Installing, Operating and Maintaining D-C V★S Power Module

25 Thru 150 HP @ 230 VAC
50 Thru 300 HP @ 460 VAC

V★S®
DRIVES

Instruction Manual D2-3029-2

RELIANCE ELECTRIC

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Section 1
RECEIVING AND HANDLING

1.0 ACCEPTANCE

Reliance Electric terms of sale, in all instances, are F.O.B. point of origin. Therefore, it is important that you thoroughly inspect this 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 the quantity is short, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight or express agent within 15 days of receipt and request that he make an inspection. It is the responsibility of the Consignee to make claim for any shortage or damage in transit against the Carrier.

Claims for loss or damage in shipment must not be deducted from the Reliance Electric invoice, nor should payment of the Reliance® invoice be withheld awaiting adjustment of such claims since the Carrier guarantees safe delivery.

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

1.1 UNPACKING AND STORING

After receipt inspection, repack and store the equipment in a clean, dry area until ready to use. Under no conditions should the equipment be stored where ambient temperature will rise above 65° C (149° F) or fall below -40° C (-40° F), where corrosive conditions exist, or where high humidity is likely to cause condensation on the equipment. Reliance publication D-8079 provides further information on storage procedures and precautions. Proper storage is a must to insure satisfactory drive operation and to maintain warranty coverage.

Section 2
GENERAL INFORMATION

2.0 GENERAL

This manual contains installation, startup, operating, maintenance and troubleshooting instructions for the three-phase D-C V★S® Power Module as illustrated in Figure 2.1. The manual should be read **before** performing installation or startup activities. Also, the following fundamental warnings must be kept in mind **at all times.**

DANGER
THE POWER MODULE SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT. SEVERE OR FATAL INJURY AND/OR EQUIPMENT DAMAGE COULD OCCUR IF INDIVIDUALS ARE NOT FAMILIAR WITH THE HAZARDS RESULTING FROM IMPROPER OPERATION.

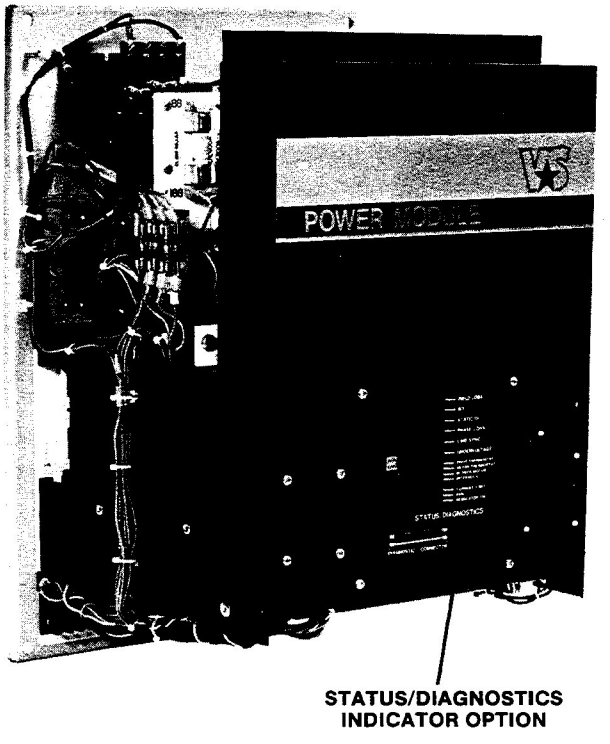


Figure 2.1 — Front View of Typical D-C V★S Power Module

DANGER
EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER MODULE. ALL PHASES OF THE A-C POWER LINE MUST BE DISCONNECTED FROM THE POWER MODULE BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THE EQUIPMENT. SEVERE OR FATAL INJURY COULD RESULT UNLESS POWER IS REMOVED.

WARNING
THE NATIONAL ELECTRICAL CODE REQUIRES THAT AN NEC APPROVED FUSED DISCONNECT SWITCH OR CIRCUIT BREAKER BE USED AHEAD OF THE POWER MODULE AND POWER TRANSFORMER (IF USED) ON THE INCOMING A-C LINE. PERSONAL INJURY COULD RESULT IF AN EASILY ACCESSIBLE MEANS OF LINE VOLTAGE DISCONNECTION IS NOT PROVIDED.

WARNING
DO NOT OPERATE THIS POWER MODULE ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF THE MAXIMUM ALLOWABLE AVAILABLE SYMMETRICAL RMS FAULT CURRENTS AS LISTED IN TABLE 2.2. PERSONAL INJURY AND/OR DAMAGE TO EQUIPMENT COULD OCCUR. EXTERNAL DISCONNECT MEANS MUST HAVE ABILITY TO INTERRUPT AVAILABLE FAULT CURRENT.

2.1 POWER MODULE DESCRIPTION

The Power Module described in this manual may be applied to D-C drive applications with ratings within the following ranges:

- From 25 thru 150 horsepower at an armature voltage of 240 volts D-C with 230-volt A-C, three-phase, 50/60 Hz input voltage.
- From 50 thru 300 horsepower at an armature voltage of 500 volts D-C with 460-volt A-C, three-phase, 50/60 Hz input voltage.

The Power Module provides adjustable voltage armature power to the D-C motor by phase-controlled rectification of three-phase plant power. The three-phase controlled rectifier, major and minor loop regulators,

constant potential field exciter and all basic sequencing controls make up the Power Module. See Figures 2.1 and 2.2. The Power Module is UL recognized as a drive component and **must be combined with an appropriate user-supplied armature loop contactor to form a complete, safe drive package.**

2.2 POWER MODULE IDENTIFICATION

These Power Modules are manufactured as standard modules to a set of Reliance specifications or as modified units to customer specifications. The Power Module can be positively identified by the nameplate mounted on the Power Module.

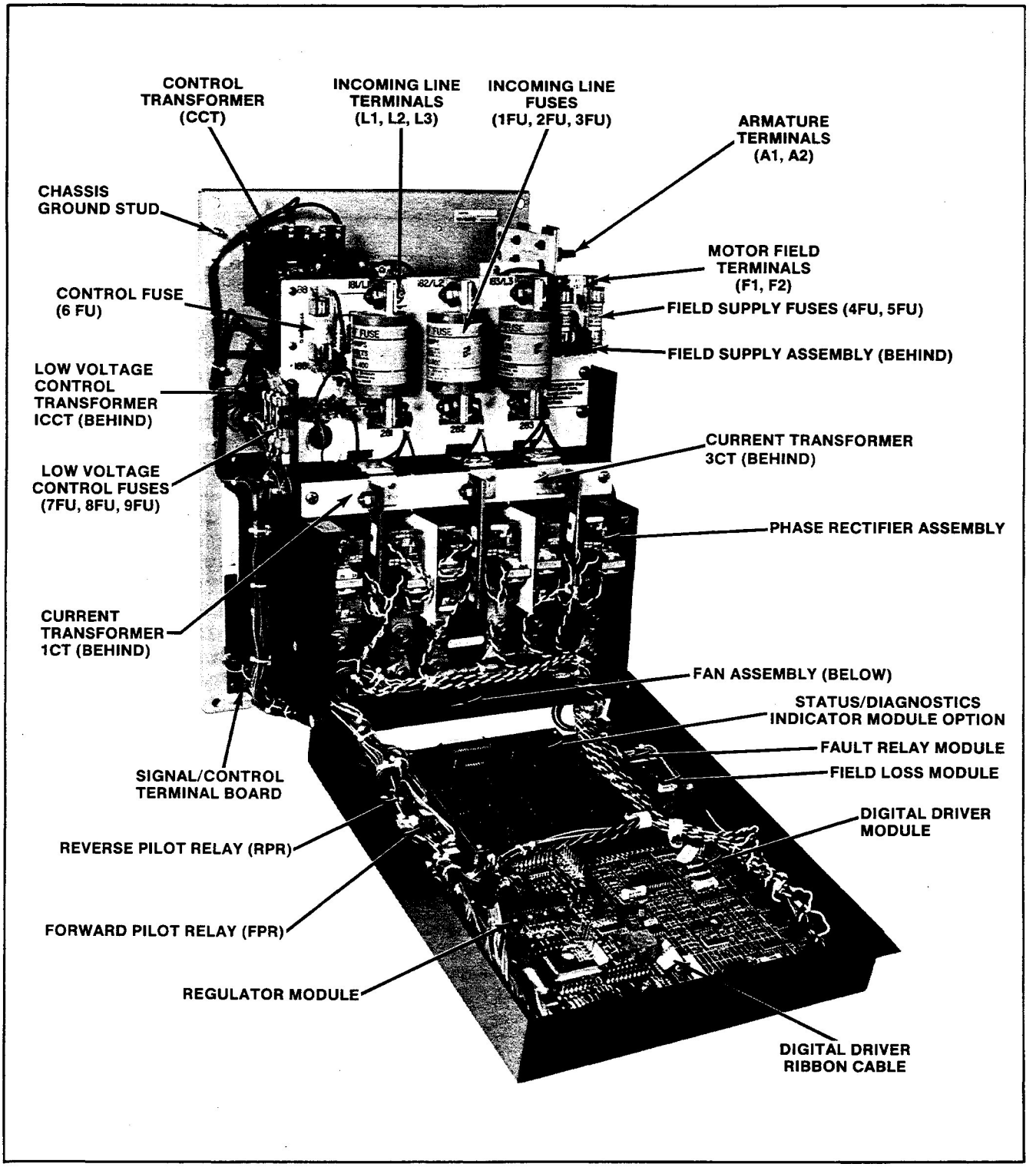


Figure 2.2 — Inside View of Typical D-C V★S Power Module

If the Power Module is built to a Reliance model number specification, its model number uniquely describes the hardware furnished. An alpha-numeric model number will be printed on the Power Module's identification nameplate. This model number will also be present on the shipping label on the outside of the power module shipping container. The model number provides a complete specification as noted here:

- Model 19C401:
  Open chassis Power Module with fixed potential field supply and basic sequencing
  25 thru 75 hp with 230 VAC input power, 240 VDC armature, 150 VDC field
  50 thru 150 hp with 460 VAC input power, 500 VDC armature, 300 VDC field

- Model 19C406:
  Open chassis Power Module with fixed potential field supply and basic sequencing
  100 thru 150 hp with 230 VAC input power, 240 VDC armature, 150 VDC field
  200 thru 300 hp with 460 VAC input power, 500 VDC armature, 300 VDC field

If the Power Module is built to customer specifications, a Reliance sales order number will be imprinted on the nameplate, appearing as a six-digit number following a plant code prefix (such as 1GA-684792 or 10TT-896401). Use this identification number whenever discussing this drive equipment with Reliance Electric personnel. It uniquely describes a Power Module manufactured to customer specifications.

2.3 STANDARD FEATURES

1. Start/stop and speed selection (5-100%).
2. Torque selection (10-150%).
3. Unidirectional operation, coast-to-rest.
4. 20 to 1 (20:1) controlled speed range by armature voltage control.
5. Separately adjustable rates of linear acceleration and deceleration. Adjustable from 0.5 to 30 seconds.
6. Jumper reconnectable regulator circuit to allow either armature voltage regulation or closed loop speed regulation with tachometer feedback. Provides:
   - 5% speed change with 95% load change by voltage regulation.
   - 1% speed change with 95% load change by speed regulation using an RE045 A-C tachometer or 5PY D-C tachometer.
   - 0.5% speed change with 95% load change by speed regulation using a BC42 tachometer.
7. Jog at set speed by selector switch.
8. Adjustable IR drop compensation (0 to 12%).
9. Adjustable minimum speed (5 to 30%).
10. Adjustable maximum speed (70 to 100%).
11. 150% one minute current rating.
12. 50/60 Hz compatibility.
13. Ability to deliver rated output and operate within specified regulation tolerance limits with A-C line variations of ±10% of nominal. Capable of operating without power module damage to 25% low incoming line.
14. Sequencing to provide coordination of minor loop, major loop and armature contactor during start, stop and jog operation.
15. Isolated armature voltage and current feedback to insure complete isolation between armature and regulating circuits.
16. Fused and isolated 115-volt A-C supply for push-button and regulator control.
17. Conveniently located incoming and outgoing power terminal locations for easy cable entry and connection.
18. Contactor driver relays to power user-supplied 115-volt armature loop contactor(s).
19. Phase sequence insensitive design allows drive operation regardless of incoming phase rotation.
20. Surge protection from A-C line and D-C load transients.
21. Current limit, adjustable from 10 to 150% of drive full-load current.
22. Short-circuit protection by means of three incoming line current limiting fuses.
23. Overcurrent IET (instantaneous electronic trip).
24. Solid state motor overload protection.
25. Power module overtemperature protection by means of integral thermostat.
26. Built-in field current loss protection.
27. Test Buffer/Meter Filter Module provides:
    - 1-volt D-C isolated signal to meter armature current.
    - 4.0-volt D-C isolated signal to meter armature voltage.
    - Buffered interface to allow measurement and monitoring of selected regulator voltages.

2.4 SPECIFICATIONS

General specifications for the D-C V★S Power Module are listed in Table 2.1. Power Module current ratings are furnished in Table 2.2.

2.4.1 Line Voltage

These Power Modules can be operated on either 230-volt or 460-volt incoming power. Power Modules are manufactured and connected at the factory for 460-volt operation. The Power Module can be easily reconnected for operation on 230-volt, three-phase A-C line power as indicated in Section 5 in Figures 5.6, 5.7, and 5.11.

Since the Power Module is basically a current rated device, operation of a given Power Module on 230-volt A-C line power will provide one half the nominal horsepower capability of the 460-volt Power Module rating.

2.4.2 Armature Loop Contactors

An armature loop contactor **must** be used between the phase-controlled power rectifier and D-C motor armature. Power Module logic sequences the contactor and regulator operation in such a way that current flow through the armature loop contactor is never broken in normal operation by contactor contacts. Refer to Figures 2.3 and 2.4. An armature loop contactor is required to provide positive power disconnect in all applications.

WARNING

THE ARMATURE LOOP CONTACTOR IS NOT PROVIDED STANDARD IN THE POWER MODULE. THE USER MUST INSTALL AN ARMATURE LOOP CONTACTOR THAT HAS A 115-VOLT A-C COIL WITH A MAXIMUM CURRENT DRAW OF 440 MILLIAMPERES. ARMATURE REVERSING APPLICATIONS WILL REQUIRE TWO SUCH CONTACTORS. PILOT RELAYS ARE PROVIDED AS AN INTEGRAL PART OF THIS POWER MODULE AND PROVIDE COIL DRIVE AND COORDINATION OF THE ARMATURE LOOP CONTACTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN PERSONAL INJURY.

Table 2.1 — General Specifications

A-C Line Input Voltage
230/460 VAC (nominal, 60 Hz)
220/440 VAC (nominal, 50 Hz)
Three-phase only
Line Voltage Variation
±10% of nominal
A-C Line Frequency
Three-phase, 50/60 Hz
Line Frequency Range
48 thru 62 Hz
Output Voltages (armature and field)
See Table 2.2
Power Module-Drive Horsepower Range
25 thru 150 (with 230 VAC input)
50 thru 300 (with 460 VAC input)
Direction Control
Standard: Unidirection
Optionally: Bidirection
Maximum Speed Adjustment
70 to 100% of base motor speed
(user adjustable)
Minimum Speed Adjustment
5 to 30% of base motor speed.
(user adjustable)
Operator Speed Adjustment
Infinitely adjustable
(up to 100% of base speed)
Operator Torque Adjustment
Infinitely adjustable
(10 to 150% of rated load)
IR Drop Compensation
0 to 12% of rated load
(user adjustable)
Power Module Speed Range
20:1
Current Limit
Factory shipped: 150% of full load
User adjustable: 10 to 150% of full load
Regulation (with 95% load change)
3 to 5% with voltage feedback
1.0% with specific tachometer feedback
0.5% with specific tachometer feedback
Minimum Load for Stable Operation
5%
Acceleration/Deceleration Rates
0.5 to 30 seconds linear time
(user adjustable separately)
Armature Circuit Overload Capacity
150% of armature current rating
for 1 minute (max)
Power Module Efficiency (rated speed/rated load)
99%
Power Module Dissipation
Refer to Paragraph 2.4.3
Displacement Power Factor (rated speed)
86% typical
Transient Protection
MDV and output RC circuit
Power Module Service Factor
1.0
Duty
Continuous
Ambient Temperature (Storage)
-40 to 65°C (-40° to 149°F)
Ambient Temperature (Operational)
0 to 55°C (32 to 131°F)
Relative Humidity (storage and operational)
5 to 95% (without condensation)
Operational Altitude
To 3300 ft (1000 m) above sea level
without derating
Power Module Dimensions and Weight
Refer to Figure 3.1
Wiring Diagram
WD/30071-2 (Refer to Figures 5.6 thru 5.11.)

