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DC SCR Drives

for BC155

6/15 **Installation & Operating Manual** MN702

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Introduction

Introduction

Thank you for purchasing the Baldor BC154/BCWD140 Series NEMA-4X (IP-65) SCR DC Motor Speed and Torque Control. It is designed for applications requiring washdown watertight integrity. Its housing is ruggedly constructed of die cast aluminum which is protected with an acrylic coating for the ultimate in corrosion resistance. All switches are sealed with rubber boots and the main speed potentiometer has a shaft seal.

Short circuit and transient protection are provided for ultimate in reliability. Electronic overload protection prevents motor burnout and demagnetization of PM motors. The control can be operated in either the Speed or Torque mode via jumper selection. The current range, which is also jumper selectable, eliminates the necessity for calibration of IR Compensation and Current Limit for most applications. AC line voltage 230/115VAC (jumper selectable), DC armature voltage (180/90VDC) and feedback type may be Armature/Tachometer.

Standard features include armature fusing (fuse sold separately), electronic start/stop switch, and an LED indicator array for Power On, Stop and Overload. Although factory set for most applications, a variety of trim pots allow adjustments of parameters.

SAFETY NOTICE

A Warning statement indicates a potentially hazardous situation which, if not avoided, could result in injury or death.

A Caution statement indicates a potentially hazardous situation which, if not avoided, could result in damage to property.

A Note indicates additional information that is not critical to the installation or operation.

WARNING: This equipment may contain voltages as high as 1000 volts! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start-up procedure or troubleshoot this equipment.

WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury.

WARNING: Electrical shock can cause serious or fatal injury. Be sure that all power is disconnected and there is no voltage present from this equipment or equipment to which it is or will be connected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation and start-up procedures.

WARNING: This unit has an automatic restart feature that will start the motor whenever input power is applied and a RUN (FWD or REV) command is issued. If an automatic restart of the motor could cause injury to personnel, the automatic restart feature should be disabled.

WARNING: If possible, do not adjust trim pots with the main power applied. Electrical shock can cause serious or fatal injury. If adjustments are made with the main power applied, an insulated adjustment tool must be used to prevent shock hazard and safety glasses must be worn.

WARNING: Do not use this drive in an explosive environment. An explosion can cause serious or fatal injury. This drive is not explosion proof.

WARNING: When the Enable jumper is installed, the drive and motor will start and run when AC power is applied, when power is restored after a momentary power loss, or after an overload or TCL fault is reset. The user must ensure that automatic start up of the driven equipment will not cause injury to operating personnel or damage to the driven equipment. The user is responsible for providing suitable audible or visual alarms or other devices to indicate that the drive may start at any moment. Failure to observe this warning could result in severe bodily injury or loss of life.

WARNING: Do not use start/stop, inhibit or enable functions as a safety disconnect. Use only an AC line disconnect for that purpose. Failure to observe this warning could result in severe bodily injury or loss of life.

Caution: Disconnect motor leads (A1 and A2) from control before you perform a Dielectric Withstand test on the motor. Failure to disconnect motor from the control will result in extensive damage to the control. The control is tested at the factory for high voltage / leakage resistance as part of Underwriter Laboratory requirements.

Caution: Do not connect AC power to the Motor terminals A1 and A2. Connecting AC power to these terminals may damage the control.
Caution: Baldor recommends not to use Grounded Leg Delta transformer power leads that may create ground loops. Instead, we recommend using a four wire Wye.
Caution: Suitable for use on a circuit capable of delivering not more than 5,000 RMS symmetrical short circuit amperes listed here at rated voltage.
Caution: Adjusting the current limit above 150% of the motor nameplate rating can cause overheating and demagnetization of the PM motor.
Caution: Shunt wound motors may be damaged if field windings remain energized for an extended period of time without armature rotation.
Caution: Adjusting the CL above 150% of motor rating can cause overheating and possibly demagnetization of some PM motors. Consult motor manufacturer.
Caution: Do not connect switches or relays in series with the armature (A1 and A2). Armature switching can cause catastrophic failure of motor and/or control.
Caution: 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) – the shield should be grounded on the drive side only.
Caution: Do not set the maximum speed above the rated motor RPM since unstable motor operation may occur.

Receiving

Each control is thoroughly tested at the factory and carefully packaged for shipment.
When you receive your control, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your control.
2. Verify that the part number you received is the same as the part number listed on your purchase order.
3. Do not unpack until ready for use.

