| 1/8 | 1/4 | 1.3 | 2 | 12 |
| 1/6 | 1/3 | 1.7 | 2-1/2 | 12 |
| 1/4 | 1/2 | 2.5 | 4 | 12 |
| 1/3 | 3/4 | 3.3 | 5 | 12 |
| 1/2 | 1 | 5.0 | 8 | 12 |
| 3/4 | 1-1/2 | 7.5 | 12 | 12 |
| 1 | 2 | 10.0 | 15 | 25 |

### SHUNT FIELD WIRING CHART

| AC INPUT VOLTS (VAC) | DC Field Supply (VDC) | |
|---|---|---|
| | Low Voltage | High Voltage |
| 115 | 50 | 100 |
| 230 | 100 | 200 |
| Field Connection On Control | F+, L1 | F+, F– |

WARNING: If control is wired to a transformer for isolation or for voltage matching, always disconnect power to the control from secondary side of transformer. If disconnect is made on the primary side of the transformer, voltage surge may damage the control.

*D. Fusing.*

The BC140 contains a built-in replaceable AC line fuse rated 12A-240 VAC. (Use Buss type MDA or equiv.) The AC line fuse protects the control against catastrophic failure. If the fuse blows, the control is miswired, the motor is shorted or grounded, or the Speed Control Module is defective. (Note: jumping of fuse will void warranty) Armature Fuse (fuse holder located on left side of speed control module) supplied separately according to motor rating (see fuse chart on page 8 table 6.)

## SECTION III. OPERATION

1. Set ON/OFF power switch to "OFF."
2. Set speed control knob to "0."
3. Set FWD-BRK-REV switch (optional ) to "FWD."
4. Turn power switch to "ON" gradually increase speed control knob setting. Motor should come up to speed smoothly and remain stable. (NOTE: If control fails to operate, see Troubleshooting Guide, Section V, p. 11, 12)

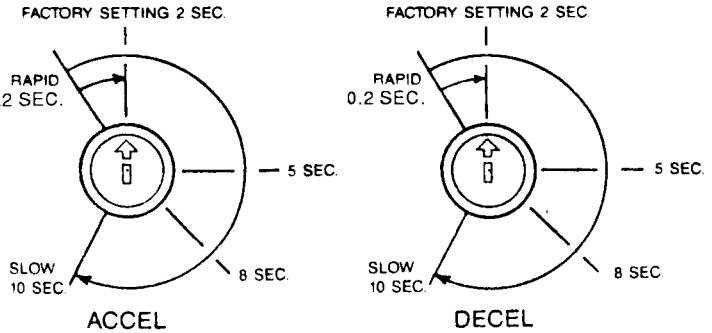
## SECTION IV. ADJUSTMENTS AND CONTROL FUNCTIONS

The BC140 has been factory adjusted to provide 0 to full speed range using the speed control knob. Minimum and maximum speed trimpots are provided to change the speed from other than 0 to full speed. An acceleration start 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.

**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.

The following procedure, presented in order of adjustment sequence, should be used when readjusting all trimpot functions:

FIG. 5




A. *Acceleration Start and Deceleration.* ACCEL and DECEL trimpots are located on the left side of the speed control module. If the ACCEL and/or DECEL are to be readjusted to different times, adjust trimpots according to Fig 5.

B. *Minimum Speed Adjustment.* If a higher than zero minimum speed is desired, readjust the minimum speed by turning the speed control knob to zero setting (full CCW position). Then adjust the Min. Speed Trimpot to the desired setting. (Baldor recommends that the speed control knob not be used to stop the motor since all circuitry is energized and could suddenly cause motor to start if a fault occurs).

NOTE: The min. speed adjustment will affect the max. speed setting. Therefore, it is necessary to readjust the minimum speed first and then the maximum speed.

C. *Maximum Speed Adjustment.* Turn Speed Control Knob to full speed (maximum CW position). Adjust max. speed trimpot to new desired setting.

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.

D. *Current Limit (CL/Torque Adjustment).* CL circuitry is provided to protect the motor and control against overloads. The CL also limits the inrush current to a safe level during startup. The CL is factory set to approximately 1.5 times the full load rating of the motor. (CL trimpot is nominally set to approx. 75% of full CW rotation.) CL LED will light when control is in current limit.

NOTE: The correct value Plug-in Horsepower Resistor® must be installed in order for the CL and IR comp. to operate properly.

**To set the CL to factory specifications adjust as follows:**

1. Set speed control knob at approximately 30-50% CW rotation. Set CL trimpot to full CCW position.
2. Connect a DC ammeter in series with the armature lead.
3. Lock shaft of motor (be sure CL pot is in full CCW position). Apply power and rotate CL pot CW slowly until DC ammeter reads 1.5 times motor rating (do not exceed 2 times motor rating).

**NOTE:** If only an AC ammeter is available, it can be installed in series with AC input line. Follow above instructions; however, set AC amperage at .75 times motor rating.

E. *IR Compensation Adjustment.* 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 comp should be adjusted as follows:

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

1. Set IR comp. trimpot at approximately 25% of CW rotation. Run motor unloaded at approximately 1/3 speed and record RPM.
2. Run motor with maximum load and adjust IR comp. trimpot so that the motor speed under load equals the unloaded speed per step 1.
3. Remove load and recheck unloaded RPM. If unloaded RPM has shifted, repeat procedure for more exact regulation.

The BC140 is now compensated to provide minimal speed change under large variations of applied load.

