

Installing, Operating  
and Maintaining  
FlexPak Plus  
D-C V★S Drives  
and Modification Kits

3-Phase Nonregenerative  
3 – 20hp at 230V/3-Phase A-C Input  
3 – 40hp at 460V/3-Phase A-C Input



Instruction Manual D-3938-2

December, 1991

**RELIANCE**  
**ELECTRIC** 

# SECTION 1 INTRODUCTION

**1.0 General** – This manual familiarizes the user with the three phase, FlexPak™ Plus D-C V★S® drive controller. (Refer to Figure 1.1.) It describes assembly and installation procedures, gives a general overview of operations, and contains information on troubleshooting, maintenance, the ordering of spare parts, and specifications.

The manual should be read **before** performing installation or start-up activities. Also, there are certain fundamental warnings which must be kept in mind **at all times**. These are:

## DANGER

THE DRIVE SYSTEM SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF ALL EQUIPMENT IN THE SYSTEM. PERSONAL INJURY AND/OR EQUIPMENT DAMAGE MAY OCCUR IF INDIVIDUALS ARE NOT FAMILIAR WITH THE HAZARDS RESULTING FROM IMPROPER OPERATION.

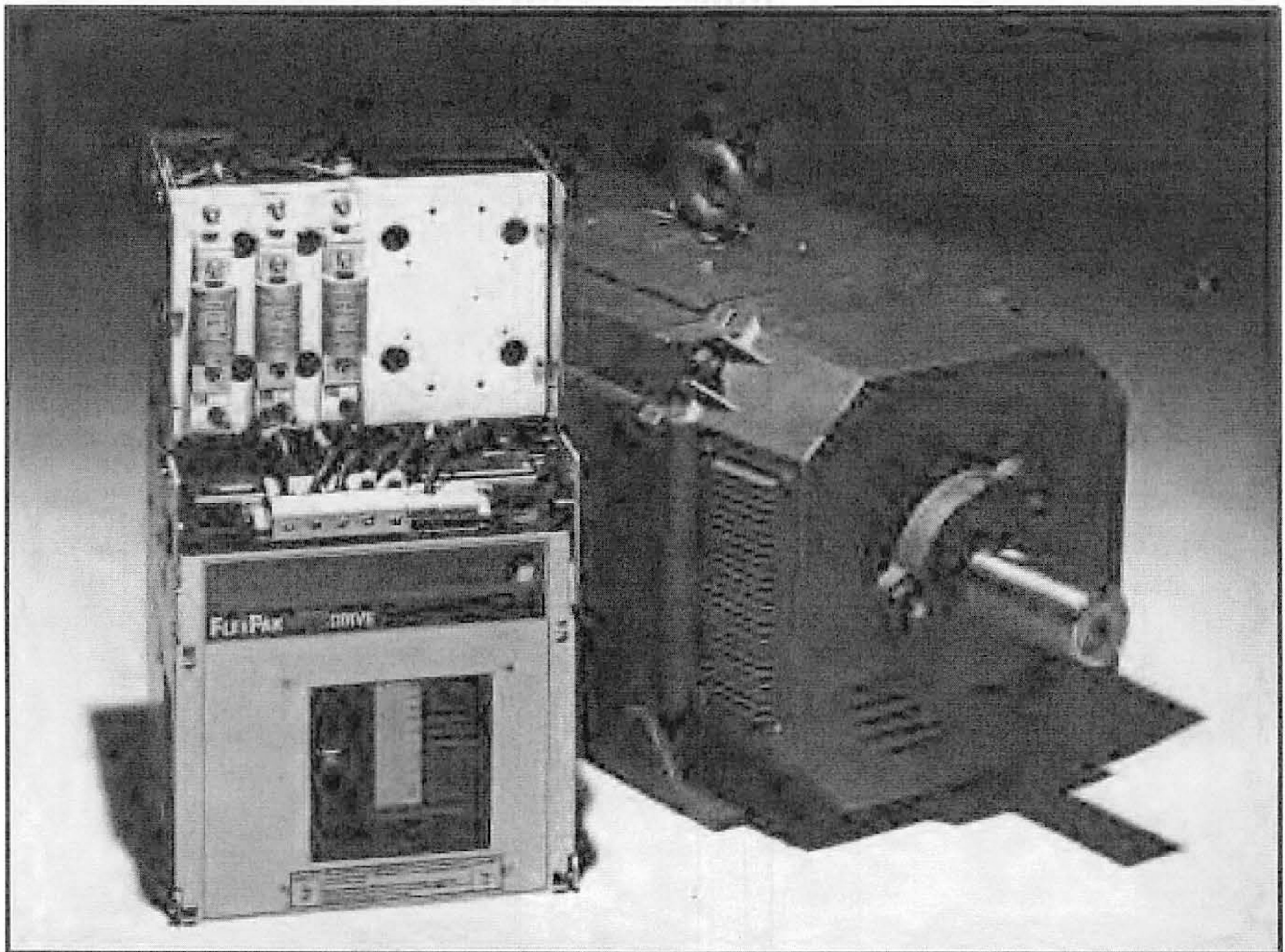


Figure 1.1 – FlexPak Plus Complete w/Optional Status Diagnostic Indicator and Super RPM Motor



**DANGER**

CONTROLLER EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER UNIT IN THE FLEXPAC PLUS CONTROLLER. THUS A-C POWER MUST BE REMOVED FROM THE UNIT BEFORE IT IS SAFE TO TOUCH INTERNAL PARTS OF THE CONTROLLER. PERSONAL INJURY MAY RESULT UNLESS POWER IS REMOVED.

**WARNING**

DO NOT OPERATE THE FLEXPAC PLUS CONTROLLER ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF 5000 AMPERES. DAMAGE TO EQUIPMENT AND PERSONAL INJURY MAY OCCUR.

**WARNING**

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

## SECTION 2

### GENERAL CONTROLLER INFORMATION

**2.0 General** – The FlexPak Plus D-C V\* $\Delta$ S drive controller may be applied to three phase d-c drive applications with ratings within the following ranges:

- From 3 to 20 hp with a 230 VAC, 50/60 Hz input voltage
- From 3 to 40 hp with a 460 VAC, 50/60 Hz input voltage

The controller provides power-conversion and control circuits which convert the a-c line voltage into adjustable d-c voltage in order to effectively control the drive motor.

The FlexPak Plus controller is provided, as standard, in a chassis type configuration for panel mounting within a larger electrical enclosure. The Remote Operator Controls may then be placed on the larger enclosures face or some distance away.

The three phase FlexPak Plus is available as a Complete Controller with Auxiliary Panel. The Complete Controller and the Auxiliary Panel (Figure 2.1) are Underwriters Laboratories (U.L.) listed.

Optional Modification Kits conveniently expand the capability of the Basic Controller and Auxiliary Panel.

The controller's features are summarized in Table 2.A.

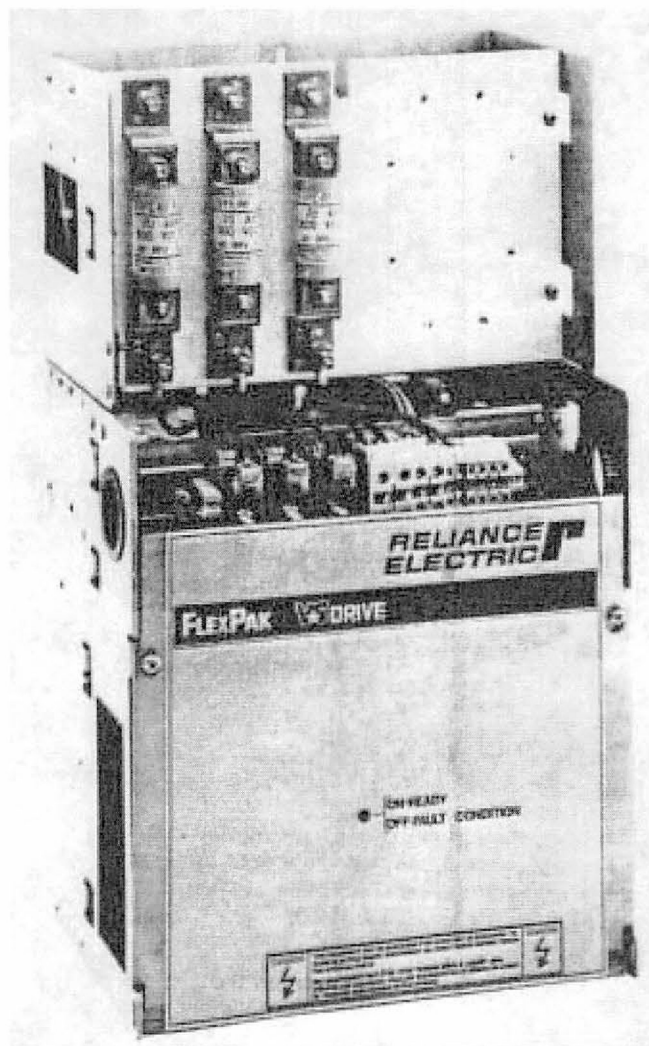


Figure 2.1 – Basic Controller and Auxiliary Panel

**Table 2.A – FlexPak Plus Features Summary**

Category	Feature
Controller Functions	<ul style="list-style-type: none"> <li>• START/STOP</li> <li>• RUN/JOG</li> <li>• FORWARD/REVERSE</li> <li>• Speed selection (5 to 100%)</li> <li>• Unidirection operation with coast-to-rest on stop command standard. (Dynamic braking and reversing available as options.)</li> <li>• 20:1 controlled-speed range by means of armature voltage control.</li> <li>• Auxiliary Panel armature loop contactor removes power to drive motor.</li> <li>• Isolated armature voltage and current feedback decouples armature power from operator devices and provides additional noise immunity.</li> <li>• With specified tachometers 0.5% or 1.0% speed regulation with a 95% load change.</li> <li>• Operates and delivers rated output speed with specified regulation tolerance limits even with a-c Line variations of <math>\pm 10\%</math> of nominal rated input voltage.</li> </ul>
Speed Regulation	<ul style="list-style-type: none"> <li>• Jumper reconnectable regulator circuits which allow armature (A) or tachometer feedback (T) regulation.</li> <li>• With voltage regulation, 3 to 5% speed regulation with 95% load change.</li> <li>• With tachometer specified, 1% speed regulation with a 95% load change. (Tachometers are: RE-045 a-c tachometer; also 5PY or RE-020 d-c tachometer.)</li> <li>• With tachometer specified, 0.5% speed regulation with 95% load change. (Tachometer is BC42.)</li> </ul>
User Adjustments	<ul style="list-style-type: none"> <li>• Adjustable IR drop compensation (0 to 12% of rated load).</li> <li>• Adjustable maximum speed (70 to 100% of base motor speed).</li> <li>• Adjustable minimum speed (5 to 30% of base motor speed).</li> <li>• Adjustable current limit (10 to 150% of full-load current).</li> <li>• Adjustable, separately set linear acceleration and deceleration rates (0.5 to 30 sec.)</li> </ul>
Safety	<ul style="list-style-type: none"> <li>• Control circuitry guards against automatic restarting of equipment after resumption of interrupted a-c incoming power.</li> <li>• Regulator and Operator's Controls isolated from a-c line for personnel protection.</li> <li>• Armature voltage and current feedback isolated to assure separation of power and regulator circuits.</li> </ul>
Hardware	<ul style="list-style-type: none"> <li>• Conveniently located screw terminal connections for incoming a-c and outgoing d-c power allow easy cable entry and connection.</li> <li>• Auxiliary Panel a-c line fuses protect Power Cube from armature short circuit and power relays provide positive power disconnect.</li> <li>• Protection from momentary surges on a-c line and from d-c load transients.</li> </ul>

**2.1 Operator's Controls** – For proper operation of the FlexPak Plus controller, it is necessary to provide Remote Operator's Controls. Reliance Electric offers a wide variety of operator control stations which may include the following devices:

- SPEED control potentiometer (5K)
- TORQUE control potentiometer (10K)
- AUTO/MANUAL selector switch (SPDT)
- RUN/JOG selector switch (SPST)

- FORWARD/REVERSE selector switch (DPDT)
- START/STOP selector switch (pushbuttons or special)

**2.2 D-C Drive Motors** – Reliance Electric offers a complete power-matched drive system for the controller and the application. Thus, the choice of Reliance Electric motors assures optimum performance and unmatched single-source responsibility.

**2.3 Modification Kits** – The basic capability of the controller can be quickly and conveniently extended with the use of a variety of optional Modification Kits. The Basic Controller modifications are:

- Tachometer Feedback
- Voltage/Tachometer Follower
- Instrument Interface/Preset Speed
- Test Meter Adapter
- Status/Diagnostic Indicator
- Dancer Follower

- Master Isolated Reference Receiver
- Contactor Adapter

The Auxiliary Panel modifications are:

- Blower Motor Starter
- Reversing Contactor
- Circuit Breaker
- Auxiliary M Contact
- Remote Dynamic Braking Kits are also available.

Complete descriptions of each Kit are given in Section 7.

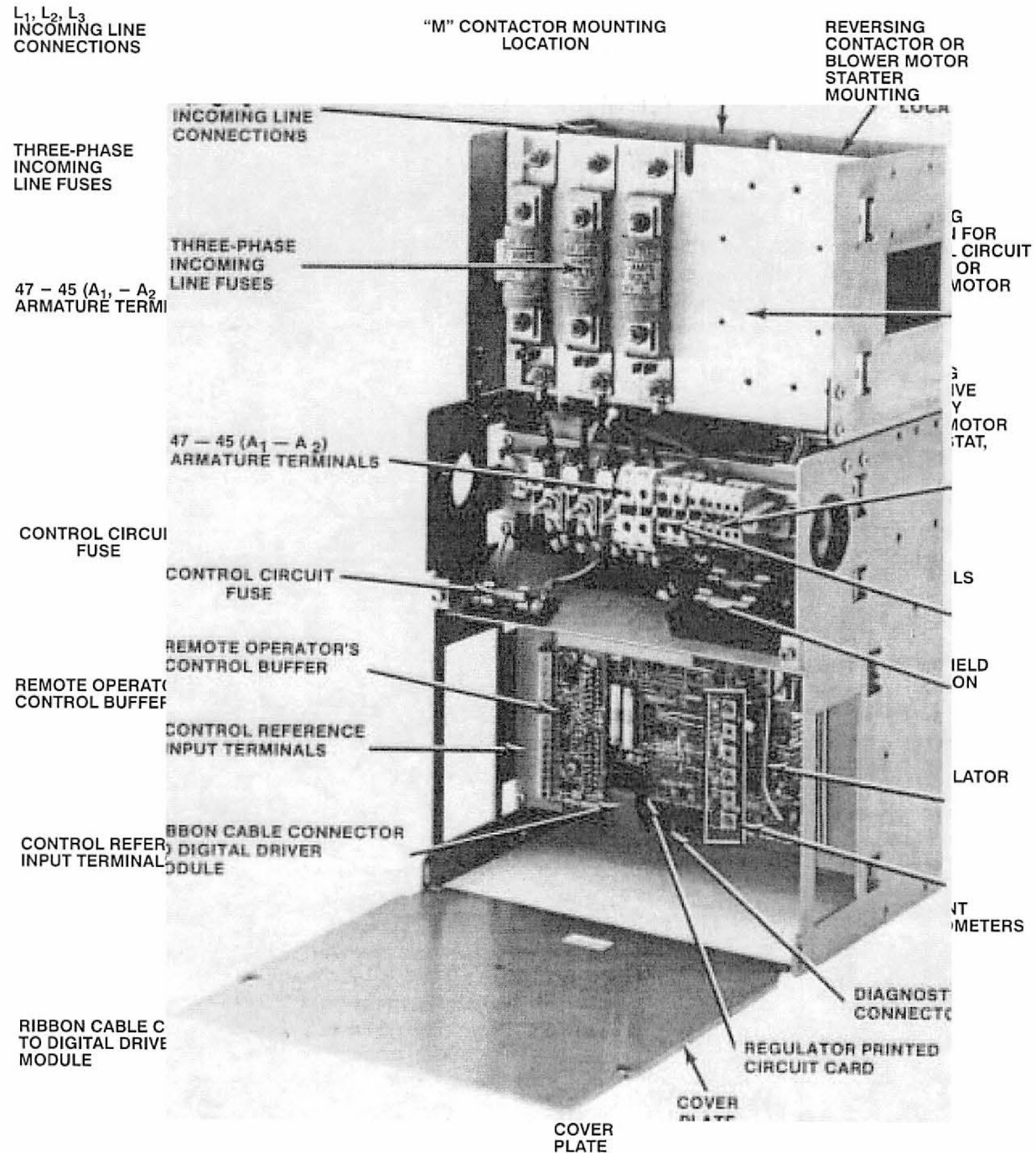


Figure 2.2 – FlexPak Plus D-C V\*S Drive 3 -40 HP Complete Controller Open Cover of Basic Drive

**Table 2.B – Specifications**

<b>A-C Line Input Voltage</b> 230/460 VAC (nominal, 60 HZ) 220/440 VAC (nominal, 50 Hz) three phase only <b>Line Voltage Variation</b> $\pm 10\%$ of nominal <b>A-C Line Frequency</b> Three Phase, 50/60 Hz Line Frequency Range 48-62 Hz <b>Output Voltages</b> (armature and field) See Table 2.D <b>Controller-Drive HP Range</b> 3-20 (with 230 VAC input) 3-40 (with 460 VAC input) <b>Direction Control</b> Standard: Unidirection Optionally: Forward/Reverse <b>Maximum Speed Adjustment</b> 70 to 100% of base motor speed (user adjustable) <b>Minimum Speed Adjustment</b> up to 30% of base motor speed (user adjustable) <b>Operator Speed Adjustment</b> Infinitely adjustable with optional control pot (up to 100% of base speed)	<b>Operator Torque Adjustment</b> Infinitely adjustable at optional control pot (10 to 150% of rated load) <b>IR Drop Compensation</b> 0 to 12% of rated load (user adjustable) <b>Controllable Speed Range</b> 20:1 <b>Current Limit</b> Factory shipped: 150% of full load User adjustable: 10 to 150% of full load <b>Regulator (with 95% load change)</b> 3 to 5% with voltage feedback 1.0% with specified tachometer feedback 0.5% with specified tachometer feedback <b>Minimum Load for Stable Operation</b> 5% <b>Acceleration/Deceleration Rates</b> 0.5 to 30 sec. linear time (user-adjusted separately) <b>Armature Circuit Overload Capacity</b> 150% of armature current rating for 1 minute (max.) <b>Efficiency (rated speed/rated load)</b> Controller only: 97% Complete drive including motor 85% (typical) ①	<b>Displacement Power Factor</b> 68% (typical) ① <b>Transient Protection</b> MOV and Output RC Circuit <b>Controller Service Factor</b> 1.0 <b>Duty</b> Continuous <b>Ambient Temperature</b> (storage and operational) 0° to 55°C (32° to 131°F) <b>Relative Humidity</b> (storage and operational) 5 to 95% (without condensation) <b>Operational Altitude</b> To 3300 ft (1000 m) above sea level without derating <b>Controller Weight (approx.)</b> 37 lb (87.8 Kg) <b>Controller Dimensions (LWD)</b> (A) = 18.75x10.62x8.00 in. (476x270x203 mm) (B) = 18.75x10.62x9.50 in. (476x370x241 mm) A – 3-10 HP/230V, 3-20 HP 460V B – 15-20 HP/230V, 25-40 HP 460V
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① Typical percent shown. Exact figure dependent on motor base speed and frame size.