Table 1-1 Electrical Ratings

Model Number	Input Volts (VAC)	Max. Line Current (Amps RMS)	Armature (VDC)	Max. Current (ADC)	Max. Field Current @ 200/100 VDC	Max Power HP, (kW)
BC155	208/230	38	180	26	2.5A	5

Table 1-2 Performance Specifications

Parameter	Specification	Factory Setting
Speed Range (Ratio)	50:1	-
Armature Feedback Load Regulation (0 – Full Load, 50:1 Speed Range) – % Base Speed	1	-
Tachometer Feedback Load Regulation (0 – Full Load, 50:1 Speed Range) – % Set Speed	1	-
Line Voltage Regulation (At full load, ±10% Line Variation) % Speed	0.5	-
Control Linearity – % Speed vs Speed Setting	2	-
Acceleration (ACCEL) Trimpot Range – Seconds	1 – 10	3
Deceleration (DECEL) Trimpot Range – Seconds	1 – 10	1
Maximum Speed (MAX) Trimpot Range – % Base Speed	50 – 110	100
Minimum Speed (MIN) Trimpot Range – % Base Speed	0 – 30	0
Current Limit (CL) Trimpot Range – % Full Load	0 – 200	150
IR Compensation (IR) (At Full Load) – Volts	0 – 48	6
Tachometer Feedback Input Volts/1000 RPM – VDC	7 / 50	Set for Arm. Feedback
Maximum Operating Ambient Temperature at Full Load – °C / °F	40/104	-

Chapter 2

Installation

WARNING: Do not use this drive in an explosive environment. An explosion can cause serious or fatal injury. This drive is not explosion proof.

Introduction

The BC155 is intended to be installed in a vertical position on a flat surface free of moisture, metal chips, or corrosive atmosphere.
Control installation must ensure unrestricted air flow through the heatsink cooling fins.

Mounting

The BC155 control is designed for use on machine applications. Mount the BC155 on a flat surface free of moisture, metal chips, corrosive atmosphere, or excessive vibration. Mount the control in such a manner that there is unrestricted air flow through the heat sink cooling fins.

A 5K ohm speed potentiometer is provided with each control. Install the potentiometer using the hardware provided. Be sure to install the insulating disk between the pot and the panel mounting surface.

Enclosure – When mounting the BC155 in an enclosure, the enclosure must be large enough to allow for proper heat dissipation. The maximum allowable ambient temperature at full rating is 40ºC/104ºF. The WATTS LOSS value of the control at full load is 60 watts.

Electrical Connections

Connection terminals are shown in Figure 2-1.

Figure 2-1 Connection Diagrams

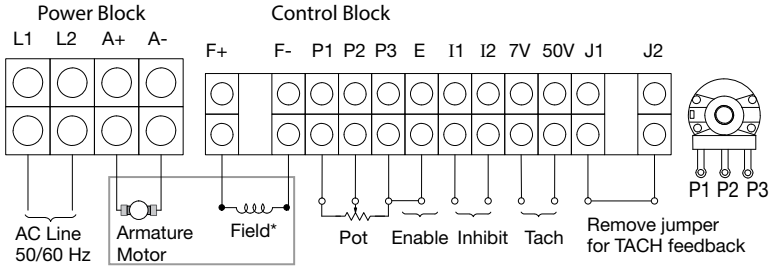


Table 2-1 Terminal Block Wiring

Terminal Designation	Connection Designation	Supply Wire Gauge (AWG – Copper)		Tightening Torque max.
		Minimum	Maximum	(lb-in)
Power Block	L1, L2, A+, A-	10 (max. 50 ft.)	8 (max. 100 ft.)	20
Control Block	F+, F- (200 VDC field)	22	12	4.4
	F+, L1 (100 VDC field)			
	Signal – Control Wiring			

AC Power

Verify AC Line voltage matches to control voltage rating, (208/230VAC - 50/60 Hz. 1phase). Connect AC Line to L1 and L2 terminals and tighten to correct torque (Table 2-1). The installer should provide fuse or circuit breaker protection for each Ungrounded supply conductor. Use a 40 Amp rated fuse (Buss type SC-40 or equivalent). Do not fuse neutral or grounded conductors. The control can be turned ON and OFF using the AC line. Auto-Inhibit® circuitry automatically resets critical components each time the AC line is interrupted. This, along with Acceleration Start and Current Limit, (CL), provides a smooth start each time the AC line is applied.