## SECTION V. TROUBLESHOOTING GUIDE

The following Troubleshooting Guide is intended for use by a qualified technician. The Guide is designed to isolate common malfunctions of the control and/or motor. It should be used with the parts lists and schematics contained in this manual.

| SYMPTOM | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 1. Motor does not run; power ON indicator not lit. | 1. Power switch in OFF position, or AC voltage not brought to L1, L2 terminals. | 1. Move power switch to ON position. Correct wiring to control. |
| | 2. Blown line fuse. | 2. Replace line fuse with 12A rated 3AB-type fuse. If fuse blew due to miswiring, speed control module may be defective. |
| | 3. Defective power switch. | 3. Replace power switch. |
| 2. Motor does not run; power ON indicator lit. | 1. Speed control knob set to 0. | 1. Turn knob CW to start motor. |
| | 2. Defective motor. | 2. Check for defective motor, worn brushes, etc. Replace motor. |
| | 3. Plug-in Horsepower Resistor® not installed. | 3. Install proper Plug-in Horsepower Resistor® |
| | 4. CL trimpot set to min. (CCW). (CL indicator led on control board lit). | 4. Adjust CL trimpot to 75% |
| 3. Motor hums, or runs at very low speed (with control knob set at high number) or motor slows down substantially when load is applied. | 1. Low voltage. | 1. Check line voltage at control and rewire as required. |
| | 2. Overload condition; control in current limit mode (CL trimpot not set correctly). | 2. Reduce loading; CL trimpot setting may have to be increased. See Section IV. |
| | 3. Plug-in Horsepower Resistor® not correct size. | 3. Install proper size Plug-in Horsepower Resistor® |
| | 4. Incorrect wiring. Armature and shunt connections interchanged (shunt motor only). | 4. Correct wiring (armature has lower resistance than field). |

## SECTION V. TROUBLESHOOTING GUIDE

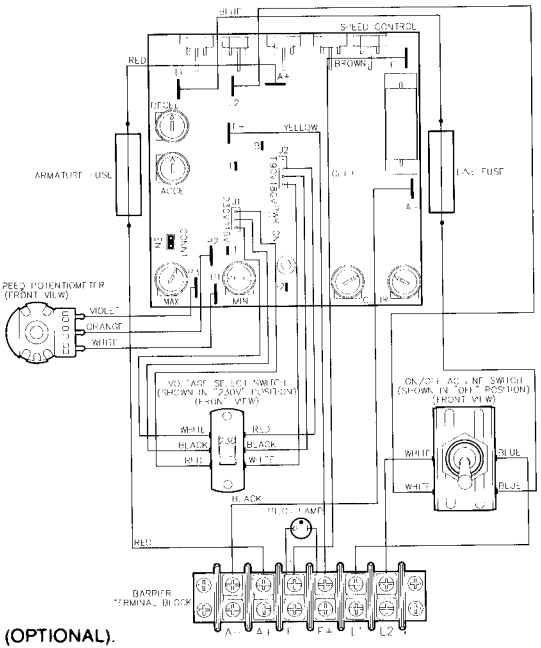
| SYMPTOM | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 4. Erratic motor performance. | 1. Defective motor, worn brushes, etc. | 1. Repair motor. |
| | 2. Overload condition. | 2. Remove overload. |
| | 3. Plug-in Horsepower Resistor ® wrong size. | 3. Replace resistor with proper size. |
| | 4. IR comp and/or CL trimpots not set properly. | 4. Readjust trimpots as per Section IV. |
| | 5. Defective speed control module. | 5. Replace module. |
| | 6. Dual Voltage Switch set in wrong position. | 6. Recheck line voltage and set Dual Voltage Switch to proper position "115" or "230." |
| 5. Motor runs in wrong direction. | 1. Armature leads reversed. | 1. Reconnect armature leads. |

The following portion of the Troubleshooting Guide refers only to controllers that have the FWD-BRK-REV switch option.

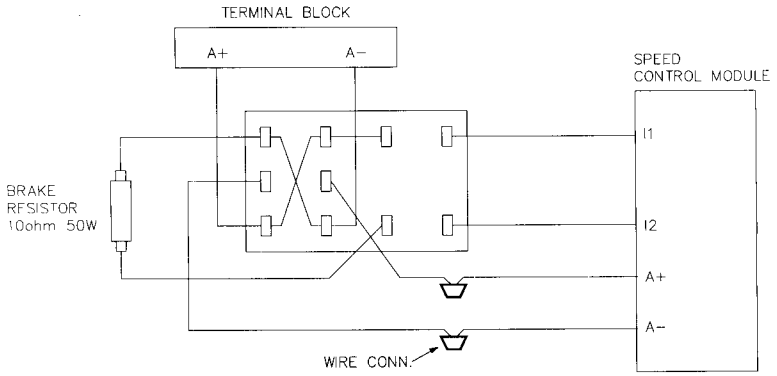
| SYMPTOM | POSSIBLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| 1. Motor will not run in either forward or reverse direction. | 1. Faulty wiring or loose connections to reversing switch. | 1. Correct wiring (see internal wiring diagram). |
| | 2. Defective FWD-BRK-REV switch. | 2. Replace switch assembly. |
| 2. No braking action in brake mode. | 1. Faulty wiring or loose connection. | 1. Correct wiring. |
| | 2. Faulty FWD-BRK-REV switch. | 2. Replace switch assembly. |
| | 3. Defective Brake Resistor. | 3. Replace resistor. |

# SECTION VI. (A) INTERNAL WIRING DIAGRAMS

## 1. *BC140*




## 2. FORWARD-BRAKE-REVERSE SWITCH (OPTIONAL).




# BALDOR®
## MOTORS AND DRIVES

**FORT SMITH, ARKANSAS 72902 U.S.A.**

PHONE 501-646-4711 FAX 501-648-5792



A40244B REV. B 12/00 PC 4M 05/02