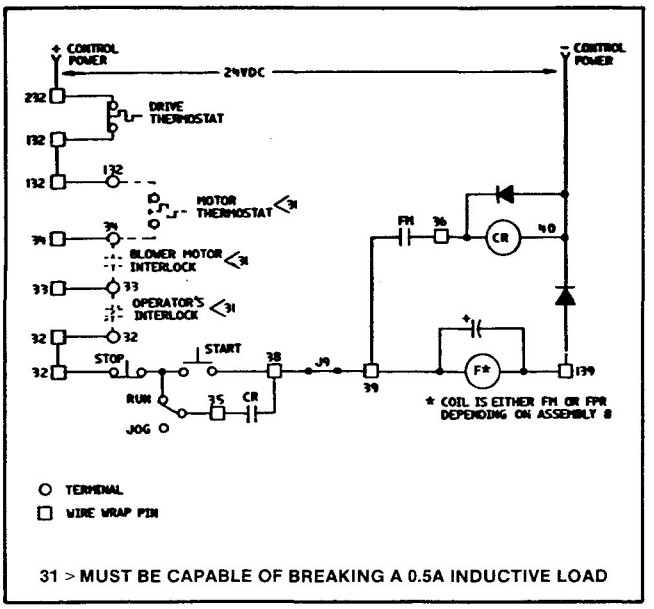


Figure 2.3 — Unidirectional Control Circuit (Simplified)

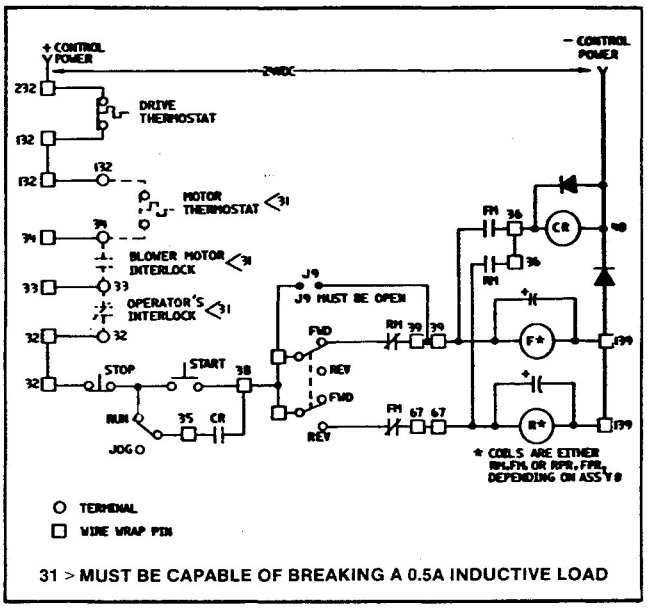


Figure 2.4 — Bidirectional Control Circuit (Simplified)

Table 2.2 — Power Module Current Ratings

HP Ratings	Full Load Rated RMS A-C Line Current (Amperes)		Full Load Rated D-C Armature Current (Amperes)		Field Supply Current Capacity (Amperes) ①		Maximum Allowable Available Symmetrical RMS Fault Current ②		Transformer	
									Rated KVA	Maximum KVA ③
	230V	460V	240V	500V	150V	300V	230V	460V		
25	84	—	93	—	15	—	25000	—	34	880
30	99	—	110	—	15	—	25000	—	40	880
40	127	—	144	—	15	—	25000	—	51	880
50	158	79	178	86	15	15	25000	25000	63	880
60	187	91	212	100	15	15	25000	25000	75	880
75	244	116	265	129	15	15	25000	25000	93	880
100	275	152	325	167	15	15	45000	25000	118	880
125	340	180	400	205	15	15	45000	25000	145	880
150	408	219	480	250	15	15	45000	25000	175	880
200	—	275	—	325	—	15	—	45000	220	1650
250	—	340	—	400	—	15	—	45000	275	1650
300	—	408	—	480	—	15	—	45000	330	1650

① Because of the nature of field loss protective circuitry, this supply must only be used for motor field excitation.

②

WARNING

DO NOT OPERATE THIS POWER MODULE ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF THE MAXIMUM ALLOWABLE VALUES AS LISTED. PERSONAL INJURY AND/OR DAMAGE TO EQUIPMENT COULD OCCUR. EXTERNAL DISCONNECT MEANS MUST HAVE ABILITY TO INTERRUPT AVAILABLE FAULT CURRENT.

③ Drives have been designed for maximum of three units per maximum transformer rating.

2.4.3 Power Module Thermal Considerations

An open chassis Power Module is furnished for mounting within a user-supplied enclosure. The user is responsible for assuring that the maximum temperature within the enclosure remains at or below 55° C (131° F) under worst case operating conditions.

When designing the enclosure ventilating system or when sizing a non-ventilated enclosure in which the Power Module is to be mounted, the energy dissipation of all components within that cabinet must be considered.

Power Module dissipation can be expressed by this equation:

$$\text{Watts Loss} = W_f + (3 \times I_{A\text{-}FL})$$

Where:

W_f = 150 for 25-75 hp, 230 VAC Power Modules
350 for 100-150 hp, 230 VAC Power Modules
150 for 50-150 hp, 460 VAC Power
350 for 200-300 hp, 460 VAC Power Modules

$I_{A\text{-}FL}$ = Full-load rated armature current as listed in Table 2.2.

2.4.4 Efficiency and Power Factor

Figure 2.5 illustrates typical Power Module efficiency versus speed and load.

Displacement power factor is almost entirely a function of operating speed. Figure 2.6 illustrates the displacement power factor versus speed.

2.4.5 Extruder Version Model Numbers

Extruder versions of the power module includes the following accessories:

- M-Contactor (mounted on back panel)
- Auxiliary Contactor (mounted on back panel)
- Test Meter Adapter
- Blower Motor Starter (separately mounted)

Table 2.3 lists the model numbers by horsepower.

Table 2.3 Extruder Version Model Numbers

HP	MODEL NUMBER
50	355C33D
60	355C34D
75	355C35D
100	355C36D
125	355C37D
150	355C38D
200	355C39D
250	355C40D
300	355C41D

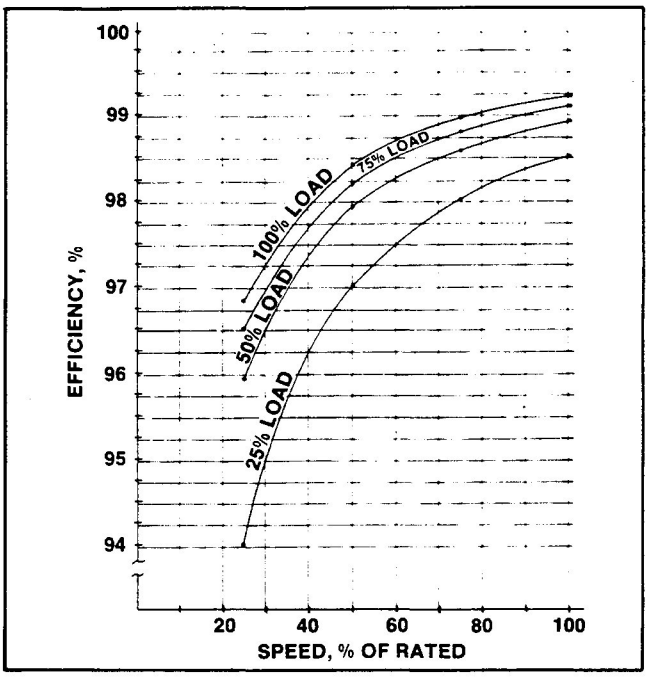


Figure 2.5 — Power Module Efficiency

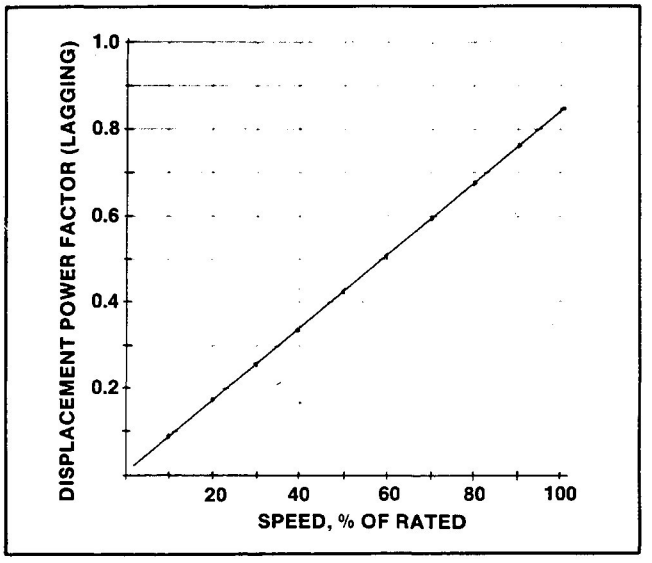


Figure 2.6 — Displacement Power Factor

Section 3
INSTALLATION

3.0 GENERAL

This section outlines the procedures that are to be followed in order to properly install the D-C V★S Power Module.

The D-C motor must be installed and wired in accordance with its own installation instructions.

The following general warnings should be kept in mind **before** planning begins. They should be considered a general checklist which, if followed, will minimize installation problems and decrease assembly time.

DANGER
THE POWER MODULE SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT. SEVERE OR FATAL INJURY AND/OR EQUIPMENT DAMAGE COULD OCCUR IF INDIVIDUALS ARE NOT FAMILIAR WITH THE HAZARDS RESULTING FROM IMPROPER OPERATION.

DANGER
EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER MODULE. ALL PHASES OF THE A-C POWER LINE MUST BE DISCONNECTED FROM THE POWER MODULE BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT. SEVERE OR FATAL INJURY COULD RESULT UNLESS POWER IS REMOVED.

DANGER
BE ABSOLUTELY CERTAIN THAT A GROUND WIRE FROM THE INCOMING A-C POWER LINE IS PROPERLY CONNECTED TO THE CHASSIS GROUND TERMINAL PROVIDED. WITHOUT PROPER GROUNDING, FATAL INJURY COULD OCCUR.

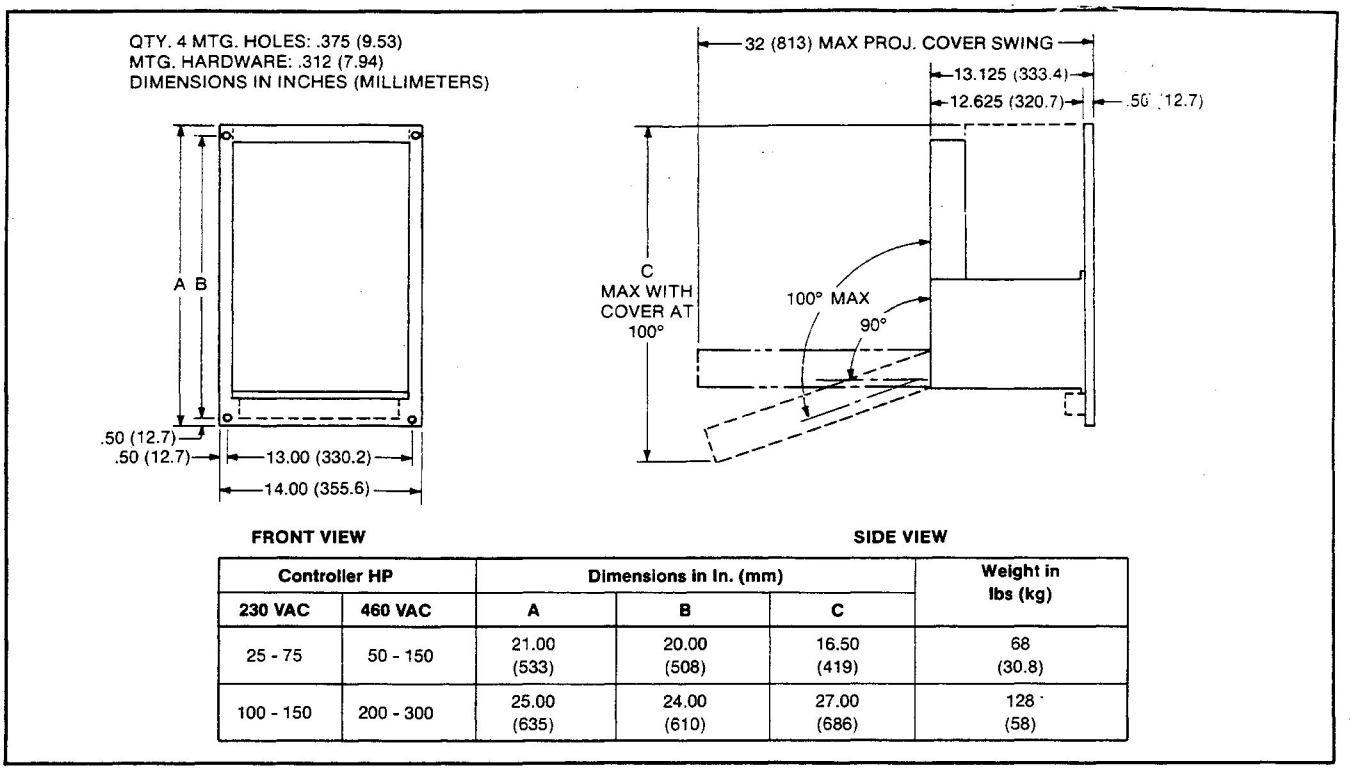
WARNING
THE POWER MODULE REQUIRES A THREE-PHASE POWER SUPPLY THAT PROVIDES EITHER 230 VAC OR 460 VAC AT 60 HZ OR 220 VAC OR 440 VAC AT 50 HZ. IF CORRECT VOLTAGE IS NOT AVAILABLE, IT WILL BE NECESSARY TO INSTALL A TRANSFORMER BETWEEN THE POWER SUPPLY AND THE POWER MODULE. DO NOT OPERATE THIS POWER MODULE ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF THE MAXIMUM ALLOWABLE AVAILABLE SYMMETRICAL RMS FAULT CURRENT AS LISTED IN TABLE 2.2. PERSONAL INJURY AND/OR DAMAGE TO EQUIPMENT COULD OCCUR. EXTERNAL DISCONNECT MEANS MUST HAVE ABILITY TO INTERRUPT AVAILABLE FAULT CURRENT.

WARNING
THE USER IS RESPONSIBLE FOR CONFORMING WITH THE NATIONAL ELECTRICAL CODE WITH RESPECT TO MOTOR, POWER MODULE AND OPERATOR DEVICE INSTALLATION, WIRING AND STARTUP. THE USER IS ALSO RESPONSIBLE FOR UNDERSTANDING AND APPLYING ALL OTHER APPLICABLE LOCAL CODES WHICH GOVERN SUCH PRACTICES AS WIRING PROTECTION, GROUNDING, DISCONNECTS AND OVERCURRENT PROTECTION. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN PERSONAL INJURY AND/OR EQUIPMENT DAMAGE.

3.1 OPEN CHASSIS POWER MODULES

The Power Module is provided in an open chassis configuration for installation within a customer-supplied enclosure. Open chassis dimensions are provided in Figure 3.1. The user is responsible for assuring that the maximum temperature within the enclosure remains at or below 55°C (131°F) under worst case operating conditions.

When designing the enclosure ventilating system or when sizing a non-ventilated enclosure in which the Power Module is to be mounted, the energy dissipation of all components within that cabinet should be considered. Power Module dissipation is defined in Paragraph 2.4.3.



Controller HP		Dimensions in In. (mm)			Weight in lbs (kg)
230 VAC	460 VAC	A	B	C	
25 - 75	50 - 150	21.00 (533)	20.00 (508)	16.50 (419)	68 (30.8)
100 - 150	200 - 300	25.00 (635)	24.00 (610)	27.00 (686)	128 (58)

Figure 3.1 — Open Chassis Power Module Mounting Data

3.2 LAYOUT GUIDELINES

This paragraph lists recommended layout procedures common to all D-C V★S Power Modules described by this manual.

Guideline 1 — Power Modules are designed to be hung within 10° of vertical. **Do not** mount on a horizontal surface.

Guideline 2 — In locating the open chassis Power Module, it is necessary to leave at least 4 inches (102 mm) clearance between Power Modules, including top, bottom and sides. This unobstructed area allows for proper air circulation through the phase rectifier. **Do not** place directly in a corner. Leave it at least 8 inches (200 mm) from the top or 6 inches (150 mm) from the bottom of the enclosure. (See Figure 3.2.) Heat builds up at the top of the enclosure and may exceed the permissible inside ambient temperature upper limit. At the bottom of the enclosure, the Power Module must be high enough to allow air to flow upwards. Refer to Paragraph 3.3 for mounting instructions.

Guideline 3 — Regardless of the above placement guidelines, the user is responsible for providing ambient temperatures that meet the Power Module's specifications:

- 0 to 55° C for open chassis.
- 5 to 95% relative humidity **without** condensation.

Guideline 4 — Incoming three-phase A-C power terminations are located at the top of the Power Module. Outgoing armature power terminations are located at the top of the Power Module. Control and signal wiring terminations are located at the bottom of the Power Module. (See Figure 3.3.)

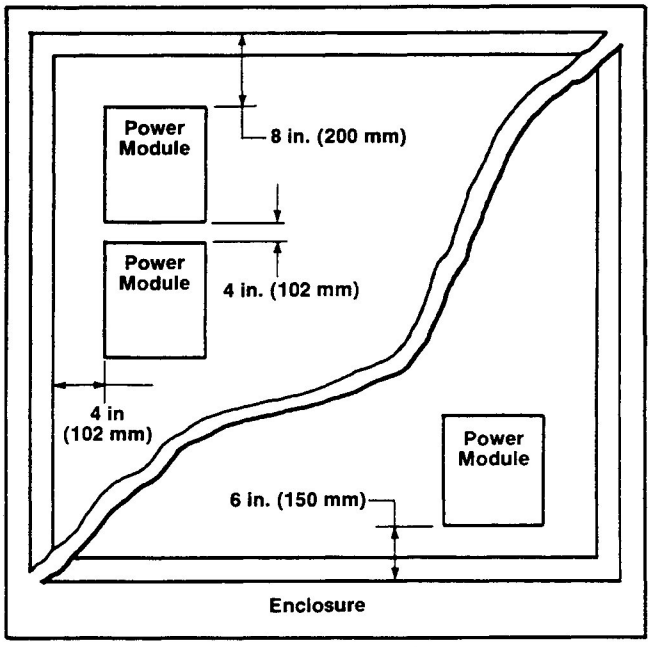


Figure 3.2 — Enclosure Mounting Minimum Distances

Guideline 5 — **Do not** route the tachometer feedback signal cable, if used, with A-C or D-C control or power wiring. Also use the specified wire for this function.

Guideline 6 — Although auto-transformers may step up and step down A-C power supply voltage, they **do not** isolate the driven system from the A-C line. Users should consider using an isolation transformer if the application conditions warrant it.

If an isolation or auto-transformer is used ahead of the Power Module, the disconnect switch should be placed on the A-C power line between the power source and the transformer primary. Again, use a fused disconnect switch. (**Do not** use a circuit breaker type switch because of the high inrush of transformer equipment.)

