MinPak® Plus
D-C V★S® Drive

DRIVES

Instruction Manual D-3838-6

June, 1994

Table of Contents

Chapter/Topic **Page**

1: Receive and Accept the MinPak Controller

Receive and Accept the Shipment 1:1
Store the Controller 1:1
File a Return Request 1:1
Drive Identification Nameplate 1:1

2: Introduction to the Controller

Scope of This Manual 2:1
MinPak Plus Single-Phase D-C Controller Specifications 2:1
MinPak Plus Single-Phase D-C Controller Description 2:3

3: Install and Wire The Drive

General 3:1
Install the Controller – Panel Layout 3:1
Controller Mounting Dimensions 3:2
Install The Motor 3:2
Install A Disconnect 3:3
Wire The Drive 3:3
General Wiring Practices 3:5
Wire A-C Power to the Controller 3:6
Wire the D-C Motor to the Controller 3:10
Install the Field Supply 3:10
Wire the Field Supply 3:10
Wire the Speed Reference Circuit 3:10

4: Start-up and Adjustment

General 4:1
Power Off Inspection 4:2
Motor Ground Check 4:2
50 Hertz Operation 4:2
230 Volt A-C Applications 4:2
Horsepower – Current Scaling 4:2
Regulation Mode Selection 4:3
Power On 4:3
Drive Set-Up Procedure 4:4
Basic Regulator Maximum Safe Operating Adjustments 4:4
Verify the Correct Direction of Motor Rotation 4:5
Determination of Tachometer Output Polarity 4:5
Adjusting Minimum Speed 4:5
Set Zero Speed 4:5
Adjusting Maximum Speed 4:7
Drive Acceleration Time 4:7
Drive Deceleration Time 4:7
Current Limit 4:7
IR Drop Compensation 4:7

5: Troubleshooting

General 5:1
Wiring Errors 5:1
A-C Line and Power Input 5:1
D-C Motor 5:1
Remote M Contactor 5:1
Optional Kits 5:1
Troubleshooting Flowcharts 5:1

6: Replacement Parts

Appendix A

Quick Reference Guide A:1

Appendix B

Glossary of Terms B:1

Appendix C

Theory of Operation C:1

List of Figures

Figure/Description **Page**

Figure 1-1. Typical MinPak Plus Nameplate. 1:1
Figure 3-1. Enclosure Mounting Minimum Distances 3:1
Figure 3-1A. Open Panel Mounting Maximum Distances 3:1
Figure 3-1B. Mounting Orientations 3:1
Figure 3-2. Controller Mounting Dimensions. 3:2
Figure 3-3. Drive Connection Diagram. 3:4
Figure 3-3A. Cover Ground Wire 3:5
Figure 3-4. Chassis Wells, Wire Routing. 3:5
Figure 3-5. Armature Contactor Sequencing and Regulator Start/Stop Timing. 3:7
Figure 3-6. Non-Reversing Drive Control Circuit. 3:7
Figure 3-7. Reversing Drive Control Circuit. 3:8
Figure 3-8. Motor Armature Circuit Connection. 3:9
Figure 3-7. Connecting Field Supply. 3:10
Figure 3-10. Reference Circuit for Manual Operator's Speed Reference Circuit. 3:11
Figure 3-11. Reference Circuit for Follower Reference Kit without the use of the Manual Operator's Reference Option. 3:11
Figure 3-12. Reference Circuit for Follower Reference Kit with the use of the Manual Operator's Reference Option and an Auto/Manual Switch. 3:12
Figure 4-1. Regulator Module Screen. 4:1
Figure 4-2. Drive Current Scaling Setup. 4:3
Figure 4-3. Regulator Function Potentiometers 4:4
Figure 4-4. Controller with J10 Jumper in Zero Speed Circuit 4:6
Figure 4-5. Zero Minimum Speed Correction 4:6
Figure 5-1. Controller Schematic 5:2
Figure 5-2. Controller Technical Data 5:3
Figure 5-3. Modification Kits Schematics 5:4

Figure 5-4. Circuit Breaker or Line Fuses Open When Power is Applied. 5:6
Figure 5-5. Fuse Blows After Start. 5:7
Figure 5-6. Motor Doesn't Start. 5:8
Figure 5-7. "M" Contactor Picks-Up But Only Remains in as Long as the Start Button is Pushed. 5:10
Figure 5-8. "M" Contactor Picks-Up But Motor Does Not Run. 5:11
Figure 5-9. Motor Runs Away. 5:15

List of Tables

Table/Description **Page**

Table 2-1. Controller Model Numbers 2:5
Table 2-1A. Local Operator Control Faceplates 2:3
Table 2-1B. Remote Operator Control Stations 2:4
Table 2-2. Isolation Transformer Specifications 2:5
Table 2-3. Fuse Requirements 2:6
Table 2-4. Controller Modification Kits. 2:6
Table 4-1. Current Feedback Scaling 4:2
Table 4-2. Control Power Voltages 4:4
Table 4-3. Initial/Final Adjustment Settings 4:8
Table 6-1. Replacement Parts 6:1

1: Receive and Accept the MinPak Plus Controller

Receive and Accept the Shipment

The Reliance® Electric MinPak Plus Single-Phase D-C Drive (herein referred to as the 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 Sale, in all instances, are Freight On Board (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.

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 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 Sales Office for assistance. To find the nearest Reliance Electric Sales Office for assistance, call toll-free 1-800-245-4501.

Store the Controller

After receipt inspection, repack the Controller in its original shipping container until ready for installation. To ensure satisfactory operation at startup and to maintain warranty coverage, store the controller as follows:

- In its original shipping container in a clean, dry, safe place;
- In an ambient temperature that does not exceed 65°C (149°F) or goes below -30°C (-22°F);
- Within a relative humidity range of 5 to 95% without condensation;
- Away from a corrosive atmosphere. In harsh environments, cover the shipping/storage container.
- At an altitude of less than 3,000 meters (10,000 ft.) above sea level.

File a Return Request

To return the Controller, send a written request to Reliance Electric within ten days of receipt. Do not return equipment without a numbered Equipment Return Authorization Form, available from your local Reliance Electric Sales Office. To find the nearest Reliance Electric Sales Office for assistance, call toll-free 1-800-245-4501. Reliance Electric reserves the right to inspect the equipment on site.

Drive Identification Nameplate

Your controller has a nameplate on the front cover which identifies the specific model number design, applicable A-C input power and D-C output power data. Refer to the nameplate in Figure 1-1. All communications concerning this product should refer to the appropriate model number information.

The technical power information should be referenced to verify proper power application.

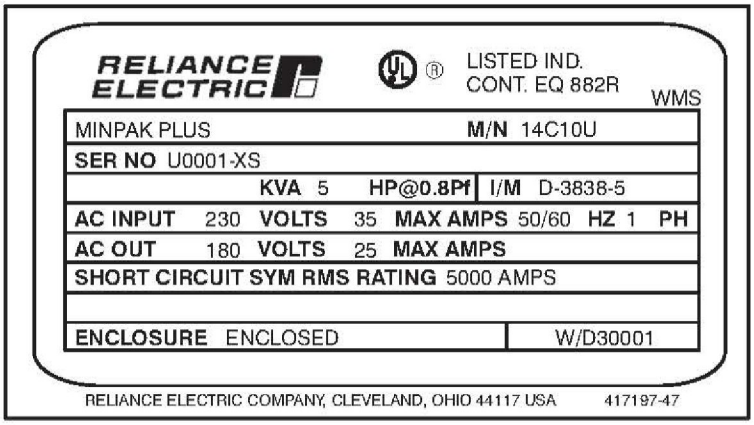


Figure 1-1. Typical MinPak Plus Nameplate.

2: Introduction to the Controller

Scope of This Manual

This manual familiarizes you with the MinPak Plus D-C Controller. It describes receiving, storage, application, implementation and installation procedures and provides an overview of specifications and operations.

Read this manual in its entirety before installing and powering the Controller. Observe all danger notes, warning notes, and caution notes; these precautions point out potentially hazardous procedures and conditions. All three types of precautions are enclosed in a box to call attention to them.

- A **DANGER** alerts a person that high voltage is present that could result in severe bodily injury or loss of life.
- A **WARNING** alerts a person to 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.

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.

MinPak Plus Single-Phase D-C Controller Specifications

Input Voltage and Frequency Ratings:

Nominal Line Voltage	115 or 230 VAC
Number of Phases	Single
Voltage Variation	± 10% of Nominal
Nominal Line Frequency	50 or 60 cycles
Frequency Variation	± 2 cycles of Nominal

A-C Line Fault Ampacity:

Allowable A-C Line Symmetrical	1,000 or (horsepower dependent)
Fault Current (RMS)	5000 amps (with NEC or CEC approved external disconnect) (See Table 2-1).

A-C Line KVA:

Maximum Source KVA	(See Table 2-1)
Multiple Drives per Line	Maximum 3 Drives per Line
Minimum Source KVA	(See Table 2-1)

D-C Voltage Ratings:

115 VAC Line:	
Armature Voltage	90 VDC
Field Voltage	50 or 100 VDC
230 VAC Line:	
Armature Voltage	180 VDC
Field Voltage	100 or 200 VDC

Service Factor Ratings:

Service Factor	1.0 Continuous
Overload Capacity (controller only)	1.5 of full load rating for one minute
Minimum Load	5% of rated load

Service Conditions:

Thermal:

Chassis	55°C Maximum
Cabinet	40°C Maximum

Altitude:

Chassis and Cabinet	3300 feet above sea level
Above 3300 feet	Derate 3% for every 1000 ft above 3300 ft up to 10,000 ft.

Humidity:

Chassis and Cabinet	5 to 95% Non-condensating
Environment	The Controller should be located in an area that is free of dust, dirt, acidic or caustic vapors, vibration and shock, temperature extremes, steam and/or excessive moisture, and electrical or electromagnetic noise interference.

Basic Regulator Maximum Recommended Operating Adjustments:

CAUTION: The following adjustments are maximum safe operating ranges. Potentiometers on the regulator, particularly current limit, may exceed these ranges. Failure to observe this precaution could result in damage to, or destruction of, equipment.

Maximum Speed	50 to 100% of motor base speed
Minimum Speed	0 to 50% of motor base speed
Current Limit	10 to 150% of rated load
IR Drop Compensation	0 to 12% of armature voltage at rated load
Acceleration Rate	0.5 to 30 sec
Deceleration Rate	0.5 to 30 sec

Regulation (with 95% load change):

Voltage Regulation	3 to 5% of base speed
CEMF Regulation	2 to 3% of base speed with IR Drop Compensation
Speed Regulation (RE020, RE045 or 5PY tach)	1.0% of base speed
(BC42 tach)	0.5% of base speed

Speed Range:

Operator's Speed Adjustment	0 to 100%
Specification Speed Range	20 : 1

Drive Efficiency:

Controller Only	97% (rated load and speed)
Controller and Motor	85% typical[1]

[1]Typical percent shown. Figure depends on motor base speed and frame size.

Displacement Power Factor:

Displacement Power Factor	68% typical[1]

[1]Typical percent shown. Figure depends on motor base speed and frame size.

MinPak Plus Single-Phase D-C Controller Description

The Reliance Electric MinPak Plus Single-Phase D-C Controller is a full-wave power converter without back rectifier, complete with an analog current minor loop and an analog major loop for armature voltage or speed regulation by tachometer feedback. The product line has been set-up to be sold as listed in Table 2-1.

The Controller is provided, as standard, in a NEMA Type 4/12 enclosure intended for wall or panel mounting. It is made up of a chassis and hinged cover. (Type 4 may be generally defined as a "wash-down" design. The enclosure may be easily converted into a chassis-only type configuration for panel mounting within a large electrical enclosure. An optical remote control station may then be placed on the larger enclosure's face or some distance away.

A single power POWER ON/OFF circuit breaker is standard with each chassis and is independent of the cover and faceplate.

For proper operation of the Controller, it is necessary to use an Operator's Station. The Operator Stations allow the tailoring of control functions for the application.

There are two basic configurations that may be selected:

- Local Station – station mounted on Controller Chassis Cover
- Remote Station – station mounted remotely as a separate unit

Local Station

Available is a selection of 8 standard Faceplates in order to configure a controller to a specific drive application. Refer to Table 2-1A. The Faceplate design maintains the NEMA Type 4/12 rating assuming the Cover is properly installed.

Table 2-1. Controller Model Numbers

Model Number							Optional			Transf. KVA	
Enclosed	Chassis	HP	VAC	(3) A-C Amps (RMS)	D-C Arm. (Volts)	D-C Arm. Amps Avg.	D-C Field Volts	Amp. MAX	Power Supply Capacity(2)	MAX	MIN
14C10	14C20	1/4	115	3.5	90	2.5	100	3.0	1000	40.0	0.50
		1/3	115	5.2	90	3.7	100	3.0	1000	40.0	0.75
		1/2	115	7.0	90	5.0	100	3.0	1000	40.0	1.50
		3/4	115	10.5	90	7.5	100	3.0	1000	40.0	1.50
14C11	14C21	1/2	230	3.5	180	2.5	200	3.0	1000	40.0	1.50
		3/4	230	5.2	180	3.7	200	3.0	1000	40.0	1.50
		1	230	7.0	180	5.0	200	3.0	1000	40.0	2.00
		1 1/2	230	10.5	180	7.5	200	3.0	5000	40.0	3.00
14C12	14C22	2	230	14.0	180	10.0	200	3.0[1]	5000	40.0	5.00
		3	230	21.0	180	15.0	200	3.0[1]	5000	40.0	10.0
14C13	14C23	5	230	35.0	180	25.0	200	3.0[1]	5000	40.0	10.0

[1]Standard
[2]Maximum permissible available symmetrical RMS fault current (amperes) with NEC or CEC external approved disconnect.
[3]Does not include current required for Field Supply (if used).

Table 2-1A. Local Operator Control Faceplates

When Using A MinPak Plus Controller With:	Specify Operator's Control Faceplate Model	Functions Provided[1]					
		Start/ Stop	Speed-setting Pot	Torque-setting Pot	Run/ Jog Selector	Forward/ Reverse Selector	Automat-ic/Manual Selector
Blank Faceplate (Use with Remote Station)	14C200	no	no	no	no	no	no
Basic Features	14C201	yes	yes	no	yes	no	no
Basic Features Plus Armature-Reversing	14C202	yes	yes	no	yes	yes	no
Basic Features Plus Automatic/Manual Modes of Operation	14C203	yes	yes	no	yes	no	yes
Basic Features Plus Armature-Reversing and Automatic/ Manual Modes of Operation	14C204	yes	yes	no	yes	yes	yes
Basic Features Plus Torque Control	14C205	yes	yes	yes	yes	no	no
Basic Features Plus Armature-Reversing and Torque Control	14C206	yes	yes	yes	yes	yes	no
Basic Features Plus Torque Control and Automatic/Manual Modes of Operation	14C207	yes	yes	yes	yes	no	yes
Basic Features Plus Armature-Reversing, Torque Control and Automatic/Manual Modes of Operation	14C208	yes	yes	yes	yes	yes	yes

Remote Station

If the application requires the Operator Control Station to be remotely located, the following three steps must be followed:

- Select the **blank** Remote Operator Station Cover Faceplate (Model 14C200)
- Order a Remote Operator Adapter Kit, Model 14C200. (This unit provides a connection point for the Remote Station.)
- Specify a Reliance Remote Operator Control Station and then connect it to the Controller. Refer to Table 2-1B.

NOTE: *Whenever a reference kit and remote operator buffer kit are used without an auto/manual switch, do the following:*

1. *Cut the J1 jumper on all reference kits used, and*
2. *Add a jumper from terminal 326 to 426 on the remote operator buffer kit.*

Table 2-1B. Remote Operator Control Stations

When Using A MinPak Plus Controller With:	Specify Operator's Station Model	Start/Stop Rocker Switch	Speed Setting Potentiometer	Run/Jog Selector	Forward/ Reverse Selector
Basic Features (Standard Unidirectional Station)	9C45	yes	yes	yes	no
NEMA type 4 Station with Basic Features	9C18	yes	yes	yes	no
Explosion-Proof Station with Basic Features	9C17	yes	yes	yes	no
Basic Features Plus Armature Reversing (Standard Reversing Station)	9C46	yes	yes	yes	yes
NEMA Type 4 Station for Reversing	9C19	yes	yes	yes	yes
Explosion-Proof Station for Reversing	9C16	yes	yes	yes	yes

See Table 2-2 for Isolation Transformer Specifications and Table 2-3 for fuse requirements.

In addition, Reliance offers a wide range of modification kits which broaden the application range of the Basic Controller. These kits are pre-engineered and all plug into specific circuits of the Basic Controller or the Auxiliary Panel. A summary of these kits is presented in Table 2-4.

Table 2-2. Isolation Transformer Specifications.

HP	kVA	Primary VAC	Secondary VAC	Reliance Part Number
1/4–1/3	0.75	230/460	115	77530-10S
1/4–1/3	0.75	575	115	Special Order
1/2	1.0	230/460	230	Special Order
1/2	1.0	575	115	Special Order
3/4	1.5	115	115	77530-12V
3/4	1.5	575	115	77530-11V
3/4	1.5	230/460	115	77530-10V
3/4	1.5	230/460	230	Special Order
3/4	1.5	575	230	Special Order
1	2.0	230/460	230	77530-8W
1	2.0	575	230	Special Order
1-1 1/2	3.0	230/460	230	77530-8X
1-1 1/2	3.0	575	230	Special Order
2–3	5.0	230/460	230	77530-8Y
2–3	5.0	575	230	77530-9Y
5	10.0	230/460	230	77530-8RC
5	10.0	575	230	77530-9RC

NOTE: *Smaller drives through 3/4 HP @ 115 VAC and 2.0 HP @ 230 VAC may be used with permanent magnetic field motors, and those drive models are supplied without a D-C field supply.*

Table 2-3. Fuse Requirements.

HP	A-C Line Volts	Dual Element Class K5, RK5, 250VAC Fuse		Reliance Part Number
		Quantity	AMP	
1/4-3/4	115	1[1]	15	64676-1W
1/2-1 1/2	230	2	15	64676-1W
2-3	230	2	30	64676-1Z
5	230	2	50	64676-1AD

[1]Install fuse in input line L1 (hot line).

Table 2-4. Controller Modification Kits.

Kit Name	Kit Model Number	Controller Modification ?[1]	Options Required	Instruction Manual
Local Operator Station Faceplate	14C201 thru 8	no	None	–
Blank Operator Station Faceplates	14C200	no	Reliance Remote Operator Control Station	–
Remote Operator Adapter Kit	14C220	yes	(See Blank Faceplate, just above.)	–
Double Pole Circuit Breaker	14C210 thru 13	yes	None	–
Auxiliary Mounting Bracket[2]	14C209	no	Always used with some other option; included with Field Supply Kit.	–
Reversing Contactor	14C217 & 14C218	yes	FORWARD/REVERSE selector switch on Operator Station (See table 2-1A.)	D2-3307
Auxiliary M Contact	14C219	no	Auxiliary Mounting Bracket	–
Tachometer Feedback	14C221	yes	None	D-3969
Voltage/Tachometer Follower	14C223	yes	May need AUTO/MANUAL selector switch	D-3971
Torque Taper	14C224	yes	None	–
Test Meter Adapter	14C225	no	None	D-3970
Automatic Reversing	14C226	no	Auxiliary Mounting Bracket Reversing Contactor Kit	–
Dynamic Braking	14C214 thru 16	no	None	–
Instrument Interface/ Preset Speed	14C222	yes	If preset speed only, may need AUTO/ MANUAL switch. If follows process controller, may need AUTO/MANUAL switch.	D-3967
Master Isolated Reference Receiver	14C229	yes	Master Isolated Reference Transmitter	–
Dancer Follower	14C230	yes	None	D-3966

[1] Modification here means that some work such as jumper placement, resistor clipping, or wiring reconnection must be performed.

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.

DANGER

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

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCKOUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

General

This Section outlines the procedures that are to be followed to properly install the MinPak Plus Single-Phase D-C Drive. Refer to Figure 3-2 for mounting dimensions.

Install the Controller – Panel Layout

The controller is designed as a wall or panel mount unit and must be hung within 10° of vertical with the rear of the chassis firmly bolted to the mounting surface. Do not mount the chassis in a horizontal position. Reference figures 3-1, 3-1A and 3-1B for minimum mounting distances and/or mounting orientations.

Leave 2 inches (50 mm) clearance around the 3 unhinged sides of the chassis. This area must remain unobstructed for proper air circulation through the heat sink. Do not place the controller directly in a corner, leave at least 8 inches (200 mm) from the top and 6 inches (150 mm) from the bottom of the cabinet.

Regardless of the above placement guidelines, the user is responsible for ensuring that the Controller's ambient specification of 0 to 55°C is met. Relative humidity must be kept within 5% to 95% without condensation.

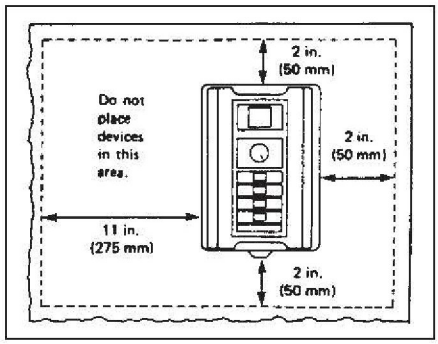


Figure 3-1. Enclosure Mounting Minimum Distances

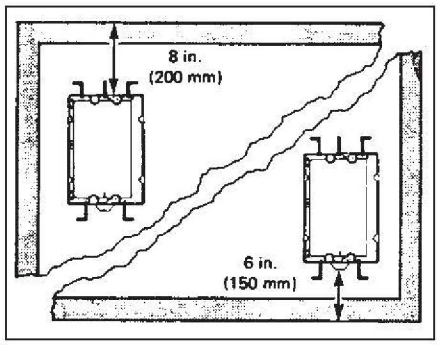


Figure 3-1A. Open Panel Minimum Mounting Distances

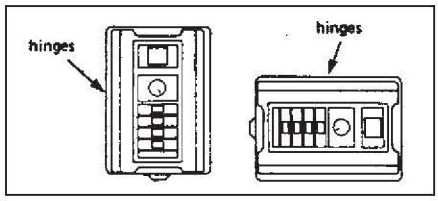


Figure 3-1B. Mounting Orientations

Controller Mounting Dimensions

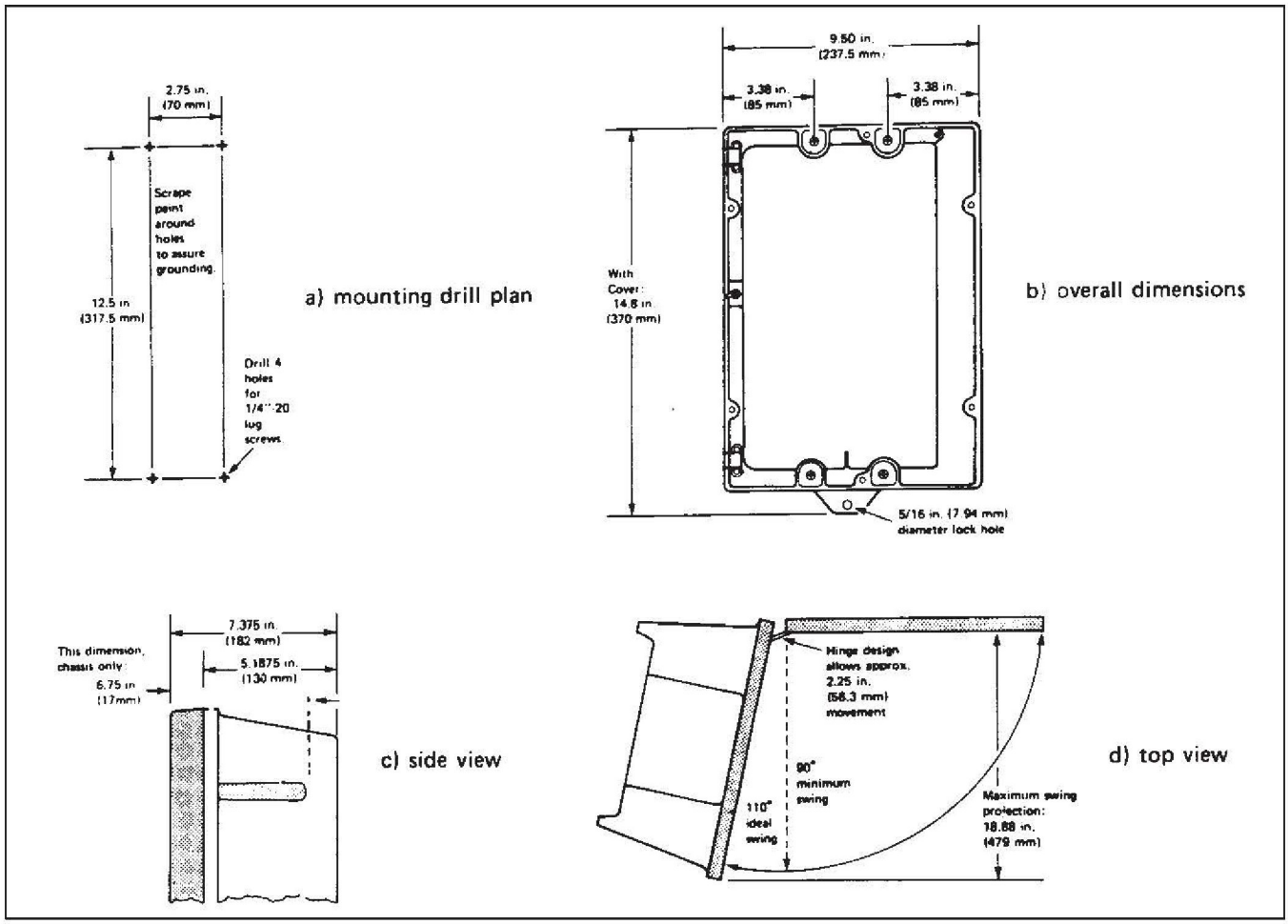


Figure 3-2. Controller Mounting Dimensions.

Install The Motor

1. Verify that the motor is the appropriate rating to use with the controller.
2. Install the D-C motor in accordance with its own installation instructions.
3. 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

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCKOUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Install a fused disconnect or circuit breaker in the incoming A-C line. It must accommodate a maximum symmetrical A-C fault current of 5,000 amperes for controller ratings greater than 1 HP or 1,000 amperes for controller ratings of 1 HP or less.

The National Electrical Code requires that a two pole, fused disconnect switch be installed on the incoming A-C line ahead of the Drive. Fuses for this disconnect switch should be chosen from Table 2-3. They should be dual element, slow blow type, or Class K5.

The disconnect switch should be within clear view of machine operating and maintenance personnel for easy access and safety. An open-type switch with provisions for a padlock is recommended.

Wire The Drive

Reference Figures 3-3 and 3-4 when wiring the drive.

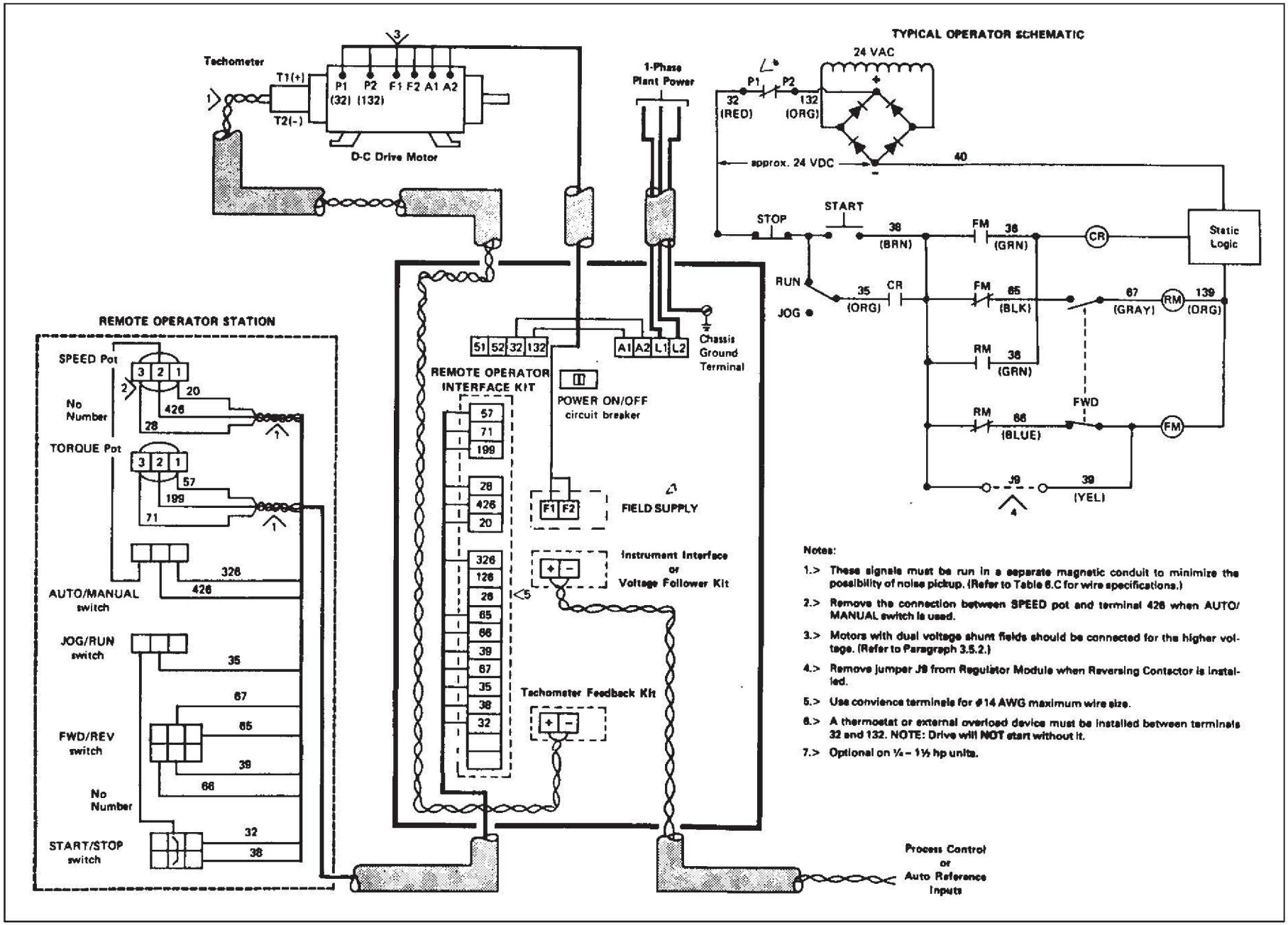


Figure 3-3. Drive Connection Diagram.

