COST: $8.00

Installing, Operating and Maintaining DC1 V★S Drive

FOR NEMA 4 RATED DC1 CONTROLLERS

NOTE: THIS INSTRUCTION MANUAL COVERS THE INSTALLATION AND START-UP DETAILS FOR ALL DC1-80 AND DC1-90 SERIES CONTROLLERS. FOR CROSS REFERENCE PURPOSES, USE THE CHART BELOW FOR SPECIFIC MODEL NUMBER RATINGS FOR NEMA 4 VERSIONS OF THE STANDARD NEMA 12 DC1 CONTROLLER. INSTRUCTION AND START-UP INSTRUCTIONS ARE IDENTICAL.

NEMA 4 DC1 CONTROLLER MODEL NUMBER	STANDARD NEMA 12 DC1 CONTROLLER REFERENCE
DC1-80	DC1-60
DC1-82	DC1-62
DC1-90, DC1-95	DC1-70
DC1-91	DC1-71
DC1-92, DC1-97	DC1-72
DC1-94	DC1-74

REPLACEMENT PARTS ARE IDENTICAL AS WELL EXCEPT FOR SPECIAL BOOTS ON TOGGLE SWITCHES. REFERENCE RELIANCE PART NUMBER 4DC10000. IN ADDITION, MODELS DC1-95 AND DC1-97 FEATURE A SPECIAL 10-TURN SPEED POTENTIOMETER AND NOT THE SINGLE-TURN POTENTIOMETER ON ALL OTHER DC1-90 SERIES CONTROLLERS. REFERENCE RELIANCE PART NUMBER 600594-14SFX FOR REPLACEMENTS.

V★S®

DRIVES

D2-3099-4
February, 1992

RELIANCE ELECTRIC

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1: Receive and Accept the Controller

Receive and Accept the Shipment

The Reliance Electric DC1 V★S® Controller (herein referred to as controller) has been designed, manufactured and thoroughly tested to provide many years of reliable service. The shipping container in which you received your controller has been specifically designed to protect it during transportation and handling.

Reliance® terms of sales, in all instances, are F.O.B. point of origin. It is your responsibility to thoroughly inspect the equipment before accepting shipment from the transportation company.

If any of the items called for on the bill of lading or express receipt are damaged or are not included, **do not** accept the shipment until the freight or express agent makes an appropriate notation on your freight bill or express receipt.

If any concealed loss or damage is discovered later, notify your freight or express agent within 15 days of receipt and request that he make an inspection of the shipment. Keep the entire shipment intact in its original shipping container.

The consignee is responsible for making claim against the Carrier for any shortage or damage occurring in transit. Claims for loss or damage in shipment must not be deducted from the Reliance Electric invoice, nor should payment of the Reliance invoice be withheld while awaiting adjustment of such claims since the carrier guarantees safe delivery.

If considerable damage has been incurred and the situation is urgent, contact the nearest Reliance Electric Sales Office for assistance.

Store the Controller until Installation

After receipt inspection, repack the controller in its shipping container until installation. If a period of storage is expected, store in the original shipping container with its internal packing.

To ensure satisfactory drive operation at startup and to maintain warranty coverage, store the equipment:

- in its original shipping container in a clean, dry, safe place.
- in an ambient temperature that does not exceed 65°C (149°F) or go below -30°C (-22°F).
- within a relative humidity range of 5 to 95% without condensation.
- away from a highly corrosive atmosphere. In harsh environments, cover the shipping/storage container.

File a Return Request

1. To return equipment, send a written request to Reliance Electric within ten days of receipt.
2. Do not return equipment without a numbered authorization form (ERA form) from Reliance Electric.
3. Reliance Electric reserves the right to inspect the equipment on site.

2: Introduction to the Controller

Scope of This Manual

The products described in this Instruction Manual are manufactured by Reliance Electric Industrial Company.

This Manual familiarizes you with the controller. It describes receiving, storage and installation procedures; provides an overview of specifications and operations; and includes troubleshooting, maintenance and replacement parts data.

Read this manual in its entirety before installing and starting the controller. Observe all dangers, warnings, and cautions; these precautions point out potentially hazardous procedures. All three types of precautions are enclosed in a box to call attention to them.

- A **danger** alerts a person that high voltage or the potential of motor rotation is present that could result in severe bodily injury or loss of life.
- A **warning** alerts a person of potential bodily injury if procedures are not followed.
- A **caution** alerts a person that, if procedures are not followed, damage to, or destruction of, equipment could result.

Controller Configurations

The controller converts single-phase A-C line power to adjustable D-C power for either speed or torque control of D-C motors rated 1/4 through 2 horsepower. The controller is specifically performance matched to Reliance D-C Motors to provide a compact controller/motor package. It will operate all Reliance 1/4 through 2 horsepower permanent magnet or wound field D-C motors with compatible armature and field voltages.

The controller is available in a wide array of application specific configurations, either in an open chassis or a NEMA/UL 12K enclosure design. Table 2-1 lists available open chassis configurations, and Table 2-2 lists the enclosed configurations.

Table 2-1. Open Chassis Controllers Listed by Features and Configuration.

Controller Features	Controller Model Number by Configuration	
	Speed Control	Torque Control
Basic	DC1-40 DC1-50 DC1-45 [1]	DC1-43 DC1-53
Basic plus Process Control	DC1-42 DC1-46 [1] DC1-52	DC1-44 DC1-54

[1] Special customer model.

Table 2-2. NEMA/UL 12K Enclosed Controllers Listed by Features and Configuration.

Controller Features	Controller Model Number by Configuration	
	Speed Control	Torque Control
Basic	DC1-60 DC1-65 [1] DC1-70 [2] DC1-75 [1] [2]	DC1-63 DC1-73 [2]
Basic plus Process Control	DC1-62 DC1-66 [1] DC1-72 [2] DC1-76 [1] [2]	DC1-64 DC1-74 [2]
Basic plus DB/Reversing	DC1-71 [2] [3]	

[1] Special customer model.
[2] Includes operator's controls.
[3] Cannot be used with D-C Tachometer speed feedback

Controller Features

Standard DC1 V★S Drive Controllers available are listed in Tables 2-1 and 2-2.

Basic Controller Features, All Models

- A-C line power reconnectable for single-phase 115 volts or 230 volts:
  - 115 volts A-C: 90 volts armature/50 volts field supply
  - 230 volts A-C: 180 volts armature/100 volts field supply
- 50 or 60 cycle power without modification
- Full-wave, half-controlled armature voltage rectifier with back diode for improved armature form factor
- Half-wave field supply for shunt wound D-C motors
- Short circuit protection by incoming line fuse
- Line transient protection by metal oxide varistor and RC circuit
- Armature current scaling by reconnectable jumper for horsepower rating
- Unidirectional operation with coast-to-rest stop
- Motor overload protection by internal motor thermostat
- Provisions for remote start and/or remote stop

Speed Control Features (Models DC1-40, 42, 45, 46, 50, 52, 60, 62, 65, 66, 70, 71, 72, 75, 76)

- All features listed in "Basic Controller Features, All Models"
- Speed control by armature voltage regulation or motor mounted D-C tachometer (Except DC1-71)
- Potentiometer motor speed adjustment
- Independently adjustable maximum and minimum speeds
- Fixed rate acceleration
- Adjustable current limit
- Jumper selectable Armature voltage feedback scaling (90 or 180 volts)
- Adjustable IR drop compensation

Speed Control with Reversing and Dynamic Braking (Model DC1-71)

- All features listed in "Basic Controller Features, All Models" and "Speed Control Features"
- Reversing direction of rotation by a FORWARD/OFF/REVERSE switch; The "off" position (or center position of the switch) applies dynamic braking (braking capabilities listed in Table 2-5)
- Selector Switch has detent feature which requires release of pressure on the switch when passing from forward to reverse. When combined with the dynamic braking action, this feature minimizes the possibility of plug reversing the motor.

CAUTION: The drive must be at zero speed before changing the direction of rotation. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Speed Control with Isolated Process Control Interface (Models DC1-42, 46, 52, 62, 66, 72, 76)

- All features listed in "Basic Controller Features, All Models" and "Speed Control Features"
- Motor speed adjustment by potentiometer (Manual mode) or process control output signal (Automatic mode)
- Manual/Automatic mode switching by selector switch
- Process control signal input selection by jumper: 1 to 5 mA, 4 to 20 mA, 10 to 50 mA, or 0 to 10 volts reference signal, grounded or ungrounded
- Isolated input 300K ohm differential
- Process interface (PI) Gain adjustment
- Process Interface (PI) Bias adjustment

Basic Torque Control Features (Models DC1-43, 44, 53, 54, 63, 64, 73, 74)

- All features listed in "Basic Controller Features, All Models"
- Motor torque adjustment by potentiometer
- Independently adjustable maximum and minimum torque
- Fixed rate reference timing
- Adjustable speed limit by voltage limit or motor mounted D-C tachometer feedback
- Jumper selectable Armature voltage feedback scaling (90 or 180 volts)

Torque Control with Isolated Process Control Interface (Models DC1-44, 54, 64, 74)

- All features listed in "Basic Controller Features, All Models" and "Basic Torque Control Features"
- Motor torque adjustment by potentiometer (Manual mode) or process control output signal (Automatic mode)
- Manual/Automatic mode switching by selector switch
- Process control signal input selection by jumper: 1 to 5 mA, 4 to 20 mA, 10 to 50 mA, or 0 to 10 volts reference signal, grounded or ungrounded
- Isolated input 300K ohm differential
- Process Interface (PI) Gain adjustment
- Process Interface (PI) Bias adjustment

Controller Specifications

Ratings

- Service factor 1.0
- Continuous Duty
- Load capacity: 150% for 1 minute
- Line voltage variations: ±10% of rated
- A-C Line frequency: 48 to 62 Hertz
- Maximum allowable symmetrical A-C line fault current: 10,000 amperes
- Controller ratings by motor horsepower: Refer to Table 2-3
- Ambient temperature
  Open chassis models:
  0° to 55°C (32° to 131°F)
  NEMA/UL 12K enclosed:
  0° to 40°C (32° to 104°F)
- Altitude: 3300 feet (1000 meters) maximum
- Non-Condensing Relative Humidity 5 to 95%
- Nema 12K enclosure is intended for indoor use. It provides protection against dust, falling dirt and dripping non-corrosive liquids. It will not protect against internal condensation.

Controller Performance

- Controlled speed range: minimum to motor base speed
- Efficiency (at rated speed and load):
  Controller – 97%
  Controller and motor – 78% (typical)
- Displacement power factor (at rated speed and load): 70%

Table 2-3. Controller Ratings by Motor Horsepower.

Motor HP	115-Volt A-C Input / 230-Volt A-C Input					
	Rated A-C Line Amperes [1]	Input KVA	D-C Armature Voltage	Rated Armature Current (amperes)	Available Field Voltage	Available Field Current (amperes)
1/4	3.1	.36	90	2.5	50	2.0
	—	—	—	—	—	—
1/3	4.2	.48	90	3.7	50	2.0
	—	—	—	—	—	—
1/2	6.2	.71	90	5.0	50	2.0
	3.1	.71	180	2.5	100	2.0
3/4	9.4	1.0	90	7.5	50	2.0
	4.7	1.0	180	3.7	100	2.0
1 [2]	12.5	1.4	90	10.0	50	2.0
	6.2	1.4	180	5.0	100	2.0
1-1/2	—	—	—	—	—	—
	9.4	2.2	180	7.5	100	2.0
2 [2]	—	—	—	—	—	—
	12.5	2.9	180	10.0	100	2.0

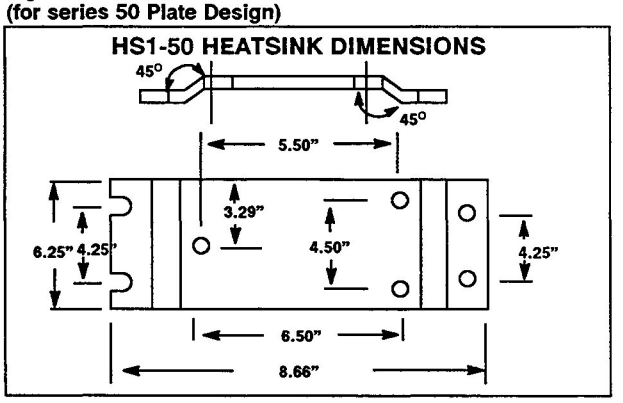
[1] Includes motor field current.