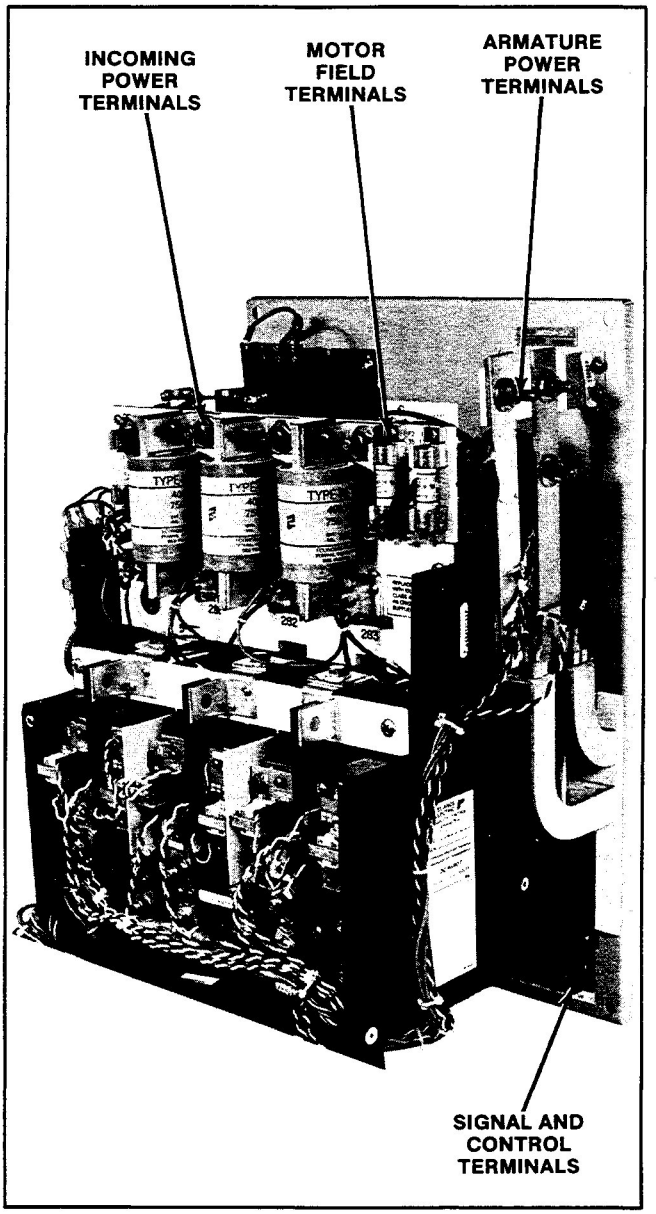


Figure 3.3 — Wiring Entries

An isolation transformer is not necessary unless the application conditions require one. However, its use provides distinct advantages:

- Risk of personal injury is reduced should accidental contact be made with an electrical conductor from the drive.
- A-C power line disturbances, or transients, are minimized by an isolation transformer, thereby reducing or eliminating damage to other solid-state equipment, power-conversion components in the Power Module and other user-equipment on the same A-C line.
- The transformer provides electrical isolation between the A-C power lines and the drive motor. Damaging currents may be eliminated in instances where a D-C output accidentally becomes grounded in a unit where the A-C electrical system is grounded.

For detailed information, refer to Paragraph 3.5.

Guideline 7 — The National Electrical Code requires that a three-pole, fused disconnect switch be installed on the incoming A-C line **ahead** of the Power Module to provide branch circuit protection. The fuse should be Class K5.

It is recommended that the disconnect switch be placed within easy reach of operating and maintenance personnel. **Do not** place it inside a surrounding enclosure since cabinet doors may be locked. (Consult your local codes.)

Guideline 8 — It is necessary to connect the GND (green/ground) wire of the four-conductor incoming A-C line to the terminal provided on the chassis. Ring type connectors are recommended. The user must be sure that the ground wire is connected to the plant ground at the source. The motor frame should also be grounded.

Guideline 9 — If a thermostat is used to provide motor overload protection, it is essential to properly connect the motor thermostat to terminals 34 and 132.

NOTE: *The drive will not start unless external overload or interlock devices are connected between terminals 32, 33, 34 and 132. Refer to Figure 3.4.*

Guideline 10 — When planning signal or control wire runs, follow these practices:

- Conduits should be steel.
- If these conduits cross 460 VAC conductors, make sure the cross is at 90°.
- Do not route signal wires through junctions or terminal boxes that contain non-signal A-C or D-C (115/230/460V) wires.

Guideline 11 — Operational altitude above sea level may not exceed 3300 ft (1000 m). Derate horsepower 3% for each 1000 ft (300 m) above this altitude.

3.3 POWER MODULE MOUNTING

This paragraph outlines the procedures to be followed to mount the Power Module.

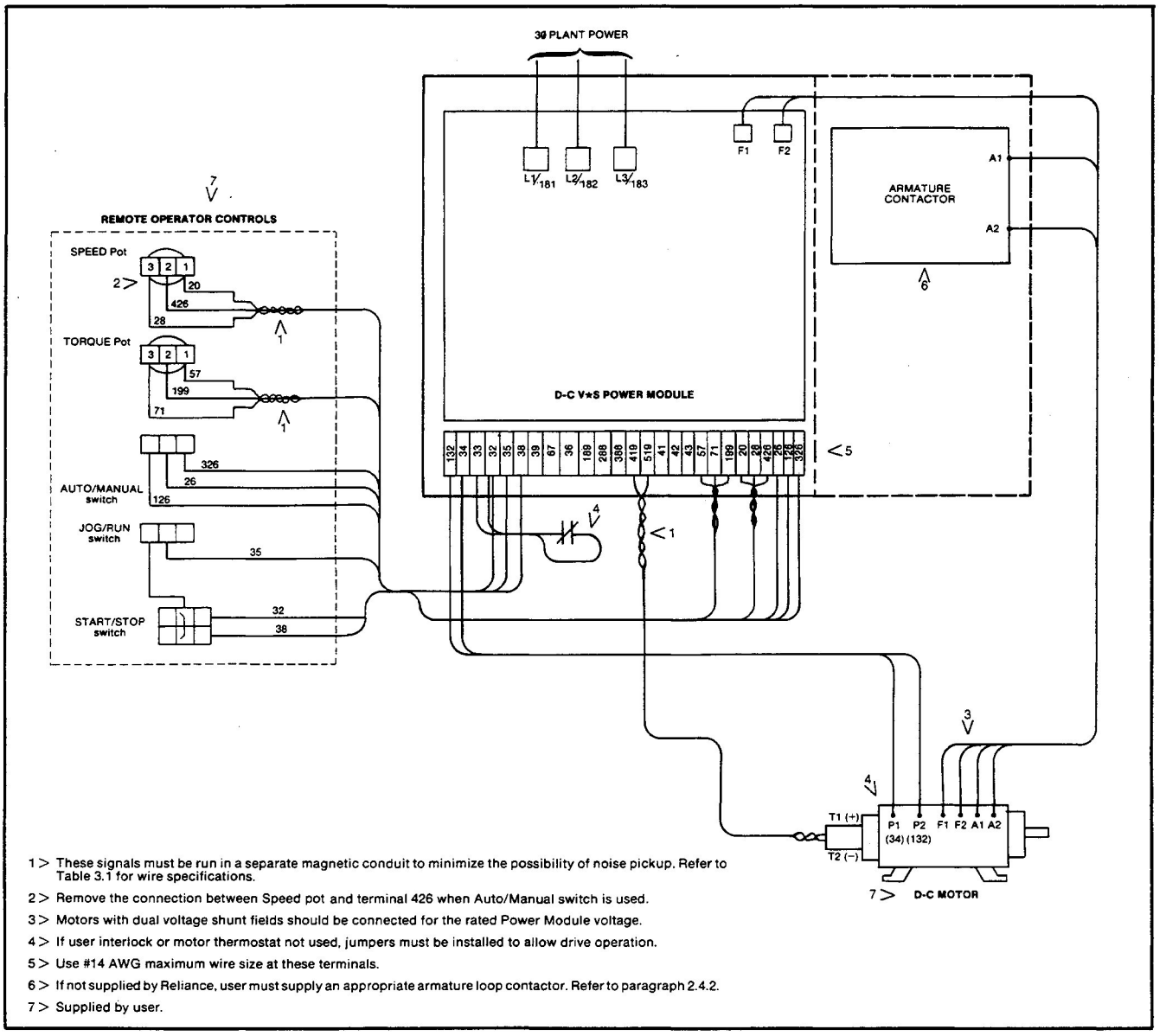
Determine the exact placement of the chassis on the panel following Guideline 2 of Paragraph 3.2. (Refer to Figure 3.1 for mounting dimensions.) Scribe the panel. Drill all holes large enough to accept 5/16-inch mounting bolts. Scrape the paint around the holes to allow washers and bolts to make solid ground contact.

3.4 POWER WIRING

This paragraph briefly outlines the procedures to be followed when wiring A-C power supply lines to the Power Module and D-C power circuits to the drive motor. A basic connection diagram is given at Figure 3.4.

DANGER

BEFORE WIRING, MAKE SURE THAT A-C LINE DISCONNECT SWITCH IS LOCKED OPEN. EVEN IF POWER HAS NOT BEEN APPLIED TO THE INCOMING LINE, THIS PRACTICE ASSURES PERSONAL SAFETY. IF NO LOCKOUT DEVICE EXISTS, REMOVE THE FUSES WITH AN INSULATED TOOL AND PLACE A WARNING TAG ON THE BOX. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN FATAL INJURY.



1 > These signals must be run in a separate magnetic conduit to minimize the possibility of noise pickup. Refer to Table 3.1 for wire specifications.

2 > Remove the connection between Speed pot and terminal 426 when Auto/Manual switch is used.

3 > Motors with dual voltage shunt fields should be connected for the rated Power Module voltage.

4 > If user interlock or motor thermostat not used, jumpers must be installed to allow drive operation.

5 > Use #14 AWG maximum wire size at these terminals.

6 > If not supplied by Reliance, user must supply an appropriate armature loop contactor. Refer to paragraph 2.4.2.

7 > Supplied by user.

Figure 3.4 — System Connection Diagram for Non-Reversing Applications (Refer to Figure 5.8 for Reversing Application)

WARNING

THE ARMATURE LOOP CONTACTOR IS NOT PROVIDED STANDARD IN THE POWER MODULE. THE USER MUST INSTALL AN ARMATURE LOOP CONTACTOR THAT HAS A 115-VOLT A-C COIL WITH A MAXIMUM CURRENT DRAW OF 440 MILLIAMPERES. ARMATURE REVERSING APPLICATIONS WILL REQUIRE TWO SUCH CONTACTORS. PILOT RELAYS ARE PROVIDED AS AN INTEGRAL PART OF THIS POWER MODULE AND PROVIDE COIL DRIVE AND COORDINATION OF THE ARMATURE LOOP CONTACTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN PERSONAL INJURY.

All interconnecting wire should be sized and installed in conformance with NEC, CEC or local codes. Refer to the Power Module and motor nameplates for electrical data. Note that long cable runs may require that a larger gauge be used to avoid excessive voltage drop. Use of stranded wire, up to 19 strand, is also recommended. Wire according to Figure 3.4 and Table 3.1.

After wiring, examine all terminals to determine that connections are correctly made at **both** ends. Confirm wire identification. Examine the firmness of the connections.

WARNING

DO NOT ALLOW CONDUCTORS TO GROUND ON THE CHASSIS. CHECK INTEGRITY OF ALL WIRE INSULATION BEFORE DRAWING. REMOVE ONLY ENOUGH INSULATION TO MAKE A FIRM TERMINAL CONNECTION. PERSONAL INJURY COULD RESULT IF A BARE WIRE TOUCHES THE CHASSIS.

3.5 ISOLATION TRANSFORMERS

Although an auto-transformer may be required because of A-C line voltage levels, it is unable to provide a number of benefits standard with an isolation transformer.

The general requirements for an isolation transformer are:

- Three-phase
- 3 to 8% impedance
- Nonregulated
- Sinusoidal output
- 50/60 Hz, as required
- 150% overload for 1 minute (max.)

Table 3.1 — Wire Specifications

Use in Power Module	Type Conductor	Required Characteristics	Acceptable Types
Remote Operator Control Station: • AUTO/MANUAL • JOG/RUN • START/STOP	• Single conductor and/or multi-conductor	• Stranded copper • AWG No. 16 • 600 VAC rating • Insulation; polyvinyl chloride (PVC) • Temperature range: 40°-105° C (104°-221° F) • Unshielded	• Any single conductor meeting NEC required characteristics
Remote Operator Control Station: • SPEED pot • TORQUE Pot	• Three-conductor • Twisted with two twists per inch	• Stranded copper (19 x 29) • AWG No. 16 • 600 VAC rating • Twist per foot: 24 (½-inch lay)	• User may twist single conductors of required specifications • Reliance Part No. 417900-79X or equivalent
• Tachometer Feedback	• Two-conductor • Twisted pair with two twists per inch	• Insulation: polyvinyl chloride (PVC) • Temperature range: 40°-105° C (104°-221° F) • Unshielded	• User may twist single conductors of required specifications. • Reliance Part No. 417900-76EAD or equivalent

Refer also to Table 2.2 for specific information on transformer sizing requirements. In the "Transformer" column at the right, maximum KVA and rated KVA figures are listed in relation to specific D-C motor hp/VAC ratings.

Reliance Electric offers a number of isolation transformers suitable for use with this Power Module.

3.6 HP/CURRENT SCALING JUMPERS

It is necessary to inspect the HP/Current Scaling jumpers on the Regulator Module to be sure that they are connected correctly for a specific drive motor.

Step 1 — On the drive motor, locate the nameplate. Note the nameplate horsepower.

Step 2 — On the Regulator Module, locate the scaling pins and, near them, the black pigtail jumpers (Figure 3.5). Do not move the pigtail jumpers if they are connected to the proper pins. Refer to Table 3.2 for the proper pins. If the pigtail jumpers must be reconnected, carefully lift the connector housing straight up and off the pins. Slide the connectors straight down over the proper pins. If the number of connections listed in the "Pin Connections" column of Table 3.2 indicates fewer jumper connections than there are jumpers, connect any of the pigtail jumpers to the listed pin(s) and allow the remaining pigtail jumper(s) to hang free and unconnected.

Table 3.2 — Horsepower Calibration

HP Rating	Pin Connections	
	230 VAC	460 VAC
25	5.7 & 10	—
30	5.7 & 13	—
40	5.7 & 19	—
50	10 & 19	5.7 & 10
60	36	5.7 & 13
75	5.7 & 36	45
100	19 & 36 ①	10 & 19
125	5.7, 27, 36 ①	36
150	5.7, 13, 27, 36 ①	5.7 & 36
200	—	19 & 36 ①
250	—	5.7, 27, 36 ①
300	—	5.7, 13, 27, 36 ①

① The larger of these Power Modules (100, 125 and 150 hp at 230-volt A-C input and 200, 250 and 300 hp at 460-volt A-C input) **cannot** be recalibrated to operate motors smaller than 100 hp (230-volt A-C input) or 200 hp (460-volt A-C input). With that exception, Power Modules may be readily recalibrated for alternate horsepowers.

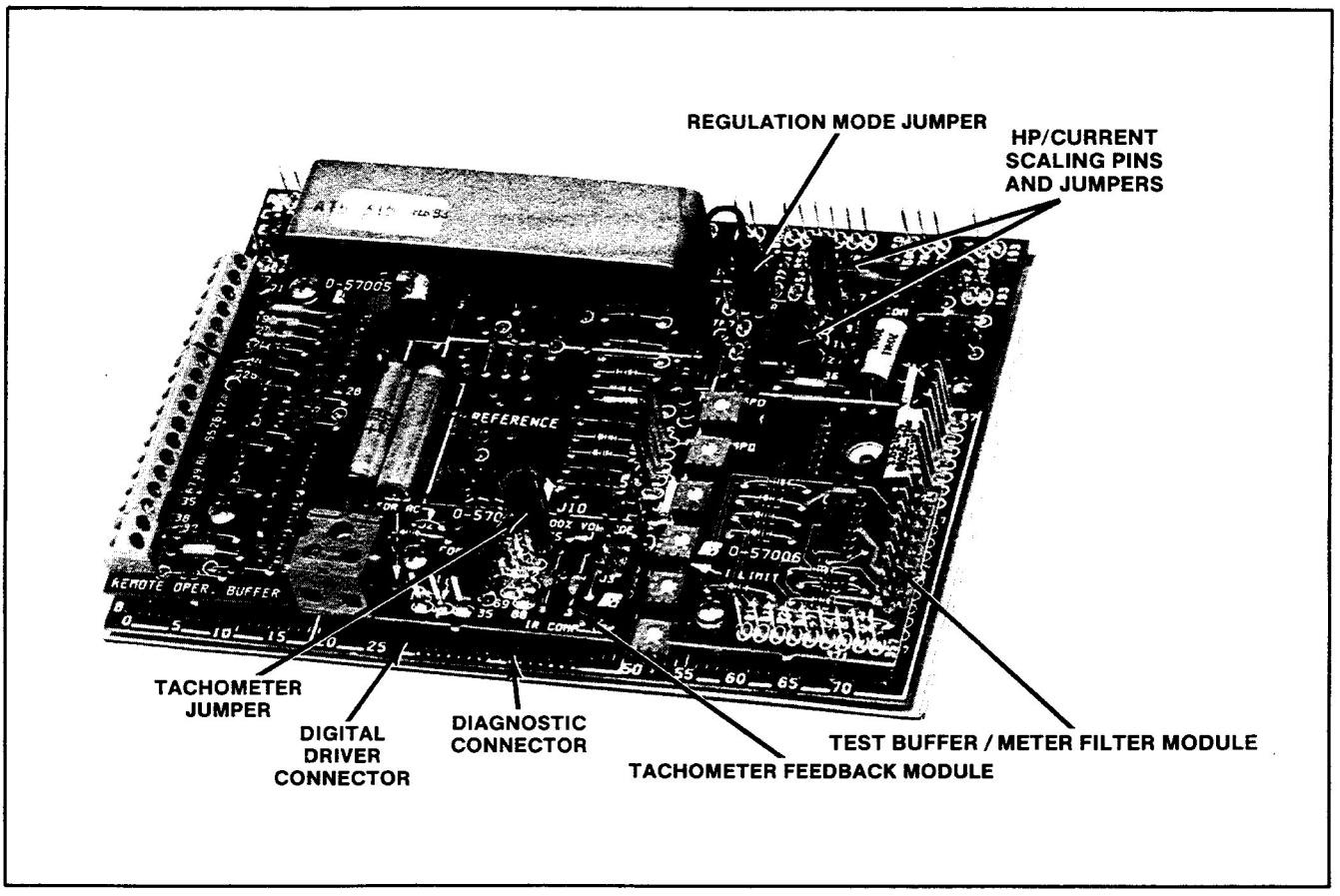


Figure 3.5 — Important Details of Regulator Module

3.7 REGULATION MODE JUMPER

This Power Module offers two types of drive regulation. The first, which is factory-shipped, is armature voltage feedback (A).