**2.4 Specifications** – The more important specifications for the FlexPak Plus controller are listed in Table 2.B. Refer also to Table 2.D where other ratings are indicated in relation to d-c motors of specific horsepower.

**2.4.1 Line Frequency** – The FlexPak Plus controller is able to operate without modification from a three-phase power source having a frequency range from 48 to 62 Hz.

**2.4.2 Voltage Tolerance** – The FlexPak Plus controller delivers output current and voltage, as listed in Table 2.D. It will also operate within these regulation specifications even with incoming line voltage at  $\pm 10\%$  of nominal.

**2.4.3 Line Impedance Requirements** – The FlexPak Plus controller must be connected to a plant power supply with maximum permissible available symmetrical RMS fault current no greater than 5000 amperes. (Refer to Table 2.D.)

#### WARNING

**DO NOT OPERATE THE FLEXPAC PLUS CONTROLLER ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF 5000 AMPERES. DAMAGE TO EQUIPMENT AND PERSONAL INJURY MAY OCCUR. EXTERNAL DISCONNECT MEANS MUST HAVE ABILITY TO INTERRUPT A 5000 AMP RMS CURRENT FAULT.**

**2.4.4 Relay Control Circuit** – The regulator board is set up for use with 24 VDC main contactors having a coil resistance greater than or equal to 100 ohms, 14C300 only; 14C301 to 14C305 is 1000 ohms. The control logic sequences the contractor and the control relay on the regulator so that current flow thru the main contactor is never broken in normal operation by the contracts. Refer to Figures 5.1, and 5.2.

The standard controller includes an M contactor. However, the Optional Basic Controller does not have an M contactor. An M contactor is required to provide positive power disconnect in all applications.

**WARNING**

IN THE OPTIONAL BASIC DRIVE, THE USER MUST INSTALL AN M CONTACTOR THAT HAS A 115 VAC COIL WITH A MAXIMUM CURRENT DRAW OF 440 MILLIAMPS. THE CONTACTOR ADAPTER KIT MUST BE INSTALLED WITH THE USER'S M CONTACTOR. (REFER TO D-3955) PERSONAL INJURY MAY OCCUR IF THIS IS NOT INSTALLED.

**2.4.5 A-C Line Fuse Requirements** – A-C line protection is provided with the Auxiliary Panel. The Optional Basic FlexPak Controller, however, does not include a-c line protection. Fused a-c line protection must be used. Refer to Table 2.C for proper fuse sizing. (Note: Semi-conductor current limiting fuses must be used.)

**Table 2.C – Fuse Requirements**

HP	A-C Line Volts	Fuse Specification (one per Phase)	
		Reliance Part No.	Rating
3-10	230	64676-12BX	70A, 500V
15	230	64676-12CC	125A, 500V
20	230	64676-12CC	125A, 500V
3-20	460	64676-12BX	70A, 500V
25-30	460	64676-12CC	125A, 500V
40	460	64676-12CC	125A, 500V

**Table 2.D – D-C Motor/Controller/Transformer Specifications**

Controller Model Numbers	HP	VAC @ 60 Hz	A-C Amps (RMS)	D-C Arm. (Volts)	D-C Arm. Amps (avg.)	D-C Field Volts	Amp. Max. ①	Power Supply Capacity ②	Transformer	
									Maximum kVA ③	Rated kVA
14C300	3	230	12	240	12	150	5	5000	30	④ 6
	5	230	20	240	20	150	5	5000	50	④10
	7-1/2	230	28	240	29	150	5	5000	63	④12-1/2
	10	230	36	240	38	150	5	5000	80	16
14C301	15	230	51	240	55	150	5	5000	115	23
14C302	20	230	66	240	72	150	5	5000	145	30
14C303	3	460	7	500	6	300	5	5000	30	④ 6
	5	460	11	500	10	300	5	5000	50	④10
	7-1/2	460	14	500	14	300	5	5000	63	④12-1/2
	10	460	18	500	18	300	5	5000	80	16
	15	460	26	500	27	300	5	5000	115	23
	20	460	34	500	36	300	5	5000	145	30
14C304	25	460	40	500	43	300	5	5000	175	35
	30	460	47	500	51	300	5	5000	205	41
14C305	40	460	63	500	69	300	5	5000	250	55

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

② Maximum permissible available symmetrical RMS fault current with NEC or CEC external approved disconnect.

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

④ Minimum required KVA size is 15 KVA for proper operation.



## SECTION 3 INSTALLATION

**3.0 General** – This Section outlines the procedures that are to be followed in order to properly install a Flex-Pak Plus controller.

The d-c motor should be installed and wired in accordance with installation instructions supplied with each drive.

There are certain general warnings and cautions that 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. As a user aid, they are listed here.

### **DANGER**

**THIS UNIT SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS TYPE OF EQUIPMENT. THEY SHOULD ALSO BE FAMILIAR WITH THE POTENTIAL HAZARDS INVOLVED. IF THIS WARNING IS NOT OBSERVED, PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.**

### **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, PERSONAL INJURY MAY OCCUR.**

### **WARNING**

**THE CONTROLLER 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 CONTROLLER. DO NOT OPERATE THE FLEXPAK PLUS CONTROLLER ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF 5000 AMPERES. DAMAGE TO EQUIPMENT AND PERSONAL INJURY MAY OCCUR.**

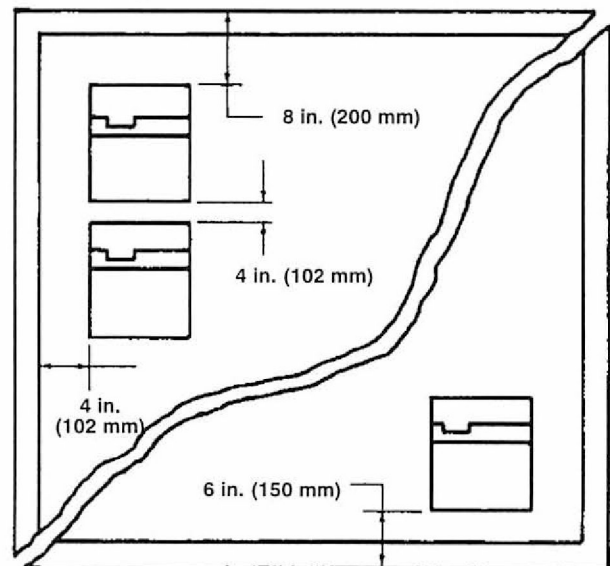
### **WARNING**

**THE USER IS RESPONSIBLE FOR CONFORMING WITH THE NATIONAL ELECTRICAL CODE WITH RESPECT TO MOTOR, CONTROLLER AND OPERATOR DEVICE INSTALLATION, WIRING AND START-UP. 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.**

**3.1 Layout Guidelines** – This Paragraph lists recommended layout procedures common to all FlexPak Plus controllers.

**Guideline 1** – The FlexPak Plus controller is designed as a panel-mounted unit. It is to be hung within 10° of vertical with the rear of the Chassis firmly resting against the mounting surface. (Do not position the Chassis on a horizontal surface.)

**Guideline 2** – It is necessary to leave at least a 4 inch (102 mm) clearance between controllers including top, bottom and side. This unobstructed area allows 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 or 6 inches (150 mm) from the bottom of the enclosure. (Refer to Figure 3.1.) Heat builds up at the cabinet's top and may exceed the permissible inside ambient temperature upper limit. At the cabinet's bottom, the unit must be high enough to allow air to flow upwards.

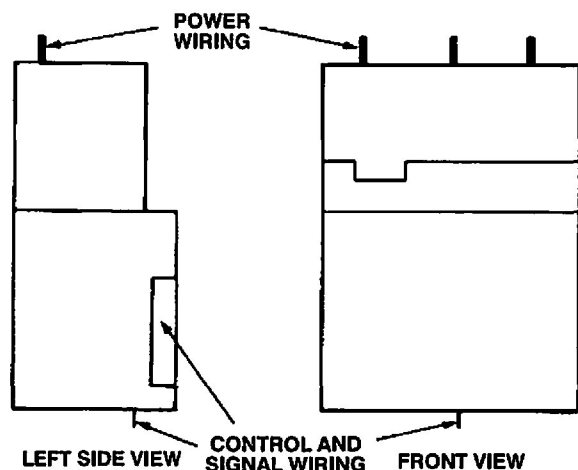


**Figure 3.1 – Enclosure Mounting Minimum Distances**

**Guideline 3** – Regardless of the above placement guidelines, the user is responsible for providing ambient temperatures that meet the controllers specifications of 0° to 55°C (32° to 131°F). This must be given careful consideration especially to units located near the very top of the supplied enclosure. Relative humidity must be kept between 5 and 95% **without** condensation.

**Guideline 4** – Due to the U-shaped panel design of the FlexPak Plus, the controller must be mounted in the vertical position to allow for proper cooling.

The controller is also designed to allow for power wiring to enter from the top and for control and signal wiring to be routed in thru the openings in the sides of the controller or from the bottom. (Refer to Figure 3.2.)



**Figure 3.2 – Mounting and Wiring Orientations**

**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 controller, 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.).

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

- Personal injury is guarded against 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 controller and other user-equipment on the same ac 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 3.4.

**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 controller 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 three-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. In many cases it is adequate to use a screw in the conduit box near the motor.

**Guideline 9** – A thermostat is used to guard against motor overload protection. It is essential to properly connect the motor thermostat to connections 34 and 132.

**CAUTION:** External overload devices must be connected between terminals 32, 33, 34 and 132. The drive will not start without them.

Refer to Figure 3.4 where a typical Operator's Station schematic is shown.

**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.

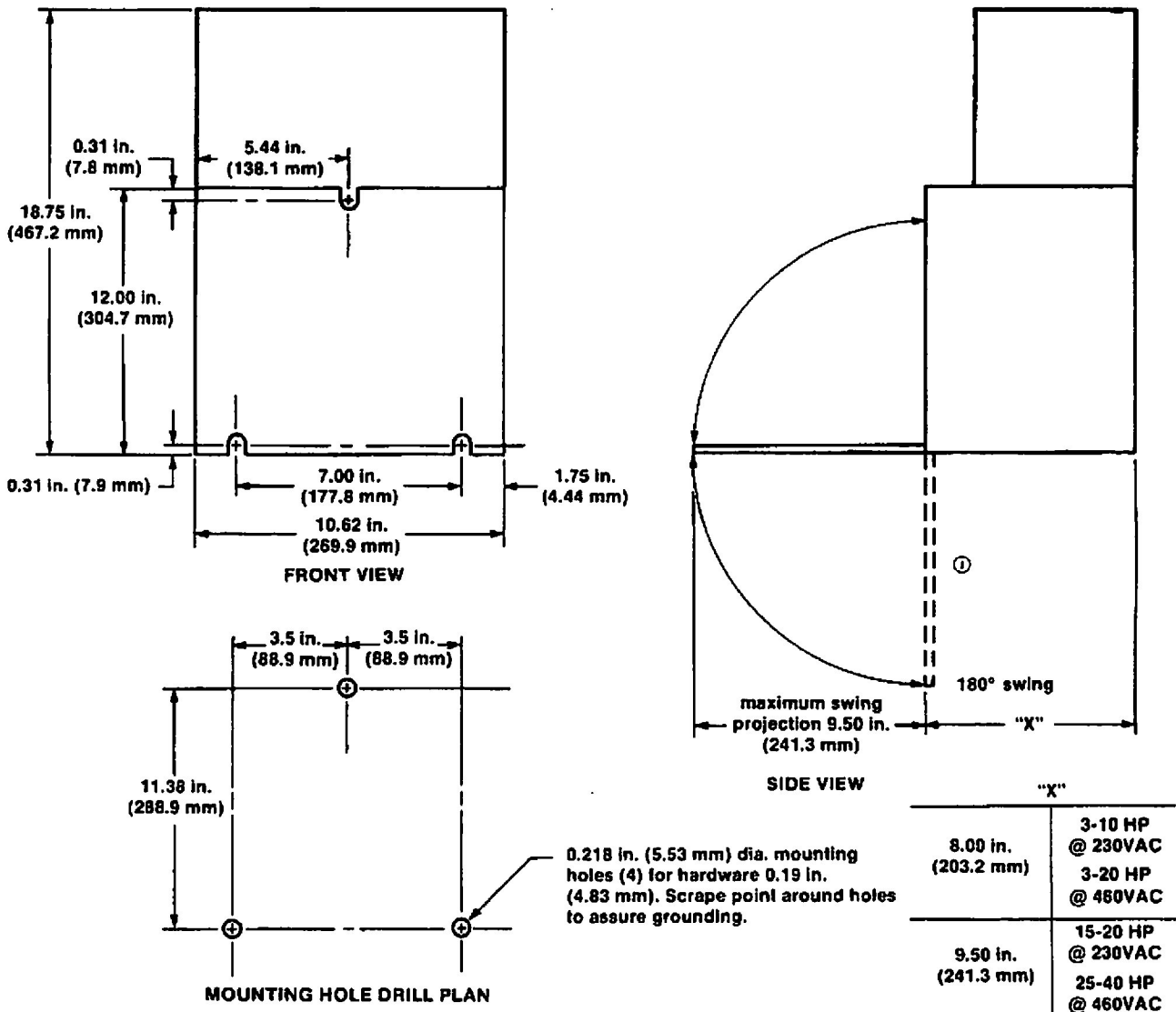
**3.2 Mounting** – This Paragraph outlines the procedures to be followed to mount the FlexPak Plus controller.

Determine the exact placement of the Chassis on the Panel. (Refer to Figure 3.3 for mounting dimensions.) Scribe the panel. Drill three holes large enough to accept #10 mounting bolts. Scrape the paint around the holes to allow washers and bolts to make a ground contact.

**3.3 Power Wiring** – This Paragraph briefly outlines the procedures to be followed when wiring a-c power supply lines to the controller and d-c control circuits to the drive. A basic connection diagram is given at Figure 3.4.

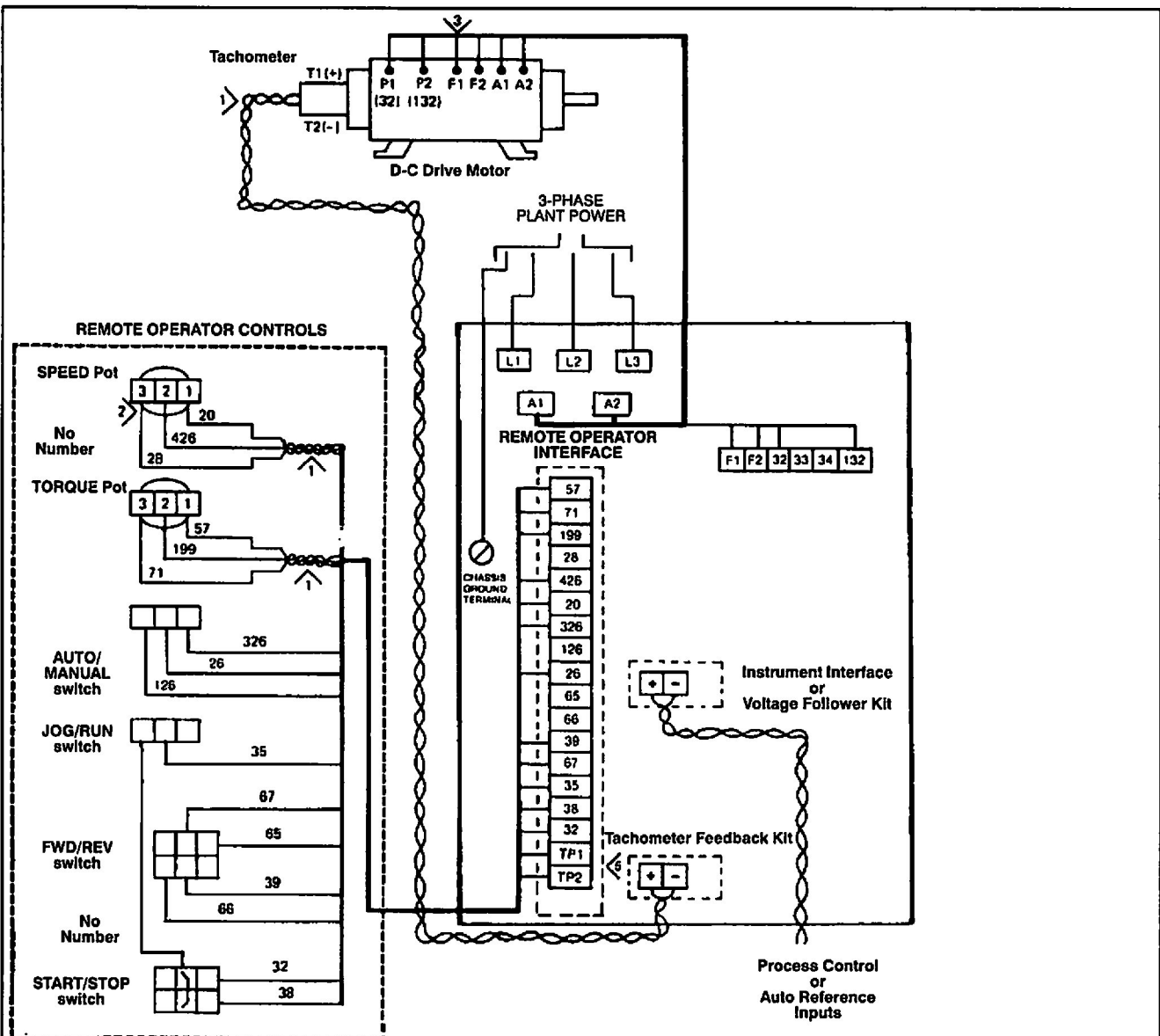
**DANGER**

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.



