AUGUST, 1982

INSTRUCTION MANUAL D-3937

INSTALLING, OPERATING, and MAINTAINING

MINPAK PLUS

D-C VS DRIVES

and MODIFICATION KITS

RELIANCE ELECTRIC

SECTION 1
INTRODUCTION

1.0 General – This manual familiarizes the user with the three phase, MinPak™ Plus D-C V★S® drive controller. (Refer to Figure 1.1.) It describes assembly and

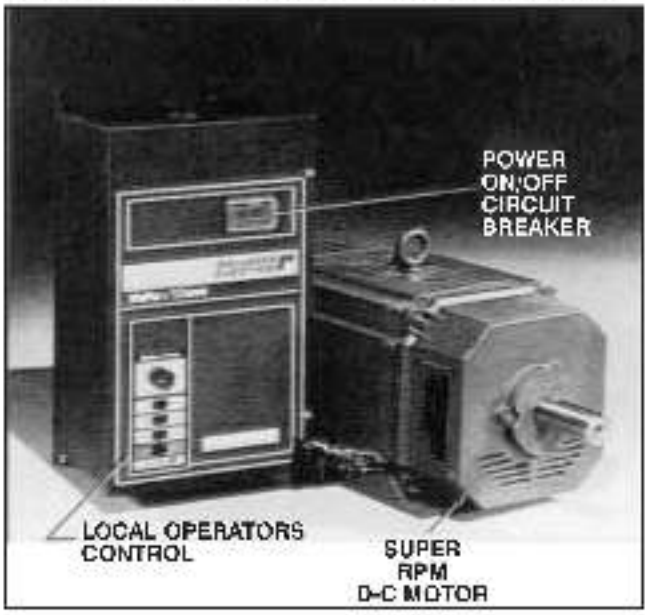

Figure 1.1 - MinPak Plus Controller and Super RPM Motor

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.

DANGER

CONTROLLER EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE POWER UNIT IN THE MINPAK 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

THE NATIONAL ELECTRICAL CODE REQUIRES THAT AN N.E.C. APPROVED CLASS K-5 FUSED DISCONNECT SWITCH 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.

WARNING

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

SECTION 2
GENERAL CONTROLLER INFORMATION

2.0 General – The Minpak Plus D-C V*S drive controller may be applied to three phase d-c drive applications with ratings with n the follow ng ranges:

- From 3 to 20 hp w th a 230 VAC. 50/60 Hz input voltage
- From 3 to 40 hp w th a 460 VAC. 50/60 Hz input voltage

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

The Minpak Plus controller s provided, as standard, in a NEMA 12 enclosure intended for wall or panel mounting. A three pole power on/off circu t breaker is standard with a door interlock.

The operators controls can either be local and door mounted or a remote control station is also available.

The three phase MinPak Plus is Underwriters Laboratories (U.L.) listed and Canadian Standards Association. (C.S.A.) certified.

Optional Modification Kits conveniently expand the capability of the three phase Minpak Plus.

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

2.1 Operator's Control Station – For proper operation of the Minpak Plus controller, it s necessary to use an Operator's Control Station. (Refer to Figure 2.1.) The Operator Stat ons allow the tailoring of control functions for the application. These may include:

- SPEED control potentiometer
- TORQUE control potent ometer
- AUTO/MANUAL selector switch
- RUN/JOG selector switch
- FORWARD/REVERSE selector switch
- START/STOP selector switch

There are two basic configurations that may be selected:

- Stat on mounted on controller cover
- Stat on mounted remotely as a separate unit

2.1.1 Local Station – When the Stat on s mounted locally on the Cover, users may select from 8 standard Faceplates (Model No. 14C201 thru 14C208) in order to configure a controller to a specific drive application. Refer to I/M D3977 which includes an inclusive listing of Faceplate types, Model Numbers and functions. Assuming the Cover s properly installed, the Faceplate design maintains the NEMA Type 12 rating.

REMOTE OPERATOR CONTROL STATION

Figure 2.1 – **Remote and Local Operator Control Stations**

Figure 2.2 – MinPak Plus with Standard Blank Operator Station Cover

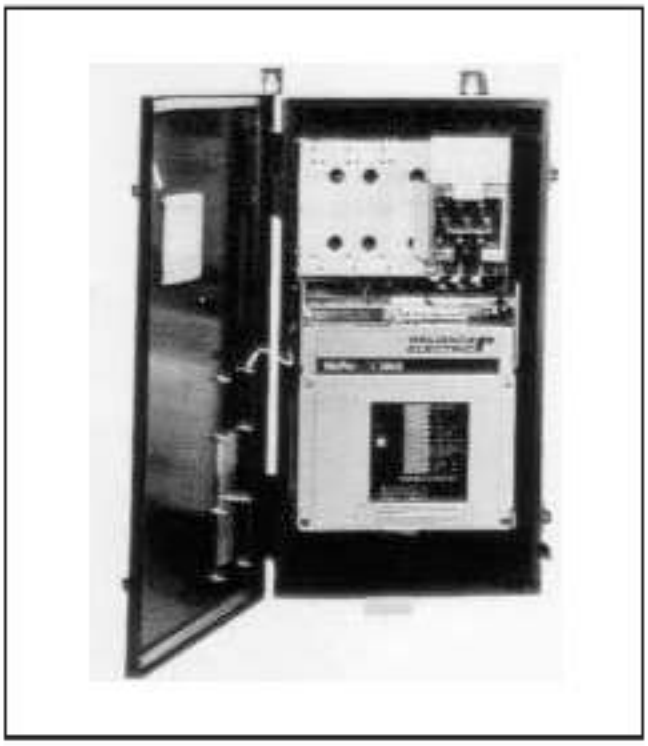

Figure 2.3 – MinPak Plus with Optional Status/Diagnostic Indicator Kit

2.1.2 Remote Stations – Some applications may require that the Operator's Control Station be remotely located. Briefly, the following three steps describe what must be done:

- Maintain the standard **blank** Remote Operator Station Cover Faceplate (Refer to Figure 2.2)
- Order a Remote Operator Adapter Kit, Model 14C220. (This unit provides a connection point for the Remote Station.)
- Specify a Reliance Remote Operator Control Station. Connect it to the controller.

Reliance offers a variety of Remote Operator Stations that are compatible with the MinPak Plus controller. (Refer to Table 2.B.)

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

The Auxiliary Panel modifications are:

- Blower Motor Starter
- Reversing Contactor
- Circuit Breaker
- Auxiliary M Contact
- Dynamic Braking (Kit is mounted on top of NEMA 12 enclosure)

Complete descriptions of each Kit are given in Section 7. Refer also to Table 7.A.

2.4 Specifications – The more important specifications for the MinPak Plus controller are listed in Table 2.C. 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 MinPak Plus controller is 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 MinPak 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 ±10% of nominal.

2.4.3 Line Impedance Requirements – The MinPak

Table 2.A – MinPak Plus Features Summary

Category	Feature
Controller Functions	• START/STOP • RUN/JOG • FORWARD/REVERSE • Speed selection (5 to 100%) • Torque selection (10 to 150%) • Uni direction operation with coast-to-rest on stop command standard. (Dynamic braking and reversing available as options.) • 20:1 controlled-speed range by means of armature voltage control. • Armature loop contactor removes power to drive motor. • Isolated armature voltage and current feedback decouples armature power from operator devices and provides additional noise immunity. • With tachometers specified, 0.5% or 1.0% speed regulation with a 95% load change. • Operates and delivers rated output speed with specified regulation tolerance limits even with a-c Line variations of ±10% of nominal rated input voltage.
Speed Regulation	• Jumper reconnectable regulator circuits which allow armature (A) or tachometer feedback (T) regulation. • With voltage regulation, 3 to 5% speed regulation with 95% load change. • 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.) • With tachometer specified, 0.5% speed regulation with 95% load change. (Tachometer is BC42.)
User Adjustments	• Adjustable IR drop compensation (0 to 12% of rated load). • Adjustable maximum speed (70 to 100% of base motor speed). • Adjustable minimum speed (5 to 30% of base motor speed). • Adjustable current limit (10 to 150% of full-load current). • Adjustable, separately set linear acceleration and deceleration rates (0.5 to 30 sec.)
Safety	• Control circuitry guards against automatic restarting of equipment after resumption of interrupted a-c incoming power. • Regulator and Operator's Controls isolated from a-c line for personnel protection. • Armature voltage and current feedback isolated to assure separation of power and regulator circuits.
Hardware	• Conveniently located screw terminal connections for incoming a-c and outgoing d-c power allow easy cable entry and connection. • Circuit Breaker causes positive opening of a-c line circuit in order to help protect Power Cube from armature short circuit. • Protection from momentary surges on a-c line and from d-c load transients.

Pluscontroller must be connected to a short-circuit system designed to operate on plant power supplies with maximum permissible available symmetrical RMS fault currents of 5000 amperes. (Refer to Table 2.D.)

WARNING

DO NOT OPERATE THE MINPAK 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.

2.5 Enclosure – NEMA Type 12 is generally defined as an indoor enclosure that is dusttight and oiltight. It is designed to resist fibers, flyings, dust, dirt and light oil splashings.

Table 2.B – Remote Operator Control Stations

When Using a MinPak Plus Controller With:	Specify Operator's Station Model	Functions Provided			
		Star/Stop Rocker Switch	Speed Setting Potentiometer	Run/Jog Selector	Forward/Reverse Selector
Basic features (standard unidirectional Station)	9C45	Yes	Yes	Yes	No
NEMA Type 4 Station with basic features	9C18	Yes	Yes	Yes	No
Explosion-proof Station with basic Features	9C17	Yes	Yes	Yes	No
Basic features plus armature reversing (standard reversing Station)	9C46	Yes	Yes	Yes	Yes
NEMA Type 4 Station for reversing	9C19	Yes	Yes	Yes	Yes
Explosion-proof Station for reversing	9C16	Yes	Yes	Yes	Yes

Table 2.C – Specifications

A-C Line input Voltage
230/460 VAC (nominal, 60 HZ)
220/440 VAC (nominal, 50 Hz)
three phase only

Line Voltage Variation
+10% of nominal

A-C Line Frequency
Three Phase, 50/60 Hz

Line Frequency Range
48-62 Hz

Output Voltages (armature and field)
See Table 2.D

Controller-Drive HP Range
3-20 (with 230 VAC input)
3-40 (with 460 VAC input)

Direction Control
Standard: Uni direction
Optionally: Forward/Reverse

Maximum Speed Adjustment
70 to 100% of base motor speed
(user adjustable)

Minimum Speed Adjustment
up to 30% of base motor speed
(user adjustable)

Operator Speed Adjustment
Infinitely adjustable with optional control pot
(up to 100% of base speed)

Operator Torque Adjustment
Infinitely adjustable at optional control pot
(10 to 150% of rated load)

IR Drop Compensation
0 to 12% of rated load
(user adjustable)

Controllable Speed Range
20:1

Current Limit
Factory shipped: 150% of full load
User adjustable: 10 to 150% of full load

Regulator (with 95% load change)
3 to 5% with voltage feedback
1.0% with specified tachometer feedback
0.5% with specified tachometer feedback

Minimum Load for Stable Operation
5%

Acceleration/Deceleration Rates
0.5 to 30 sec. linear time
(user-adjusted separately)

Armature Circuit Overload Capacity
150% of armature current rating for 1 minute (max.)

Efficiency (rated speed/rated load)
Controller only: 97%
Complete drive including motor 85% (typical) ①

Displacement Power Factor
68% (typical) ①

Circuit Breaker Rating
3-10 HP @ 230 VAC – 50 AMP
3-20 HP @ 460 VAC – 50 AMP
15-20 HP @ 230 VAC – 100 AMP
25-40 HP @ 460 VAC – 100 AMP

Transient Protection
MOV and Output RC Circuit

Controller Service Factor
1.0

Duty
Continuous

Ambient Temperature
Storage: 0-55°C (32° to 131°F)
Operation: 0-40°C (32° to 104°F)

Relative Humidity (storage and operational)
5 to 95% (without condensation)

Operational Altitude
To 3300 ft (1000 m) above sea level without derating

Controller Weight (approx.)
80 lb (36.3 Kg)

Controller Dimensions (LWD)
26.75 x 14.00 x 13.00 Inch
(679.4 x 355.6 x 330.2 MM)

Frontal Swing Projection
14.00 Inch (355.6 MM)

① Typical percent shown. Exact figure dependent on motor base speed and frame size.
② Assumes proper installation procedures.

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 ④	Rated kVA
14C310	3	230	12	240	12	150	5	5000	30	③ 6
	5	230	20	240	20	150	5	5000	50	③10
	7-1/2	230	28	240	29	150	5	5000	63	④12-1/2
	10	230	36	240	38	150	5	5000	80	16
14C311	15	230	51	240	55	150	5	5000	115	23
14C312	20	230	66	240	72	150	5	5000	145	30
14C315	3	460	7	500	6	300	5	5000	30	③ 6
	5	460	11	500	10	300	5	5000	50	③10
	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
14C313	25	460	40	500	43	300	5	5000	175	35
	30	460	47	500	51	300	5	5000	205	41
	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 and Class K-5 Fuses ahead of the controller.

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 MinPak 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 MINPAK 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 MinPak Plus controllers.

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

Guideline 2 – It is necessary to leave at least a 6 inch (150 mm) clearance between controllers including top,

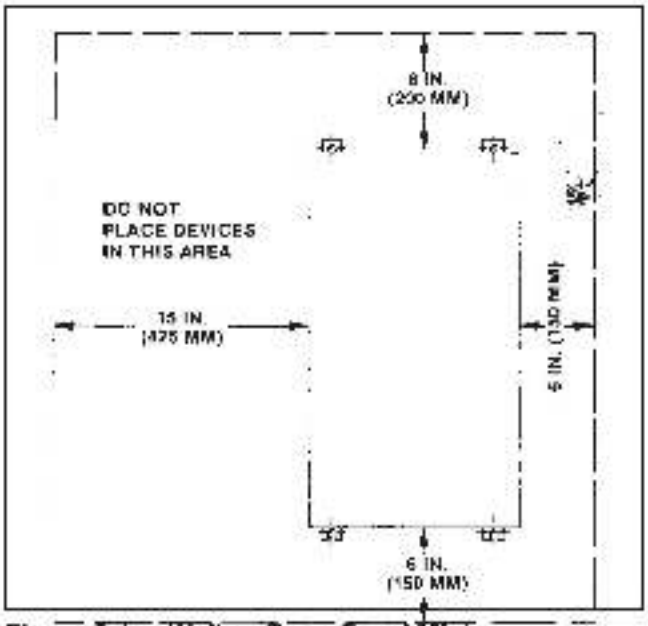

Figure 3.1 – Wall or Open Panel Minimum Mounting Distances

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.)

Guideline 3 – Since the controller's Cover is hinged, additional clearance must be provided on the fourth side of the Chassis. (Refer to Figure 3.1.)

Guideline 4 –If mounting the controller within a larger enclosure, **do not** place it directly in a corner. Leave at least 8 inches (200 mm) from the top or 6 inches (150mm) from the bottom of the enclosure. Also leave 8 inches (200 mm) between the enclosure side wall and the **unhinged** side of the controller. (Refer to Figure 3.2.) Heat builds up at the cabinet's top and may exceed the permissible ins de ambient temperature upper limit. At the cabinet's bottom, the unit must be high enough to allow air to flow upwards.

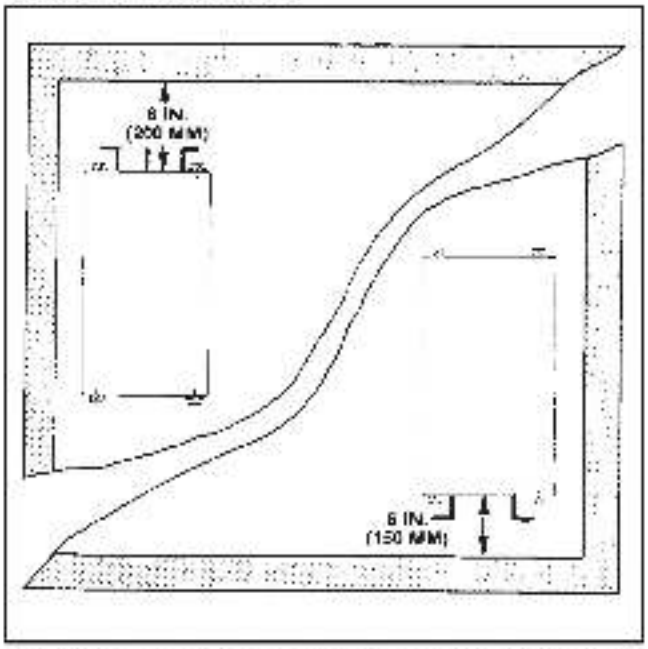

Figure 3.2 – Enclosure Mounting Minimum Distances

Guideline 5 –Regardless of the above placement guidelines, the user is responsible for providing ambient temperatures that meet the controller's specifications. For units mounted on an open panel or wall this range is 0° - 40°C (32° -104°F).