[2] DC1-50, 52, 53 and 54 plate design and must be mounted to a steel plate 18" x 18" to meet 1 HP @ 115 VAC and 2 HP @ 230 VAC, or an optional heatsink (HS1-50) can be purchased.

Table 2-4. Controller Isolation Transformer Ratings

HP	Transformer KVA
1/4	0.5
1/3	0.75
1/2	1.0
3/4	1.50
1	2.00
1-1/2	3.00
2	5.00

Figure 2-1. HS1-50 Heatsink Dimensions (for series 50 Plate Design)



Speed Control Adjustment Ranges

- Maximum speed: 50 to 100% of motor base speed with speed setting pot at its maximum setting
- Minimum speed: 10 to 50% of motor base speed with speed setting pot at its minimum setting
- Current limit: 20 to 150% rated current
- IR drop compensation: 0 to 10% at rated armature voltage
- Speed regulation characteristics: refer to Table 2-5.
- Acceleration ramp time to maximum speed: 6 sec ±2 sec (other times available by changing capacitors)
- Dynamic braking provided in Model DC1-71 only: designed for applications requiring infrequent stops of loads in which the inertia reflected to the motor is approximately equivalent to or less than the motor armature inertia. Refer to Table 2.6.

CAUTION: Do not use dynamic braking on applications with reflected inertias higher than motor armature inertia or when frequent stops are necessary. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

- Isolated process follower input
  Maximum speed: 50 to 100% with reference at maximum
  Minimum speed: 0 to 70% with reference at minimum

Torque Control Adjustment Ranges

- Minimum torque: 10 to 50% of rated motor torque
- Maximum torque: 50 to 150% of rated motor torque
- Speed/Voltage limit: 40 to 110% base speed

Table 2-5. Speed Regulation Characteristics.[4]

Type of Regulation	Line Voltage ±10%	Load Change 95%	Regulated Speed Range	Temperature ±10°C	Field Heating Cold Normal [1]
Armature Feedback (Voltage)	0.1%	2-5% [2]	20:1	1.0%	5-12%
Tachometer Feedback (Speed) [3]	0.1%	1%	30:1	1.5%	0.5%

[1] Applies to wound field D-C motors only.

[2] Dependent upon specific motor characteristics and IR drop compensation adjustment.

[3] Applicable to non-reversing models only.

[4] All percentages expressed relative to maximum speed.

Table 2-6. Dynamic Braking Capabilities.

Description	Input Voltage	Motor Horsepower						
		1/4	1/3	1/2	3/4	1	1-1/2	2
Braking Torque (% Full Load Torque)	115	129	103	66	44	34	-	-
	230	-	-	200	190	130	88	62
Allowable Stops Per Minute	115	12	11	8	6	2	-	-
	230	-	-	8	6	1	1	1

3: Install and Wire the Drive

DANGER
ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Install the Drive

Review all installation and wiring instructions thoroughly before proceeding. Throughout the installation and wiring procedures, use Figure 3-1 to locate adjustment potentiometers, terminal boards, special selector jumpers and pins. Wiring diagrams are given in Figures 5-1 through 5-5.

Install the Controller

1. Remove the controller cover and inspect for any physical damage. Report any shipping damage to the carrier.
2. Locate the controller where it will have the unrestricted ventilation area as indicated in Figure 3-2. For the Heatsink versions, allow for unrestricted air flow over the rear cooling fins and sides. Allow at least 4" above the controller to access the fuse cap.

   For the flat plate designs allow 1" around the controller for service access. Also note that an 18" by 18" steel plate is required to meet the 1 HP @ 115 VAC and 2 HP @ 230 VAC.
3. Make sure that ambient temperatures in the controller area

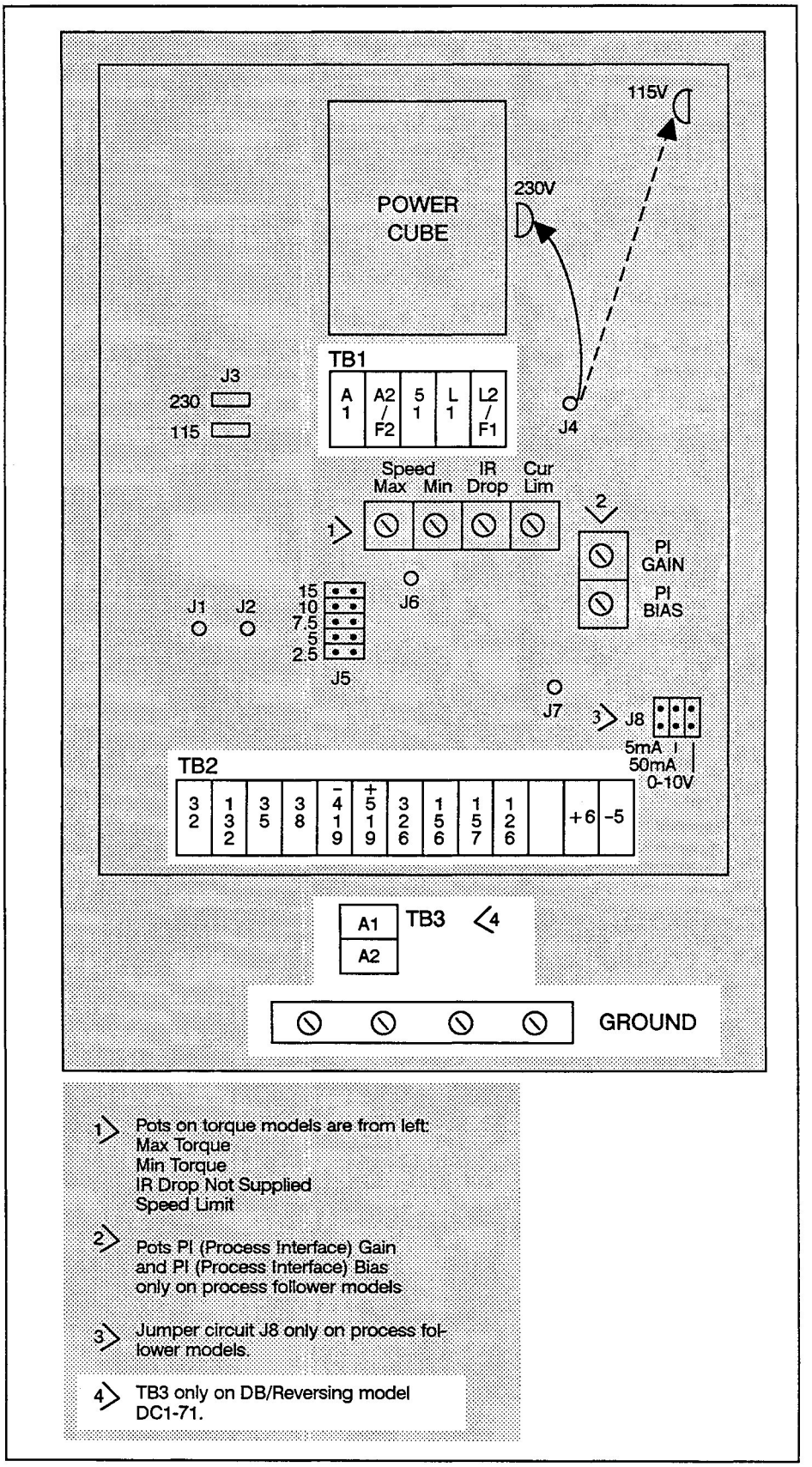


Figure 3-1. Locate Controller Terminal Boards and Ground Point.

are within 0°C and 40°C (32°F and 104°F) for enclosed controllers or 0°C and 55°C (32°F and 131°F) for open chassis controllers.

4. Route power and control wiring through the conduit openings provided in the bottom of the enclosed controller. The area above the controller must be kept clear of live electrical circuits to avoid accidental contact when accessing the fuse. (See Figure 3-2.)
5. Remove the fuse cap for access to the top mounting slot.
6. Mount the controller in a vertical, upright position, fuse on top. Mount the flat plate design with the fuse on the right side. See Figure 3-2 for dimension and mounting details.
7. Seal the conduit entries of the enclosed controller, using the Reliance metal hub (part 608826-2A) and plug (part 608826-1A) or equivalent (these parts are not supplied), to retain the NEMA/UL 12K enclosure ratings.
8. Replace the fuse cap.

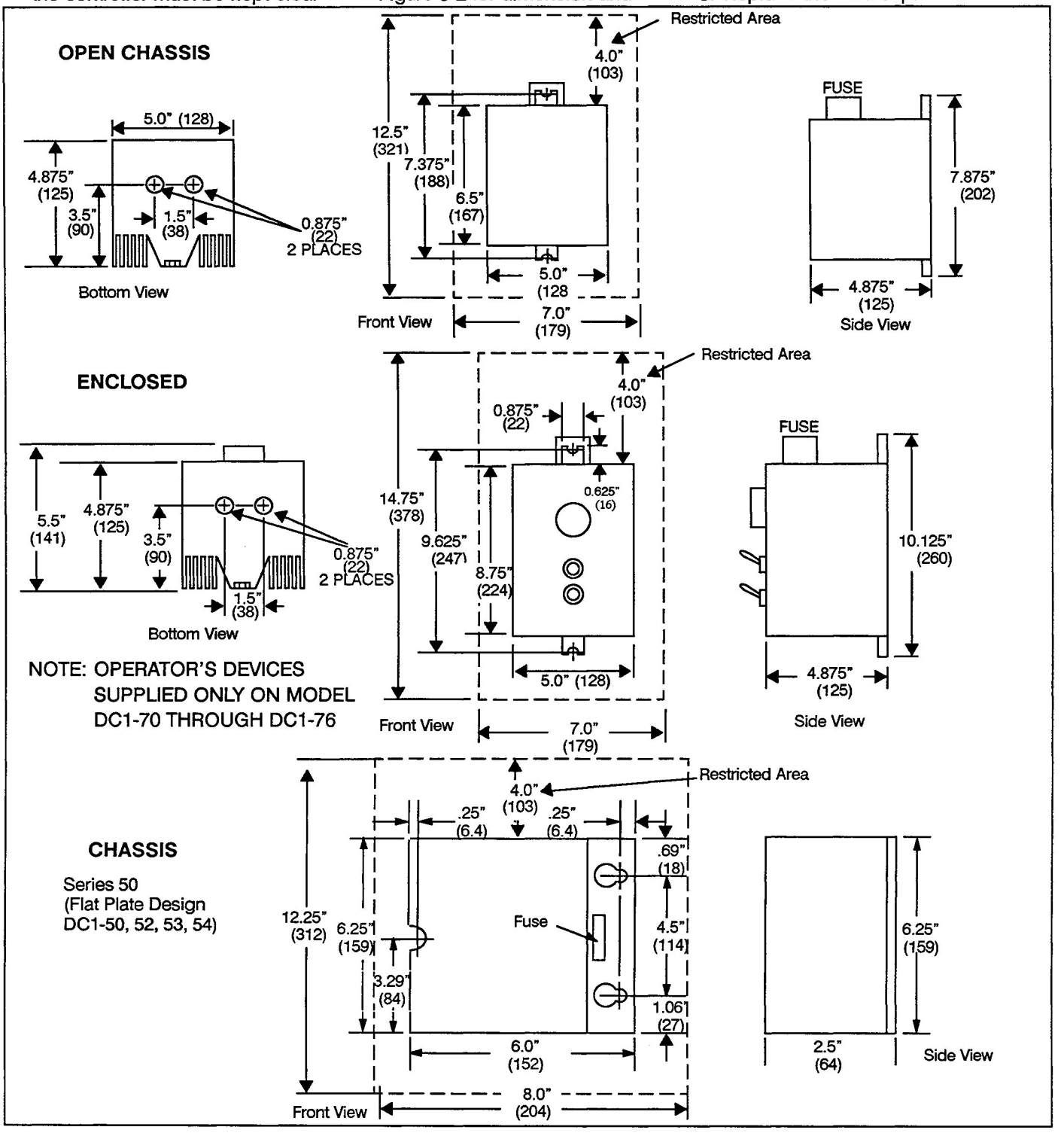


Figure 3-2. Dimension and Mounting Data for Enclosed and Open Chassis Controllers.