Optionally, the user may also use tachometer feedback (T) regulation. The model-number Power Modules are equipped with circuitry (Tachometer Feedback Module 0-57004) to accept tachometer feedback from either an A-C or D-C tachometer if so desired. Refer to Figure 3.5.

DANGER
IF UNSURE WHICH REGULATION MODE THE POWER MODULE SHOULD HAVE, IT IS IMPORTANT TO FIND OUT. IF THE JUMPER IS NOT PROPERLY CONNECTED, FATAL INJURY COULD RESULT.

3.7.1 Armature Voltage Regulation

Check to be certain that the regulation mode jumper is in the voltage feedback (A) position (Figure 3.5). With this done, the drive will operate as an armature voltage regulator.

3.7.2 Tachometer Feedback Regulation

1. Connect twisted pair tachometer wires T1 (+) and T2 (-) to terminals 519 and 419, respectively, on the signal/control wiring terminal board along the lower edge of the Power Module. Maintain the twist as long as possible.
2. Place the black pigtail jumper of the Tachometer Feedback Module on one of its ten pins. Exactly which depends on the voltage scaling factor. On the motor's nameplate, find the base speed (rpm). On the tachometer's nameplate, find the output voltage per 1000 rpm.

   Take these two figures and relate them to Table 3.3. Read across to the right column where the 100% voltage figure is indicated. Place the jumper on the pin that corresponds to the value selected.

DANGER
WHEN A REVERSING CONTACTOR IS INSTALLED OR FOR ANY REASON THE TACHOMETER OUTPUT VOLTAGE IS REVERSED, JUMPERS J1 AND J2 ON THE TACHOMETER FEEDBACK MODULE MUST BE REMOVED REGARDLESS OF THE TYPE TACHOMETER USED. FATAL INJURY COULD RESULT IF THIS PROCEDURE IS NOT FOLLOWED.

3. If an A-C tachometer is being used, complete this step; otherwise, proceed to Step 4.

   Locate jumpers J1 and J2 on the Tachometer Feedback Module (Figure 3.6). Clip out and discard these jumpers for operation with an A-C tachometer.
4. Turn the IR potentiometer fully CCW since IR compensation is not used with tachometer feedback. If IR compensation is left in the circuit, erratic operation may result.
5. Place the regulation mode jumper on the Regulator Module in the tachometer feedback (T) position (Figure 3.5).

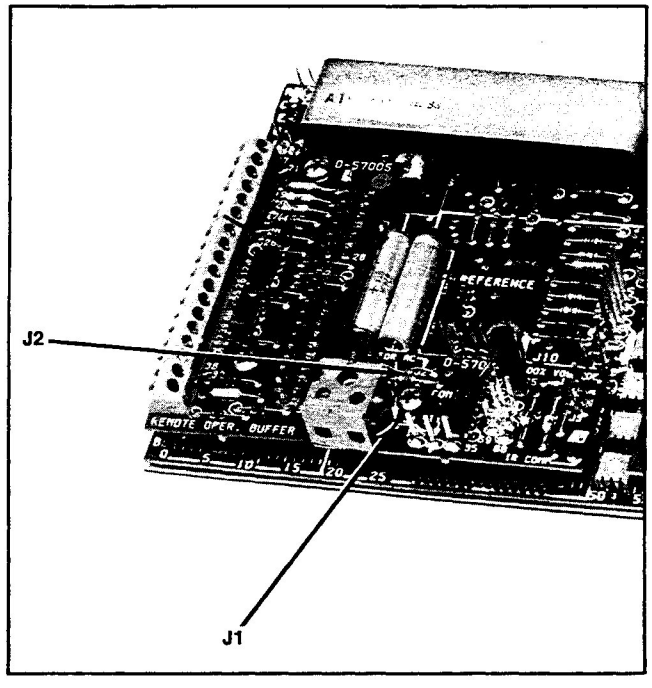


Figure 3.6 — Jumpers J1 and J2 on Tachometer Feedback Module

Table 3.3 — Tachometer Voltage Scaling

Motor Base Speed (rpm)	Tachometer (volts/1000 rpm)	100% Voltage Connection
1150	20 VDC	23
1750	20 VDC	35
1150	50 VDC	58
3450	20 VDC	69
1750	50 VDC	88
1150	100 VDC	115
3450	50 VDC	175
1750	100 VDC	175
1150	45 VAC	52
1750	45 VAC	79
3450	45 VAC	155

3.8 OVERSPEED WARNING

DANGER
THE MACHINERY BUILDER IS RESPONSIBLE FOR INSURING THAT DRIVEN MACHINERY, ALL DRIVETRAIN MECHANISMS NOT SUPPLIED BY RELIANCE ELECTRIC AND PROCESS LINE MATERIAL ARE CAPABLE OF SAFE OPERATION AT MAXIMUM SPEEDS. FAILURE TO DO SO CAN RESULT IN DESTRUCTION OF MECHANISM OR MATERIAL AND FLYING FRAGMENTS, ENDANGERING OPERATING PERSONNEL.

The D-C motor is performance rated to develop nameplate horsepower when operated at rated base speed. The base speed of the D-C motor is defined as the speed at which the motor will operate when excited with rated armature terminal voltage, rated shunt field current and when coupled to a driven load requiring rated torque. The actual speed at which the motor will run under these conditions will fall within a range of ±7.5% from nameplate base speed. Typical base speeds for industrial D-C machines include 650, 850, 1150, 1750 and 2500 rpm.

Many D-C machines are also performance rated to operate above base speed in a "constant horsepower" or "field weakened" mode. These D-C machines may be incorporated into adjustable speed drive systems which allow controlled reduction in shunt field current while maintaining rated armature terminal voltage. When so operated, most of these motors will deliver their rated horsepower at any speed between base speed and the indicated maximum field weakened speed. A D-C machine with an 1150 rpm base speed and the capability to be operated to 1950 rpm in a field weakened mode will be nameplated 1150/1950 rpm.

Although rarely encountered, a single component failure may occur within the drive Power Module that can apply armature voltages in excess of 100% rated armature voltage to the motor, causing the motor speed to significantly exceed either base speed or rated field weakened speed. Under these conditions, motor speed may be unresponsive to the Operator's SPEED potentiometer and/or other speed references. Should such a condition occur, the drive must be quickly stopped using the appropriate "stop" device, and the fault condition located and corrected before returning the drive to operation.

During such a condition, the D-C motor, associated drivetrain equipment, driven machinery and the driven process itself may be subjected to operating speeds well in excess of normal rated speeds. As such, the following considerations are necessary:

All Reliance Electric Drive packages manufactured after February 1, 1982, (in which the motor and Power Module are both manufactured by Reliance Electric and furnished together on the same Reliance Sales Order) have a maximum safe speed (MSS) in excess of the speed that would occur under the single-point failure discussed above or are equipped with a speed limiting device such as tachometer loss and overspeed protection, armature voltage relays or a motor overspeed switch.

Assume the drive equipment is operated on three-phase power supplies listed below.

Rated Armature Voltage	Rated A-C Line Voltage	Maximum A-C Line Voltage
240 volts D-C	230 volts A-C	253 volts A-C
500 volts D-C	460 volts A-C	506 volts A-C
600 volts D-C	550 volts A-C	605 volts A-C

If the above A-C and D-C voltage conditions are not applicable to the installation in question, then it becomes the responsibility of the user to calculate attainable motor speed under the single component failure condition using the procedure outlined below and to verify that this speed does not exceed the MSS of the motor.

Calculation Procedure:

$$S_{MAX} = 1.49 \times \frac{VAC}{Eg\,(NL)} \times S_B$$

Where:

S_{MAX} = Attainable motor speed under the single component condition
VAC = Nominal RMS line-to-line voltage
Eg(NL) = Armature voltage no load
S_B = Base speed at full field and rated armature voltage

The motor maximum safe speeds, which vary as a function of motor frame diameter, are listed below. Examination of the motor nameplate may indicate an MSS slightly different for that specific machine. In that case, motor nameplate MSS takes precedence.

Reliance Motor Frame Size	Maximum Operating Speed, rpm	Reliance Motor Frame Size	Maximum Operating Speed, rpm
56	5500	B400ATZ	2760
B160	5000-5200	B500ATZ	2650
B180ATZ	5000	B580ATZ	2475
B210ATZ	4500	B680ATZ	2100
B250ATZ	4500	B840ATZ	1720
B280ATZ	4500	B960ATZ	1600
B320ATZ	3600	B1200	1600
B360ATZ	3400	B1400	1440
		B1600	1200

CAUTION: Motor frames not listed in the above tabulation, or motors manufactured by others, may not operate within their maximum safe speeds when a single-point failure occurs. In these cases, it becomes the responsibility of the user to verify the motor maximum safe operating speed and confirm (using the procedure above) that attainable motor speed under a single-point fault condition falls below the maximum safe operating speed.

Section 4
STARTUP AND ADJUSTMENTS

4.0 GENERAL

This section provides startup and adjustment procedures to be followed after the assembly and installation of the Power Module is complete. All initial operation checks and final adjustments to the Power Module **must** be made in conformance to the procedures, warnings and recommendations listed here.

DANGER
THE POWER MODULE SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT. SEVERE OR FATAL INJURY AND/OR EQUIPMENT DAMAGE COULD OCCUR IF INDIVIDUALS ARE NOT FAMILIAR WITH THE HAZARDS RESULTING FROM IMPROPER OPERATION.

DANGER
EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER MODULE. ALL PHASES OF THE A-C POWER LINE MUST BE DISCONNECTED FROM THE POWER MODULE BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT. SEVERE OR FATAL INJURY COULD RESULT UNLESS POWER IS REMOVED.

4.1 TEST EQUIPMENT

The only test equipment needed to perform this startup and adjustment procedure is a volt-ohmmeter with a minimum sensitivity of 20,000 ohms per volt. Simpson Model 260, Triplett Model 630 or equivalents are acceptable.

Reliance Electric offers several devices to aid the user in measuring regulator voltages, monitoring key drive points, and performing automatic diagnostic testing.

4.1.1 Test Buffer/Meter Filter Module (Standard)

The standard Test Buffer/Meter Filter Module (0-57006) provides ready access to a number of key signals by interfacing the Regulator Module and the user's voltmeter. See Figure 3.5. Table 4.1 lists the functions that can be measured and the appropriate terminals to monitor for the respective function.

4.1.2 Status/Diagnostics Indicator (Optional)

The optional Status/Diagnostics Indicator mounts on the front surface of the Power Module (Figure 4.1) and utilizes an LCD to visually annunciate the status of thirteen critical drive functions and to indicate drive shutdown as a result of protective circuit action. Refer to Table 4.2 for a summary of the functions monitored along with a probable cause of malfunction with corrective action for each function.

The LCD consists of two bars: a left-hand (vertical solid strip) and a right-hand (thirteen vertical bar segments) that are to the left of the thirteen functions printed on the faceplate. The left bar flashes on and off at a rate of about one cycle per second when any of the protective circuits activate, indicating a malfunction. Simultaneously, a right-hand bar segment appears beside the protective circuit function, printed on the faceplate, that tripped. In this way, the user can quickly identify the protective circuit whose operation caused a drive shutdown, remedy the fault, and return the drive to operation.

The bottom three segments of the right bar of the LCD indicate the following when lit (the left bar will be off):

- Input power applied to the Power Module (REGULATOR ON).

Table 4.1 — Test Buffer/Meter Filter Module Functions

For Function	Use Terminals	Normal Indication (VDC)
Unregulated +20 VDC Power Supply	+456 −357	16-28
Unregulated −20 VDC Power Supply	−471 +357	16-28
Regulated +11.2 VDC Power Supply	+356 −357	10.8 - 11.5
Regulated −11.2 VDC Power Supply	−371 +357	10.8-11.5
Drive Reference Signal	+826 −357	0-9.6
Major Loop Feedback	−819 +357	0-4.0
Armature Voltage Feedback	−816 +357	0-4.0
Current Feedback	−817 +357	0-1.0

Table 4.2 — Summary of Status/Diagnostics Indicator Functions with Corrective Action

Function	Cause	Action
Field Loss	Loss of field excitation	Replace field bridge.
	Open field in motor	Repair motor.
	Open/shorted field circuit wiring	Correct wiring problem.
	Blown fuse in field supply	Check for short in field wiring or motor. Replace fuse.
IET	Excessive load conditions in armature circuit	Reset pushbutton.
	Continuous tripping of IET and blowing of incoming line fuses	Look for short or low impedance in armature circuit. Correct problem and reset drive.
Static Overload	Excessive loads for periods above drive specifications	Limit loading to rating. Reset pushbutton.
Phase Loss	Loss of a phase on the three-phase incoming line	Check incoming line conditions. Take corrective action.
Line Sync	Phase relationship on the incoming line is out of specification	Check incoming line conditions. Take corrective action.
	Excessive incoming line notching	Correct line conditions by adding line filters, isolation transformers, etc.
Undervoltage	Incoming line potential has dipped to an insufficient level	Check incoming line conditions. Take corrective action.
Drive Thermostat	Excessive drive heating	Check ventilation systems for drive enclosure. Check drive ambient conditions against specifications. Review loading conditions on drive and take corrective action.
	Open thermostat in drive	Replace thermostat.
Motor Thermostat	Excessive motor heating	Check motor ventilation system. Check for dirty filter on blower. Check motor ambient conditions. Review loading conditions on motor and take corrective action.
	Open thermostat in motor	Replace thermostat.
Blower Motor	Blower motor interlock has dropped out — overloads	Check ventilation system of motor, especially filter conditions.
	Fuses blown on starter	Check out condition of blower motor. Replace fuse and correct condition on motor.
Interlock (This function is for an interconnection of a machine interlock to shut down the drive under an emergency situation)	Fault or emergency condition exists on machine being driven by Power Module	Correct condition on machine.
Current Limit	Drive is operating at current limit setting	None necessary.
Run	Control circuitry in run mode condition	None necessary.
Regulator ON	+11.2-volt power present on the Regulator Module	None necessary.

- Armature loop contactor coil energized (RUN).
- Armature current equal to the setting of the current limit adjustment (CURRENT LIMIT).

Refer to Instruction Manual D-3963 for complete operating details.

4.2 POWER OFF INSPECTION

It is necessary to make a physical inspection of the Power Module and its associated units. The purpose of this check is to look for possible physical damage or improper connections.

Inspect all plug-in circuit boards. Test each for a firm mounting condition.

Each should be mechanically connected to the Regulator Module by means of a mounting post screw and electrically connected to the Regulator Module by a series of parallel pins. If any of the pins are bent, improper operation could result. Examine the pins to make sure they are perfectly parallel. Only one pin may fit through a hole in the circuit board.

Inspect all screw terminal connections. Make sure the wires are firmly connected. Also make sure that there is enough insulation on the wires to prevent a short between the conductors.

Inspect the signal wiring from the Operator's Control Station. A series of wires will connect to individual terminals on the signal/control wiring terminal strip mounted along the lower edge of the Power Module. Determine that all wires are firmly seated in the terminal strip. Make sure all wires are connected.

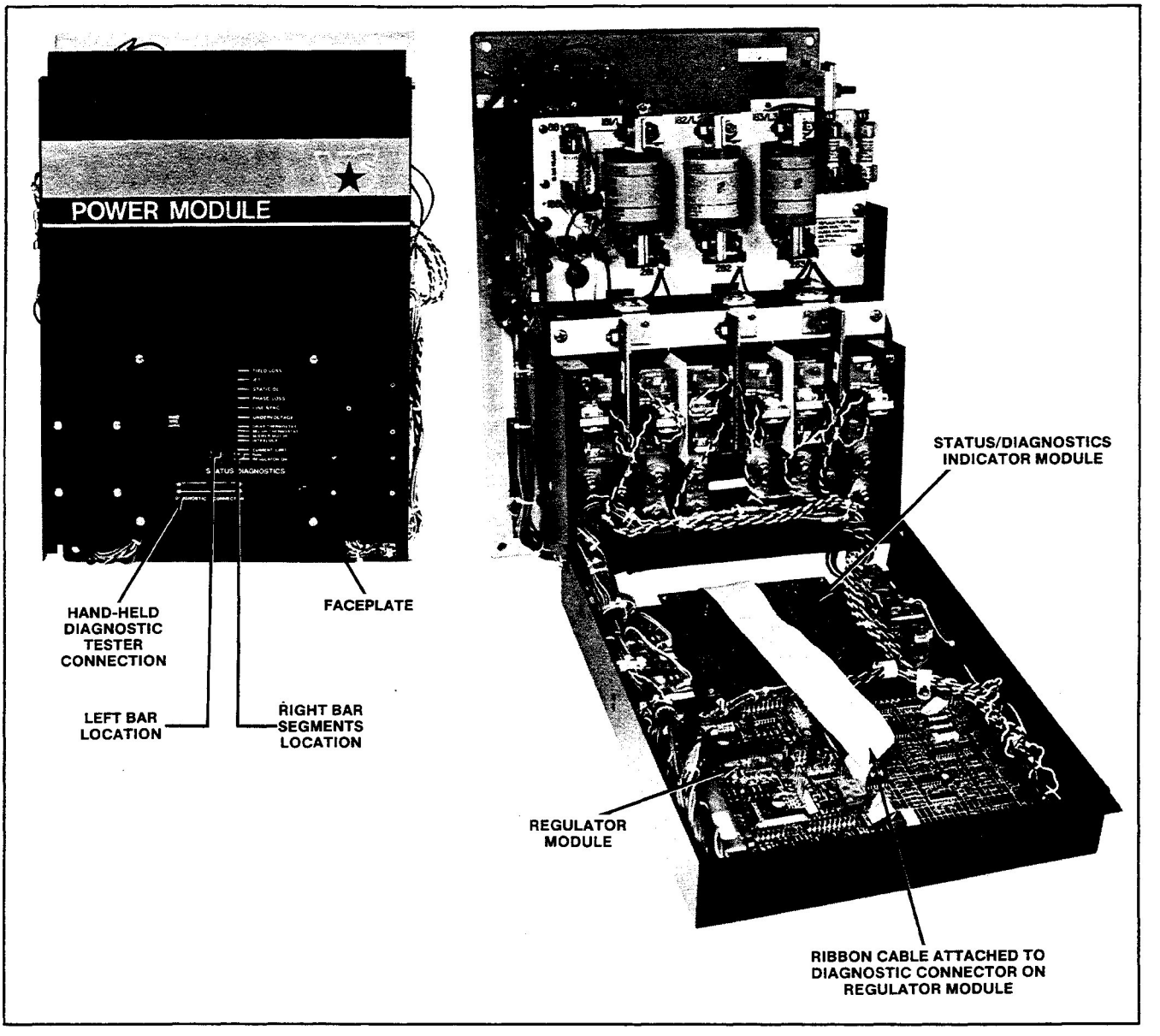


Figure 4.1 — Status/Diagnostics Indicator Installed

4.3 MOTOR GROUND CHECK

Check the drive motor to assure that no damaging grounds, other than earth ground, exist within the motor.