Guideline 6 – Conduit knockouts are provided on top and bottom of this cabinet. Plan controller placement on the wall or panel to allow for conduit runs. Proper care should be taken when installing conduit to maintain NEMA 12 type rating.

Guideline 7 – If the controller is placed in a larger enclosure, do not place it so that the Cover, if used, cannot swing open at least 90° minimum. Allowing for a full 110° swing aids subsequent installation and trouble shooting. (Note that the Cover will swing open to the left).

Guideline 8 – **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 9 –The controller requires a three-phase power supply that provides either 230 VAC or 460 VAC at 50/60 Hz. If correct voltage is not available, it will be necessary to install a transformer between the power supply and the controller.

WARNING

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

Guideline 10 – 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 11 – 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.)

Note that the standard POWER ON/OFF circuit breaker is a three-pole circuit breaker designed only to provide

over-current protection for the Internal Power Cubes containing the power semiconductors. It should not be considered a proper main disconnect device.

Guideline 12 – 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 13 – 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 14 – 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 15 – Operational altitude above sea level may not exceed 3300 ft (1000 m). Derate horsepower 3% for each 1000 ft (300 m) above this altitude.

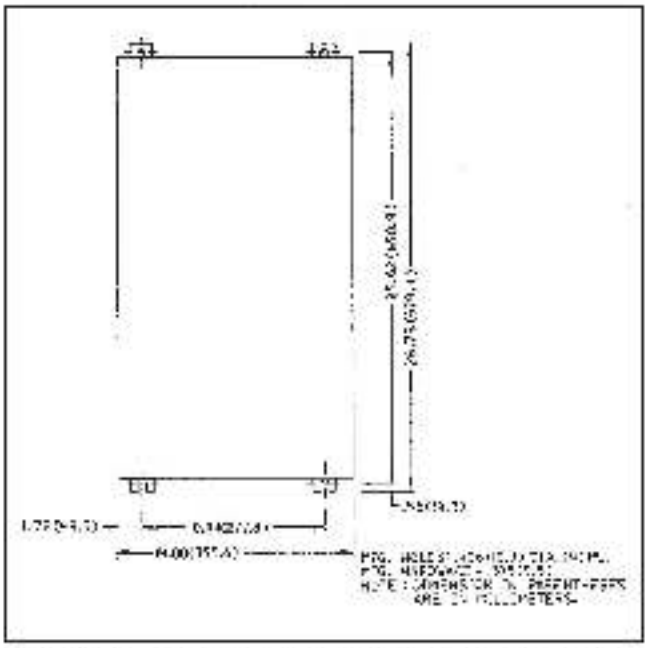

Figure 3.3 – Three Phase MinPak Plus Mounting Dimensions

3.2 Mounting – This Paragraph outlines the procedures to be followed to mount the MinPak 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.

Choose four 3/8 inch lug bolts. The length depends upon the depth of the entire mounting surface. Mount controller using lug bolts.

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. IF THIS WARNING IS NOT OBSERVED PERSONAL INJURY MAY RESULT.**

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.

> **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 autotransformer may be required because of a-c line voltage levels, it is feasible to provide a number of benefits standard with an isolation transformer.

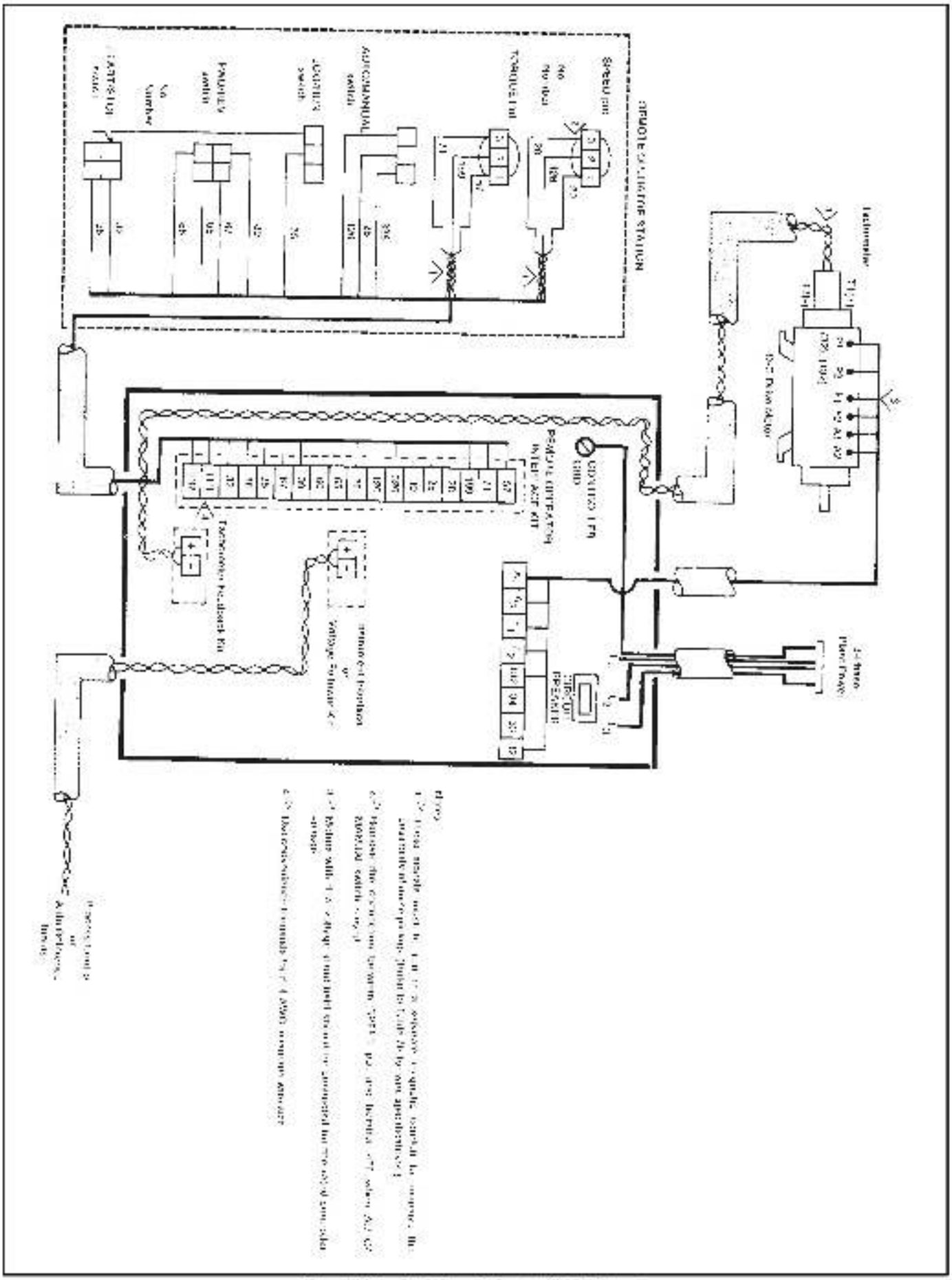

Figure 3.4 – System Connection Diagram

The general requirements for an isolation transformer are:

- Three phase
- 3 to 6% impedance
- Non-regulated
- 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 MinPak Plus controller.

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	36	10	19
		15	27
15	54	20	36
20	72		
		25	45
		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

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 Jumper – The MinPak Plus controller offers 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 permanently 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.

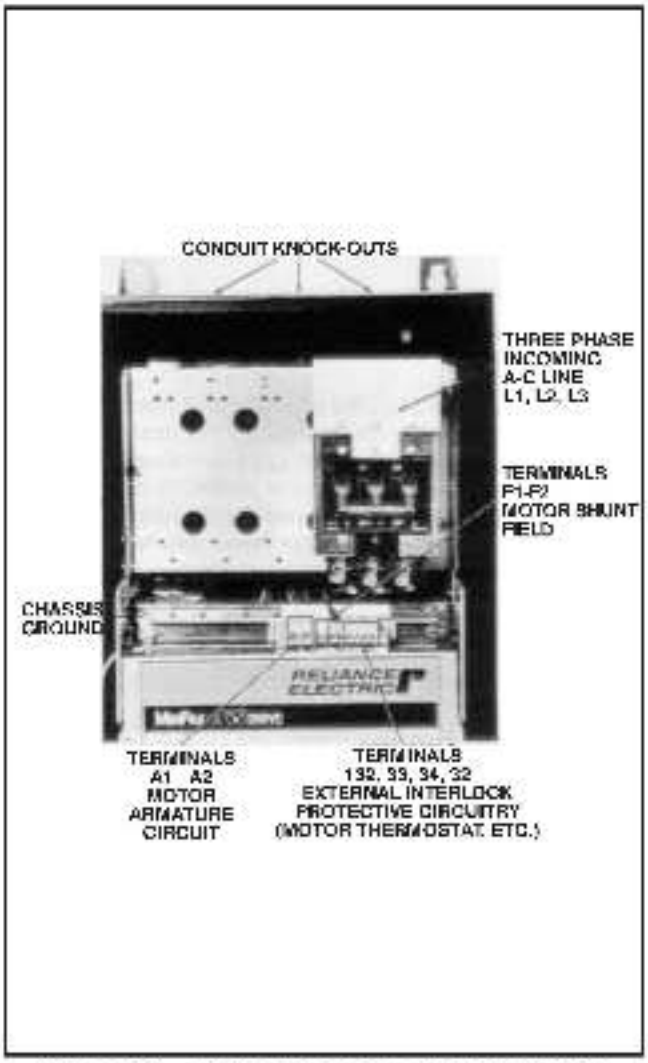

Figure 3.5 – Three Phase Minpak Plus Wiring Locations

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

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_B = Base speed at full field and rated armature voltage

Eg (NL) = Armature voltage no load

MSS = Max safe operating speed

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

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	2175
B210ATZ	4500	B680ATZ	2100
B250ATZ	4500	B810ATZ	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.

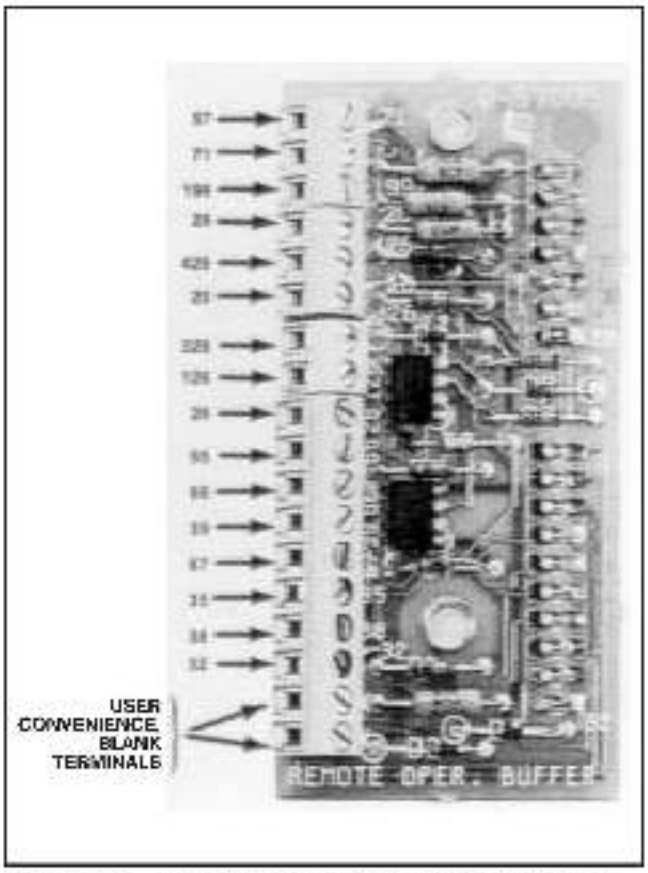

Figure 3.6 – Remote Operator's Buffer Terminal Markings

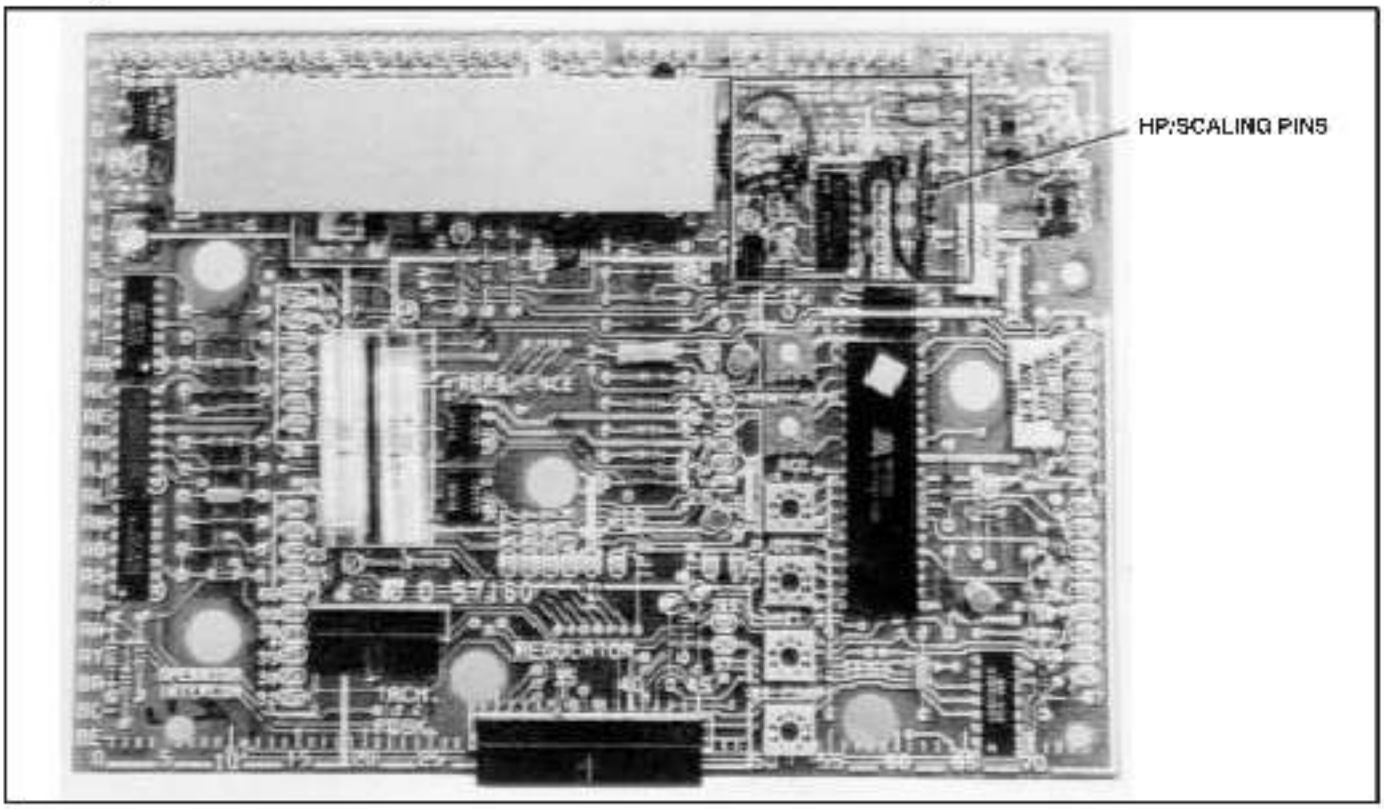

Figure 3.7 – Regulator Module, HP/Current & Scaling Pins

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 MINPAK 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 MinPak 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. If a Local Station is used on the Cover, there are 2 connectors that mate with the Regulator Module at Pins 32 (RED) and 28 (GRN). (See Figure 4.2.)

If a Remote Station is used, 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. Refer to Figure 4.1.) Determine that all wires are firmly seated in the terminal strip.