Motor Armature

Connect motor armature leads A+ and A-terminals and tighten to correct torque (Table 2-1). The armature fuse provides overload protection for the motor and control. The factory installed fuse is rated for maximum horsepower (type SC-40, 40Amp). To provide proper protection for motors rated less than maximum, use a fuse sized at approximately 1.7 times the DC amperage rating of the motor.

Ground Connection

Connect an earth ground conductor to the green ground screw terminal on case (not shown). Tighten to correct torque - 20 lb-in.

Field Connection

Shunt wound field motors only. Connect motor field to terminals F+ and F- (for full voltage 200 VDC), or to terminals F+ and L1 (for half voltage 100 VDC) and tighten to correct torque (Table 2-1).

Control Circuit Wiring

For Speed Potentiometer, Enable, Inhibit, and Tachometer wiring, use terminals P1, P2, P3, E, I1, I2, 7V, 50V, J1, and J2, (remove J1 – J2 jumper for Tach Feedback) and tighten to correct torque (Table 2-1). The control circuit fuse (not shown) provides protection for the Speed Control Module, power bridge and field supply. The factory installed fuse is type 3AG, 4Amp, (or equivalent).

Speed Potentiometer Connection

A 5K ohm speed potentiometer is provided with each control. Connect the speed pot to the Control Circuit Terminal strip, terminals P1, P2, and P3 and tighten to correct torque (Table 2-1)and tighten to 4.4 lb-in.

ENABLE

WARNING: When the Enable jumper is installed, the drive and motor will start and run when AC power is applied, when power is restored after a momentary power loss, or after an overload or TCL fault is reset. The user must ensure that automatic start up of the driven equipment will not cause injury to operating personnel or damage to the driven equipment. The user is responsible for providing suitable audible or visual alarms or other devices to indicate that the drive may start at any moment. Failure to observe this warning could result in severe bodily injury or loss of life.

The BC155 can be started and stopped with the Enable Circuit, (open to stop), using a Switch or contact connected to terminals 'E' and 'P3' on the Control Terminal strip. Remove the factory installed jumper between the 'E' and 'P3' terminals (Figure 2-1) before connecting and using the Enable Circuit.

INHIBIT

The BC155 can be started and stopped with an Inhibit Circuit using a switch or contact, (close to stop), connected to terminals 'I1' and 'I2' on the Control Terminal strip. When the switch or contact is closed, the motor will coast to stop. When the switch or contact is opened, the motor will accelerate to the speed set with the speed pot.

DC TACHOMETER CONNECTION

A DC tachometer can be used for speed regulation of 1% of set speed. If using a tachometer, remove the factory installed jumper wire from terminals J1 and J2 terminal strip Figure 2-1.
Set IR Comp trimpot to fully CCW position.

Table 2-2 Tachometer Connections

Tachometer Output Voltage Rating	Terminal Connection
7 Volts / 1000 RPM	(+) Lead to Terminal 7V
	(-) Lead to Terminal I2 or F-
50 Volts / 1000 RPM	(+) Lead to Terminal 50V
	(-) Lead to Terminal I2 or F-

Seven (7) Volts per 1000 RPM Tachometer

If using a 7 Volts/1000 RPM tachometer, connect the Positive (+) lead to Terminal 7V, and connect the Negative (-) lead to the I2 or F- Terminal on the Control Terminal Strip.

Fifty (50) Volts per 1000 RPM Tachometer

If using a 50 Volts/1000 RPM tachometer, connect the Positive (+) lead to Terminal 50V, and connect the Negative (-) lead to the I2 or F- Terminal on the Control Terminal Strip.

Other Tachometer Voltages

The tachometer input circuit is designed for 7 Volts/1000 or 50 Volts/1000 RPM DC Tachometers used with 1800 RPM motors. If using a tachometer other than 7 or 50 Volts/1000 RPM, or for motors other than 1800 RPM, an external ½ watt resistor must be installed in series with the tachometer signal. The resistance value of the series resistor, (RT), can be calculated using the formula –

RT = (1.3 X VT X S) – 16000 where:

VT = Tachometer Voltage in Volts per 1000 RPM.

S = Motor base speed in RPM.