Install the Motor

1. Install the D-C motor in accordance with its own installation instructions.
2. Make sure that coupled applications have proper shaft alignment with the driven machine or that belted applications have proper sheave/belt alignment to minimize unnecessary motor loading.

Install a Disconnect

DANGER

THE NEC REQUIRES THAT AN APPROVED CLASS K5 FUSED DISCONNECT SWITCH OR CIRCUIT BREAKER BE USED AHEAD OF THE CONTROLLER IN THE INCOMING A-C LINE AND BE LOCATED WITHIN SIGHT OF THE CONTROLLER OR BE LOCKABLE. MAKE SURE POWER IS OFF BEFORE WORKING ON THE CONTROLLER OR EQUIPMENT. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Provide a fused disconnect or circuit breaker in the incoming A-C line according to NEC. See Figure 3-3.
2. Size the fused disconnect or circuit breaker to accommodate a maximum symmetrical A-C fault current of 10,000 amperes
3. For flat plate models supplied without a fuse on the panel the customer must provide an external fuse, (See Figure 3-3B) for each drive for short circuit protection **in addition to** the normal branch circuit protection (Figure 3-3A). The recommended fuse is recognized component (JDYX2) Bussman Part Number ABC-20, 250V, 20A, non-time delay fast - acting fuse (or equivalent).

CAUTION: When a fused disconnect is used, the fuse must be a one-time Class K5. Do not use dual element, slow blow Class K5 fuse. Failure to observe this precaution could result in damage to, or destruction of the equipment.

4. When the D-C Tachometer option is used, a controller isolation transformer must be used between the A-C power source and the controller to isolate the controller from the A-C power source ground. Each such controller must have its own isolation transformer. The controller chassis must still be tied to the building ground system at the grounding point provided. The transformer is sized per Table 2-4. An auto transformer cannot be used since it will not provide isolation from ground.

WARNING

WHEN THE START/STOP SWITCH DOES NOT INCLUDE AN A-C POWER DISCONNECT FUNCTION IN THE STOP POSITION, THE A-C POWER DISCONNECT SWITCH MUST BE MOUNTED IN CLOSE PROXIMITY TO THE OPERATOR'S START/STOP CONTROLS. THIS IS REQUIRED AS THE DC1 DRIVE DOES NOT HAVE AN ARMATURE LOOP CONTACTOR AND A SINGLE FAULT LIKE A THYRISTOR SHORT MAY CAUSE MOTOR ROTATION WHEN IN THE STOP MODE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

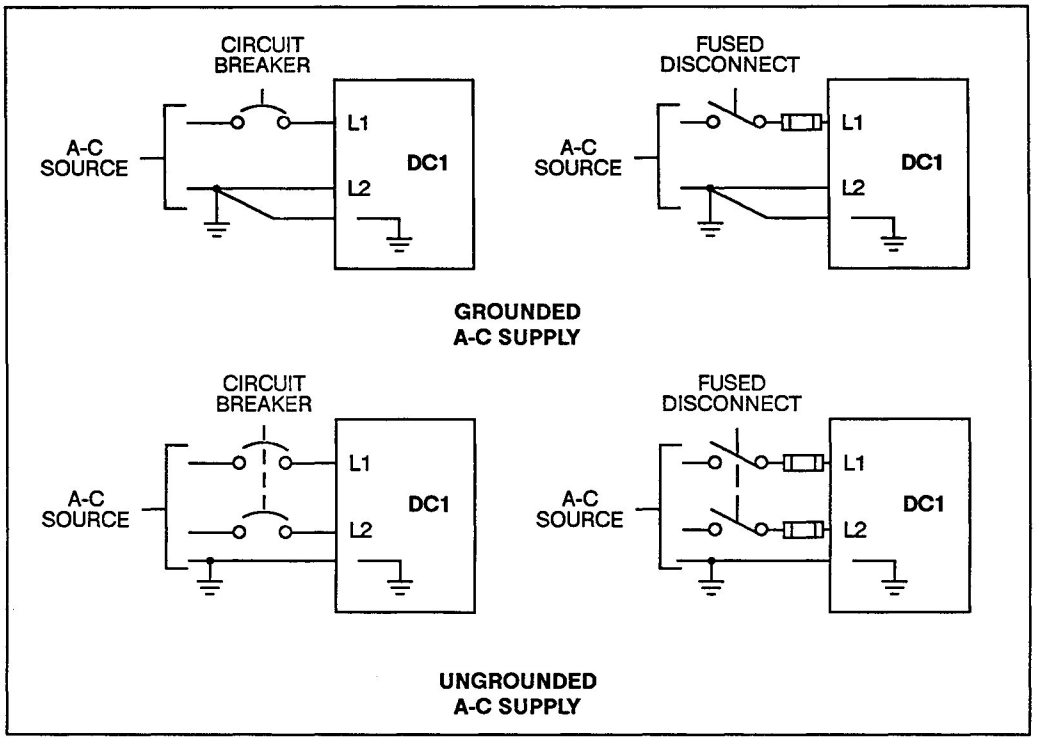


Figure 3-3A. Provide a Fused Disconnect or Circuit Breaker

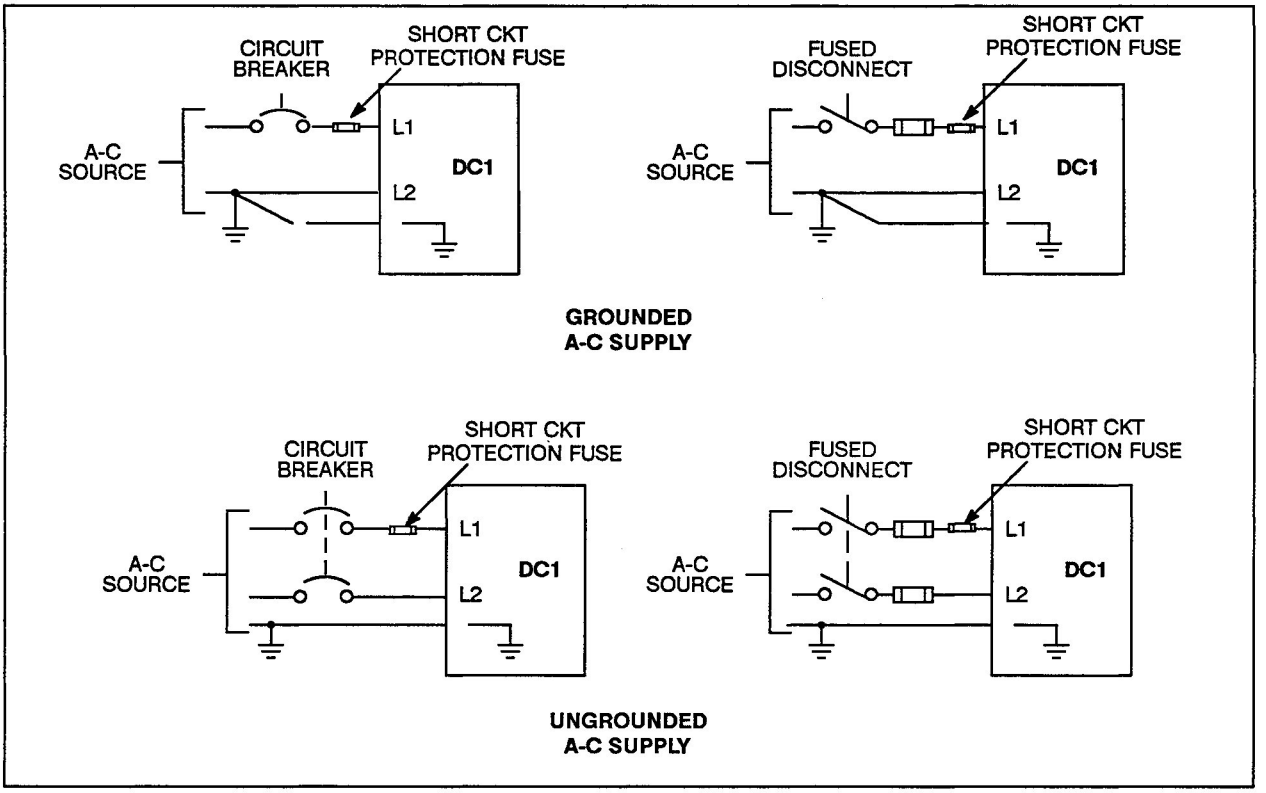


Figure 3-3B. Additional external fuse for flat plate designs.

Wire the Drive

DANGER

THE USER IS RESPONSIBLE FOR CONFORMING TO THE NEC AND THE CEC AND ALL OTHER APPLICABLE LOCAL CODES WITH RESPECT TO WIRING PRACTICES, GROUNDING, DISCONNECTS, AND OVERCURRENT PROTECTION. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Ground the Controller and Enclosure, the Motor, and the Operator's Control Station.

DANGER

CONNECT THE GROUND WIRE BROUGHT IN WITH THE INCOMING A-C POWER LINE TO THE CONTROLLER GROUND POINT. CONNECT AN APPROPRIATE EQUIPMENT GROUNDING CONDUCTOR UNBROKEN FROM THE CONTROLLER GROUND POINT, THE MOTOR FRAME, THE TRANSFORMER ENCLOSURE IF USED, THE CONTROLLER ELECTRICAL ENCLOSURE, THE WIRING CONDUITS, AND THE OPERATOR'S CONTROL STATION TO AN APPROPRIATE GROUNDING ELECTRODE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Locate the convienence ground point provided at the bottom edge of the heat sink.
2. Run a suitable equipment grounding conductor **unbroken** from this controller ground point to the plant ground (grounding electrode). A ring lug is recommended at the ground point.
3. Connect a suitable grounding conductor from each conduit to this controller ground point.
4. Connect a suitable equipment grounding conductor to the motor frame, the transformer enclosure if used, and the controller enclosure. Run this conductor **unbroken** to the grounding electrode.
5. Connect the ground wire brought in with the incoming A-C power line to the controller ground point.

Wire A-C Power to the Controller

WARNING

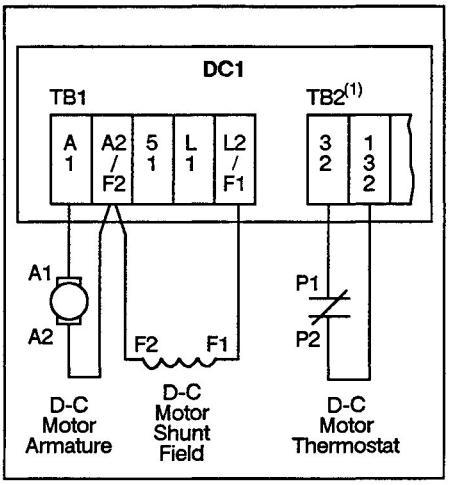
DO NOT OPERATE THE CONTROLLER ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF 10,000 AMPERES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY AND DAMAGE TO, OR DESTRUCTION OF, THE EQUIPMENT.