DANGER

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

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCKOUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS 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 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 THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Locate the Controller ground point provided.
2. Run a suitable equipment grounding conductor **unbroken** from the Controller ground point (see step 1) 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 GND (green/ground) wire brought in with the incoming A-C power line to the controller ground point.

Ground the Optional Faceplate

A ground wire is supplied as standard with each Faceplate. Connect the ground wire to a bolt on the underside of the cover and to the controller chassis. Refer to Figure 3-3A.

NOTE: *Since the green wire is fixed by the user on a faceplate bolt, the installation should be performed when the faceplate is fitted.*

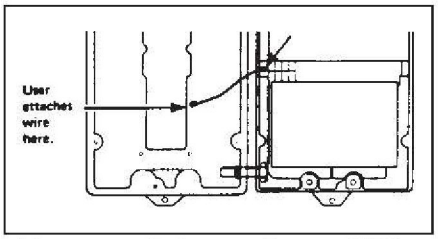


Figure 3-3A. Cover Ground Wire

General Wiring Practices

The Controller is designed for Tachometer input wires, A-C and D-C power entry at the top and control and signal wiring to enter from the bottom. See Figure 3-4.

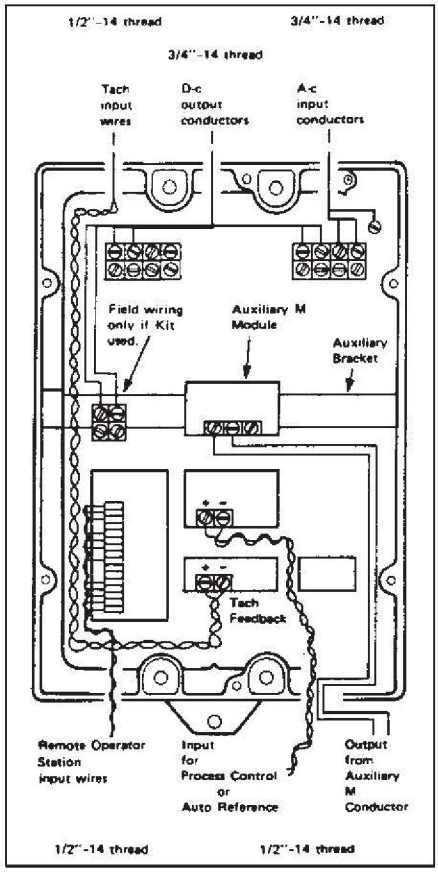


Figure 3-4. Chassis Wells, Wire Routing

Reference signal wiring should be run in a separate steel conduit isolated from all A-C and D-C power and control. All reference signals should be wired with either twisted double or twisted triple conductor wire, 2 twists per inch, stranded copper, AWG No. 16, 600 VAC rated, poly-vinyl chloride insulation, with a temperature range of 40 – 105°C (104 – 221°F). Signal wires should not be run in parallel with high voltage or electrically noisy conductors. Always cross such conductors at 90°.

Tachometer Feedback, Instrument Interface and Voltage/Tachometer Follower signal wiring should be run in a separate conduit isolated from all A-C and D-C power and logic control. Wiring should be the same as for the reference signals above.

For mounting with external contactors and solenoids, coils

should be suppressed to reduce noise.

Wire A-C Power to the Controller

DANGER

THE DRIVE REQUIRES A SINGLE-PHASE POWER SOURCE OF EITHER 115 VAC OR 230 VAC, 50 OR 60 HZ. IF THE CORRECT VOLTAGE IS NOT AVAILABLE, A TRANSFORMER MUST BE INSTALLED BETWEEN THE POWER SOURCE AND THE DRIVE. DO NOT OPERATE THE CONTROLLER WITH AVAILABLE SHORT CIRCUIT CURRENTS IN EXCESS OF 5000 AMPERES. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Size the A-C line supply conductors for the specific controller rating and according to all applicable codes.
2. Wire the A-C line supply per Figure 3-3.

Power Transformation

Although auto transformers may step up or down the A-C power supply voltage, they do not isolate the Drive from the A-C line. Users should consider using an isolation transformer in lieu of an auto transformer for the following advantages:

- Should a person come in contact with the A-C incoming line, an isolation transformer would reduce the risk of severe or fatal injury.
- A-C power line disturbances and transients are minimized by an isolation transformer, thus reducing possible damage to solid state components.
- With an isolation transformer, the Drive is free of plant power system grounds, providing electrical isolation for the Drive from those grounds. Damaging currents may be avoided in instances where the D-C output is accidentally grounded or where the D-C motor circuits go to ground.

Reliance offers a series of isolation transformers suitable for use with the MinPak Plus Drive. Refer to Table 2-2.

Motor Overload Protection

Reliance utilizes a D-C motor thermostat for motor thermal overload protection. The thermostat is brought out through the motor terminal box as leads P1 and P2. These two leads must be wired to the Controller terminals 32 and 132. The thermostat leads can be run with the motor armature and field power wiring.

If an additional inverse time overload is added, its normally closed contact should be wired in place of the motor thermostat and connected to the controller at terminals 32 and 132, or in series with the motor thermostat when both are used.

NOTE: *The Drive will not start if the circuit between 32 and 132 is not made.*

Place a jumper between terminals 32 and 132 if an external overload device is not connected at these terminals.

Armature Loop Contactor Sequencing

WARNING

THE MINPAK PLUS D-C DRIVE MUST EMPLOY A CONTACTOR IN THE MOTOR ARMATURE LOOP FOR POSITIVE DISCONNECT OF THE MOTOR FROM THE DRIVE IN A STOP CONDITION. AN INADVERTENT START CAUSED BY NOISE OR DRIVE COMPONENT FAILURE MAY CAUSE UNEXPECTED MOTOR AND MACHINE MOVEMENT IF A CONTACTOR IS NOT USED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

In all cases, the Drive must have an armature loop contactor to disconnect the motor from the Controller on a Stop.

When the Armature Loop Contactor is not supplied by Reliance, its "ON/OFF" sequence must be integrated into the sequence control of the regulator just as when the Contactor is supplied by Reliance. The "ON" sequence requires that the contactor is closed and approximately 8 milliseconds later the Drive CR Relay is energized to release the regulator. The "OFF" sequence requires that the Drive CR Relay first clamps the regulator (drop-out of the CR Relay is about 8 milliseconds) and then the contactor is allowed to drop-out.

The M Contactor Adapter Kit is to be used to connect the Contactor to the Regulator to incorporate this sequencing function.

Refer to Figure 3-5 for Regulator/Contactor Start/Stop timing.

The Contactor that is used must have a 25VDC coil and a maximum current draw of 150 milli-amps. A 220 MFD capacitor must be connected in parallel with the

contactor coil for drop-out timing. (See Figure 3.5)

Refer to Figure 3.6 and Figure 3.7 for M Contactor connection when the Contactor is not supplied by Reliance.

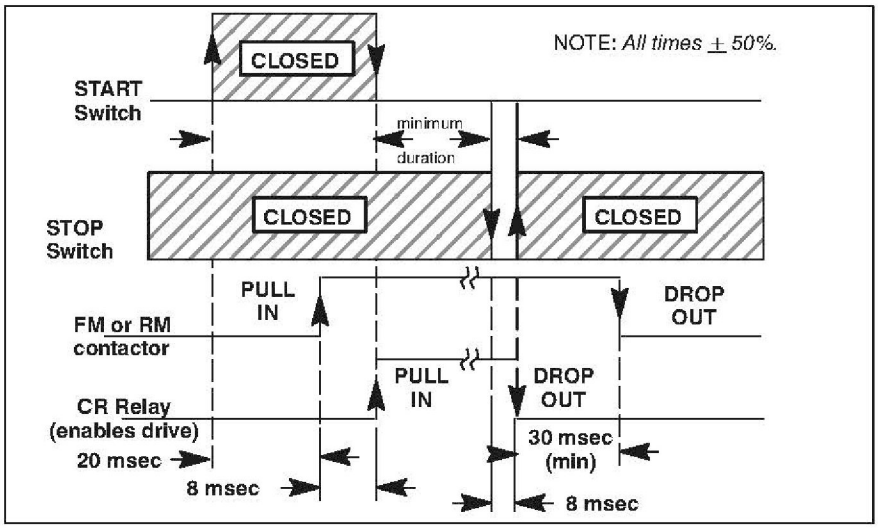


Figure 3-5. Armature Contactor Sequencing and Regulator Start/Stop Timing.

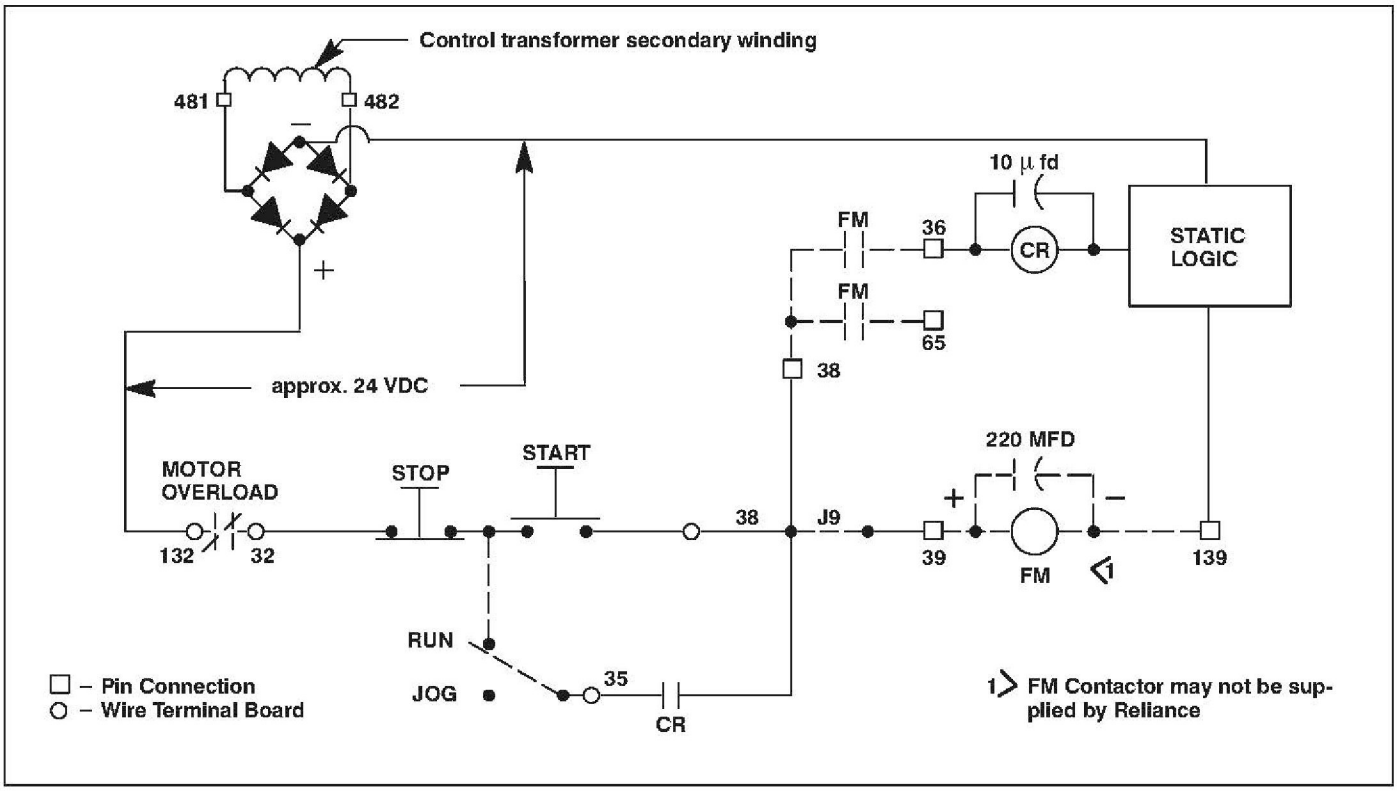
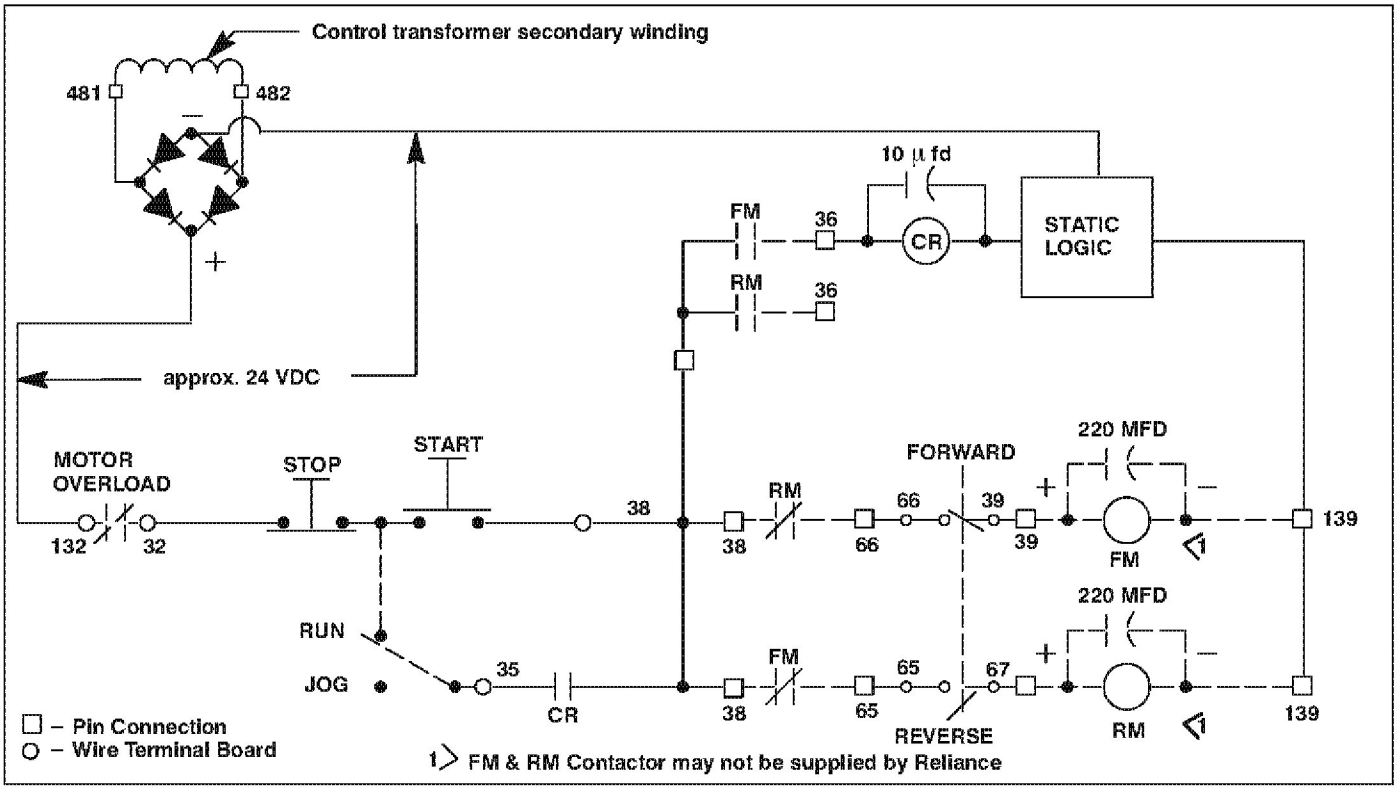


Figure 3-6. Non-Reversing Drive Control Circuit.



NOTE: *When Reversing is used, the J9 Jumper on the Regulator Board must be cut.*

Figure 3-7. Reversing Drive Control Circuit.

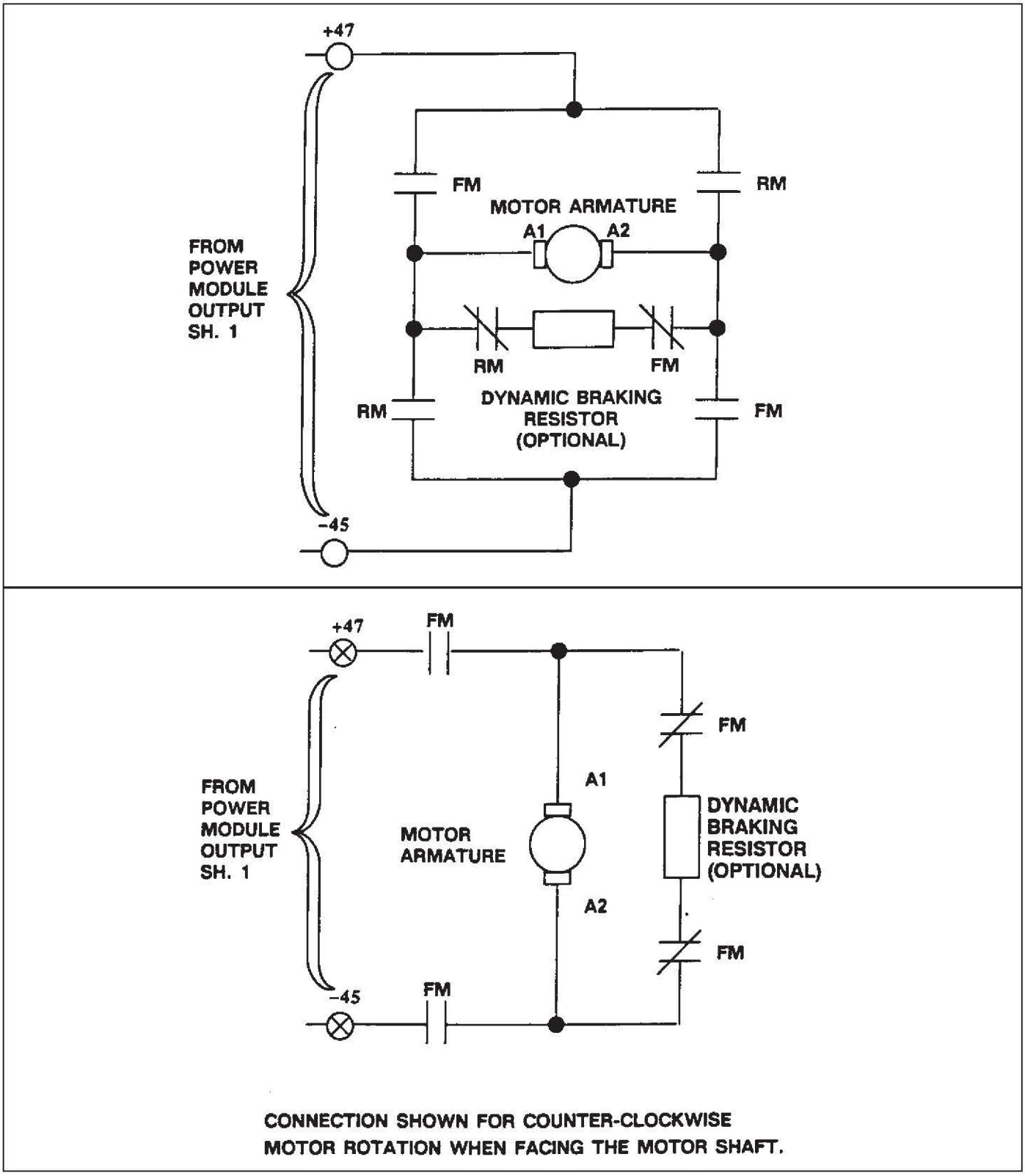


Figure 3-8. Motor Armature Circuit Connection.

Wire the D-C Motor to the Controller

1. Size the motor armature circuit conductors for the specific controller rating and according to 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). See Figure 3-8 for the Motor Armature Circuit Connection. Refer to "Wire the Field Supply" in this manual for field supply connections.

Install the Field Supply

The Field Supply Kit provides full-wave field excitation for shunt-wound D-C motors. It may be optionally applied to controllers from 1/4 thru 1 1/2 HP. (It is a standard feature for 3 and 5 HP MinPak Plus controllers.)

The Kit is an assembly consisting of a terminal block (F1, F2), a field power cube, two wiring harnesses, bracket support and mounting hardware. The user provides the F1/F2 conductors to the drive motor. No other equipment is required.

To install the Kit, follow these procedures.

Step 1 – Mount Field Kit

a. Remove screws from 1TB.

b. Remove screws from the support bracket.

c. Remove screw leads 32 and 132 from 2TB.

d. Remove the support bracket from the unit.

e. Mount the Field Supply Kit onto the unit.

f. Reinstall leads 32 and 132 onto 2TB.

g. Mount 1TB to the Field Supply Kit.

Wire the Field Supply

D-C field supply voltage and maximum field amperes are listed in Table 2-1.

Step 1 – Wire Field Supply Power Cube

Wire from the field supply power cube to terminals 51 and 52 on 2TB as shown in Figure 3-9.

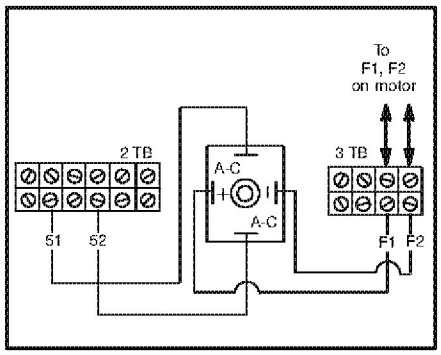


Figure 3-9. Connecting Field Supply.

Step 2 – Route Wires and F1/F2 Connection

The user-supplied field wiring conductors should be drawn into the chassis. Route them as indicated in Figure 3-3. Move them to the upper screws on 3TB and connect F1/F2 according to the label or Figure 3-9.

Wire the Speed Reference Circuit

When only a Manual Operator's Speed Pot Reference function is utilized, the circuit shown in Figure 3-10 should be followed.

In this configuration (see Figure 3-10), the J4 jumper on the Regulator Board is NOT to be cut, the reference input is through terminal 426 to the LVTU. The J4 Jumper is only removed when the reference is brought in to terminal 126. Lead 126 is not to be taken outside of the cabinet as it is not buffered.

Reliance offers four Reference Kits for Automatic Process Following. These kits are:

1. Voltage/Tachometer Follower Kit, M/N 14C223.
2. Instrument Interface/Preset Speed Kit, M/N 14C222.
3. Dancer Follower Kit, M/N 14C230.
4 Dancer Position kit, M/N 14C233.

These Kits can be used as Automatic Reference Followers with or without a Manual optional function. If used without a Manual option function, as described above, the reference circuit for these kits is set-up as shown in Figure 3-11. If the Automatic Reference Kits are to be used with a Manual optional function as described above, the reference circuit for these kits is set-up as shown in Figure 3-12.

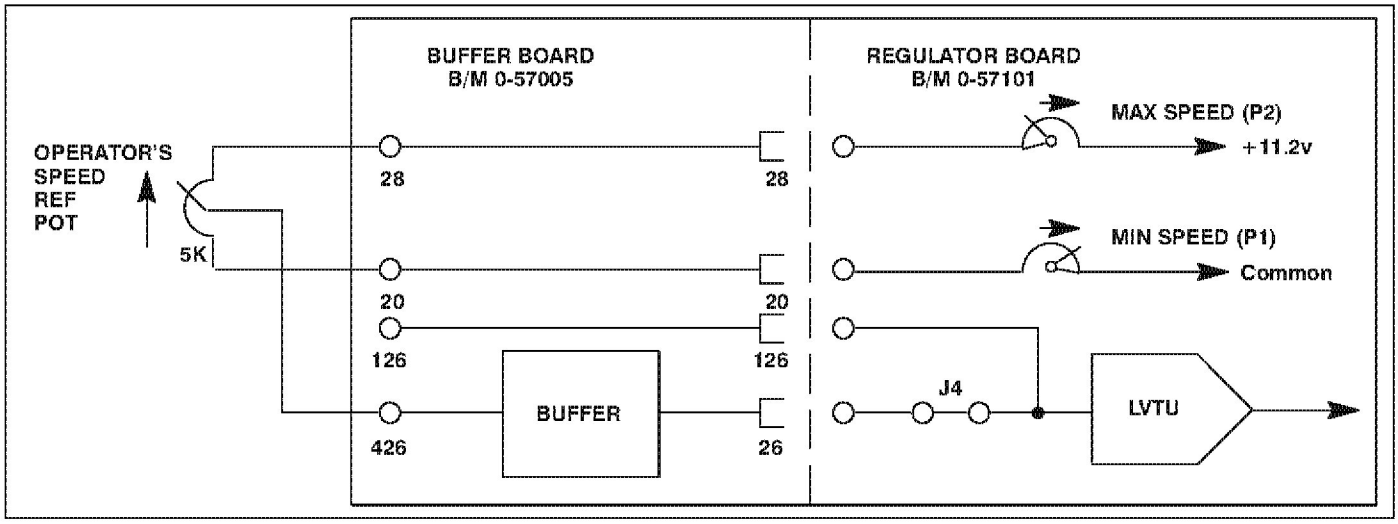


Figure 3-10. Reference Circuit for Manual Operator's Speed Reference Circuit.

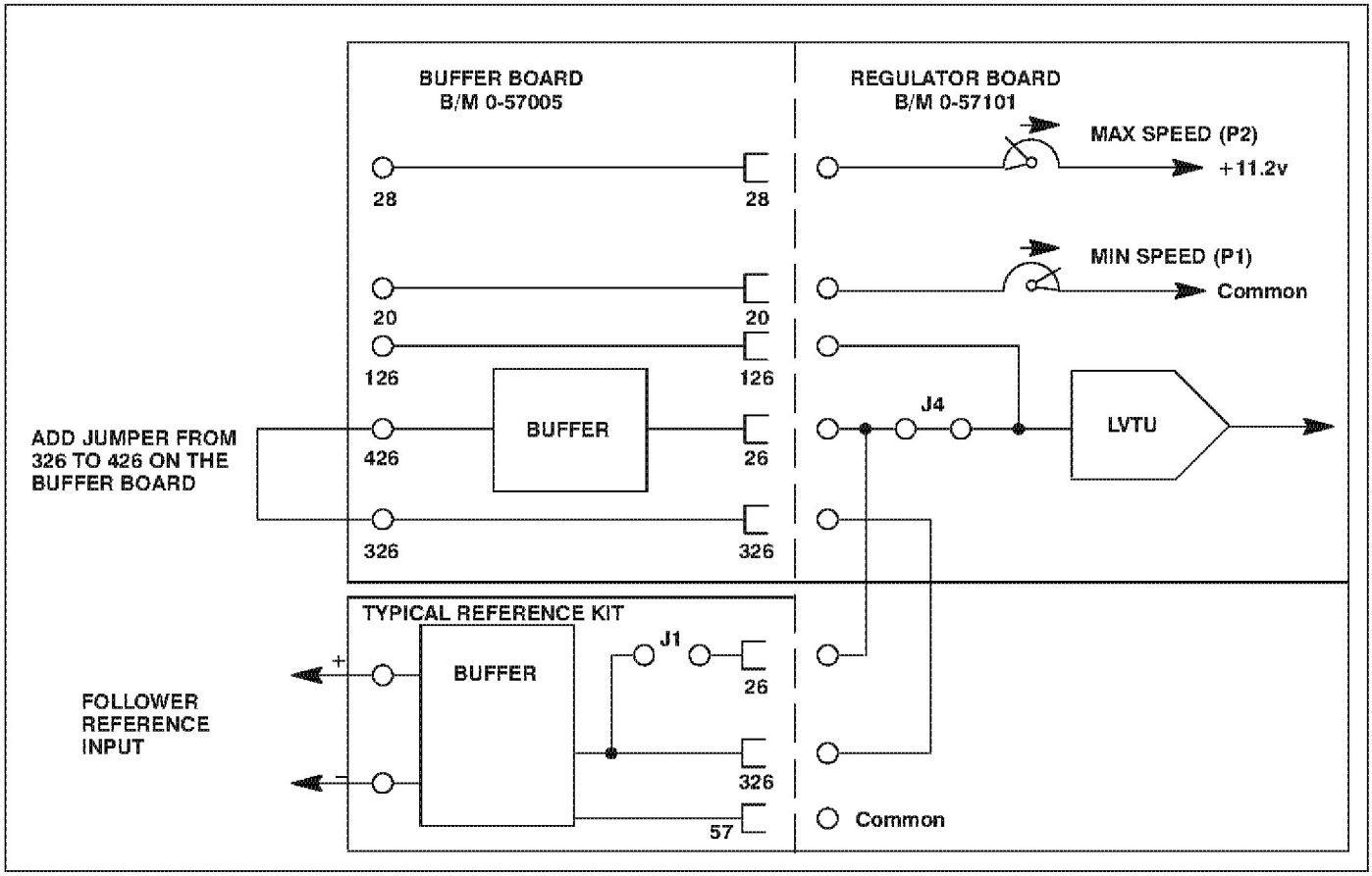


Figure 3-11. Reference Circuit for Follower Reference Kit without the use of the Manual Operator's Reference Option.