① Avoid exposed electrical connections in this area below drive. Hinged door is conductive metal.

**Figure 3.3 – Mounting Dimensions**



**Notes:**

- 1> These signals must be run in a separate magnetic conduit to minimize the possibility of noise pickup. (Refer to Table 7.B 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 controller voltage.
- 4> Remove jumper J9 from Regulator Module when Reversing Contactor is installed.
- 5> Use convenience terminals for #14 AWG maximum wire size.
- 6> If auxiliary Panel is not used, user must supply an appropriate M contactor. Refer to Paragraphs 2.4.4 and I/M D3955.

**Figure 3.4 – System Connection Diagram**

### WARNING

IN THE OPTIONAL BASIC DRIVE, THE USER MUST INSTALL AN M CONTACTOR THAT HAS A 115 VAC COIL WITH A MAXIMUM CURRENT DRAW OF 440 MILLIAMPS. THE CONTACTOR ADAPTER KIT MUST BE INSTALLED WITH THE USER'S M CONTACTOR. (REFER TO D-3955) PERSONAL INJURY MAY OCCUR IF THIS IS NOT INSTALLED.

All interconnecting wire should primarily be sized and installed in conformance with N.E.C., C.E.C. or local codes. Refer to the controller 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.

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

For applications using the 230V, 3-10 HP FlexPak Plus, wires to the motor armature (A1 and A2) must be lugged with the provided lugs, or equivalent, before connection to the appropriate relay terminals.

### 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.

**3.4 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.)

Refer also to Table 2.D 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 the FlexPak Plus controller.

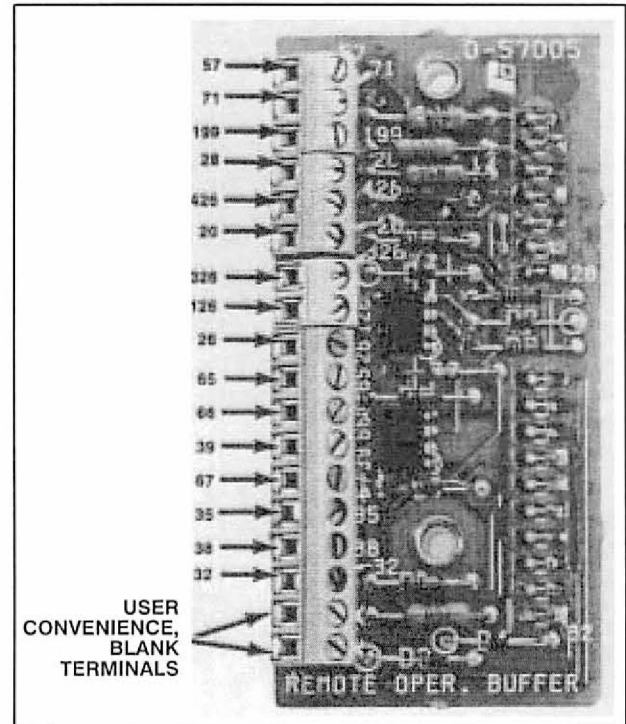


Figure 3.5 – Remote Operators Buffer Terminal Markings

**3.5 HP/Current Jumper** – It is necessary to inspect the Current Scaling/Horsepower Jumper on the Regulator Module to be sure that it is connected correctly for a specific drive motor.

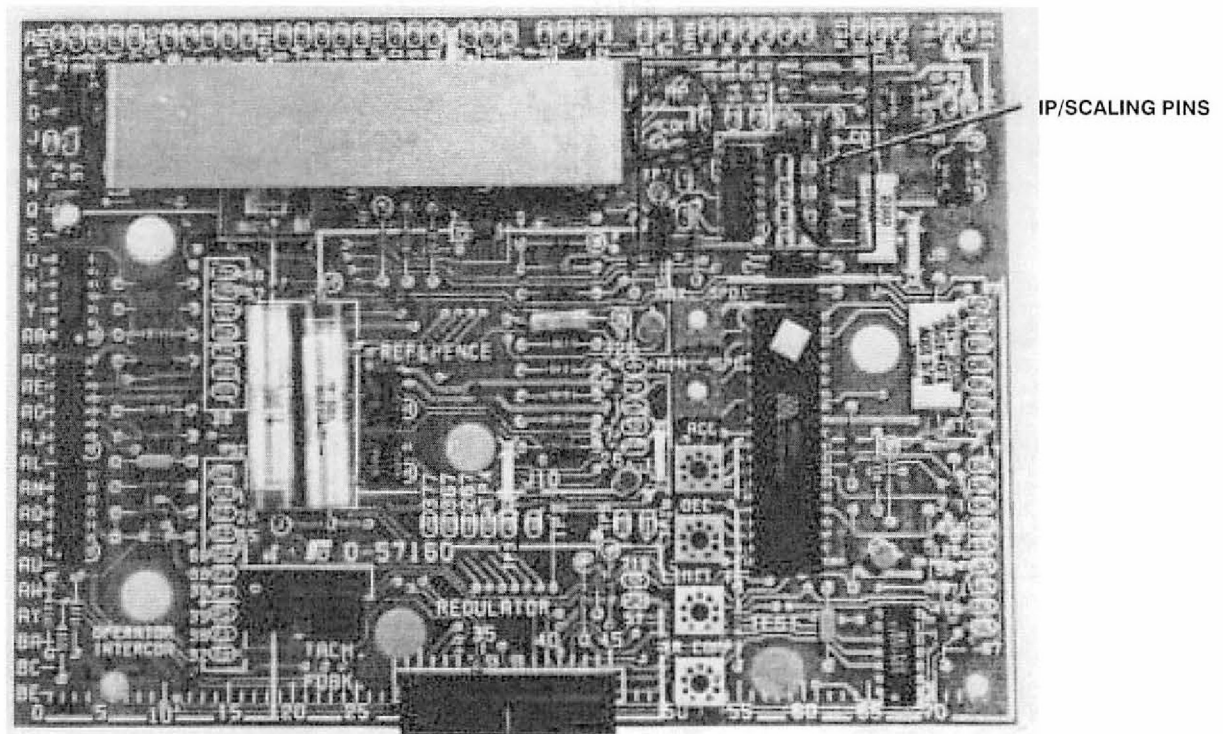
**Step 1** – On the drive motor, locate the nameplate. Note the full-load current.

**Step 2** – Or, if current is not shown on the nameplate, refer to Table 3.A. Relate the columns in the table with known motor data. Read across to the right column marked "Motor Current." This figure indicates the proper jumper connection to make on the Module where a corresponding number is etched.

Table 3.A – Horsepower Calibration

230 VAC HP	Motor Current Pin Connection	460 VAC HP	Motor Current Pin Connection
3	13	3	5.7
5	19	5	10
7.5	27	7.5	13
		10	19
		15	27
① 10	36	20	36
15	54	① 25	45
20	72	30	54
		40	72

① High HP units cannot be directly scaled to the lower HP units, above line, due to current transformers ratios used in feedback loop



**Figure 3.6 – Regulator Module, HP/Current Scaling Pins**

**Step 3** – On the Regulator Module, locate the scaling pins. (Refer to Figure 3.6.) Near them, locate the black pig-tail type jumper. Do not move it if it is connected to the proper pin. If it must be reconnected, carefully lift connector housing straight up and off the pin. Slide the connector straight down over the proper pin.

**3.6 Regulation Mode** – The FlexPak Plus controller of drive regulation. The first, which is factory shipped, is armature voltage feedback (A).

Optionally, the user may also use tachometer feedback (T) regulation. In order to use this modes, however, the Regulation Mode Jumper, one end of which is perma-

nently fixed to the Regulator Module, must be moved to one of two positions. Details of jumper placement are noted in Section 7, D-3969.

#### **DANGER**

**IF YOU ARE UNSURE WHICH REGULATION MODE A CONTROLLER SHOULD HAVE, IT IS IMPORTANT YOU FIND OUT. IF THE JUMPER IS NOT PROPERLY CONNECTED, PERSONAL INJURY MAY RESULT.**



## 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.

**3.7 Overspeed** – 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 DC 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 it's 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 controller 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 operators speed potentiometer and/or other speed references. Should such a condition occur, the drive must be quickly stopped using the appropriate "stop" pushbutton, 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 (where the motor and controller are both manufactured by Reliance Electric and furnished together on the same Reliance Sales Order) have a maximum safe speed (M.S.S.) 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. (Assuming 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 D-C	253 volts A-C
500 volts D-C	460 volts D-C	506 volts A-C
600 volts D-C	550 volts D-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 M.S.S. of the motor.

### CHART I

VAC = Nominal RMS line-to-line voltage

S<sub>B</sub> = Base speed at full field and rated armature voltage

E<sub>g</sub> (NL) = Armature voltage no load

MSS = Max safe operating speed

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

The motor Maximum Safe Speed, which varies as a function of motor frame diameter, are listed below. Examination of the motor nameplate may indicate a M.S.S. slightly different for that specific machine. In that case, motor nameplate M.S.S. 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

### START-UP AND ADJUSTMENT

**4.0 General** – This Section provides start-up and adjustment procedures to be followed after the assembly and installation of the controller is complete. All initial operation checks and final adjustments to the controller must be made in conformance to the procedures, warnings and recommendations listed here.

#### DANGER

THE FLEXPAC PLUS CONTROLLER IS AT LINE VOLTAGE WHEN A-C LINE POWER IS CONNECTED TO THE POWER UNIT INSIDE THE CONTROLLER. BEFORE WORKING ON, OR TOUCHING ANY INTERNAL PARTS OF, THE CONTROLLER, REMOVE INCOMING A-C LINE POWER AT THE MAIN DISCONNECT SWITCH. PERSONAL INJURY MAY RESULT IF THIS WARNING IS NOT FOLLOWED.

#### DANGER

DURING INITIAL START-UP, THE CONTROLLER AND ITS ASSOCIATED EQUIPMENT MUST BE OPERATED AND/OR ADJUSTED ONLY BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL. THESE INDIVIDUALS SHOULD BE FAMILIAR WITH THE DESIGN AND OPERATION OF THIS EQUIPMENT AND WITH THE HAZARDS INVOLVED. PERSONAL INJURY AND/OR DAMAGE TO THE CONTROLLER COULD RESULT FROM UNFAMILIARITY.

**4.1 Power Off Inspection** – It is necessary to make a superficial inspection of the FlexPak Plus controller and its associated units. The purpose of this check is to look for possible physical damage or improper connections.

Inspect all plug-in Modification Kits. Test each for a firm mounting condition.

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

Inspect all screw terminal connections on the Modification Kits. 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 Control Station. A series of wires will connect to individual terminals on a strip mounted on the Remote Operator Interface Module. (This Module is mounted on the Regulator Module.) Determine that all wires are firmly seated in the terminal strip. Make sure all wires are connected.

**4.2 Motor Ground Check** – It may be necessary to make a check of the drive motor to assure that no damaging grounds – other than earth ground – exist within the motor.

**CAUTION:** Although a megger may be used for this test, if one is used, all conductors between the drive motor and the FlexPak Plus controller are to be disconnected and moved aside. **The megger's high voltage can cause damage to the controller's circuits.**

**Step 1** – Attach one lead from the 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 FlexPak Plus controller.

**4.3 Power On Adjustments** – Once all the preliminary power-off static adjustments have been performed with acceptable results, the a-c line power is to be applied to the controller, but the load is not connected. It is important to follow these 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 CONTROLLER. EXERCISE EXTREME CAUTION WHEN PERFORMING THESE TESTS. PERSONAL INJURY CAN 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 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.

**4.3.1 Regulator Module Pots** – The Regulator Module has six adjustable potentiometers mounted on it. (Refer to Figure 4.1.) They control the following functions:

- Maximum speed (full CCW: 50 -70% speed)
- Minimum speed (full CCW: Drive Min. Speed 5%)
- Acceleration rate (full CCW)
- Deceleration rate (full CCW)
- Current limit (factory-set at 150%)
- IR comp (full CCW)

The potentiometers are factory preset for the safest or most conservative operation.

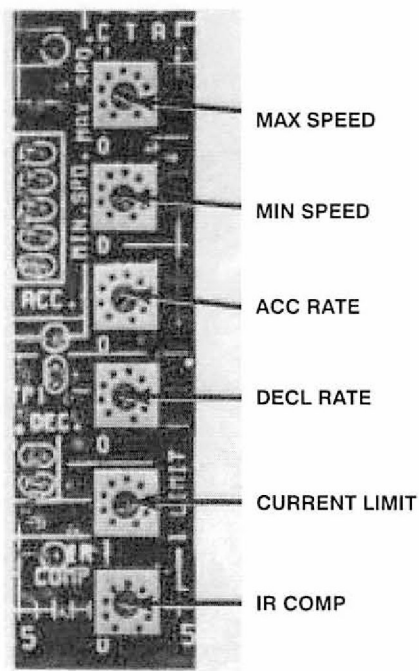


Figure 4.1 – Regulator Module Potentiometers

### DANGER

USE ONLY ON HAND TO HOLD THE SCREW-DRIVER. KEEP YOUR OTHER HAND BEHIND YOU. DO NOT USE YOUR OTHER HAND TO BRACE YOURSELF AGAINST THE CONTROLLER, PANEL OR ENCLOSURE. PERSONAL INJURY COULD RESULT IF YOU ACCIDENTALLY TOUCH A COMPONENT AT LINE VOLTAGE.

**4.3.2 Maximum Speed (Voltage)** – The Maximum Speed Potentiometer on the Regulator Module 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.

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

Locate the Maximum Speed Potentiometer on the Regulator Module. (Refer to Figure 4.1.) The letters MAX SPD are printed on the Module. Note that CW rotation represents an **increase** in speed. CCW represents a **decrease**.

### 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 SERIOUS PERSONAL INJURY COULD RESULT.

On the Operator Station, increase the 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 maximum speed on the SPEED dial. Use a small insulated slot screwdriver.

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:** A further adjustment may be needed but it should be performed after completing Paragraph 4.3.3. Note that the maximum and minimum speed adjustments are interactive; a change in one affects the other.

**4.3.3. Minimum Speed (Voltage)** – The Minimum Speed Potentiometer on the regulator has been factory preset for drive minimum speed, 5%. By means of adjustment, this speed may be raised or lowered. 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.

Again, the motor speed can be determined 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 that CW represents an **increase**; CCW represents a **decrease**.

**NOTE:** *Carefully recheck the maximum speed adjustment for desired setting Since the maximum and minimum speed adjustments are interactive, a change in one affects the other. At times, it may be necessary to work back and forth for precise adjustments.*

**4.3.4 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.

**4.3.5 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 accelerating 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.

**4.3.6 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, motor speed rising characteristics may result. Instability and oscillation in motor speed will result.

## SECTION 5 TROUBLESHOOTING

**5.0 General** – This Section details troubleshooting information for the FlexPak Plus controller. Its organization is as follows:

- General troubleshooting concepts (Paragraphs 5.1, 5.2, 5.3 and 5.4)
- Specific symptom/probable cause/recommended procedures (Paragraph 5.5)
- Reference schematics, photos and diagrams of the controller (Paragraph 5.6)

### **DANGER**

**CONTROLLER EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER UNIT IN THE FLEXPAC PLUS CONTROLLER. THUS, A-C POWER MUST BE REMOVED FROM THE UNIT BEFORE IT IS SAFE TO TOUCH THE INTERNAL PARTS OF THE FLEXPAC PLUS. PERSONAL INJURY MAY RESULT UNLESS POWER IS REMOVED.**

### **DANGER**

**THE FLEXPAC PLUS CONTROLLER SHOULD BE SERVICED ONLY BY QUALIFIED ELECTRICAL MAINTENANCE PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF ALL APPLICATION EQUIPMENT IN THE SYSTEM. PERSONAL INJURY AND/OR EQUIPMENT DAMAGE MAY OCCUR IF INDIVIDUALS ARE NOT FAMILIAR WITH THE HAZARDS RESULTING FROM IMPROPER OPERATION.**

In addition to step-by-step troubleshooting procedures, there are some generalized comments that should be kept in mind at all times. These may be divided into wiring errors (Paragraph 5.1), incoming a-c line problems (Paragraph 5.2), motor problems (Paragraph 5.3) and mechanical problems (Paragraph 5.4).

A number of optional kits have also been developed to assist in troubleshooting the drive. These are:

- Status/Diagnostic indicator kit which installs on the faceplate of the drive & utilizes a LCD to visually enunciate 13 critical drive functions in regards to their status as well as indicating the specific fault area. (Refer to Instruction Manual D-3963).

- The Diagnostor which is a portable device about the size of a digital voltmeter. The Diagnostor will exercise the regulator module and the digital driver board and logically determine the operating conditions of these modules. It also has the ability to analyze the power bridge circuitry while the drive is operating and determine if a problem exists within the power bridge area. The Diagnostor uses a LCD to visually enunciate the logic output condition of its test. Two terminals coupled with specified pushbutton positions on the Diagnostor faceplate allow access to various waveforms and voltages within the controller via a scope or meter to assist in troubleshooting the drive.
- The test meter adapter kit provides a convenient means of monitoring voltage on the regulator module with an external user supplied voltmeter (Refer to Instruction Manual D-3970)

**5.1 Wiring Errors** – The single most common problem preventing normal d-c drive operation is incorrect wiring within a 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 controller that had previously been functioning correctly if initial wiring techniques were poorly performed.

For those not familiar with proper FlexPak Plus controller wiring, other Sections in this manual may be consulted. For more complex problems, Section 7 may be used to uncover wiring problems in the optional Modification Kits.

**5.2 A-C Line Problems** – The following are typical problems located on the incoming a-c line:

- A-c line voltage incorrect for the specific controller, which may operate on 230 or 460 VAC @ 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 FlexPak Plus controller.



**5.3 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 FlexPak Plus controller is **completely** disconnected.
- A volt-ohmmeter (VOM) may be used for ground checking without disconnecting conductors to the FlexPak Plus controller.
- Check the field windings for open or short conditions.
- Check continuity through the armature and brushes. Use terminals A1 and A2 at the Controller as test points.