> **CAUTION:** If a megger is used for this test, all conductors between the drive motor and the Power Module must be disconnected and moved aside. The megger's high voltage can cause damage to the Power Module's circuits.

Step 1 — Attach one lead from an ohmmeter to the motor frame to make a simple resistance check.

Step 2 — Touch the test probe to each of the two power, two thermostat, and two field leads to the motor. If the reading to ground on any terminal is **less than** 100,000 ohms, a ground condition exists.

Step 3 — If a ground condition exists, inspect the motor thoroughly for internal shorts.

Step 4 — When the grounding condition is corrected, reconnect the conductors from the Power Module.

4.4 POWER ON ADJUSTMENTS

1. Recheck the setting of the horsepower/current scaling jumpers per Paragraph 3.6 and Table 3.2.
2. Recheck the position of the regulation mode jumper per Paragraph 3.7. If tachometer regulation is being used, recheck tachometer feedback connections and tachometer voltage scaling per Table 3.3.
3. Make sure the load is **not** connected.

Once these checks have been made and once all the preliminary power off static adjustments have been performed with acceptable results, apply A-C line power to the Power Module. It is important to observe the following steps closely. Observe all cautions and warnings.

DANGER
WITH A-C POWER APPLIED AND WITH THE POWER ON/OFF SWITCH IN THE ON POSITION, HAZARDOUS VOLTAGE EXISTS IN THE POWER MODULE. EXERCISE EXTREME CAUTION WHEN PERFORMING THESE TESTS. FATAL INJURY COULD RESULT.

DANGER
IF CIRCUIT BREAKER HAS TRIPPED OR FUSES HAVE CLEARED THE FIELD SUPPLY, ITS WIRING MUST BE INSPECTED FOR DAMAGE. REAPPLYING POWER TO THE POWER MODULE, THE FIELD VOLTAGE MUST BE RECHECKED FOR PROPER VOLTAGE AT MOTOR TERMINALS F1, F2. IF THIS VOLTAGE IS BELOW 90% OF THE FIELD VOLTAGE SPECIFIED ON THE MOTOR NAMEPLATE, THE POWER MODULE MUST NOT BE STARTED UNTIL PROPER VOLTAGE IS OBTAINED. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN OVERSPEEDING THE MOTOR AND/OR THE MACHINERY COUPLED TO THE MOTOR SHAFT AND/OR FATAL INJURY.

4.4.1 Regulator Module Potentiometers

DANGER
USE ONLY ONE HAND TO HOLD THE SCREWDRIVER. KEEP YOUR OTHER HAND BEHIND YOU. DO NOT USE YOUR OTHER HAND TO BRACE YOURSELF AGAINST THE POWER MODULE, PANEL OR ENCLOSURE. FATAL INJURY COULD RESULT IF YOU ACCIDENTALLY TOUCH A COMPONENT AT LINE VOLTAGE.

The Regulator Module has six adjustable potentiometers mounted on it. (Refer to Figure 4.3.) The potentiometers are factory-preset as noted below for the safest or most conservative operation. They control the following functions and should be initially set as follows:

- Maximum speed (full CCW: 70% speed)
- Minimum speed (full CCW: Drive Min Speed 5%)
- Acceleration rate (full CCW)
- Deceleration rate (full CCW)
- Current limit (factory-set at 150% = 6th dot on pot)
- IR compensation (full CCW)

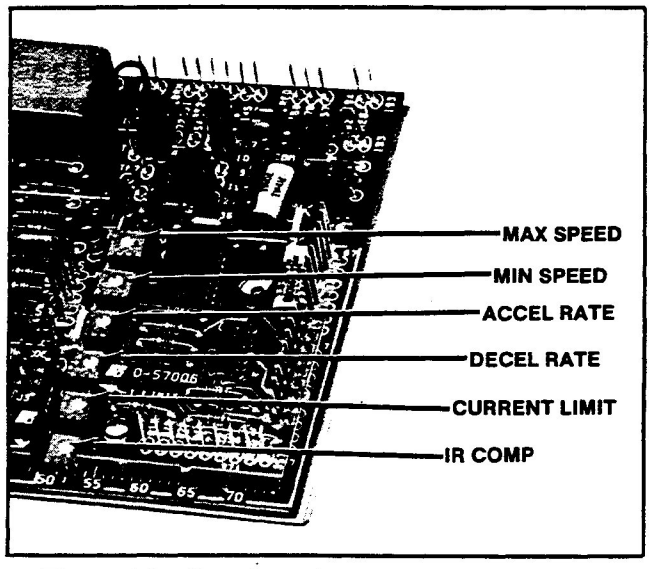


Figure 4.2 – Regulator Module Potentiometers

Maximum Speed (Voltage) — The Maximum Speed potentiometer on the Regulator Module (Figure 4.3) has been factory-preset for 70% of a typical motor base speed of about 1750 rpm. By means of adjustment, the maximum speed may be raised to suit the application. The result is the highest speed that can be set by the operator on the SPEED dial. The control range is 70 to 100% of rated speed. Note that CW rotation represents an **increase** in speed. CCW represents a **decrease.**

The method for determining if the motor and driven equipment are operating at an acceptable maximum speed for the application is to measure speed with a tachometer.

DANGER
WHEN PERFORMING THIS ADJUSTMENT PROCEDURE, DO NOT ALLOW THE DRIVE MOTOR TO EXCEED ITS RATED MAXIMUM SPEED AS LISTED ON THE NAMEPLATE. EQUIPMENT DAMAGE AND/OR FATAL INJURY COULD RESULT.

Increase the Operator Station SPEED dial slowly in the direction of 10, which is 100% of full travel. If, as the SPEED dial is turned toward the 10 setting, the speed exceeds the maximum acceptable speed, **immediately** decrease the speed on the SPEED dial.

In **some cases,** to avoid exceeding the maximum operating speed, it may be necessary to turn the Maximum Speed potentiometer completely CCW before turning the SPEED dial completely CW.

If the 10 setting on the SPEED dial is lower than the desired speed, increase the setting on the Maximum Speed potentiometer to the necessary speed. To increase the maximum speed, turn the potentiometer CW.

NOTE: *Maximum and minimum speed adjustments are interactive: a change in one affects the other. Therefore, it may be necessary to work back and forth until maximum and minimum speeds are set as desired.*

Minimum Speed (Voltage) — The Minimum Speed potentiometer on the Regulator Module has been factory-preset for a drive minimum speed of 5%. By means of adjustment, this speed may be raised (CW represents an **increase**) or lowered (CCW represents a **decrease**). The result is the lowest moving speed the operator can set on the SPEED dial. The control range is 5% to 30% of rated speed.

The method for determining if the motor and driven equipment are operating at an acceptable maximum speed for the application is to measure speed with a tachometer.

With the SPEED dial at zero position and using a small, insulated slot screwdriver, carefully turn the Minimum Speed potentiometer until the desired minimum is reached.

NOTE: *Maximum and minimum speed adjustments are interactive: a change in one affects the other. Therefore, it may be necessary to work back and forth until maximum and minimum speeds are set as desired.*

Acceleration and Deceleration Rates — The Acceleration and Deceleration Rate potentiometers on the Regulator Module have been factory-preset for a typical linear acceleration rate of six seconds to maximum and minimum speed. This time can be adjusted over a range of 0.5 to 30 seconds from a fully stopped condition.

Current Limit — Although it will probably not be necessary to make any adjustment in the factory-set current limit value of 150% of rated load, it is possible to change this governing value. (Individual application speed changes or load changes on sustained overloads may require readjustment. Also, applications requiring torque limiting or acceleration of high inertia loads may require a change from this value.)

To reduce the torque output of the drive, turn the Current Limit potentiometer CCW. Note, however, that turning CCW too far may prevent the drive accelerating to the desired speed. Note: 100% = 4th dot on pot.

IR Compensation — IR (voltage) compensation is a feature which makes up for the armature resistance of a motor that causes a drop in speed as the load is increased. The IR Compensation potentiometer is factory-set at zero. **The IR compensation feature can be adjusted between 0 and 12% of rated load and is used only for a voltage regulation mode. When using a tachometer feedback, the IR Compensation potentiometer must be turned completely CCW.**

CAUTION: If the IR Compensation potentiometer is set too high, a rising motor speed characteristic could result, causing instability and oscillation in motor speed.

Section 5
TROUBLESHOOTING

5.0 GENERAL

This section details troubleshooting information for this D-C V★S Power Module. Its organization is as follows:

- Test equipment (Paragraph 5.1)
- General troubleshooting concepts that should be kept in mind at all times: wiring errors (Paragraph 5.2), incoming A-C line problems (Paragraph 5.3), motor problems (Paragraph 5.4) and mechanical problems (Paragraph 5.5)
- Specific symptom/probable cause/recommended procedures (Paragraph 5.6)
- Reference schematics, photos and diagrams of the Power Module (Paragraph 5.7)

DANGER
THE POWER MODULE SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT. SEVERE OR FATAL INJURY AND/OR EQUIPMENT DAMAGE COULD OCCUR IF INDIVIDUALS ARE NOT FAMILIAR WITH THE HAZARDS RESULTING FROM IMPROPER OPERATION.

DANGER
EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER MODULE. ALL PHASES OF THE A-C POWER LINE MUST BE DISCONNECTED FROM THE POWER MODULE BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT. SEVERE OR FATAL INJURY COULD RESULT UNLESS POWER IS REMOVED.

5.1 TEST EQUIPMENT

There are several standard and optional devices that assist in troubleshooting the drive:

- The standard Test Buffer/Meter Filter Module which is mounted on the Regulator Module. (Refer to Paragraph 4.1.1 and Table 4.1.)
- The optional Status/Diagnostics Indicator which mounts on the front surface of the Power Module. (Refer to Paragraph 4.1.2 and Table 4.2.)
- The optional Hand-Held Diagnostic Tester which connects either to the Power Module or to the Status/Diagnostics Indicator. (Refer to Paragraph 4.1.3.)

5.2 WIRING ERRORS

The single most common problem preventing normal D-C drive operation is incorrect wiring within the system. A maintenance person should spend at least five minutes carefully looking over the wiring before taking active steps involving tests and replacement. Remember that a loose or grounded wire can occur in a Power Module that had previously been functioning correctly if initial wiring techniques were poorly performed. For those not familiar with proper Power Module wiring, other sections in this manual may be consulted.

5.3 A-C LINE PROBLEMS

The following are typical problems located on the incoming A-C line:

- A-C line voltage incorrect for the specific Power Module, which may operate on 230 or 460 VAC at 60 Hz.
- Main disconnect switch contains fuses improperly rated for the drive. (The fuses must be large enough to prevent nuisance tripping yet small enough to protect the circuit and equipment on the circuit.)
- A-C conductors must be of adequate size for the application.
- If an isolation transformer is used, it must be sized according to the requirements of the drive system. The transformer itself must be wired for the correct output voltage (230/460 VAC) in relation to the Power Module.

5.4 MOTOR PROBLEMS

Do not overlook the possibility that the malfunction may be located in the drive motor. The following steps should become part of a troubleshooting routine:

- Recheck all motor connections for firmness and correct identification.
- Check that no obvious grounds have occurred on any of the wires. However, **do not** use a megger when checking for grounds unless the motor wiring to the Power Module is **completely** disconnected.
- A volt-ohmmeter (VOM) may be used for ground checking without disconnecting conductors to the Power Module.
- Check the field windings for open or short conditions.

- Check continuity through the armature and brushes. Use terminals A1 and A2 at the Power Module as test points.

5.5 MECHANICAL PROBLEMS

It may be that the malfunction is a simple mechanical problem. The load on the drive motor may be too large, or it may have too high an inertia. The results are long stopping times and current-limit starting demands. Also, the freedom of motion of the load device should be considered.

5.6 POWER MODULE MALFUNCTIONS

Table 5.1 presents an organized troubleshooting sequence based on a symptom with the probable cause and a suggested procedure approach. It develops from the most simple, obvious malfunction to more complex ones.

5.7 SCHEMATICS, DIAGRAMS

In order to aid with the troubleshooting process, various schematics and diagrams (Figures 5.6 thru 5.11) are included. Note that these drawings are the latest revisions as of the date of publication of this manual. The manufacturer cannot guarantee that subsequent changes will not occur; although, if any do, they should be minor. In cases of doubt, contact your local Reliance Electric Sales Office.

