JUNE 1981

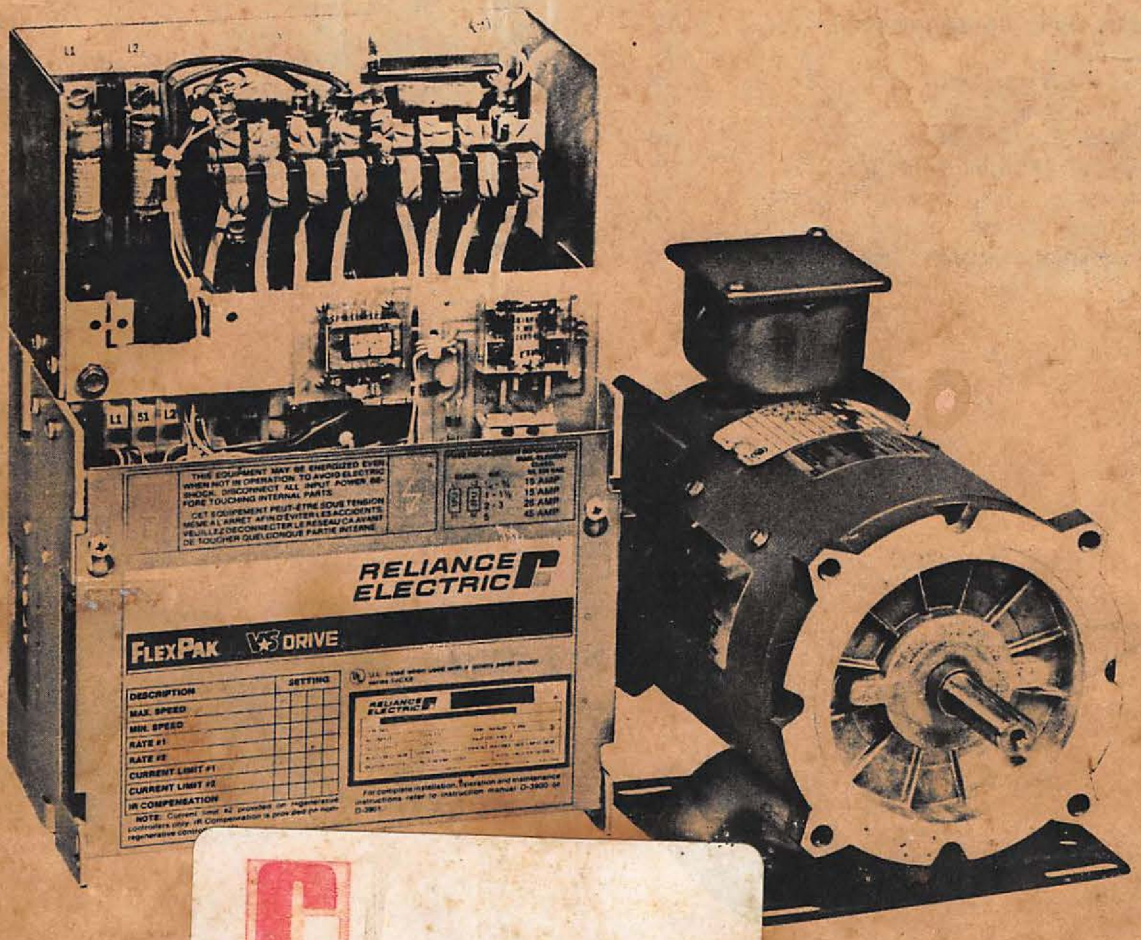
INSTRUCTION MANUAL D-3900

INSTALLING, OPERATING, and MAINTAINING

FLEXPAK PLUS

D-C VS DRIVE

and MODIFICATION KITS



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Section 1
INTRODUCTION

1.0 General — This manual familiarizes the user with the FlexPak™ Plus D-C V★S® drive controller. (Refer to Figure 1.1.) It describes assembly and installation procedures, gives a general overview of operation, 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 FLEXPAK 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 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.

WARNING
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.