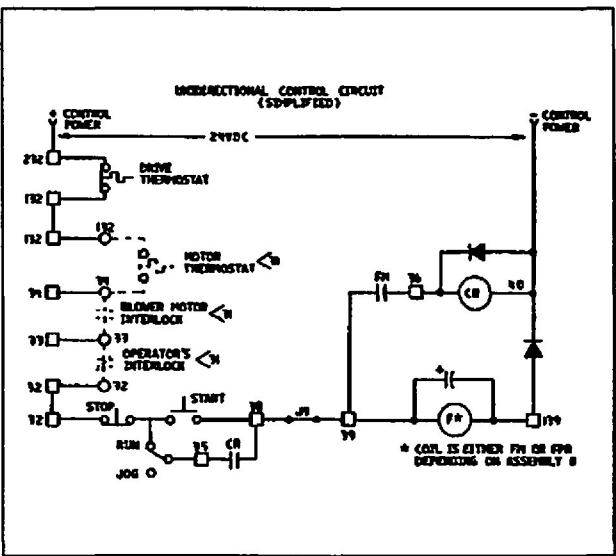


Figure 5.1 – Unidirectional Control Circuit (simplified)

**5.4 Mechanical** – 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. Thus, the freedom of motion of the load device should be considered.

**5.5 Controller Malfunctions** – Table 5.A presents an organized troubleshooting sequence based on a symptom/probable cause/suggested procedure approach. They develop from the most simple, obvious malfunction to more complex ones.

**5.6 Schematics, Diagrams** – In order to aid with the troubleshooting process, various schematics and diagrams 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.

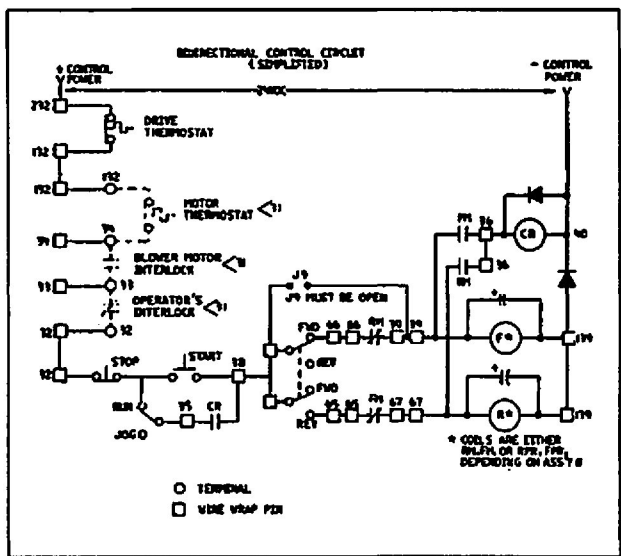


Figure 5.2 – Bidirectional Control Circuit (simplified)

Symptom	Probable Cause	Recommended Procedures
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### TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE COMPLETE CONTROLLER

Symptom	Probable Cause	Recommended Procedures
1. POWER ON/OFF circuit breaker trips or fuses clear when power is applied.	Incorrect wiring connections to controller; from controller to motor; in motor.  Short in Power Cube. Short in Field Supply.	<p style="text-align: center;"><b>DANGER</b></p> <p><b>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.</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Connect ohmmeter from terminal 38 to 39 on TB.</li> <li><input type="checkbox"/> Remove a-c power at the disconnect.</li> <li><input type="checkbox"/> Remove leads to L1, L2, L3, A1, A2 and F1, F2, on incoming side of controller's respective location.</li> <li><input type="checkbox"/> Open the power disconnect switch.</li> <li><input type="checkbox"/> Check for a ground condition at L1/181, L2/182, L3/183, A1, A2, F1 and F2. Do this at controller (internal) side of 1TB. If a ground is discovered, check wiring connections on Power Cube and motor field terminals F1 and F2.</li> <li><input type="checkbox"/> If no ground exists, examine the controller chassis for loose wires and/or foreign objects.</li> <li><input type="checkbox"/> 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.</li> <li><input type="checkbox"/> If a ground is found, it is in the conductors to the motor or in the motor itself.</li> <li><input type="checkbox"/> Disconnect the motor from the conductors at the drive motor.</li> <li><input type="checkbox"/> Test A1, A2, F1 and F2 conductors for a ground. (If one exists, examine connections and insulation for areas where shorts could occur.)</li> <li><input type="checkbox"/> 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.</li> <li><input type="checkbox"/> Replace Power Cube.</li> <li><input type="checkbox"/> Replace Field Supply.</li> </ul>
2. Drive motor does not start.	Main a-c line disconnect not closed; or fuse blown; or no power applied ahead of disconnect.  Drive interlocks preventing operation. 32 to 33 on TB  Drive motor thermostat wires not connected on FlexPak Plus controller terminals 34 and 132 on TB.  External overload wires not connected on FlexPak Plus controller terminals 34 and 33 on TB.  Drive thermostat wires not connected on FlexPak Plus controller terminals 132 to 232	<ul style="list-style-type: none"> <li><input type="checkbox"/> Check disconnect switch, fuses in it, and voltage on line.</li> <li><input type="checkbox"/> Verify that all user-installed interlocks are in a state (physical condition and wiring connections) to allow a start.</li> <li><input type="checkbox"/> Check connections to thermostat: at drive motor P1, P2; at controller 34, 132.</li> <li><input type="checkbox"/> Check for open thermostat inside motor. Make a resistance check of thermostat. (It should read a short, or low resistance, if it is closed,</li> <li><input type="checkbox"/> Check connections to external overload. (Blower Motor Starter O/L)</li> <li><input type="checkbox"/> Check for open overload, Make a resistance check to overload. (It should read a short, or low resistance, if it is closed.)</li> <li><input type="checkbox"/> Check connections to thermostat at drive power bridge heat sink, at controller 132 or 232.</li> <li><input type="checkbox"/> Check for open thermostat. Make a resistance check to the thermostat. (It should read a short, or low resistance, if it is closed).</li> </ul>
3. In non-reversing controllers only . . . Controller's M contactor not picking up when START switch is pressed (closed).	Faulty M contactor.  Faulty start/Stop switch.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Open the power disconnect switch,</li> <li><input type="checkbox"/> Examine M contactor for firm seating.</li> <li><input type="checkbox"/> On the M contactor, connect an ohmmeter on 139 and 39 Wires, The reading should be 150 to 1000 ohms</li> <li><input type="checkbox"/> If these readings cannot be obtained, replace the M contactor. (Refer to Table 6.A.)</li> <li><input type="checkbox"/> Check START/STOP switch, but first remove a-c line power at main disconnect.</li> <li><input type="checkbox"/> Connect ohmmeter to terminal 32 on the Remote Operator Adapter.</li> <li><input type="checkbox"/> Touch probe to terminal 38 on the Remote Operator Adapter.</li> <li><input type="checkbox"/> Place switch in the START (closed) position,</li> <li><input type="checkbox"/> If the switch is properly functioning, a short will be seen on the meter.</li> <li><input type="checkbox"/> 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.</li> <li><input type="checkbox"/> 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.</li> </ul>

**TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE COMPLETE CONTROLLER (Continued)**

Symptom	Probable Cause	Recommended Procedures
4. In reversing controllers only . . . Controller's M contactor not picking up when START switch is pressed (closed).	FORWARD/REVERSE switch malfunction,  M contactor malfunctioning.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Examine Remote Operator Adapter on Regulator Module for firm seating and proper wiring and pin connections.</li> <li><input type="checkbox"/> Test FORWARD/REVERSE switch. Use basic technique outlined above for the START/STOP switch.</li> <li><input type="checkbox"/> On the Auxiliary M pins located on the Regulator Module, connect an ohmmeter. Place it on the pin 39 and pin 67.</li> <li><input type="checkbox"/> Place the FORWARD/REVERSE switch in the FORWARD position. The reading should be approximately 150 to 1000 ohms if it is operating properly.</li> <li><input type="checkbox"/> Without changing test points, place the switch in the REVERSE position. The reading should be between 150 to 1000 ohms. If it is operating properly. If a short is observed, remove jumper J9 and repeat the test.</li> <li><input type="checkbox"/> If a 150 -1000 ohm resistance reading cannot be obtained when the switches are open, the M contactor is malfunctioning and must be replaced.</li> </ul>
5. M contactor picks up but remains in only when START pushbutton is pressed and held in.	RUN/JOG switch is in JOG position.  CR relay not picking up.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Place the RUN/JOG switch in the RUN position.</li> <li><input type="checkbox"/> Connect a volt-ohmmeter on the Remote Operator Adapter. Place it on terminal 35.</li> <li><input type="checkbox"/> Connect the second probe to connection 139 connected to the FlexPak Plus M contactor.</li> <li><input type="checkbox"/> The reading should be +24 VDC for normal operation.</li> <li><input type="checkbox"/> Next, shift the probe from terminal 35 to terminal 38 on the same terminal board. However, leave the second probe where it is.</li> <li><input type="checkbox"/> Press the START switch. The reading should be approximately 24 VDC for normal operation.</li> <li><input type="checkbox"/> Press the START/STOP switch to STOP, and then START. A 24 VDC (approximately) reading should continue to appear. If it does not, the CR relay is not picking up. In this case, replace the Regulator Module.</li> </ul>
6. Drive motor does not run, but M contactor and CR pull up.  (Use this procedure only if controller does not have optional Test Meter Adapter Kit.)	No input signal from SPEED potentiometer on Control Station.	<ul style="list-style-type: none"> <li><input type="checkbox"/> If the controller 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.)</li> <li><input type="checkbox"/> Check the SPEED potentiometer on the Control Station. First, open the power disconnect switch.</li> <li><input type="checkbox"/> 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.)</li> <li><input type="checkbox"/> For proper operation, the reading should be 5K ohms.</li> <li><input type="checkbox"/> Disconnect the VOM lead from terminal 20. Connect it to terminal 426.</li> <li><input type="checkbox"/> Turn the SPEED potentiometer from 10 to 0. The resistance should vary from 5K to 0 ohms. If it does not, replace the potentiometer.</li> </ul>
7. Drive motor does not run, but M contactor and CR Pull up.  (Use this procedure only if controller has optional Test Meter Adapter Kit. )	No input signal from SPEED pot.	<p><input type="checkbox"/> First check the main power supplies. This must be done with power applied to the FlexPak Plus controller,</p> <div style="border: 1px solid black; background-color: black; color: white; padding: 10px; text-align: center;"> <p><b>DANGER</b></p> <p><b>THE PROCEDURE DESCRIBED HERE IS PERFORMED WITH LIVE A-C VOLTAGE APPLIED TO THE CONTROLLER. USE ONLY ONE HAND TO APPLY VOM LEADS/PROBES. KEEP YOUR OTHER HAND BEHIND YOU AT ALL TIMES. DO NOT HOLD ONTO THE CONTROLLER FOR SUPPORT. PERSONAL INJURY MAY RESULT IF THESE PRECAUTIONS ARE NOT TAKEN.</b></p> </div> <ul style="list-style-type: none"> <li><input type="checkbox"/> Connect one lead of volt-ohmmeter to test pin 357 on the Test Meter Adapter Module.</li> <li><input type="checkbox"/> Connect the second lead to test pin 356 on the Module.</li> <li><input type="checkbox"/> The reading should be within the range of 10.8 to 11.5 VDC for normal operation.</li> <li><input type="checkbox"/> Next, remove the lead from pin 356. Place it on pin 456.</li> <li><input type="checkbox"/> The reading should be within the range of +16 to +28 VDC for normal operation.</li> <li><input type="checkbox"/> Next, remove the lead from pin 456. Place it on pin 471.</li> <li><input type="checkbox"/> The reading should be within the range of -16 to -28 VDC for normal operation.</li> <li><input type="checkbox"/> If the proper readings are obtained, the power supplies may be assumed to be operating correctly.</li> <li><input type="checkbox"/> If incorrect reading are obtained, replace the Regulator Module.</li> <li><input type="checkbox"/> 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.)</li> <li><input type="checkbox"/> Connect one lead of a volt-ohmmeter to pin 357 on the Test Meter Adapter Module.</li> <li><input type="checkbox"/> Connect the other lead to pin 826. Readings vary from 0 to +8.2 VDC, depending on the set point of the SPEED potentiometer dial.</li> <li><input type="checkbox"/> 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 controller. (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.)</li> <li><input type="checkbox"/> If the SPEED potentiometer is functioning normally, and if the J4 jumper is placed/removed, as necessary, replace the Regulator Module.</li> </ul>

**TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE COMPLETE CONTROLLER (Continued)**

Symptom	Probable Cause	Recommended Procedures
8. Drive motor does not run with M contactor picked up. Potentiometer properly operating.  Continue this symptom on next page.	No output from Power Cubes, 45-47.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Examine armature wiring. First, open the power disconnect switch.</li> <li><input type="checkbox"/> Check armature wiring for loose connections.</li> <li><input type="checkbox"/> Turn a-c power on again.</li> </ul> <div style="border: 1px solid black; padding: 10px; text-align: center; margin: 10px 0;"> <p><b>DANGER</b></p> <p><b>THE PROCEDURE DESCRIBED HERE IS PERFORMED WITH LIVE A-C VOLTAGE APPLIED TO THE CONTROLLER. USE ONLY ONE HAND TO APPLY VOM LEADS/PROBES. KEEP YOUR OTHER HAND BEHIND YOU AT ALL TIMES. DO NOT HOLD ONTO THE CONTROLLER FOR SUPPORT. PERSONAL INJURY MAY RESULT IF THESE PRECAUTIONS ARE NOT TAKEN.</b></p> </div> <ul style="list-style-type: none"> <li><input type="checkbox"/> Connect a volt-ohmmeter to terminals 47 and 45 on TB.</li> <li><input type="checkbox"/> Place the START/STOP switch in the START position.</li> <li><input type="checkbox"/> Increase the speed reference by turning the SPEED dial in the direction of 10.</li> <li><input type="checkbox"/> The reading across 47 and 45, it may be 0 to 240 VDC for 230 VAC controllers. It should be 0 to 500 for 460 VAC controllers.</li> <li><input type="checkbox"/> If no reading is obtained across 47 and 45, it may be necessary to replace the Power Cubes and/or the Regulator Module, digital driver module. In order to determine which, read on.</li> </ul>
	Regulator module suspected because no output reading at 45-47.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Test the regulator module for output to digital driver module (PREF).</li> <li><input type="checkbox"/> Turn power off! Open main disconnect.</li> <li><input type="checkbox"/> Connect a VOM, careful not to short pins together to terminals 280 (PREF) &amp; 57 (OV) on the regulator module.</li> <li><input type="checkbox"/> Restore power to controller.</li> <li><input type="checkbox"/> Place the start/stop switch in start position.</li> <li><input type="checkbox"/> Turn the speed pot to full on position.</li> <li><input type="checkbox"/> Voltage on VOM should be +5 volts.</li> <li><input type="checkbox"/> If this reading cannot be obtained replace regulator module.</li> </ul>
	Digital driver module suspected because no output reading at 45-47.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Test the digital driver for firing pulses. (Note: Make sure above test on regulator module has been completed first.)</li> <li><input type="checkbox"/> Turn power off. Open main disconnect.</li> <li><input type="checkbox"/> Loosen regulator/digital drive module assembly (four screws in each corner. So that access to digital driver module on back side of assembly is possible. (Refer to Figure 5.7.)</li> <li><input type="checkbox"/> Connect scope common to Pin 57 on regulator module.</li> <li><input type="checkbox"/> Connect scope probe to resistor on primary side of pulse transformer located at 7A or Digital Driver Board (Refer to Figure 5.4.)</li> <li><input type="checkbox"/> Restore power to controller.</li> <li><input type="checkbox"/> Place the start/stop switch in start position.</li> <li><input type="checkbox"/> Turn SPEED POT to full on position.</li> <li><input type="checkbox"/> 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).</li> <li><input type="checkbox"/> If these readings cannot be obtained, replace digital drive module.</li> </ul>
	Power cubes suspected because no output reading at 45-47.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Establish that power cube is receiving pulse inputs from digital drive module. (Refer to above previous test.)</li> <li><input type="checkbox"/> If power cubes are receiving pulses, yet no reading across 45-47, determine that the contacts on M are closing.</li> <li><input type="checkbox"/> Replace drive motor wiring with light bulbs (2 light bulbs for 240 volt, 4 light bulbs for 500 volt armatures, series connection.)</li> <li><input type="checkbox"/> Run drive and look at waveform across light bulbs. (Should be six pulse/16.7 MSEC) If pulse is missing indicates bad power cube.</li> <li><input type="checkbox"/> Check individual power cubes.</li> <li><input type="checkbox"/> Connect scope across 51 &amp; 47 on terminal strip look to see if SCR is switching if not replace power cube.</li> <li><input type="checkbox"/> Repeat for 51 &amp; 45, 52 &amp; 47, 52 &amp; 45, 53 &amp; 47 &amp; 53 &amp; 45 if necessary.</li> </ul>
9. Remote Operator Control Station functions not operating.	Malfunctioning switches.	<ul style="list-style-type: none"> <li><input type="checkbox"/> Check START/STOP switch, but first remove a-c line power at main disconnect.</li> <li><input type="checkbox"/> Connect ohmmeter to terminal 32 on the Remote Operator Adapter.</li> <li><input type="checkbox"/> Touch probe to terminal 38 on the Remote Operator Adapter,</li> <li><input type="checkbox"/> Place switch in the START (closed) position.</li> <li><input type="checkbox"/> If the switch is properly functioning, a short will be seen on the meter.</li> <li><input type="checkbox"/> 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.</li> <li><input type="checkbox"/> 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.</li> </ul>