1. Size the A-C line supply conductors for the specific controller rating and according to all applicable codes.
2. Run the A-C line supply through a conduit entry in the bottom of the controller to terminals TB1-L1 and TB1-L2/F1.

Wire the D-C Motor to the Controller

1. Size the motor armature circuit conductors A1 and A2 according to all applicable codes.
2. Run the D-C motor armature leads and the shunt field supply leads (if a permanent magnet field motor is not used) through the same conduit entry used for the A-C line supply.
3. **For all models except DC1-71 (DB/reversing):** If CW motor rotation is desired (CW when facing the motor shaft), connect motor armature leads A1 and A2 to controller terminals TB1-A1 and TB1-A2/F2, respectively, as shown in Figure 3-4. If CCW motor rotation is desired (CCW when facing the motor shaft), reverse the motor armature connections at terminals TB1-A1 and TB1-A2/F2.

   For the DB/reversing Model DC1-71 only: If CW motor rotation is desired when the Reverse switch is in the FORWARD position (CW when facing the motor shaft), connect motor armature leads A1 and A2 to controller terminals TB3-A1 and TB3-A2, respectively. If CCW motor rotation is desired (CCW when facing the motor shaft), reverse the motor armature connections at terminals TB3-A1 and TB3-A2.



(1) If terminals 32 and 132 are not connected by some means then the drive will **not** operate.

Figure 3-4. Connect the Armature, Field, Thermostat (CW Rotation)

4. Connect the motor shunt field supply leads F1 and F2 to controller terminals TB1-L2/F1 and A2/F2, respectively. See Figure 3-4.

   Reliance shunt wound D-C motors are supplied with dual voltage, reconnectable fields, 50/100 volts or 100/200 volts. Reference Table 2-3 (Controller Ratings by Motor Horsepower) in this manual and note the available field voltage(s). Connect the voltage field according to the desired available field voltage. See Figure 3-5 for low voltage field and high voltage field connections.
5. Verify that the field is connected as shown on the motor nameplate or the connection diagram in the terminal box on the motor.
6. Connect the motor thermostat leads P1 and P2 to controller terminal TB2-32 and TB2-132, respectively, See Figure 3-4.

   If a motor thermostat is not used, another means of motor and branch circuit overload thermal protection must be used.

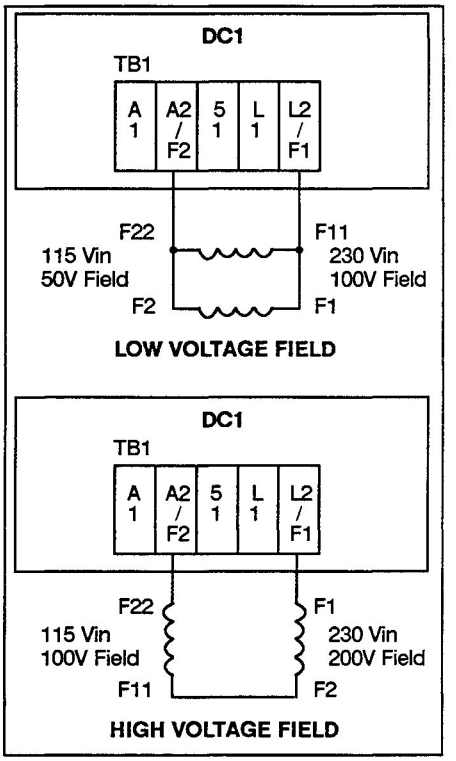


Figure 3-5. Connect the Voltage Field, If Applicable

Wire the Run/Stop Circuit

For drives without operator devices on the controller:

1. Run the Run/Stop pushbutton or normally open contact wiring in the remaining conduit entry separate from the A-C and D-C power wiring.

WARNING

A MAINTAINED CLOSED CONTACT CAN CAUSE THE CONTROLLER TO AUTOMATICALLY RESTART IF LINE INPUT POWER IS REMOVED AND THEN RE-APPLIED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

2. Connect the Run/Stop pushbutton or normally open contact as shown in Figure 3-6.
3. If run/stop control is remote, remove the factory-installed jumper between terminals TB2-35 and TB2-132. See Figure 3-6. With the operator's run/stop controls mounted remotely from the controller, the A-C fused disconnect or circuit breaker must

be mounted in close proximity to the operators controls.

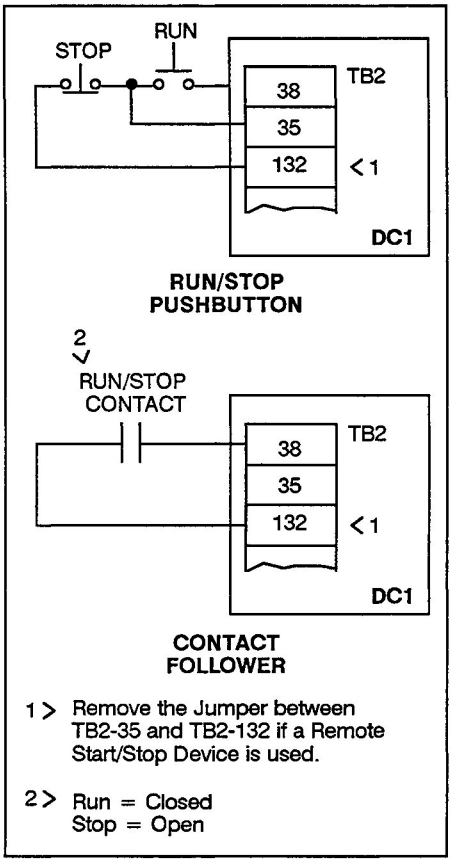


Figure 3-6. Connect the Run/Stop Circuit

Wire the Reference Signal Reference Potentiometer

For drives without operator devices in the controller:

1. Run all reference wiring in the same conduit as the Run/Stop control wiring separate from the A-C and D-C power wiring.
2. Use #16 AWG unshielded cable that is twisted triple conductor with at least two twists per inch.

DANGER

BECAUSE THE REFERENCE POT IS CONNECTED THROUGH THE REGULATOR TO THE ARMATURE POWER CIRCUIT, THE POT TERMINALS ARE AT LINE POTENTIAL. USE A POT THAT HAS A PLASTIC SHAFT TO INSULATE THE OPERATOR KNOB FROM THIS POWER CIRCUIT AND THAT IS CAPABLE OF WITHSTANDING HI-POT TESTS AT 2000 VOLTS D-C FOR ONE MINUTE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

3. Connect a 5K ohm, 0.25 watt pot having an insulated operator knob, such as Reliance Model 14C230 or equivallent, as shown in Figure 3-7.

Wire the Process Control and/or Manual/Automatic Devices (if required)

Selected controller models have a high impedance isolated input to interface with process signals. If both manual control (controller responds to a reference potentiometer) and process control (controller responds to an automatic signal) are desired, a Manual/Automatic switch is included in selected controller models.

1. Use #16 AWG unshielded cable that is twisted double conductor with at least two twists per inch.
2. Wire the process control input to terminals TB2-6(+) and TB2-5(–). See Figure 3-7.
3. Wire the buffered process control reference output TB2-126(+), which must be connected to TB2-326, the controller reference input point. See Figure 3-7.
4. Wire the Manual/Automatic switch, if required, as shown in Figure 3-7.

Wire the D-C Tachometer Speed Feedback Signal

All of the controllers, except the DC1-71 or one user configured for motor reversing, can utilize a D-C tachometer as speed feedback. The tachometer must have a voltage range of 18.5 to 21 volts per 1000 RPM, maximum of 37 volts at maximum speed

1. Run the two tachometer signal leads in a separate conduit from the motor to the controller.
2. Use #16 AWG unshielded two wire cable that is twisted at least two twists per inch.
3. The D-C Tachometer must be connected with the negative lead to terminal 419 and the positive to terminal 519 for the desired direction of rotation. Refer to Figure 3-8.

WARNING

THE D-C TACHOMETER MUST BE CONNECTED WITH THE NEGATIVE LEAD TO TERMINAL 419 AND THE POSITIVE LEAD TO TERMINAL 519 FOR THE DESIRED DIRECTION OF ROTATION. REVERSE CONNECTION WILL CAUSE THE MOTOR TO RUN AT MAXIMUM UNCONTROLLED SPEED WHICH COULD CAUSE DAMAGE TO THE MOTOR OR MACHINE OR RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

4. When the D-C tachometer option is used, a controller isolation transformer must be used between the A-C power source and the controller to isolate the controller from the A-C power source ground. Each such controller must have it's own isolation transformer.
5. Any DC1 controller used in a motor reversing application connot employ a D-C tachometer speed feedback.

6. **Note:** a D-C tachometer used as a speed feedback signal for one controller cannot be used as the speed reference signal for another controller.

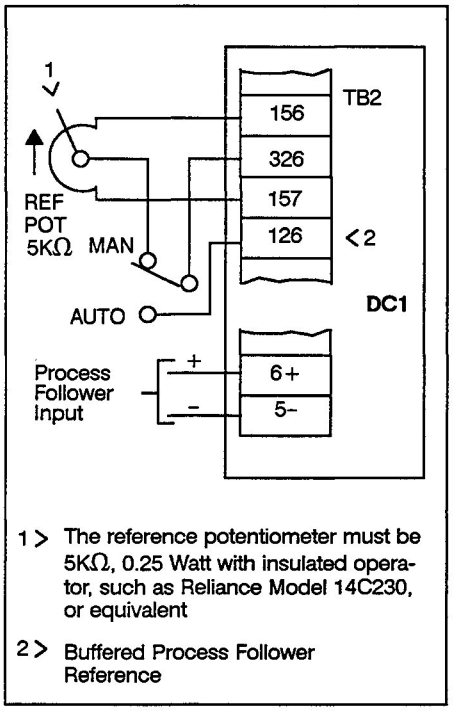


Figure 3-7. Connect the Reference Signal

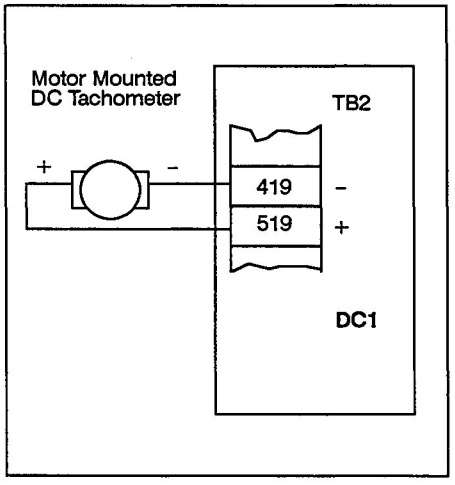


Figure 3-8. Connect the D-C Tachometer

4: Setup and Adjust the Drive

DANGER
ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST AND/OR SERVICE THIS EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Review all setup and adjustment instructions thoroughly before making any adjustments or applying power to the controller. For your convenience throughout the setup and adjustment procedures, use Figure 4-1 to locate adjustment pots, terminal boards, special selector jumpers and pins. Wiring diagrams are given in Figures 5-1 through 5-5.

Position the Controller Jumpers to Fit Application

The controller can operate on either 115V or 230V at multiple horsepower ratings and in various modes. Make sure the circuit jumpers are properly set for the application as described on the following pages. See Figure 4-1, which locates these special selector jumpers and pins.

J4: A-C Input Voltage Jumper

1. This jumper is on all controller models and is factory set for 230 VAC.
2. Verify that J4 is positioned to match A-C input line power.
3. If operation is on 115V, relocate J4 to the 115-volt jumper position.