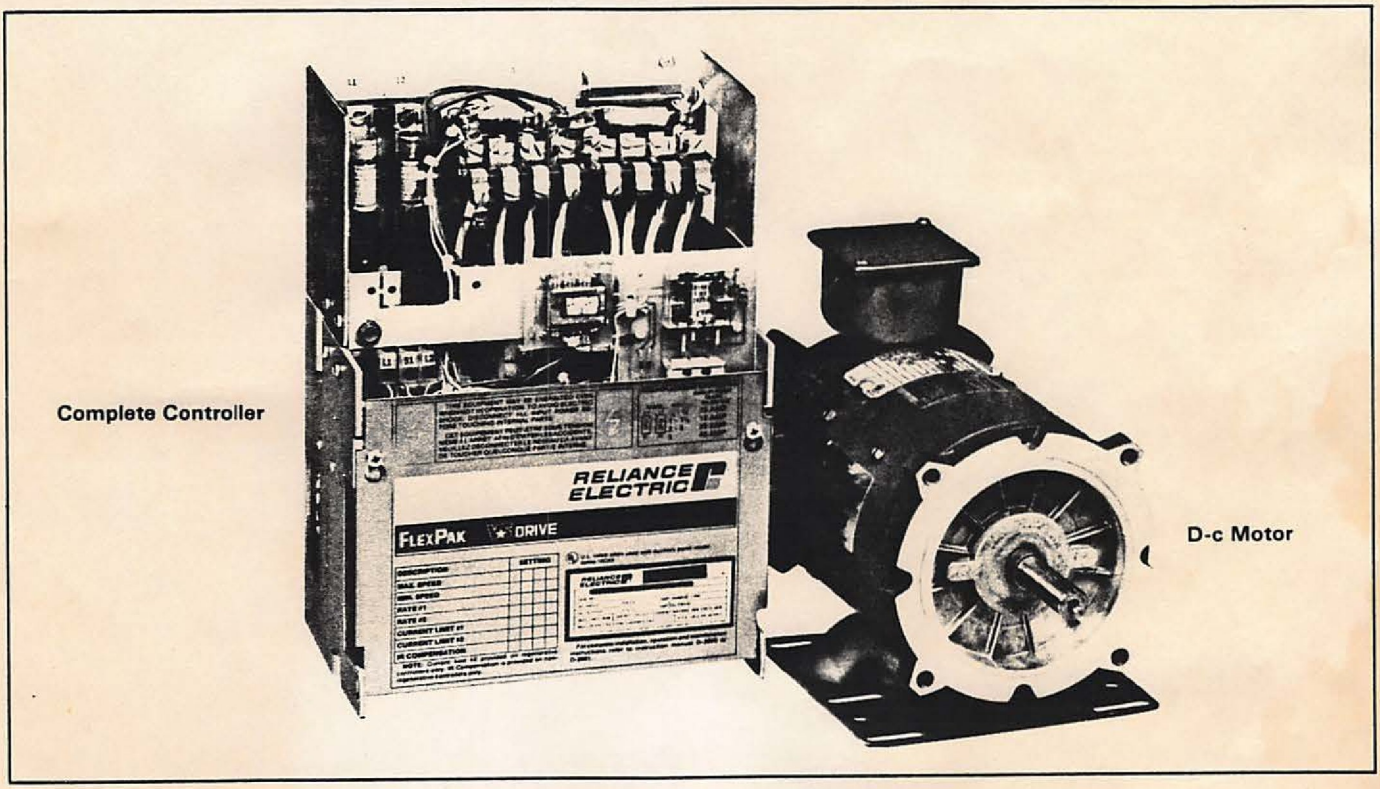


Figure 1.1 — FlexPak Plus Complete Controller and Typical Motor

Section 2
GENERAL CONTROLLER INFORMATION

2.0 General — The FlexPak Plus D-C V★S drive controller may be applied to single-phase d-c drive applications with ratings within the following ranges:

- From ¼ to ¾ hp with a 115 VAC, 50/60 Hz input voltage
- From ½ to 5 hp with a 230 VAC, 50/60 Hz input voltage

Reliance Electric d-c motors, which may be used with the controller, may be either permanent magnetic motors up to 1½ hp or wound field (excited) motors up to 5 hp.

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 enclosure's face or some distance away.

The FlexPak Plus is available in two basic configurations: the Basic Controller and the Complete Controller (Basic Controller with Auxiliary Panel). Both the Basic Controller and the Auxiliary Panel (Figure 2.1) are Underwriters Laboratories (U.L.) recognized. Both units when used together (Complete Controller) are 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.

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.