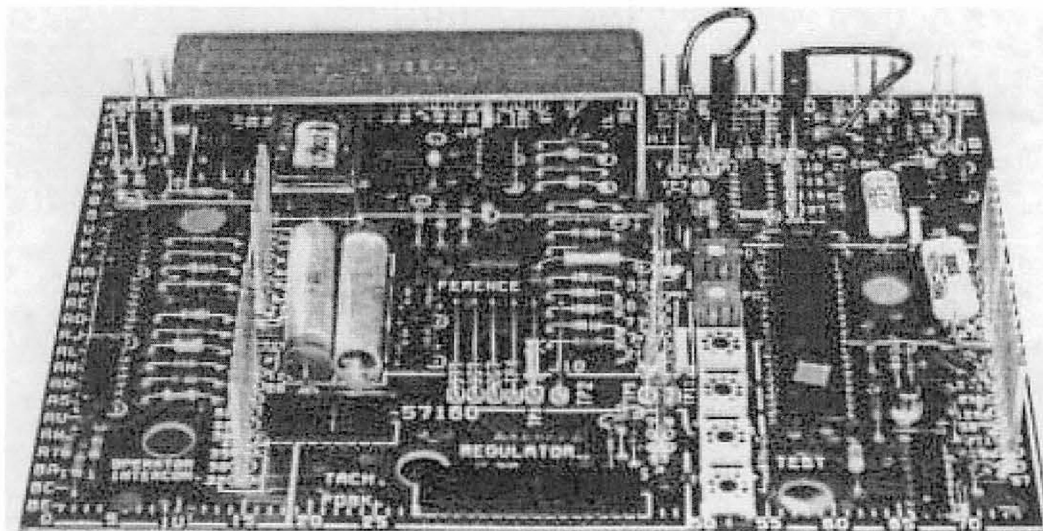


Figure 5.3 – Regulator Module

RESISTORS  
ON PRIMARY SIDE  
OF PULSE TRANSFORMERS

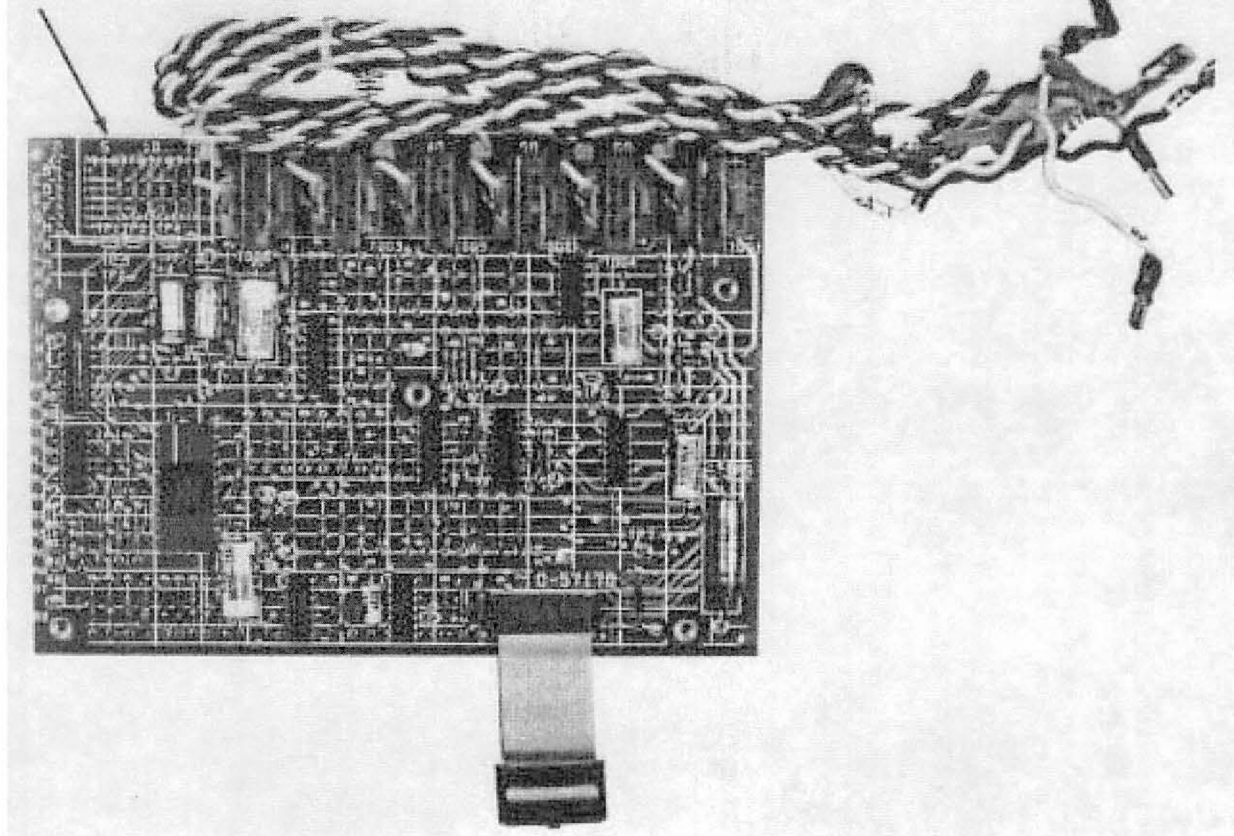


Figure 5.4 – Digital Driver Module

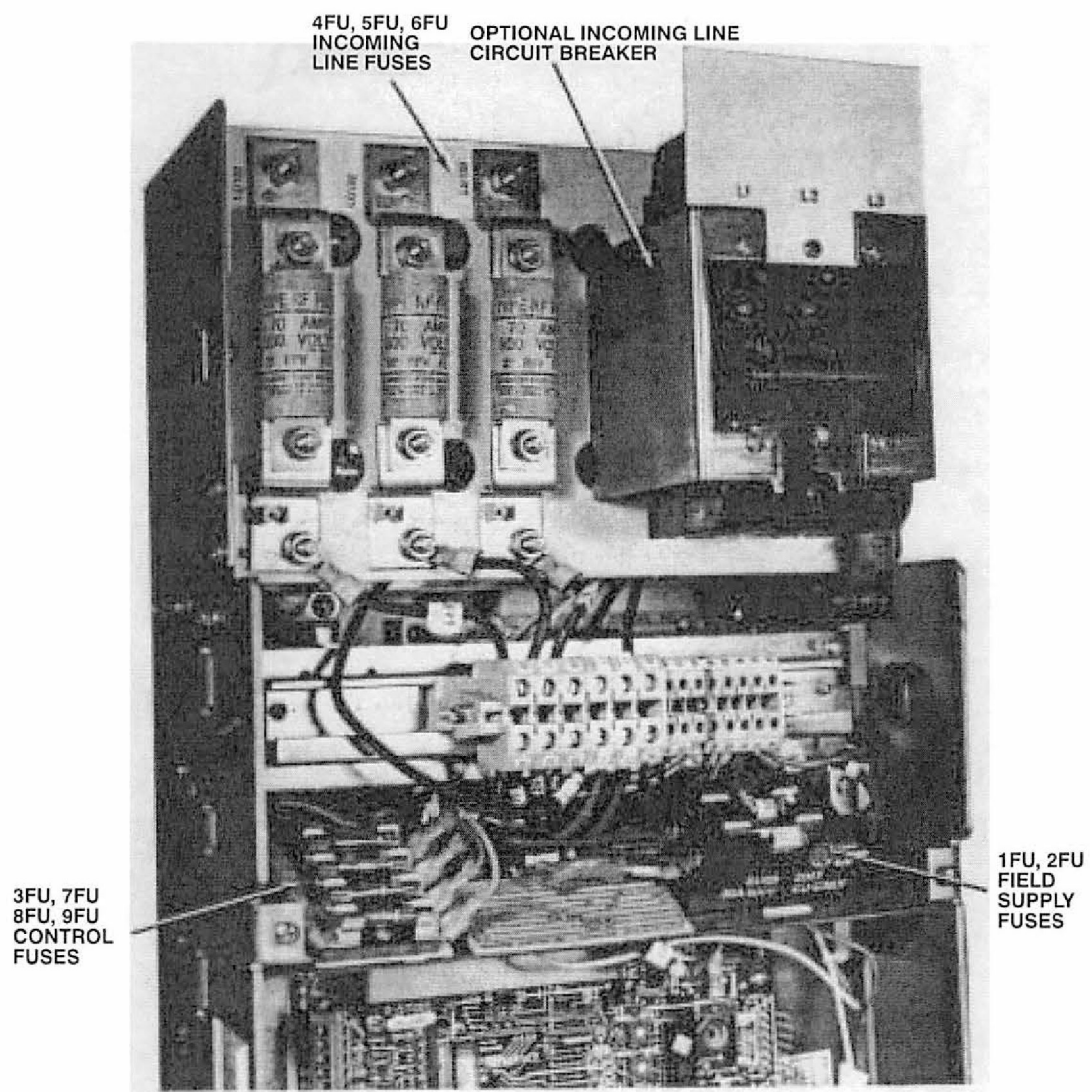


Figure 5.5 – CB/Fuse Locations



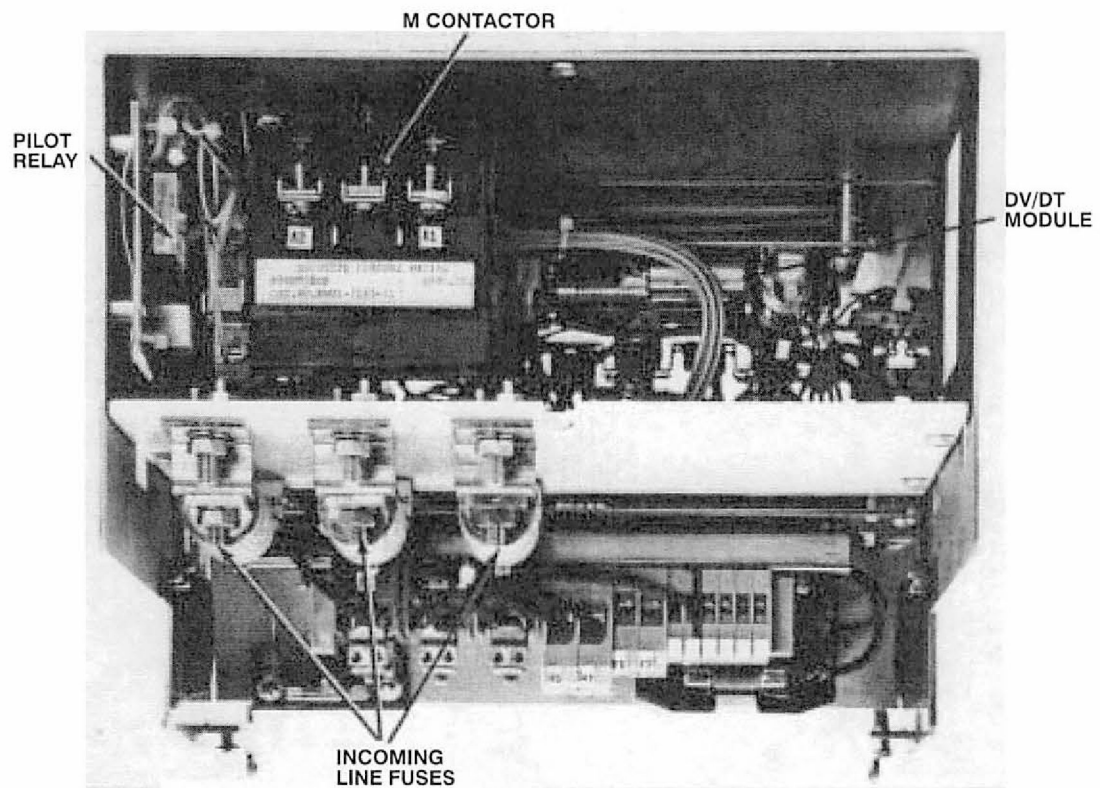


Figure 5.6 – Top View of Controller

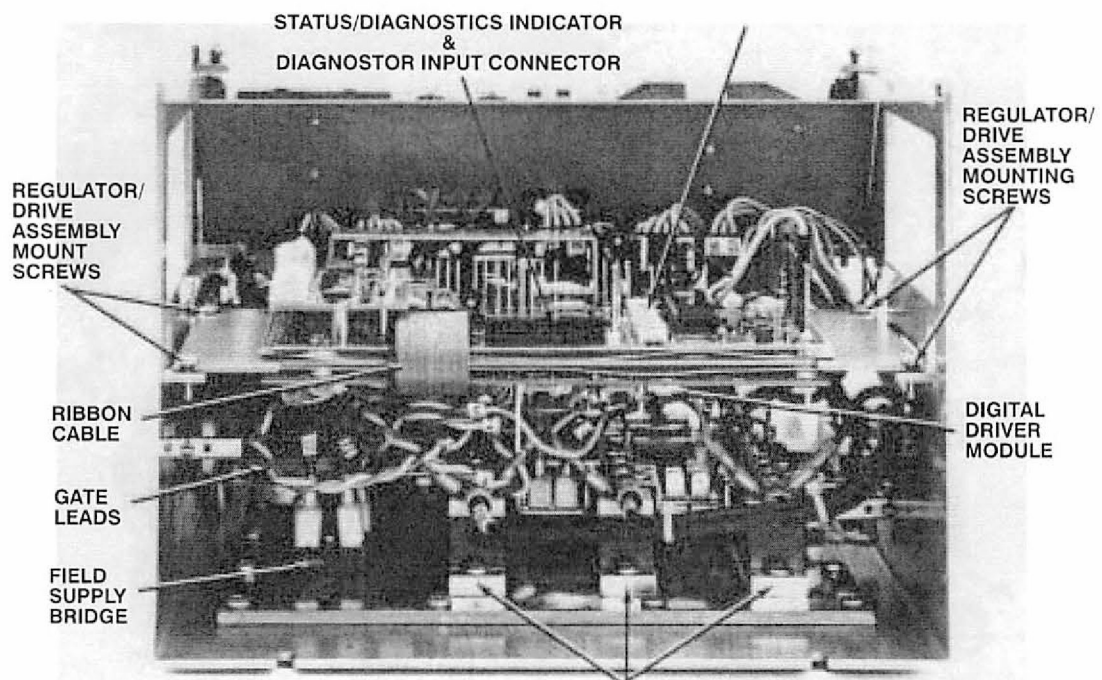
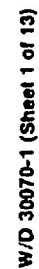


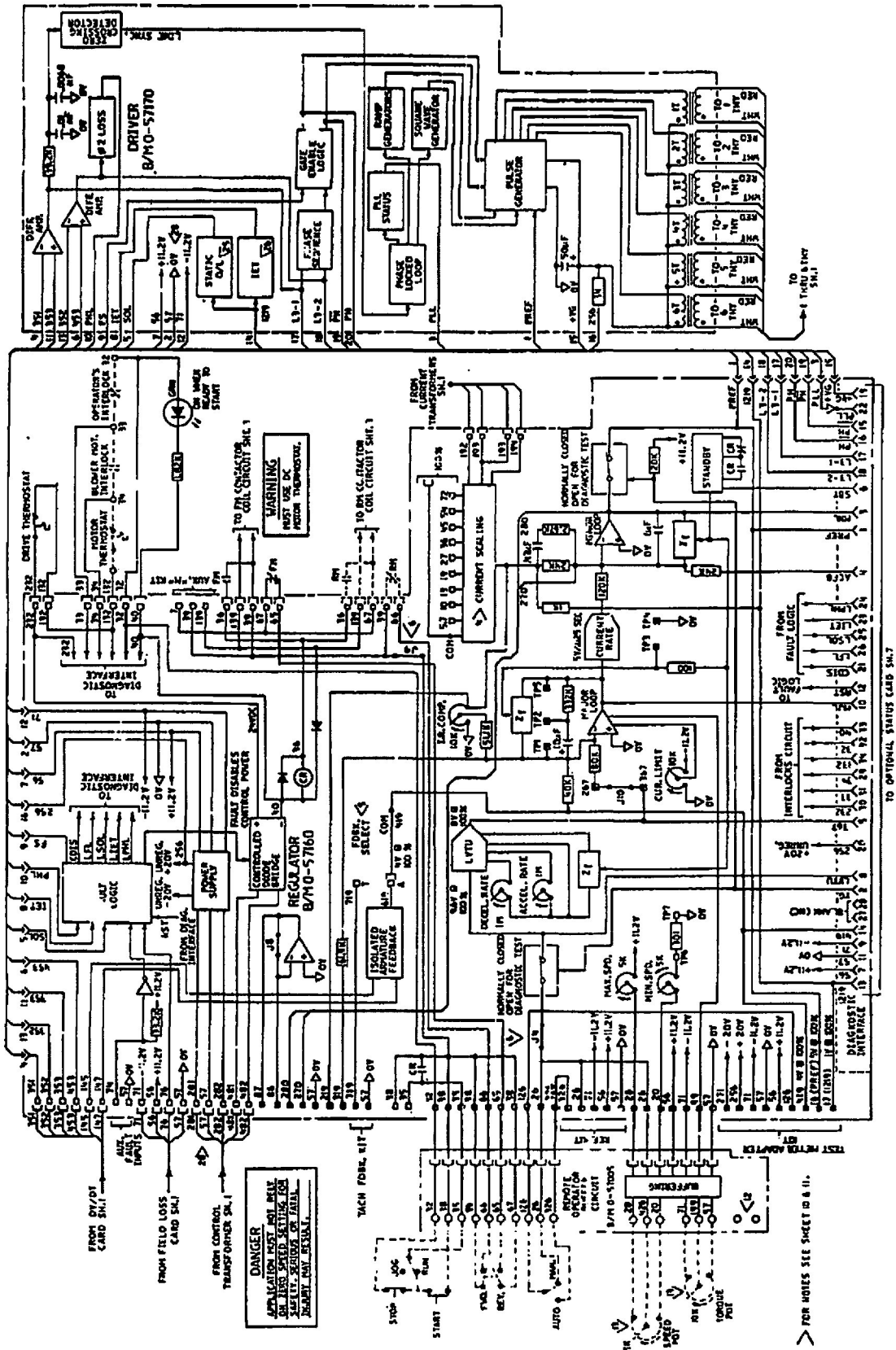
Figure 5.7 – Bottom View of Controller





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Figure 5.10 – Controller Regulator Module & Digital Driver Module Schematics