In this configuration (see Figure 3-11), the J1 jumper on the Reference Kit Board is to be cut and a jumper added between terminals 326 and 426 of the Buffer Board. This inserts the reference signal through the reference buffer circuit to pin 26 of the Regulator Board.

The J4 jumper on the Regulator Board is not to be removed in this configuration (see Figure 3-11).

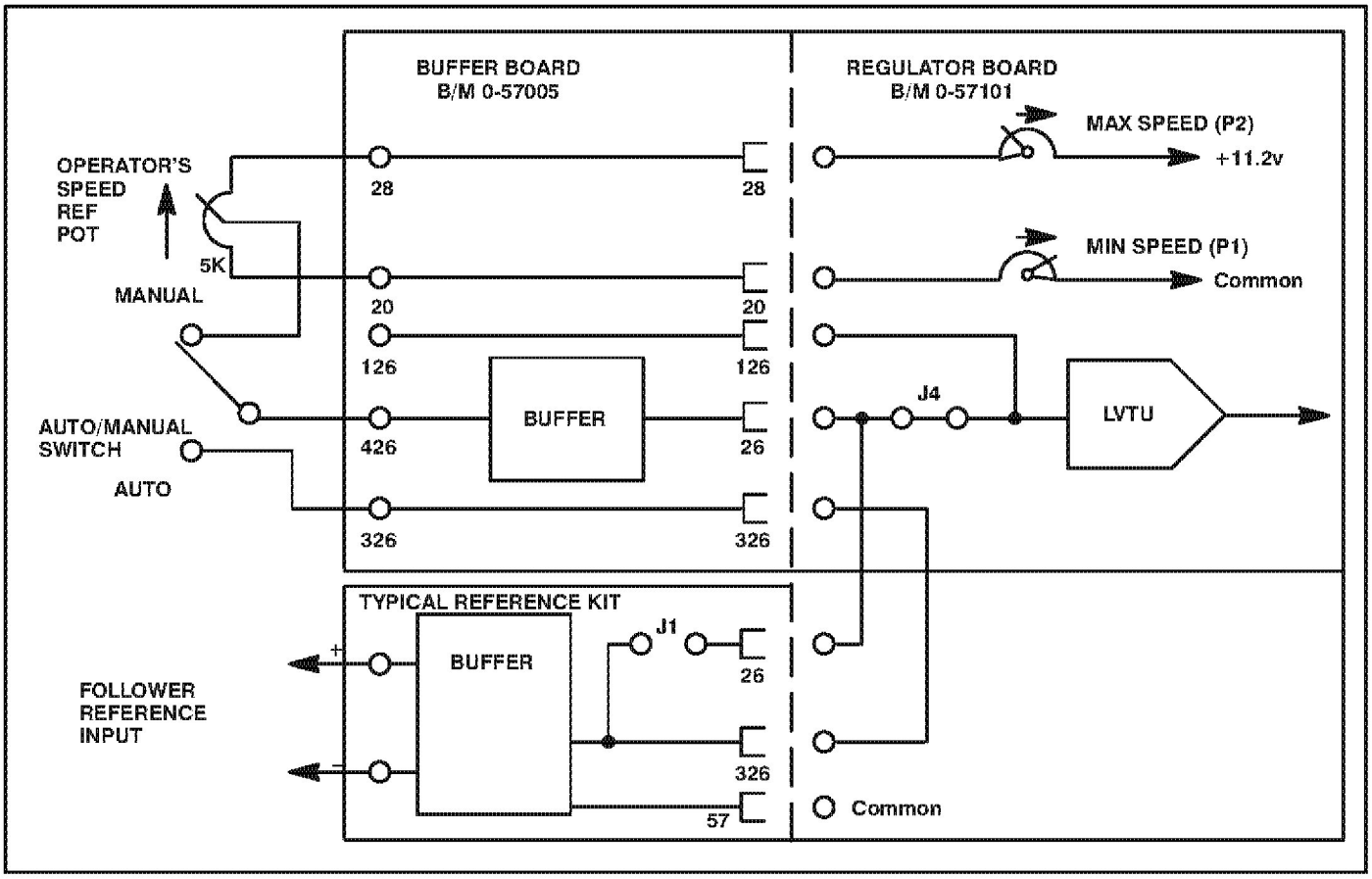


Figure 3-12. Reference Circuit for Follower Reference Kit with the use of the Manual Operator's Reference Option and an Auto/Manual Switch.

In this configuration (see Figure 3-12), the J1 jumper on the Reference Kit must be cut but the J4 jumper on the Regulator Board is not to be cut.

4: Start-up and Adjustment

General

This section details the start-up and adjustment for the basic MinPak Plus Drive as an armature voltage regulator and/or as a speed regulator. Reference Figure 4-1 for location of adjustments, test points and the relative positioning of optional kits on the regulator module. Record final settings of potentiometers and jumpers in Table 4-3.

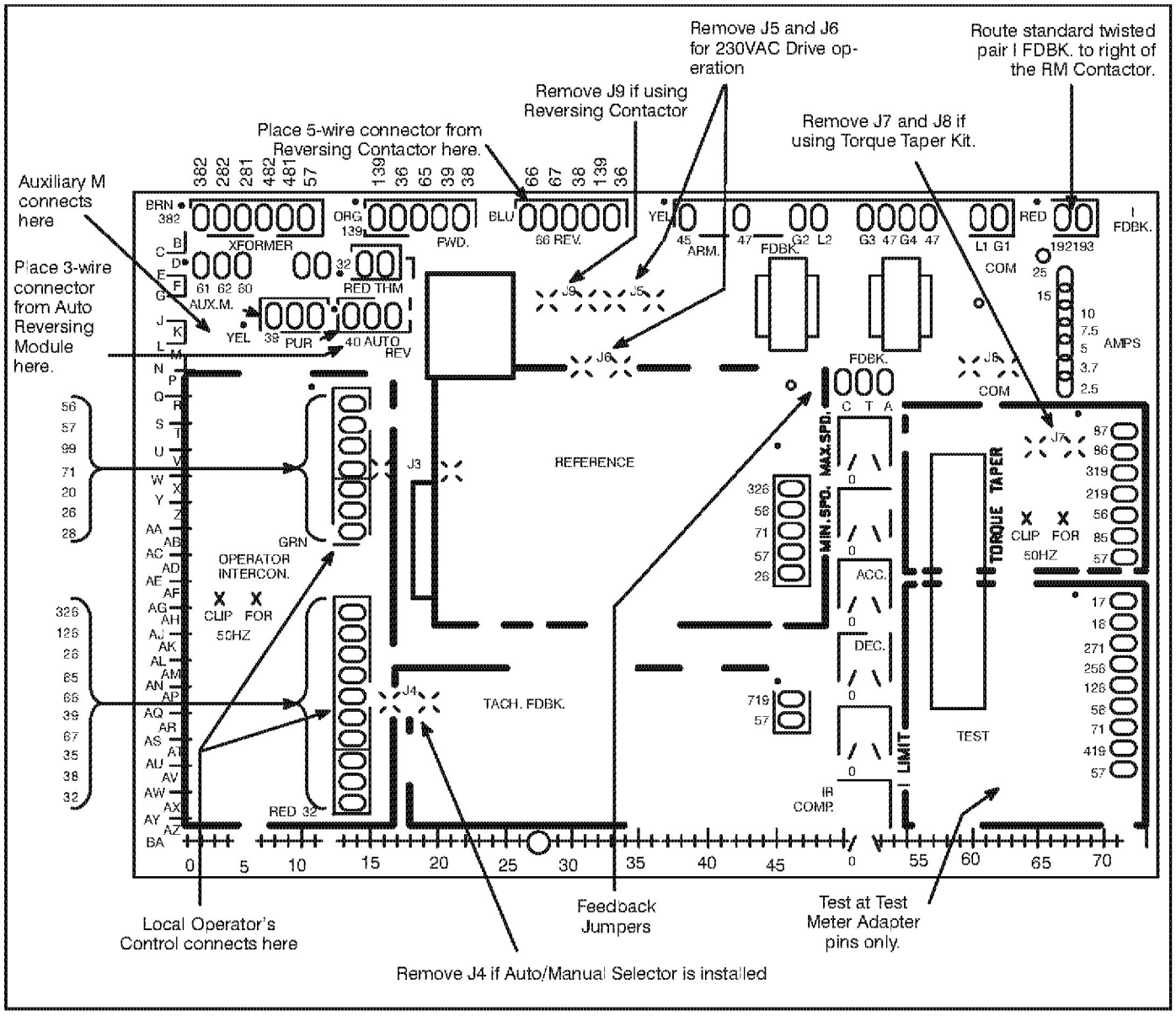


Figure 4-1. Regulator Module Screen.

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. 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.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCKOUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Power Off Inspection

NOTE: *These procedures assume that the A-C incoming line is locked off and that the load is uncoupled from the motor.*

Inspect the Controller and modification kits for possible physical damage or improper connections. Electrical connections between the modification kits and the Regulator are made via box connectors over board pins. Before inserting the kits, verify that the mating pins are straight and parallel. Only one pin will fit in each box connector. All kits are to be securely fastened to the regulator board by the screws provided.

Verify the wiring of the operator's station and wiring to the Drive. All wire connections should be made with sufficient bare wire to make a good electrical connection. The removal of an excessive length of insulation may needlessly expose conductors with the possibility of shorts or safety hazards resulting.

Motor Ground Check

The D-C Motor frame and conduit box should be connected to a good earth ground per the motor instruction manual.

Verify that there is no path to ground in either the D-C Motor armature circuit, the shunt field circuit or the thermostat circuit. Connect one lead of an ohmmeter to the motor frame and the other lead to the two armature leads, the two field leads and to the two thermostat leads. If a reading of less than 100,000 ohms is observed, a ground condition exists and MUST be cleared before power is applied.

CAUTION: A meggar may be used for this motor ground check, but all conductors between the motor and the controller must be disconnected. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

50 Hertz Operation

When the Drive is used in 50 hertz applications, it is necessary to clip two resistors on the Regulator Board. These resistors are located at grid AF4 to AF10 and AA63 to AA69.

230 Volt A-C Applications

For 230 VAC applications, the FlexPak Plus Regulator must be modified by clipping jumpers J6 and J5. See Figure 4-1. This modification has probably been made at the factory upon Model Number specification, however, this should be verified. Clip both sides of the jumpers to ensure a clean circuit break.

Horsepower – Current Scaling

Since a MinPak Plus Drive covers a wide range of horsepower ratings (see Table 4-1), it is necessary to scale the Drive for the application motor. The Current Scaling Jumper on the Regulator Board must be set for the specific motor full load current rating. Locate the nameplate on the drive motor and then note the full-load current. If current is not shown on the nameplate, refer to Table 4-1. Relate the left or center columns in Table 4-1 with known motor data. Read across to the right column marked "Motor Current". This value indicates the proper jumper connection to make on the Regulator Board where a corresponding number is etched on the Printed Circuit Board.

Table 4-1. Current Feedback Scaling

Motor HP		Motor Current/PIN Connections
115 VAC	230 VAC	
1/4	1/2	2.5A
1/3	3/4	3.7A
1/2	1	5.0A
3/4	1 1/2	7.5A
–	2	10.0A
–	3	15.0A
–	5	25.0A

Refer to Figure 4-2 to select the appropriate current scaling connection. Place the current scaling jumper on the proper connection. NOTE: *Do not move the jumper if it is connected to the proper connection.*

If the jumper must be reconnected, carefully lift it straight up and off the connector. Slide the jumper straight down over the proper connection.

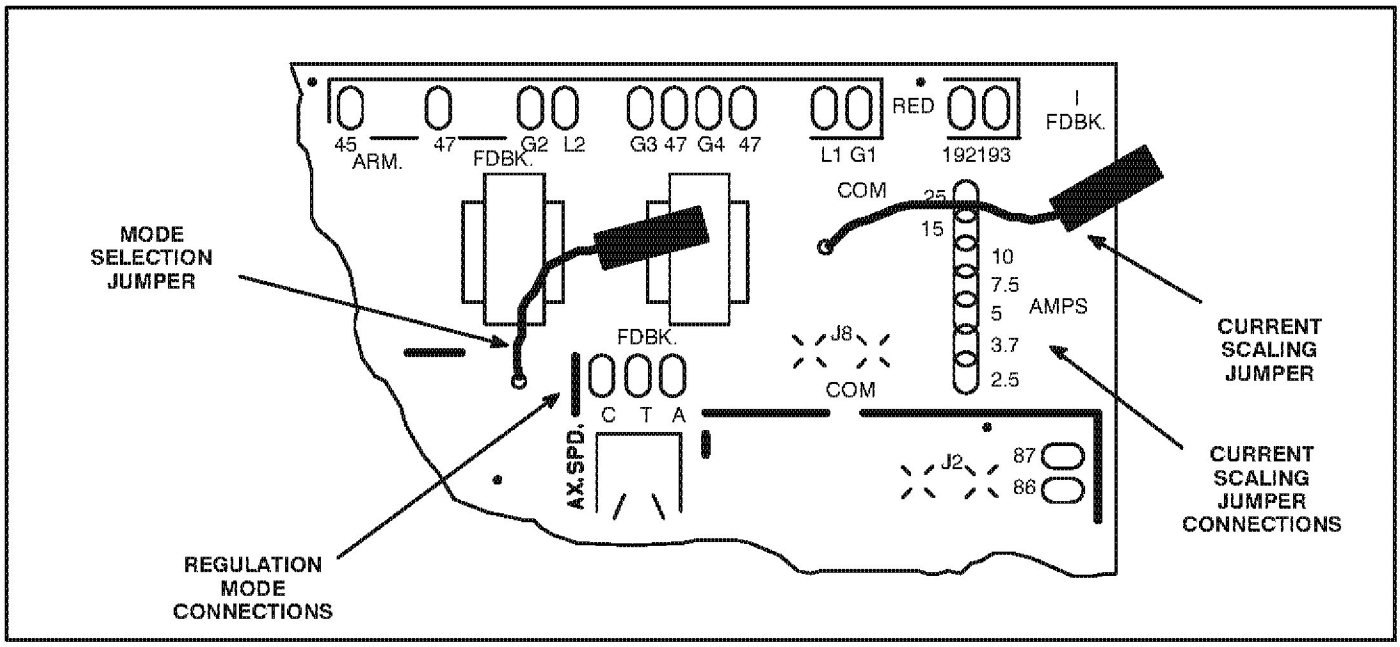


Figure 4-2. Drive Current Scaling Setup.

Regulation Mode Selection

The MinPak Plus Drive has three modes of regulation; A = Speed Regulation by Armature Voltage, T = Speed Regulation by Tachometer or C = Counter EMF Feedback.

This initial Set-up Procedure will be conducted in the Armature Voltage Mode with the selection jumper set on pin A on the Regulator Board even though a tachometer may be used in the final system configuration. Refer to Figure 4-2 and set the Regulation Mode jumper to the A position.

Power On

Once all the preliminary checks have been completed, apply A-C Power to the Drive. Carefully observe all cautions and warnings.

DANGER

THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

FOR DRIVES WITH A FIELD SUPPLY KIT, IF THE CIRCUIT BREAKER HAS TRIPPED OR THE POWER FUSES HAVE BLOWN, THE FIELD SUPPLY KIT AND ITS WIRING MUST BE INSPECTED FOR DAMAGE. AFTER RE-APPLYING POWER TO THE DRIVE, THE FIELD VOLTAGE MUST BE CHECKED FOR PROPER VOLTAGE AT MOTOR TERMINALS F1 AND F2. IF THIS VOLTAGE IS BELOW 90% OF THE SPECIFICATION VOLTAGE, THE DRIVE MUST NOT BE STARTED UNTIL PROPER VOLTAGE IS OBTAINED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Verify that the F1 – F2 Field Supply Voltage is the same as the motor nameplate voltage if the Field Supply Kit is used. The field supply is standard on 3 thru 5 HP drives.

Check and verify control power voltages before proceeding. See Table 4-2 for nominal values.

Table 4-2. Control Power Voltages.

Function	Terminal(s) /Pin(s)	Nominal Values (VDC)
Unregulated +20 VDC	256	+20 VDC ±5%
Unregulated -20 VDC	271	-20 VDC ±5%
Regulated +11.2 VDC	56	+11.2 VDC ±5%
Regulated -11.2 VDC	71	-11.2 VDC ±5%

Drive Set-Up Procedure

Basic Regulator Maximum Safe Operating Adjustments

The following adjustments are available on the Basic Regulator (see Figure 4-3):

CAUTION: The following adjustments are maximum safe operating ranges. Potentiometers on the regulator, particularly current limit, may exceed these ranges. Failure to observe this precaution could result in damage to, or destruction of, equipment.

Maximum Speeed ..... 50 to 100% of motor base speed
Minimum Speed ..... 0 to 100% of motor base speed
Current Limit ..... 10 to 150% of armature voltage at rated load
IR Drop Compensation ..... 0 to 2% of rated load
Acceleration Rate ..... 0.5to 30 seconds
Deceleration Rate ..... 0.5to 30 seconds

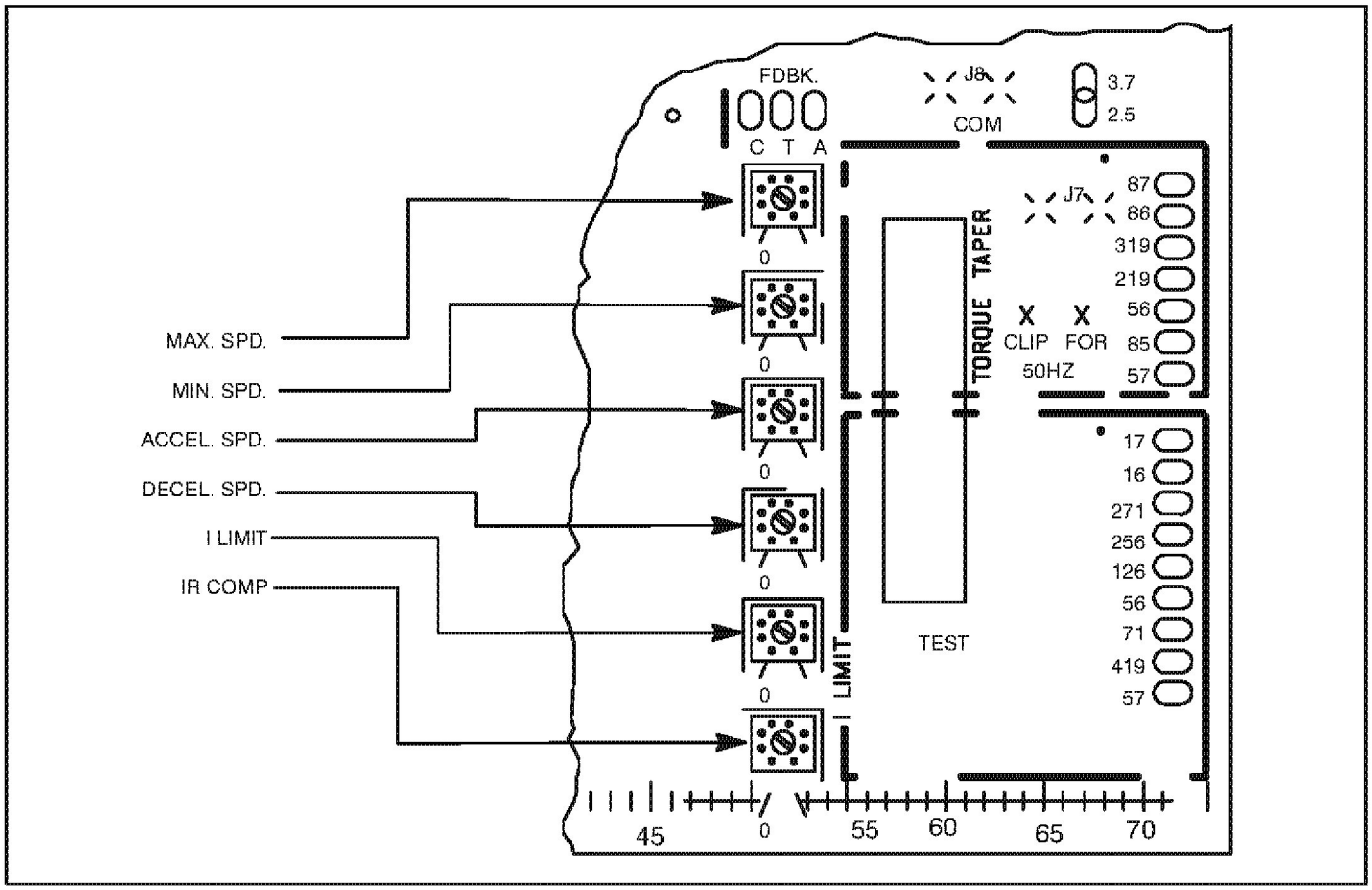


Figure 4-3. Regulator Function Potentiometers

Verify the Correct Direction of Motor Rotation

Connect the regulator mode jumper to the "A" position. (This initially sets up the drive as a voltage regulator for purposes of start up. Later on you may need to move the jumper to the "T" position if your drive is to be speed regulated.) Set the "IR COMP" rheostat to zero (fully CCW).

Assuming that the drive is using an operator's station similar to the one shown in figure 3-3:

Set the operators speed pot to "zero".

If a torque pot is used, set it fully CW.

If an "auto/manual" switch is used, set it to "manual".

If a "run/jog" switch is used, set it to "run".

If a "fwd/rev" switch is used, set it to "fwd".

Now initiate a "start". If no motor rotation is observed, slowly advance the operator's speed pot until rotation occurs. Verify that the motor is rotating in the proper direction for "forward".

If the direction of rotation is wrong, stop the drive. To change the direction of rotation, remove all power, and then switch the "A1" and "A2" connections to the motor armature.

Determination of Tachometer Output Polarity

If your system does not employ a tachometer, this step should be ignored.

If your system does employ a tachometer feedback for speed regulation, the tachometer feedback kit (Model # 14C221) will need to be installed. Refer to instruction manual D-3969 for further information on the setup for the tachometer feedback kit.

If you are going to use a D-C tachometer, and have the feedback kit installed, it will be necessary to verify that you have the correct polarity of tachometer output. To check the polarity of the tachometer leads, start the motor and run it in a forward direction. While the tachometer is rotating, use a voltmeter to determine the forward polarity. Mark the leads accordingly, (+) and (−).

Adjusting Minimum Speed

Set the operator's speed pot at zero and initiate a drive start. Measure the motor or machine speed with a hand tachometer to determine when the desired minimum speed is reached. Adjust the minimum speed pot to attain the desired minimum speed of the machine. Using a small screwdriver, turn the rheostat CW to increase the minimum speed, or CCW to decrease the minimum speed.

If no tachometer is available, motor speed can be approximated by measuring the armature voltage. Speed is proportional to voltage if the IR drop is disregarded. Therefore, if we adjust the minimum speed rheostat for the right percentage of armature voltage (as the minimum speed is a percentage of designed maximum speed) the machine speed will be fairly close to the desired value.

DANGER

ALTHOUGH THE MINIMUM SPEED ADJUSTMENT ON THIS DRIVE MAY ALLOW FOR ADJUSTMENT TO ZERO SPEED. THIS ZERO SPEED SETTING MUST NOT BE USED WHERE THE OPERATOR MAY RELY ON A MAINTAINED ZERO AS AN OFF OR STOP CONDITION. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Set Zero Speed

DANGER

EQUIPMENT IS AT LINE VOLTAGE WHEN POWER IS CONNECTED. LOCKOUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE WHEN ALTERING THE MINIMUM SPEED CIRCUIT FOR ZERO SPEED APPLICATIONS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE APPLICATION REQUIRES ZERO SPEED WITHOUT SUCH DISCONNECTION, THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDITIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

See Figure 4-4 and Figure 4-5 for zero speed circuit configurations.

Controllers with P/N 57100 regulators that do not have a J10 jumper can achieve zero minimum speed by turning the minimum speed rheostat fully counter-clockwise. Controllers that have a J10 jumper can achieve zero minimum speed by moving the J10 jumper between K71 and K72, and turning the MIN SPD rheostat fully counter-clockwise. (See Figure 4-5.)

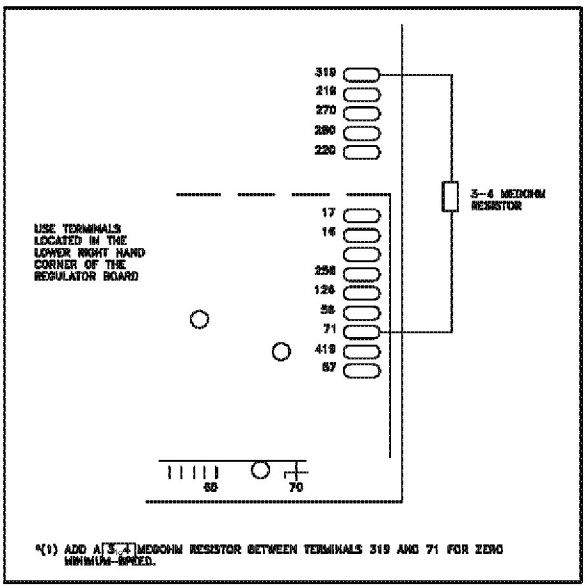


Figure 4-4. Controller with J10 Jumper in Zero Speed Circuit

NOTE: *A 3 to 4 megohm resistor between terminals 319 and 71 can be used if some indication of speed is still detected after zero speed is commanded. (See Figure 4-4).*

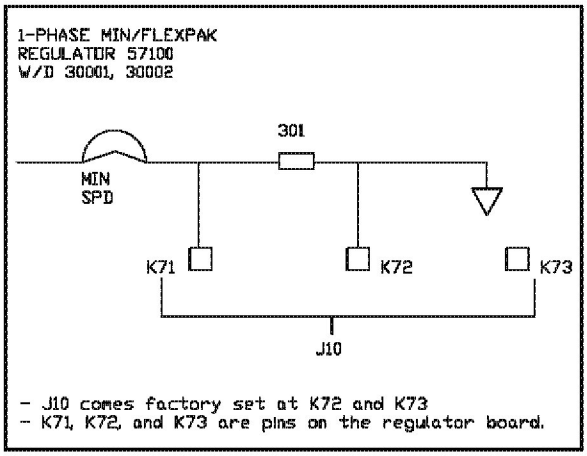


Figure 4-5. Zero Minimum Speed Correction

Adjusting Maximum Speed

1. Initially set the MAX. SPD. potentiometer on the Regulator Board fully counter-clockwise. This should prevent the motor from overspeeding with the Operator's Speed Potentiometer set at 100%.
2. Gradually increase the Operator's Speed Potentiometer to 100%. Observe that the motor and drive machine do not exceed their maximum safe speed.
3. Using a suitable screwdriver, adjust the MAX. SPD. potentiometer clockwise until 100% motor speed is obtained.

WARNING

WHEN PERFORMING THIS ADJUSTMENT, USE EXTREME CARE TO KEEP THE DRIVE MOTOR FROM EXCEEDING ITS RATED MAXIMUM SPEED AS LISTED ON THE NAME-PLATE. CARE SHOULD ALSO BE GIVEN TO THE MAXIMUM SAFE SPEED OF THE DRIVEN EQUIPMENT SO AT NO TIME IS IT DRIVEN BEYOND ITS MAXIMUM ALLOWED SAFE SPEED AS DETERMINED BY THE EQUIPMENT MANUFAC-TURER. FAILURE TO OB-SERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

NOTE: *Since the minimum and maximum speed setting potentiometers are interactive, it will be necessary to readjust MIN. SPD. Both should be checked several times to ensure that the desired range of speed is set properly.*

Drive Acceleration Time

The reference acceleration circuit ramps the speed reference input. It is adjustable by the ACC. potentiometer over a 0.5 to 30.0 second range.

With the Drive in the "Stop" mode, set the Operator's Speed Potentiometer to 100%. Start the Drive and adjust the ACC. potentiometer to the desired acceleration time to maximum speed for the machine and process.