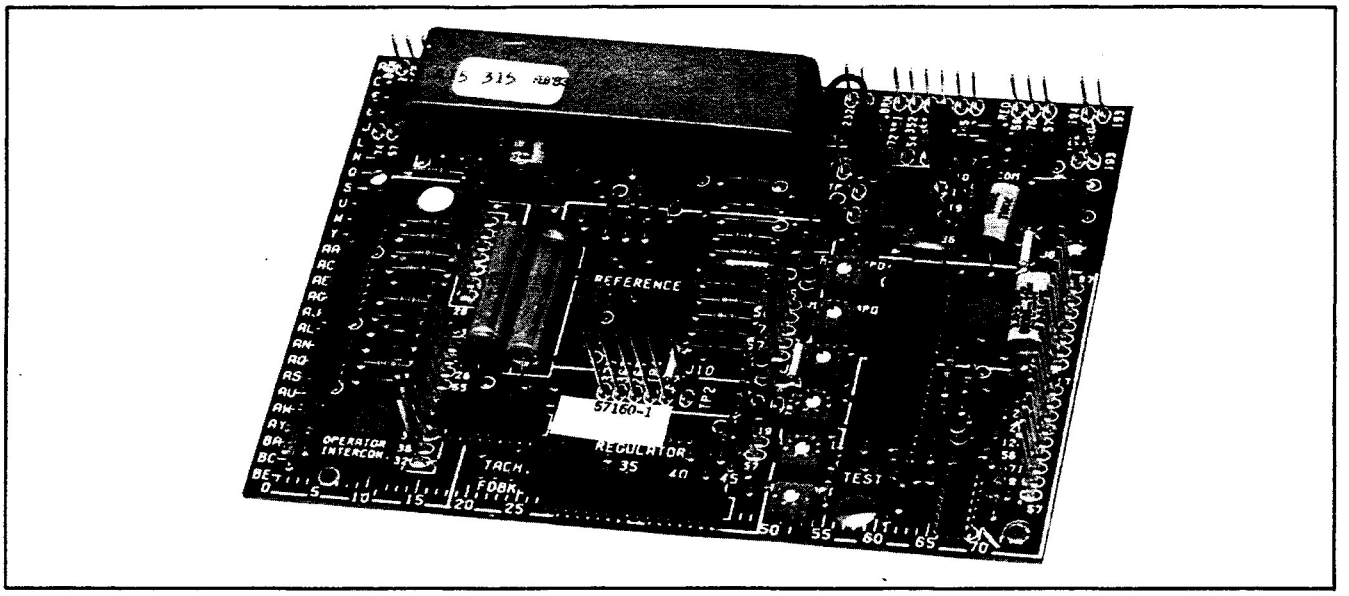


Figure 5.1 — Regulator Module without Standard Modules Installed

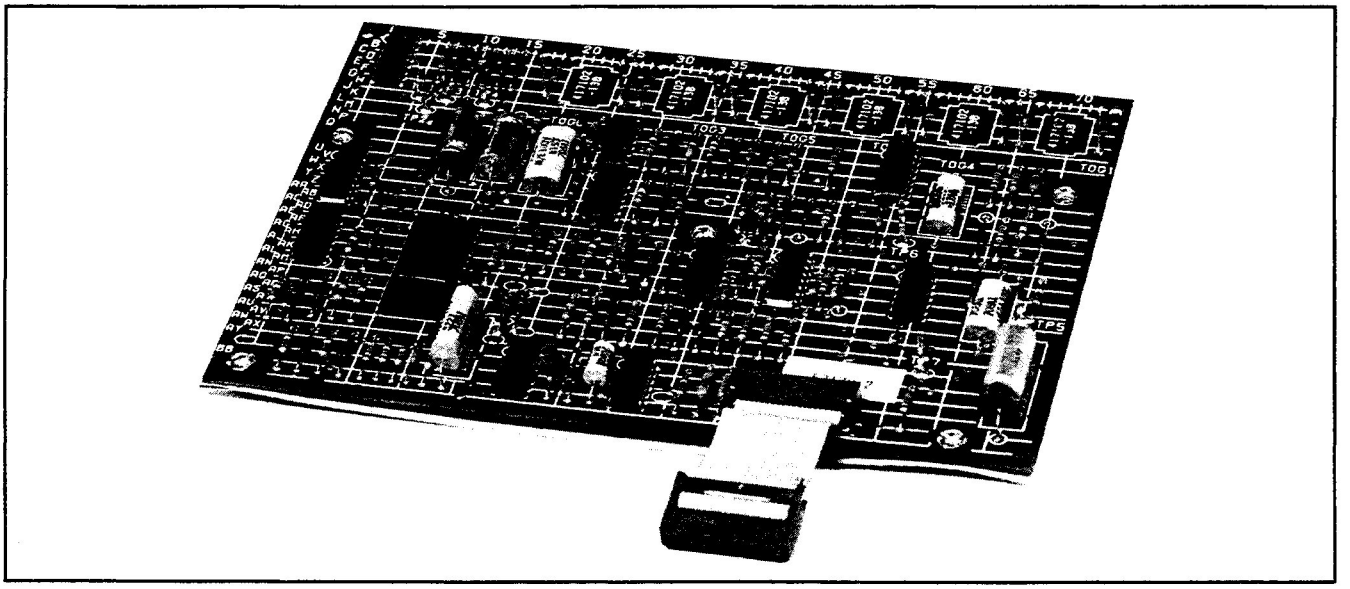


Figure 5.2 — Digital Driver Module

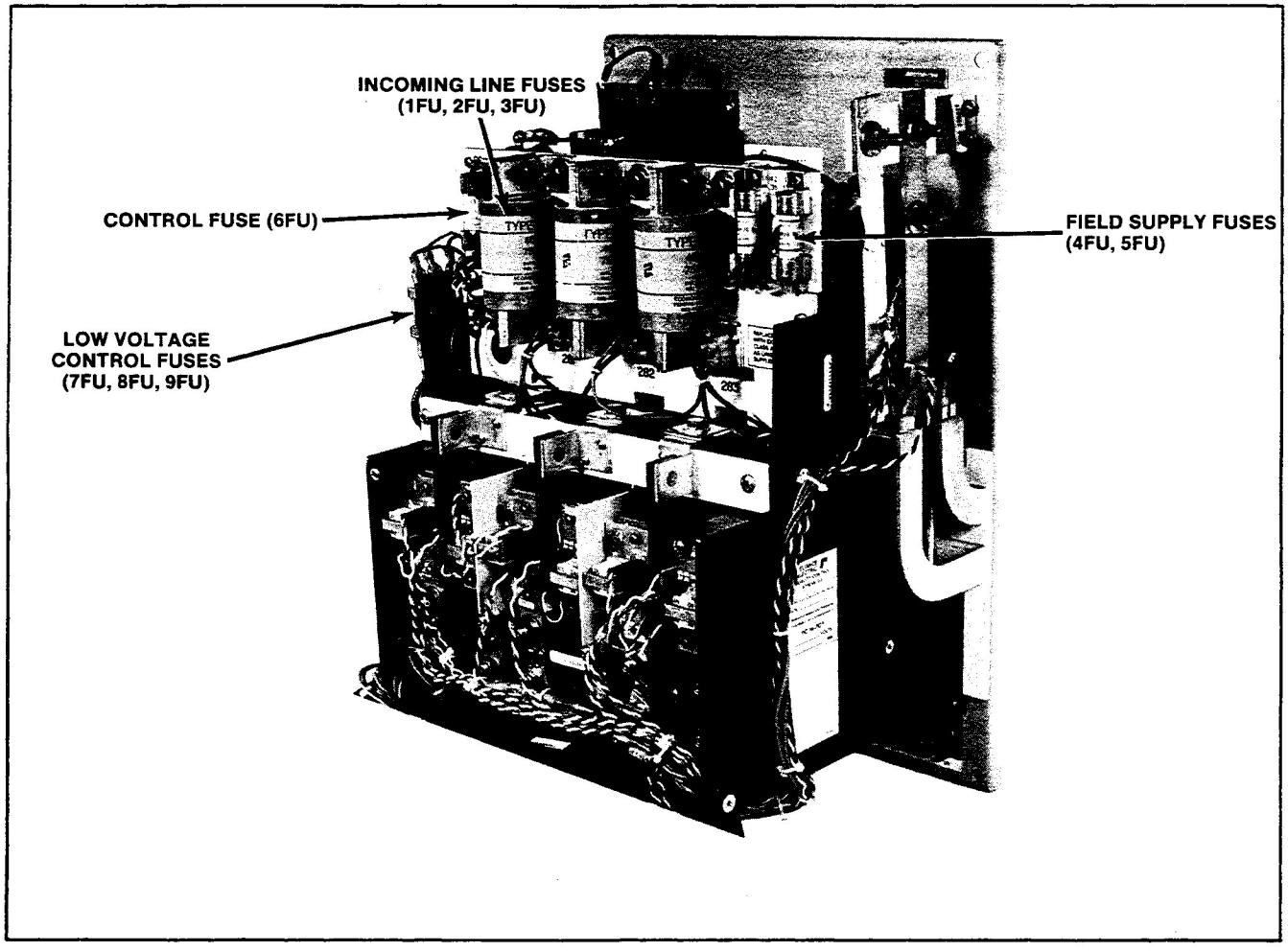


Figure 5.3 — Fuse Locations

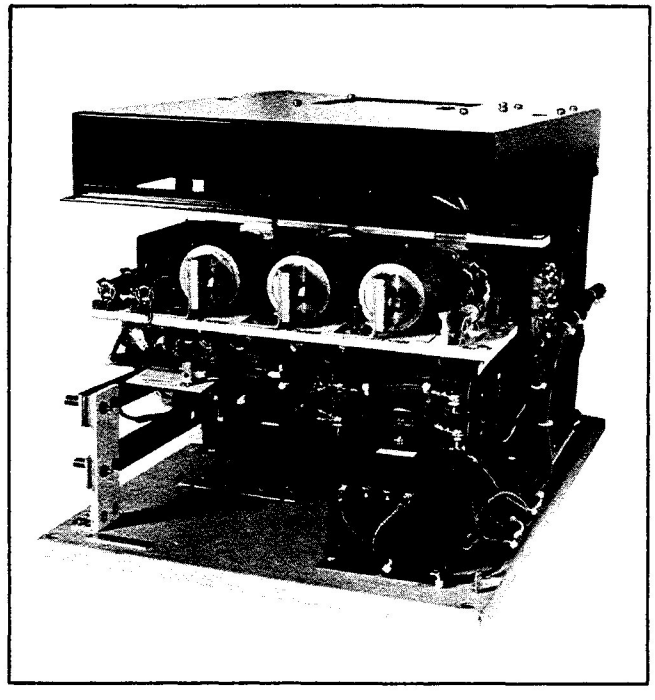


Figure 5.4 — Top View of Power Module

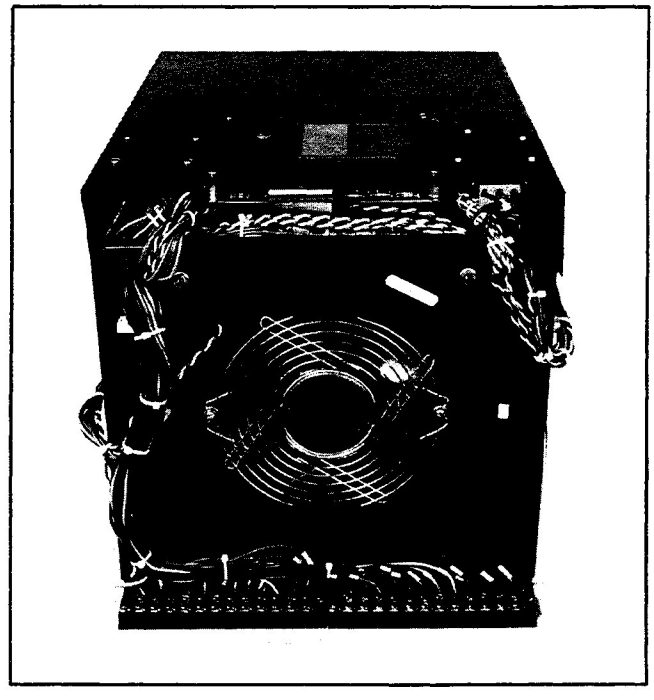


Figure 5.5 — Bottom View of Power Module

Table 5.1 — Troubleshooting Suggestions

Symptom	Probable Cause	Recommended Procedures
1. Circuit breaker trips or fuses clear when power is applied.	Incorrect wiring connections to Power Module from Power Module to motor; in motor.	**DANGER** **IF CIRCUIT BREAKER HAS TRIPPED OR FUSES HAVE CLEARED, THE FIELD SUPPLY AND ITS WIRING MUST BE INSPECTED FOR DAMAGE. AFTER RE-APPLYING POWER TO THE DRIVE, THE FIELD VOLTAGE MUST BE RE-CHECKED FOR PROPER VOLTAGE AT MOTOR TERMINALS F1, F2. IF THIS VOLTAGE IS BELOW 90% OF THE FIELD VOLTAGE SPECIFIED ON THE MOTOR NAMEPLATE, THE DRIVE MUST NOT BE STARTED UNTIL PROPER VOLTAGE IS OBTAINED. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN OVERSPEEDING THE MOTOR AND/OR THE MACHINERY COUPLED TO THE MOTOR SHAFT AND POSSIBLE FATAL INJURY.** ☐ Remove A-C power at the disconnect. ☐ Remove leads to L1, L2, L3, A1, A2 and F1, F2, on **incoming** side of Power Module's respective location. ☐ Open the power disconnect switch. ☐ Check for a ground condition at L1/181, L2/182, L3/183, A1, A2, F1 and F2. Do this at Power Module side of these connections. ☐ If no ground exists, examine the Power Module chassis for loose wires and/or foreign objects. ☐ If no ground exists and if no foreign objects are discovered, reconnect the incoming conductors A1, A2 and F1 and F2. Then check for grounds at these terminals. ☐ If a ground is found, it is in the conductors to the motor or in the motor itself. ☐ Disconnect the motor from the conductors at the drive motor. ☐ Test A1, A2, F1 and F2 conductors for a ground. (If one exists, examine connections and insulation for areas where shorts could occur.) ☐ If no grounds are found in the conductors, check the motor for a ground condition. If a ground is located here, examine and/or replace the motor, as necessary.
	Short in Phase Rectifier Module.	☐ Replace Phase Rectifier Module.
	Short in Field Supply.	☐ Replace Field Supply.
	Short in Control Transformer.	☐ Replace Control Transformer.
2. Drive motor does not start.	Main A-C line disconnect not closed; or fuse blown; or no power applied ahead of disconnect.	☐ Check disconnect switch, fuses in it, and voltage on line.
	Drive interlocks preventing operation. 32 to 33 on TB	☐ Verify that all user-installed interlocks are in a state (physical condition and wiring connections) to allow a start.
	Drive motor thermostat wires not connected at Power Module terminals 34 and 132 on TB.	☐ Check connections to thermostat: at drive motor P1, P2; at controller 34, 132. ☐ Check for open thermostat inside motor. Make a resistance check of thermostat. (It should read a short, or low resistance, if it is closed.
	External overload wires not connected at Power Module terminals 34 and 33 on TB.	☐ Check connections to external overload. (Blower Motor Starter O/L). ☐ Check for open overload. Make a resistance check to overload. (It should read a short, or low resistance, if it is closed.)
	Drive thermostat wires not connected at Power Module terminals 132 to 232.	☐ Check connections to thermostat at drive power bridge heat sink, at controller 132 or 232. ☐ Check for open thermostat. Make a resistance check to the thermostat. (It should read a short, or low resistance, if it is closed.)
3. Armature loop contactor not picking up when START switch is pressed (closed).	Faulty START/STOP switch.	☐ Check START/STOP switch, but **first** remove A-C line power at main disconnect. ☐ Connect ohmmeter to terminal 32 on the Remote Operator Adapter. ☐ Touch probe to terminal 38 on the Remote Operator Adapter. ☐ Place switch in the START (closed) position. ☐ If the switch is properly functioning, a short will be read on the meter. ☐ Check the STOP function. Place the RUN/JOG switch in the RUN position. Connect the ohmmeter to terminals 32 and 35. Place the switch in the STOP position, which should open it if it is functioning correctly. If there is a short, it will be seen on the meter. If there is no short, the circuit is opened and the switch is functioning correctly. ☐ Using similar techniques, test the RUN/JOG switch in the RUN position at terminals 32 and 35. When the switch is in the RUN position, a short should be read.
(Continue this symptom on next page.)	J9 jumper is cut (non-reversing Power Module).	☐ Connect ohmmeter from terminal 38 to 39 on TB. (It should read short. If not, re-install J9 jumper.

Table 5.1 — Troubleshooting Suggestions (Continued)

Symptom	Probable Cause	Recommended Procedures
3. Armature loop contactor not picking up when START switch is pressed (closed). (Continued)	FORWARD/REVERSE switch malfunction (reversing Power Module).	☐ Connect ohmmeter from terminal 38 to 39 on TB. ☐ Place the FORWARD/REVERSE switch in FORWARD position. ☐ If the switch is properly functioning, a short will be read on the meter. ☐ Reconnect ohmmeter from terminal 38 to 67 on TB. ☐ Place the FORWARD/REVERSE switch in REVERSE position. ☐ If the switch is properly functioning, a short will be read on the meter.
	Faulty pilot relay (non-reversing Power Module).	☐ Connect ohmmeter from terminal 39 on TB to pin 139 on Regulator Module. ☐ The meter should read approximately 1600 ohms. ☐ If the 1600-ohm resistance reading cannot be obtained, replace the pilot relay.
	Faulty pilot relay (reversing Power Module).	☐ Verify proper operation of FORWARD/REVERSE switch. ☐ Connect ohmmeter from terminal 67 on TB to pin 39 on Regulator Module. ☐ The meter should read approximately 1600 ohms. ☐ If the 1600-ohm resistance reading cannot be obtained, replace the pilot relay.
	Faulty armature loop contactor.	☐ Connect an A-C voltmeter from terminal 288 to 189 on TB. ☐ Re-apply A-C line power. ☐ With START switch pressed, check for 115 VAC on meter. ☐ A reading of significantly less than 115 VAC would indicate a shorted or faulty contactor coil. (Check for pilot relay auxiliary contact closed from terminal 288 on TB to terminal 188 on control transformer on START command before replacing contactor.)
	Faulty reversing contactor.	☐ Repeat above test with A-C voltmeter connected from terminal 388 to 189 on TB. (Pilot relay auxiliary contact is connected from terminal 388 on TB to terminal 188 on control transformer.)
4. Armature loop contactor picks up but remains in only when START switch is pressed.	RUN/JOG switch in JOG position.	☐ Place RUN/JOG switch in the RUN position.
	CR relay not picking up or seal around contact not closing.	☐ Connect volt-ohmmeter from terminal 36 on bottom TB to pin 40 on Regulator Module. ☐ Press the START switch. The reading should be approximately 24 VDC. (If reading is not obtained, check auxiliary M contacts from terminals 39 to 36 (FORWARD) and 67 to 36 (REVERSE) on TB for closed when START switch is pressed. If contacts close, replace Regulator Module.) ☐ If 24 VDC is read, connect ohmmeter from terminals 35 to 38 on TB. Contact should close (short on ohmmeter) when START switch is pressed. If not, replace Regulator Module.
5. Drive motor does not run, but armature loop contactor and CR pull up. **(Use this procedure only if Power Module does not have the Test Buffer/Meter Filter Module.)**	No input signal from SPEED potentiometer.	☐ If the Power Module does not have an optional AUTO/MANUAL switch, inspect the Regulator Module to determine that jumper J4 **is in place.** (The jumper is removed when the AUTO/MANUAL switch is installed.) ☐ Check the SPEED potentiometer on the Control Station. First, open the power disconnect switch. ☐ Connect a volt-ohmmeter to the Regulator Module Remote Operator Adapter inputs. Connect one lead to terminal 28. Connect the other to terminal 20. (Refer to Figure 3.4 for a Remote Station.) ☐ For proper operation, the reading should be 5K ohms. ☐ Disconnect the VOM lead from terminal 28. Connect it to terminal 426. ☐ Turn the SPEED potentiometer from 10 to 0. The resistance should vary from 5K to 0 ohms. If it does not, replace the potentiometer.
6. Drive motor does not run, but armature loop contactor and CR pull up. **(Use this procedure only if Power Module has Test Buffer/Meter Filter Module.)** (Continue this symptom on next page.)	No input signal from SPEED pot.	☐ First check the main power supplies. This must be done with power applied to the Power Module. **DANGER** **THE PROCEDURE DESCRIBED HERE IS PERFORMED WITH LIVE A-C VOLTAGE APPLIED TO THE POWER MODULE. USE ONLY ONE HAND TO APPLY VOM LEADS/PROBES. KEEP OTHER HAND BEHIND YOU AT ALL TIMES. DO NOT HOLD ONTO THE POWER MODULE FOR SUPPORT. FATAL INJURY COULD RESULT IF THESE PRECAUTIONS ARE NOT TAKEN.** ☐ Connect one lead of volt-ohmmeter to test pin 357 on the Test Buffer/Meter Filter Module. ☐ Connect the second lead to test pin 356 on this Module. ☐ The reading should be within the range of 10.8 to 11.5 VDC for normal operation. ☐ Next, remove the lead from pin 356. Place it on pin 456. ☐ The reading should be within the range of +16 to +28 VDC for normal operation. ☐ Next, remove the lead from pin 456. Place it on pin 471. ☐ The reading should be within the range of -16 to -28 VDC for normal operation. ☐ If the proper readings are obtained, the power supplies may be assumed to be operating correctly. ☐ If incorrect readings are obtained, replace the Regulator Module. ☐ Next, check the reference voltage input signal. (This changes in direct proportion to an increase of SPEED potentiometer voltage caused by a turning of the dial.) ☐ Connect one lead of a volt-ohmmeter to pin 357 on the Test Buffer/Meter Filter Module. ☐ Connect the other lead to pin 826. Readings vary from 0 to +9.6 VDC, depending on the set point of the SPEED potentiometer dial.