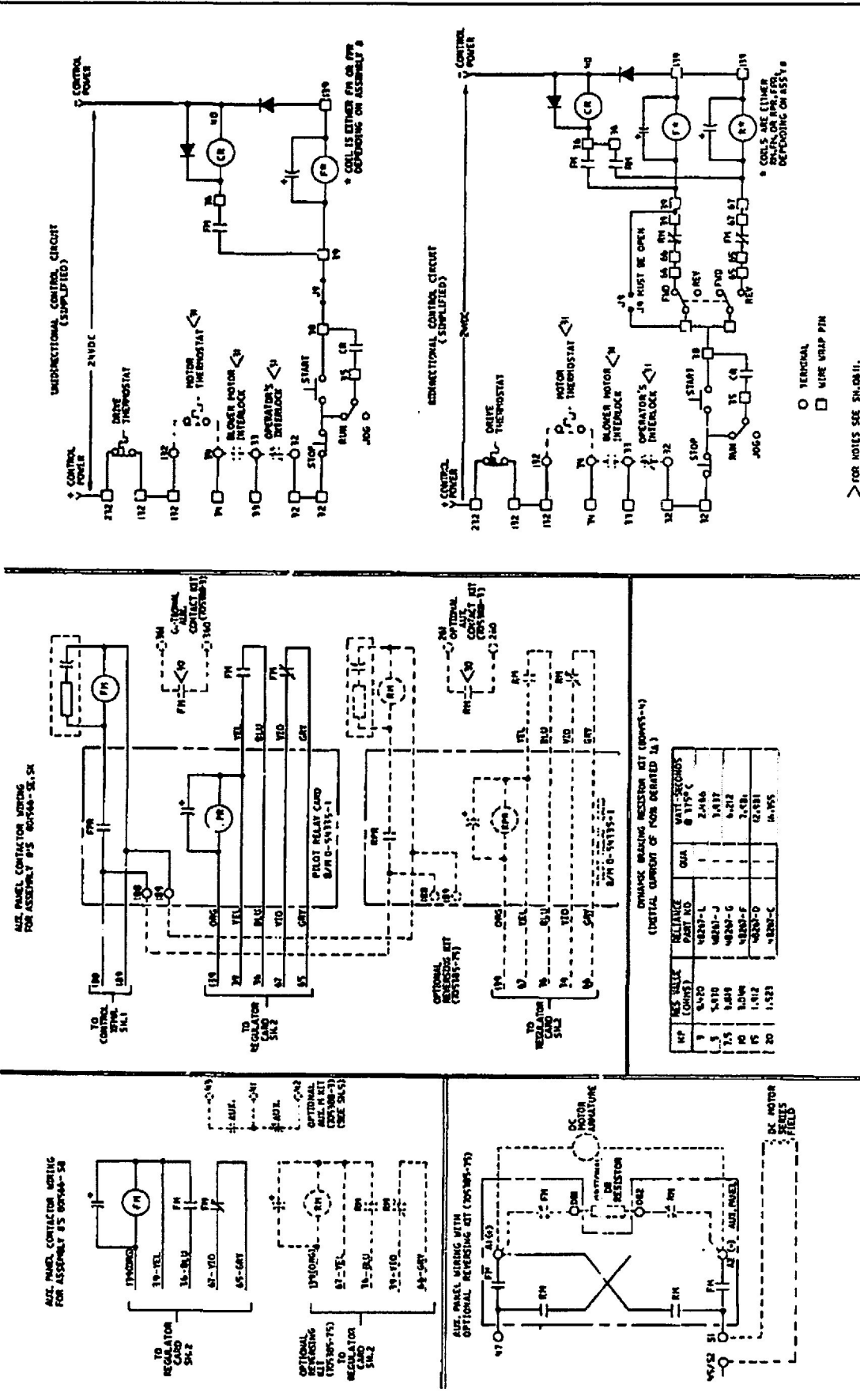
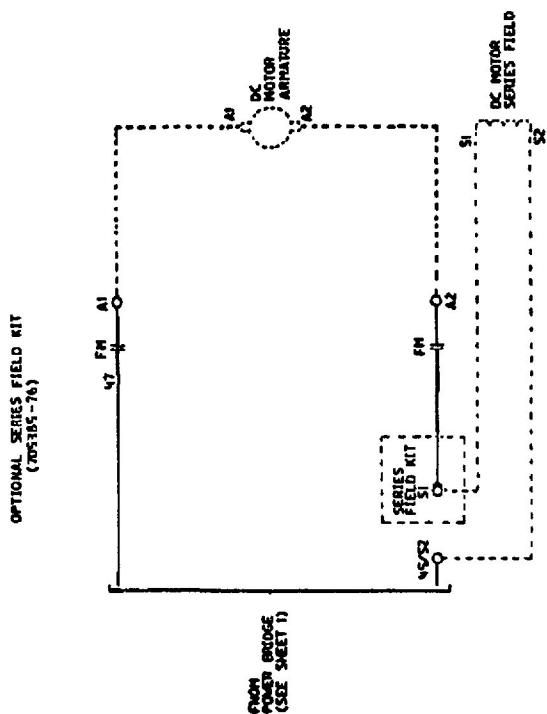


Figure 5.11 - 230 VAC Auxiliary Panel Assembly Schematic





OPTIONAL CIRCUIT BREAKER KIT  
(705190-5)  
(MTC OR AUX. PNL.)

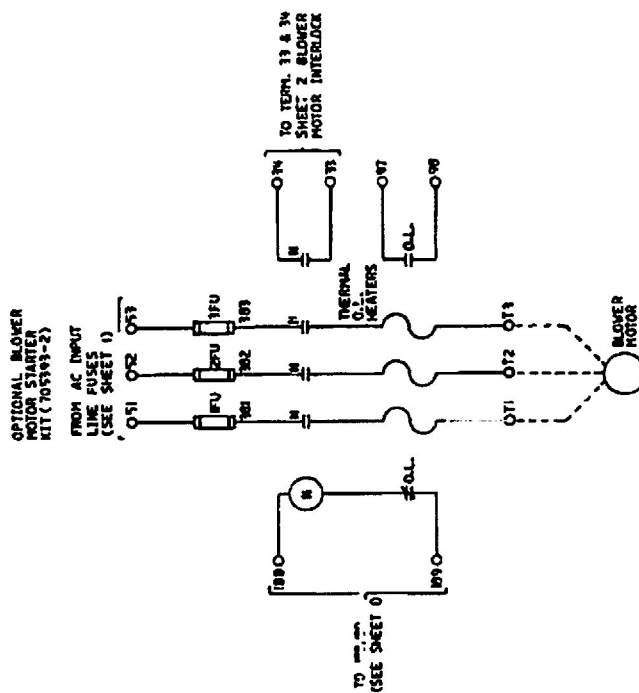
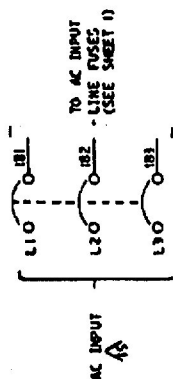


Figure 5.13A – Modification Kit Schematics



**DANGER**  
OPERATION MUST NOT BEYOND SPEC'D RATINGS FOR SAFETY, SERVICE OR FAULT-INDICATING PURPOSES.

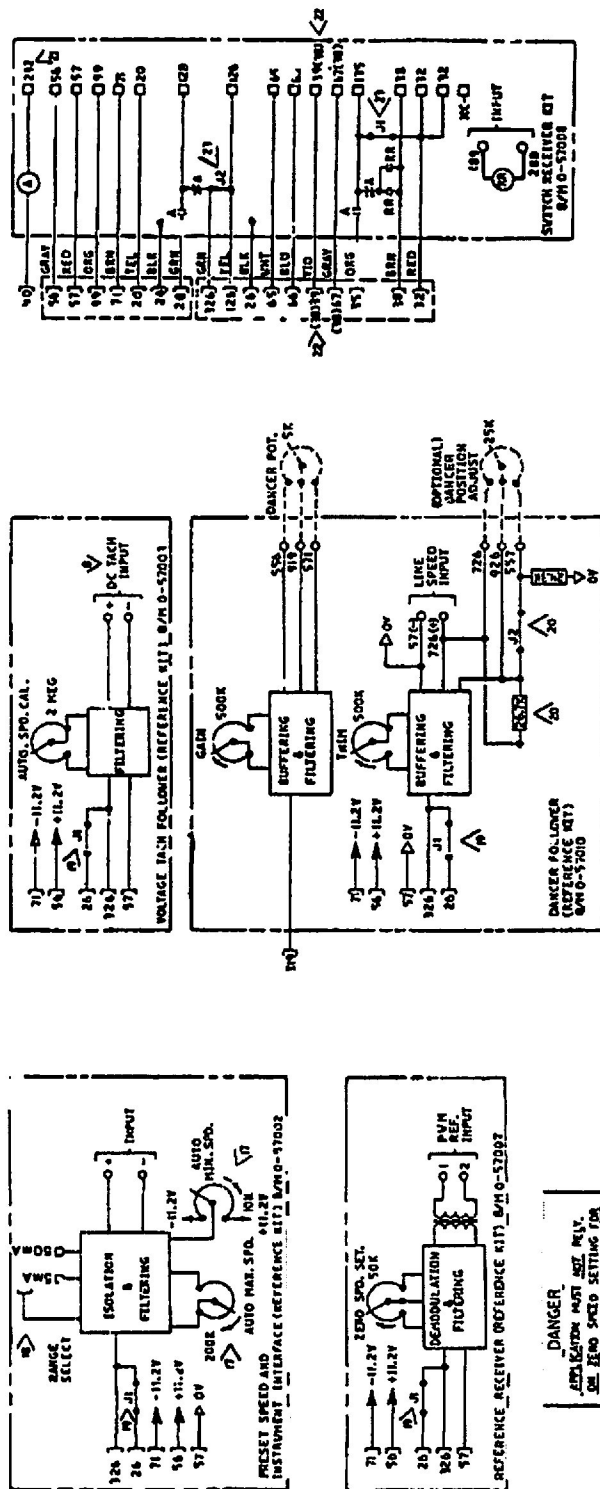
☐ APPROXIMATE WEIGHT - ☐ WEIGHT TO IDENTIFY PAGE  
☐ FOR THE OFFICE. ☐ FOR THE OFFICE. ☐ FOR THE OFFICE. ☐ FOR THE OFFICE.  
☐ MATHEMATICAL ☐ MATHEMATICAL ☐ MATHEMATICAL ☐ MATHEMATICAL.

> FOR NOTES SEE 5M.108 H

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### Figure 5.13B – Modification Kit Schematics

# OPTIONAL CIRCUITS



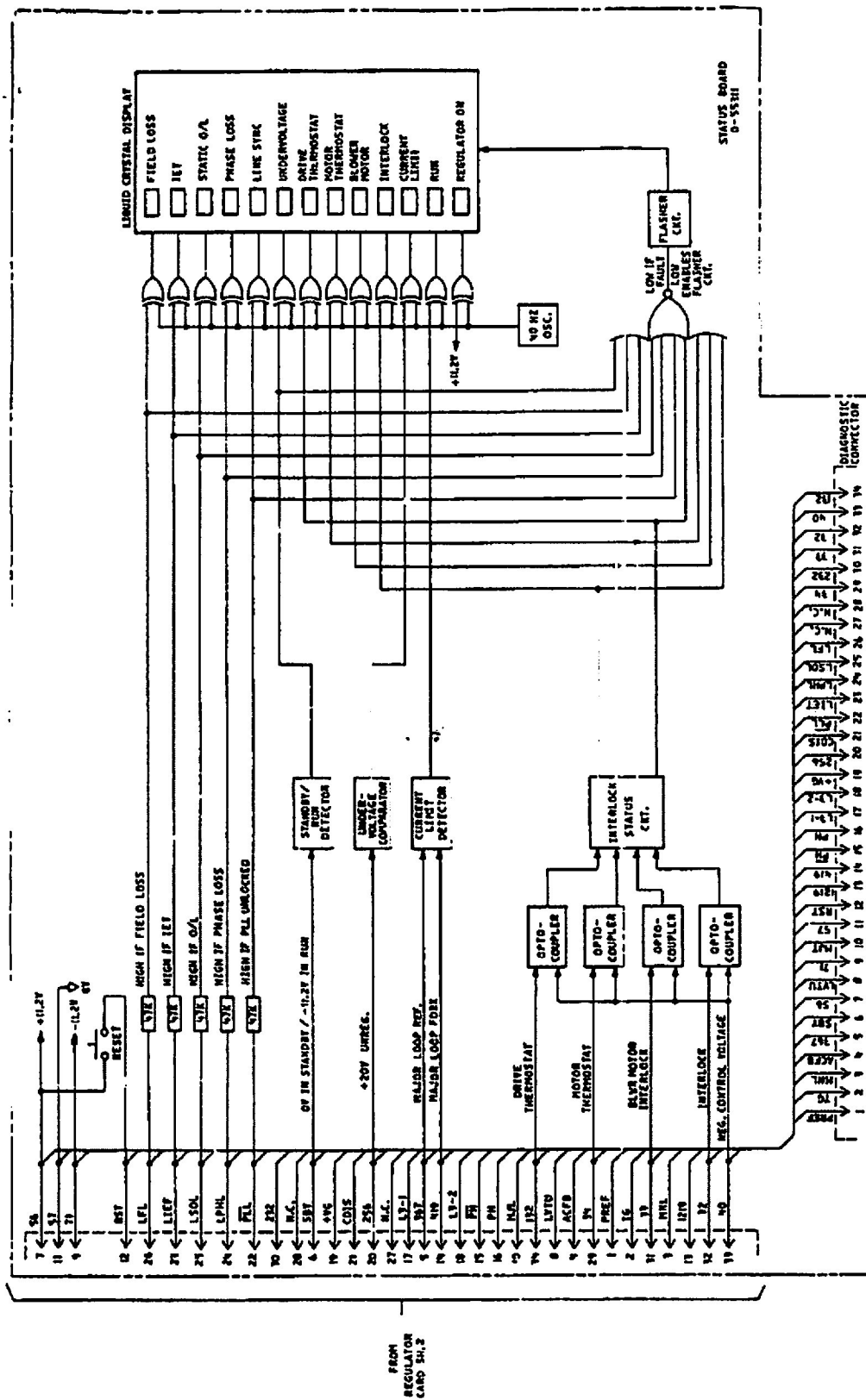
**DANGER**  
ADJUSTMENT MUST NOT BE MADE ON ZERO SPEED SETTING FOR SAFETY REASONS OR DATA CORRUPTION WILL RESULT.

- ☐ PRESET SPEED AND INSTRUMENT INTERFACE (REFERENCE KIT 0-57002)
- ☐ REFERENCE RECEIVER (REFERENCE KIT 0-57007)
- ☐ VOLTAGE TACH FOLLOWER (REFERENCE KIT 0-57003)
- ☐ ZERO SPEED SET (REFERENCE KIT 0-57007)

> FOR NOTES SEE SH. 08.11.

Figure 5.13C – Modification Kit Schematics

OPTIONAL CIRCUITS

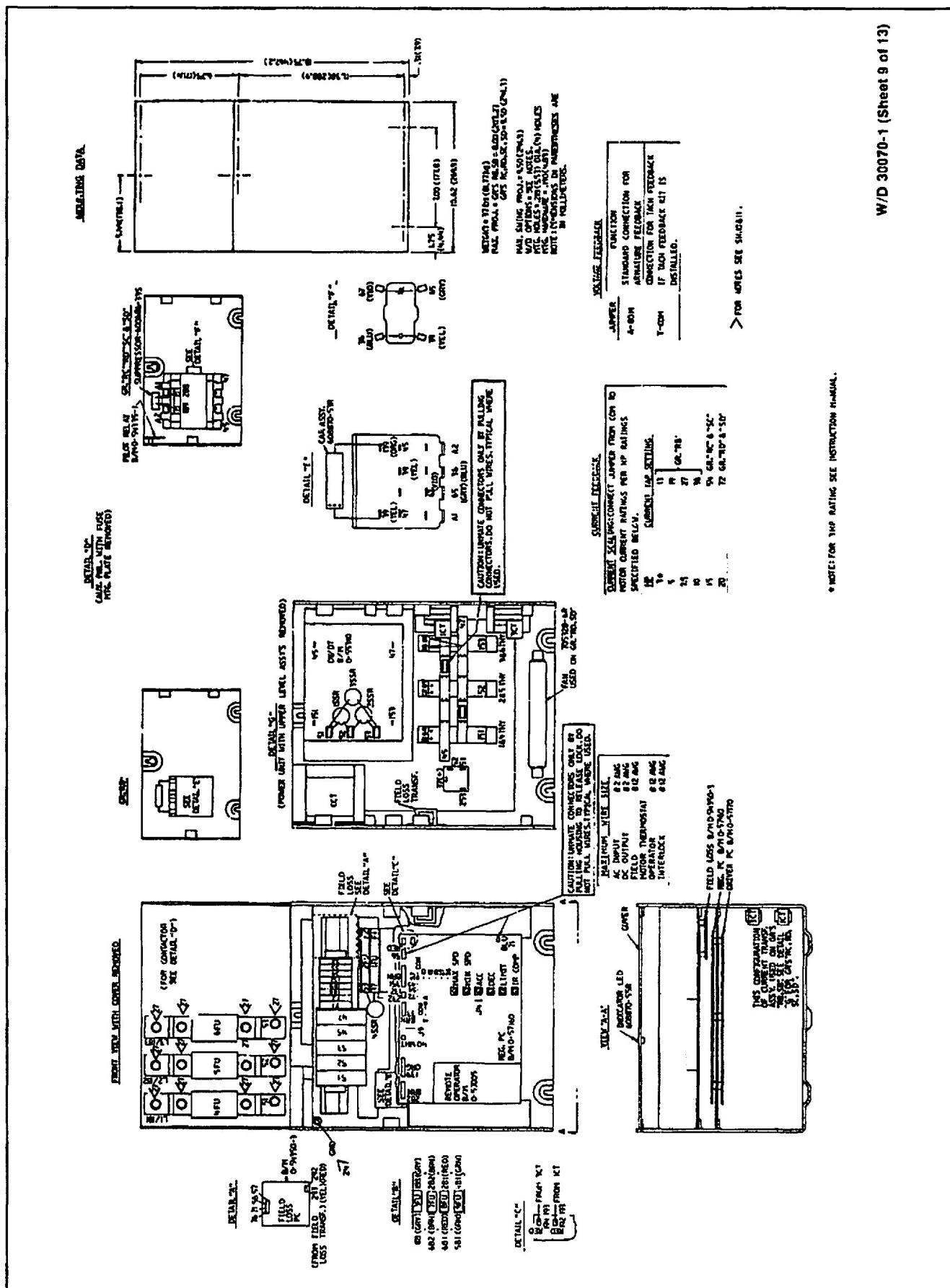


> FOR NOTES SEE SH. 0-611

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Figure 5.14 – Status/Diagnostic Indicator Kit Schematic