J3: Armature/Field Voltage Jumper

1. This jumper is on all controller models and is factory set for 230 volts to provide 180 volts armature/100 volts field supply to the motor.
2. Verify that J3 is positioned to match A-C input line voltage selected with jumper J4.
3. If operation is on 115V, relocate J3 to the 115-volt jumper position to provide 90 volts armature/50 volts field supply to the motor.
4. **Note:** If the controller is used with the D-C tachometer for speed feedback, remove the J3 jumper. The J3 jumper is used to calibrate the appropriate voltage feedback level for the application applied voltage. When voltage feedback is not employed but speed feedback via the D-C tachometer is used, the voltage feedback circuit is disconnected when the J3 jumper is removed. Tape this J3 jumper to the inside of the controller so it is available in the event it is needed in the future.

J5: Controller Output Current Jumper

1. This jumper is on all controller models and is factory set for 2.5 amperes.
2. Select the appropriate controller output current rating from the Table 4-1.
3. Position J5 for the current rating selected in Step 2.

Table 4-1. Controller D-C Output Current Rating.[1]

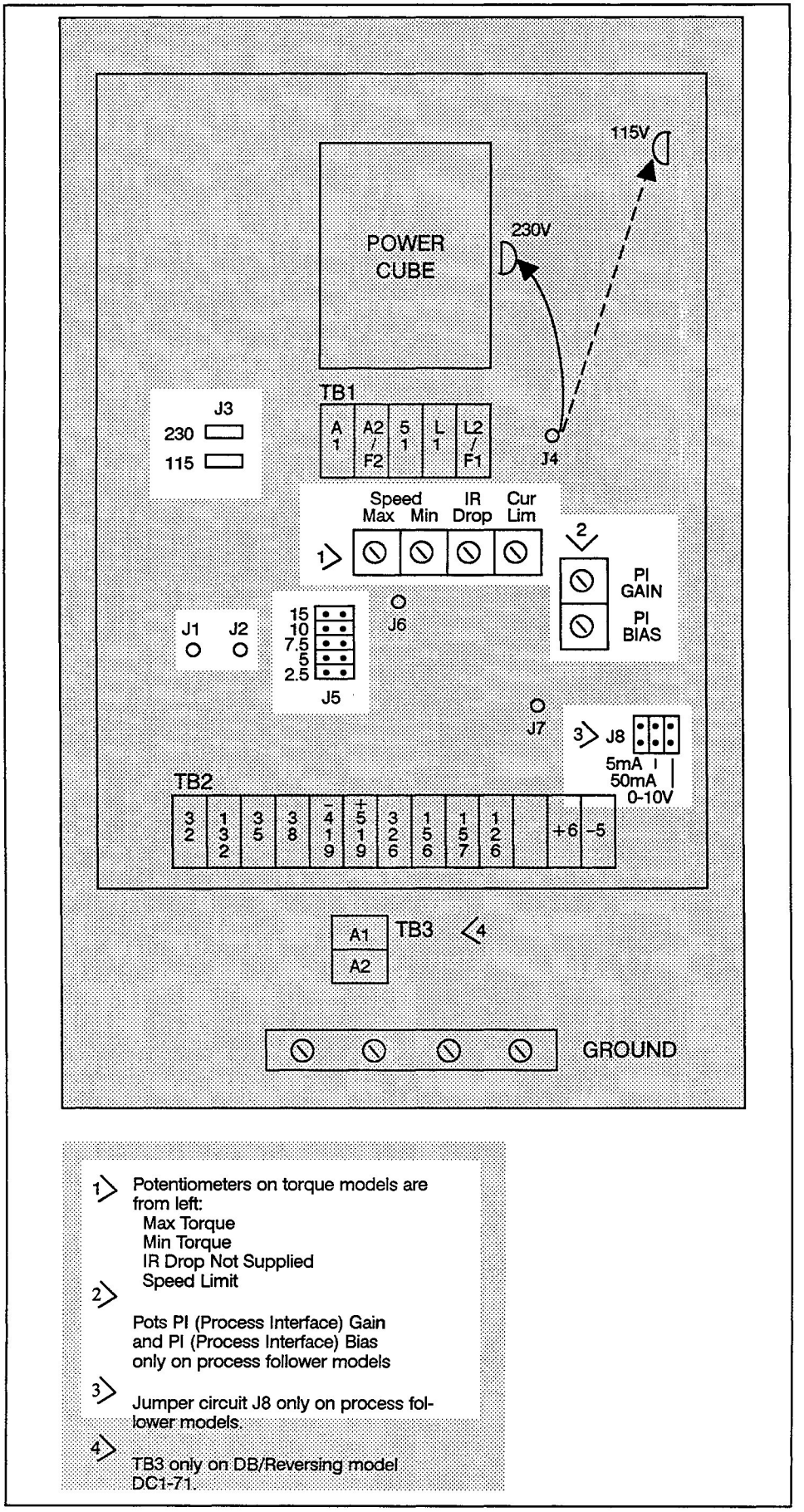
Motor HP	Controller Output Current Rating by Input Voltage Rating	
	115 VAC	230 VAC
1/4	2.5	-
1/3	5	-
1/2	5	2.5
3/4	7.5	5
1	10	5
1-1/2	-	7.5
2	-	10

[1] Measured with average reading D-C ammeter.

J8: Process Control Interface Jumper

1. This jumper is on process control interface controllers Models DC1-42, 44, 46, 52, 54, 62, 64, 66, 72, 74, and 76.
2. Select the J8 jumper position based on the process control signal to be used:

Process Control Signal	Jumper Position
1 - 5 mA	5 mA
4 - 20 mA	50 mA
10 - 50 mA	50 mA
0 - 10 VDC	0 - 10 V



1 Potentiometers on torque models are from left:
Max Torque
Min Torque
IR Drop Not Supplied
Speed Limit

2 Pots PI (Process Interface) Gain and PI (Process Interface) Bias only on process follower models

3 Jumper circuit J8 only on process follower models.

4 TB3 only on DB/Reversing model DC1-71.

Figure 4-1. Locate Jumpers, Pins, and Potentiometers on the Controller Circuit Board.

J1 and J2: Acceleration Rate Wire Wrap Pins

1. These wire wrap pins are on all controller models. All controller models are shipped to provide approximately 6 seconds acceleration time to full speed. To adjust this acceleration rate, proceed to Step 2.
2. Select the time desired and note the capacitance required to achieve that acceleration rate.

Time	Capacitance (Between J1 and J2)[1]
17.5 sec	2.00 µF
10.0 sec	.68 µF
6.0 sec	as shipped
4.5 sec [2]	.68 µF
3.3 sec [2]	.47 µF
1.8 sec [2]	.22 µF
1.1 sec [2]	.10 µF
0.6 sec	None

[1] Use the capacitors of the low leakage type. Leakage current should be less than 0.1 microamps at 15V and 70° ambient. If a polarized capacitor is used, install with J1 at the positive with respect to J2.

[2] For times less than 6 seconds, the two 47uFD capacitors supplied with the controller between J1 and J2 must be removed. These two capacitors are physically located on the circuit board at locations AW16-AW13 and AV16-AV13. Note that J1 and J2 (see Figure 5-3) are supplied only for the customer to add capacitance if so desired.

3. **If the time selected in Step 2 is more than 6 seconds**, add a capacitor with the capacitance noted in Step 2 between J1 and J2.

   If the time selected in Step 2 is less than 6 seconds, remove one or more of the capacitors that are supplied with the controller between J1 and J2 and replace with capacitors that have the capacitance noted in Step 2.

Startup and Adjust the Controller

Note: This procedure covers both Speed Control and Torque Control controllers. Therefore, you will find references to "speed or torque" when the type of control is important.

1. Verify that the circuit board pots (Figure 4-1) are set as indicated below:

   With Speed Control models:
   - Maximum Speed – fully CCW
   - Minimum Speed – fully CCW
   - IR Drop Compensation – fully CCW
   - Current Limit – 60% of full scale
   - Process Interface Gain on Process Control models only – fully CCW
   - Process Interface Bias on Process Control Models only – fully CCW

   With Torque Control models:
   - Maximum Torque – fully CCW
   - Minimum Torque – fully CCW
   - Speed Limit – 60% of full scale
   - Process Interface Gain on Process Control models only – fully CCW
   - Process Interface Bias on Process Control models only – fully CCW

2. Set the operator's speed or torque pot fully CCW.

3. If your controller includes process control, push the Auto/Manual switch to Manual; otherwise proceed to Step 4.

4. If your controller includes a Forward/Reverse switch, set the switch to the Forward position and proceed to Step 5.

DANGER

THE REMAINING STEPS ARE MADE WITH POWER ON. EXERCISE EXTREME CAUTION AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

5. Apply A-C input power.

6. Check the direction of motor rotation:

   - Press the Run button and quickly press the Stop switch to verify correct motor rotation. If the motor shaft doesn't rotate because all potentiometers are set to minimum levels, turn the Speed or Torque potentiometer slightly CW and repeat this start/stop operation.

   - If motor shaft rotation is incorrect, press the Stop switch and wait for the motor to completely stop. Remove A-C input power, and reverse the motor armature power lead A1 and A2. Reapply A-C input power and repeat the direction of rotation check.

   - On applications utilizing D-C tachometer speed feedback, when the direction of rotation of the motor is changed, the polarity of the tachometer also changes. The connection of the tachometer must remain 419 negative with respect to 519 for a given direction or rotation. If the motor direction of rotation was wrong and has to be changed, however, the tachometer polarity was correct, the tachometer connection will also have to change to maintain 419 negative with respect to 519.

WARNING

THE D-C TACHOMETER MUST BE CONNECTED WITH THE NEGATIVE LEAD TO TERMINAL 419 AND THE POSITIVE LEAD TO TERMINAL 519 FOR THE DESIRED DIRECTION OF ROTATION. REVERSE CONNECTION WILL CAUSE THE MOTOR TO RUN AT MAXIMUM UNCONTROLLED SPEED WHICH COULD CAUSE DAMAGE TO THE MOTOR OR MACHINE OR RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

7. On controllers employing D-C tachometer speed feedback, the following steps may be used to determine the correct direction of rotation and the correct polarity of the D-C tachometer speed feedback signal.
   - Reconnect J3 jumper to the appropriate voltage level so the motor can be run as a voltage regulator.
   - Remove the D-C tachometer leads from terminals 419 and 519, clearly marking the leads to distinguish one from the other, and connect a D-C voltmeter (0 to 60 volt scale) to the D-C tachometer leads.
   - Set-up the controller to establish the desired direction of rotation per Steps 1 thru 6 above.
   - With the desired direction of rotation established, using the voltmeter that is connected to the D-C tachometer signal leads, determine the polarity of the D-C tachometer leads. Mark the negative polarity lead 419 and the positive lead 519.
   - Stop the controller, remove A-C power, remove the J3 jumper and connect the D-C tachometer leads to the controller as noted above, (–) 419 and (+) 519.
   - Repeat adjustment procedure above.

8. Adjust the speed or torque range:

WARNING

DO NOT DEPEND ON THE MINIMUM POSITION OF THE SPEED OR TORQUE SETTING POT TO STOP THE MOTOR. IN THE MINIMUM POSITION, THE CONTROLLER AND MOTOR ARE STILL ENERGIZED. THE DRIVE MAY RESTART UNEXPECTEDLY. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

With Speed Control models:

- Use a hand-held tachometer to monitor motor speed; or use a multimeter to measure armature voltage, which is approximately proportional to speed (115-volt control: 90 VDC = 100% speed; 230-volt control: 180 VDC = 100% speed).
- Press the Run button and slowly turn the Speed potentiometer to maximum (fully CW). The motor should run at about 50% of maximum.
- Slowly turn the Maximum Speed potentiometer CW until about 80% speed is reached.
- Turn the Speed potentiometer fully CCW.
- Turn the Minimum Speed potentiometer CW until the desired minimum speed is reached.
- Repeat the Speed Control procedure until the desired maximum and minimum speeds are reached.

With Torque Control models:
Torque control models must only be used when synchronizing this driven machine section with other process machine sections on which there is a drive that consistently and reliably establishes line speed.