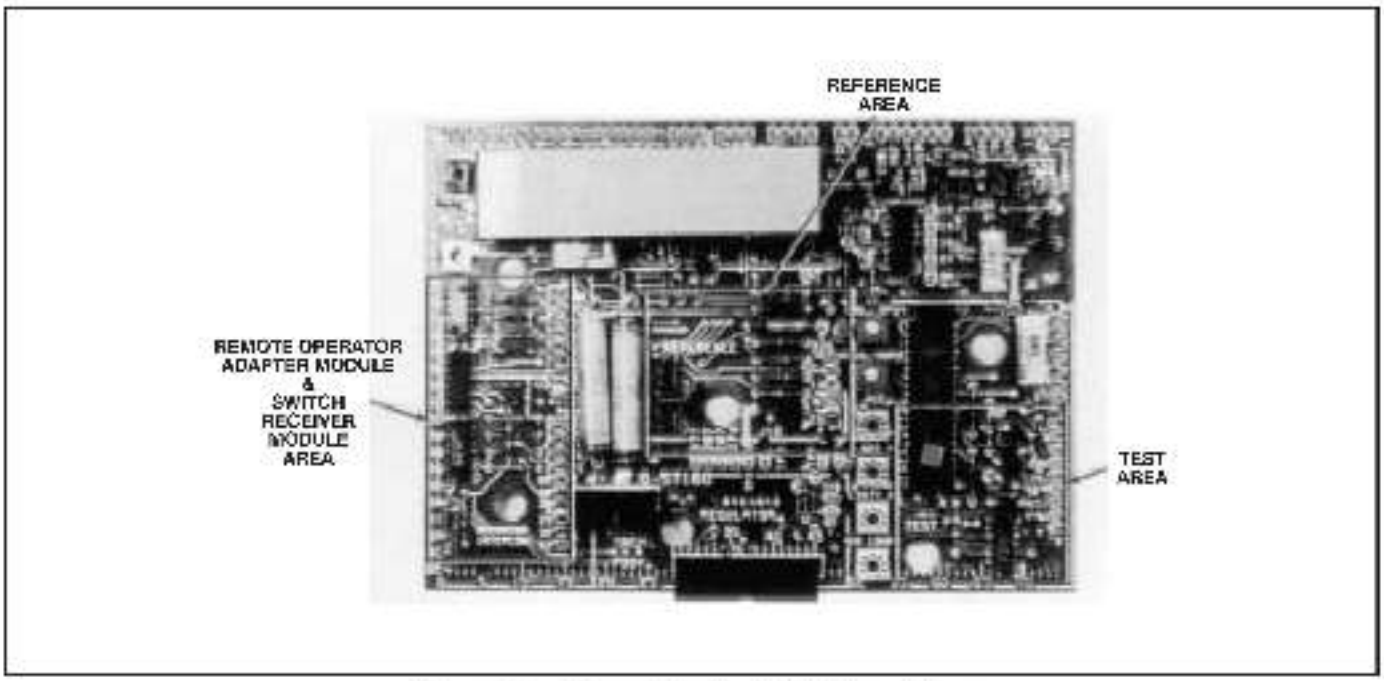

Figure 4.1 – Regulator Module Kit Locations

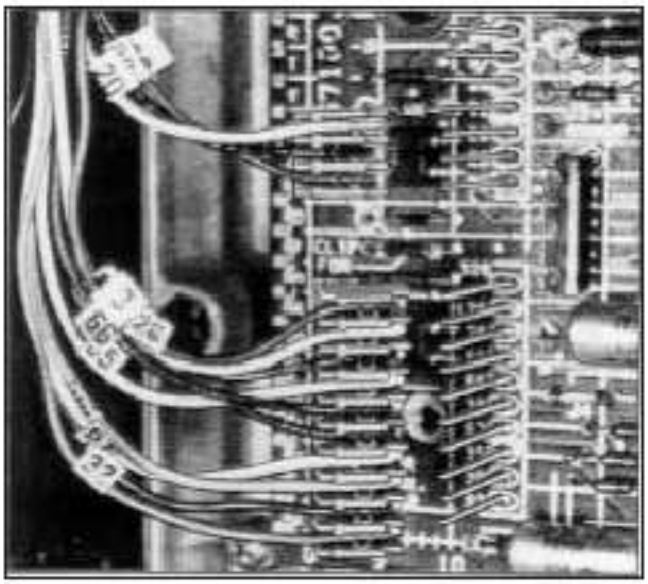

Figure 4.2 – Local Faceplate Connectors

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 MinPak 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 MinPak 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

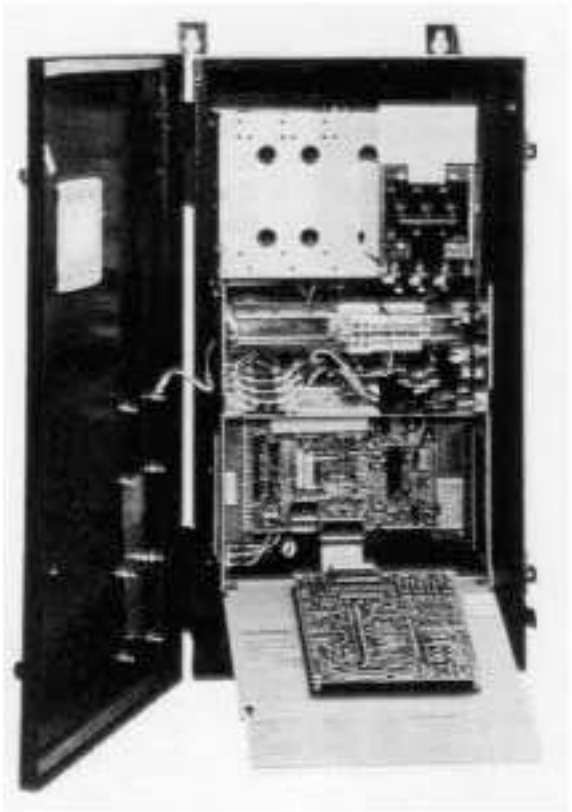

Figure 4.3 – Three Phase MinPak Plus Internal Layout

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 4.4.) 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.

DANGER

USE ONLY ON HAND TO HOLD THE SCREWDRIVER. 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

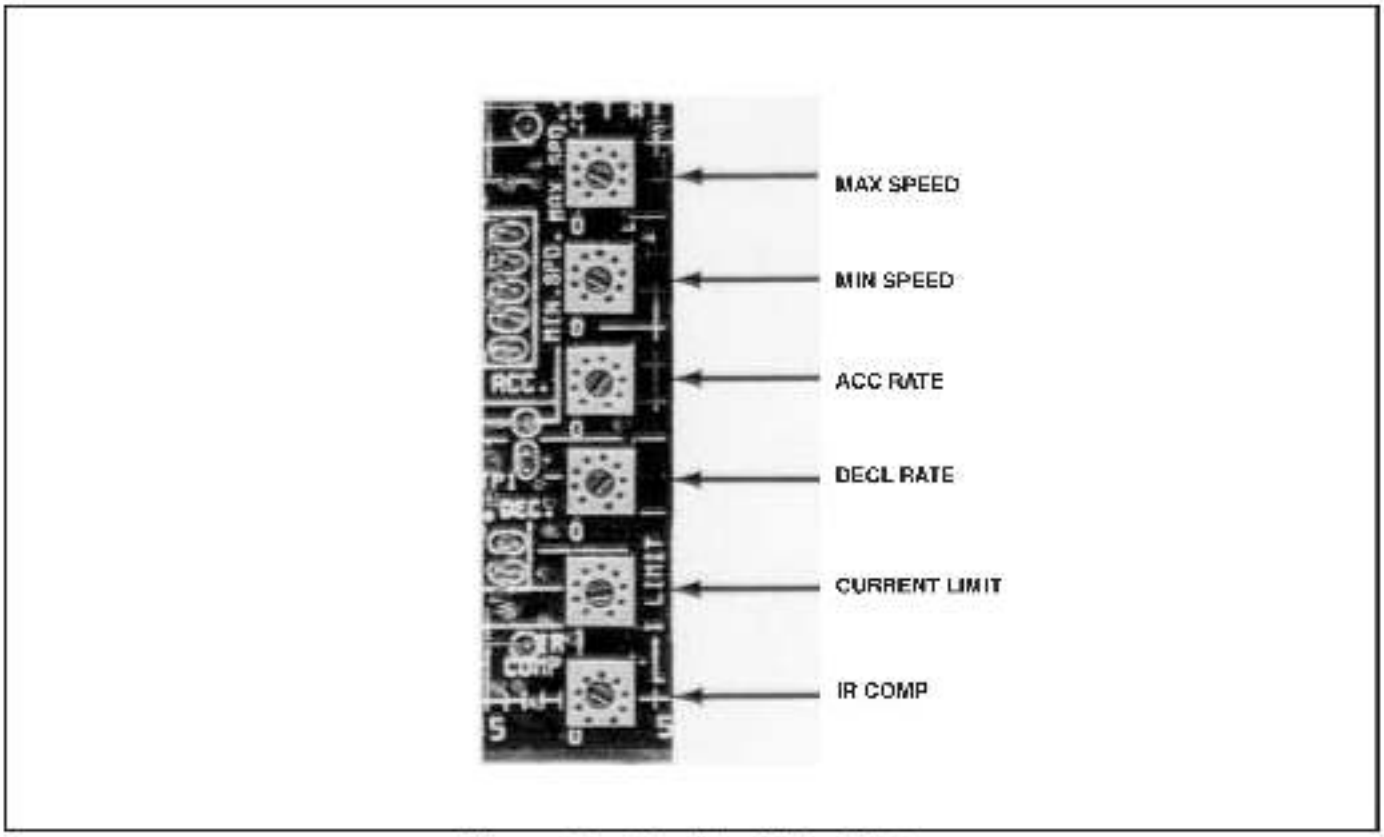

Figure 4.4 – Regulator Module Pots

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 MinPak 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 MINPAK PLUS CONTROLLER. THUS, A-C POWER MUST BE REMOVED FROM THE UNIT BEFORE IT IS SAFE TO TOUCH THE INTERNAL PARTS OF THE MINPAK PLUS. PERSONAL INJURY MAY RESULT UNLESS POWER IS REMOVED.

DANGER

THE MINPAK 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 MinPak 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 MinPak 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 MinPak Plus controller is **completely** disconnected.
- A volt-ohmmeter (VOM) may be used for ground checking without disconnecting conductors to the MinPak 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.

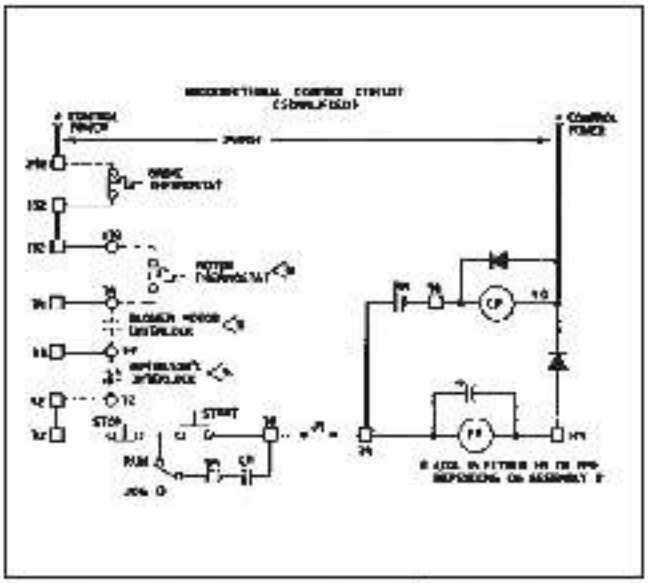

Figure 5.1 – Unidirectional Control Circuit (simplified)

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 or Distributor.

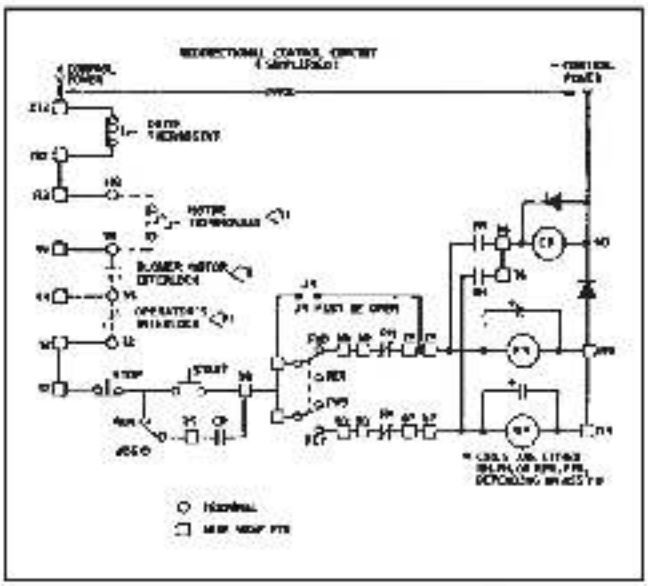

Figure 5.2 – Bidirectional Control Circuit (simplified)

TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE THREE PHASE MINPAK PLUS 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.	**DANGER** **IF CIRCUIT BREAKER HAS TRIPPED OR FUSES HAVE CLEARED,THE FIELD SUPPLY AND ITS WIRING MUST BE INSPECTED FOR DAMAGE. AFTER RE-APPLYING POWER TO THE DRIVE, THE FIELD VOLTAGE MUST BE RE-CHECKED FOR PROPER VOLTAGE AT MOTOR TERMINALS F1, F2. IF THIS VOLTAGE IS BELOW 90% OF THE FIELD VOLTAGE SPECIFIED ON THE MOTOR NAMEPLATE, THE DRIVE MUST NOT BE STARTED UNTIL PROPER VOLTAGE IS OBTAINED. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN OVERSPEEDING THE MOTOR AND/OR THE MACHINERY COUPLED TO THE MOTOR SHAFT AND POSSIBLE FATAL INJURY.** ☐ Remove all power at the disconnect. ☐ Remove leads to L1, L2, L3, A1, A2 and F1, F2, on incoming side of controller's respective location. ☐ Open the power disconnect switch. ☐ Check for a ground condition at 31, 32, 33, A1, A2, F1 and F2. Do this internal to controller. If a ground is discovered, check wiring connections on Power Cube and motor field terminals F1 and F2. ☐ If no ground exists, examine the controller chassis for loose wires and/or foreign objects. ☐ If no ground exists and if no foreign objects are discovered, reconnect the incoming conductors A1, A2 and F1 and F2. Then check for grounds at these terminals. ☐ If a ground is found, it is in the conductors to the motor or in the motor itself. ☐ Disconnect the motor from the conductors at the drive motor. ☐ Test A1, A2, F1 and F2 conductors for a ground. (If one exists, examine connections and insulation for areas where shorts could occur.) ☐ If no grounds are found in the conductors, check the motor for a ground condition. If a ground is located here, examine and/or replace the motor, as necessary.
	Short in Power Cube.	☐ Replace Power Cube.
	Short in Field Supply.	☐ Replace Field Supply.
2. Drive motor does not start.	Main circuit disconnect not closed; or fuse blown; or no power applied ahead of disconnect.	☐ Check disconnect switch, fuses in it, and voltage on line.
	Drive interlocks preventing operation. 32 to 33 on TB.	☐ Verify that all user installed interlocks are in a state (physical condition and wiring connections) to allow a start.
	Drive motor thermostat wires not connected on MinPak Plus controller terminals 34 and 132 on TB.	☐ Check connections to thermostat at drive motor P1, P2; at controller 34, 132. ☐ Check for open thermostat inside motor. Make a resistance check of thermostat. (It should read a short, or low resistance, if it is closed.)
	External overload wires not connected on MinPak Plus controller terminals 34 and 33 on TB.	☐ Check connections to external overload. (Blower Motor Starter O/L) ☐ Check for open overload. Make a resistance check to overload. (It should read a short, or low resistance, if it is closed.)
	Drive thermostat wires not connected on MinPak Plus controller terminals 132 to 232.	☐ Check connections to thermostat at drive power bridge heat sink, at controler 132 or 232. ☐ Check for open thermostat. Make a resistance check to the thermostat. (It should read a short, or low resistance, if it is closed.
3. Remote or Local Operator Control Station functions not operating.	Malfunctioning switches.	☐ Check START/STOP switch, but first remove all line power at main disconnect. ☐ Connect ohmmeter to terminal 32 (red) pin on the switch. (Note numbers here refer to numbers noted on Remote Station wiring diagram at Figure 5.8. ☐ Touch probe to wire 35 (brown) pin on the switch. ☐ Place switch in the START (closed) position. ☐ If the switch is properly functioning, a short will be seen on the meter. ☐ Check the STOP function. Place the RUN/JOG switch in the RUN position. Connect the ohmmeter to terminals 32 (red) and 35 (orange). Place the switch in the STOP position, which should open it. If it is functioning correctly, If there is a short, it will be seen on the meter. If there is no short, the circuit is opened, and the switch is functioning correctly. ☐ Using similar techniques, test the RUN/JOG switch. The pins are 35 (orange) and 32 (red). When the switch is in the RUN position, a short should be read.
	Improper wiring connections.	☐ For a Remote Operator Control Station, compare actual wiring with Figure 5.4. A Local Operator Control Station uses 2 cable harnesses, so wiring should not be a problem. However, check the pin connectors on the Regulator Module for proper fitting.

TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE THREE PHASE MINPAK PLUS CONTROLLER (Continued)

	Symptom	Probable Cause	Recommended Procedures
4.	In non-reversing controllers only . . . Controller's M contactor not picking up when START switch is pressed (closed).	Faulty M contactor	☐ Open the power disconnect switch. ☐ Examine M contactor for firm seating. ☐ On the M contactor, connect an ohmmeter on 139 and 39 wires. The reading should be 150 to 1000 ohms. ☐ If these readings cannot be obtained, replace the M contactor. (Refer to Table 6.A.)
		Faulty START/ STOP Switch	☐ Check START/STOP switch, but first remove all line power at main disconnect. ☐ Connect ohmmeter to pin 32 for Local Operators station or terminal 32 on the remote operator adapter. ☐ Place switch in START position. If functioning correctly a short will be indicated on the meter. ☐ Place RUN/JOG in RUN position, connect ohmmeter to terminals or pins 32 & 33 respectively. ☐ Place switch in STOP position, which should open if functioning correctly.
5.	In reversing controllers only . . . Controller's M contactor not picking up when Start switch is pressed (closed).	FORWARD/REVERSE switch malfunction.	☐ Examine Remote or Local Operator or Regulator Module for firm seating and proper wiring and pin connections. ☐ Test FORWARD/REVERSE switch. Use basic technique outlined above for the START/STOP switch.
		M contactor malfunctioning.	☐ On the Auxiliary M pins located on the Regulator Module, connect an ohmmeter. Place it on the pin 39 and pin 67. ☐ Place the FORWARD/REVERSE switch in the FORWARD position. The reading should be approximately 150 to 1000 ohms if it is operating properly. ☐ Without changing test points, place the switch in the REVERSE position. The reading should be about 150 to 1000 ohms if it is operating properly. If a short is observed, remove jumper J9 and repeat the test. ☐ If a 150 to 1000 ohms resistance reading cannot be obtained when the switches are open, the M contactor is malfunctioning and must be replaced.
6.	M contactor picks up but remains in only when START pushbutton is pressed and held in.	RUN/JOG switch is in JOG position.	☐ Place the RUN/JOG switch in the RUN position.
		CR relay not picking up.	☐ Connect a volt ohmmeter on the Remote Operator Adapter if used. Place it on terminal 35 for both remote & local control. ☐ Connect the second probe to connect on 139 connected to the MinPak Plus M contactor. ☐ The reading should be 1.24 VDC for normal operation. ☐ Next, shift the probe from terminal 35 to terminal 36 on the same terminal board. However, leave the second probe where it is. ☐ Press the START switch. The reading should be approximately 24 VDC for normal operation. ☐ 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.
7.	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.	☐ If the controller does not have an optional AUTO/MANUAL switch, inspect the Regulator Module to determine that jumper J4 **is in place.** (This jumper is removed when the AUTO/MANUAL switch is installed.) ☐ Check the SPEED potentiometer on the Control Station. First, open the power disconnect switch. ☐ Connect a volt-ohmmeter to the Regulator Module Remote Operator Adapter inputs, if used. ☐ Connect one lead to terminal 28. Connect the other to terminal 20. (Refer to Figure 3.4 for a Remote Station.) ☐ For proper operation, the reading should be 5K ohms. ☐ Disconnect the VOM lead from terminal 20. Connect it to terminal 426. ☐ Turn the SPEED potentiometer from 10 to 0. The resistance should vary from 5K to 0 ohms. If it does not, replace the potentiometer.

TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE THREE PHASE MINPAK CONTROLLER (Continued)

Symptom	Probable Cause	Recommended Procedures
8. 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.	☐ First check the main power supplies. This must be done with power applied to the MinPak Plus controller. **DANGER** **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.** ☐ Connect one lead of volt-ohm meter to test pin 357 on the Test Meter Adapter Module. ☐ Connect the second lead to test pin 826 on the Module. ☐ The reading should be within the range of +10.8 to +11.5 VDC for normal operation. ☐ Next, remove the lead from pin 356. Place it on pin 456. ☐ The reading should be within the range of +16 to +28 VDC for normal operation. ☐ Next, remove the lead from pin 456. Place it on pin 471. ☐ The reading should be within the range of -16 to -28 VDC for normal operation. ☐ If the proper readings are obtained, the power supplies may be assumed to be operating correctly. ☐ If incorrect reading are obtained, replace the Regulator Module. ☐ Next, check the reference voltage input signal. (This changes in direct proportion to an increase of SPEED potentiometer voltage caused by a turning of the dial.) ☐ Connect one lead of a volt ohmmeter to pin 357 on the Test Meter Adapter Module. ☐ Connect the other lead to pin 826. Readings vary from 0 to +18.2 VDC, depending on the set point of the SPEED potentiometer dial. ☐ 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.) ☐ If the SPEED potentiometer is functioning normally, and if the J4 jumper is placed/removed, as necessary, replace the Regulator Module.
9. Drive motor does not run with M contactor picked up. Potentiometer properly operating.	No output from Power Cubes, 45-47	☐ Examine armature wiring. First, open the power disconnect switch. ☐ Check armature wiring for loose connections. ☐ Turn on power on again. **DANGER** **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.** ☐ Connect a volt ammeter to terminals 47 and 45 on TB. ☐ Place the START/STOP switch in the START position. ☐ Increase the speed reference by turning the SPEED dial in the direction of 10. ☐ The reading across 47 and 45 should be 0 to 240 VDC for 230 VAC controllers. It should be 0 to 500 for 460 VAC controllers. ☐ 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.)
	Regulator module suspected because no output reading at 45-47	☐ Test the regulator module for output to digital driver module (PREF). ☐ Turn power off. Open main disconnect. ☐ Connect a VOM, careful not to short wires together to terminals 280 (PREF) & 57 (DV) on the regulator module. ☐ Restore power to controller. ☐ Place the start/stop switch in start position. ☐ Turn the speed pot to full on position. ☐ Voltage on VOM should be 10 volts. ☐ If this reading cannot be obtained replace regulator module.
	Digital driver module suspected because no output reading at 45-47	☐ Test the digital driver for firing pulses. (Note: Make sure above test on regulator module has been completed first.) ☐ Turn power off. Open main disconnect. ☐ 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.) ☐ Connect scope common to Pin 57 on regulator module. ☐ Connect scope probe to resistor on primary side of pulse transformer located at 7A on Digital Driver Board. (Refer to Figure 5.4.) ☐ Restore power to controller. ☐ Place the start/stop switch in start position. ☐ Turn SPEED POT to full on position. ☐ A firing pulse waveform (+11.3V) 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. (11A, 10A, 11A, 13A, 9A). ☐ If these readings cannot be obtained, replace digital drive module.

TABLE 5.A – TROUBLESHOOTING SUGGESTIONS FOR THE THREE PHASE MINPAK CONTROLLER (Continued)

Symptom	Probable Cause	Recommended Procedures
9. Drive motor does not run with M contactor picked up. Potentiometer smoothly operating.	Power cubes suspected because no output reading at 45-47	☐ Establish that power cube is receiving pulse inputs from digital drive module. (Refer to above previous test.) ☐ If power cubes are receiving pulses, yet no reading across 45-47, determine that the contacts on M are closing. ☐ Replace drive motor wiring with light bulbs (2 light bulbs for 240 volt, 4 light bulbs for 500 volt armatures' series connection.) ☐ Run drive and look at waveform across light bulbs. (Should be six pulses/16.7 MSEC) If pulse is missing indicates bad power cube. ☐ Check individual power cubes. ☐ Connect scope across 45 & 47 on terminal strip lock to see if SCR is switching if not replace power cube. ☐ Repeat for 51 & 45, 52 & 47, 52 & 45, 52 & 47 & 53 & 45 if necessary.
10. Remote Operator Control Station functions not operating.	Malfunctioning switches.	☐ Check START/STOP switch, but first remove a-c line power at main disconnect. ☐ Connect ohmmeter to terminal 32 on the Remote Operator Adapter. ☐ Touch probe to terminal 38 on the Remote Operator Adapter. ☐ Place switch in the START (closed) position. ☐ If the switch is properly functioning, a short will be seen on the meter. ☐ Check the STOP function. Place the RUN/JOG switch in the RUN position. Connect the ohmmeter to terminals 32 and 35. Place the switch in the STOP position, which should open it if it is functioning correctly. If there is a short, it will be seen on the meter. If there is no short, the circuit is opened, and the switch is functioning correctly. ☐ Using similar techniques, test the RUN/JOG switch in the RUN position, a. terminals 32 and 35. When the switch is in the RUN position, a short should be read.