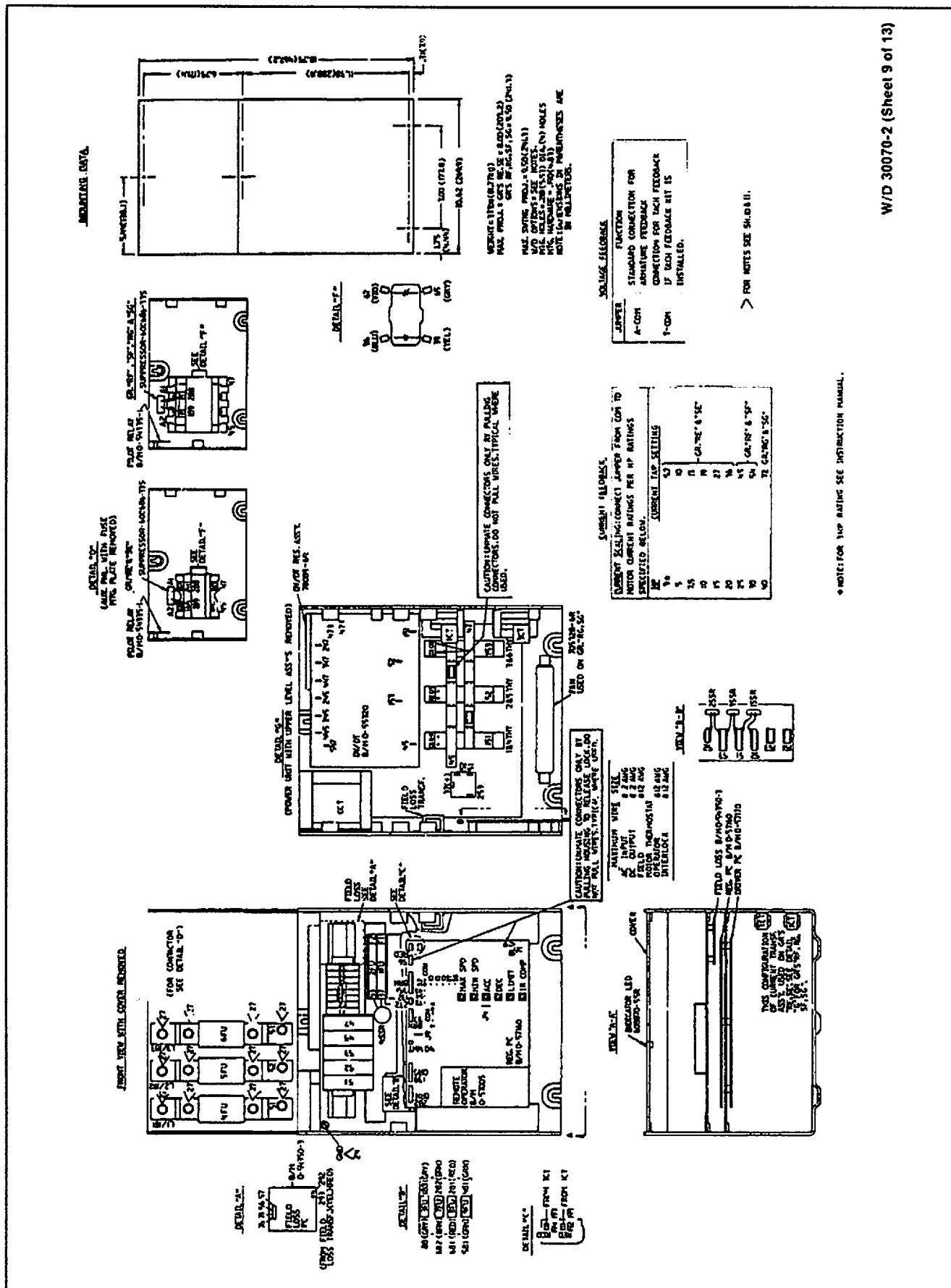


PANEL RATING INFORMATION										BASIC POWER UNIT — REPLACEMENT PARTS TABLE																											
WIRING DIA.		AC INPUT		DC OUTPUT		CONTROL TRANSF.		CURRENT TRANSF.		FIELD CURRENT TRANSF.		IM		FUSES		OVOT RESISTION ASSY.		REGULATOR PC CARD		DRIVER PC CARD		FIELD LOSS PC CARD		REMOTE OPERATOR PC CARD		LED ASSY.		SUPPRESSION ASSY.		SUPPRESSION ASSY.		FIELD BRIDGE F.D.		POWER CUBE		THERMO-STAT	
RE	RE	20	440	34	500	34	200	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
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RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120		
RF	RF	10	440	17	500	17	100	5	NI027-04V	64070-23R	64070-23R	64070-23R	64070-23R	64070-23V	64070-23V	70001-01	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-91120	0-9112				

AUT. PANEL - REPLACEMENT PARTS TABLE									
FUNCTION	WIRING DIA.	REF. ASSY.	AUT. PANEL	CONTACTOR	AUX. CONTACT	CONTACTOR SUPPRESSION ASSY.	PILOT RELAY PC CARD	LINE FUSE (5000)	SPECIAL CONNECTOR HARDWARE (FOR FUSES)
BASIC	RE	RE	80344-35	78050-03R	78050-1	80040-15S	0-91120-1	0-91120-1	0-91120-1
	RF	RF	80344-35	78051-50R	78051-1	80040-15S	0-91120-1	0-91120-1	0-91120-1
	RC	RC	80344-35	78001-50R	78001-1	80040-15S	0-91120-1	0-91120-1	0-91120-1
BASIC & DB	SE	SE	80344-35	78050-03R	78050-1	80040-15S	0-91120-1	0-91120-1	0-91120-1
	SF	SF	80344-35	78051-50R	78051-1	80040-15S	0-91120-1	0-91120-1	0-91120-1
	SC	SC	80344-35	78001-50R	78001-1	80040-15S	0-91120-1	0-91120-1	0-91120-1

Figure 5.16A — Technical Data 460 VAC Three Phase FlexPak Plus





# NOTE SHEET

- 1> Function of panel rating, see Sh. 8.
- 2> If motor has series field, wire between 45/52 and FM contact is removed, and series field kit installed.
- 3> This contact is present only on Assy. No. 802220-RB & SB.
- 4> For Current Scaling, see table on Sh. 9.
- 5> For Feedback select, see table on Sh. 9.
- 6> Remove jumper (J4) if Auto/Manual switch is used.
- 7> Remove jumper (J9) if Reverse Contactor kit is used.
- 8> Wiring for 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. (See note 14 for insulation temp. rating.)
- 9> For DC 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 AC 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> Aux. Contact rating: 1 Amp @ 30 VDC or 0.5 Amp @ 120 VAC (Resistive).
- 12> User convenience terminal for #14 AWG max. wire size.
- 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 wiring. (See note 14 for insulation temp. rating.) See I/M for details.
- 14> Recommended insulation Temp. Rating: 75°C.

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Figure 5.17A -- Technical Notes

**DANGER**

- 15> A.) AN EXTERNAL, U/L LISTED, 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: 5000A.

- 16> When installing replacement power cubes, apply a very thin, uniform thickness film of DOW #111 to mounting surface. Film is too thick if it squeezes out around power cube after power cube is torqued down. Start the mounting screws carefully into existing threads, and then torque to 25 to 30 in-lbs.
- 17> Set Auto Min. Speed with input on minimum, then set Auto Maximum Speed with input at maximum. Motor must not exceed its speed or voltage rating.
- 18> Jumper for various process controllers.
- 19> Remove jumper if Auto/Manual switch is used.
- 20> Clip resistor (26.7K) and jumper (J2) when optional Dancer Position Adjust Pot. is installed.
- 21> Not associated with 232 Drive Thermostat circuit on Sh. 2. 232 is open in auto mode ("A" not energized.)
- 22> Numbers parenthesized are shown when different from original identification marking on kit.
- 23> Cut jumpers (J1 & J2) if Remote Operator is installed.

**DANGER**

- 24> EACH DRIVE MUST BE GROUNDED ACCORDING TO CODE REQUIREMENTS. USING THE DRIVE "GND." TERMINAL.

- 25> The nominal Overload Threshold is 111% of rated current. With circuit tolerances, 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%.
- 27> For proper hardware and torque spec. see replacement parts table (special connector hardware) sheet 8.

**WARNING**

- 28> DRIVES ARE SHIPPED WITH 57 (OV) FLOATING, DEPENDING ON THE APPLICATION. 57 MAY BE LEFT FLOATING, OR TIED TO EARTH GROUND. IF LEFT FLOATING, THE REGULATOR CIRCUITS MAY RISE TO A HIGH POTENTIAL.
- 29> If using an AC Tach, remove J1 & J2.
- 30> Contact Rating: 125 VAC, 3 AMPS.
- 31> Contact must be capable of breaking a 0.5 AMP, inductive load.

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Figure 5.17B - Technical Notes

**DANGER**

EQUIPMENT IS AT LINE VOLTAGE WHEN AC POWER IS CONNECTED TO THE POWER UNIT. 3  
PHASE AC POWER LINE MUST BE DISCONNECTED FROM THE POWER UNIT BEFORE IT IS SAFE  
TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT.

**START UP CHECK LIST**

**A. BEFORE AC POWER IS APPLIED:**

1. DRIVE IS SUPPLIED AS A VOLTAGE REGULATOR. IF USED AS A VOLTAGE REGULATOR, CHECK THAT JUMPER AT L51 ON THE REGULATOR CARD IS CONNECTED TO PIN "A" (ARMATURE FDBK) AT L52 SEE W/D SHEET 2 OR I/M.
2. IF DRIVE IS TO BE A SPEED REGULATOR, CHECK THAT JUMPER AT L51 ON THE REGULATOR CARD IS CONNECTED TO PIN "T" (TACH FDBK) AT L49. BE SURE TACHOMETER IS CONNECTED TO TACHOMETER FEEDBACK KIT AND SCALED PROPERLY. SEE TABLES IN NOTES OR 10 FOR TACH SCALING. SEE I/M.
3. CHECK THAT THE CURRENT FEEDBACK JUMPER AT H63 ON THE REGULATOR CARD IS SET TO THE PROPER TAP. REFER TO TABLE ON SH. 9 OF W/D, AND I/M.
4. CHECK POLARITY OF ARMATURE AND FIELD WIRING.
5. RECOMMENDED INITIAL POT SETTINGS.
  - (1) CURRENT LIMIT POT FACTORY PRESET TO 150%.  
DOT 7. DO NOT DISTURB.
  - (2) IR COMP. POT FULLY CCW DOT 1
  - (3) MAX. SPEED POT FULLY CCW DOT 1
  - (4) MIN. SPEED POT FULLY CCW DOT 1
  - (5) ACCEL. POT FULLY CCW DOT 1
  - (6) DECEL. POT FULLY CCW DOT 1

**B. AFTER AC POWER IS APPLIED (BEFORE STARTING DRIVE)**

**DANGER**

DANGEROUS VOLTAGES ARE PRESENT IN DRIVE WHENEVER AC VOLTAGE IS PRESENT, WHETHER  
OR NOT DRIVE IS STARTED. DO NOT TOUCH ANY POWER CIRCUITS OR WIRING WHEN LINE  
VOLTAGE IS ON.

1. CHECK THAT AC LINE VOLTAGE IS WITHIN 10% OF RATED INPUT VOLTAGE. SEE SHEET 8.
2. CHECK THAT FIELD VOLTAGE IS PRESENT AT MOTOR TERMINALS (F1, F2).
3. TURN THE SPEED OR VOLTAGE REFERENCE INITIALLY TO "0".

**DANGER**

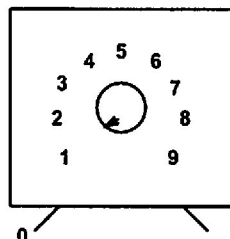
DURING THE INITIAL START-UP AND ADJUSTMENTS. BE PREPARED TO STOP DRIVE IN CASE  
INCORRECT SET-UP IN FIELD OR TACHOMETER SHOULD CAUSE UNCONTROLLED ACCELERATION OF  
THE MOTOR. IF THE DRIVE IS NOT SHUT DOWN IMMEDIATELY UNDER SUCH CIRCUMSTANCES,  
PERSONAL INJURY AND/OR MACHINE DAMAGE MAY RESULT.

CAUTION: NEVER STOP DRIVE EXCEPT UNDER EMERGENCY BY INTERRUPTING INCOMING POWER.  
DAMAGE TO THE DRIVE MAY RESULT.

**DRIVE ADJUSTMENT PROCEDURE**

CAUTION: DO NOT PLUG A KIT PCB INTO (OR REMOVE IT FROM) THE DRIVE WITHOUT FIRST  
TURNING CIRCUIT BREAKER TO "OFF" POSITION. DO NOT USE AN OHMMETER TO CHECK  
TRANSISTORS OR ASSOCIATED CIRCUITS. A TEST METER ADAPTOR KIT IS AVAILABLE TO  
TEST REGULATOR CIRCUITS.

NOTE: ADJUSTMENTS BELOW REFER ONLY TO STANDARD DRIVES. FOR CUSTOM DRIVE SYSTEM SETTINGS  
REFER TO SYSTEM'S DOCUMENTATION.



PRINTED CIRCUIT POTENTIOMETER

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Figure 5.17C – Technical Notes

1. CURRENT LIMIT:
  - a) FACTORY PRESET TO 150%. ADJUST AS DESIRED FOR MAX. CURRENT 150%. (CCW DECREASES CURRENT).
  - b) DOT #4 IS APPROXIMATELY 100%.
2. MAX SPEED:
  - a) SET MAX. SPEED AND MIN SPEED POTS CCW.
  - b) SET SPEED (OR VOLTAGE) CONTROL POT TO MINIMUM.
  - c) START DRIVE AND GRADUALLY INCREASE SPEED (OR VOLTAGE) CONTROL POT TO MAXIMUM. WAIT UNTIL SPEED STABILIZES.
  - d) INCREASE MAX. SPEED POT UNTIL DESIRED MAX. SPEED (SPEED REGULATOR) OR MAX. VOLTAGE (VOLTAGE REGULATOR) IS ATTAINED. MOTOR MUST NOT EXCEED ITS SPEED OF VOLTAGE RATING.
  - e) FOR REFERENCE DOT #1 CORRESPONDS TO MAX. SPEED APPROXIMATELY 70% RATED SPEED, AND EACH SUCCEEDING DOT ADDS 5% UNTIL DOT #7 CORRESPONDS TO 100% RATED SPEED (VOLTAGE). DOT #8 & #9 LOCATIONS INSURE 100% CAN BE OBTAINED IN ALL DRIVES.
3. MIN. SPEED:
  - a) SET SPEED (OR VOLTAGE) CONTROL POT TO "0".
  - b) START DRIVE AND INCREASE MIN. SPEED POT CW UNTIL DESIRED MIN. SPEED (SPEED REGULATOR) OR MIN. VOLTS (VOLTAGE REGULATOR) IS ATTAINED. WAIT UNTIL SPEED STABILIZES.
  - c) FOR REFERENCE, DOT #1 NORMALLY CORRESPONDS TO MIN. SPEED OF APPROXIMATELY 3% AND EACH SUCCEEDING DOT ADDS 5% TILL DOT #9 CORRESPONDS TO APPROXIMATELY 40% RATED SPEED. SEE I/M.
4. IR COMP: ONLY USED ON VOLTAGE REGULATOR SYSTEMS.  
ALL OTHER SYSTEMS MUST HAVE IR COMP  
POT FULLY CCW (SET TO DOT #1).
  - a) RUN DRIVE UNLOADED AT MAX. RATED SPEED.
  - b) LOAD DRIVE TO FULL LOAD.
  - c) ADJUST IR COMP CW UNTIL SPEED IS AT THE DESIRED LEVEL. (DO NOT EXCEED RATED SPEED).
  - d) TYPICAL MOTORS WILL HAVE AN IR COMP SETTING OF ABOUT DOT #3.
5. ACCEL:
  - a) SET ACCEL. POT CCW (DOT 1).
  - b) START DRIVE AND TURN ACCEL. POT CW TO INCREASE ACCEL. RATE. ADJUST TO DESIRED RATE. TO SET FAST ACCEL. RATES ACCURATELY, A CHART RECORDER OR A STORAGE SCOPE MAY BE REQUIRED TO MONITOR THE SPEED (ARMATURE VOLTS OR TACH).
  - c) FOR REFERENCE, DOT #9 CORRESPONDS TO AN ACCEL. RAMP RATE OF ABOUT (0 TO 100% REFERENCE)/0.3 SEC. AND EACH DOT ADDS ABOUT 5 SECONDS, SO DOT #1 CORRESPONDS TO RAMP RATE OF ABOUT (0 TO 100% REFERENCE)/45 SEC.
6. DECEL:
  - a) SET DECEL. POT CCW (DOT 1).
  - b) START DRIVE AND RUN AT MAXIMUM SPEED.
  - c) QUICKLY SET THE REFERENCE TO ZERO AND TURN DECEL. POT CW TO INCREASE DECEL. RATE. ADJUST TO DESIRED RATE. TO SET FAST DECEL. RATES ACCURATELY A CHART RECORDER OR A STORAGE SCOPE MAY BE REQUIRED TO MONITOR THE SPEED (ARMATURE VOLTS OR TACH). THIS ADJUSTMENT MAY REQUIRE THE MOTOR TO BE LOADED IF THE DESIRED DECEL. RATE IS FASTER THAN THE COAST-TO-REST RATE OF THE UNLOADED MOTOR.  
  
 NOTE: THE DECEL. CIRCUITS ARE NOT USED DURING A STANDARD STOP SEQUENCE UTILIZING THE STOP SWITCH.
  - d) FOR REFERENCE, DOT #9 CORRESPONDS TO A DECEL. RAMP RATE OF ABOUT (100% TO 0 REFERENCE)/0.3 SEC. AND EACH DOT ADDS ABOUT 5 SECONDS, SO THAT DOT #1 CORRESPONDS TO RAMP RATE OF ABOUT (100% TO 0 REFERENCE)/45 SECONDS.

#### MAINTENANCE AND SERVICE SUGGESTIONS

THE OPTIONAL METER ADAPTOR KIT, STATUS INDICATOR AND/OR DIAGNOSTOR WILL ASSIST IN DETERMINING WHETHER MAIN PCB'S ARE FUNCTIONALLY OPERATIONAL. AN UNDERSTANDING OF THE WAVEFORMS INVOLVED WILL ISOLATE TROUBLE AREAS. IT IS SUGGESTED THAT THE USER BECOME FAMILIAR WITH DRIVE VOLTAGE LEVELS WHEN EQUIPMENT IS OPERATING NORMALLY. ALL VOLTAGE LEVELS ARE NOMINAL AND MAY INDICATE  $\pm 10\%$  OF STATED VALUE DEPENDING ON METER ACCURACY AND ACTUAL VALUE OF AC SUPPLY VOLTAGES. SEE I/M FOR DETAILS.