Example: If a 20 Volts/1000 RPM tachometer is used with a 3600 RPM motor:

RT = (1.3 X 20 X 3600) – 16000 = 77600 Ohms (Ω)

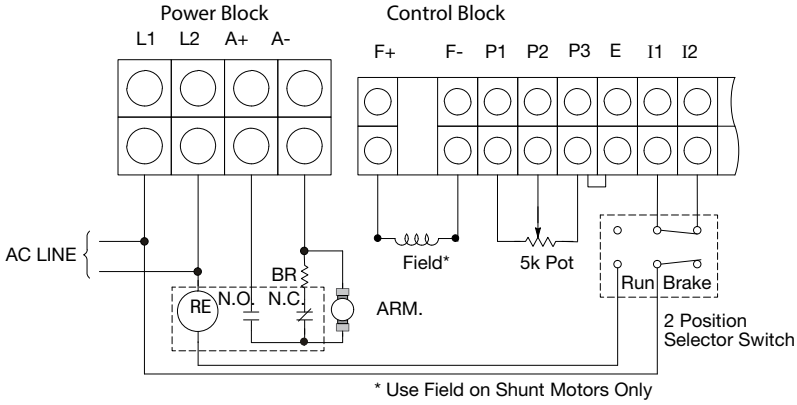
Choose the closest standard ½ watt resistor value, which, in this case would be 75000 Ohms, (75 KΩ).

ARMATURE SWITCHING / DYNAMIC BRAKING

If the armature is to be disconnected and re-connected with the AC power applied, connect a RUNBRAKE switch and contactor with a dynamic brake resistor in the armature circuit.
The Inhibit Circuit must be simultaneously activated when braking. Connect a double pole double throw, (DPDT), switch or control relay to the armature circuit and Inhibit Circuit.

Determine the braking resistor value and wattage rating according to braking requirements.
Determine the contactor rating in accordance with the motor voltage and current rating.
The Inhibit Circuit removes power from the motor during braking. When armature power is applied, the Inhibit Circuit releases and allows a smooth motor start. See Figure 4-2.

Figure 2-2 Dynamic Brake Circuit



START-UP AND ADJUSTMENTS

After the control has been mounted properly and electrical connections have been completed,

1. Verify the speed adjust potentiometer is set fully counterclockwise.
2. Apply AC power.
3. Observe the Power ON LED indicator is illuminated. If not on, refer to troubleshooting.
4. Verify correct direction of motor rotation.

Start the control. The motor shaft should begin to rotate as the potentiometer knob is turned clockwise, or the analog speed reference signal is increased.
Verify the motor shaft is rotating in the desired 'forward' direction.
If the direction of rotation is incorrect, stop the control and disconnect AC power.
Switch the motor lead connections at the A+ and A- terminals.
If a tachometer is connected, the leads may also need to be switched for correct signal polarity.
If the CL LED is on, refer to troubleshooting.

TRIMPOT ADJUSTMENTS

The control contains trimpots which have been factory set for most applications. Some applications may require readjustment to tailor the control for a specific performance requirement.

Minimum Speed Trimpot (MIN)
The MIN trimpot sets the minimum speed of the motor when the main speed pot is set fully counterclockwise, or when the analog speed reference signal is at minimum. The MIN trimpot is factory set to approximately 15% of pot rotation. To increase the minimum speed, rotate the MIN trimpot clockwise. To decrease the minimum speed, rotate the MIN trimpot counterclockwise.

Maximum Speed Trimpot (MAX)
The MAX trimpot sets the maximum speed of the motor when the main speed potertiometer is set fully clockwise or when the analog speed reference signal is at maximum. The MAX trimpot is factory set to approximately 65% of pot rotation. To increase the maximum speed, rotate the MAX trimpot clockwise. To decrease the maximum speed, rotate the MAX trimpot counterclockwise.

Note: The MAX trimpot is inoperative in the voltage following mode.

Caution: Do not set the maximum speed above the rated motor RPM since unstable motor operation ay occur.

Note: The MIN and MAX trimpots are interactive. Re-adjusting the MIN trimpot will affect the maximum speed setting, and conversly, adjusting the MAX trimpot will affect the minimum speed setting. Therefore, it may be necessary to readjust both trimpots to achieve the desired MIN and MAX motor speed.

Deceleration Trimpot (DECEL)
The DECEL trimpot controls the amount of ramp-down time when the main speed pot or analog speed reference signal is changed to a lower speed. The DECEL trimpot is factory set to 1 second which is the amount of time to decelerate from full speed to zero speed. To increase the deceleration time, rotate the DECEL trimpot clockwise. To decrease the deceleration time, rotate the DECEL trimpot counterclockwise.

Note: The deceleration time cannot be made less than the natural coast time of the motor and load.