- Load the motor with a reasonable constant load over the speed range. Such a system may be a pre loaded dancer loop preceding a center driven winder. See Figure 4-2.
- Provide a means of measuring torque, such as measuring armature current. For example, take 1 HP motor at 180 VDC and a rated armature current of 5 amps:

$$\frac{1 \text{ HP} \times 5250}{1750 \text{ RPM}} = 3 \text{ ft-lbs}$$

Therefore, 5 amps equals 3 ft-lbs.

- Re-establish the torque load on the motor and load the torque cell for maximum torque.
- Press the Run button and slowly turn the Torque potentiometer to maximum (fully CW).
- Slowly turn the Maximum Torque potentiometer until the maximum desired torque is reached.
- Turn the torque potentiometer fully CCW.
- Slowly turn the Minimum Speed potentiometer CW until the minimum desired torque is reached.
- Repeat this Torque Control procedure until the maximum and minimum torques are reached.

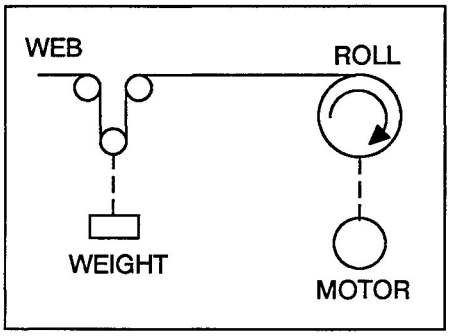


Figure 4-2. Pre-loaded Dancer Loop Preceding Winder.

9. Adjust the current or speed limit:

With Speed Control models:
The maximum D-C current output from the controller with the Current Limit potentiometer turned CW is about 150% of the J5 armature current setting. If 150% of the J5 armature current is excessive for the application or if stress on the driven equipment must be reduced, turn the Current Limit potentiometer CCW until adequate setting is obtained.

With Torque Control models:

- With minimum load torque (motor disconnected or an empty winder roll without web), turn the Torque potentiometer fully CW.
- Adjust speed limit with the Speed Limit potentiometer for maximum desired motor application speed or 90/180 VDC on the armature.
- Return the Torque potentiometer fully CCW.

10. **With Speed Control models only:** If the torque demand on the drive motor is relatively uniform, IR drop compensation is not required. Turn the IR Drop Compensation potentiometer to zero (CCW).

    If the load torque is changing (i.e., a conveyor that can be empty and then some time later loaded with material), the increased load will cause a speed change. Motors that have a fixed speed droop with load may have this speed change compensated with the IR Drop potentiometer. (Fig 4-3) Turn the IR Drop compensation potentiometer slightly CW until this droop is minimized. After adjusting IR Drop Compensation to minimize speed change with load the maximum and minimum speed settings should be rechecked for proper settings. Note that excessive IR Drop Compensation can cause motor instability and hunting. Motors that have a speed droop that varies excessively with operating speed (Fig 4-4) cannot use IR Drop Compensation. A Tachometer should be used for better speed regulation.

11. Press the Stop switch and wait for the motor to completely stop. Remove A-C input power.
12. If you have a Process Control controller model, proceed to "Setup the Process Control."

On models employing D-C Tachometer Speed Feedback, the IR Drop Compensation potentiometer should be set at zero, fully CCW.

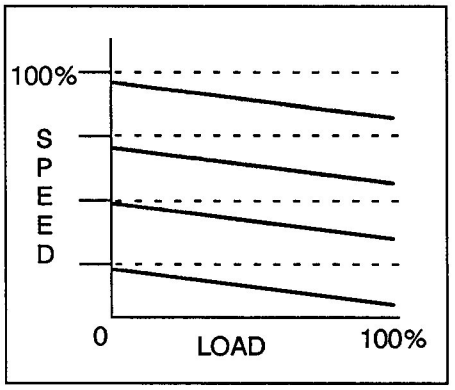


Figure 4-3. Fixed Speed Droop With Load Change

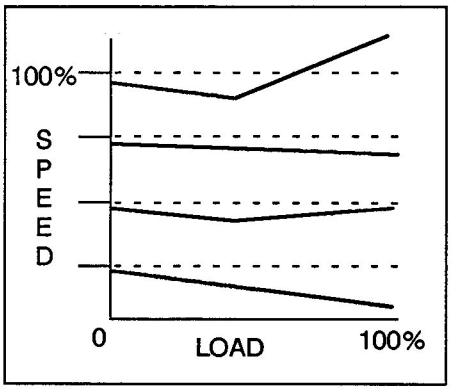


Figure 4-4. Variable Or Rising Speed Droop With Load Change

Setup for Process Controller

Note: The process control input (5 and 6) is buffered from the armature circuit by 362K ohms of resistance. The buffered reference signal output on TB2-126 is positive with input TB2-6(+) and TB2-5(-). Inputs at TB2-5 or TB2-6 may be grounded or left ungrounded as required by the signal source equipment

1. Push the Auto/Manual switch to Auto.

WARNING

THE PROCESS CONTROL SIGNAL INPUT TERMINALS TB2-5 AND TB2-6 ARE FLOATING AT LINE POTENTIAL WITH LIMITED POWER WHEN THE INPUT CIRCUIT IS OPEN. CONNECTION OF THE SIGNAL SOURCE CIRCUIT WILL DECREASE THIS OPEN CIRCUIT SIGNAL TO ZERO. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

2. Verify that jumper J8 is properly positioned for your reference signal.
3. Apply A-C input power and press the Start button.
4. Command minimum reference from your process control unit and adjust the Process Interface (PI) Bias potentiometer to the desired minimum operating speed or torque.
5. Increase the process control reference signal to maximum and adjust the Process Interface (PI) Gain potentiometer to the desired maximum operating speed or torque. Repeat Steps 4 and 5 until proper maximum and minimum speed or torque are attained.
6. Press the Stop switch and wait for the motor to completely stop. Remove A-C input power.

5: Service the Drive

DANGER:
ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, AND/OR SERVICE THIS EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Should you encounter any difficulty with the operation of your controller, review Table 5-2 before performing any troubleshooting on the drive.

The controller contains all regulator circuitry on one printed circuit board and all power conversion components (thyristors and diodes) in one power cube. If you determine that there has been a failure in either of these, replacement parts are available from Reliance. Refer to Table 5-1 for specific DC1 parts. Figures 5-1 through 5-5 are wiring diagrams of the five controller configurations.

DANGER
SERVICING IS DONE WITH POWER ON. EXERCISE EXTREME CAUTION AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Table 5-1. Controller Replacement Parts[1]

Description	Reliance Part Number
Line fuse	
DC1-50, 52, 53, 54, 55, 56	64676-35G (20A)
All other models	64676-61AR (25A)
Power Cube	
All models	701819-14AB
Circuit Board	
DC1-40, 45, 50, 60, 65, 70, 71, 75	0-57210-20
DC1-43, 53, 63, 73	0-57210-21
DC1-44, 54, 64, 74	0-57210-22
DC1-42, 46, 52, 62, 66, 72, 76	0-57210-23
Speed Pot	
DC1-70, 71, 72, 73, 74, 75, 76	401286-41H
Run/Stop Switch	
DC1-70, 71, 72, 73, 74, 75, 76	49869-17A
Reversing Switch	
DC1-71	49869-14R
Braking Resistor	
DC1-71	63481-49AM

[1] These parts are available from your local Reliance Electric Distributor or direct from Reliance.

Reliance Electric Industrial Company
Cleveland Service Center
4950 East 49th Street
Cleveland, Ohio 44125
Order Entry Phone: 216-266-7247

Table 5-2. Servicing Steps.

Indication	Possible Cause	Corrective Action
Controller incoming line fuse blows when power is applied to the controller.	Faulty incoming A-C line wiring or and inadvertent ground in the branch circuit or within the controller enclosure.	Check all incoming A-C wires and terminations to and within the controller. Correct any faulty wiring and remove any grounds. Replace blown fuse.
Controller incoming line fuse blows when Start command is given	Motor armature shorted or grounded.	Repair or replace motor. Replace blown fuse.
	Shorted SCR or faulty regulator	Replace entire controller.
	Loose or corroded connection or faulty, incorrect or grounded wiring.	Check all terminal connections and wiring between the line, controller and motor are correct. Replace blown fuse.
	Sudden, severe application of overload to the motor.	Investigate driven equipment for possible cause and correct. Replace blown fuse.
	Circuit board faulty.	Replace entire controller.
Motor does not rotate.	Faulty, incorrect or grounded wiring.	Check all external wires and terminations at the controller. Check all wiring within the motor conduit box. Correct any faulty wiring.
	Incoming line fuse blown and/or upstream protection devices open.	Investigate upstream equipment for possible cause and correct. Replace blown fuse.
	Open or faulty manual speed or torque potentiometer.	Check all speed or torque pot wiring and the operation of speed or torque potentiometer. Correct.
	With Process Control models; faulty, misconnected or miscalibrated reference signal.	Check automatic reference signal for presence and value. Check for proper polarity. Check jumper for proper calibration. Correct as necessary.
	Run/Stop or Forward/Off/Reverse switch faulty or in the incorrect position.	Investigate and/or replace switch as necessary.
	Motor thermostat open.	Check for continuity with ohmmeter. Let motor cool if found to be open.
	Open circuit between terminals 132 and 35. Either a jumper or normally closed remote stop device must be connected between these two terminals in order for the drive to operate.	Repair faulty switch or insert jumper as required.
	Current feedback jumper set lower than applied motor horsepower.	Recheck and reset as necessary.

(Continued on next page)

Table 5-2. Servicing Steps (Continued).

Indication	Possible Cause	Corrective Action
Drive will not go to zero speed or torque.	**DANGER** **DO NOT DEPEND ON THE MINIMUM POSITION OF THE SPEED OR TORQUE SETTING POT TO STOP THE MOTOR. IN THE MINIMUM POSITION, THE CONTROLLER AND MOTOR ARE STILL ENERGIZED. NOISE, IMPROPER WIRING, POWER LINE DISTURBANCES, MALFUNCTIONING COMPONENTS, OR MECHANICAL BINDING MAY CAUSE THE DRIVE TO RESTART UNEXPECTEDLY. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY OR LOSS OF LIFE.**	
	For safety, the controller is factory set for a minimum speed or torque setting of 10% of maximum	Contact your local Reliance Sales Office.
	Controller faulty.	Replace entire controller.
Motor does not reach top speed or deliver rated torque.	Low line voltage.	Check for rated line voltage and correct if not within 10% of the input voltage rating.
	With Process Control models, improperly set maximum speed pots.	Reset maximum speed pots.
	With Process Control models, reference signal producing less than expected maximum value.	Adjust source of automatic reference signal or proper output signal range.
	Overload.	Check for cause of overload and correct.
	Improperly calibrated jumper.	Check and reset as necessary.
	Faulty circuit board.	Replace entire controller.
Unstable speed or poor regulation when applied as an armature voltage regulator.	Incorrectly set IR drop compensation pot.	Readjust IR drop compensation pot.
	Faulty circuit board.	Replace entire controller.
Controller with D-C tachometer feedback.		
Motor runs at maximum uncontrolled speed	D-C tachometer polarity not correct for given direction of motor rotation, 419 negative with respect to 519.	Verify D-C tachometer polarity and lead connection.
	No D-C tachometer output signal.	Verify tachometer voltage. Verify tachometer coupling.
Motor speed unstable with changing load.	IR drop compensation pot not set at zero (CCW).	Set IR drop compensation pot to zero (CCW).