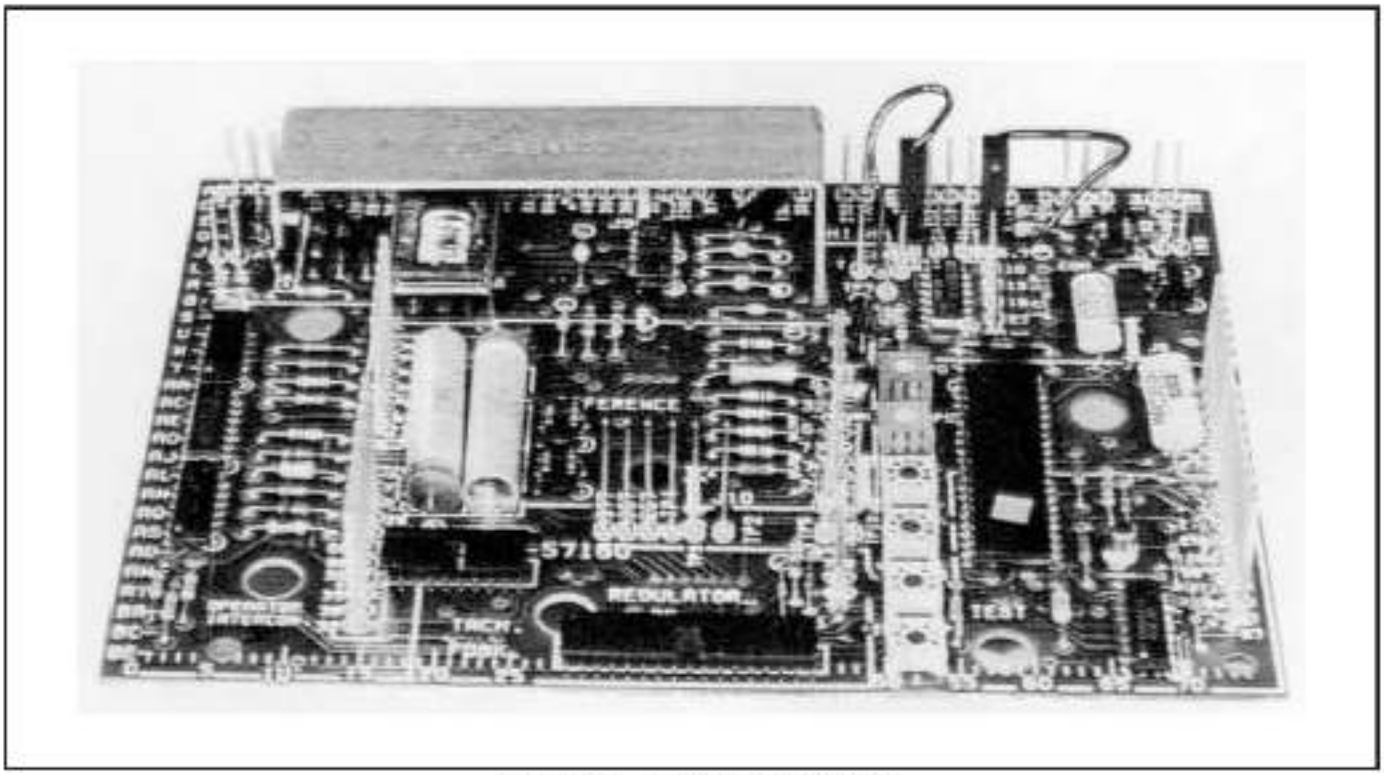

Figure 5.3 – Regulator Module

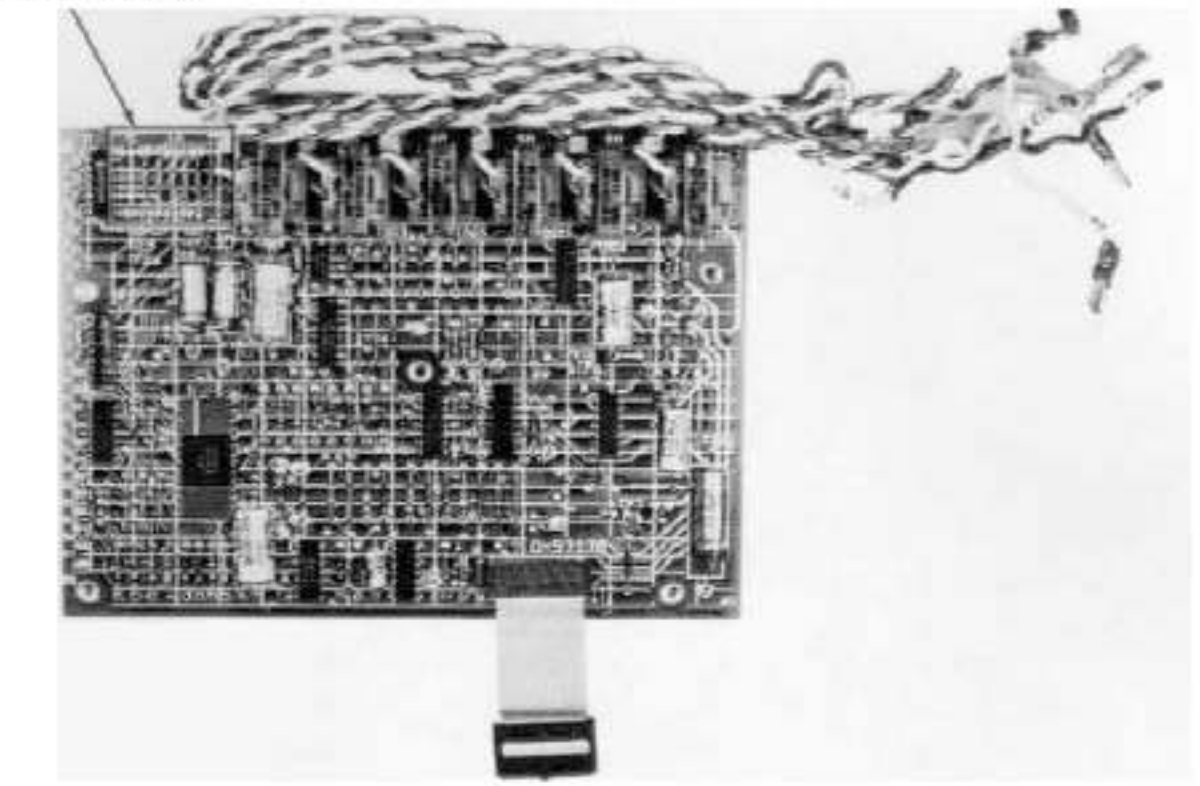

Figure 5.4 – Digital Driver Module

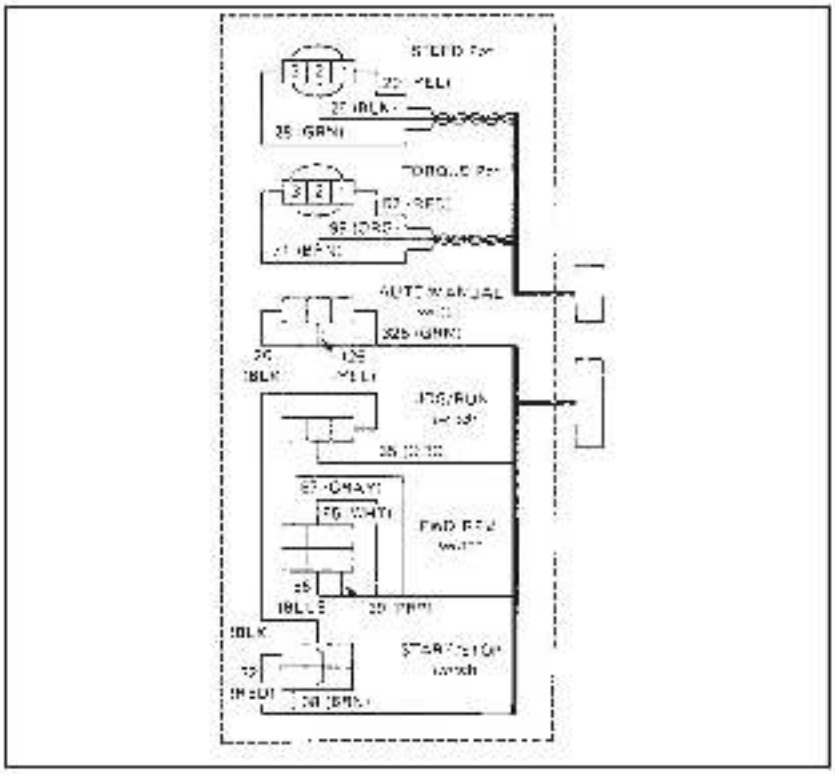

Figure 5.5 – Local Station Connection Diagram

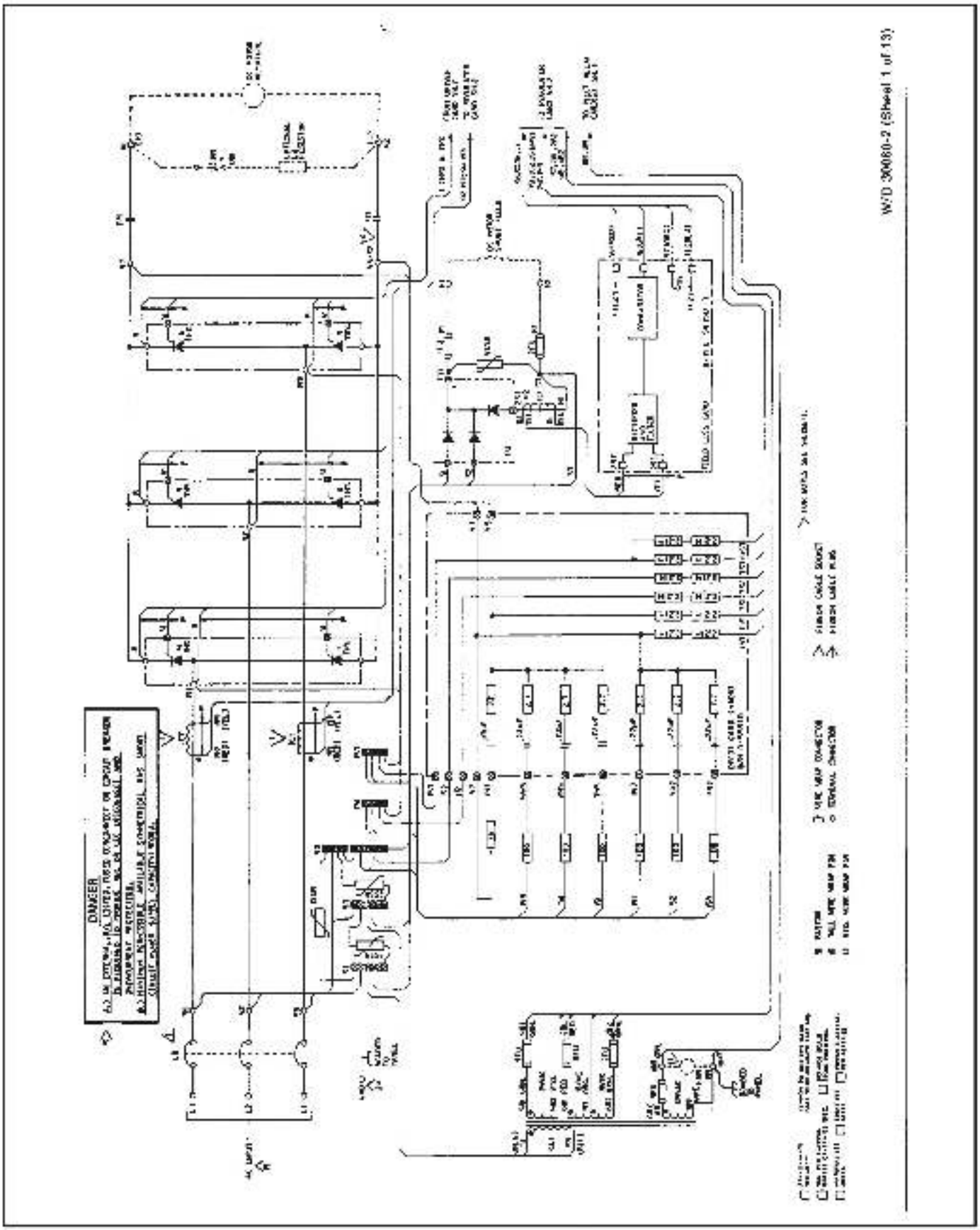

Figure 5.6 – 230 VAC Controller Power Bridge Schematic

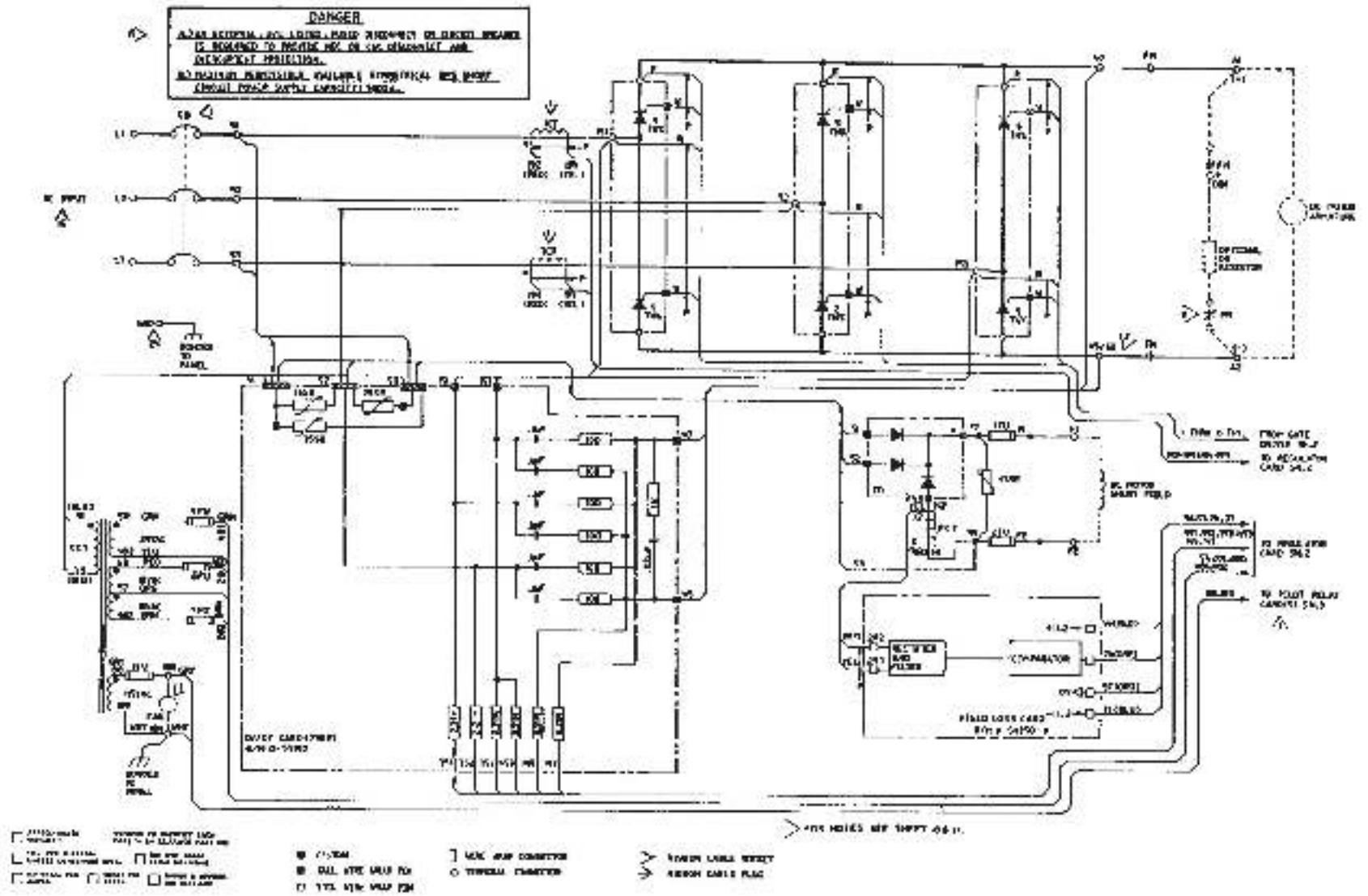

Figure 5.7 – 460 VAC Controller Power Bridge Schematic

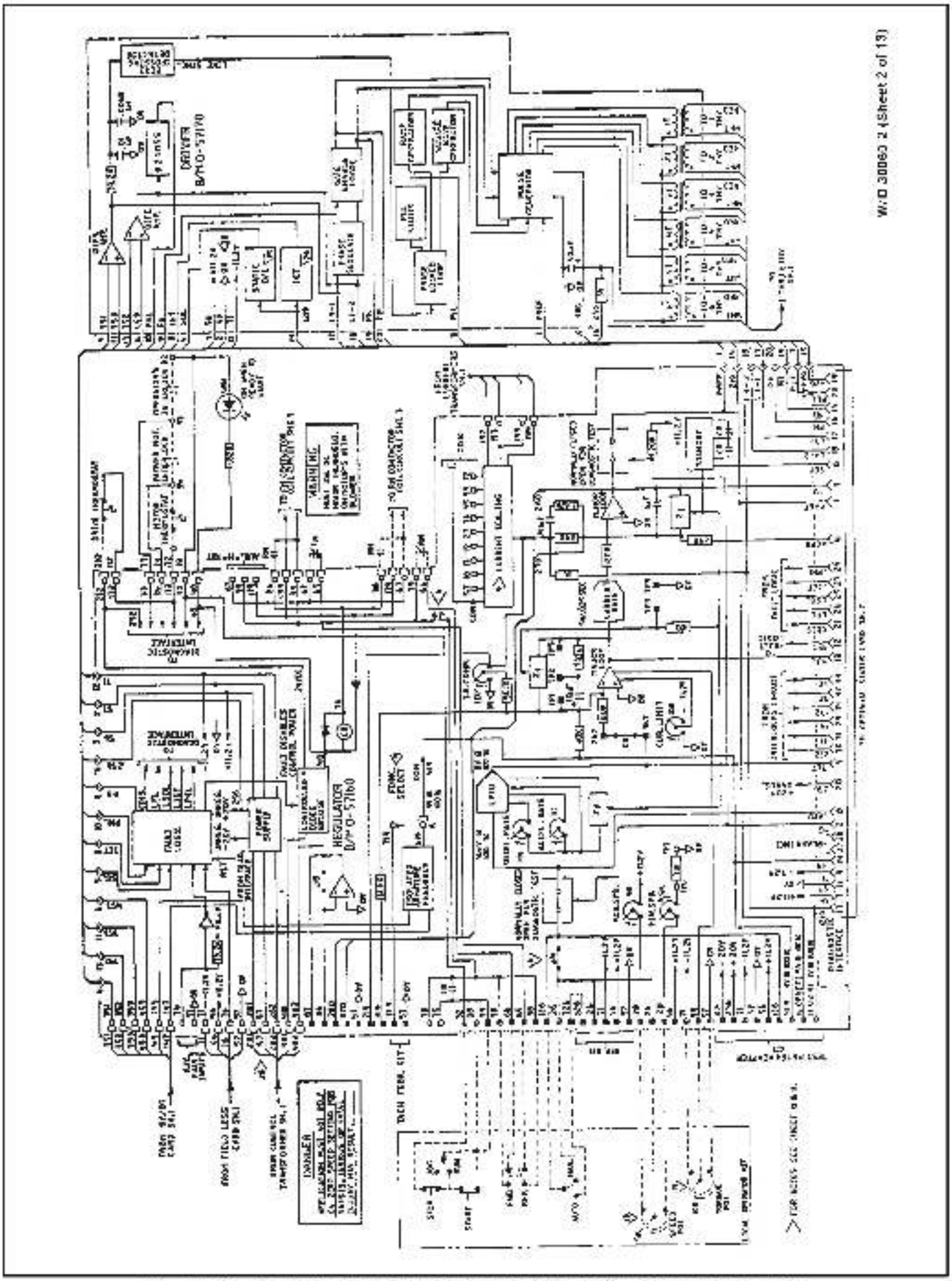

Figure 5.8 – Controller Regulator Module & Digital Driver Module Schematics

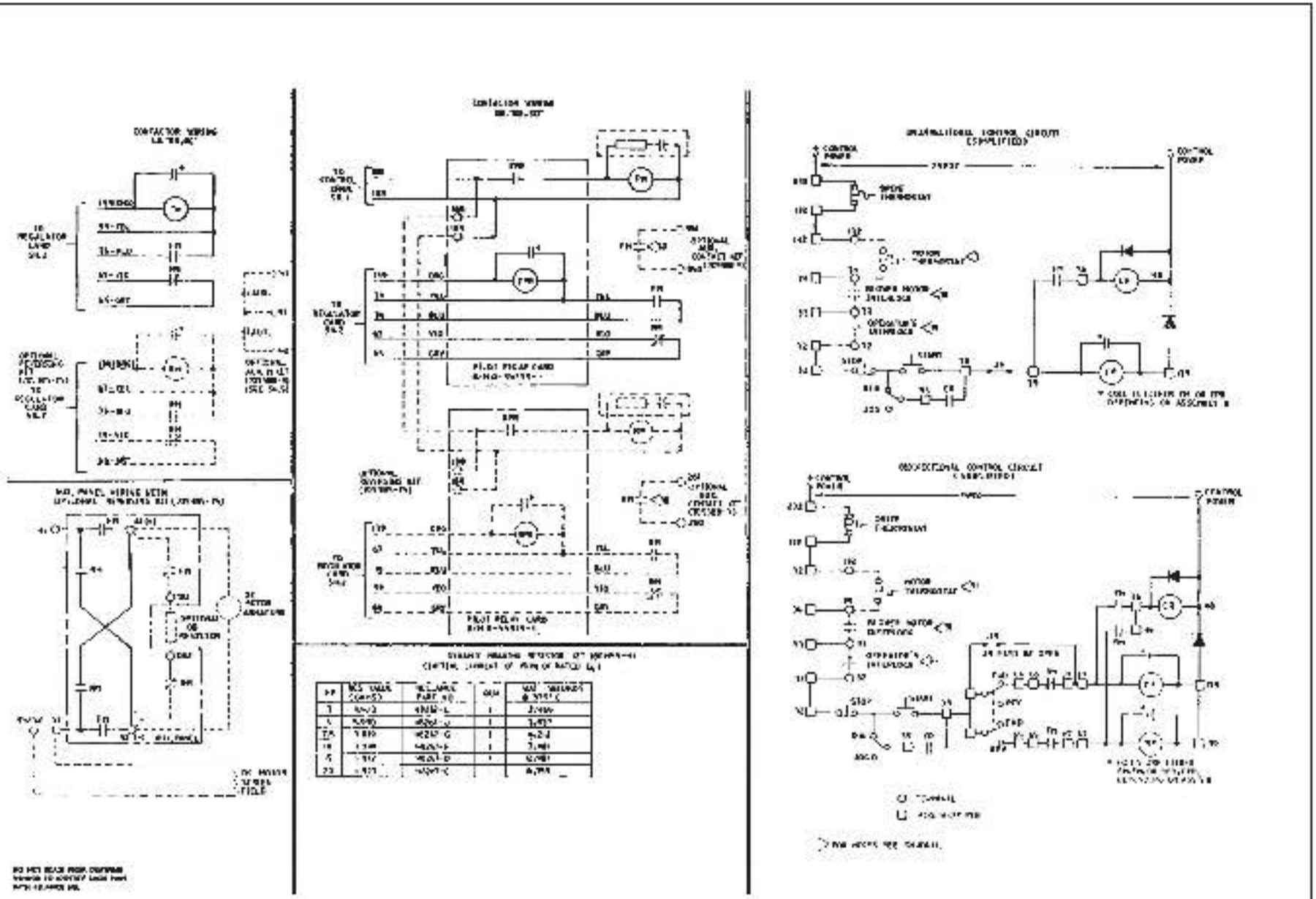