NOTE: *At very short acceleration times, the Drive cannot accelerate any faster than the available acceleration torque will allow. The minimum acceleration time that can be achieved is with the Drive in current limit. When accelerating large inertial loads, the torque required to accelerate the machine may be significantly greater than the running torque load.*

Drive Deceleration Time

The reference deceleration circuit ramps the speed reference input. Ramp rate is adjustable by the DEC. potentiometer over a 0.5 to 30.0 second range.

With the Drive in the "Start" mode and running at 100% speed, quickly turn the Operator's Speed Pot to zero. Adjust the DEC. potentiometer to the desired deceleration time from maximum speed to zero speed for the machine and process.

NOTE: *The deceleration time cannot be any less than the coast down time of the machine. This drive does not absorb energy from the rotating machine, the only means of energy absorption is the frictional drag of the machine and process. For a linear deceleration, the set deceleration time must be set longer than the coast down time.*

Current Limit

The Current (Torque) Limit (I LIMIT potentiometer) level of this drive is factory set at 150% of rated armature current. This value can be set to a lower value by adjustment of the I LIMIT potentiometer on the Regulator Board. Some applications require a lower torque limiting value so as not to damage the process material or the drive train.

NOTE: *When the current limit value is reduced, the available torque for acceleration is reduced.*

IR Drop Compensation

If tachometer feedback is to be used, set the IR COMP potentiometer to zero (fully CCW).

When the Drive is operated as an armature voltage regulator, as the process load is increased, there will be an inherent speed droop caused by the internal voltage drop in the motor which is proportional to current. This droop can be reduced by increasing the IR COMP potentiometer on the Regulator Board.

The IR COMP potentiometer has been factory set at zero, it has a range of up to 12% compensation. If you notice excessive speed droop as the machine loads down, increase the IR COMP potentiometer to correct for this. Do not set this compensation excessively high as over compensation can cause a motor speed rising characteristic which leads to instability in the motor performance. Some motors may have a speed droop at low speeds, but due to armature reactance, do not have a droop at top speed. In this case, IR COMP adjust must be checked for proper operation over the system speed range.

Table 4-3. Initial/Final Adjustment Settings

Potentiometers	Jumpers	Initial Setting (Factory)	Final Setting (User)
MAX. SPD.		Fully CCW (Dot 1)	
MIN. SPD		Fully CCW (Dot 1)	
ACC.		Fully CCW (Dot 1)	
DEC.		Fully CCW (Dot 1)	
I LIMIT		150% (Dot 7)	
IR COMP		Fully CCW (Dot 1 = 0%)	
	Feedback[1]	A	
	Current Scaling	2.5	
	J4[2]	Installed	
	J5, J6[3]	Installed	
	J7, J8[4]	Installed	
	J9[5]	Installed	

1> A-COM is the standard connection for Armature Feedback; Factory Setting.
C-COM is the connection for CEMF if CEMF transformer is installed;CEMF function was replaced by Armature feedback in Design "H".
T-COM is the connection for Tachometer Feedback if Tach Feedback Kit is installed.

2> Remove if Local Auto/Man Switch is installed.

3> Remove on 230 Volt units.

4> Remove for Torque Taper.

5> Remove when Reverse Relay (Contactor) Kit is installed.

5: Troubleshooting

General

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AN OPERATION OF THIS AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, 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.

This Section details troubleshooting information for the MinPak Plus Single Phase D-C Drive. Figures 5-1 and 5-2 show the controller schematic and technical data.

DANGER

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

Wiring Errors

Wiring errors, loose or grounded wiring are common problems encountered inhibiting operation of a drive. Verify installation wiring has been correctly executed and that the controller is free of loose terminations and grounded conductors.

A-C Line and Power Input

Verify that the applied A-C power is correct for the specific drive, i.e. either 115 or 230 volts. If the drive is being applied on 50HZ power, ensure that the "Wire A-C Power to the Controller" set-up procedure of section 4 in this instruction manual has been properly followed. If an isolation transformer has been installed on the incoming A-C power, verify it's output voltage and that it has been properly connected.

Verify that the A-C line fuses have been correctly sized per Table 2-3. The A-C and D-C power conductors should have been sized per the National Electric Code.

D-C Motor

CAUTION: a meggar may be used for this motor ground check, but all conductors between the motor and the drive must be disconnected. The meggar's high voltage can cause serious damage to the drives electronic circuits. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Recheck all motor connections for firmness and correct identification. Verify that there is no path to ground in either the D-C motor armature circuit, the shunt field circuit or the thermostat circuit. Connect one lead of a standard ohm meter to the motor frame and the other lead to the two armature leads, the two thermostat leads and to the two field leads. If a reading of less than 100,000 ohms is observed, a ground condition exists and **MUST** be corrected before power is applied. Check that the field winding is not open or shorted.

Verify the continuity of the motor thermostat and its proper connection to controller terminals 32 and 132. If a motor overload has been installed, verify that it's circuit maintains continuity in the 32 to 132 circuit.

Remote M Contactor

When the M Contactor has been supplied by others, verify that the connection of those circuits is according Figure 3-5 or Figure 3-6. The harnesses must be correctly wired to the regulator pin connectors.

Optional Kits

Verify that each of the added optional kits have been installed correctly according to the appropriate instructions. Reference Figure 5-3 for schematics of modification kits.

Troubleshooting Flowcharts

These troubleshooting flowcharts are provided to assist in the analysis of drive operational problems. Flowcharts are not all inclusive, this information is intended to focus attention on common causes of drive problems and to bring attention to possible causes and checking techniques. See Figures 5-4 through 5-9 for available troubleshooting flowcharts.

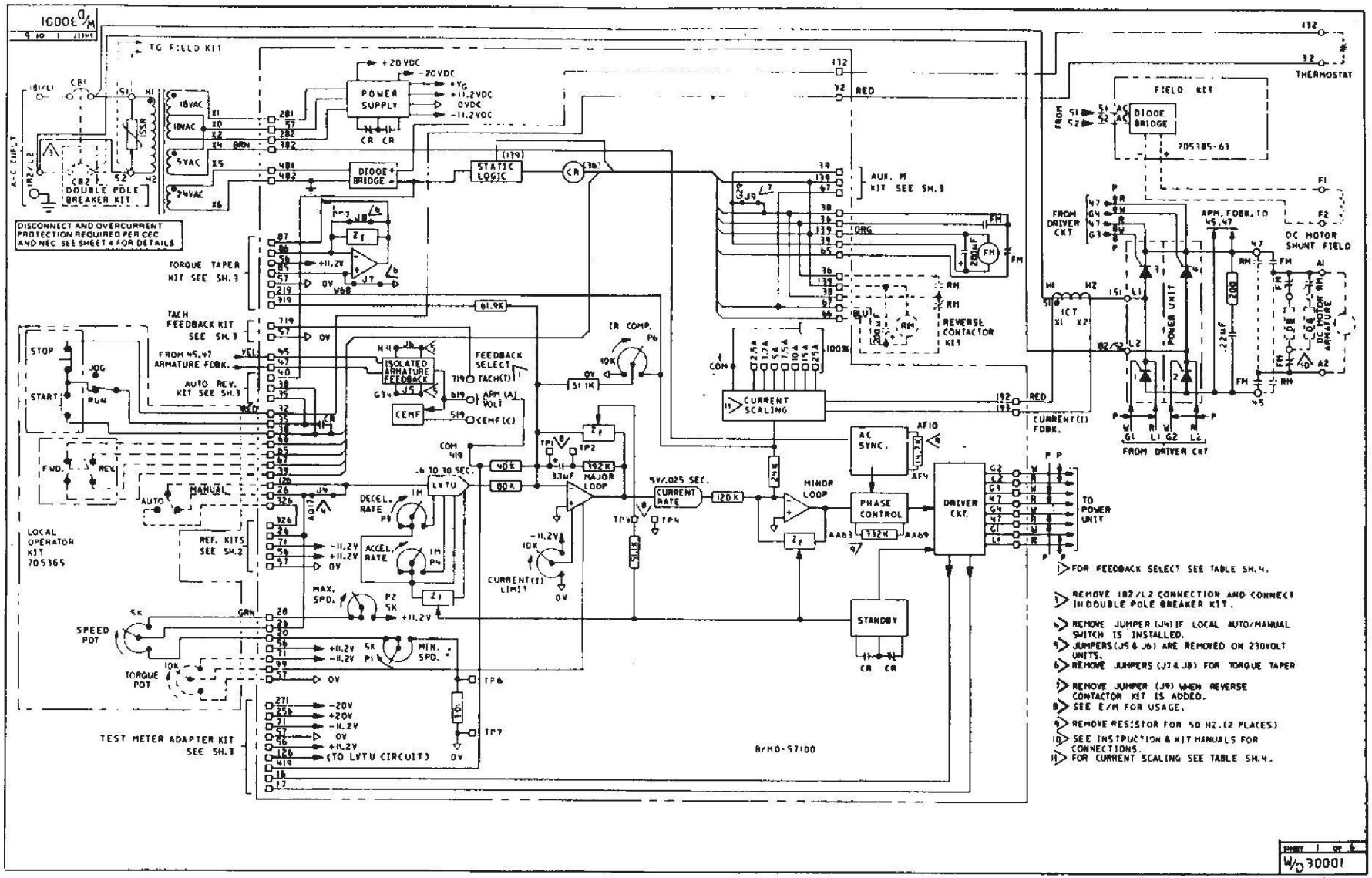
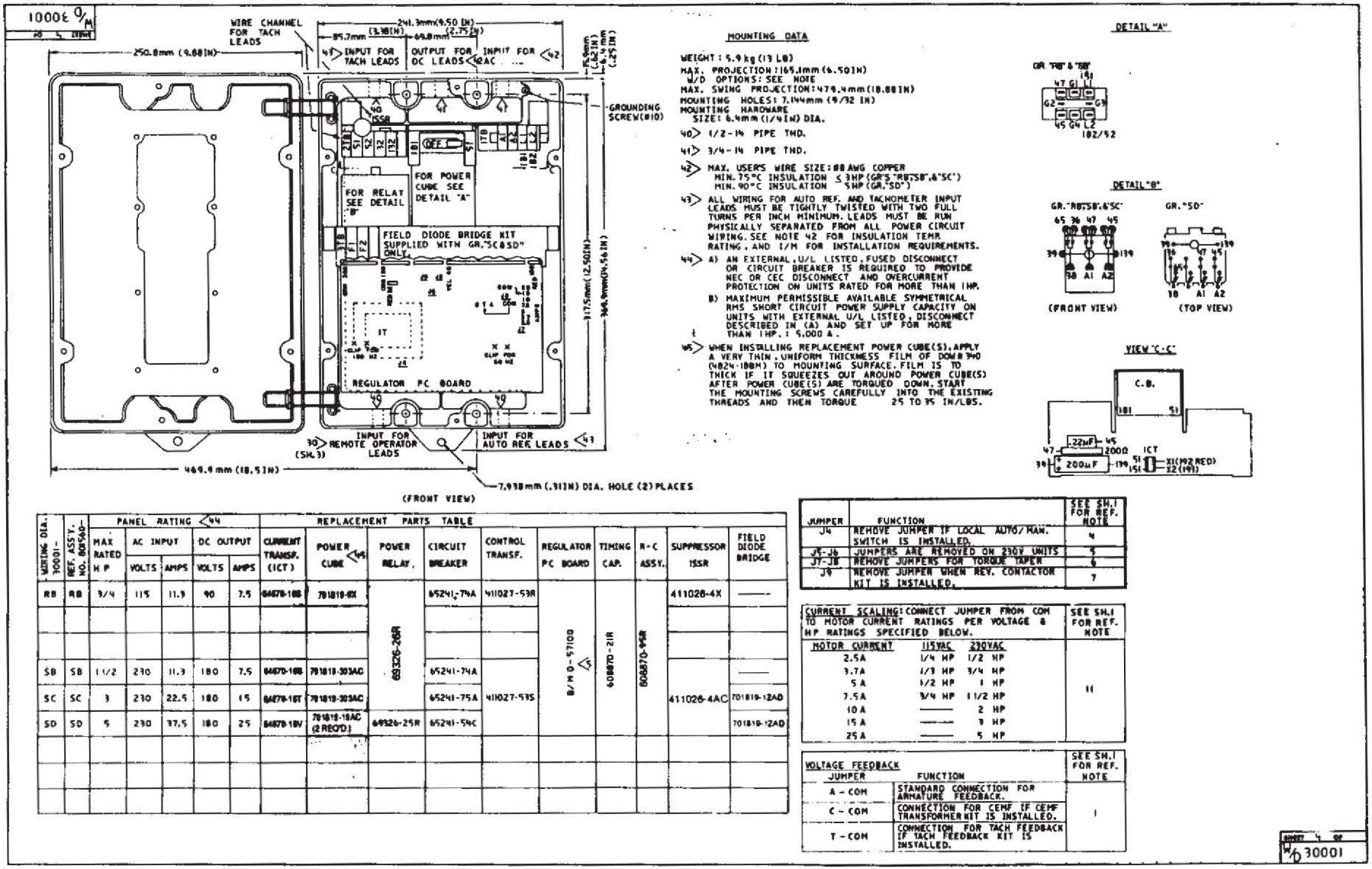


Figure 5-1. Controller Schematic.



WIRING DIA. 30001-	REF. ASS'Y. NO. 80R560-	PANEL RATING <44 MAX RATED H P	AC INPUT VOLTS	AC INPUT AMPS	DC OUTPUT VOLTS	DC OUTPUT AMPS	REPLACEMENT PARTS TABLE CURRENT TRANSF. (ICT)	POWER CUBE <45	POWER RELAY	CIRCUIT BREAKER	CONTROL TRANSF.	REGULATOR PC BOARD	TIMING CAP.	R-C ASS'Y.	SUPPRESSOR ISSR	FIELD DIODE BRIDGE
RB	RB	3/4	115	11.9	90	7.5	84870-10B	701819-0X	69326-26R	65241-79A	411027-53R	B/M 0-57100 <5	608870-21R	608870-94R	411026-4X	——
SB	SB	1 1/2	230	11.9	180	7.5	84870-10B	701819-303AC		65241-79A						——
SC	SC	3	230	22.5	180	15	84870-15T	701819-303AC		65241-75A	411027-53S				411026-4AC	701819-12AD
SD	SD	5	230	37.5	180	25	84870-18V	701819-19AC (2 REQ'D)	69326-25R	65241-54C						701819-12AD

JUMPER	FUNCTION	SEE SH.1 FOR REF. NOTE
J4	REMOVE JUMPER IF LOCAL AUTO/MAN. SWITCH IS INSTALLED.	4
J5-J6	JUMPERS ARE REMOVED ON 230V UNITS	5
J7-J8	REMOVE JUMPERS FOR TORQUE TAPER	6
J9	REMOVE JUMPER WHEN REV. CONTACTOR KIT IS INSTALLED.	7

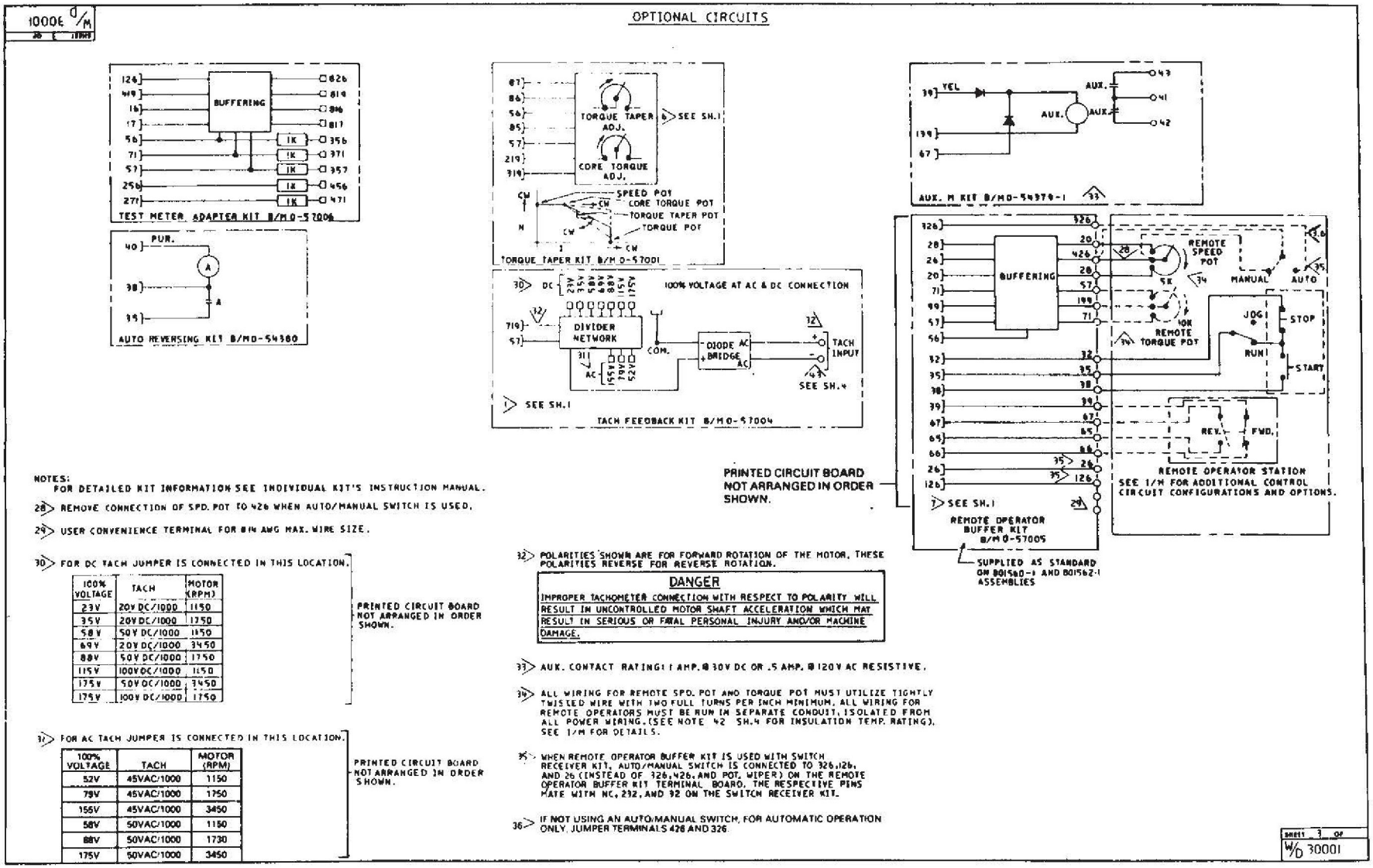
CURRENT SCALING: CONNECT JUMPER FROM COM TO MOTOR CURRENT RATINGS PER VOLTAGE & HP RATINGS SPECIFIED BELOW. — SEE SH.1 FOR REF. NOTE 11

MOTOR CURRENT	115VAC	230VAC
2.5A	1/4 HP	1/2 HP
3.7A	1/3 HP	3/4 HP
5 A	1/2 HP	1 HP
7.5A	3/4 HP	1 1/2 HP
10 A	——	2 HP
15 A	——	3 HP
25 A	——	5 HP

VOLTAGE FEEDBACK JUMPER	FUNCTION	SEE SH.1 FOR REF. NOTE
A - COM	STANDARD CONNECTION FOR ARMATURE FEEDBACK.	1
C - COM	CONNECTION FOR CEMF IF CEMF TRANSFORMER KIT IS INSTALLED.	
T - COM	CONNECTION FOR TACH FEEDBACK IF TACH FEEDBACK KIT IS INSTALLED.	

W/O 30001

Figure 5-2. Controller Technical Data.



100% VOLTAGE	TACH	MOTOR (RPM)
23V	20V DC/1000	1150
35V	20V DC/1000	1750
58V	50V DC/1000	1150
69V	20V DC/1000	3450
88V	50V DC/1000	1750
115V	100V DC/1000	1150
175V	50V DC/1000	3450
179V	100V DC/1000	1750

100% VOLTAGE	TACH	MOTOR (RPM)
52V	45VAC/1000	1150
79V	45VAC/1000	1750
156V	45VAC/1000	3450
58V	50VAC/1000	1150
88V	50VAC/1000	1730
175V	50VAC/1000	3450

Figure 5-3. Modification Kits Schematics. (Continued on next page).

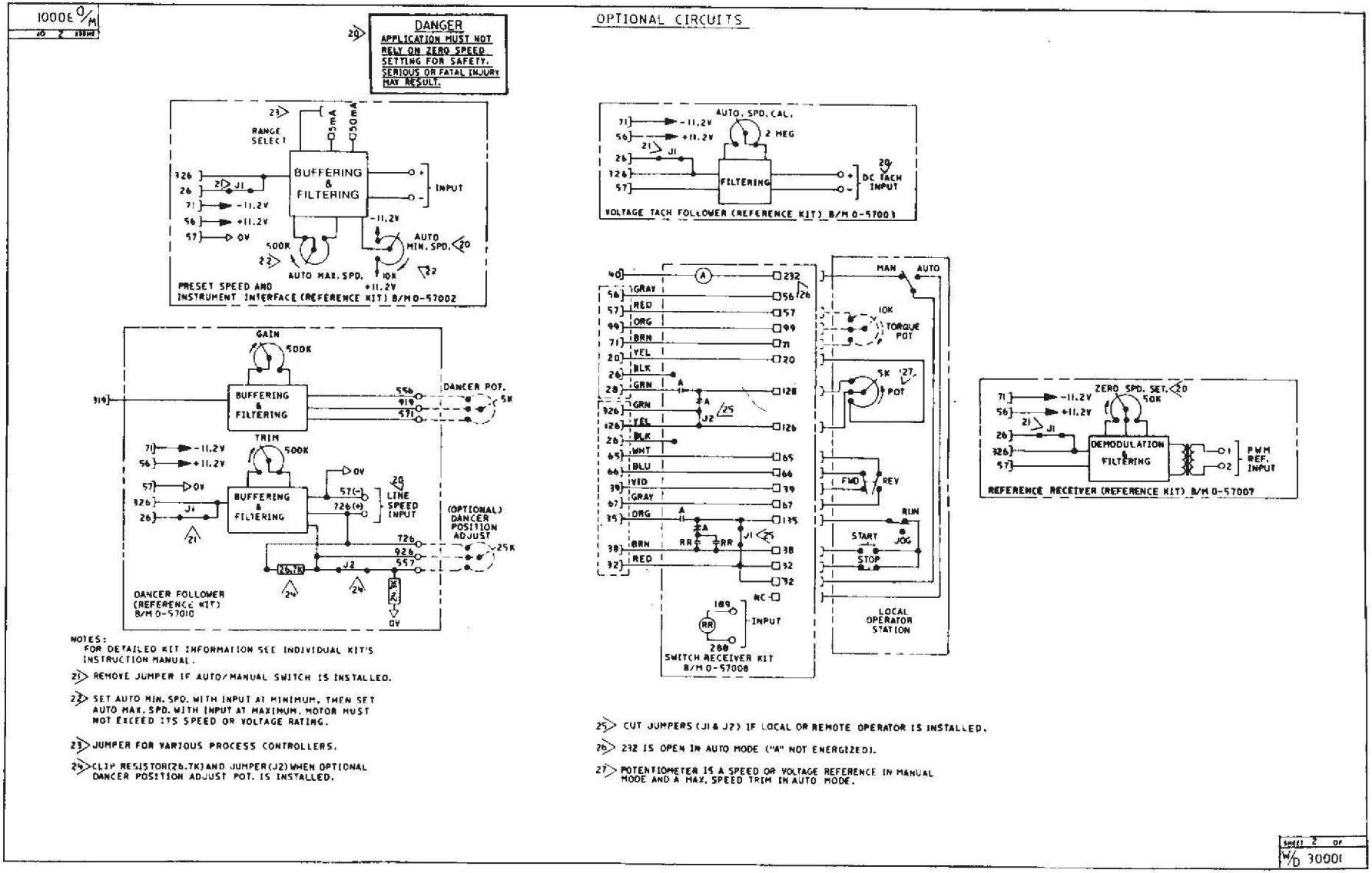


Figure 5-3. Modification Kits Schematics. (Continued from previous page).

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

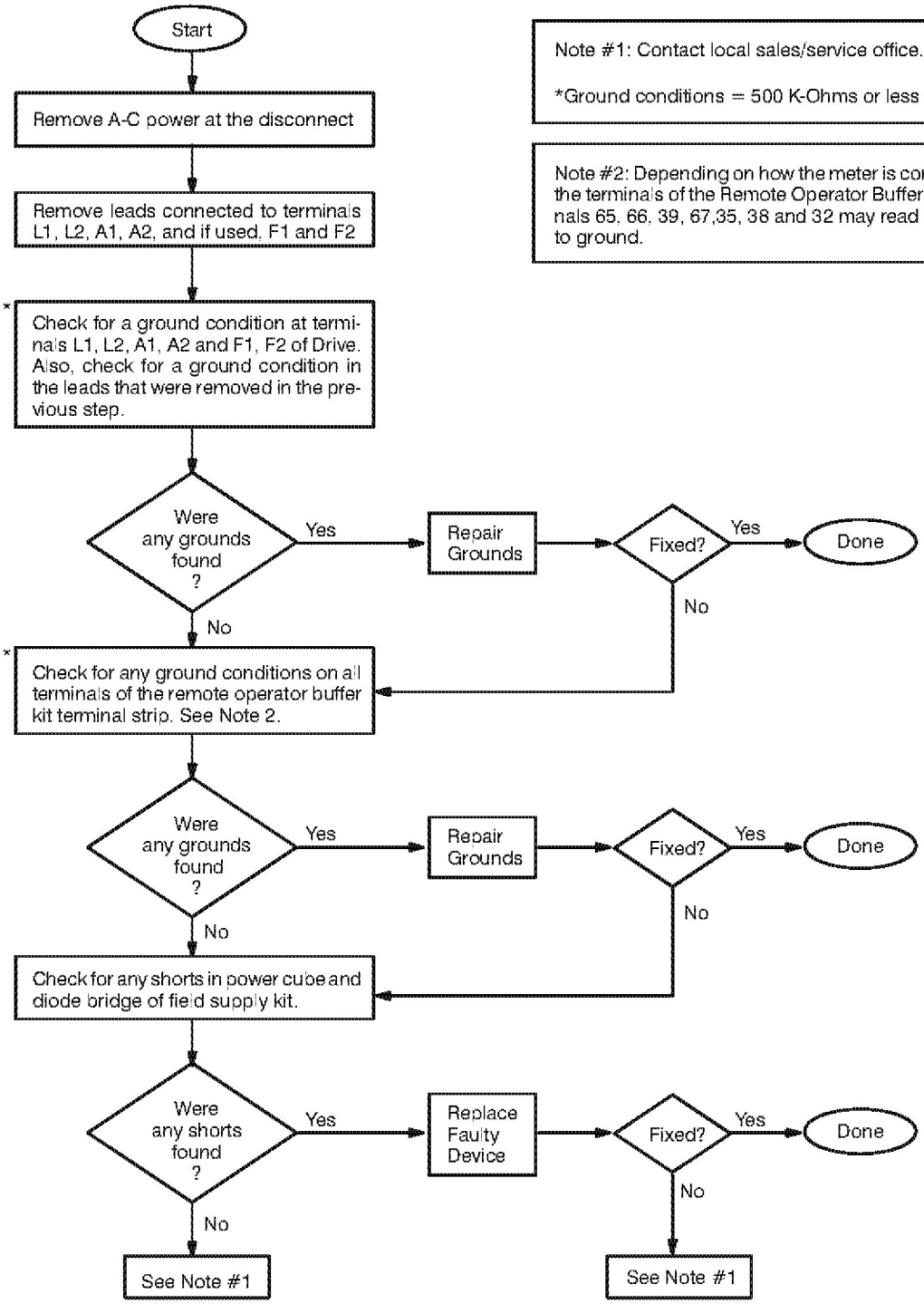


Figure 5-4. Circuit Breaker or Line Fuses Open When Power is Applied.