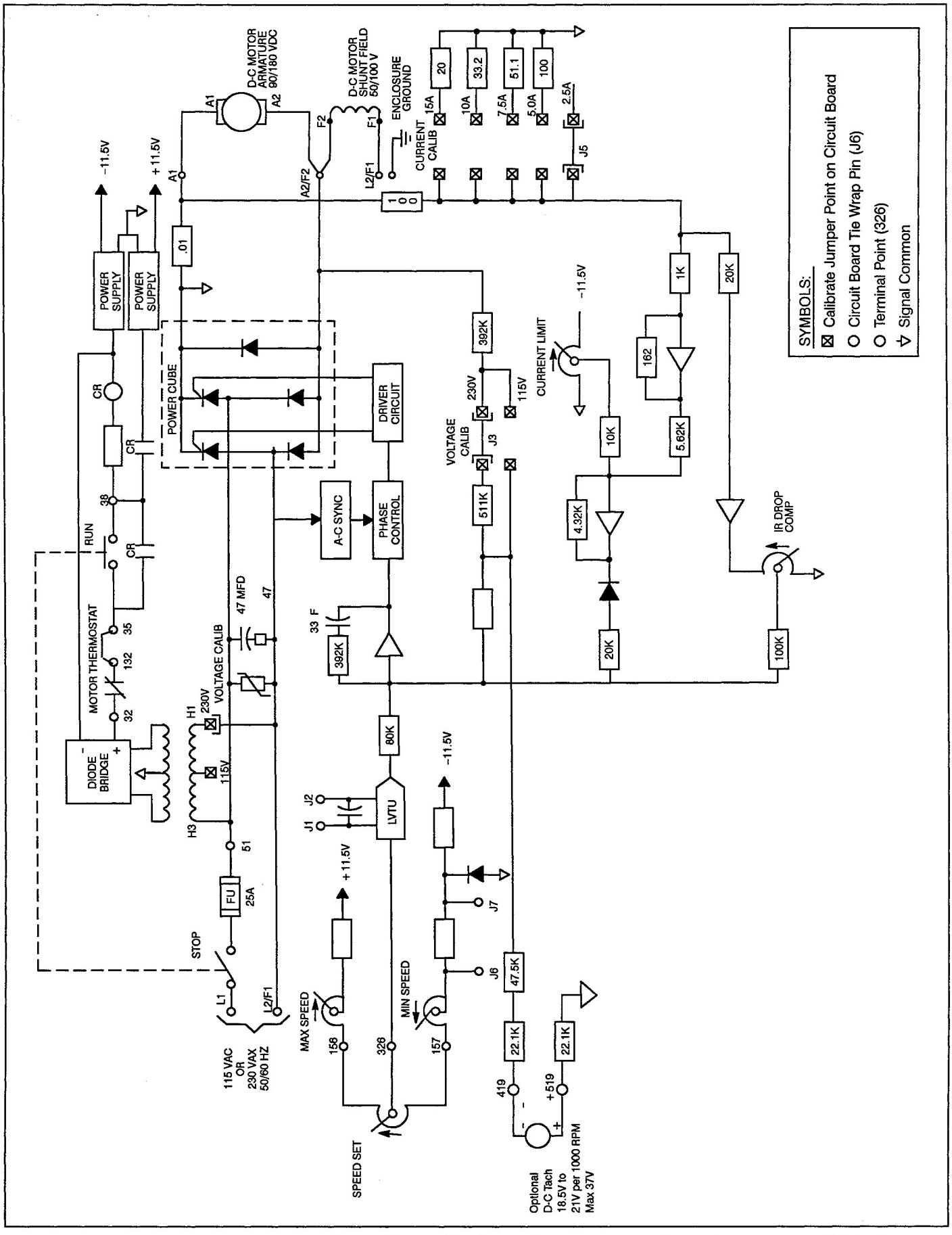


Figure 5-1. Wiring Diagram of Basic Speed Controller (Models with operator's devices remote: DC1-40, 45, 50, 60, 65; Models with operator's devices on controller: DC1-70, 75).

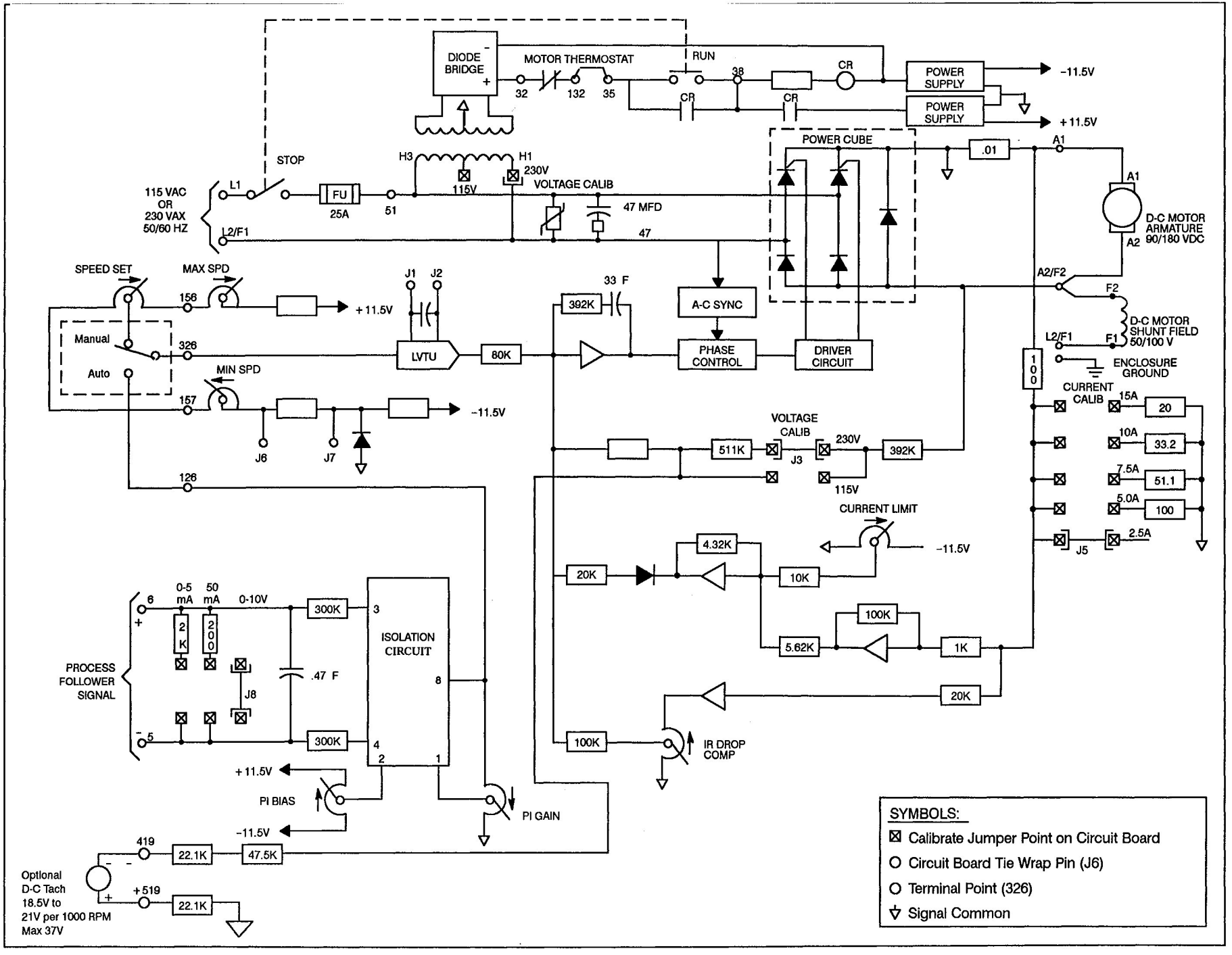


Figure 5-2. Wiring Diagram of Basic Speed Controller with Isolated Process Control (Models with operator's devices remote: DC1-42, 46, 52, 62, 66; Models with operator's devices on controller: DC1-72, 76).

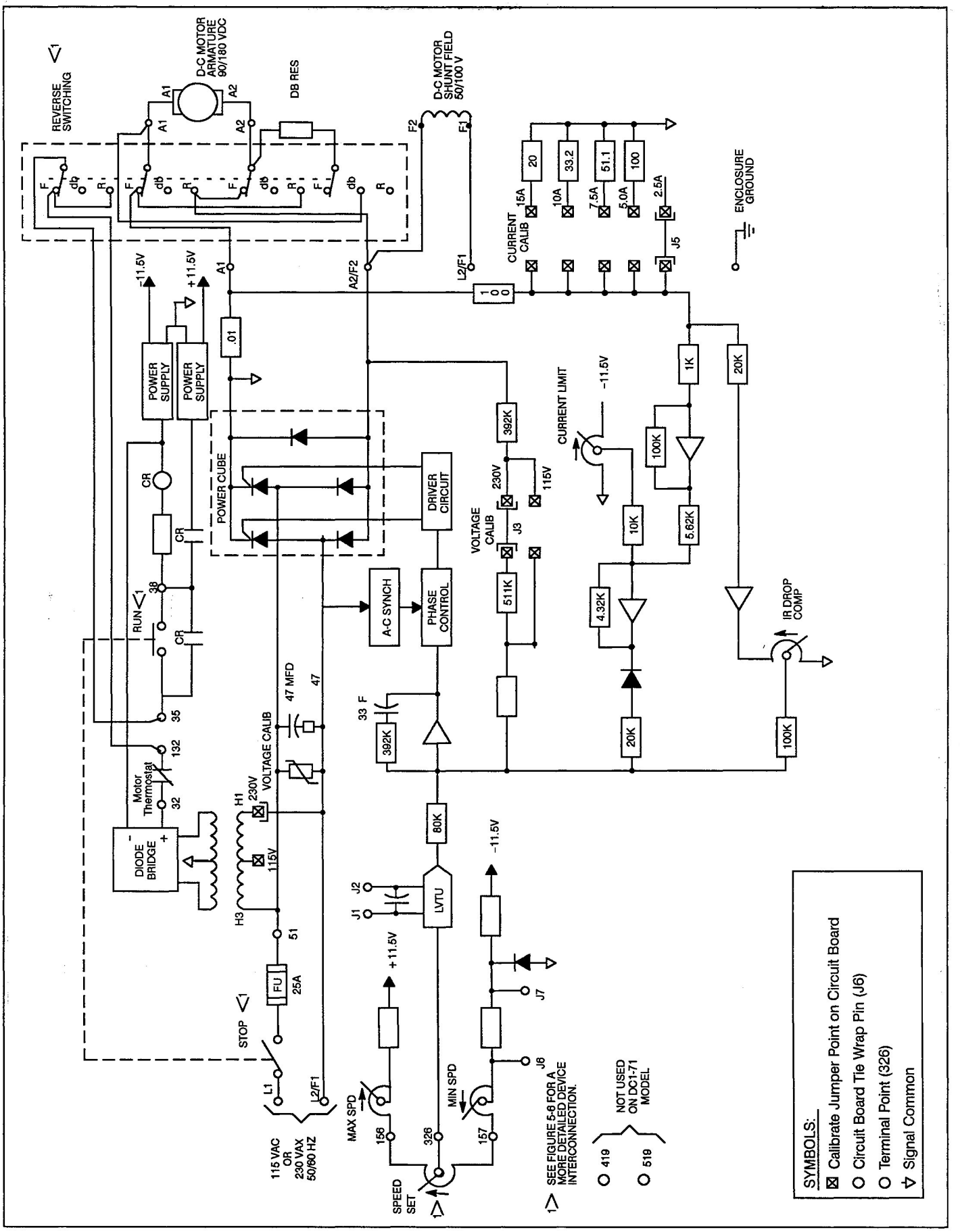


Figure 5-3. Wiring Diagram of Basic Speed Controller with Dynamic Braking and Reversing (operator's devices on controller Model DC1-71).