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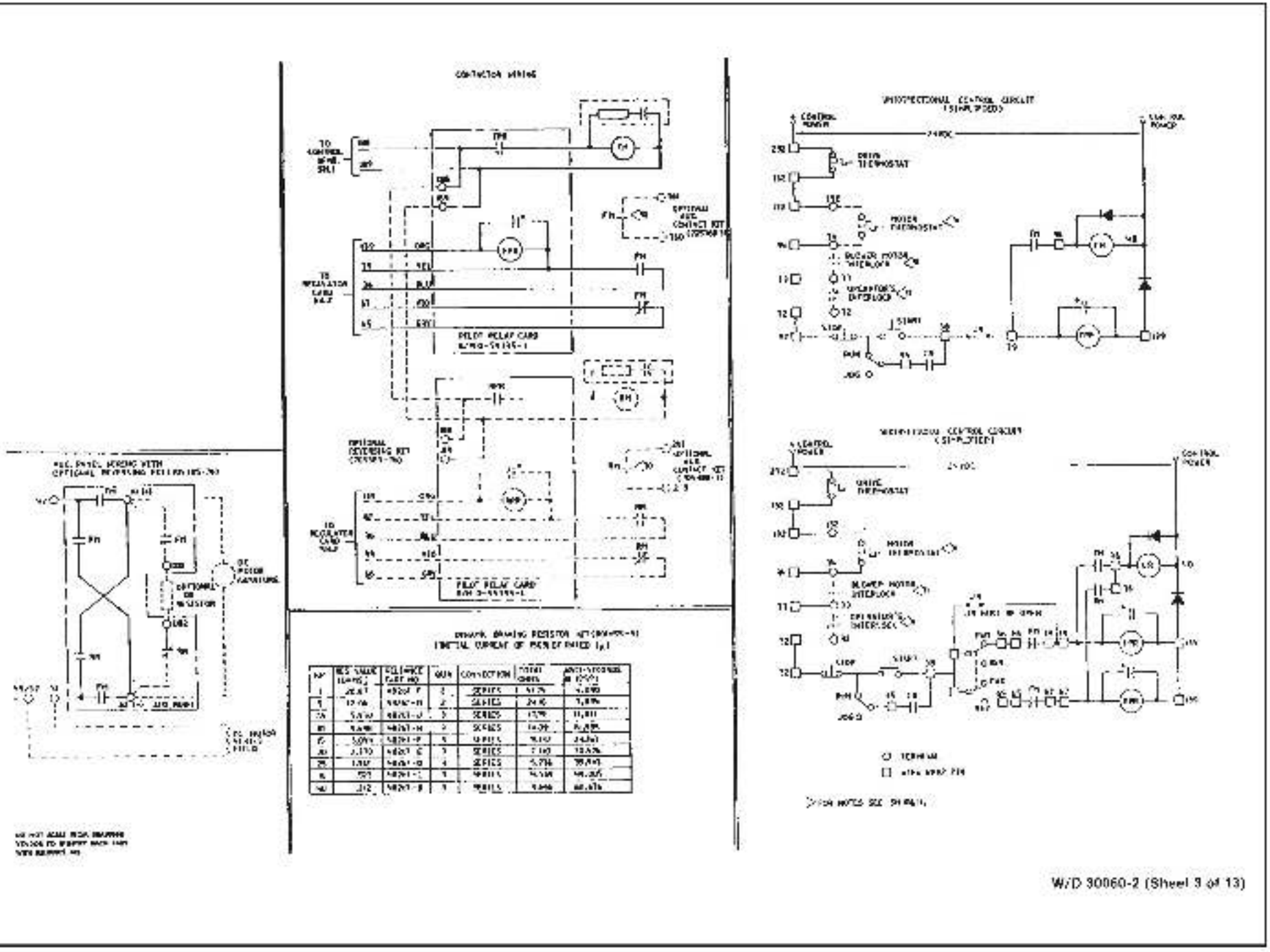
Figure 5.9 – 230 VAC Auxiliary Panel Assembly Schematics



W/D 30060-2 (Sheet 3 of 13)

Figure 5.10 – 460 VAC Auxiliary Panel Assembly Schematics

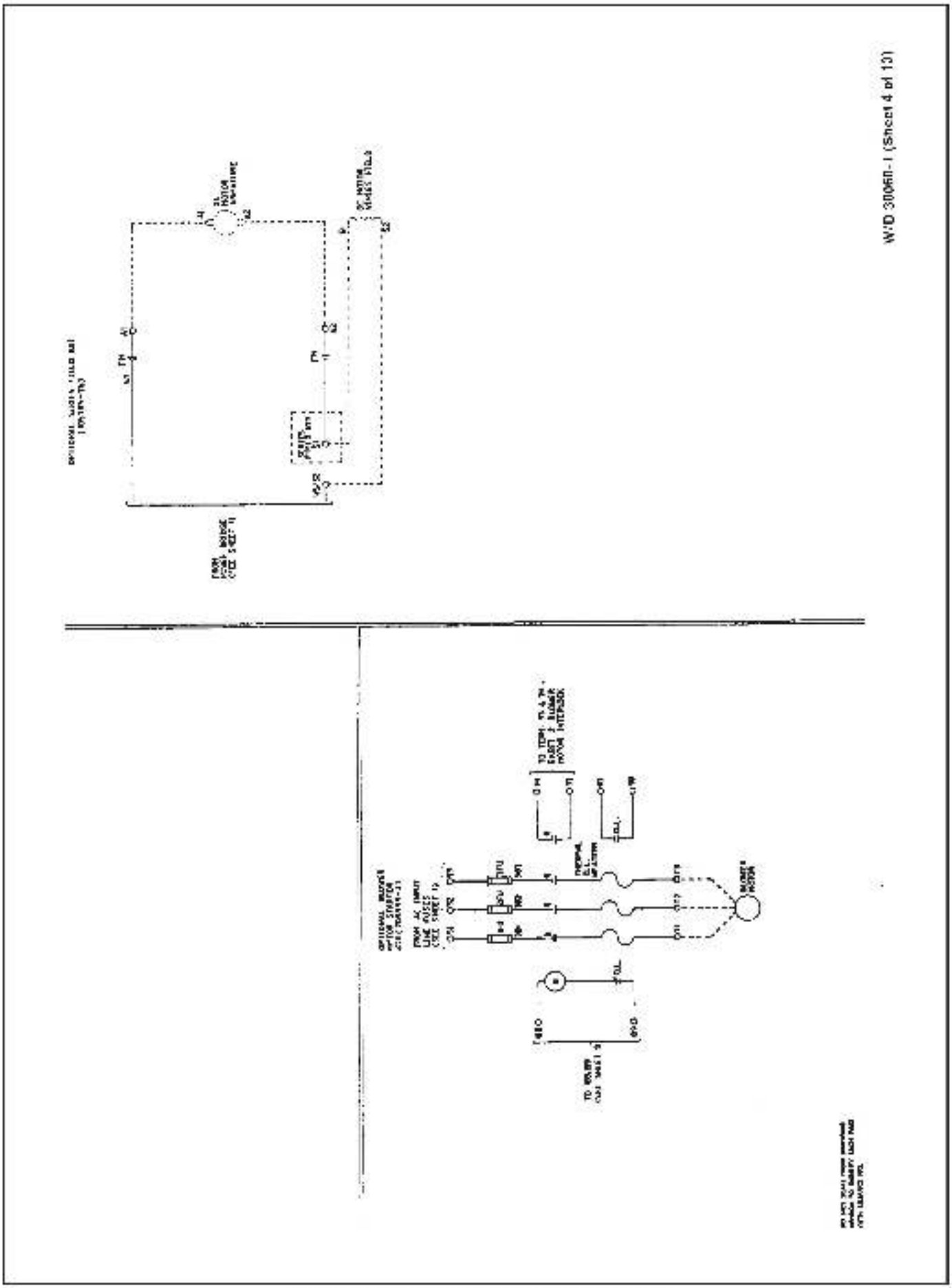


Figure 5.11A – Modification Kit Schematics

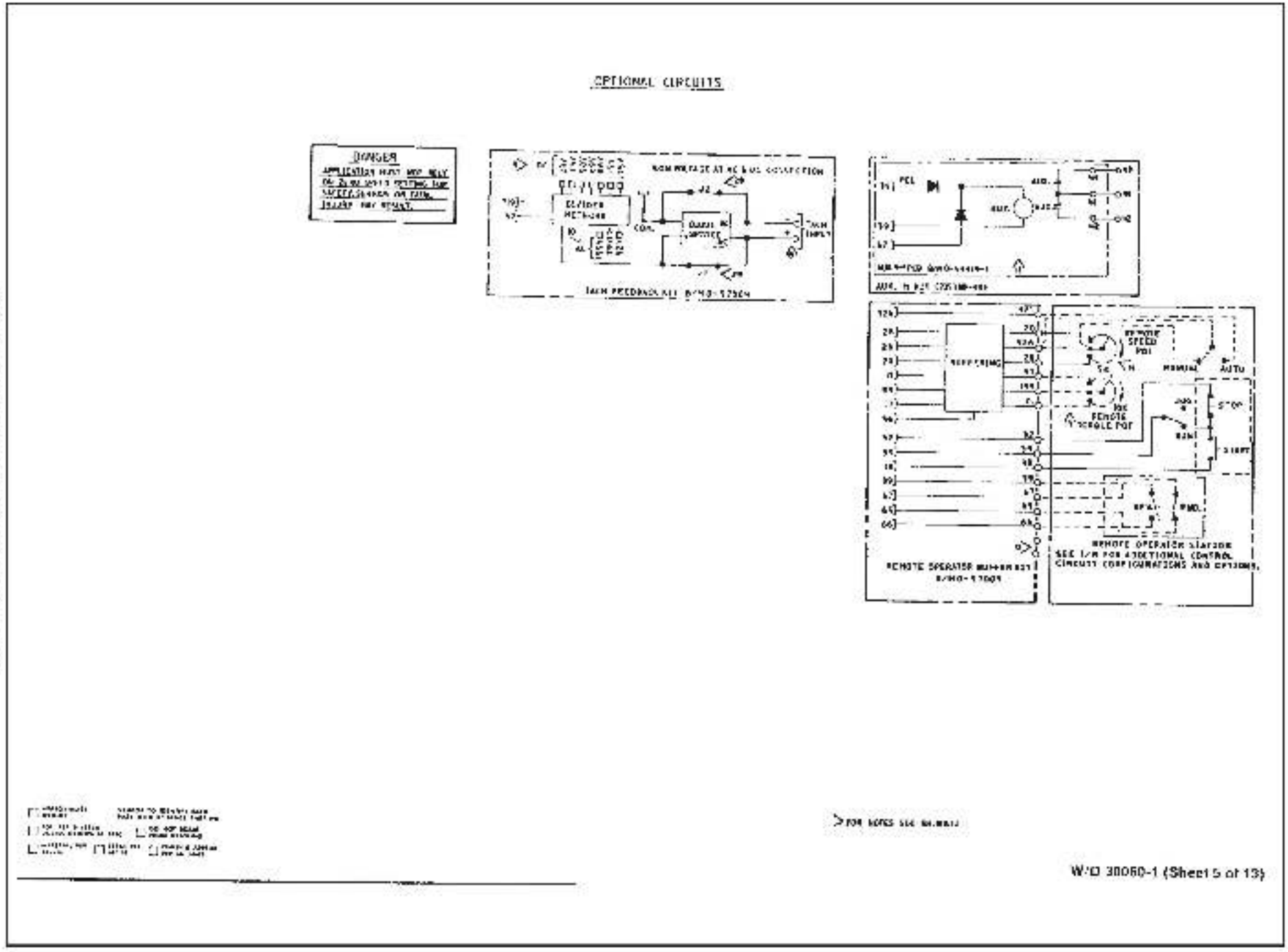


Figure 5.11B – Modification Kit Schematics

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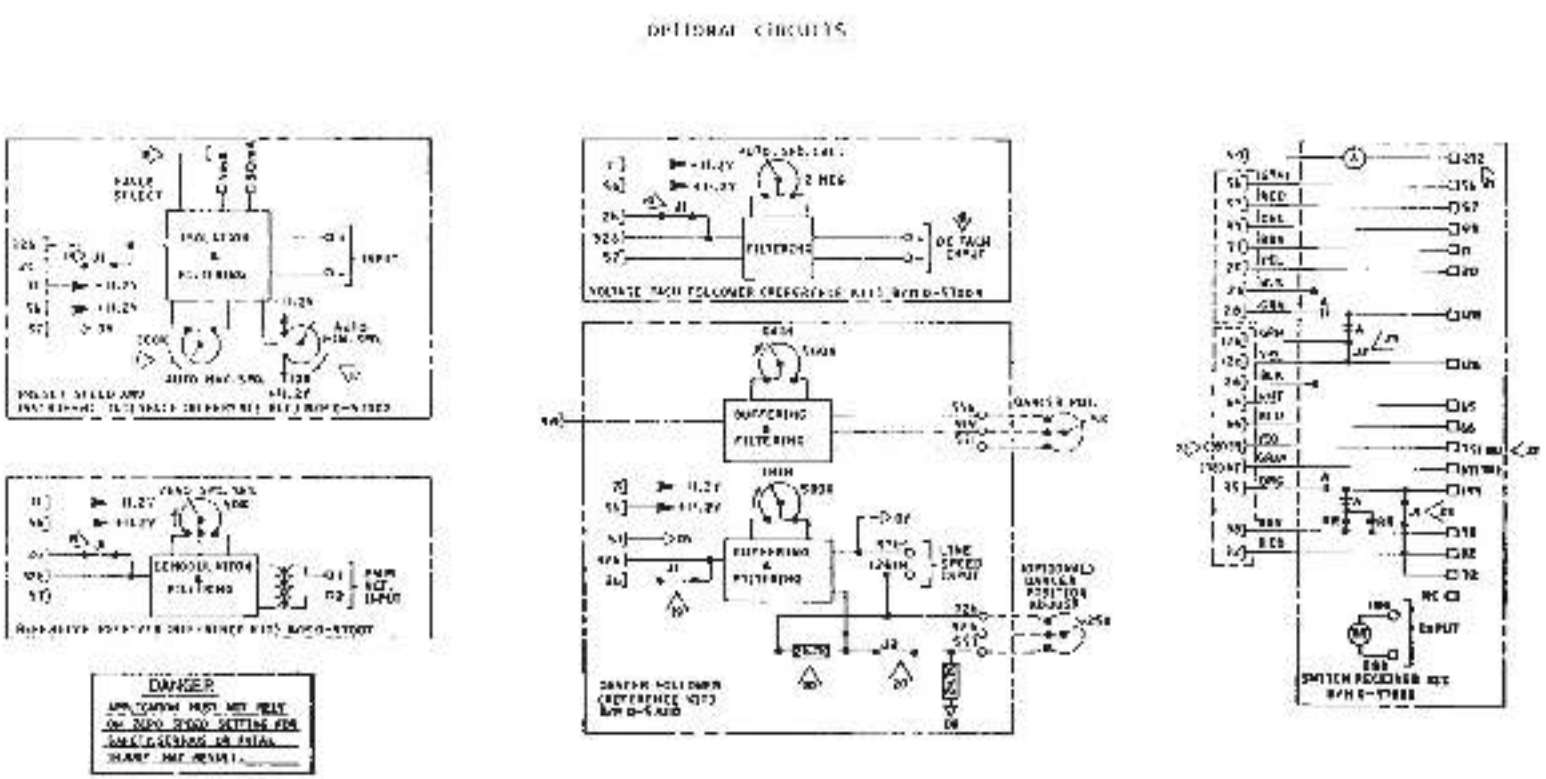
Figure 5.11.C – Modification Kit Schematics