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

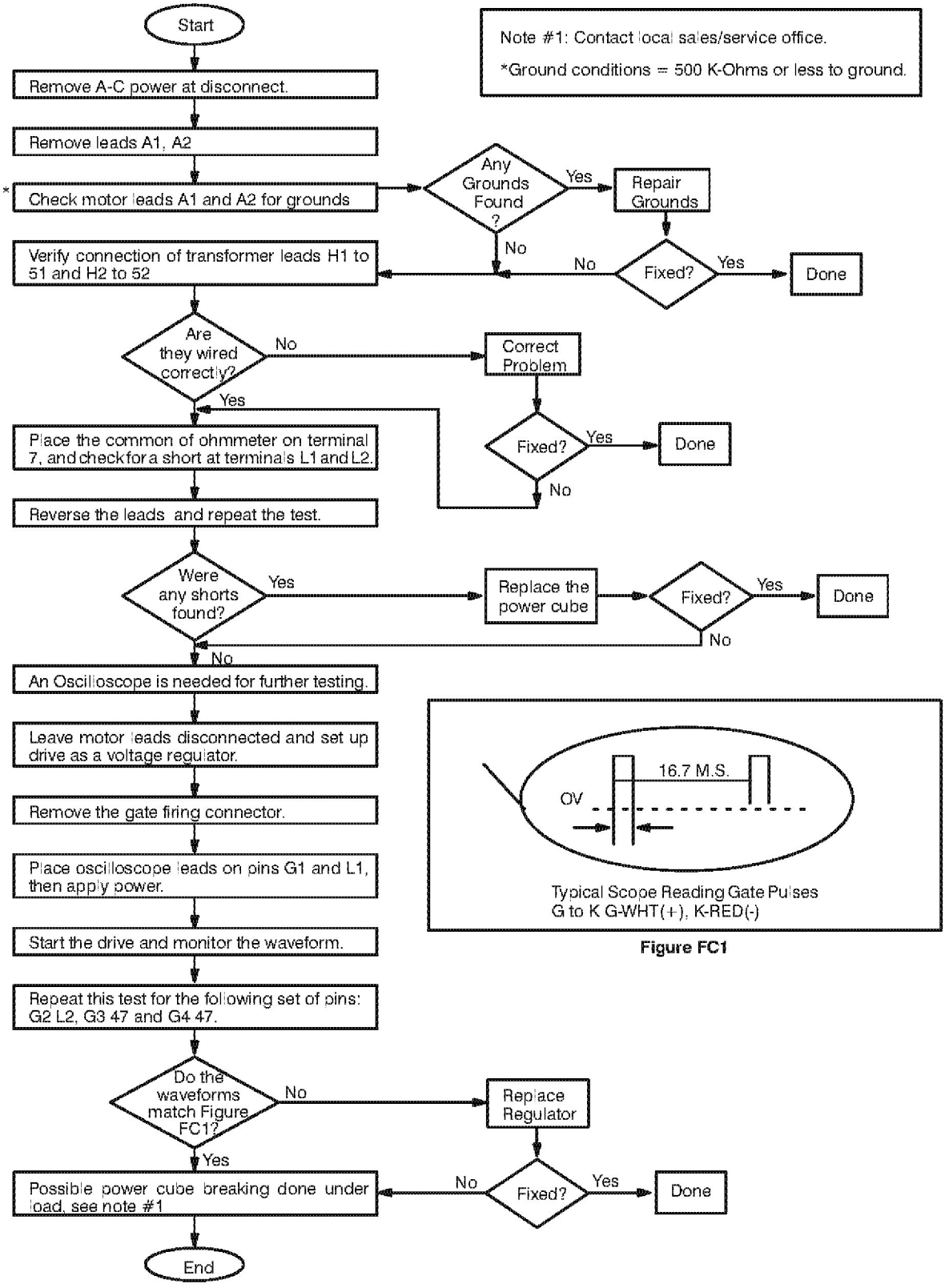


Figure FC1

Figure 5-5. Fuse Blows After Start.

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

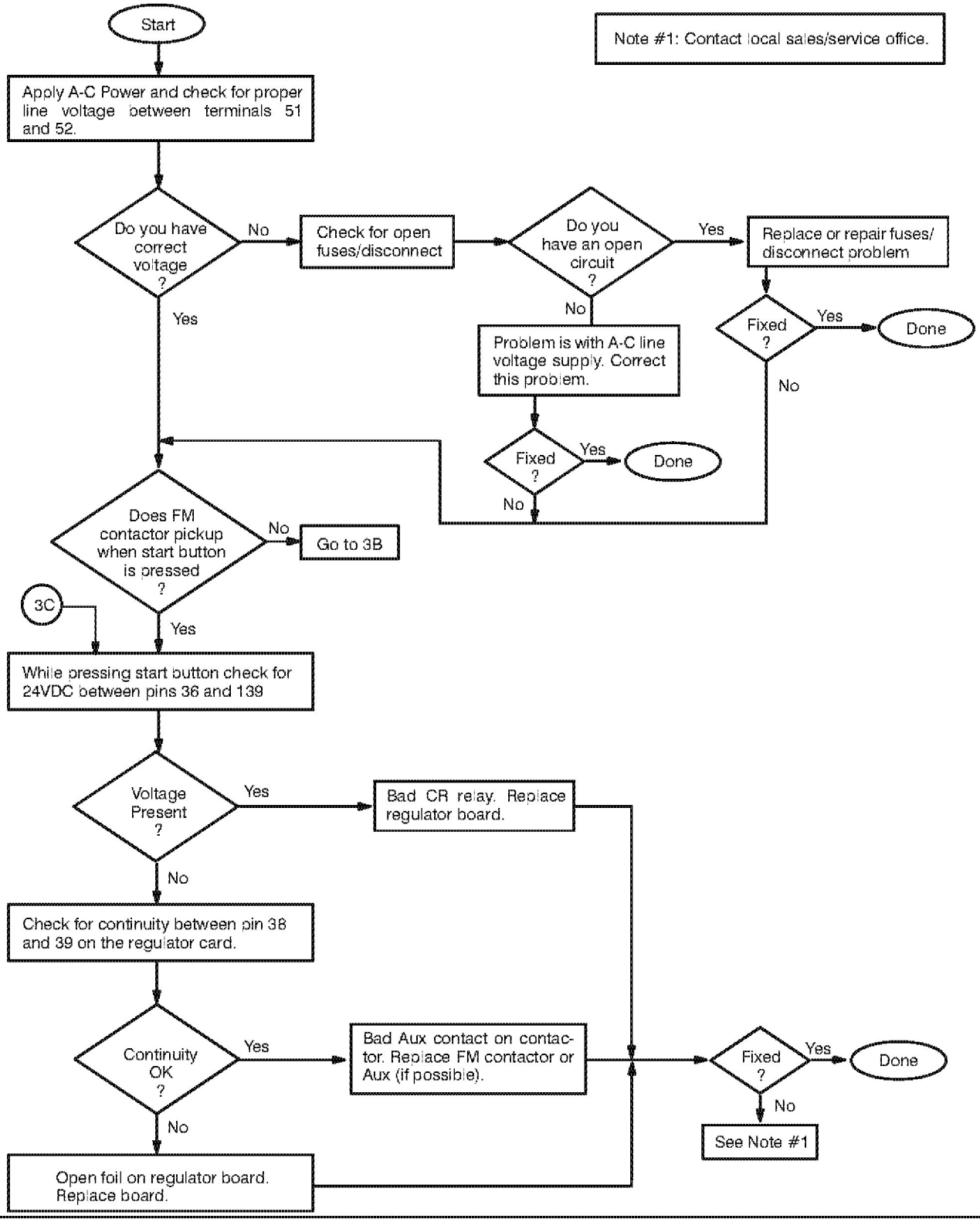


Figure 5-6. Drive Doesn't Start.

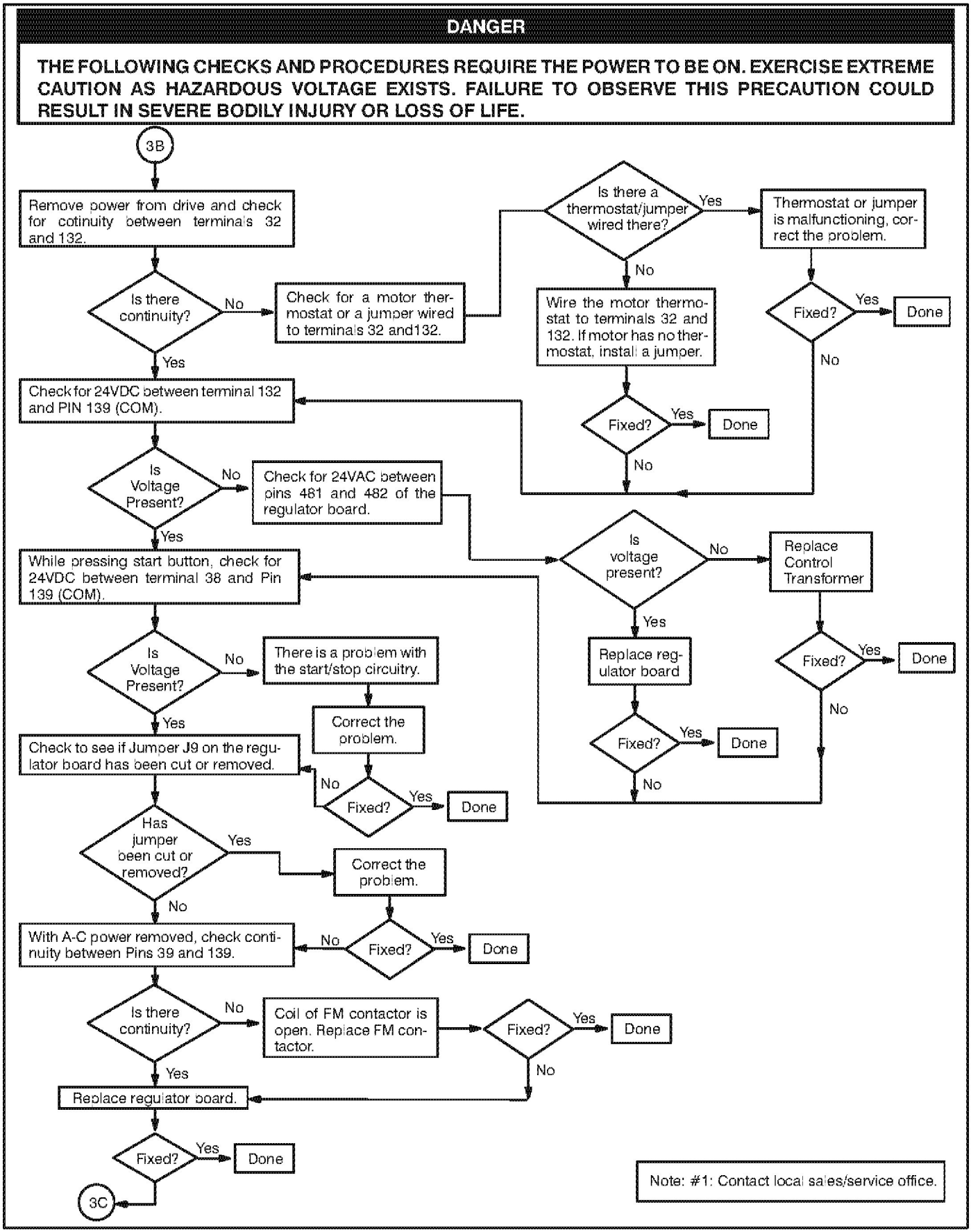


Figure 5-6. Motor Doesn't Start. (Continued)

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

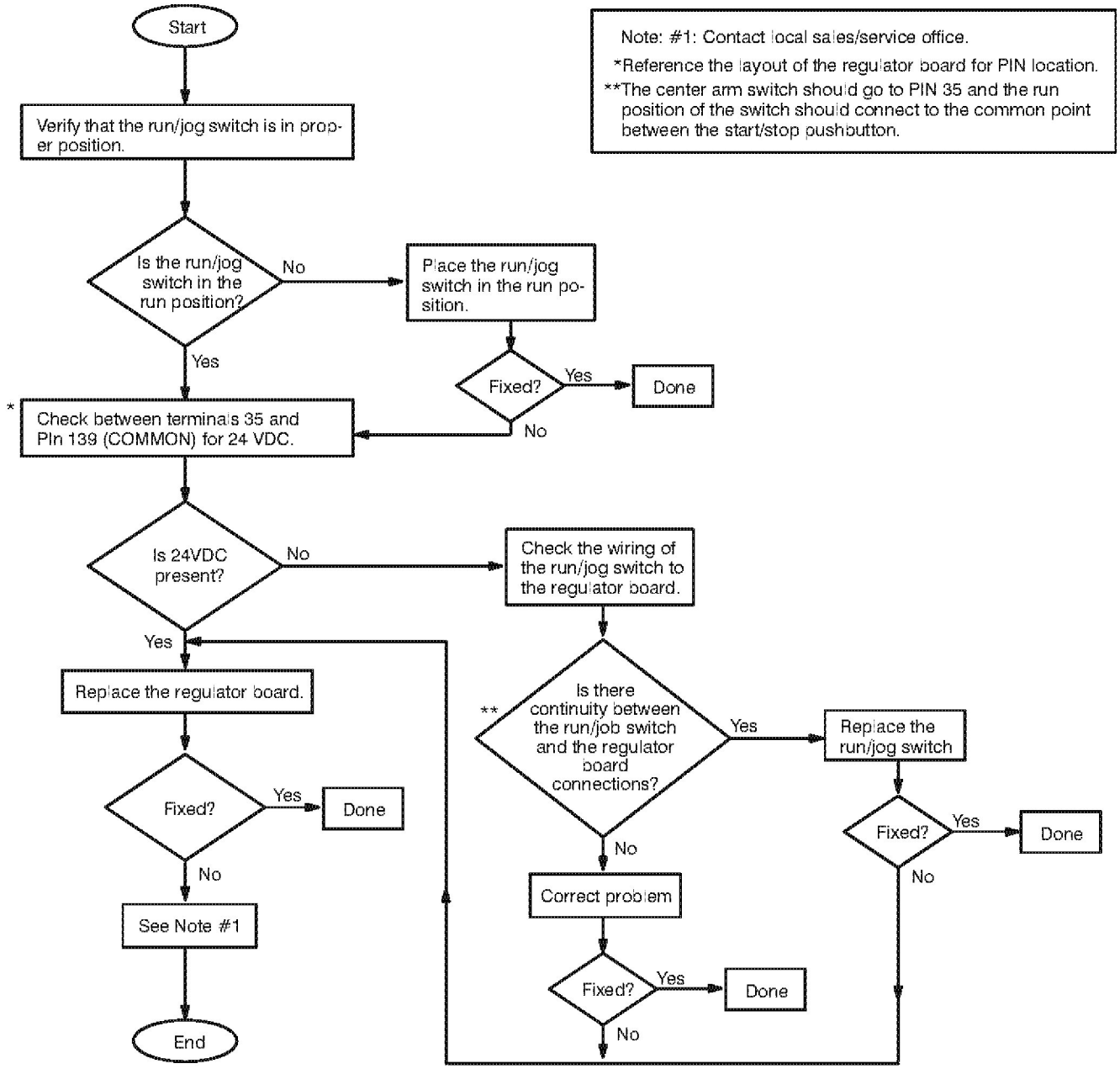


Figure 5-7. "M" Contactor Picks-Up But Only Remains in as Long as the Start Button is Pushed.

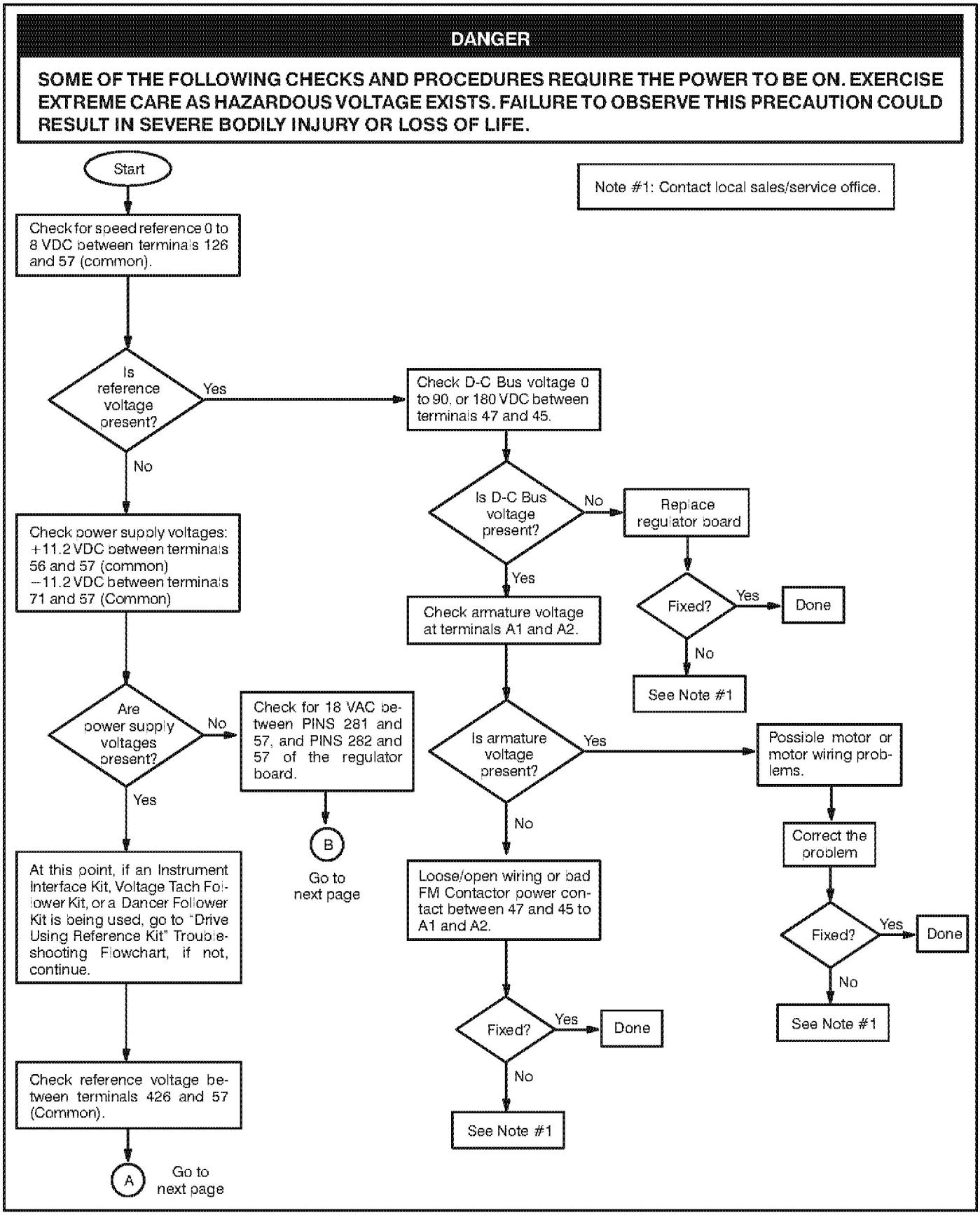


Figure 5-8. "M" Contactor Picks-Up But Motor Does Not Run.

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

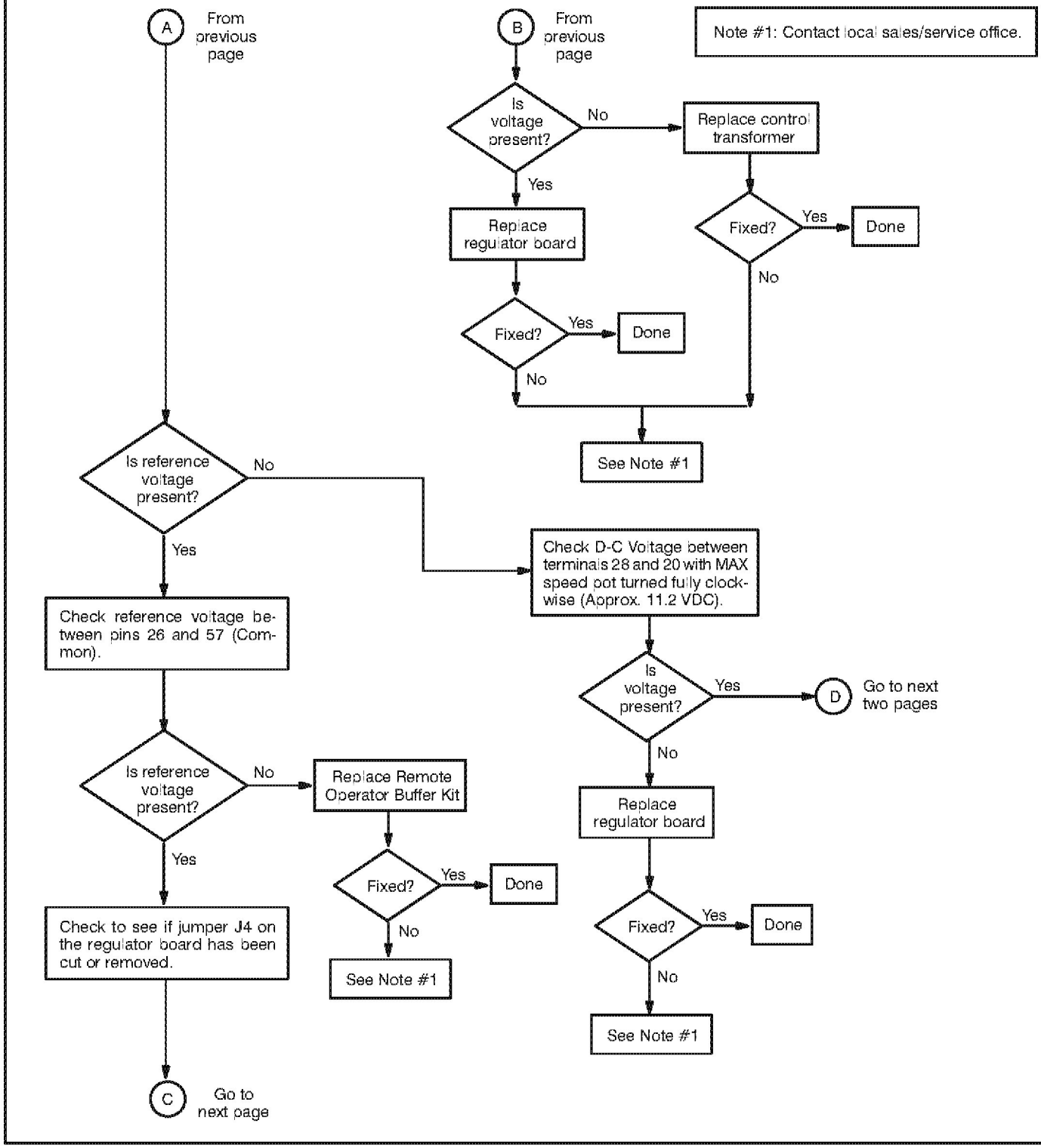


Figure 5-8. "M" Contactor Picks-Up But Motor Does Not Run. (Continued)

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

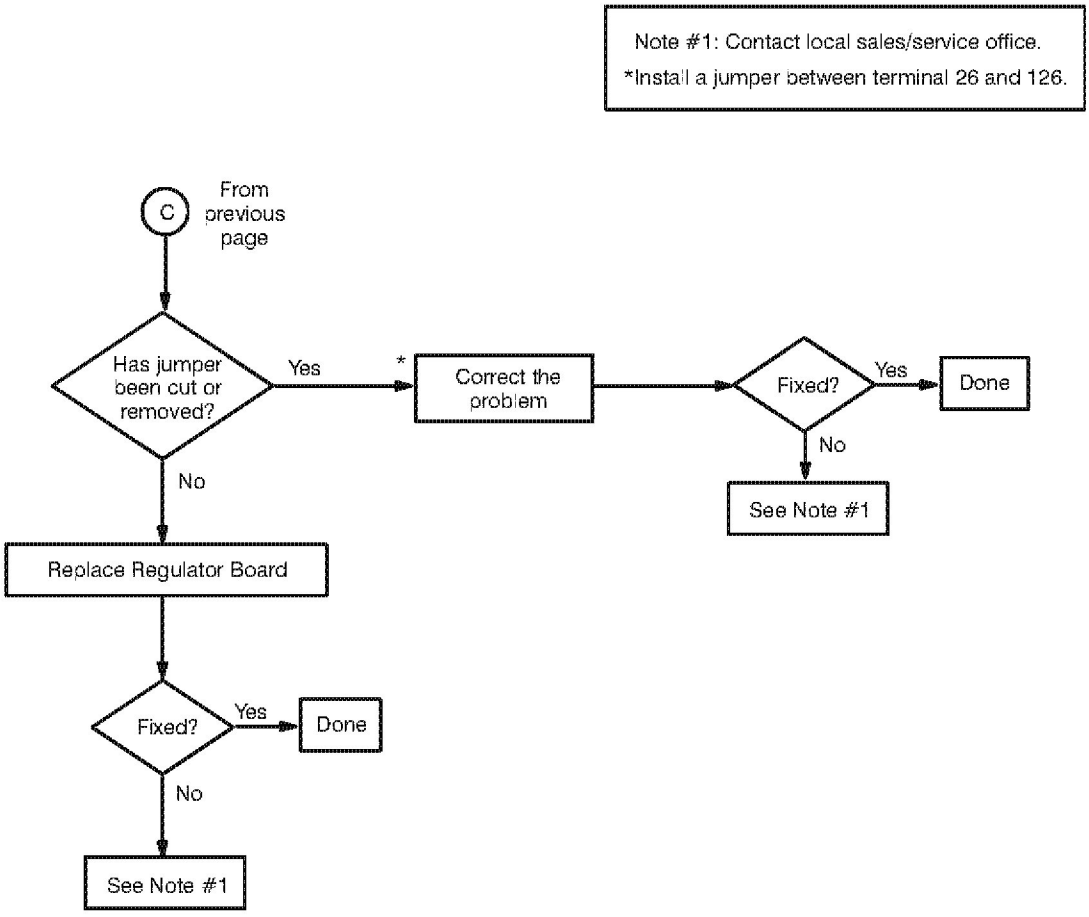


Figure 5-8. "M" Contactor Picks-Up But Motor Does Not Run. (Continued)

DANGER

SOME OF THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CARE AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

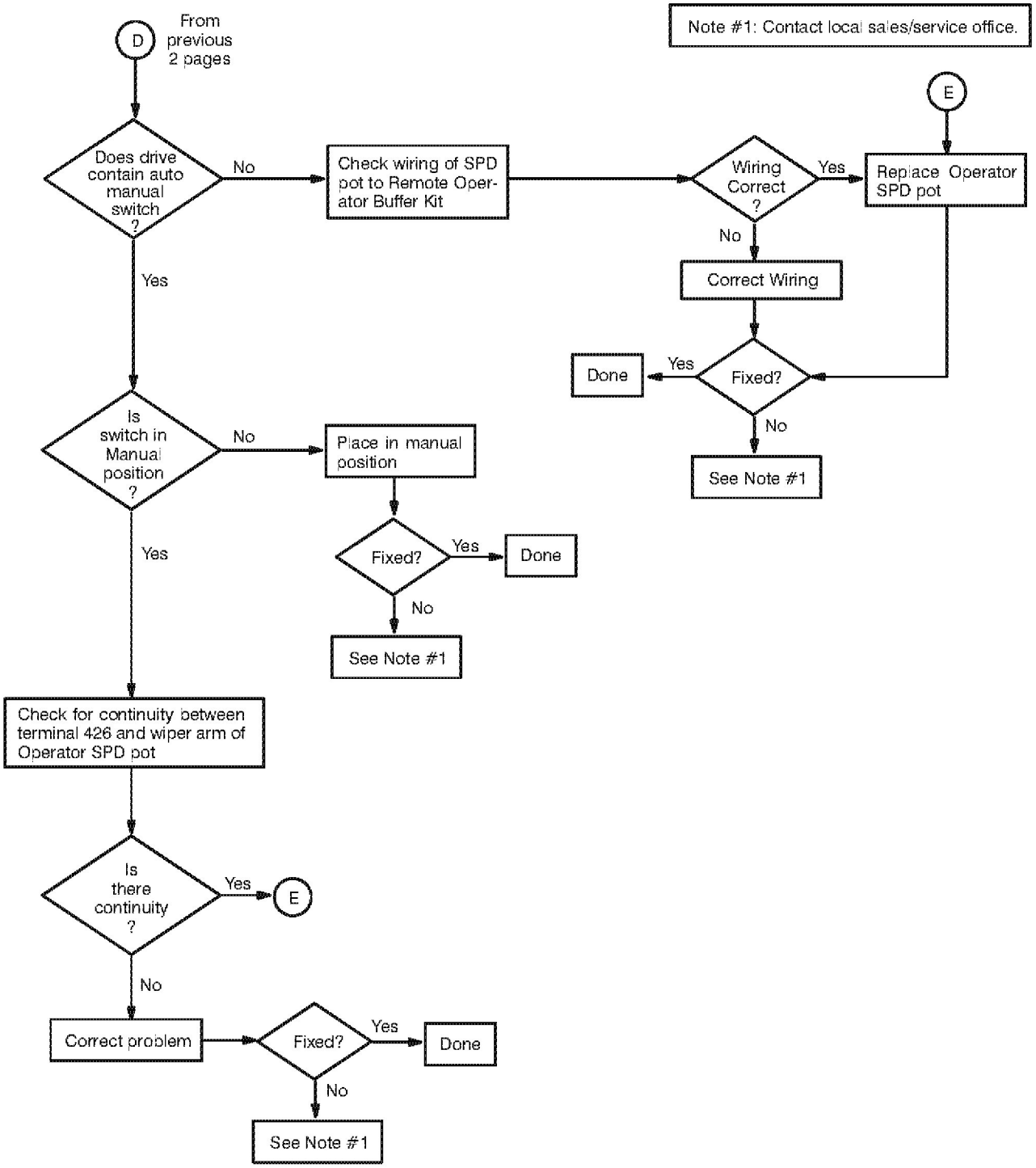


Figure 5-8. "M" Contactor Picks-Up But Motor Does Not Run. (Continued)

DANGER

THE FOLLOWING CHECKS AND PROCEDURES REQUIRE THE POWER TO BE ON. EXERCISE EXTREME CAUTION AS HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

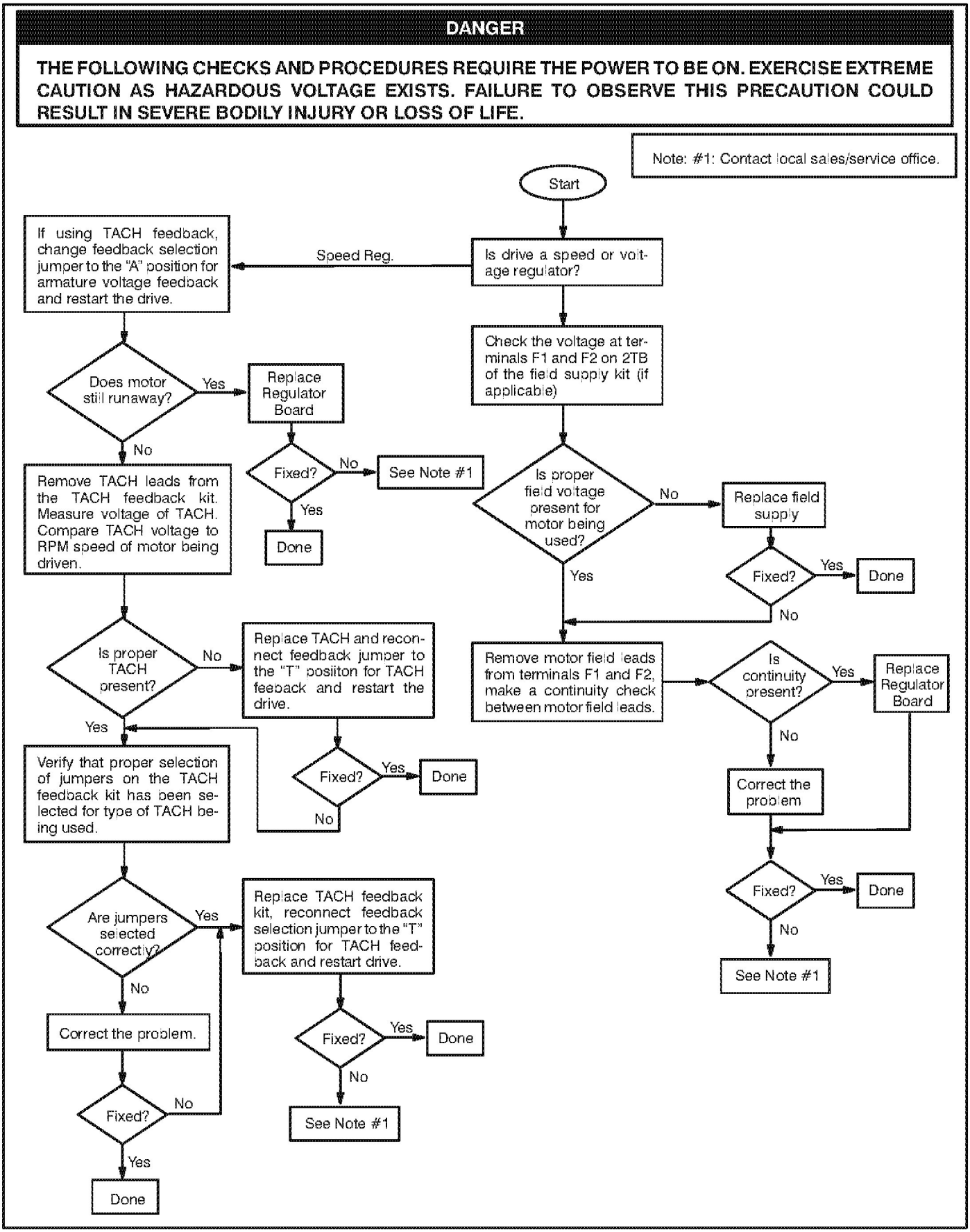


Figure 5-9. Motor Runs Away.