IR Compensation Trimpot (IR)
The IR trimpot sets the amount of compensating voltage required to keep the motor speed constant under changing loads. If the load does not vary substantially, the IR trimpot may be set to a minimum level, (approximately 1/4 of full clockwise rotation). The IR trimpot is factory set to provide approximately 3% regulation, (6 VDC). If higher performance is desired, adjust the IR trimpot as follows.

1. Set IR trimpot to approximately 25% of CW rotation. Run motor unloaded at approximately 1/3 speed – measure and record RPM.
2. Run motor with maximum load and adjust the IR trimpot so that the motor speed under load equals the unloaded speed recorded in step 1.
3. Remove the load and recheck motor RPM. If unloaded speed has shifted, repeat procedure for more precise Regulation.

Notes:

1. Excessive IR compensation will cause unstable operation and cogging.
2. If using tachometer feedback, the IR trimpot should be set to minimum, fully counterclockwise.

Current Limit Trimpot (CL)

The CL trimpot sets the current limit, (overload), which limits the maximum current, (torque), to the motor. The CL trimpot is factory set to 1.5 times (150%) the full load rating. To increase the current limit value, rotate the CL trimpot clockwise. To decrease the current limit value, rotate the CL trimpot counterclockwise. Some applications may require a lower torque limit value to prevent damage to the process material or the driven equipment.

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

To Recalibrate the CL trimpot:

1. Disconnect the AC power and connect a DC ammeter in series with either motor armature lead. Observe correct polarity.

Note: An AC ammeter can be used by connecting it in series with either AC line input lead.

2. Set the main speed potentiometer to approximately 30 – 50% clockwise position.
3. Load the motor shaft in accordance with application requirements.
4. Set the CL trimpot fully counterclockwise. Apply AC input power. The red CL LED will illuminate.
5. While observing the ammeter, rotate the CL trimpot clockwise until the desired current, (torque), value is obtained. If using an AC ammeter the measured current value will be approximately 75% of the DC current value.

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

Troubleshooting

Table 2-3 Troubleshooting Guide

Indication / Symptom	Possible Cause / Solution
Motor does not run.	AC input voltage not present at L1, L2 terminals. Verify correct wiring.
	Blown line fuse or tripped circuit breaker. Blown armature fuse or control circuit fuse. Replace blown fuse with SL-40 or equivalent. If fuse blew due to miswiring, power bridge module may be defective.
Motor is not running. Power ON LED is illuminated.	Check ENABLE or INHIBIT circuit for loose or disconnected wiring.
	Main speed pot is set to zero. Re-adjust to desired speed.
	Main speed pot, speed reference signal input, or motor connections are open. Verify there are no loose or disconnected wires.
Motor hums or runs at very low speed. Motor slows when load is applied. CL LED is illuminated.	Incorrect motor wiring. Verify correct wiring.
	Motor is overloaded. Check motor current with DC ammeter. Reduce load.
	Motor may be defective. Check motor for shorts or grounds. Check brushes.
	Current Limit (CL) trimpot may not be set correctly. Re-adjust CL trimpot in accordance with section 5.2.6.
Motor runs at high speed and does not respond to main speed pot or speed reference signal.	Check field wiring. If using tachometer feedback, check tachometer signal.