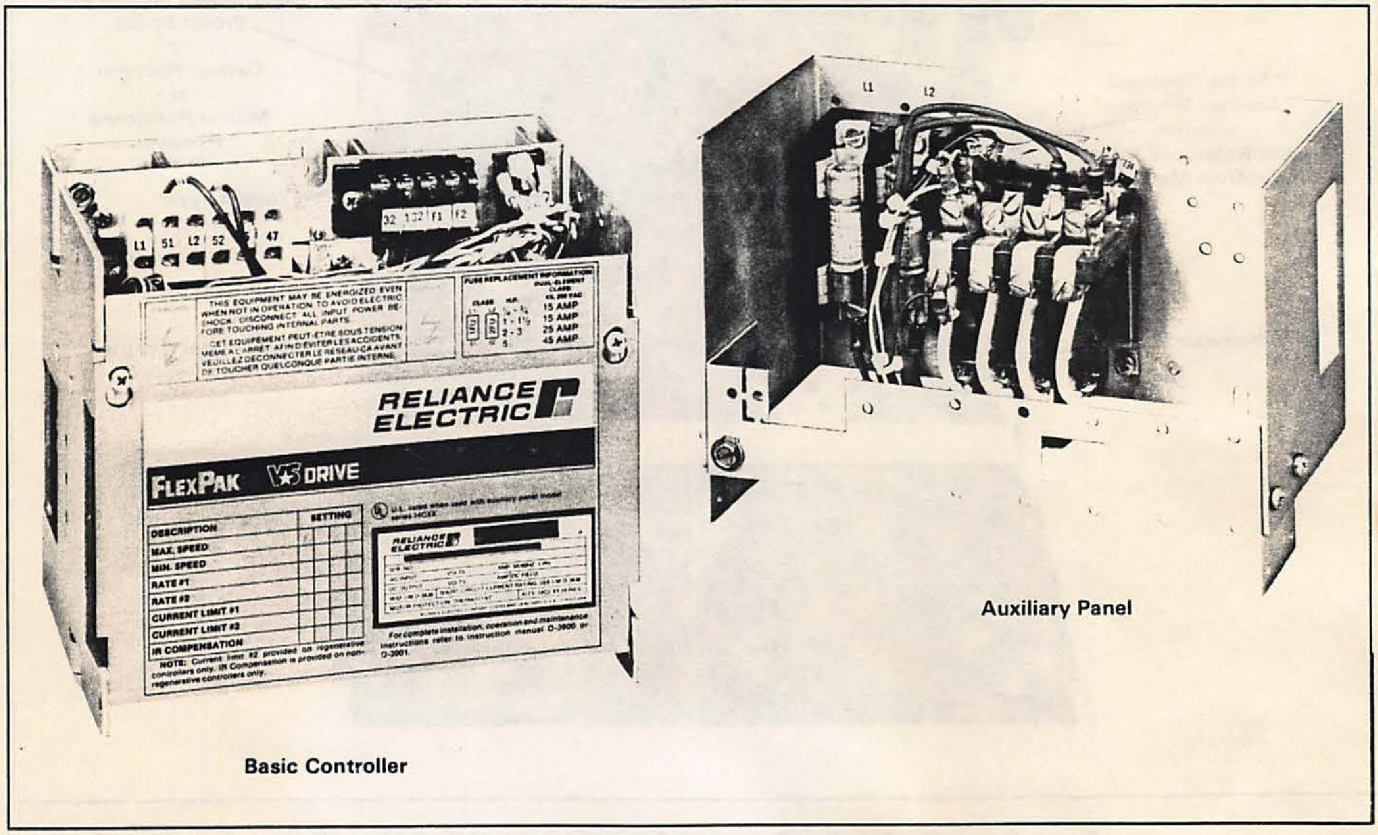


Figure 2.1 — Basic Controller and Auxiliary Panel

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. (Refer to Figure 2.2.) The Basic Controller modifications are:

- Tachometer Feedback
- Voltage/Tachometer Follower
- Instrument Interface/Preset Speed
- Field Supply (Standard on 2, 3 and 5 hp controllers)
- Torque Taper
- Test Meter Adapter
- Dancer Follower
- Master Isolated Reference Receiver
- Contactor Adapter

The Auxiliary Panel modifications are:

- Dynamic Braking
- Reversing Contactor
- Automatic Reversing
- Auxiliary M Contact

Complete descriptions of each Kit are given in Section 5. Refer also to Table 5.A.