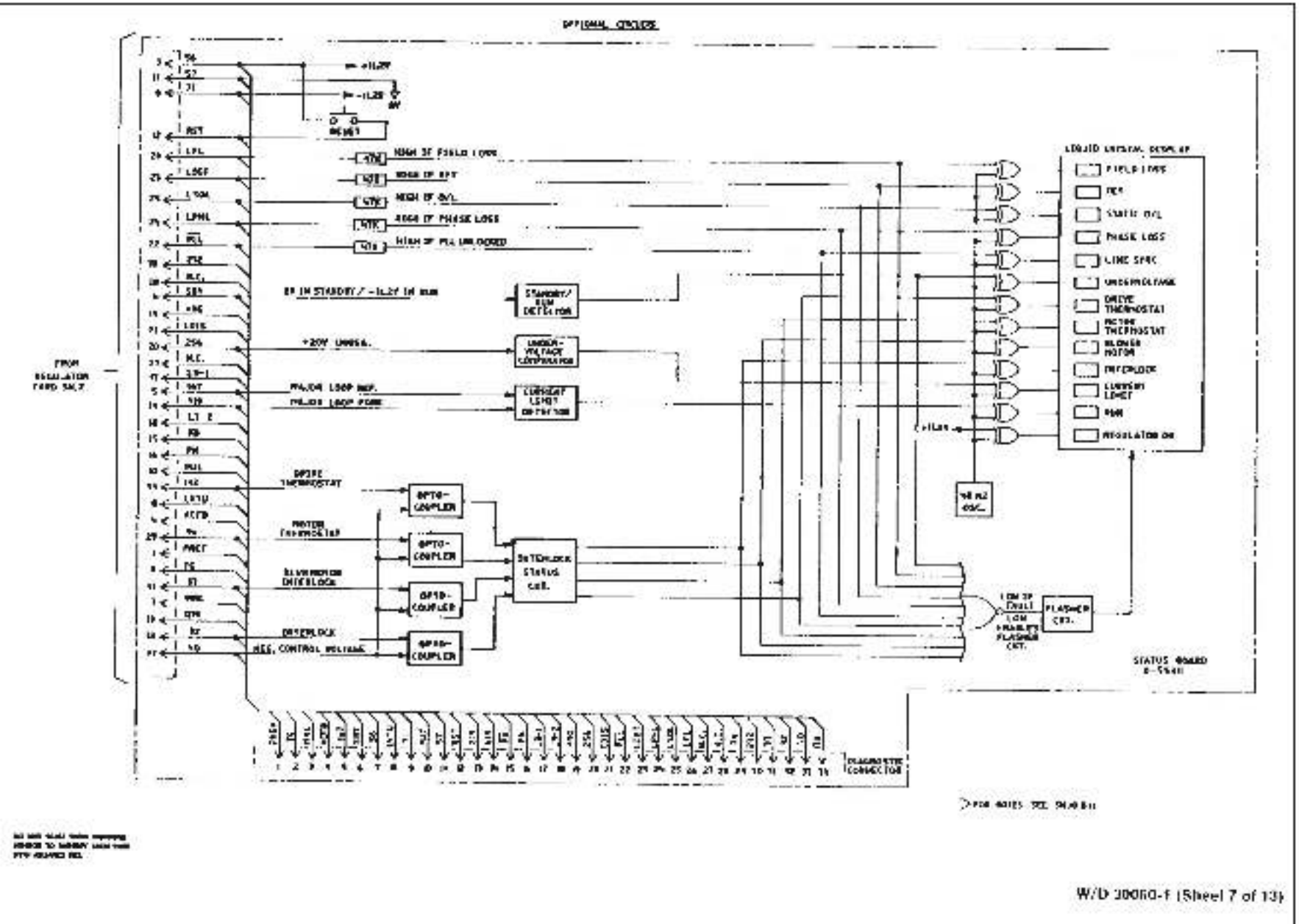


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Figure 5.12 – Status/Diagnostic Indicator Kit Schematic

Figure 5.13A – Technical Data 230 VAC Three Phase MinPak Plus

Version	Model No.	Rating No.	HP	AC Input Volts	AC Input Amps	DC Output Armature Volts	Armature Amps	Field Volts	Field Amps	Control Transformer Kit	Current Transformer Kit	Field Loss [illegible]	Fuses: [illegible] Control	Fuses: Contactor Control	Fuses: [illegible]	Replacement Parts Table: [illegible] PC Card	Driver PC Card	Field Loss PC Card	[illegible] Card	Suppressor Assy. [illegible]	Suppressor Assy. [illegible]	[illegible]	Power Cubes	[illegible]	Fan	Fan Assy.
Basic	[illegible]	[illegible]	7.5	230	28	240	29	150	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Basic	[illegible]	[illegible]	10	230	35	240	38	150	5		[illegible]														[illegible]	
Basic	[illegible]	[illegible]	20	230	60	240	72	150	5	[illegible]	[illegible]															
[illegible]	3B	3B	7.5	230	28	240	29	150	5	[illegible]	[illegible]														[illegible]	
[illegible]	4C	4C	10	230	35	240	38	150	5		[illegible]														[illegible]	
[illegible]	5D	5D	20	230	60	240	72	150	5	[illegible]	[illegible]															

Version	Model No.	Rating No.	Replacement Parts Table: Contactor	Aux. Contact	Contactor Suppressor Assy.	Contactor [illegible] Assy.	Pilot Relay PC Card	Circuit Breaker
Basic	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]
Basic	[illegible]	[illegible]						
Basic	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	———	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	———	———	[illegible]	———	[illegible]
[illegible]	[illegible]	[illegible]						
[illegible]	5D	5D	[illegible]	[illegible]	[illegible]	———	[illegible]	[illegible]

[illegible]

[illegible]

W/D 30060-1 (Sheet 8 of 13)

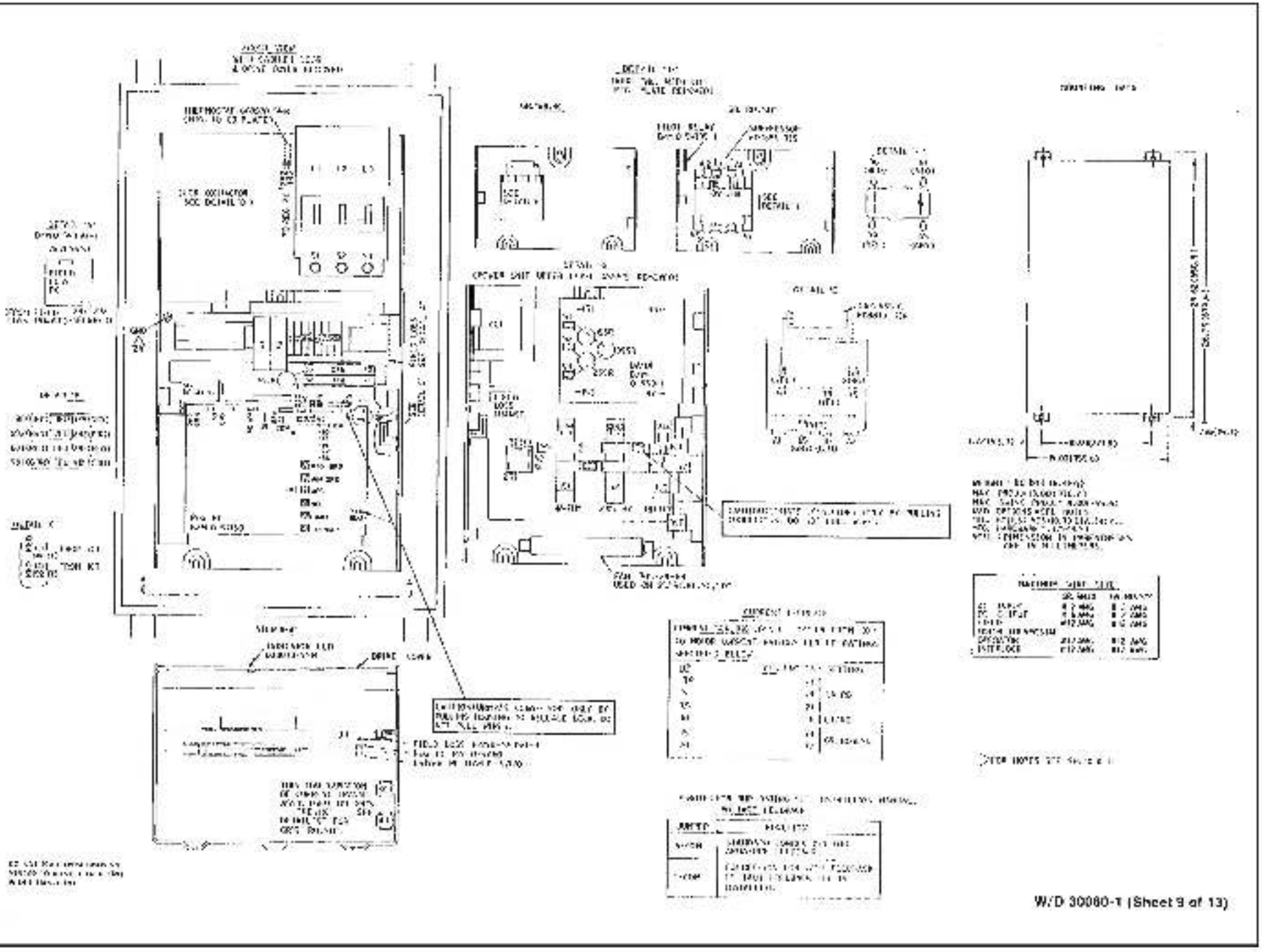

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Figure 5.13B – Technical Data 230 VAC Three Phase MinPak Plus

			PANEL RATING INFORMATION							
[illegible]	[illegible]	[illegible]	[illegible]	AC INPUT		DC OUTPUT				
						ARMATURE		FIELD		
				VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	

REPLACEMENT PARTS TABLE																		
CONTROL TRANSFORMER	CURRENT TRANSFORMER	[illegible]	FUSES			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	FIELD [illegible]	[illegible]	[illegible]	FAN	LCD ASSY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	OPTIONAL [illegible]	[illegible]
	[illegible]																[illegible]	
	[illegible]																OPTIONAL [illegible]	
	[illegible]																[illegible]	

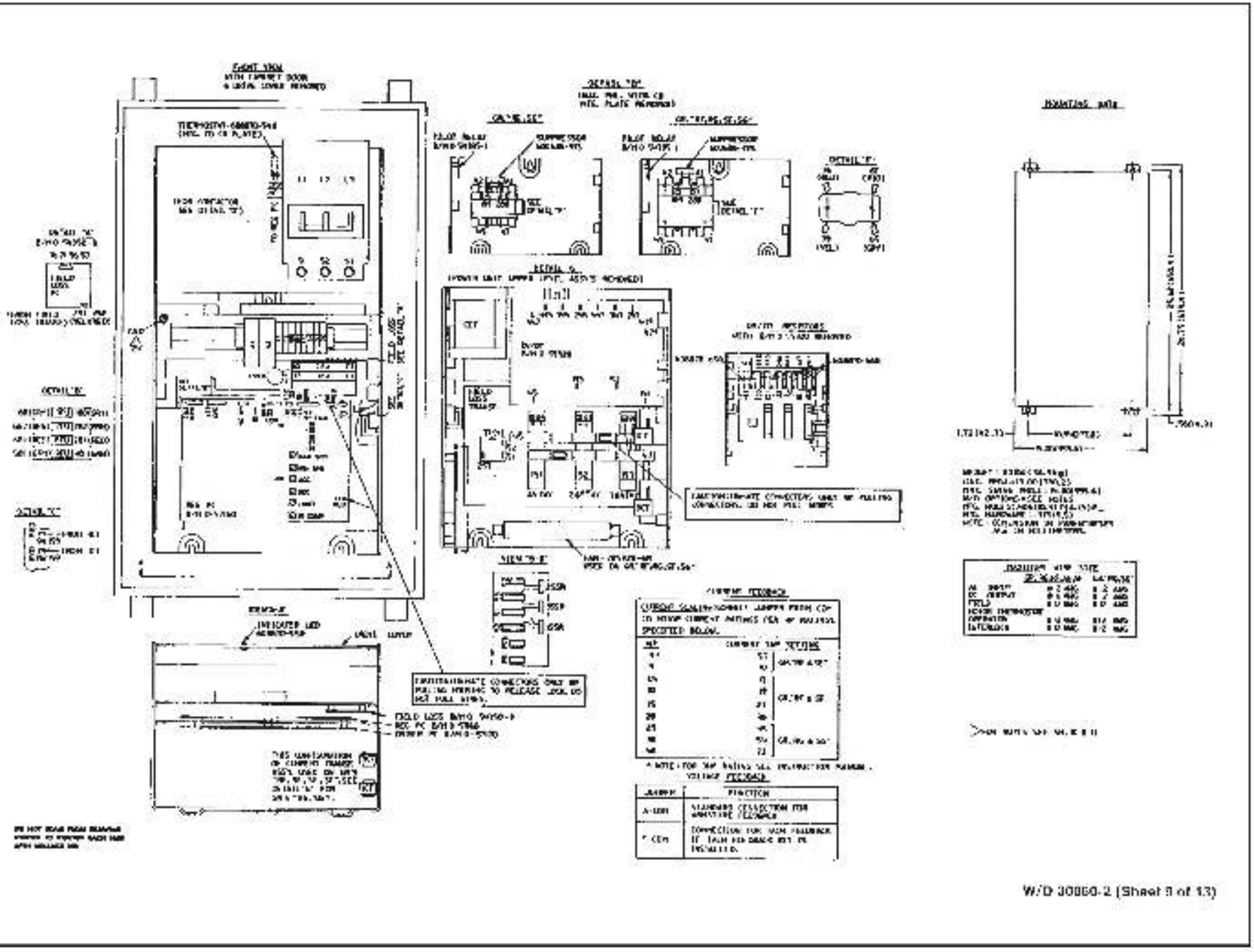
			REPLACEMENT PARTS TABLE				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CONTACTOR [illegible]	[illegible]	CIRCUIT BREAKER
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]					[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
	[illegible]	[illegible]	[illegible]				
	[illegible]	[illegible]					[illegible]

FOR NOTES SEE TABLE [illegible]

[illegible]

W/D 30050-2 (Sheet 8 of 13)

Figure 5.14A – Technical Data 460 VAC Three Phase MinPak Plus



W/D 30060-2 (Sheet 9 of 13)

Figure 5.14B – Technical Data 460 VAC Three Phase MinPak Plus

NOTE SHEET

1. Function of panel rating, see Sh. 8.
2. If motor has series field, wire between A5/S2 and FH contact is removed, and series field is included.
3. This contact is present only on Assy. No. 802120-1R3 & -1R5.
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 circuits wiring. (See note 14 for insulation temp. rating.)
9. For DC tach, jumper is connected in this location.

100% Voltage	Tach	Motor (RPM)
23V	20V/1000 RPM	1150
35V	20V/1000 RPM	1750
50V	50V/1000 RPM	1150
69V	70V/1000 RPM	1725
88V	50V/1000 RPM	1750
115V	100V/1000 RPM	1150
175V	50V/1000 RPM	3450
175V	100V/1000 RPM	1750

10. For AC tach, jumper is connected in this location.

100% Voltage	Tach	Motor (RPM)
52V	45VAC/1000 RPM	1150
75V	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 4/M for detail's.
14. Recommended insulation temp. rating: 75°C.

W/O 30060-2 (Sheet 10 of 13)

Figure 5.15B – Technical Notes

DANGER

15> A.) AN EXTERNAL, U/L LISTED, FUSED DISCONNECT OR CIRCUIT BREAKER IS REQUIRED TO PROVIDE MEANS OF SEC 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 on 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. It is recommended that power cubes be replaced as a complete set.

17> Set Auto Min. Speed with input at 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 J21 when optional Dancer Position Adjust Pot. is installed.

21> Not associated with J32 Drive Thermostat circuit or SP. 1. J32 is open in auto mode ("A" not energized).

22> Numbers parenthesized are shown when different from original identification marking on kit.

23> Cut jumpers J21 & J22 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%.

DANGER

28> DRIVES ARE SUPPLIED WITH S7 (INT FLOAT NO. DEPENDING ON THE APPLICATION, S7 MAY BE LEFT FLOATING, OR TIED TO EARTH GROUND. IF LEFT FLOATING, THE REGULATOR CIRCUITS MAY RISE TO THE LINE POTENTIAL. THE ACTUAL POTENTIAL TO BECOME IS A FUNCTION OF THE INPUT TRANSFORMER CONFIGURATION. THE AVAILABLE LEAKAGE CURRENT DUE TO THIS POTENTIAL IS LIMITED BY RFI/C IMPEDANCE RESISTORS. A DANGER EXISTS IF SEVERAL DRIVES IN A SYSTEM HAVE S7 TIED TOGETHER, AND AT THE SAME TIME, S7 IS UNGROUNDED. AT THIS CONDITION, THE AVAILABLE LEAKAGE CURRENT INCREASES. THEREFORE TO LIMIT LEAKAGE TO A SAFE VALUE, NO MORE THAN 20 DRIVES SHOULD HAVE THEIR (#1 S7) LINES TIED TOGETHER IF S7 IS LEFT FLOAT NO.

29> If using an AC Tach, remove J1 & J3.

30> Contact rating: 125 VAC, 3 Amps.