Baldor District Offices

UNITED STATES

ARIZONA
PHOENIX
4211 S 43RD PLACE
PHOENIX, AZ 85040
PHONE: 602-470-0407
FAX: 602-470-0464

ARKANSAS
CLARKSVILLE
706 WEST MAIN STREET
CLARKSVILLE, AR 72830
PHONE: 479-754-9108
FAX: 479-754-9205

CALIFORNIA
LOS ANGELES
6480 FLOTILLA STREET
COMMERCE, CA 90040
PHONE: 323-724-6771
FAX: 323-721-5859

HAYWARD
21056 FORBES STREET
HAYWARD, CA 94545
PHONE: 510-785-9900
FAX: 510-785-9910

COLORADO
DENVER
3855 FOREST STREET
DENVER, CO 80207
PHONE: 303-623-0127
FAX: 303-595-3772

CONNECTICUT
WALLINGFORD
65 SOUTH TURNPIKE ROAD
WALLINGFORD, CT 06492
PHONE: 203-269-1354
FAX: 203-269-5485

FLORIDA
TAMPA/PUERTO RICO/ VIRGIN ISLANDS
3906 EAST 11TH AVENUE
TAMPA, FL 33605
PHONE: 813-248-5078
FAX: 813-241-9514

GEORGIA
ATLANTA
62 TECHNOLOGY DRIVE
ALPHARETTA, GA 30005
PHONE: 770-772-7000
FAX: 770-772-7200

ILLINOIS
CHICAGO
340 REMINGTON BLVD.
BOLINGBROOK, IL 60440
PHONE: 630-296-1400
FAX: 630-226-9420

INDIANA
INDIANAPOLIS
5525 W. MINNESOTA STREET
INDIANAPOLIS, IN 46241
PHONE: 317-246-5100
FAX: 317-246-5110

IOWA
DES MOINES
1943 HULL AVENUE
DES MOINES, IA 50313
PHONE: 515-263-6929
FAX: 515-263-6515

MARYLAND
BALTIMORE
7071A DORSEY RUN RD
ELKRIDGE, MD 21075
PHONE: 410-579-2135
FAX: 410-579-2677

MASSACHUSETTS
BOSTON
6 PULLMAN STREET
WORCESTER, MA 01606
PHONE: 508-854-0708
FAX: 508-854-0291

MICHIGAN
DETROIT
5993 PROGRESS DRIVE
STERLING HEIGHTS, MI 48312
PHONE: 586-978-9800
FAX: 586-978-9969

MINNESOTA
MINNEAPOLIS
13098 GEORGE WEBER DR,
SUITE 400
ROGERS, MN 55374
PHONE: 763-428-3633
FAX: 763-428-4551

MISSOURI
ST LOUIS
13678 LAKEFRONT DRIVE
EARTH CITY, MO 63045
PHONE: 314-373-3032
FAX: 314-373-3038

KANSAS CITY
9810 INDUSTRIAL BLVD.
LENEXA, KS 66215
PHONE: 816-587-0272
FAX: 816-587-3735

NEW YORK
AUBURN
ONE ELLIS DRIVE
AUBURN, NY 13021
PHONE: 315-255-3403
FAX: 315-253-9923

NORTH CAROLINA
GREENSBORO
1220 ROTHERWOOD ROAD
GREENSBORO, NC 27406
PHONE: 336-272-6104
FAX: 336-273-6628

OHIO
CINCINNATI
2929 CRESCENTVILLE ROAD
WEST CHESTER, OH 45069
PHONE: 513-771-2600
FAX: 513-772-2219

OHIO (Continued)
CLEVELAND
8929 FREEWAY DRIVE
MACEDONIA, OH 44056
PHONE: 330-468-4777
FAX: 330-468-4778

OKLAHOMA
TULSA
5555 E. 71ST ST., SUITE 9100
TULSA, OK 74136
PHONE: 918-366-9320
FAX: 918-366-9338

OREGON
PORTLAND
16201 SE 98TH AVENUE
CLACKAMAS, OR 97015
PHONE: 503-691-9010
FAX: 503-691-9012

PENNSYLVANIA
PHILADELPHIA
103 CENTRAL AVENUE
SUITE 400B
MOUNT LAUREL, NJ 08054
PHONE: 856-840-8011
FAX: 856-840-0811

PITTSBURGH
159 PROMINENCE DRIVE
NEW KENSINGTON, PA 15068
PHONE: 724-889-0092
FAX: 724-889-0094

TENNESSEE
MEMPHIS
4000 WINCHESTER ROAD
MEMPHIS, TN 38118
PHONE: 901-365-2020
FAX: 901-365-3914

TEXAS
DALLAS
2920 114TH STREET SUITE 100
GRAND PRAIRIE, TX 75050
PHONE: 214-634-7271
FAX: 214-634-8874

HOUSTON
10355 W. LITTLE YORK ROAD
SUITE 300
HOUSTON, TX 77041
PHONE: 281-977-6500
FAX: 281-977-6510

UTAH
SALT LAKE CITY
2230 SOUTH MAIN STREET
SALT LAKE CITY, UT 84115
PHONE: 801-832-0127
FAX: 801-832-8911

WISCONSIN
MILWAUKEE
1960 SOUTH CALHOUN ROAD
NEW BERLIN, WI 53151
PHONE: 262-784-5940
FAX: 262-784-1215

INTERNATIONAL SALES
FORT SMITH, AR
P.O. BOX 2400
FORT SMITH, AR 72902
PHONE: 479-646-4711
FAX: 479-648-5895

BALDOR®

A MEMBER OF THE ABB GROUP

Baldor Electric Company
P.O. Box 2400, Fort Smith, AR 72902-2400 U.S.A., Ph: (1) 479.646.4711, Fax (1) 479.648.5792, International Fax (1) 479.648.5895
www.baldor.com

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