6: Replacement Parts

The spare or replacement parts for the MinPak Plus D-C Drive covered in this manual are listed in Table 6-1.

This list consists of the more common parts along with part numbers and quantities actually used in the controller.

Table 6-1. Replacement Parts

Part Description	Quantity Per Controller	Part Number
Regulator Module	1	0-57100
Current Transformer (1CT)		
3/4 and 1 1/2 HP	1	64670-16S
2 and 3 HP	1	64670-16S
5 HP	1	64670-16V
Power Cube		
1/4 to 3/4 HP 115 VAC	1	701819-303AC[1]
1/2 to 1 1/2 HP 230 VAC	1	701819-303AC[1]
2 and 3 HP 230 VAC	1	701819-303AC[1]
5 HP 230 VAC	2	701819-19AC
M Contactor		
1/4 to 3/4 HP	1	69326-26R
5 HP	1	69326-25R
Single Pole Circuit Breaker		
1/4 to 1 1/2 HP	1	65241-74A
2 and 3 HP	1	65241-75A
5 HP	1	65241-54C
Double Pole Circuit Breaker (Optional)		
1/4 to 3/4 HP 115 VAC	1 Kit	705385-62R
1/2 to 1 1/2 HP 230 VAC	1 Kit	705385-62S
2 and 3 HP 230 VAC	1 Kit	705385-62T
5 HP 230 VAC	1 Kit	705382-62V
MOV Surge Suppressor		
115-volt drives	1	411026-4X
230-volt drives	1	411026-4AC
Control Transformer		
115-volt drives	1	411027-53R
230-volt drives	1	411027-53S
Output R-C Assembly	1	608870-95R
Dynamic Breaking		
1/4 to 1/2 HP 115 VAC	1	705385-61R
2 to 3 HP 230 VAC	1	705385-61R
3/4 HP 115 VAC	1	705385-61S
1/2 to 1 1/2 and 5 HP 230 VAC	1	705385-61T
Field Supply	1	701819-12AD

1) Part Number 701819-9X has been replaced by 701819-303AW.

Rockwell Automation, Inc.
Global Customer Care
440-646-3434

Appendix A: Quick Reference Guide

DANGER

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

DANGER

THE USER IS RESPONSIBLE FOR CONFORMING TO THE NATIONAL ELECTRICAL CODE AND ALL OTHER APPLICABLE LOCAL CODES. WIRING PRACTICES, GROUNDING, DISCONNECTS, AND OVERCURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED. DISCONNECT AND LOCKOUT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

This quick reference guide is intended to assist highly experienced users to quickly identify, install, start-up, adjust, or operate the controller.

It is the responsibility of the user to observe and adhere to all precautions: **DANGER**, **WARNING**, and **CAUTION**.

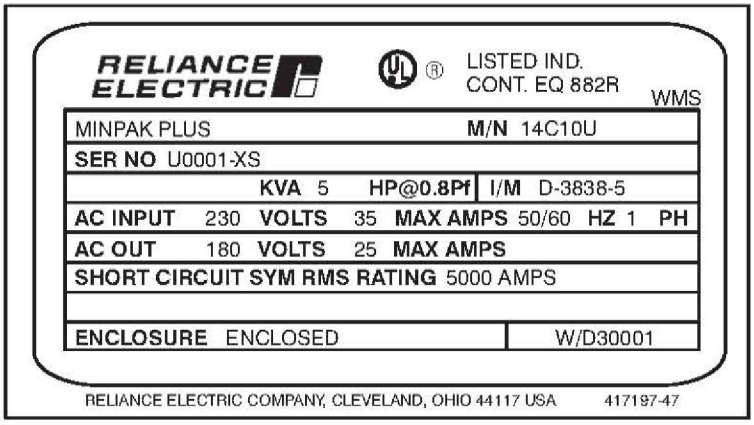


Figure A-1. Typical FlexPak Plus Nameplate.

Table A-1. Controller Model Numbers

Model Number							Optional			Transf. KVA	
Enclosed	Chassis	HP	VAC	(3) A-C Amps (RMS)	D-C Arm. (Volts)	D-C Arm. Amps Avg.	D-C Field Volts	Amp. MAX	Power Supply Capacity(2)	MAX	MIN
14C10	14C20	1/4	115	3.5	90	2.5	100	3.0	1000	40.0	0.50
		1/3	115	5.2	90	3.7	100	3.0	1000	40.0	0.75
		1/2	115	7.0	90	5.0	100	3.0	1000	40.0	1.50
		3/4	115	10.5	90	7.5	100	3.0	1000	40.0	1.50
14C11	14C21	1/2	230	3.5	180	2.5	200	3.0	1000	40.0	1.50
		3/4	230	5.2	180	3.7	200	3.0	1000	40.0	1.50
		1	230	7.0	180	5.0	200	3.0	1000	40.0	2.00
		1 1/2	230	10.5	180	7.5	200	3.0	5000	40.0	3.00
14C12	14C22	2	230	14.0	180	10.0	200	3.0[1]	5000	40.0	5.00
		3	230	21.0	180	15.0	200	3.0[1]	5000	40.0	10.0
14C13	14C23	5	230	35.0	180	25.0	200	3.0[1]	5000	40.0	10.0

[1]Standard
[2]Maximum permissible available symmetrical RMS fault current (amperes) with NEC or CEC external approved disconnect.
[3]Does not include current required for Field Supply (if used).

Table A-2. Local Operator Control Faceplates

When Using A MinPak Plus Controller With:	Specify Operator's Control Faceplate Model	Functions Provided[1]					
		Start/ Stop	Speed-setting Pot	Torque-setting Pot	Run/ Jog Selector	Forward/ Reverse Selector	Automatic/ Manual Selector
Blank Faceplate (Use with Remote Station)	14C200	no	no	no	no	no	no
Basic Features	14C201	yes	yes	no	yes	no	no
Basic Features Plus Armature-Reversing	14C202	yes	yes	no	yes	yes	no
Basic Features Plus Automatic/Manual Modes of Operation	14C203	yes	yes	no	yes	no	yes
Basic Features Plus Armature-Reversing and Automatic/Manual Modes of Operation	14C204	yes	yes	no	yes	yes	yes
Basic Features Plus Torque Control	14C205	yes	yes	yes	yes	no	no
Basic Features Plus Armature-Reversing and Torque Control	14C206	yes	yes	yes	yes	yes	no

Table A-2. Local Operator Control Faceplates

When Using A MinPak Plus Controller With:	Specify Operator's Control Faceplate Model	Functions Provided[1]					
		Start/ Stop	Speed-setting Pot	Torque-setting Pot	Run/ Jog Selector	Forward/ Reverse Selector	Automatic/ Manual Selector
Basic Features Plus Torque Control and Automatic/ Manual Modes of Operation	14C207	yes	yes	yes	yes	no	yes
Basic Features Plus Armature-Reversing, Torque Control and Automatic/ Manual Modes of Operation	14C208	yes	yes	yes	yes	yes	yes

Table A-3. Remote Operator Control Stations

When Using A MinPak Plus Controller With:	Specify Operator's Station Model	Start/Stop Rocker Switch	Speed Setting Potentiometer	Run/Jog Selector	Forward/ Reverse Selector
Basic Features (Standard Unidirectional Station)	9C45	yes	yes	yes	no
NEMA type 4 Station with Basic Features	9C18	yes	yes	yes	no
Explosion-Proof Station with Basic Features	9C17	yes	yes	yes	no
Basic Features Plus Armature Reversing (Standard Reversing Station)	9C46	yes	yes	yes	yes
NEMA Type 4 Station for Reversing	9C19	yes	yes	yes	yes
Explosion-Proof Station for Reversing	9C16	yes	yes	yes	yes

Table A-4. Isolation Transformer Specifications.

HP	kVA	Primary Vac	Secondary Vac	Reliance Part Number
1/4	0.5	230/460	115	77530-16A
	0.5	575	115	77530-17A
1/3	0.75	230/460	115	77530-16B
	0.75	575	115	77530-17B
1/2-3/4	1.5	115	115	77530-15D
		230/460	115	77530-16D
		575	115	77530-17D
		230/460	230	77530-16D
		575	230	77530-17D
1	2.0	230/460	230	77530-16E
		575	230	77530-17E
1-1 1/2	3.0	230/460	230	77530-16F
		575	230	77530-17F

Table A-4. Isolation Transformer Specifications (Continued).

HP	kVA	Primary Vac	Secondary Vac	Reliance Part Number
2	5.0	230/460	230	77530-16G
		575	230	77530-17G
3-5	10.0	230/460	230	77530-16H
		575	230	77530-17H

NOTE: *Smaller drives through 3/4 HP @ 115 VAC and 2.0 HP @ 230 VAC may be used with permanent magnetic field motors, and those drive models are supplied without a D-C field supply.*

Table A-5. Fuse Requirements.

HP	A-C Line Volts	Dual Element Class K5, RK5, 250VAC Fuse		Reliance Part Number
		Quantity	AMP	
1/4-3/4	115	1[1]	15	64676-1W
1/2-1 1/2	230	2	15	64676-1W
2-3	230	2	30	64676-1Z
5	230	2	50	64676-1AD

[1]Install fuse in input line L1 (hot line).

Table A-6. Controller Modification Kits.

Kit Name	Kit Model Number	Controller Modification ?[1]	Options Required	Instruction Manual
Local Operator Station Faceplate	14C201 thru 8	no	None	–
Blank Operator Station Faceplates	14C200	no	Reliance Remote Operator Control Station	–
Remote Operator Adapter Kit	14C220	yes	(See Blank Faceplate, just above.)	–
Double Pole Circuit Breaker	14C210 thru 13	yes	None	–
Auxiliary Mounting Bracket[2]	14C209	no	Always used with some other option; included with Field Supply Kit.	–
Reversing Contactor	14C217 & 14C218	yes	FORWARD/REVERSE selector switch on Operator Station (See table 6.B.)	D2-3307
Auxiliary M Contact	14C219	no	Auxiliary Mounting Bracket [2]	–
Tachometer Feedback	14C221	yes	None	D-3969
Voltage/Tachometer Follower	14C223	yes	May need AUTO/MANUAL selector switch	D-3971
Torque Taper	14C224	yes	None	–
Test Meter Adapter	14C225	no	None	D-3970
Automatic Reversing	14C226	no	Auxiliary Mounting Bracket Reversing Contactor Kit	–
Dynamic Braking	14C214 thru 16	no	None	–
Instrument Interface/ Preset Speed	14C222	yes	If preset speed only, may need AUTO/ MANUAL switch. If follows process controller, may need AUTO/MANUAL switch.	D-3967
Master Isolated Reference Receiver	14C229	yes	Master Isolated Reference Transmitter	–
Dancer Follower	14C230	yes	None	D-3966

[1] Modification here means that some work such as jumper placement, resistor clipping, or wiring reconnection must be performed.

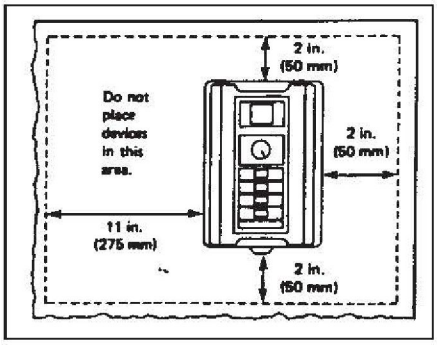


Figure A.2. Enclosure Mounting Minimum Distances.

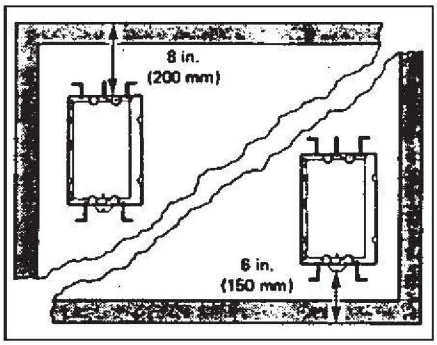


Figure A-3. Open Panel Mounting Minimum Distances.

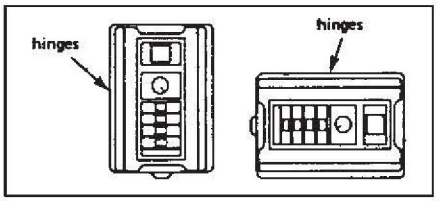


Figure A-4. Mounting Orientations

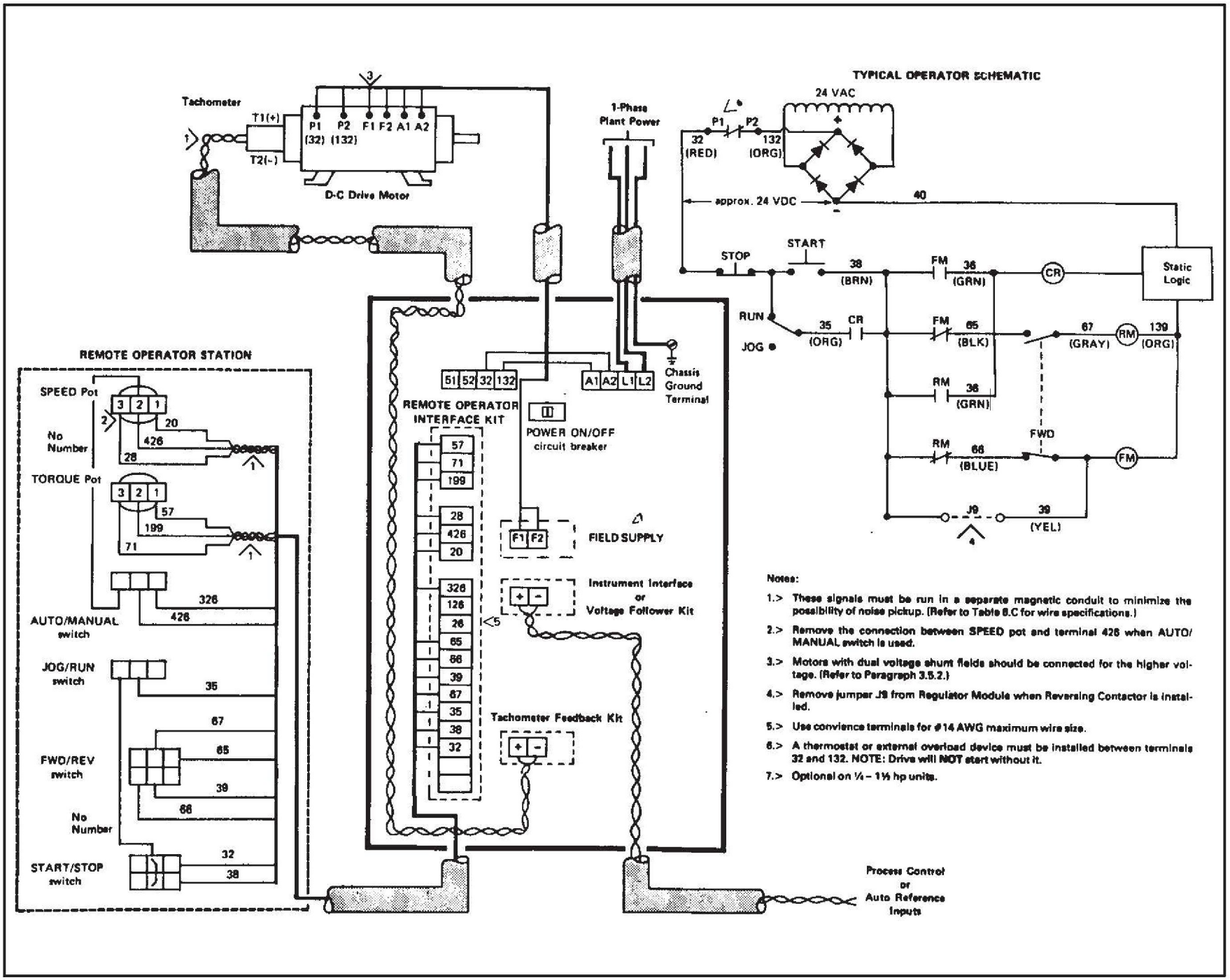


Figure A-5. Drive Connection Diagram.

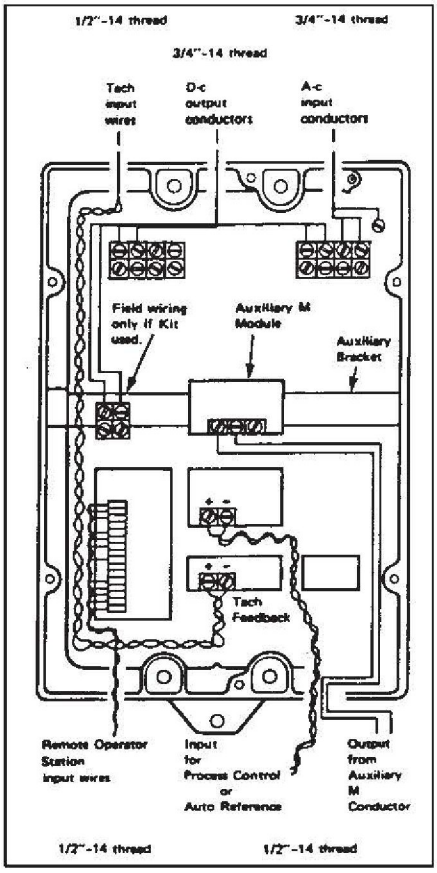


Figure A-6. Chassis Wells, Wire Routing

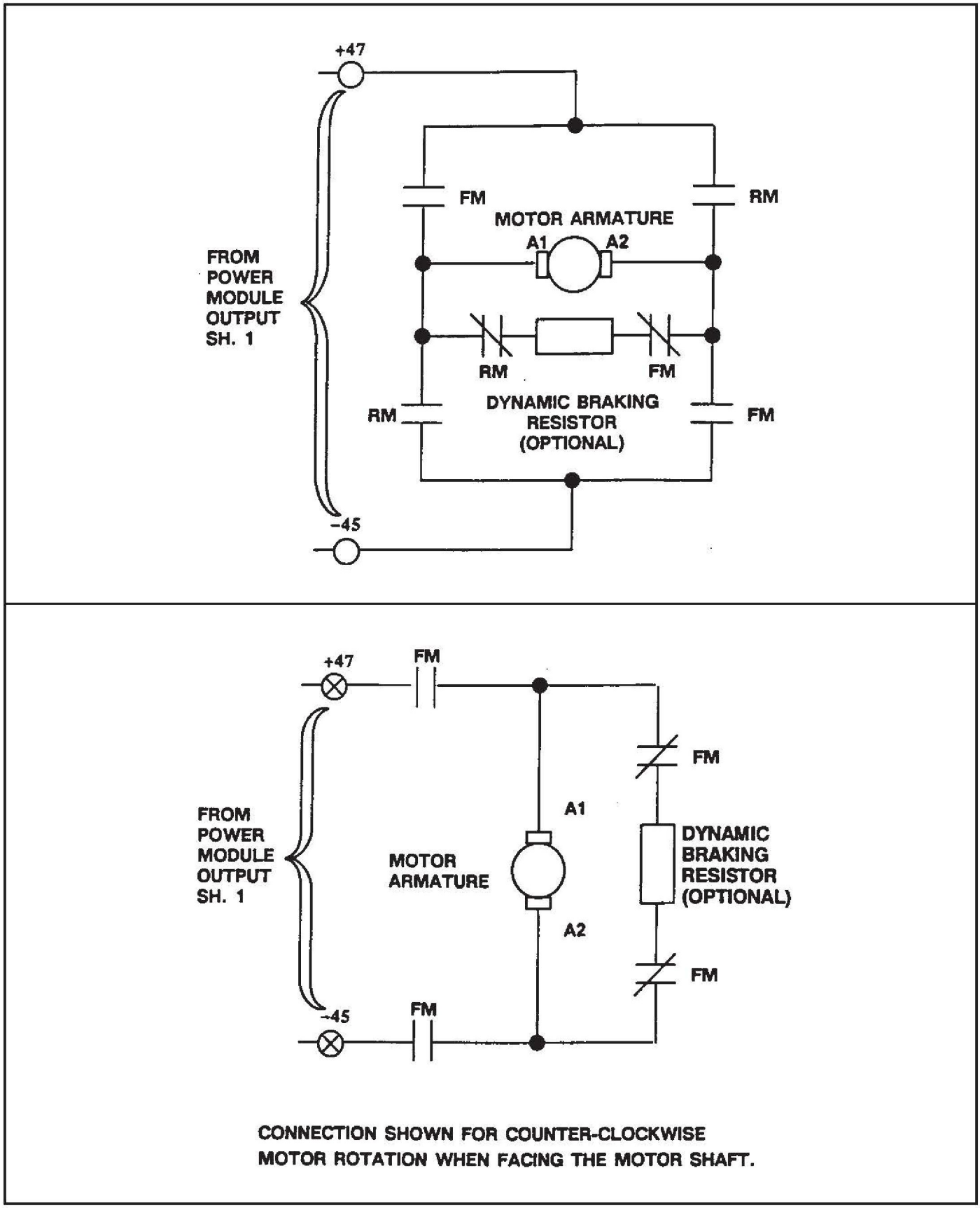


Figure A-7. Motor Armature Circuit Connection.

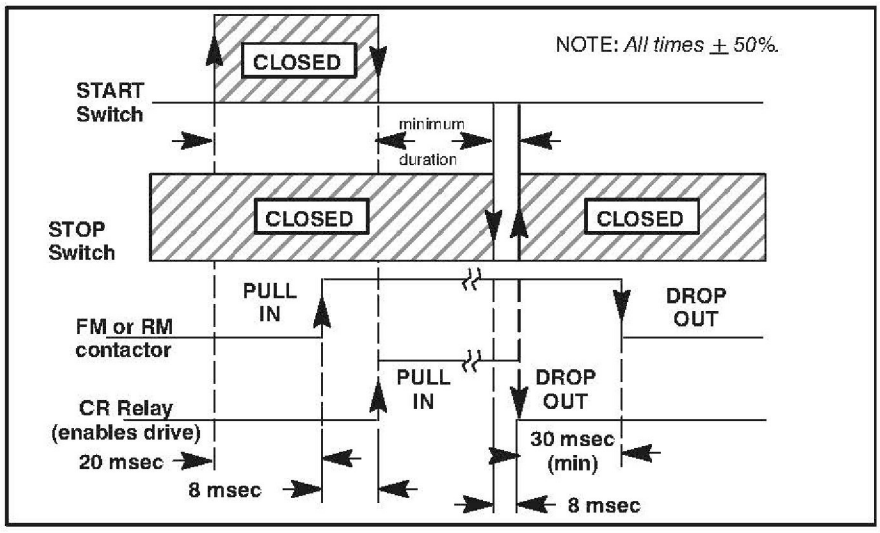


Figure A-8. Armature Contactor Sequencing and Regulator Start/Stop Timing.