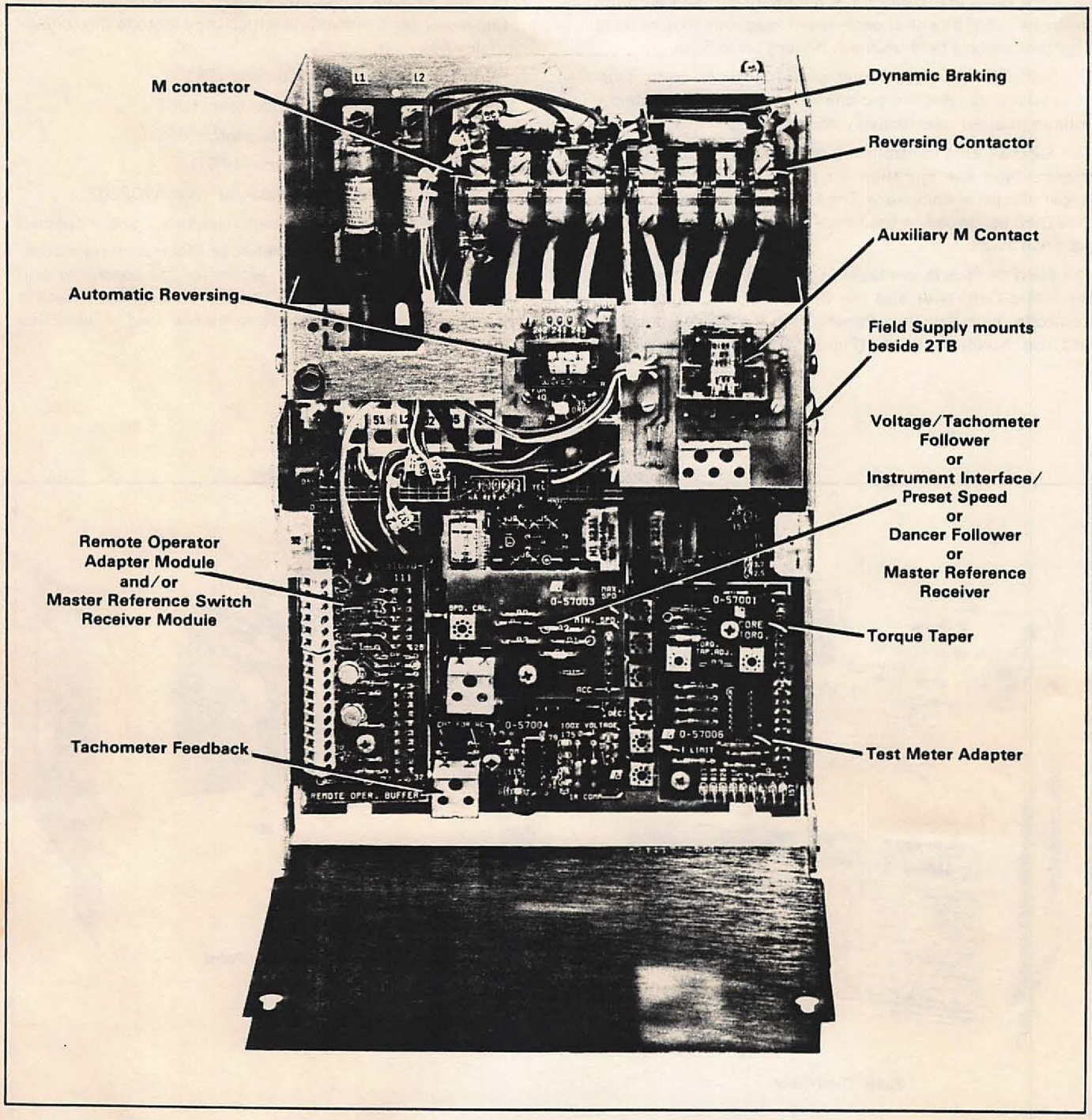


Figure 2.2 — FlexPak Plus Complete Controller with Modification Kits

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 single-phase power source having a frequency range from 48 to 62 Hz. However, for optimum 50-Hz operation, it is recommended that two resistors be removed from the Regulator Module. (Complete details are given at Paragraph 3.5.) If the resistors are not removed, there is a slight loss of performance.

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 ±10% of nominal.

Table 2.A

FLEXPAK PLUS FEATURES SUMMARY

CATEGORY	FEATURE
Controller Functions	• START/STOP • RUN/JOG • FORWARD/REVERSE • Speed selection (0 to 100%) • Torque selection (10 to 150%) • Unidirection operation with coast-to-rest or stop command standard. (Dynamic braking and reversing available as options.) • 20:1 controlled-speed range by means of armature voltage control. • With Auxiliary Panel specified, 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 in this manual, 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), counter EMF (C) or tachometer feedback (T) regulation. • With voltage regulation, 3 to 5% speed regulation with 95% load change. • With counter EMF (CEMF) regulation, 2 to 3% speed regulation with a 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 (50 to 100% of base motor speed). • Adjustable minimum speed (up to 50% 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. • With Auxiliary Panel specified, a-c line fuses protect Power Cube from armature short circuit and power relays provide positive power disconnect. • Protection from momentary surges on a-c line and from d-c load transients.

2.4.3 Line Impedance Requirements — The FlexPak Plus controller must be connected to a short-circuit protection 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 FLEXPAK PLUS CONTROLLER ON POWER SUPPLIES WITH AVAILABLE SHORT-CIRCUIT CURRENTS IN EXCESS OF 5000 AMPERES. DAMAGE TO EQUIPMENT AND PERSONAL INJURY MAY OCCUR.

2.4.4 Relay Control Circuit — The regulator board is set up for use with main contactors having a coil resistance greater than or equal to 100 ohms. The control logic sequences the contactor and the control relay on the regulator so that current flow thru the main contactor is never broken in normal operation by the contacts. Refer to Figures 6.1, 6.2 and 6.3.

The Basic Controller does not have an M contactor. An M contactor is required to provide positive power disconnect.

WARNING
THE USER MUST INSTALL AN M CONTACTOR THAT HAS A 24 VDC COIL WITH A MAXIMUM CURRENT DRAW OF 150 MILLIAMPS. FOR TIMING, A 200 MICROFARAD CAPACITOR MUST BE INSTALLED WITH CORRECT POLARITY ACROSS THE RELAY COIL. THE CONTACTOR ADAPTER KIT MUST BE INSTALLED WITH THE USER'S M CONTACTOR. (REFER TO TABLE 5.A AND PARAGRAPH 5.14.) PERSONAL INJURY MAY OCCUR IF THIS IS NOT INSTALLED.

2.4.5 A-C Line Fuse Requirements — A-c line protection is provided when the Auxiliary Panel is specified. The 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.