Table 5.1 — Troubleshooting Suggestions (Continued)

Symptom	Probable Cause	Recommended Procedures
6. Drive motor does not run, but armature loop contactor and CR pull up. (Continued) **(Use this procedure only if Power Module has Test Buffer/Meter Filter Module.)**	No input signal from SPEED pot. (Continued)	☐ If no voltage is noted between pins 357 and 826, check to see if jumper J4 on the Regulator Module is properly placed/removed for the specific Power Module. (It is to be in place, as factory-shipped, if there is no AUTO/MANUAL switch. It is to be removed if there is an AUTO/MANUAL switch.) ☐ If the SPEED potentiometer is functioning normally and if the J4 jumper is placed/removed, as necessary, replace the Regulator Module.
7. Drive motor does not run with armature loop contactor picked up. Potentiometer properly operating.	No output from phase rectifier modules, 45-47.	☐ Examine armature wiring. First, open the power disconnect switch. ☐ Check armature wiring for loose connections. ☐ Turn A-C power on again. **DANGER** **THE PROCEDURE DESCRIBED HERE IS PERFORMED WITH LIVE A-C VOLTAGE APPLIED TO THE POWER MODULE. USE ONLY ONE HAND TO APPLY VOM LEADS/PROBES. KEEP OTHER HAND BEHIND YOU AT ALL TIMES. DO NOT HOLD ONTO THE POWER MODULE FOR SUPPORT. FATAL INJURY COULD RESULT IF THESE PRECAUTIONS ARE NOT TAKEN.** ☐ Connect a volt-ohmmeter to terminals 47 and 45 on TB. ☐ Place the START/STOP switch in the START position. ☐ Increase the speed reference by turning the SPEED dial in the direction of 10. ☐ The reading across 47 and 45 should be 0 to 240 VDC for 230 VAC Power Modules or 0 to 500 VDC for 460 VAC Power Modules. ☐ If no reading is obtained across 47 and 45, it may be necessary to replace the phase rectifier modules and/or the Regulator Module, Digital Driver Module. In order to determine which, read on.
	Regulator Module suspected because no output reading at 45-57.	☐ Test the Regulator Module for output to Digital Driver Module (PREF). ☐ Turn power off. Open main disconnect. ☐ Connect a VOM, being careful not to short pins together, to terminals 280 (PREF) and 57 (0V) on the Regulator Module. ☐ Restore power to Power Module. ☐ Place the START/STOP switch in START position. ☐ Turn the SPEED pot to full on position. ☐ Voltage on VOM should be +5 volts. ☐ If this reading cannot be obtained, replace Regulator Module.
	Digital Driver Module suspected because no output reading at 45-47.	☐ Test the Digital Driver for firing pulses. (Note: Make sure above test on Regulator Module has been completed first.) ☐ Turn power off. Open main disconnect. ☐ Connect scope common to pin 57 on Regulator Module. ☐ Connect scope probe to resistor on primary side of pulse transformer located at 7A on Digital Driver Module. ☐ Restore power to Power Module. ☐ Place the START/STOP switch in START position. ☐ Turn SPEED pot to full on position. ☐ A firing pulse waveform (+11.2V) should be seen at this point. If pulse is measured, continue this test from beginning but connect scope across the following resistors to look at other five firing pulses. (14A, 10A, 11A, 13A, 8A). ☐ If these readings cannot be obtained, replace Digital Driver Module.
	Phase rectifier modules suspected because no output reading at 45-47.	☐ Establish that pulse inputs from Digital Driver Module are present at the pulse input terminals of the power semiconductor phase rectifier modules. (Refer to above previous test.) ☐ If phase rectifier modules are receiving pulses, yet no reading across 45-47, determine that the contacts on the armature loop contactor are closing. ☐ Replace drive motor wiring with light bulbs (2 light bulbs for 240-volt, 4 light bulbs for 500-volt armatures, series connection.) ☐ Run drive and look at waveform across light bulbs. (Should be six pulse/16.7 MSEC.) If pulse is missing indicates faulty phase rectifier module. ☐ Check individual phase rectifier modules. ☐ Connect scope across 51 and 47 on terminal strip. Check to see if SCR is switching. If not, replace appropriate phase rectifier module. ☐ Repeat for 51 and 45, 52 and 47, 52 and 45, 53 and 47 and 53 and 45 if necessary.
8. Remote Operator Control Station functions not operating.	Malfunctioning switches.	☐ Check START/STOP switch, but **first** remove A-C line power at main disconnect. ☐ Connect ohmmeter to terminal 32 on the Remote Operator Adapter. ☐ Touch probe to terminal 38 on the Remote Operator Adapter. ☐ Place switch in the START (closed) position. ☐ If the switch is properly functioning, a short will be read on the meter. ☐ Check the STOP function. Place the RUN/JOG switch in the RUN position. Connect the ohmmeter to terminals 32 and 35. Place the switch in the STOP position, which should open it if it is functioning correctly. If there is a short, it will be seen on the meter. If there is no short, the circuit is opened and the switch is functioning correctly. ☐ Using similar techniques, test the RUN/JOG switch in the RUN position at terminals 32 and 35. When the switch is in the RUN position, a short should be read.

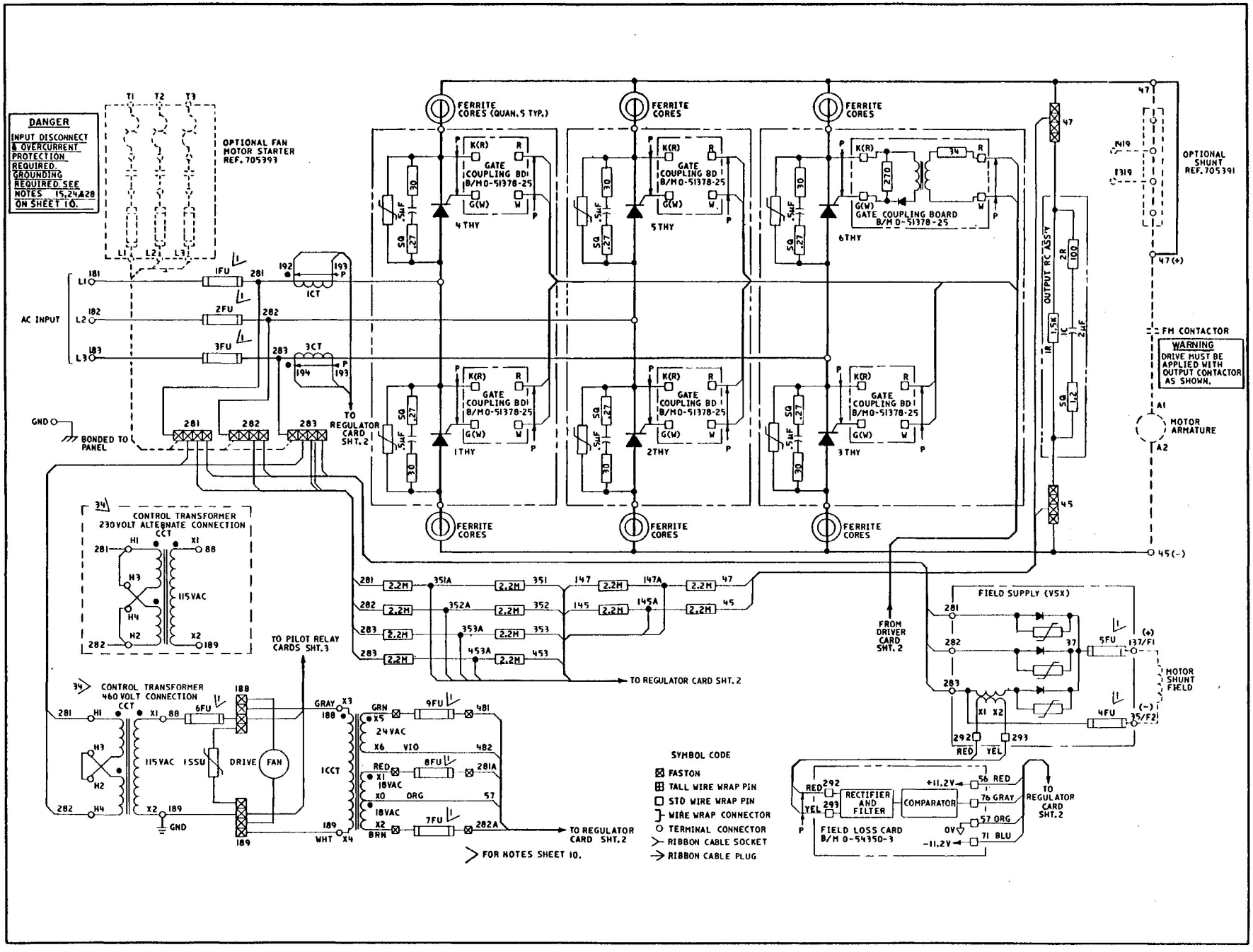


Figure 5.6 — Armature, Field and Control Power Circuitry (Sheet 1)

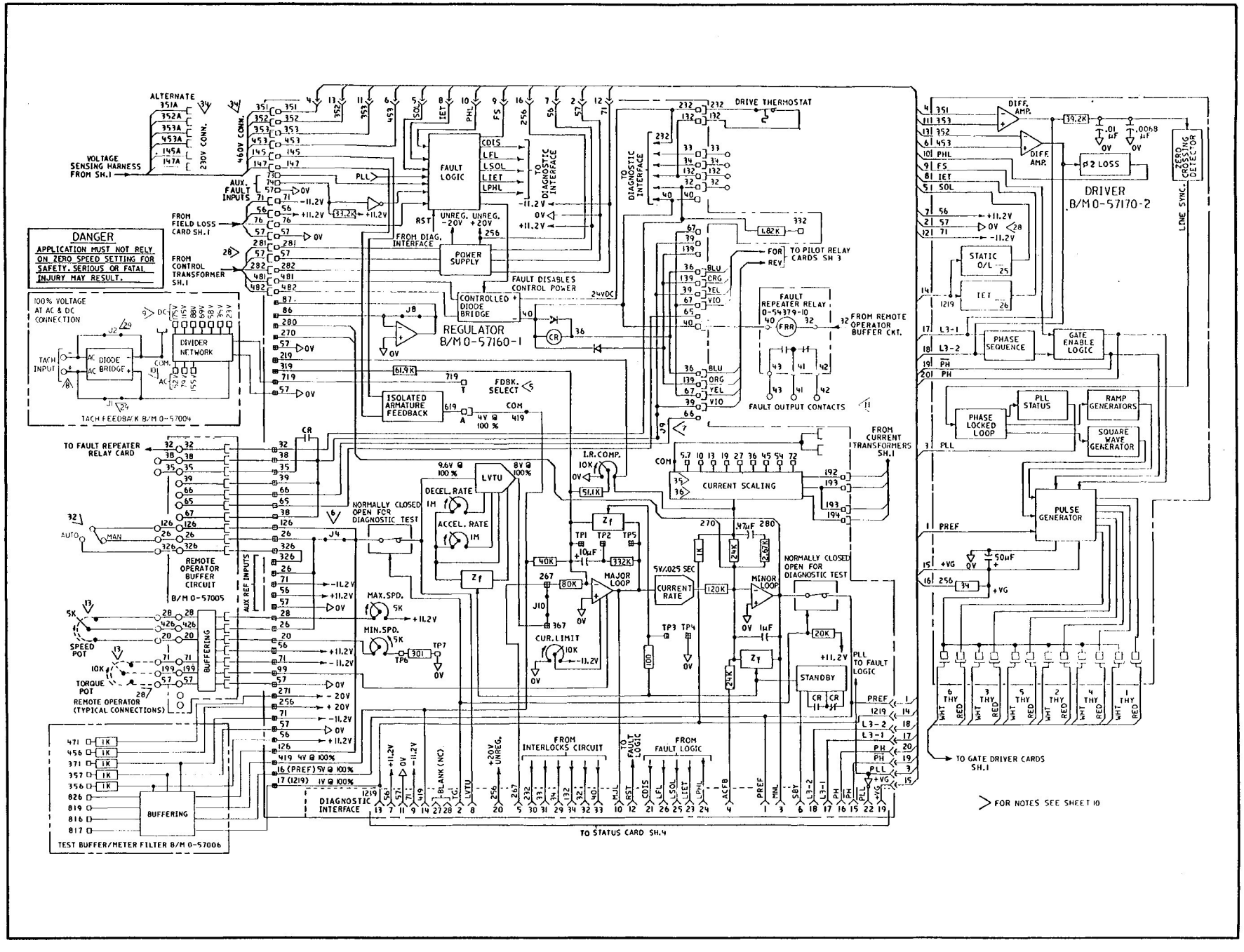


Figure 5.7 — Regulator Circuitry (Sheet 2)

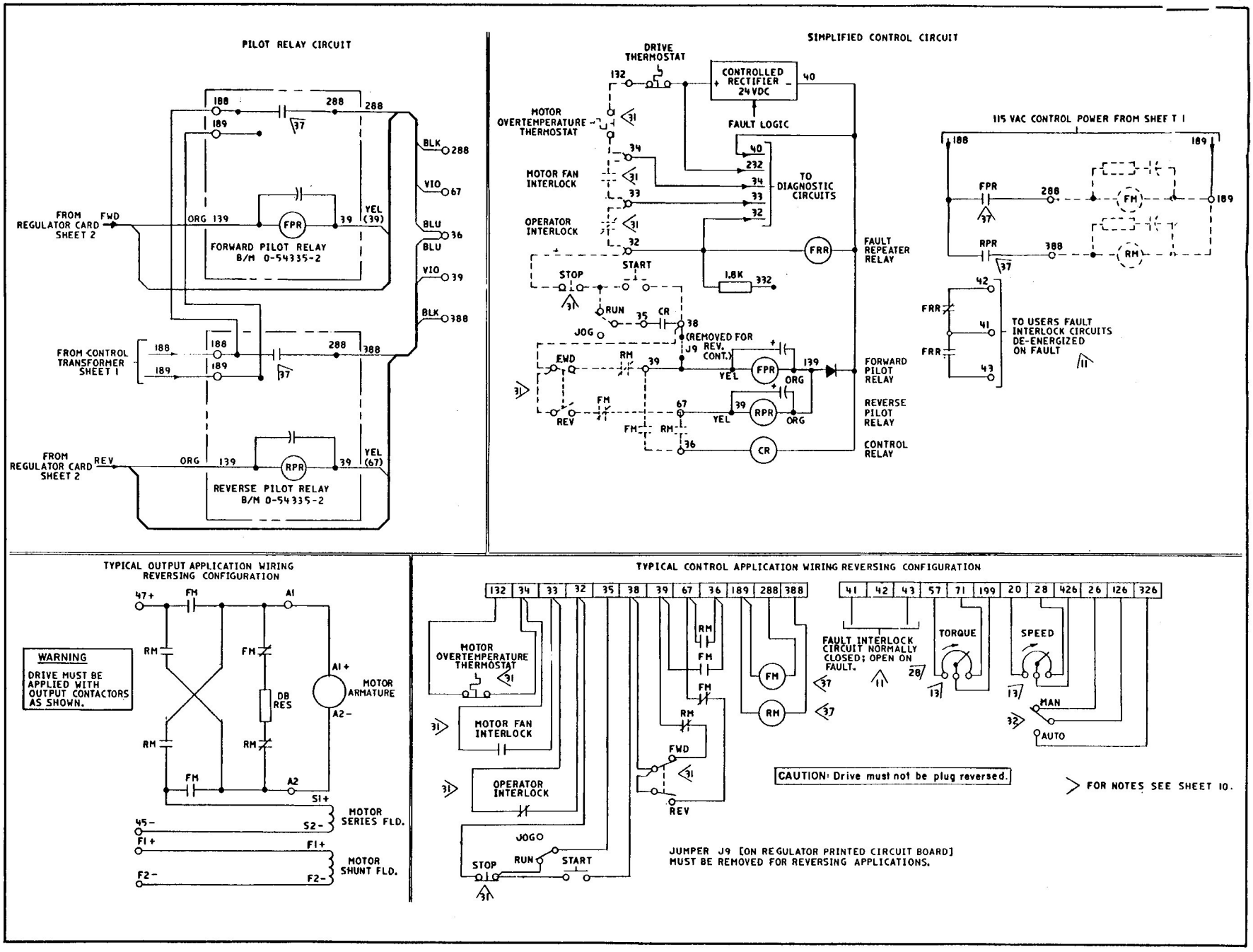


Figure 5.8 — Control Circuits (Sheet 3)

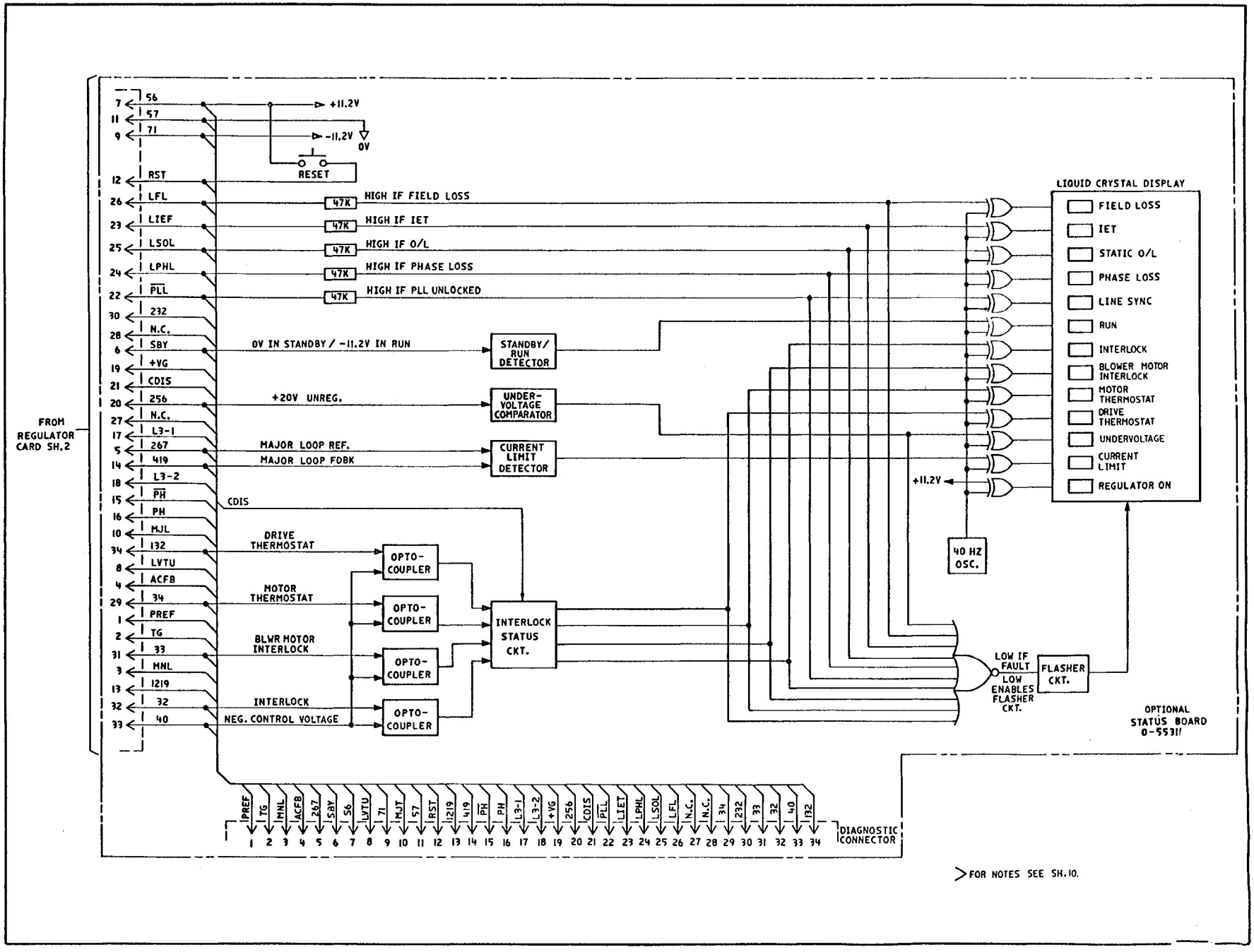


Figure 5.9 — Schematic Diagram of Optional Status/Diagnostics Indicator (Sheet 4)