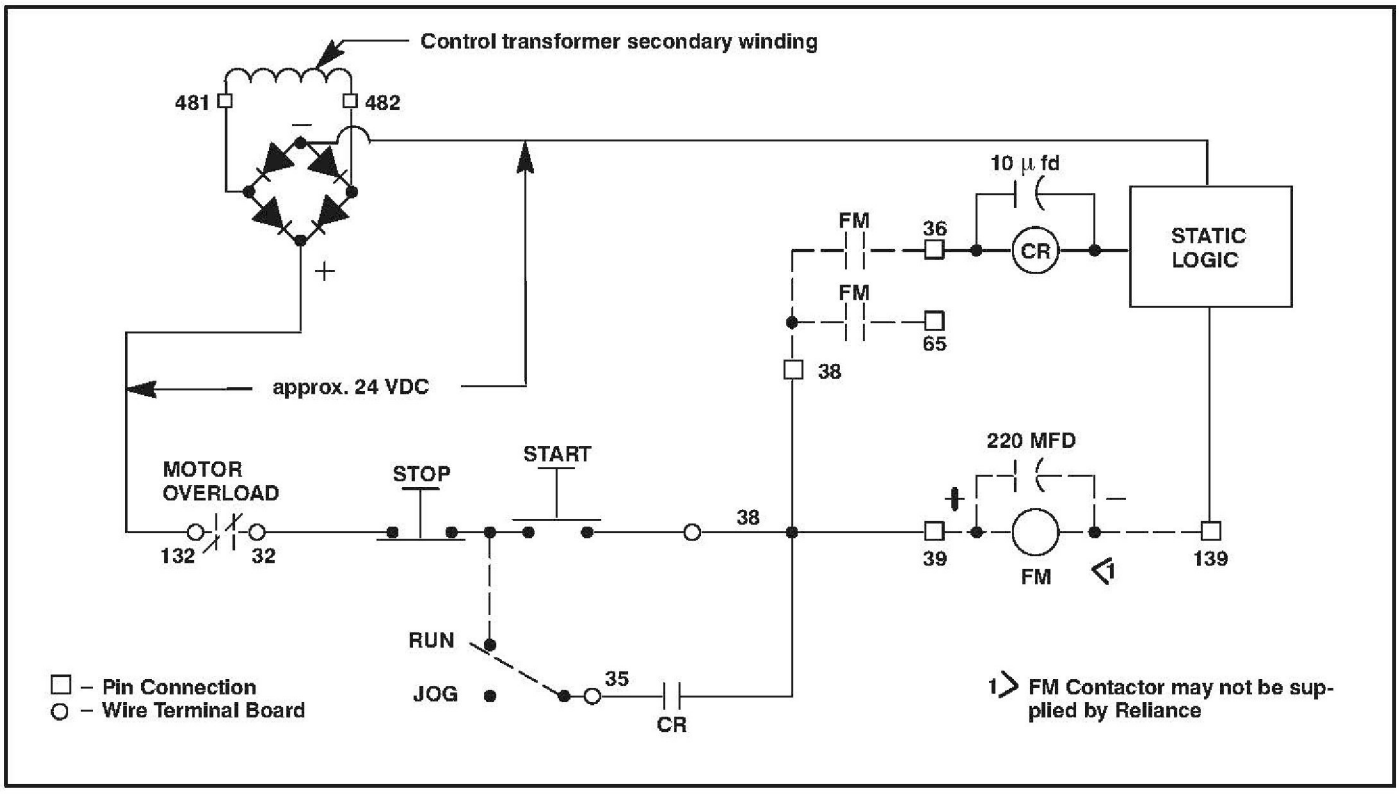
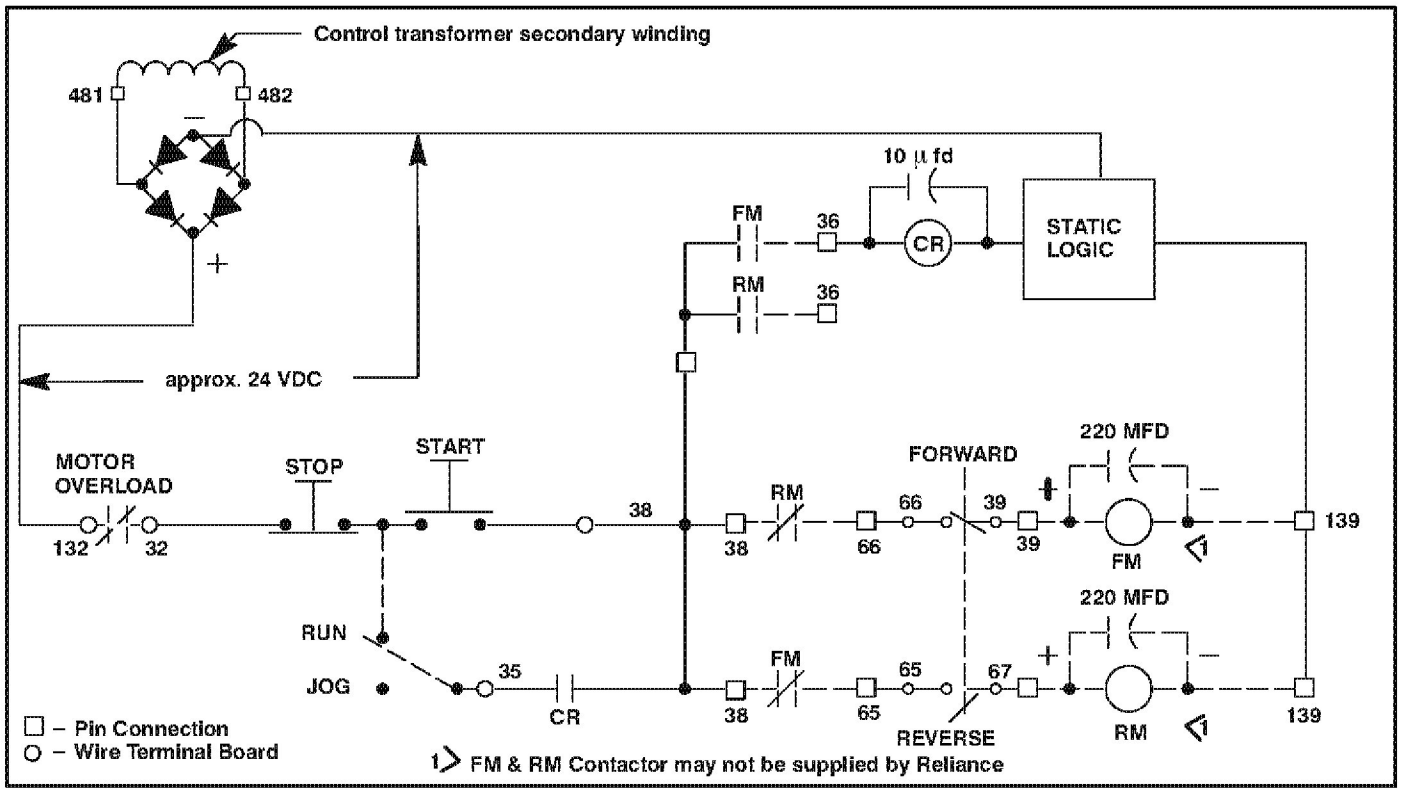


Figure A-9. Non-Reversing Drive Control Circuit.



NOTE: *When Reversing is used, the J9 Jumper on the Regulator Board must be cut.*

Figure A-10. Reversing Drive Control Circuit.

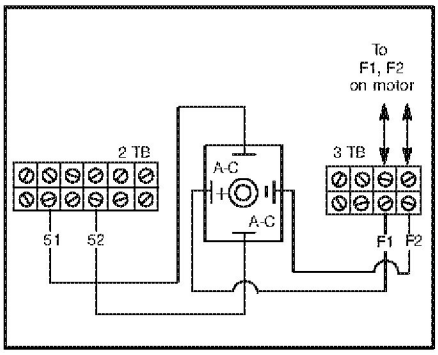


Figure A-11. Connecting Field Supply.

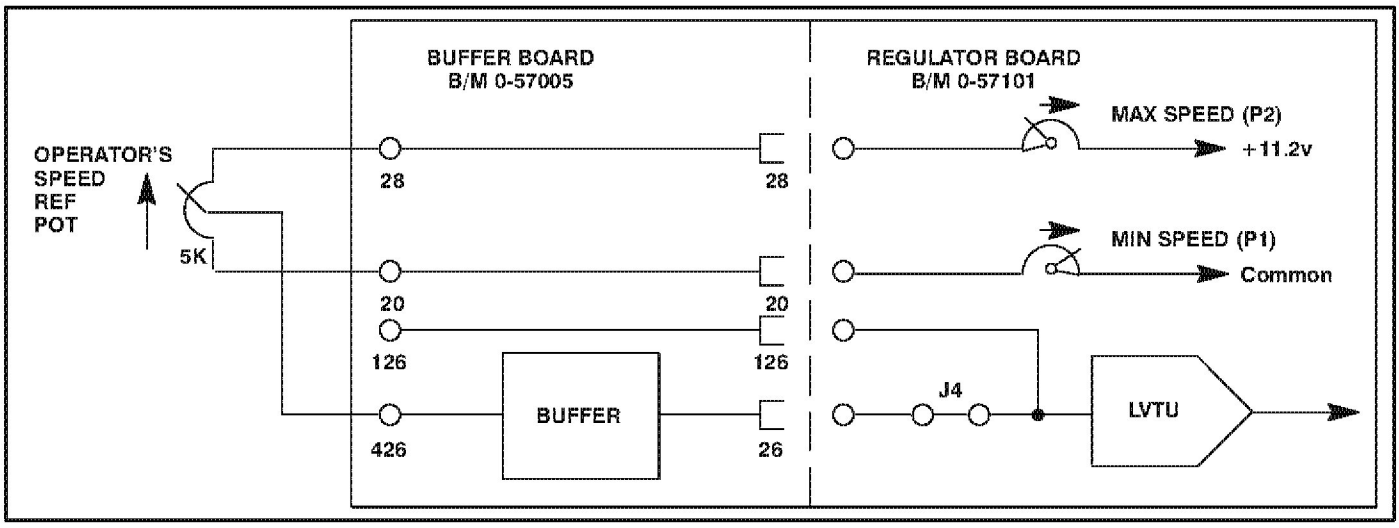


Figure A-12. Reference Circuit for Manual Operator's Speed Reference Circuit.

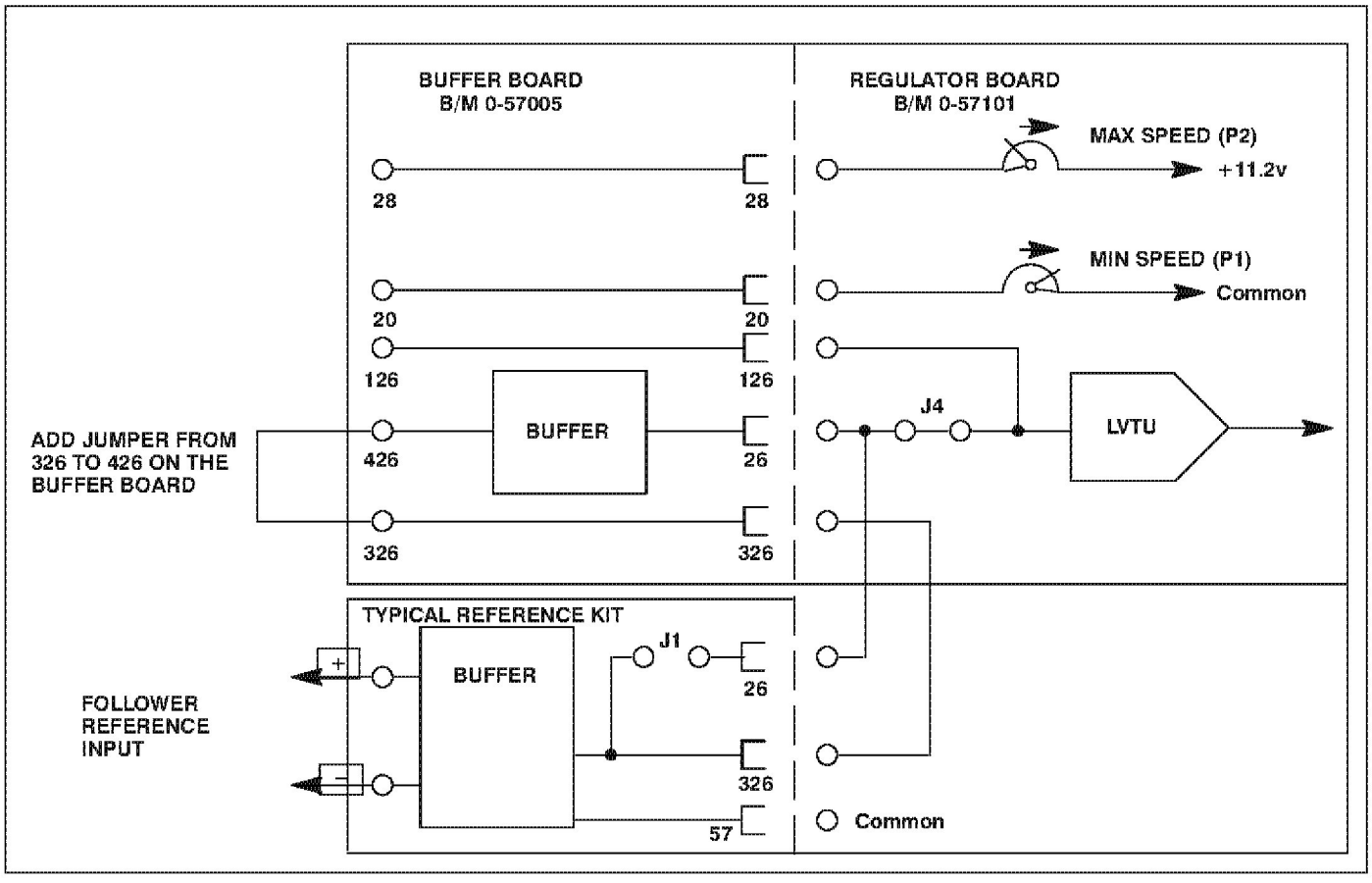


Figure A-13. Reference Circuit for Follower Reference Kit without the use of the Manual Operator's Reference Option.

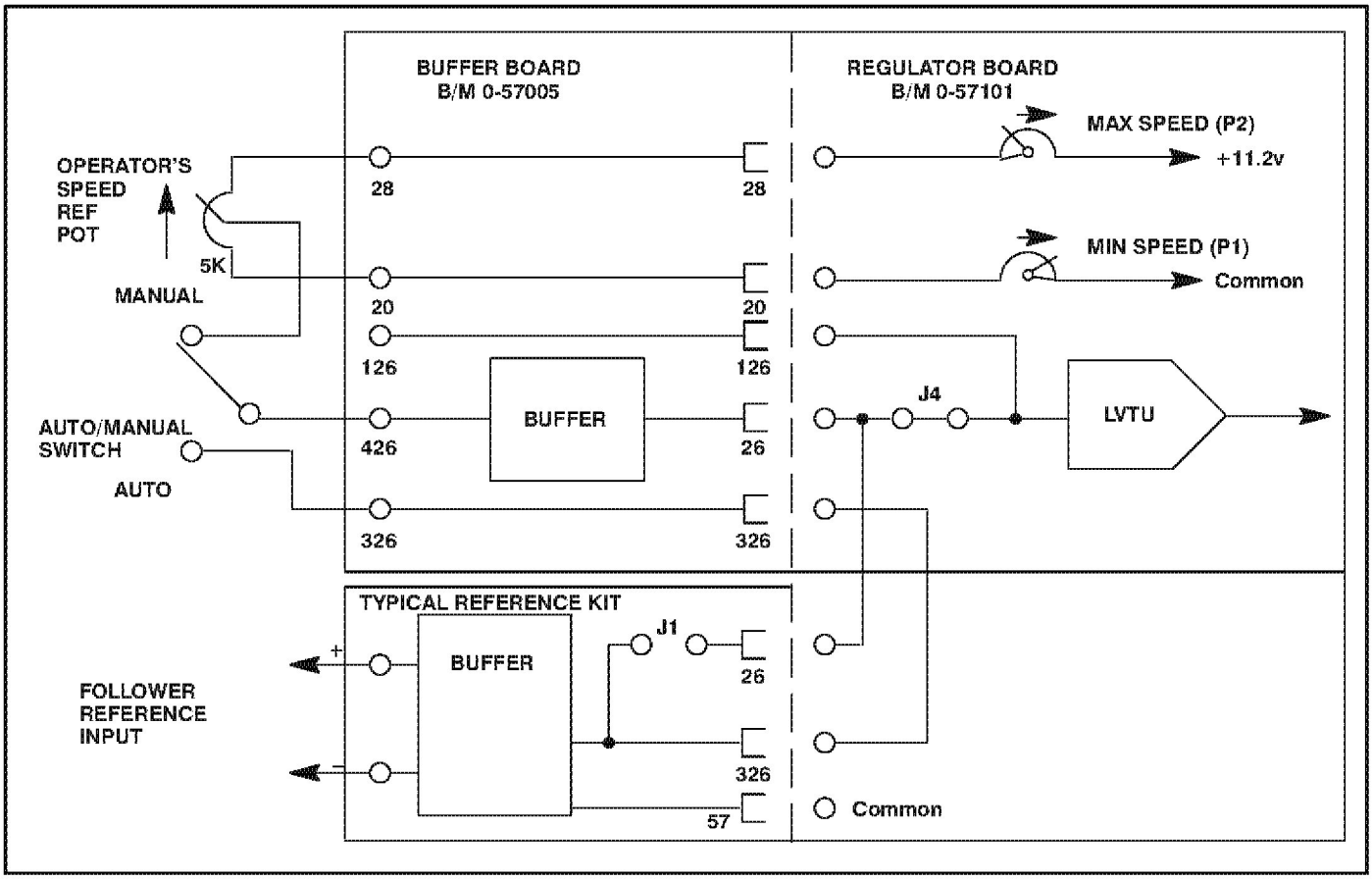


Figure A-14. Reference Circuit for Follower Reference Kit with the use of the Manual Operator's Reference Option and an Auto/Manual Switch.

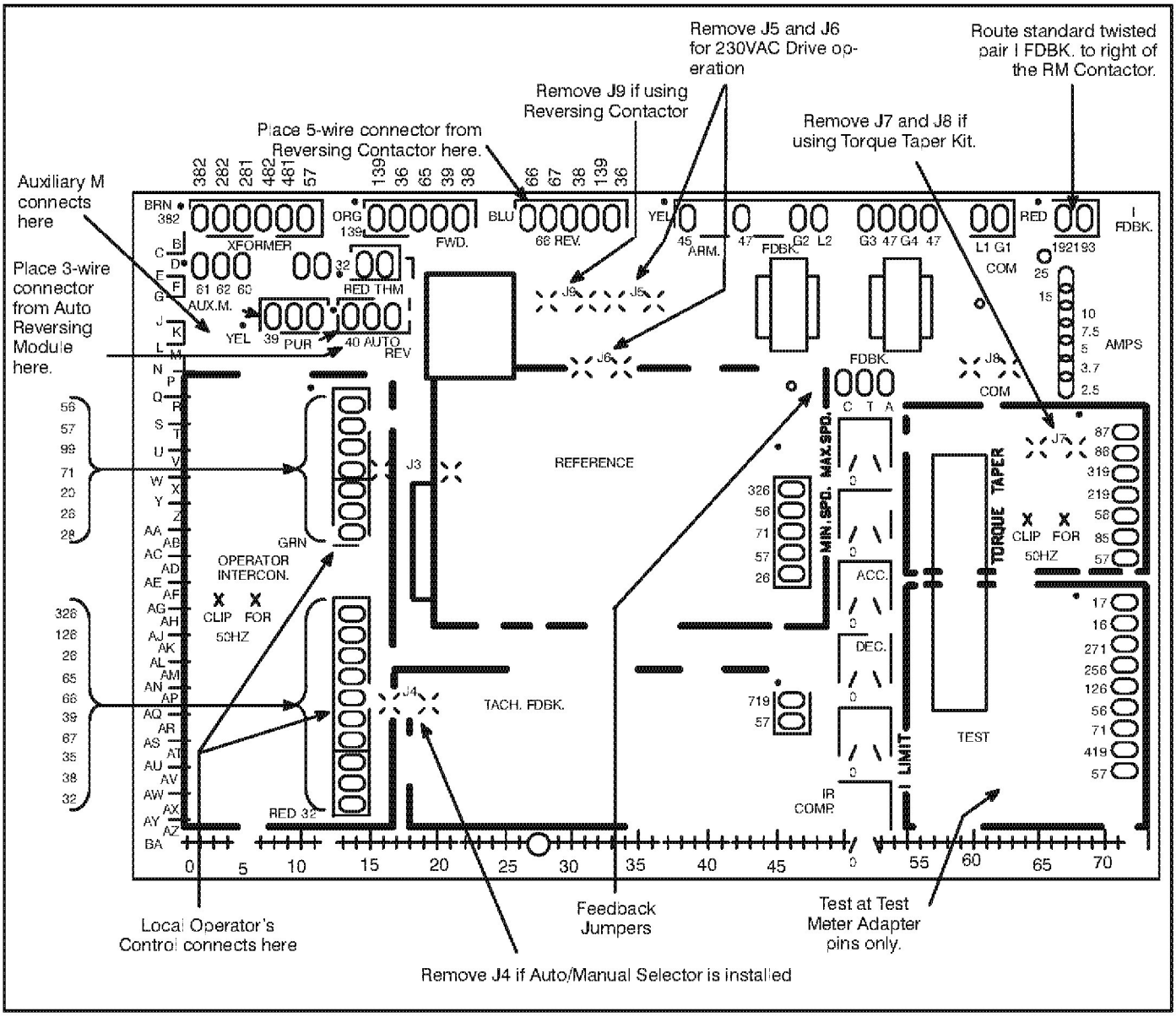


Figure A-15. Regulator Module Screen.

Table A-7. Current Feedback Scaling

Motor HP		Motor Current/PIN Connections
115 VAC	230 VAC	
1/4	1/2	2.5A
1/3	3/4	3.7A
1/2	1	5.0A
3/4	1 1/2	7.5A
–	2	10.0A
–	3	15.0A
–	5	25.0A

Table A-8. Control Power Voltages.

Function	Terminal(s) /Pin(s)	Nominal Values (VDC)
Unregulated +20 VDC	256	+20 VDC ±5%
Unregulated -20 VDC	271	-20 VDC ±5%
Regulated +11.2 VDC	56	+11.2 VDC ±5%
Regulated -11.2 VDC	71	-11.2 VDC ±5%

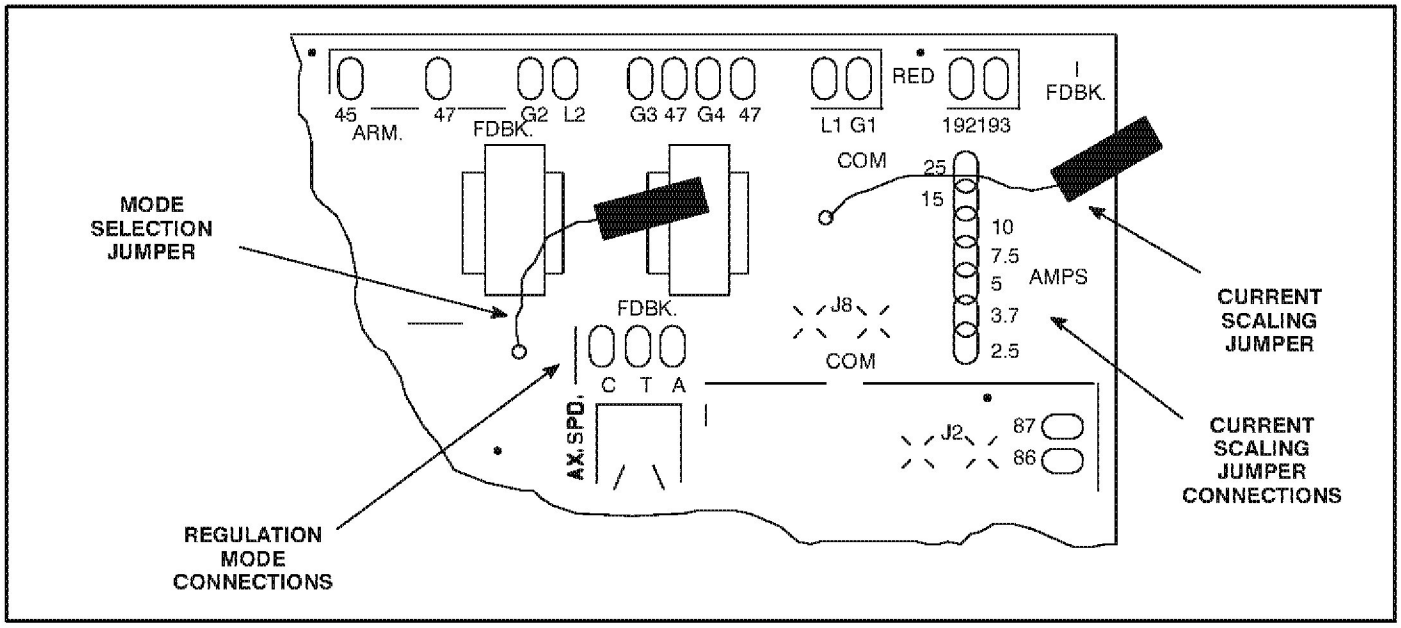


Figure A-16. Drive Current Scaling Setup.

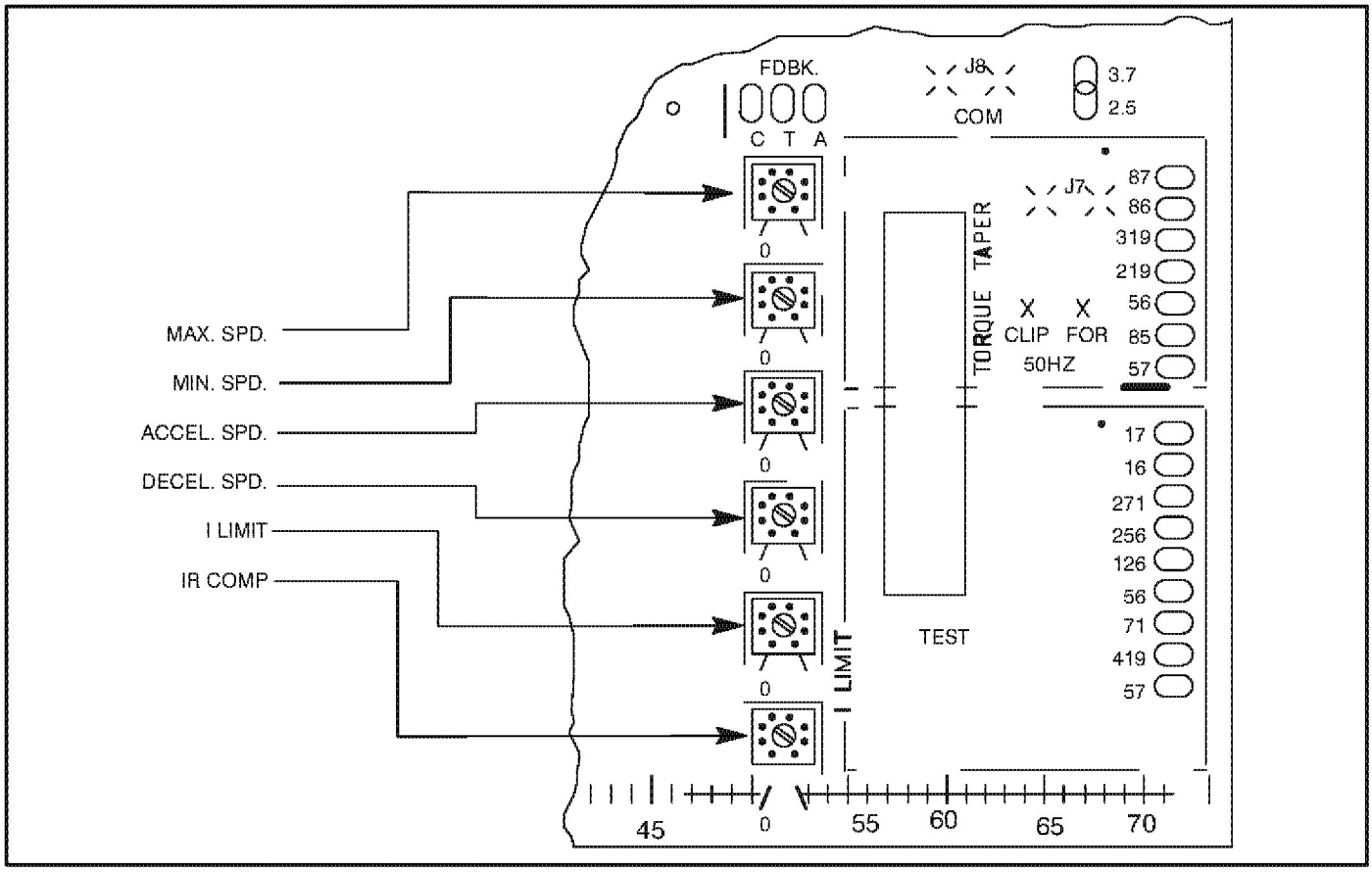


Figure A-17. Regulator Function Potentiometers

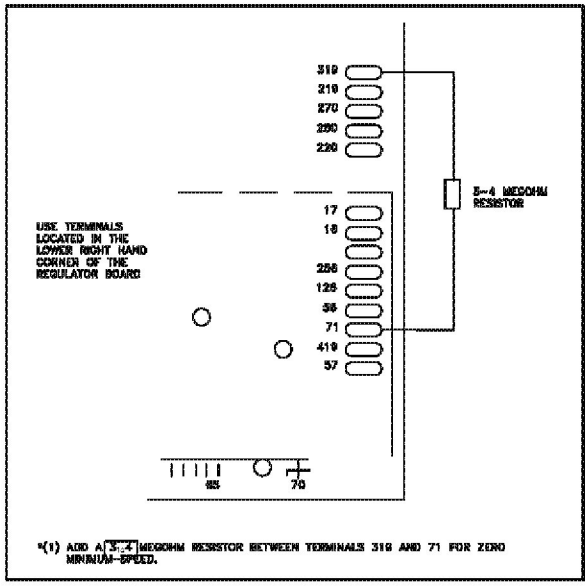


Figure A-18. Controller with J10 Jumper in Zero Speed Circuit

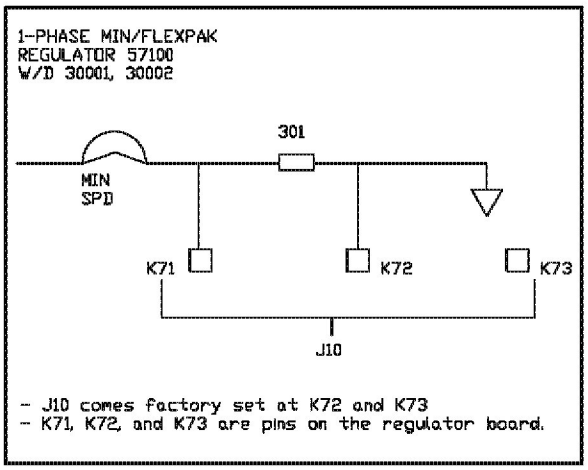


Figure A-19. Zero Minimum Speed Correction

Table A-9. Initial/Final Adjustment Settings

Potentiometers	Jumpers	Initial Setting (Factory)	Final Setting (User)
MAX. SPD.		Fully CCW (Dot 1)	
MIN. SPD		Fully CCW (Dot 1)	
ACC.		Fully CCW (Dot 1)	
DEC.		Fully CCW (Dot 1)	
I LIMIT		150% (Dot 7)	
IR COMP		Fully CCW (Dot 1 = 0%)	
	Feedback[1]	A	
	Current Scaling	2.5	
	J4[2]	Installed	
	J5, J6[3]	Installed	
	J7, J8[4]	Installed	
	J9[5]	Installed	

1> A-COM is the standard connection for Armature Feedback; Factory Setting.
C-COM is the connection for CEMF if CEMF transformer is installed;CEMF function was replaced by Armature feedback in Design "H".
T-COM is the connection for Tachometer Feedback if Tach Feedback Kit is installed.