Table 2.B

SPECIFICATIONS

A-C Line Input Voltage
115/230 VAC (nominal)
single-phase only

Line Voltage Variation
±10% of nominal

A-C Line Frequency
Single Phase, 50/60 Hz
(Jumper selectable) ①

Line Frequency Range
48-62 Hz

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

Controller-Drive HP Range
¼-¾ hp (with 115 VAC input)
½-5 hp (with 230 VAC input)

Direction Control
Standard: Unidirection
Optionally: Forward/Reverse

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

Minimum Speed Adjustment
up to 50% 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

Regulation (with 95% load change)
3 to 5% with voltage feedback
2 to 3% with CEMF 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) ②

Displacement Power Factor
68% (typical) ②

Transient Protection
MOV and Output RC Circuit

Controller Service Factor
1.0

Duty
Continuous

Ambient Temperature (storage and operational)
0° to 55°C (32° to 131°F)

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

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

Controller Weight (approx.)
Basic = 9.0 lb (4.08 kg)
Complete = 11.0 lb (4.99 kg)

Controller Dimensions (LWD)
Basic = 7.22 x 8.37 x 5.95 inches
(184 x 213 x 152 mm)
Complete = 11.97 x 8.37 x 5.95 inches
(305 x 213 x 152 mm)

① See Paragraph 3.5.

② Typical percent shown. Exact figure dependent on motor base speed and frame size.

Table 2.C

FUSE REQUIREMENTS

HP	A-C Line Volts	Dual Element Class K5, 250 VAC Fuse	
		Quantity	Amp
FOR BASIC MOTOR PROTECTION			
¼-¾	115	1①	15
½-1½	230	2	15
2-3	230	2	25
5	230	2	45
FOR SUPERIOR MOTOR PROTECTION			
¼	115	1①	6.25
⅓	115	1①	10
½	115	1①	10
¾	115	1①	15
½	230	2	6.25
¾	230	2	10
1	230	2	10
1½	230	2	15
2	230	2	20
3	230	2	25
5	230	2	45

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

Table 2.D

D-C MOTOR/CONTROLLER/TRANSFORMER SPECIFICATIONS

CONTROLLER MODEL NUMBERS		HP	VAC	A-C AMPS (RMS)	D-C ARM. (VOLTS)	D-C ARM. AMPS (avg.)	OPTIONAL		POWER SUPPLY CAPACITY ②	TRANSFORMER	
BASIC	COMPLETE						D-C FIELD VOLTS	AMP. MAX. (optional)		MAXIMUM kVA Per Phase	FULL LOAD kVA
14C50	14C50/14C80	¼	115	3.5	90	2.5	100	3.0	5000	40	0.75
		⅓	115	5.2	90	3.7	100	3.0	5000	40	0.75
		½	115	7.0	90	5.0	100	3.0	5000	40	1.0
		¾	115	10.5	90	7.5	100	3.0	5000	40	1.5
14C51	14C51/14C81	½	230	3.5	180	2.5	200	3.0	5000	40	1.0
		¾	230	5.2	180	3.7	200	3.0	5000	40	1.5
		1	230	7.0	180	5.0	200	3.0	5000	40	2.0
		1½	230	10.5	180	7.5	200	3.0	5000	40	3.0
14C52	14C52/14C82	2	230	14.0	180	10.0	200	3.0 ①	5000	40	5.0
		3	230	21.0	180	15.0	200	3.0 ①	5000	40	5.0
14C53	14C53/14C83	5	230	35.0	180	25.0	200	3.0 ①	5000	40	10.0

① Standard

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

Section 3
INSTALLATION

3.0 General — This Section outlines the procedures that are to be followed in order to properly install a FlexPak 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 SINGLE-PHASE POWER SUPPLY THAT PROVIDES EITHER 115 VAC OR 230 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. 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 2-inch (50 mm) clearance between the top of one controller and the bottom of another controller. 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.

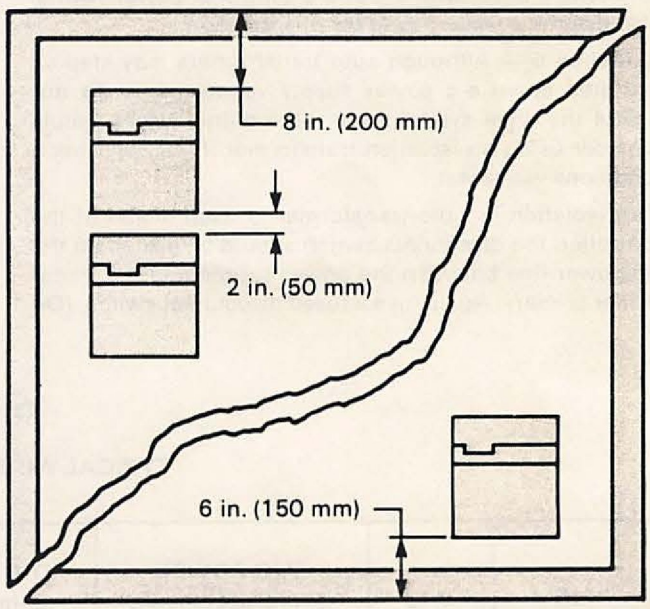


Figure 3.1 — Enclosure Mounting Minimum Distances

Guideline 3 — Regardless of the above placement guidelines, the user is responsible for providing ambient temperatures that meet the controller's specifications of 0° to 55°C (32° to 131°F). 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.)