31> Contact must be capable of breaking a 0.5 Amp, inductive load.

Figure 5.15B – 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 J51 ON THE REGULATOR CARD IS CONNECTED TO PIN "W" (ARMATURE FDBK) AT J52 SEE W/D SHEET 2 OR I/M.

2. IF DRIVE IS TO BE A SPEED REGULATOR, CHECK THAT JUMPER AT J51 ON THE REGULATOR CARD IS CONNECTED TO PIN "T" (TACH FDBK) AT J49. BE SURE TACHOMETER IS CONNECTED TO TACHOMETER FEEDBACK BIT AND SCALED PROPERLY. SEE TABLES IN NOTES 9 OR 10 FOR TACH SCALING. SEE I/M.

3. CHECK THAT THE CURRENT FEEDBACK JUMPER AT H51 ON THE REGULATOR CARD IS SET TO THE PROPER TAP. REFER TO TABLE ON SH. 5 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%. DO NOT ADJUST.
(2) IR COMP. POT FULLY CCW (P1)
(3) MAX. SPEED POT FULLY CCW (P1)
(4) MIN. SPEED POT FULLY CCW (P1)
(5) ACCEL. POT FULLY CCW (P1)
(6) DECEL. POT FULLY CCW (P1)

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 6.

2. CHECK THAT FIELD VOLTAGE IS PRESENT AT MOTOR TERMINALS (F1, F2).

3. TURN THE SPEED OR VOLTAGE REFERENCE INITIALLY TO "0".

DANGER

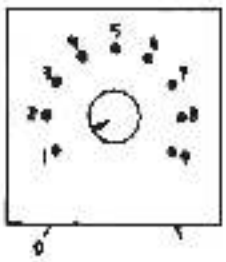
DURING THE INITIAL START-UP AND ADJUSTMENTS, BE PREPARED TO STOP DRIVE IN CASE INCORRECT SET-UP IN FIELD OR TACHOMETER SHOULD CAUSE UNCONTROLLED ACCELERATION OF THE MOTOR. IF THE DRIVE IS NOT SHUT DOWN IMMEDIATELY UNDER SUCH CIRCUMSTANCES, PERSONAL INJURY AND/OR MACHINE DAMAGE MAY RESULT.

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 X-Y PEN INTO CDR BEFORE IT FROM THE DRIVE WITHOUT FIRST TURNING CIRCUIT BREAKER TO "OFF" POSITION. DO NOT USE AN OHMETER 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

Figure 5.15C – 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 OR 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 10 TO 100% REFERENCE)/5.5 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)/0.5 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 DIAGNOSTICS 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 ± 10% OF STATED VALUE DEPENDING ON METER ACCURACY AND ACTUAL VALUE OF AC SUPPLY VOLTAGES. SEE I/M FOR DETAILS.

Figure 5.15D – Technical Notes

SECTION 6
REPLACEMENT PARTS

6.1 General – Users should consider maintaining a stock of spare parts. Table 6.A lists the more common parts along with part numbers and quantities actually used in the controller.

Table 6.A – Replacement Modules

Part Description	Quantity Per Controller	Model Number	Part Number
Regulator Module	1	14C650	0-57160
Digital Driver Module	1	14C651	0-57170
Field Loss PC	1	14C652	0-54340-3
Current Transformer (1CT, 3CT)			
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
Field Current Transformer	1	14C655	64670-24R
Power Cubes			
3 – 20 HP 230 VAC	3	14C656	70[illegible]8[illegible]9-[illegible]9AC
3 – 40 HP 460 VAC	3	14C657	70[illegible]8[illegible]9-[illegible]9AW
M Contactor (Optional)			
3 – 10 HP 230 VAC	1	14C658	41[illegible]029-[illegible]1R
15 – 20 HP 230 VAC	1	14C658	7809[illegible]-50R
3 – 40 HP 460 VAC	1	14C659	7809[illegible]-50R
Pilot Relay PC Card			
10HP – 20 HP 230 VAC	1	14C668	0-54335-[illegible]
3 – 40 HP 460 VAC	1	14C668	0-54335-[illegible]
MOV Surge Suppressor			
3 – 20 HP 230 VAC	3	14C660	41[illegible]026-6R
3 – 40 HP 460 VAC	3	14C661	41[illegible]026-9R
DV/DT PC Card			
3 – 20 HP 230 VAC	1	14C662	0-55310
3 – 40 HP 460 VAC	1	14C663	0-55320
DV/DT Resistor Assembly			
3 – 40 HP 460 VAC	1	14C664	78089-6R
Incoming Line Circuit Breaker			
3 – 10 HP 230 VAC	1	14C610	419308-D
15 – 20 HP 460 VAC	1	14C612	419308-A
3 – 20 HP 230 VAC	1	14C611	419308-C
25 – 40 HP 460 VAC	1	14C612	419308-A
115 VAC Control Fuse, 3FU	1	14C670	64676-23C

Table 6.A – Replacement Modules

Part Description	Quantity Per Controller	Model Number	Part Number
Low Voltage Control Fuses			
7FU, 8FU, 9FU	3	14C671	64676-23V
Control Transformer			
3 – 10 HP 230 VAC	1	14C665	41*027-70S
15 – 20 HP 230 VAC	1	14C666	41*027-68S
3 – 40 HP 460 VAC	1	14C667	41*027-69V
Remote Operator PC Card (Optional)	1	14C220	0-57005
Field Supply	1	14C672	608868-25R
MOV Surge Suppressor Field Supply			
3 – 20 HP 230 VAC	1	14C673	41*026-9R
3 to 40 HP 460 VAC	1	14C674	41*026-9S
Fan			
15 - 20 HP 230 VAC	1	14C669	705328-6R
20 - 40 HP 460 VAC	1	14C669	705328-6R
Field Supply Fuses			
1FU, 2FU	2	14C675	64676-30F

SECTION 7
THREE PHASE MINPAK 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, MinPak 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 MINPAK 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.)

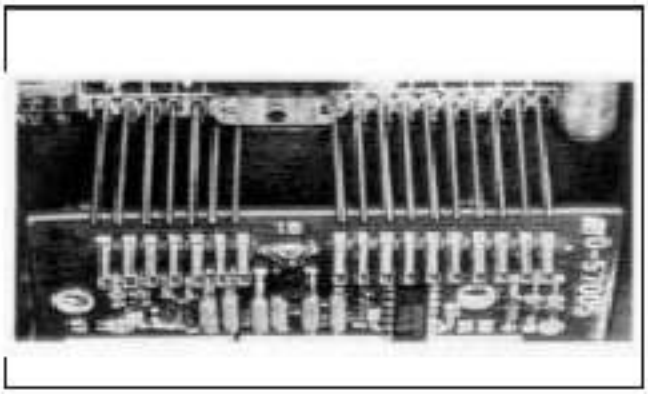


Figure 7.1 – Pin Alignment

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 ?(1)	Additional Options Required ?	Options Required	Additional User–Supplied Parts?
Local Operator Station Faceplate	D-3977	14C201 thru 14C208	No	No	None	No
Dynamic Braking	D-3957	14C420 thru 14C434	Yes	No	Auxiliary Panel w/DB Pole on Contactor Standard	Wire

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

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

Kit	Instruction Manual Number	Model No.	Controller Modification ?(1)	Additional Options Required ?	Options Required	Additional User–Supplied Parts?
Reversing Contactor	D-3858	14C400 14C401 14C402	Yes	Yes	• Fwd/Rev Selector Switch on OP Station.	No
Auxiliary M Contact	D-3860	14C480 thru 14C484	No	No	None	Wire
Blower Motor Starter	D-3861	14C510 14C520	Yes	No	None	Wire
Fan Kit	D-3862	14C560	Yes	No	None	None
Status/ Diagnostic Indicator	D-3863	14C571	Yes	No	None	None
Series Field Kit	D-3865	14C620 14C621 14C622	Yes	No	None	Wire
Dancer Follower	D-3866	14C230	Yes	Yes	Dancer Potentiometer	Wire
Instrument Interface/ Preset Speed	D-3867	14C222	Yes	No/Yes No/Yes	• If Preset Speed only, may need Auto/Manual Switch. • If follows process controller, may need Auto/ Manual Switch.	No Wire
Master Isolated Reference Receiver	D-3868	14C229	Yes	Yes	Master Isolated Reference Transmitter	Wire
Tachometer Feedback	D-3869	14C221	Yes	No	None	Wire
Test Meter Adapter	D-3870	14C225	No	No	None	No
Voltage/ Tachometer Follower	D-3871	14C223	Yes	No/Yes	May need Auto/ Manual Selector Switch	Wire
Remote Operator Adapter Kit	D-3879	14C220	Yes	Yes	Standard Blank Face Plate or Optional 14C200	Wire

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

Table 7.B – Wire Specifications

Use in Controller	Type Conductor	Required Characteristics	Acceptable Types
CONTROL WIRES			
Remote Operator Control Station: • AUTO/MANUAL • JOG/RUN • FORWARD/REVERSE • START/STOP	• Single conductor and/or multi-conductor	• Stranded copper • AWG No. 18 • 600 VAC rating • Insulation: polyvinyl chloride (PVC) • Temperature range: 40°–105°C (104°–221°F) • Unshielded	• Any single conductor meeting N.E.C. required characteristics
SIGNAL WIRES			
Remote Operator Control Station: • SPEED pot • TORQUE pot • Tachometer feedback • Instrument Interface • Voltage/Tachometer Follower	• Three conductor • Twisted with two twists per inch • Two-conductor • Twisted pair with two twists per inch	• Stranded copper (19 x 29) • AWG No. 18 • 600 VAC rating • Twist per foot: 24 (1/2-inch lay) • Insulation: polyvinyl chloride (PVC) • Temperature range: 40°–105°C (104°–221°F)	• User may twist single conductors of required specifications • Reliance Part No. 417900-79X • User may twist single conductors of required specifications. • Reliance Part No. 417900-76EAD

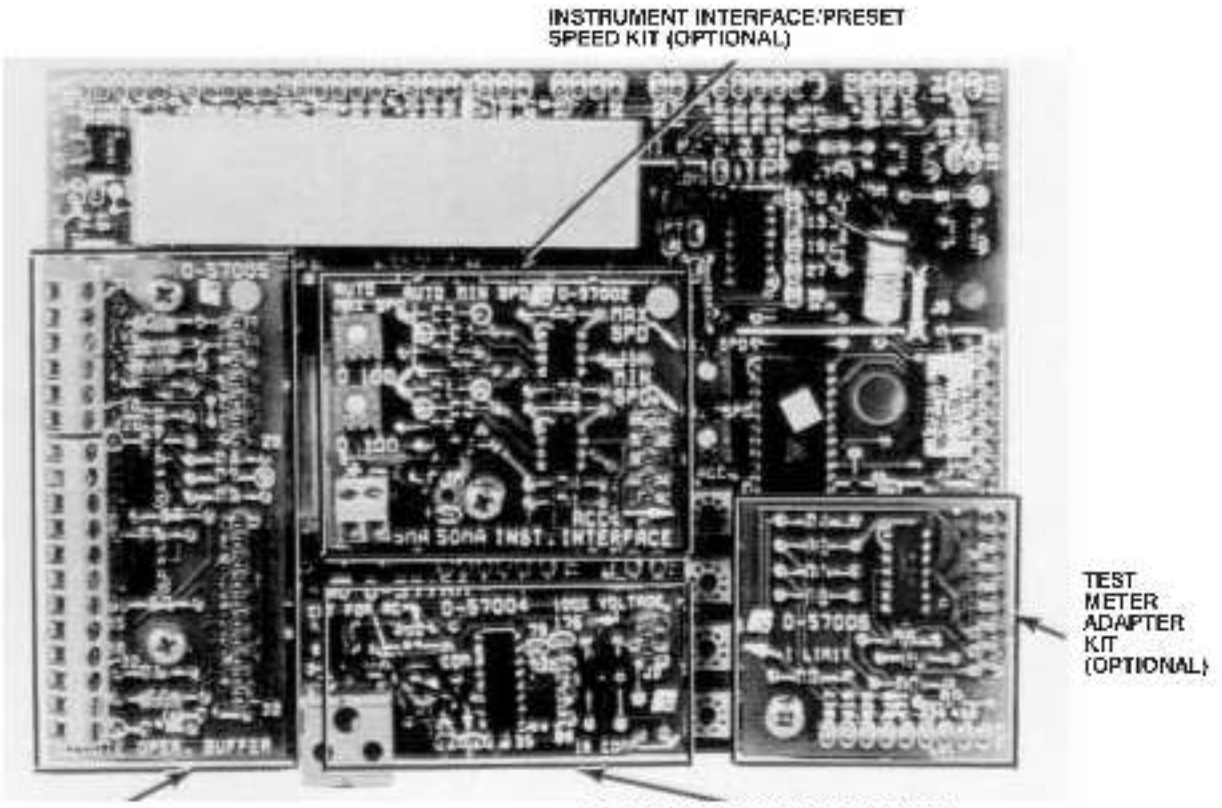


Figure 7.2 – Three Phase MinPak Plus Regulator Board with Some Typical Kits Installed

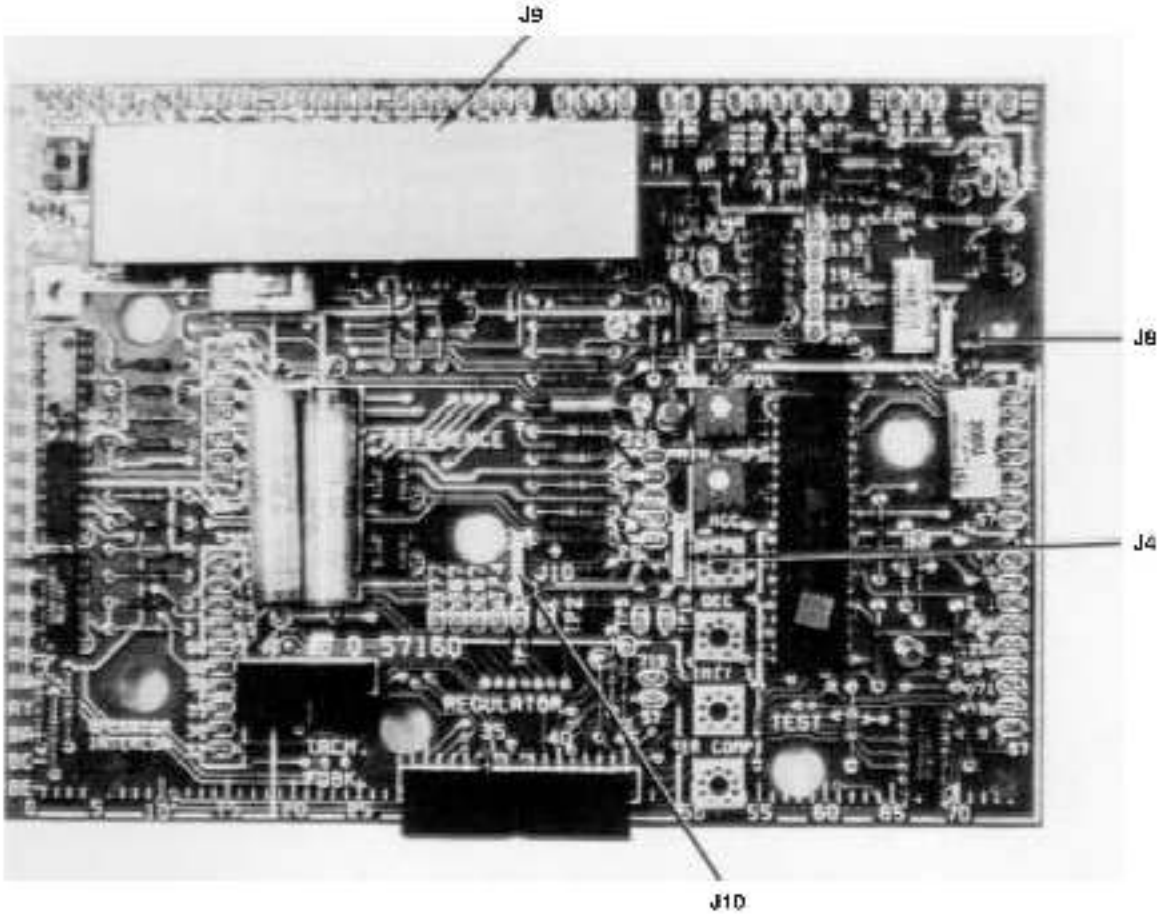


Figure 7.3 – Three Phase MinPak Plus Regulator Board Jumper Location

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