2> Remove if Local Auto/Man Switch is installed.

3> Remove on 230 Volt units.

4> Remove for Torque Taper.

5> Remove when Reverse Relay (Contactor) Kit is installed.

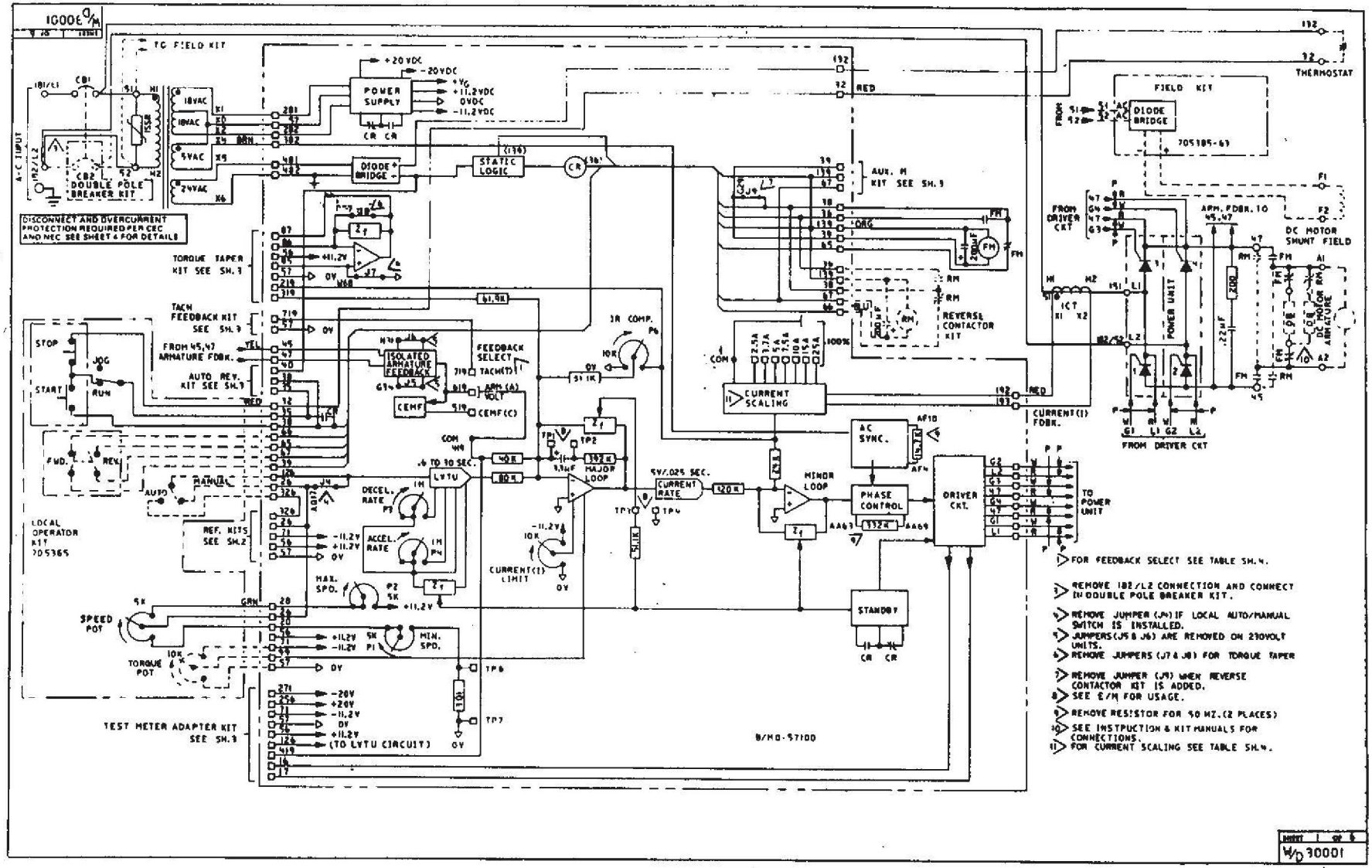
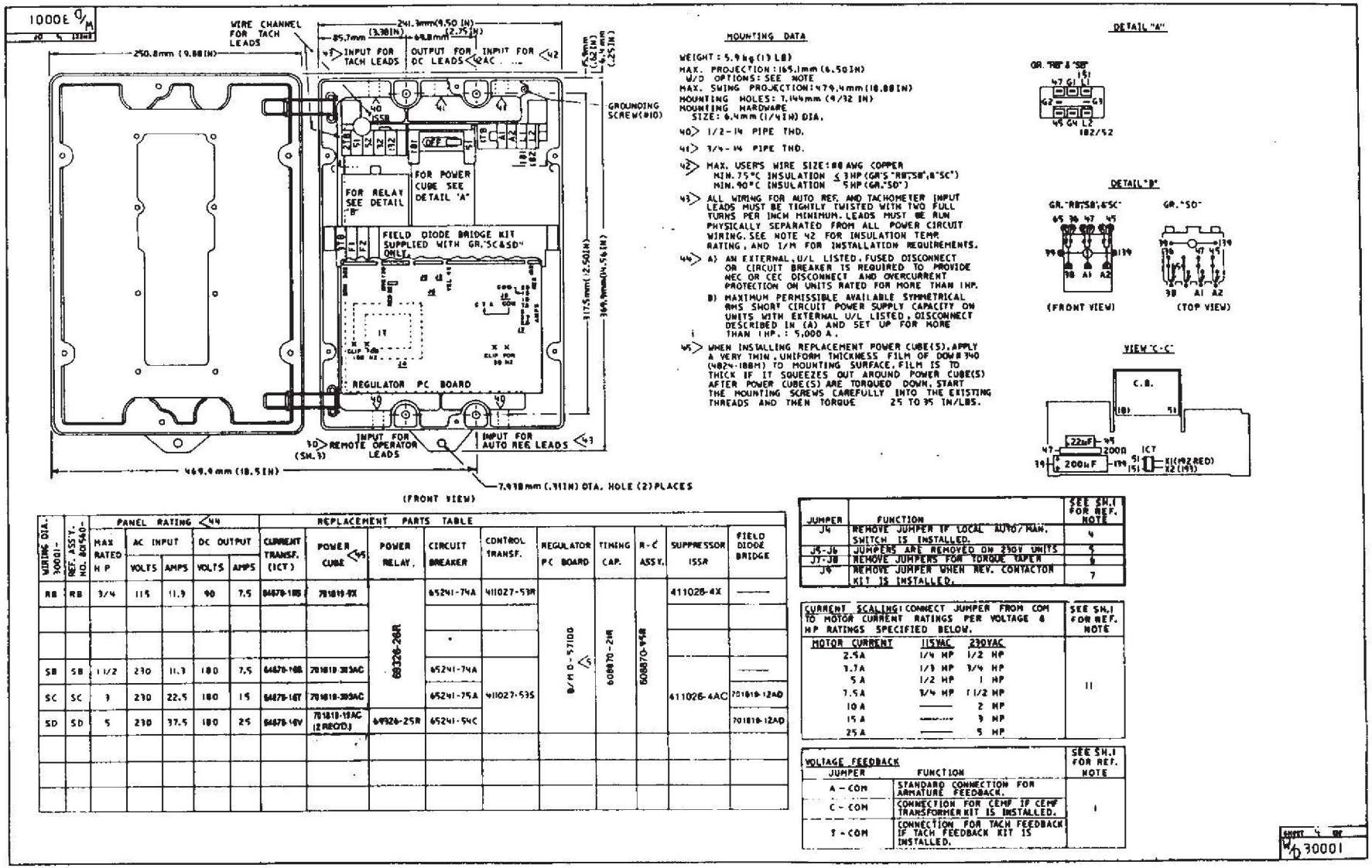


Figure A-20. Controller Schematic.



WIRING DIA. 30001-	REF. ASSY. NO. 80540-	PANEL RATING <44 MAX RATED H P	AC INPUT VOLTS	AC INPUT AMPS	DC OUTPUT VOLTS	DC OUTPUT AMPS	REPLACEMENT PARTS TABLE CURRENT TRANSF. (ICT)	POWER CUBE <45	POWER RELAY	CIRCUIT BREAKER	CONTROL TRANSF.	REGULATOR PC BOARD	TIMING CAP.	R-C ASSY.	SUPPRESSOR ISSR	FIELD DIODE BRIDGE
RB	RB	3/4	115	11.9	90	7.5	84678-18S	701819-9X	69326-26R	65241-74A	411027-53R	B/M 0-57100 <5	600870-24R	600870-9AR	411026-4X	——
SB	SB	1 1/2	230	11.9	180	7.5	84678-16S	701819-35AC		65241-74A						——
SC	SC	3	230	22.5	180	15	84678-16T	701819-39AC		65241-75A	411027-53S				411026-4AC	701819-12AD
SD	SD	5	230	37.5	180	25	84678-16V	701819-19AC (2 REQ'D.)	69326-25R	65241-54C						701819-12AD

JUMPER	FUNCTION	SEE SH.1 FOR REF. NOTE
J4	REMOVE JUMPER IF LOCAL AUTO/MAN. SWITCH IS INSTALLED.	4
J4-J6	JUMPERS ARE REMOVED ON 230V UNITS	5
J7-J8	REMOVE JUMPERS FOR TORQUE TAPER	6
J9	REMOVE JUMPER WHEN REV. CONTACTOR KIT IS INSTALLED.	7

CURRENT SCALING: CONNECT JUMPER FROM COM TO MOTOR CURRENT RATINGS PER VOLTAGE & HP RATINGS SPECIFIED BELOW. — SEE SH.1 FOR REF. NOTE 11

MOTOR CURRENT	115VAC	230VAC
2.5A	1/4 HP	1/2 HP
3.7A	1/3 HP	3/4 HP
5 A	1/2 HP	1 HP
7.5A	3/4 HP	1 1/2 HP
10 A	——	2 HP
15 A	——	3 HP
25 A	——	5 HP

VOLTAGE FEEDBACK JUMPER	FUNCTION	SEE SH.1 FOR REF. NOTE
A - COM	STANDARD CONNECTION FOR ARMATURE FEEDBACK.	1
C - COM	CONNECTION FOR CEMF IF CEMF TRANSFORMER KIT IS INSTALLED.	
T - COM	CONNECTION FOR TACH FEEDBACK IF TACH FEEDBACK KIT IS INSTALLED.	

30001

Figure A-21. Controller Technical Data.

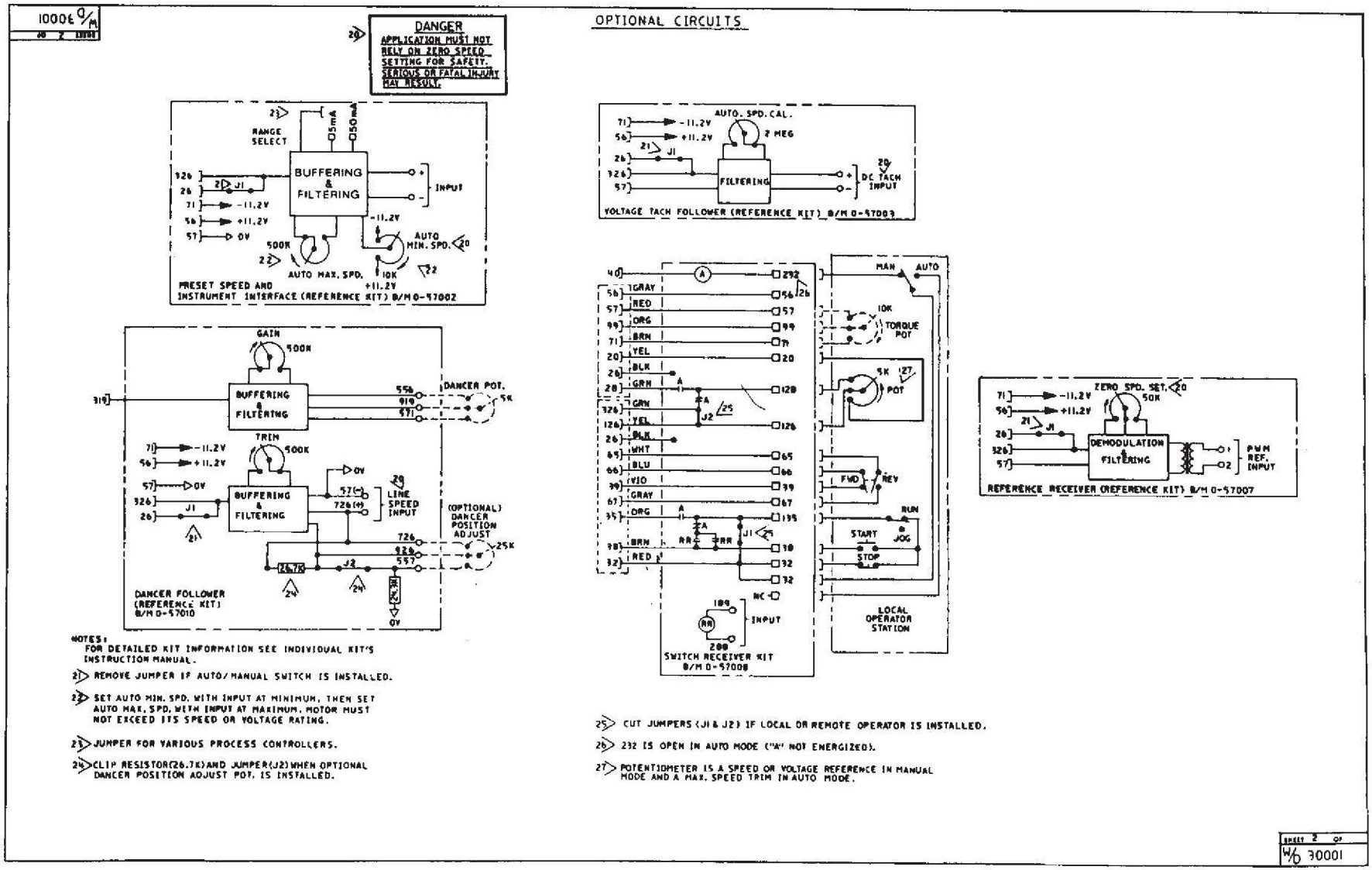


Figure A-22. Modification Kits Schematics.

B: GLOSSARY OF TERMS

Altitude:	The atmospheric altitude (height above sea level) at which the motor or controller will be operating.
Armature:	The portion of the D-C motor which rotates.
Rated Full Load Current:	Armature current in amperes.
Armature Resistance:	Measured in ohms at 25 degrees Celsius (cold).
Base Speed:	The speed which a D-C motor develops at rated armature and field voltage with rated load applied.
Chassis Ground:	Any electrical connection to the metal body of the controller.
Constant Speed:	Motor which changes speed only slightly from a no-load to a full-load condition.
Direct Current:	A current that flows only in one direction in an electrical circuit. It may be continuous or discontinuous and it may be constant or varying.
D-C Motor:	A motor using either generated or rectified D-C power. A D-C motor is usually used when variable speed operation is required.
Earth Ground:	The central ground for all electrical and A-C power within a facility. It may be the plant, magnetics, equipment, electrical, circuit, neutral or reference ground, depending on the nomenclature used at a facility.
Efficiency:	The ratio of mechanical output to electrical input. It represents the effectiveness with which the motor converts electrical energy to mechanical energy.
Electrical Time Constant:	The ratio of electrical inductance to armature resistance. Electrical time constant in seconds defined as electrical: **T/C = La x Ia / Hot IR voltage drop**
Field:	A term commonly used to describe the stationary (stator) member. The field provides the magnetic field with which the mechanically rotating (armature or rotor) member interacts.
Horse Power:	The measure of the rate of work. One horsepower is equivalent to lifting 33,000 pounds to a height of one foot in one minute. The horsepower of a motor is expressed as a function of torque and RPM. For motors, the following approximate formula may be used: **HP = T x RPM / 5250;where HP = horsepower,** **T = Torque (in lb. ft.), and** **RPM = revolutions per minute.**
Identification:	• Frame designation (actual frame size in which the motor is built) • Horsepower, speed, design and enclosure • Voltage, frequency and number of phases of power supply • Class of insulation and time rating • Application
Inertial Load:	A load (flywheel, fan, etc.) which tends to cause the motor shaft to continue to rotate after the power has been removed (stored kinetic energy). If this continued rotation cannot be tolerated, some mechanical or electrical braking means must be applied. This application may require a special motor due to the energy required to accelerate the inertia. Inertia is measured in either lb. ft. or oz. in. squared. **Inertia reflected to the shaft of the motor = (load RPM) ^ 2/Motor RPM**
Motor:	A device that converts electrical energy to mechanical energy to turn a shaft.
Nameplate:	The plate on the outside of a motor which describes the motor, HP, voltage, RPM, efficiency, design, enclosure, etc..

NEMA Definitions:	**NEMA Type 4** is generally defined as an indoor/outdoor enclosure that is watertight and dust-tight. It is designed to protect against splashing and hose-directed water within specific test limitations. **NEMA Type 12** is generally defined as an indoor enclosure that is dust-tight and oil-tight. It is designed to resist fibers, filings, dust, dirt and light oil splashing.
RPM:	Revolutions per Minute - The number of times per minute the shaft of the motor (machine) rotates.
Service Factor (SF):	When used on a motor nameplate, a number which indicates how much above the nameplate rating a motor can be loaded without causing serious degradation, (i.e. a 1.15 SF can produce 15% greater torque than a 1.0 SF rating of the same motor).
Tachometer:	A small generator normally used as a rotational speed sensing device. Tachometers are typically attached to the output shaft of a motor requiring close speed regulation. The tachometer feeds its signal to a control which adjusts its input to the motor accordingly (called "closed loop feedback" control).
Thermostat:	Units applies directly to the motor's windings which senses winding temperature and may automatically break the circuit in an overheating situation.
Torque:	Turning force delivered by a motor or gear motor shaft, usually expressed in pounds-feet: **lbs.ft. = HP x 5250 / RPM = full load torque**

Appendix C: Theory Of Operation

This is a generalized theory of operation for the MinPak Plus controller. It covers internal components and their functions. It also explains the relationship of the drive motor and the controller.

Motor – A Reliance Super RPM™ wound field D-C motor is compatible for use with the MinPak Plus controller. The Super RPM allows adjustable speed service as a straight shunt machine. It gives constant shaft torque capability from 50% of base speed to base speed when provided with fixed-shunt field excitation current and a source of adjustable D-C voltage – such as the MinPak Plus – for armature power. (The permanent magnet Super RMP D-C motors do not require a separate field excitation.)

The fixed-shunt field provides a constant-strength magnetic field against which the armature-induced field can react. Armature (and shaft) speed is then controlled by varying the terminal voltage to the armature. Motor speed is nearly proportional to armature terminal voltage.

Armature current is drawn, as needed, to provide motor torque. It is approximately proportional to load torque at the motor shaft plus a small amount required to support motor losses.

With the motor's operational needs so described, the motor controller, here the MinPak Plus, must consist of an adjustable-voltage armature supply, a fixed potential shunt field exciter (for wound-field motors **only**), and a regulator to control and adjust armature voltage under varying torque and speed requirements.

Armature Rectifier – The armature rectifier, here the internal Power Cube in the MinPak Plus controller, is a conventional single-phase, full-controlled, full-wave bridge. (Refer to Figure C-1 where it is shown in schematic form.) Using 4 thyristors, the Power Cube provides adjustable D-C voltage for the motor armature circuit by phase-controlled rectification of single-phase A-C plant power. Each of the thyristors is "turned on" by pulsing its gate at a point in the A-C input power cycle when its anode potential is positive with respect to its cathode.

Under these conditions, the application of low-power gate pulse approximately 350 microseconds in duration will cause the thyristor to conduct for as long as its anode remains positive with respect to its cathode. Anode-to-cathode polarity reversal, brought about by the sinusoidal nature of the incoming plant line, will commutate, or "turn off," the thyristor.

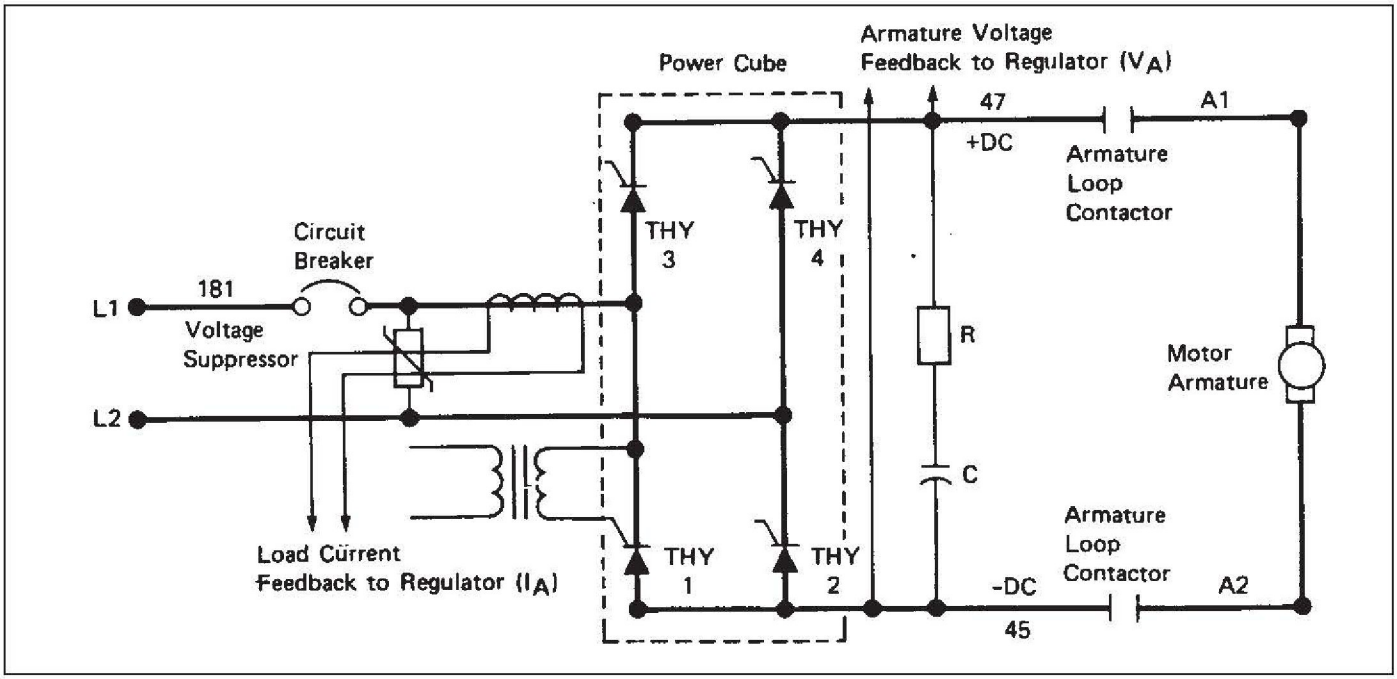


Figure C-1. Full Wave Bridge Configuration

The relative timing of the gate pulse with respect to the A-C plant supply will determine the conduction angle – that is, relative conduction time – of the thyristor and of the bridge. Thus the average D-C output voltage from the bridge to the motor armature is controlled.

Firing the thyristor gates early in the positive half-cycle of the incoming sinusoid allows it to conduct for a relatively long time until commutated off by the line. This produces low values of average D-C output voltage to the motor armature.

The power modules rated at $^1/_4$ thru 3 HP use a single discrete Power Cube which contains 4 SCRs. Power modules rated at 5 HP use 2 Power Cubes each containing 2 SCRs.

The mechanical design of the MinPak Plus Power Cube provides excellent heat-transfer characteristics. Because of its modular design, the small unit is easily replaced.

Gating Sequence, Current Flow – The basic full-wave, full-control rectifier bridge is shown in Figure C-1. When L1 (181) is positive with respect to L2 (182), current flows through thyristor No. 3, on through the motor armature, and, when the gates to thyristors No. 3 and 2 are gated ON, through thyristor No. 2.

Conversely, when L2 (182) is positive with respect to L1 (181), current flows through thyristor No. 4, on through the motor armature, and to thyristor No. 1 when the gates to thyristors No. 4 and 1 are gated ON.

A unique Reliance circuit prevents both sets of thyristors – No. 3 and 2 and No. 4 and 1 – from being gated ON at the same time. This guards against a short circuit.

Peak operating overloads such as those experienced on acceleration, shock loading, etc., are guarded against by a fast-acting, current-limiting circuit in the regulator.

Transient Protection – The controller's internal Power Cube thyristors are protected from A-C line voltage surges by a metal oxide varistor (MOV) surge suppressor connected directly across the A-C line. (Refer to Figure C-1). The MOV is available as a replaceable module in case its energy absorption rating is exceeded. An R-C network is connected across the D-C output of the Power Cube. (Refer to Figure C-1) This network prevents "ringing" in the armature circuit caused by various motors and D-C line voltage spikes.

Field Supply – The optional Field Supply Kit is available for use with MinPak Plus controllers used with motors rated at $^1/_4$ thru 5 HP. The Kit is standard on controllers for 3 – 5 HP applications.

The Field Supply is a constant-potential rectifier consisting of 4 diodes. This supply provides 50 or 100 VDC from a 115 VAC power source. It also provides 100 or 200 VDC from a 230 VAC power source.

The Field Supply is protected by the MOV surge suppressor.

Regulator Module – The Regulator Module, a standard component of each MinPak Plus controller, is discussed with respect to functions and descriptions.

The Regulator Module provides major and minor loop regulation, thyristor gate firing and sequencing. It also provides protective functions for the 4 thyristor power modules.

The Regulator Module provides the following basic functions:

- Major loop armature voltage regulation, or speed (tachometer) regulation, or counter EMF regulation
- Linear reference timing for controlled acceleration and deceleration
- Current minor loop regulator
- Thyristor gate driver circuits
- Isolated armature voltage feedback
- Rectifier and scaling resistors for isolated current transformer inputs to provide current feedback
- Start, stop, jog sequencing
- Power-up and power-down sequencing

Description – The Regulator Module is a printed circuit board which occupies approximately half of the MinPak Plus controller's Chassis. Directly behind it there is an isolation transformer which supplies isolated, low-voltage A-C power to the Regulator Module power supplies.

All electrical connections to the Regulator Module are made with tin-plated pin connectors. The input/output arrangement of these pins is intended to physically isolate the different circuits, thereby minimizing electrical noise coupling.

All optional external voltage signals which may contain electrical noise are fed through filtering and isolation circuits **prior** to entering the Regulator Module. Thus reliable operation is assured even in a noise-polluted industrial environment.

A Large-Scale Integrated Circuit (LSI) is incorporated into the Regulator Module. It drastically reduces the number of active devices, thereby producing excellent response characteristics and an exceptionally high reliability factor.

Physically the Module has identifications and locations printed in high-visibility white paint. These callouts help users identify pots, resistors, and areas where optional Kits are installed.

The Module and all optional Kits have special covering to protect the printed circuits from conductive elements such as moisture and dust.

Index

A

A-C Line and Power Input 5:1
Adjusting Minimum Speed 4:5
Adjusting Maximum Speed 4:7

B

Basic Regulator Maximum Safe Operating Adjustment 4:4

C

Controller Mounting Dimensions 3:2
Current Limit 4:7

D

D-C Motor 5:1
Determination of Tachometer Output Polarity 4:5
Drive Deceleration Time 4:7
Drive Acceleration Time 4:7
Drive Identification Nameplate 1:1
Drive Set-up Procedure 4:4

F

File a Return Request 1:1
FlexPak Plus Single-Phase D-C Controller Specifications 2:1
FlexPak Plus Single-Phase D-C Controller Description 2:4

G

General, Setup Procedures 4:1
General, Installation 3:1
General, Troubleshooting 5:1
General Wiring Practices 3:5
Glossary of Terms B:1

H

Horsepower – Current Scaling 4:2

I

Install the Motor 3:2
Install the Field Supply 3:9
Install a Disconnect 3:3
Install the Controller – Panel Layout 3:1
Install and Wire the Drive 3:1
Introduction to the Controller 2:1
IR Drop Compensation 4:7

M

Motor Ground Check 4:2

O

Optional Kits 5:1

P

Power Off Inspection 4:2
Power On 4:3

Q

Quick Reference Guide A:1

R

Receive and Accept the FlexPak Controller 1:1
Recieve and Accept the Shipment 1:1
Regulation Mode Selection 4:3
Remote M-Contactor 5:1
Replacement Parts 6:1

S

Scope of this Manual 2:1
Set Zero Speed 4:5
Start-up and Adjustment 4:1
Store the Controller 1:1

T

Troubleshooting Flowcharts 5:1
Troubleshooting 5:1

V

Verify the Correct Direction of Motor Rotation 4:5

W

Wire the Field Supply 3:9
Wire the Speed Reference Circuit 3:10
Wire D-C Power to the Controller 3:9
Wire A-C Power to the Controller 3:5
Wire the Drive 3:3
Wiring Errors 5:1

230 Volt A-C Applications 4:2
50 Hertz Operation 4:2

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