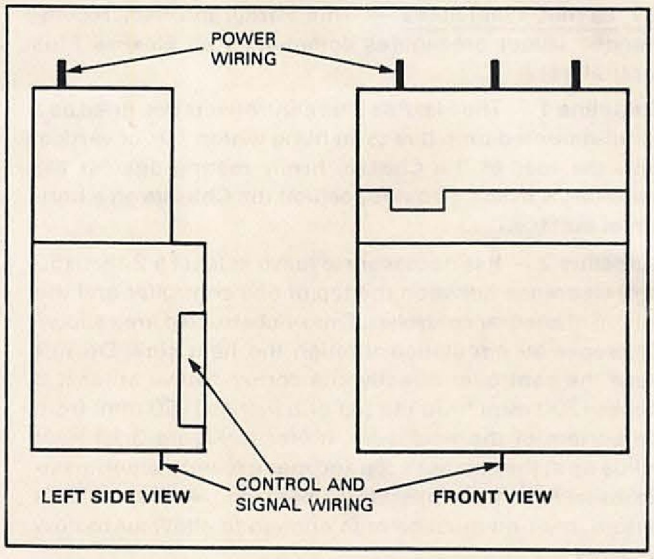


Figure 3.2 — Mounting and Wiring Orientations

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 drive 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.) Refer to Table 3.A for sizes and types.

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 a-c line.
- The transformer provides electrical isolation between the a-c power lines and the drive motor. Damaging currents may be eliminated in instances where a d-c output accidentally becomes grounded in a unit where the a-c electrical system is grounded.

For detailed information, refer to Paragraph 3.4.

Guideline 7 — The National Electrical Code requires that a two-pole, fused disconnect switch be installed on the incoming a-c line **ahead** of the controller to provide branch circuit protection. Fuses for this disconnect switch should be chosen from Table 3.A. They should be dual-element, slow blow type, or 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.

Table 3.A

TYPICAL WIRE, FUSE SIZES ①

HP	VAC	A-C POWER (min. size/insul.)	D-C ARMATURE (min. size/insul.)	D-C FIELD ② (min. size/insul.)	DISCONNECT FUSE SIZE ③ (amps)
¼	115	No. 14 AWG 75°C	No. 14 AWG 75°C	No. 14 AWG 75°C	8
⅓-½	115	No. 14 AWG 75°C	No. 14 AWG 75°C	No. 14 AWG 75°C	15
¾	115	No. 12 AWG 75°C	No. 12 AWG 75°C	No. 14 AWG 75°C	20
½	230	No. 14 AWG 75°C	No. 14 AWG 75°C	No. 14 AWG 75°C	8
¾-1	230	No. 14 AWG 75°C	No. 14 AWG 75°C	No. 14 AWG 75°C	15
1½	230	No. 12 AWG 75°C	No. 12 AWG 75°C	No. 14 AWG 75°C	20
2	230	No. 12 AWG 75°C	No. 12 AWG 75°C	No. 14 AWG 75°C	25
3	230	No. 10 AWG 75°C	No. 10 AWG 75°C	No. 14 AWG 75°C	35
5	230	No. 8 AWG 90°C	No. 8 AWG 90°C	No. 12 AWG 90°C	60

① Copper wire recommended.
② Permanent magnet motors do not require field supply.
③ Fuses must be dual-element, time-delay (slow-blow) type, or U.L. Class K5.

Guideline 9 — A thermostat is used to guard against motor overload protection. It is essential to properly connect the motor thermostat **in series** with the Operator's Control Station **STOP** selector switch at connections 32 and 132.

> **CAUTION:** An external overload device must be connected between terminals 32 and 132. The drive will not start without it.

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

Guideline 10 — When planning signal or control wire runs, as listed in Table 5.C, follow these practices:

- Conduits should be steel.
- If these conduits cross 440 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 (115/230/460 V) 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 ¼-inch 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.