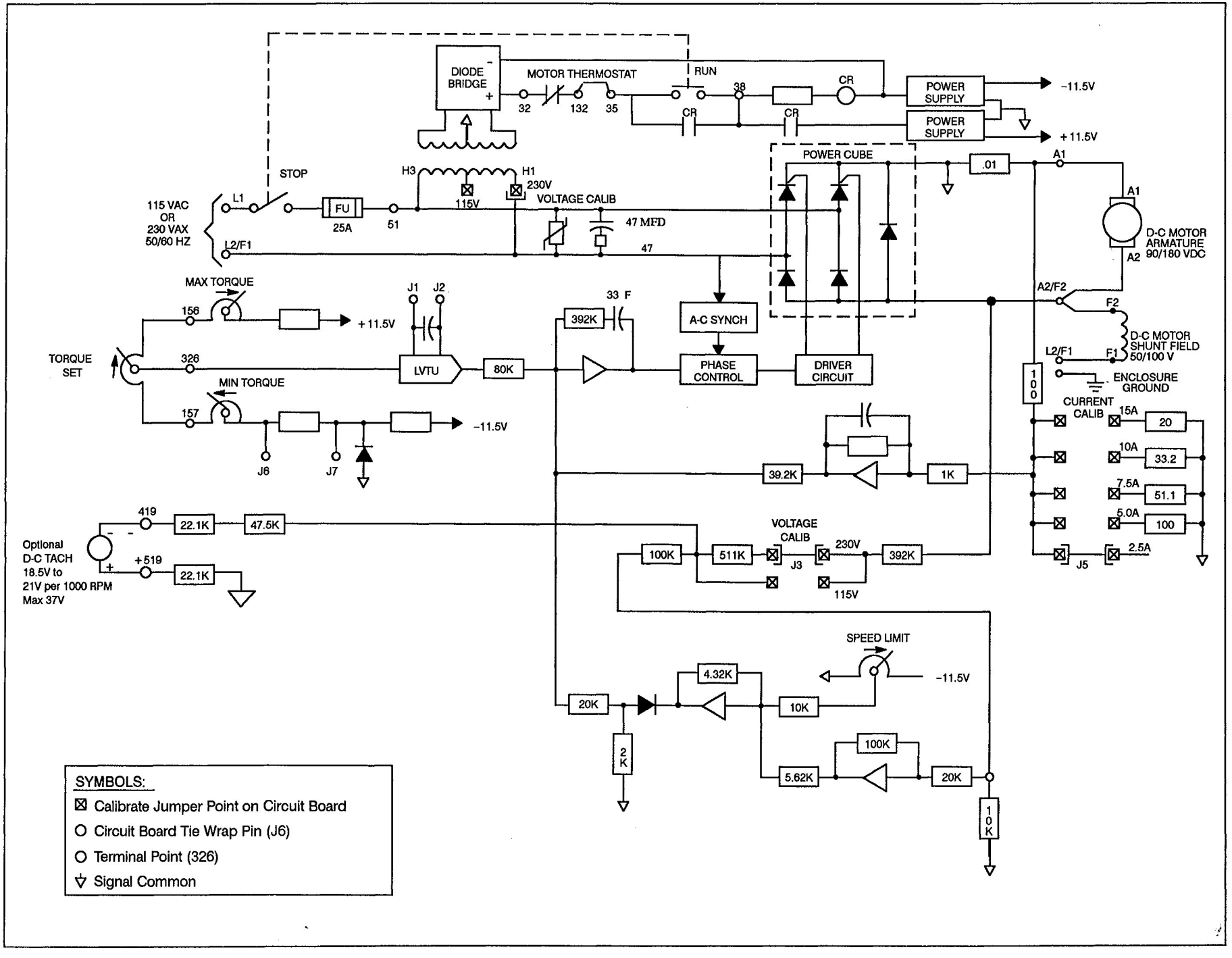


Figure 5-4. Wiring Diagram of Basic Torque Controller (Models with operator's devices remote: DC1-43, 53, 63; Model with operator's devices on controller: DC1-73).

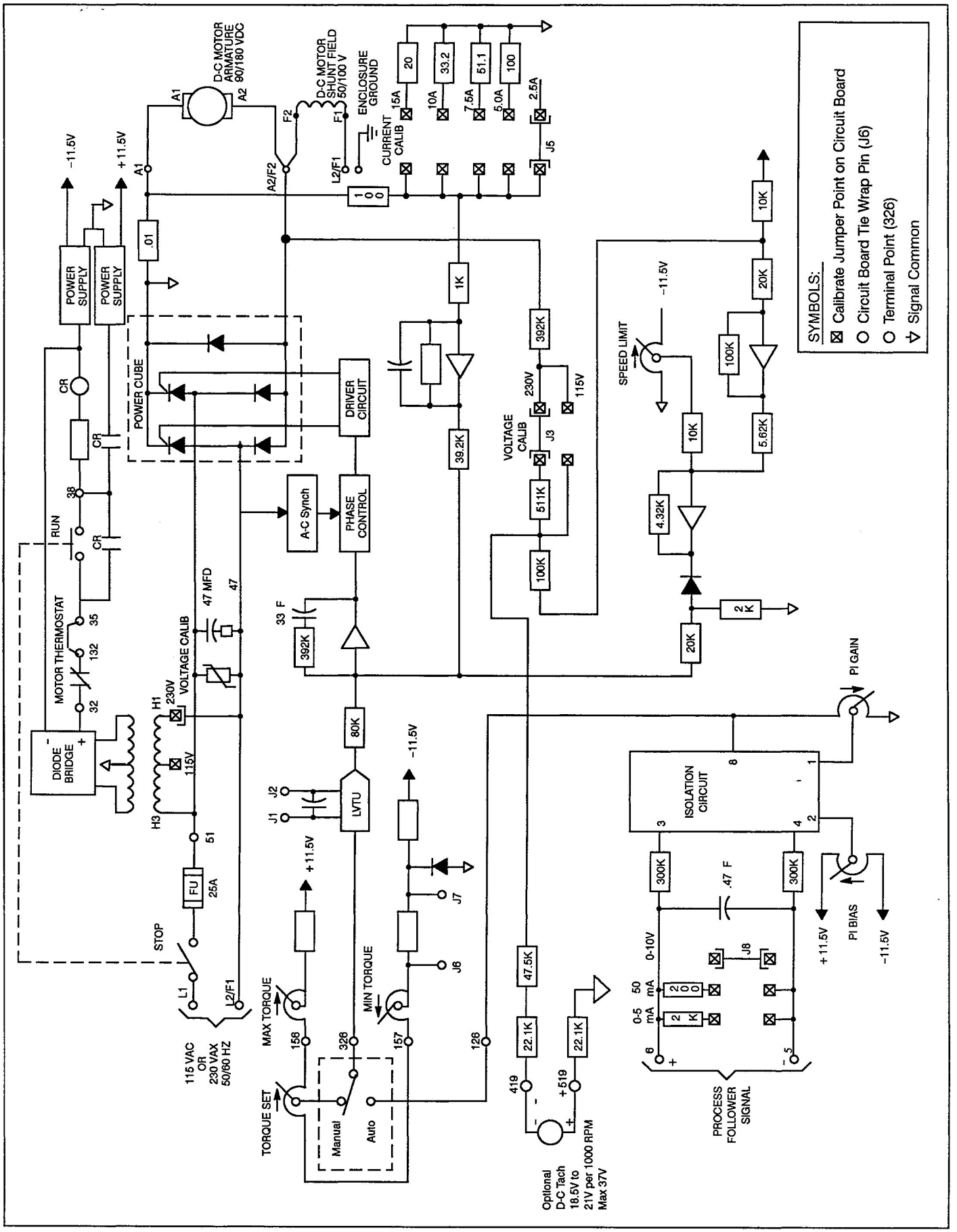
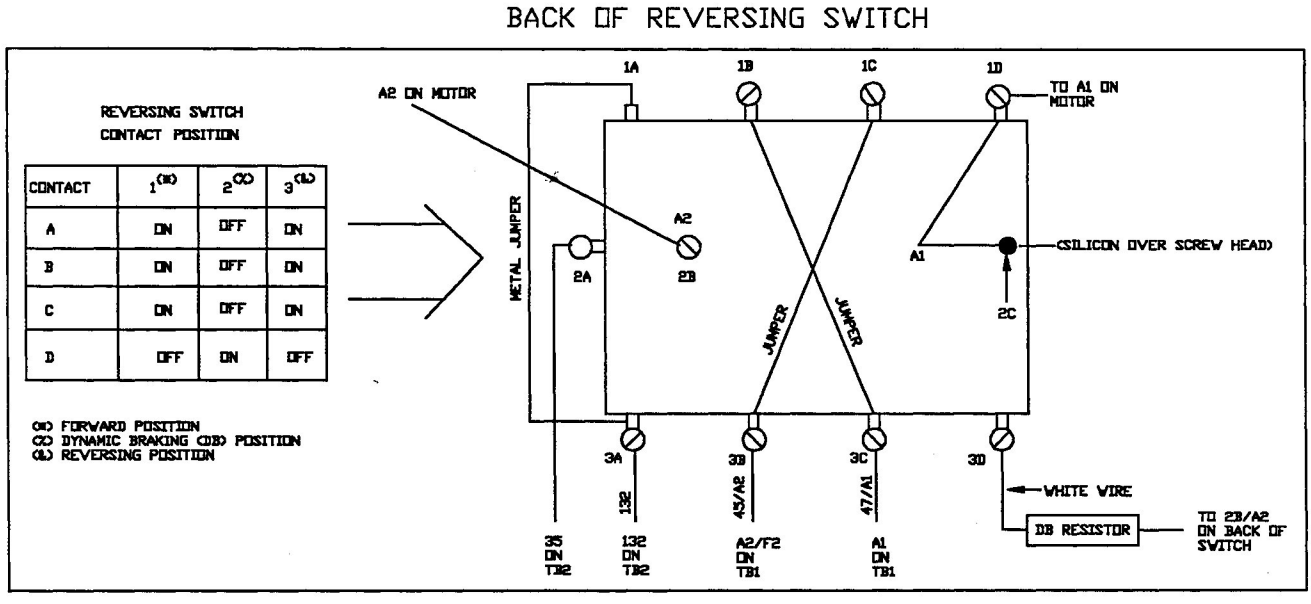
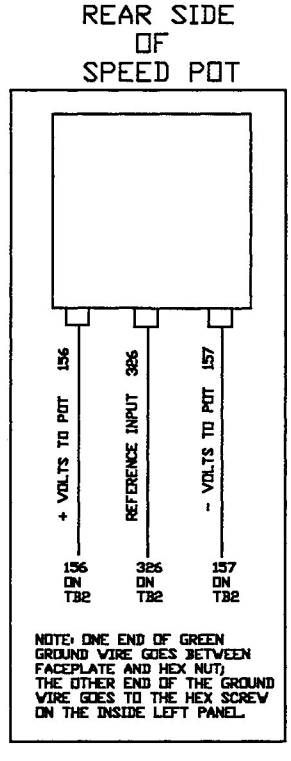


Figure 5-5. Wiring Diagram of Basic Torque Controller with Isolated Process Control (Models with operator's devices remote: DC1-44, 54, 64; Models with operator's devices on controller: DC1-74).





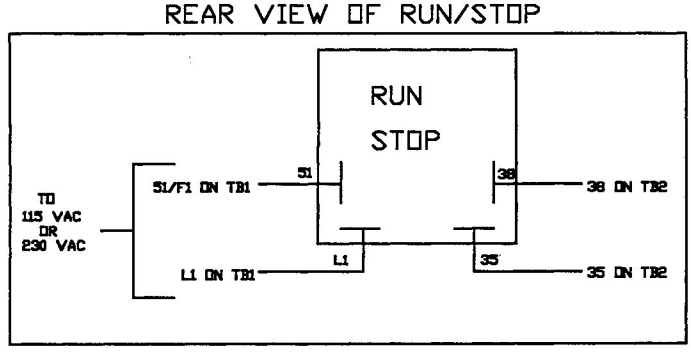


Figure 5-6. Device Interconnections of Basic Speed Controller with Dynamic Braking and Reversing (operator's devices on controller Model DC1-71)

COST: $8.00

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