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Figure 5.17D – Technical Notes

## SECTION 6 REPLACEMENT PARTS

**6.0 General** – Users should consider maintaining a stock along with part numbers and quantities actually

used in of spare parts. Table 6.A lists the more common parts the controller.

**Table 6.A – Replacement Modules**

Part Description	Quantity Per Controller	Model Number	Part Number
<b>Regulator Module</b>	1	14C650	0-57160
<b>Digital Driver Module</b>	1	14C651	0-57170
<b>Field Loss PC</b>	1	14C652	0-54340-3
<b>Current Transformer (1CT, 3CT)</b>			
3 to 10 HP 230 VAC	2	14C653	64670-22R
3 to 20 HP 460 VAC	2	14C653	64670-22R
15 to 20 HP 230 VAC	2	14C654	64670-23R
25 to 40 HP 460VAC	2	14C654	64670-23R
<b>Field Current Transformer</b>	1	14C655	64670-24R
<b>Power Cubes</b>			
3 – 20 HP 230 VAC	3	14C266	701819-19AC
3 – 40 HP 460 VAC	3	14C267	701819-19AW
<b>M Contactor (Optional)</b>			
3 – 10 HP 230 VAC	1	14C268	69326-30R
15 – 20 HP 230 VAC	1	14C268	78090-51R
3 – 40 HP 460 VAC	1	14C212	78090-51R
<b>Pilot Relay PC Card</b>			
10HP – 20 HP 230 VAC	1	14C270	0-54335-1
3 – 40 HP 460 VAC	1	14C271	0-54335-1
<b>MOV Surge Suppressor</b>			
3 – 20 HP 230 VAC	3	14C260	411026-6R
3 – 40 HP 460 VAC	3	14C261	411026-9R
<b>DV/DT PC Card</b>			
3 – 20 HP 230 VAC	1	14C214	0-55310
3 – 40 HP 460 VAC	1	14C214	0-55320
<b>DV/DT Resistor Assembly</b>			
3 – 40 HP 460 VAC	1	14C215	78089-6R
<b>Line Fuses 4FU, 5FU, 6FU</b>			
3 – 10 HP 230 VAC	3	–	64676-12BX
3 – 20 HP 460 VAC	3	–	64676-12BX
15 – 20 HP 230 VAC	3	–	64676-12CC
25 – 40 HP 460 VAC	3	–	64676-12CC
115 VAC Control Fuse, 3FU	1	14C670	64676-23V



**Table 6.A – Replacement Modules**

<b>Part Description</b>	<b>Quantity Per Controller</b>	<b>Model Number</b>	<b>Part Number</b>
<b>Low Voltage Control Fuses</b> 7FU, 8FU, 9FU	3	14C671	64676-23V
<b>Control Transformer</b> 3 – 10 HP 230 VAC	1	14C665	411027-70S
15 – 20 HP 230 VAC	1	14C666	411027-68S
3 – 40 HP 460 VAC	1	14C667	411027-69V
<b>Remote Operator PC Card</b>	1	14C220	0-57005
<b>Field Supply</b>	1	14C672	608868-25R
<b>MOV Surge Suppressor Field Supply</b> 3 – 20 HP 230 VAC	1	14C673	411026-9R
3 to 40 HP 460 VAC	1	14C674	411026-9S
<b>Fan</b> 20 HP 230 VAC	1	14C669	705328-6R
40 HP 460 VAC	1	14C669	705328-6R
<b>Field Supply Fuses</b> 1FU, 2FU	2	14C675	64676-30Y

## SECTION 7

### THREE PHASE FLEXPAC PLUS MODIFICATION KIT INSTRUCTION MANUALS

**7.0 General** – A number of optional features in the form of Modification Kits are offered with the three phase, FlexPak Plus controller. Each of these Kits extends the control of the unit and tailors its operation to specific application needs.

This Section describes the procedures that must be followed to install the Kits. Refer to Table 7.A for an informational listing.

#### DANGER

**INSTALLATION OF MODIFICATION KITS IS TO BE DONE ONLY AFTER A-C LINE VOLTAGE IS DISCONNECTED AND LOCKED OUT AT THE MAIN DISCONNECT SWITCH. DO NOT INSTALL KITS WHEN POWER IS APPLIED TO THE FLEXPAC PLUS CONTROLLER. SERIOUS PERSONAL INJURY AND EQUIPMENT DAMAGE COULD RESULT.**

**CAUTION:** Installation of the Modification Kits should be performed only by qualified electrical maintenance personnel familiar with the design and operation of this equipment. Damage could result thru unfamiliarity.

Many of the Modification Kits are designed to make electrical connection with the Regulator Module by means of pin-type connectors. These slide up through matching holes in the Modules that form part of the Kit. (Refer to Figure 7.1.)

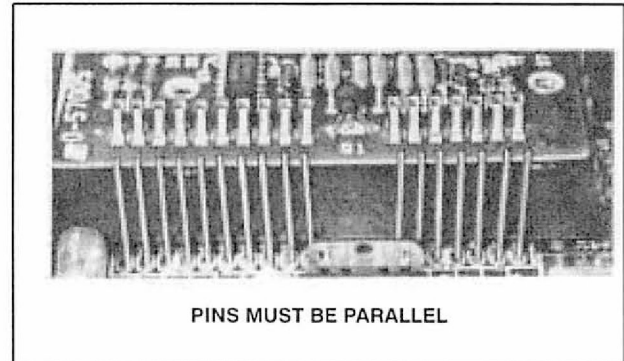


Figure 7.1 – Pin Alignment

A common installation problem is caused by bent, broken or incorrectly placed pins. Since improper operation results, care must be taken. **Exact alignment is critical.** Visually check that only **one** pin extends to the top of **each** slot once the connection is made.

Many of the Modification Kits require the removal of one or more jumpers from the Regulator Module. In such cases, carefully clip the leads on both sides of each jumper and discard it. Use a sharp pair of dykes (diagonal cutters) to assure a quick, clean cut. Do not twist the tool, since damage may result.

In cases where the Kit is secured by a mounting screw, be sure to tighten it firmly but **do not overtighten**. Excessive force can strip the threads.

Table 7.A – Modification Kit Quick Reference List

Kit	Instruction Manual Number	Model No.	Controller Modification ? <sup>①</sup>	Additional Options Required ?	Options Required	Additional User-Supplied Parts?
Circuit Breaker	D-3956	14C610 14C611 14C612	Yes	No <sup>②</sup>	None <sup>②</sup>	No
Dynamic Braking	D-3957	14C630 thru 14C642	Yes	No <sup>②</sup>	None <sup>②</sup>	Wire

**Table 7.A – Modification Kit Quick Reference List (Continued)**

<b>Kit</b>	<b>Instruction Manual Number</b>	<b>Model No.</b>	<b>Controller Modification ?<sup>①</sup></b>	<b>Additional Options Required ?</b>	<b>Options Required</b>	<b>Additional User–Supplied Parts?</b>
Reversing Contactor	D-3959	14C241 14C401 14C402	Yes	Yes <sup>②</sup>	• Fwd/Rev Selector Switch on OP Station.	No
Auxiliary M Contact	D-3960	14C480 thru 14C484	No	No <sup>②</sup>	None <sup>②</sup>	Wire
Blower Motor Starter	D-3961	14C510 14C520	Yes	No <sup>②</sup>	None <sup>②</sup>	Wire
Fan Kit	D-3962	14C560	Yes	No	None	None
Status/ Diagnostic Indicator	D-3963	14C570	Yes	No	None	None
Series Field Kit	D-3965	14C620 14C621 14C622	Yes	No	None	Wire
Dancer Follower	D-3966	14C230	Yes	Yes	Dancer Potentiometer	Wire
Instrument Interface/ Preset Speed	D-3967	14C222	Yes	No/Yes	• If Preset Speed only, may need Auto/Manual Switch.	No
				No/Yes	• If follows process controller, may need Auto/Manual Switch.	Wire
Master Isolated Reference Receiver	D-3968	14C229	Yes	Yes	Master Isolated Reference Transmitter	Wire
Tachometer Feedback	D-3969	14C221	Yes	No	None	Wire
Test Meter Adapter	D-3970	14C225	No	No	None	No
Voltage/ Tachometer Follower	D-3971	14C223	Yes	No/Yes	May need Auto/Manual Selector Switch	Wire
M Contactor Adapter Kit	D-3955	14C470	Yes	Yes	3-Phase Line Input Fuses	M Contactor Wire NEC/CEC Fuses
Auxiliary Panel	D-3958	14C240 14C331 14C332	Yes	No	None	No

① Modification here means that some work such as jumper placement, resistor clipping, or wiring reconnection must be performed.  
 ② No options required in standard product offering optional basic controller would require specific auxiliary panel for required option.

Table 7.B – Wire Specifications

Use in Controller	Type Conductor	Required Characteristics	Acceptable Types
<b>CONTROL WIRES</b>			
Remote Operator Control Station: <ul style="list-style-type: none"> <li>• AUTO/MANUAL</li> <li>• JOG/RUN</li> <li>• FORWARD/REVERSE</li> <li>• START/STOP</li> </ul>	<ul style="list-style-type: none"> <li>• Single conductor and/or multi-conductor</li> </ul>	<ul style="list-style-type: none"> <li>• Stranded copper</li> <li>• AWG No. 16</li> <li>• 600 VAC rating</li> <li>• Insulation: polyvinyl chloride (PVC)</li> <li>• Temperature range: 40°–105°C (104°–221°F)</li> <li>• Unshielded</li> </ul>	<ul style="list-style-type: none"> <li>• Any single conductor meeting N.E.C. required characteristics</li> </ul>
<b>SIGNAL WIRES</b>			
Remote Operator Control Station: <ul style="list-style-type: none"> <li>• SPEED pot</li> <li>• TORQUE pot</li> </ul> <ul style="list-style-type: none"> <li>• Tachometer feedback</li> <li>• Instrument Interface</li> <li>• Voltage/Tachometer Follow</li> </ul>	<ul style="list-style-type: none"> <li>• Three-conductor</li> <li>• Twisted with two twists per inch</li> </ul> <ul style="list-style-type: none"> <li>• Two-conductor</li> <li>• Twisted pair with two twists per inch</li> </ul>	<ul style="list-style-type: none"> <li>• Stranded copper (19 x 29)</li> <li>• AWG No. 16</li> <li>• 600 VAC rating</li> <li>• Twist per foot: 24 (1/2-inch lay)</li> <li>• Insulation: polyvinyl chloride (PVC)</li> <li>• Temperature range: 40°–105°C (104°–221°F)</li> </ul>	<ul style="list-style-type: none"> <li>• User may twist single conductors of required specifications</li> <li>• Reliance Part No. 417900-79X</li> <li>• User may twist single conductors of required specifications.</li> <li>• Reliance Part No. 417900-76EAD</li> </ul>

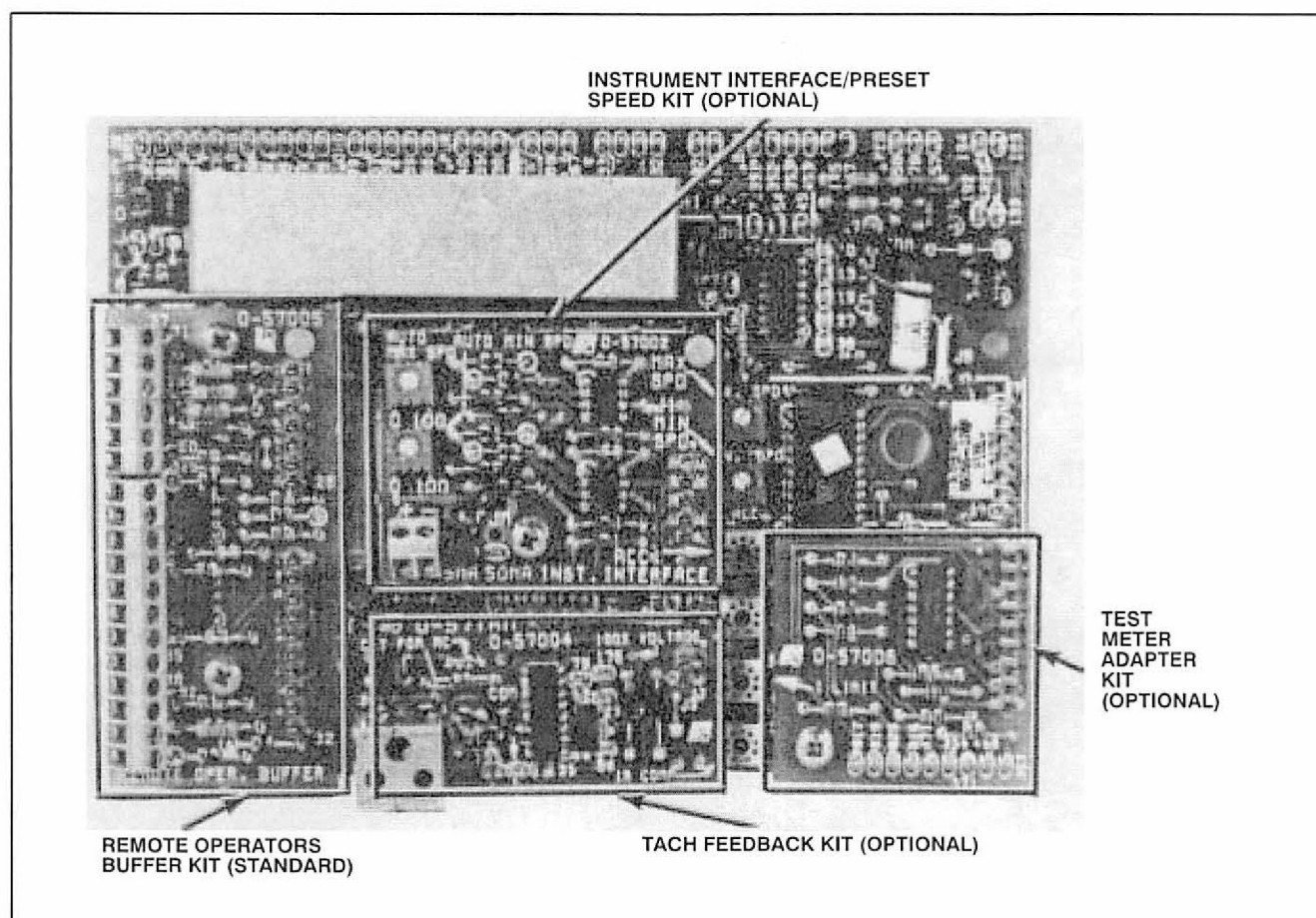


Figure 7.2 – Three Phase FlexPak Plus Regulator Board with Some Typical Kits Installed

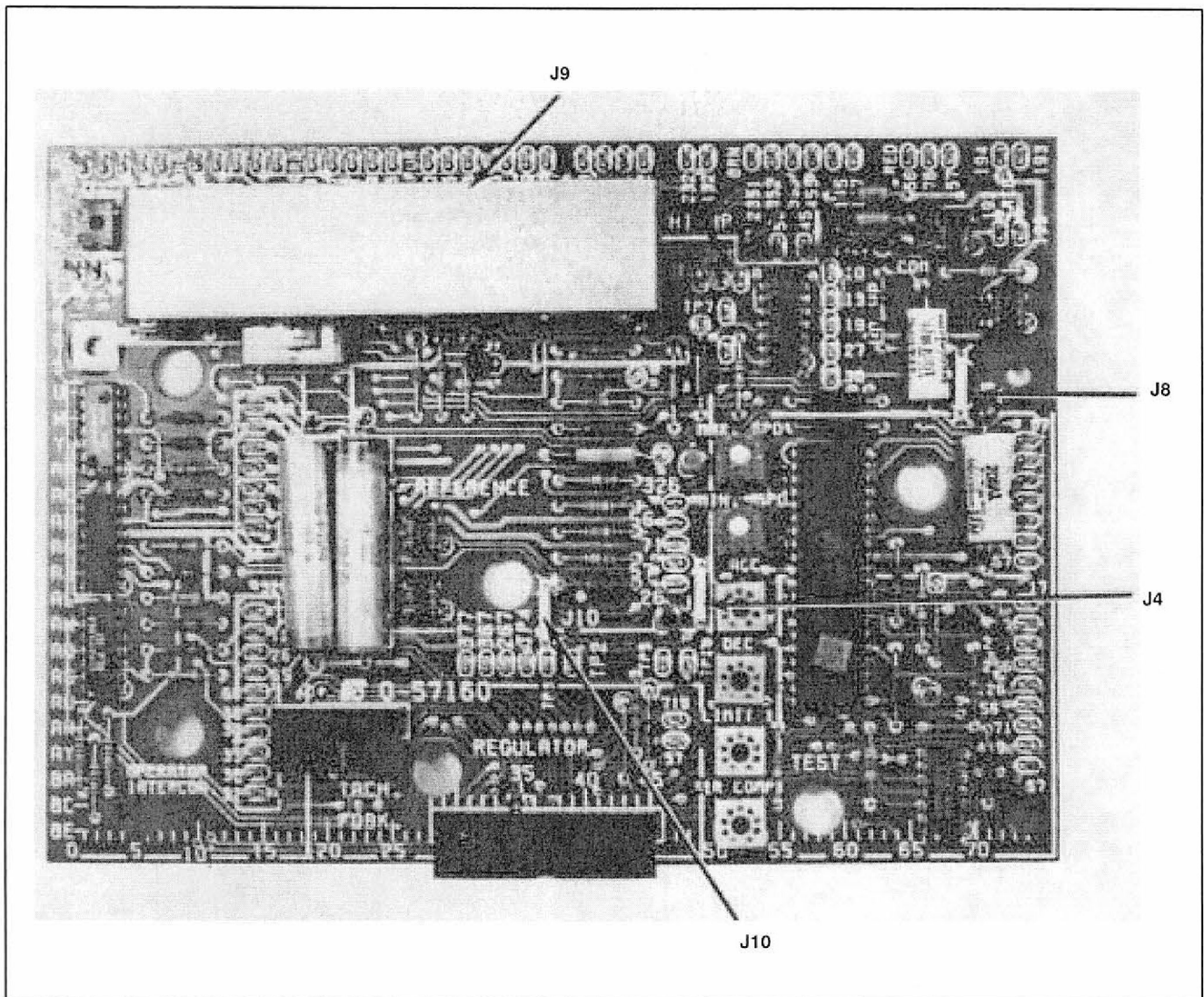


Figure 7.3 – Three Phase FlexPak Plus Regulator Board Jumper Location

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