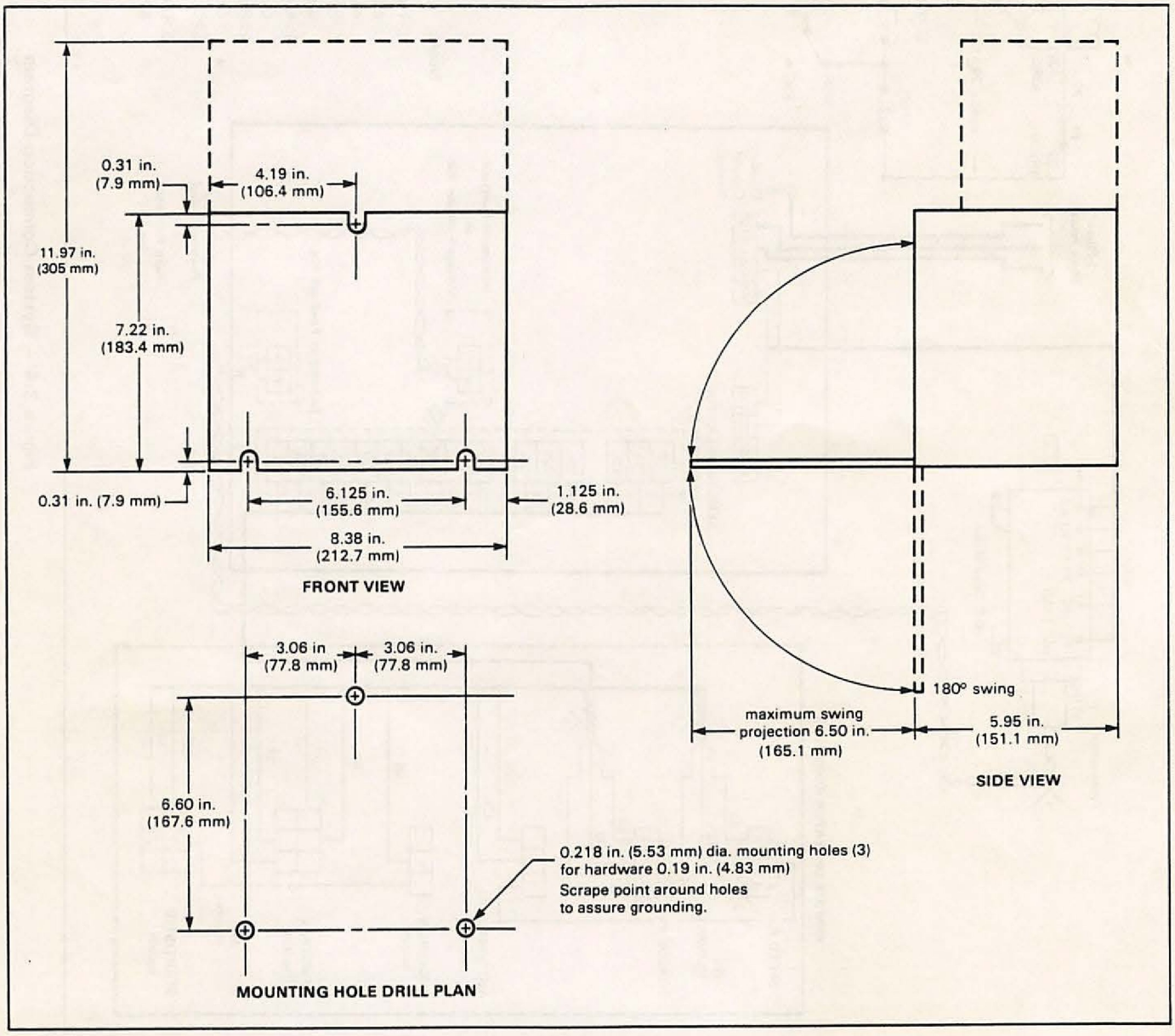
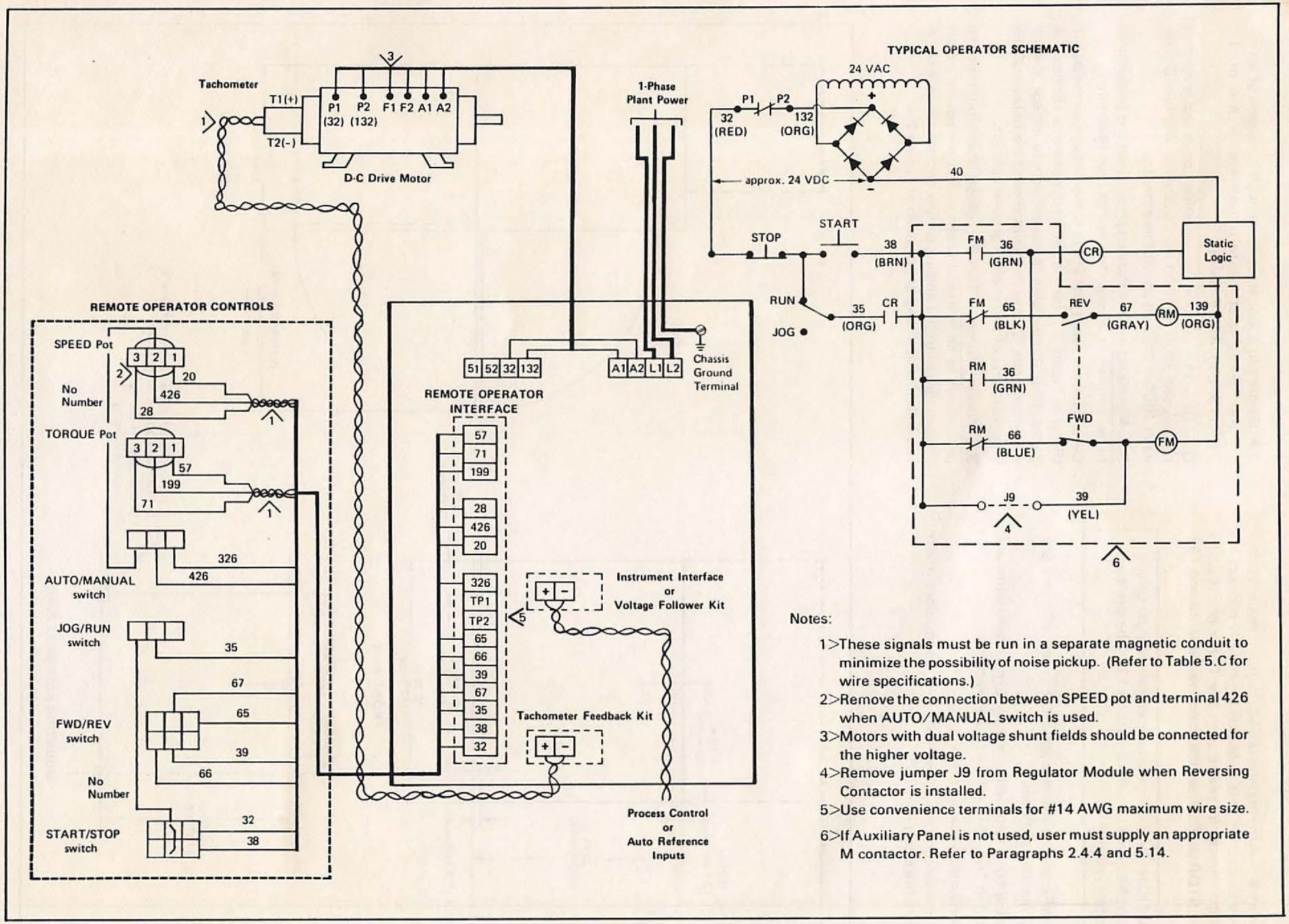