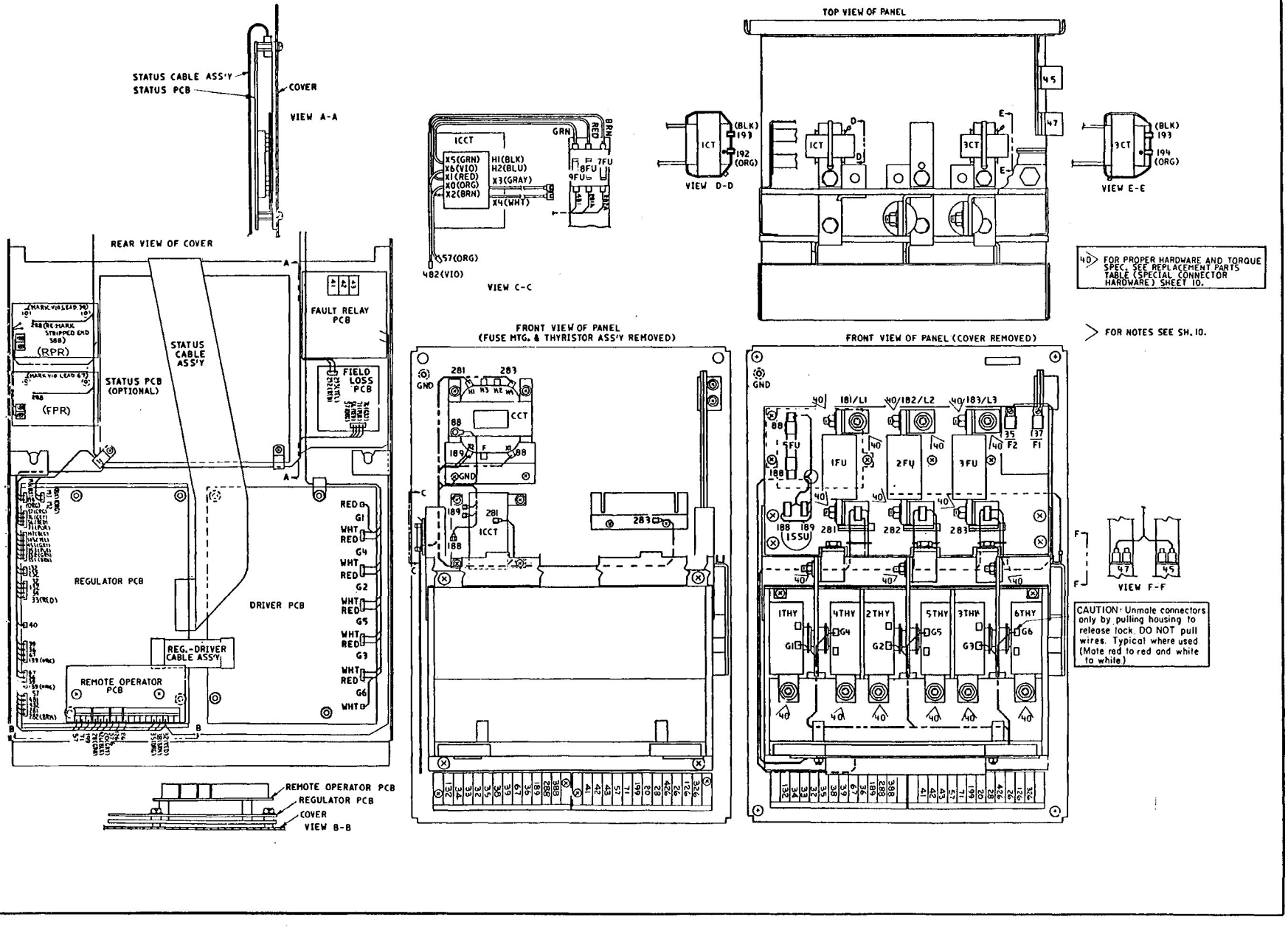


Figure 5.10 — Power Module Physical Arrangment (Sheet 8)

ALTERNATE RATING INFORMATION

CAUTION: SEE NOTES 34, 35 AND 36

ALTERNATE VOLTAGE RATING: <34

ANY ASSEMBLY MAY BE RECONNECTED FOR 230 VAC LINE INPUT. SEE SHEET 1 FOR RECONNECTION OF CONTROL TRANSFORMER PRIMARY TAPS. SEE SHEET 2 FOR RECONNECTION OF VOLTAGE SENSING HARNESS TAPS. FOR ASSEMBLIES THAT HAVE BEEN RECONNECTED FOR 230VAC LINE, THE MAXIMUM RATED ARMATURE OUTPUT VOLTAGE IS 240VDC AND RATED FIELD OUTPUT VOLTAGE IS 150VDC.

ALTERNATE CURRENT RATING: <35

ANY ASSEMBLY MAY BE RECONNECTED TO ANY LOWER CURRENT RATING USING THE CURRENT SELECTOR JUMPER TAPS ON THE REGULATOR CARD. REFER TO TABLE 1 FOR THE CORRECT CURRENT SELECTOR JUMPER POSITIONS.

TABLE 1

Ref. HP	Line Voltage	Line Current	Armature Voltage	Armature Current	Selector Jumpers
25	230VAC	84	240VDC	93	5.7 & 10
30	230VAC	99	240VDC	110	5.7 & 13
40	230VAC	127	240VDC	144	5.7 & 19
50	230VAC	158	240VDC	178	10 & 19
60	230VAC	187	240VDC	212	36
75	230VAC	244	240VDC	265	5.7 & 36
100	230VAC	275	240VDC	325	19 & 36
125	230VAC	340	240VDC	400	5.7,27,36
150	230VAC	408	240VDC	480	5.7, 13, 27, 36
50	460VAC	79	500VDC	86	5.7 & 10
60	460VAC	91	500VDC	100	5.7 & 13
75	460VAC	116	500VDC	129	45
100	460VAC	152	500VDC	167	10 & 19
125	460VAC	180	500VDC	205	36
150	460VAC	219	500VDC	250	5.7 & 36
200	460VAC	275	500VDC	325	19 & 36
250	460VAC	340	500VDC	400	5.7, 27, 36
300	460VAC	408	500VDC	480	5.7, 13, 27, 36

NOTE SHEET

1>

Controller HP		Line Fuse Rating	Field Fuse Rating	Control Fuse Rating
230 VAC	460 VAC			
25-30	50-60	200 A, 500 V	25 A, 700 V	Class K5 or RK5 1.6 A, 250 V
40-50	75-100	300 A, 500 V		
60-75	125-150	400 A, 700 V		
100-150	200-300	800 A, 500 V		Class K5 or RK5 3.2 A, 250 V

5> JUMPER A-COM FOR STANDARD ARMATURE FEEDBACK CONNECTION.

JUMPER T-COM FOR TACH FEEDBACK CONNECTION IF TACH FEEDBACK IS USED.

6> REMOVE JUMPER (J4) IF AUTO/MANUAL SWITCH IS USED.

7> REMOVE JUMPER (J9) IF REVERSE CONTACTOR IS USED.

8> WIRING OF TACHOMETER INPUT LEADS MUST BE TIGHTLY TWISTED WITH TWO FULL TURNS PER INCH (MINIMUM). LEADS MUST BE RUN PHYSICALLY SEPARATED FROM ALL POWER CIRCUIT WIRING. (75° C RECOMMENDED FOR INSULATION TEMPERATURE RATING.)

9> FOR D-C TACH, JUMPER IS CONNECTED IN THIS LOCATION.

100% Voltage	Tach	Motor (RPM)
23V	20VDC/1000 RPM	1150
35V	20VDC/1000 RPM	1750
58V	50VDC/1000 RPM	1150
69V	20VDC/1000 RPM	3450
88V	50VDC/1000 RPM	1750
115V	100VDC/1000 RPM	1150
175V	50VDC/1000 RPM	3450
175V	100VDC/1000 RPM	1750

10> FOR A-C TACH, JUMPER IS CONNECTED IN THIS LOCATION.

100% Voltage	Tach	Motor (RPM)
52V	45VAC/1000 RPM	1150
79V	45VAC/1000 RPM	1750
155V	45VAC/1000 RPM	3450

11> FRR CONTACT RATING: 7.5 AMP AT 28 VDC OR 0.5 AMPS AT 120 VAC (RESISTIVE).

13> ALL WIRING FOR REMOTE SPEED POT AND TORQUE POT MUST UTILIZE TIGHTLY TWISTED WIRE WITH TWO FULL TURNS PER INCH (MINIMUM). ALL WIRING FOR REMOTE OPERATORS MUST BE RUN IN SEPARATE CONDUIT, ISOLATED FROM ALL POWER WIRES. (75° C RECOMMENDED FOR INSULATION TEMPERATURE RATING.) SEE I/M FOR DETAILS.

Figure 5.11 — Notes for Wiring Diagram Set (Sheet 10)

15> DANGER

A) AN EXTERNAL FUSED DISCONNECT OR CIRCUIT BREAKER IS REQUIRED TO PROVIDE NEC OR CEC DISCONNECT AND OVERCURRENT PROTECTION.

B) MAXIMUM PERMISSIBLE AVAILABLE SYMMETRICAL RMS SHORT CIRCUIT POWER SUPPLY CAPACITY:
230 VAC: 25-75 HP — 25000,
100-150 HP — 45000
460 VAC: 50-150 HP — 25000,
200-300 HP — 45000

24> DANGER

EACH DRIVE MUST BE GROUNDED ACCORDING TO CODE REQUIREMENTS, USING THE DRIVE "GND" TERMINAL.

25> THE NORMAL OVERLOAD THRESHOLD IS 111% OF RATED CURRENT. WITH CIRCUIT TOLERANCE, THE THRESHOLD CAN VARY FROM 103% TO 119%. THE OVERLOAD TRIP TIME IS NOMINALLY 60 SECONDS WITH A LOAD CURRENT OF 150% OF RATED CURRENT.

26> THE IET (INSTANTANEOUS ELECTRONIC TRIP) THRESHOLD IS SET FOR A PEAK LOAD CURRENT OF 300%.

28> DANGER

DRIVES ARE SHIPPED WITH 57 (0V) FLOATING. DEPENDING ON THE APPLICATION, 57 MAY BE LEFT FLOATING OR TIED TO EARTH GROUND. IF LEFT FLOATING, THE REGULATOR CIRCUITS MAY RISE TO THE LINE POTENTIAL. THE ACTUAL POTENTIAL TO GROUND IS A FUNCTION OF THE INPUT TRANSFORMER CONFIGURATION. THE AVAILABLE LEAKAGE CURRENT DUE TO THIS POTENTIAL IS LIMITED BY HIGH IMPEDANCE RESISTORS. A DANGER EXISTS IF SEVERAL DRIVES IN A SYSTEM HAVE 57 TIED TOGETHER AND, AT THE SAME TIME, 57 IS UNGROUNDED. AT THIS CONDITION, THE AVAILABLE LEAKAGE CURRENT INCREASES. THEREFORE, TO LIMIT LEAKAGE TO A SAFE VALUE, NO MORE THAN 10 DRIVES SHOULD HAVE THEIR 0V (57) LINES TIED TOGETHER, I.E., 57 IS LEFT FLOATING.

29> IF USING AN A-C TACH, REMOVE J1 AND J2.

31> CONTACT MUST BE CAPABLE OF BREAKING A 0.5 AMP INDUCTIVE LOAD.

32> WHEN A REFERENCE KIT IS USED AND AN AUTO/MANUAL SWITCH IS DESIRED, JUMPER J1 ON THE REFERENCE KIT MUST BE REMOVED. IF NO MANUAL MODE IS DESIRED, A WIRE JUMPER BETWEEN 326 AND 126 MAY BE SUBSTITUTED FOR THE AUTO/MANUAL SWITCH.

34> CAUTION

CONTROL TRANSFORMER PRIMARY TAPS AND VOLTAGE SENSING HARNESS TAPS MUST CORRECTLY CORRESPOND TO THE A-C LINE INPUT VOLTAGE. SERIOUS DAMAGE WILL RESULT IF THIS CAUTION IS NOT FOLLOWED.

35> CAUTION

CURRENT SELECTOR JUMPER TAPS ON THE REGULATOR CARD MUST CORRESPOND TO THE MOTOR ARMATURE CURRENT RATING FOR PROPER PERFORMANCE AND OVERLOAD PROTECTION. CURRENT TAP CONNECTIONS MUST NOT BE SET HIGHER THAN THE MAXIMUM PANEL CURRENT RATING. SERIOUS DAMAGE WILL RESULT IF THIS CAUTION IS NOT FOLLOWED.

36> CAUTION

CURRENT SELECTOR JUMPER TAPS ON REPLACEMENT REGULATOR CARD MUST BE SET IDENTICALLY TO THE CURRENT TAP CONNECTIONS OF THE CARD BEING REPLACED. SERIOUS DAMAGE WILL RESULT IF THIS IS NOT FOLLOWED.

37> FPR AND RPR
PILOT RELAY CONTACT RATINGS ARE 130VAC, 0.52 AMPS HOLDING, 5.6 AMPS INRUSH. CONTACTOR COILS MUST HAVE RC NETWORK FOR DV/DT SUPPRESSION.

40> SPECIAL KEPS NUTS FOR FUSES (QTY 9):
25-30 HP, 230 VAC AND 50-60 HP, 460 VAC: PART 401599-11E (1/4-20) (60/66 IN. LBS TORQUE)

40-150 HP, 230 VAC AND 75-300 HP, 460 VAC: PART 401599-11F (5/16-18) (125/140 IN. LBS TORQUE)

SPECIAL KEPS NUTS FOR ALL EXCEPT FUSES (QTY 9):
PART 401599-11F (5/16-18) (125/140 IN. LBS TORQUE)

Figure 5.11 — Notes for Wiring Diagram Set (Sheet 10) Cont'd.

Section 6
REPLACEMENT PARTS

6.0 GENERAL

Users should consider maintaining a stock of spare parts. Table 6.1 lists the more common parts along with part numbers and quantities actually used in the Power Module.

Table 6.1 — Replacement Parts List

Part Description	Power Module HP		Qty. Per Drive	Model Number	Part Number
	230 VAC	460 VAC			
Regulator Module	25 - 150	50 - 300	1	–	0-57160-1
Digital Driver Module	25 - 150	50 - 300	1	–	0-57170-2
Field Loss Module	25 - 150	50 - 300	1	14C652	0-54350-3
Pilot Relay Module	25 - 150	50 - 300	2	–	0-54335-2
Fault Relay Module	25 - 150	50 - 300	1	–	0-54379-10
Phase Rectifier Module	25 - 75	50 - 150	3	–	86466-47S
	100 - 150	200 - 300	3	–	86466-59S
Gate Coupling Circuit	25 - 150	50 - 300	6	–	51378-25
Field Supply Assembly	25 - 150	50 - 300	1	–	705330-91R
Field Current Transformer	25 - 150	50 - 300	1	14C655	64670-24R
Line Fuses	25 - 30	50 - 60	3	–	64676-12CF
	40 - 50	75 - 100	3	–	64676-12CR
	60 - 75	125 - 150	3	–	64676-18CX
	100	200	3	–	64676-12DC
	125	250	3	–	64676-12DD
	150	300	3	–	64676-12DE
Field Supply Fuses	25 - 150	50 - 300	2	–	64676-18BB
Control Fuse (115 VAC)	25 - 75	50 - 150	1	–	64676-1H
	100 - 150	200 - 300	1	–	64676-1P
Low Voltage Control Fuses	25 - 150	50 - 300	3	14C671	64676-23V
Control Transformer	25 - 75	50 - 150	1	–	417155-R
	100 - 150	200 - 300	1	–	417155-S
Current Transformer	25 - 75	50 - 150	2	–	64670-11V
	100 - 150	200 - 300	2	–	64670-11W
Low Voltage Control Transformer	25 - 150	50 - 300	1	–	411027-62S
MOV Surge Suppressor	25 - 150	50 - 300	1	–	411026-X
Output RC Assembly	25 - 75	50 - 150	1	–	705330-32S
	100 - 150	200 - 300	1	–	705330-40R
Fan	25	50	1	–	705328-3T
	30 - 150	60 - 300	1	–	705328-T
Power Module Thermostat	25 - 150	50 - 300	1	–	608870-54S
Voltage Sensing Harness	25 - 150	50 - 300	1	–	810553-51R
Remote Operator Feedback	25 - 150	50 - 300	1	14C220	0-57005
Tachometer Feedback Module	25 - 150	50 - 300	1	14C221	0-57004
Test Buffer/Meter Filter Module	25 - 150	50 - 300	1	14C225	0-57006
Contactor	50 - 150	50 - 300	1	–	78093-60A
Blower Motor Starter	50 - 75	–	1	–	705393-W
	100 - 150	300	1	–	705393-T
	–	200 - 250	1	–	705393-X
Relay (AM)	–	250 - 300	1	–	600434-12R

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