Figure 3.3 — Mounting Dimensions



Notes:

1>These signals must be run in a separate magnetic conduit to minimize the possibility of noise pickup. (Refer to Table 5.C 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 higher 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 5.14.

Figure 3.4 — System Connection Diagram

DANGER

BEFORE WIRING, MAKE SURE THE 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.

WARNING

THE USER MUST INSTALL AN M CONTACTOR THAT HAS A 24 VDC COIL WITH A MAXIMUM CURRENT DRAW OF 150 MILLIAMPS. FOR TIMING, A 200 MICROFARAD CAPACITOR MUST BE INSTALLED WITH CORRECT POLARITY ACROSS THE RELAY COIL. THE CONTACTOR ADAPTER KIT MUST BE INSTALLED WITH THE USER'S M CONTACTOR. (REFER TO TABLE 5.A AND PARAGRAPH 5.14.) 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. Typical wire sizes and types are listed in Table 3.A as a basic guideline. Note that long cable runs may require that a larger gauge be used to avoid excessive voltage drop. Use of stranded wire 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.

If the Auxiliary Panel is employed, wires to the motor armature (A1 and A2) must be lugged with the provided lugs, or equivalent, before connection to the appropriate relay terminals. Lugs provided will accommodate:

¼ to 1½ hp — 12 AWG
1½ to 3 hp — 10 AWG
5 hp — 8 AWG

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:

- Single 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 full-load 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. (Refer to Table 3.B.)

Table 3.B

RELIANCE ELECTRIC ISOLATION TRANSFORMERS

HP	kVA	PRIMARY VAC	SECONDARY VAC	ORDER NUMBER:
¼-⅓	0.75	230/460	115	77530-10S
¼-⅓	0.75	575	115	Special Order
½	1.0	230/460	230	Special Order
½	1.0	575	115	Special Order
¾	1.5	115	115	77530-12V
¾	1.5	575	115	77530-11V
¾	1.5	230/460	115	77530-10V
¾	1.5	230/460	230	Special Order
¾	1.5	575	230	Special Order
1	2.0	230/460	230	77530-8W
1	2.0	575	230	Special Order
1½	3.0	230/460	230	77530-8X
1½	3.0	575	230	Special Order
2-3	5.0	230/460	230	77530-8Y
2-3	5.0	575	230	77530-9Y
5	10.0	230/460	230	77530-8RC
5	10.0	575	230	77530-9RC

3.5 50-Hz Operation — There may be cases when the FlexPak Plus controller is to be operated continuously on 50 Hz. If so, two resistors should be removed from the Regulator Module for optimum performance. (Refer to Figure 3.5.)

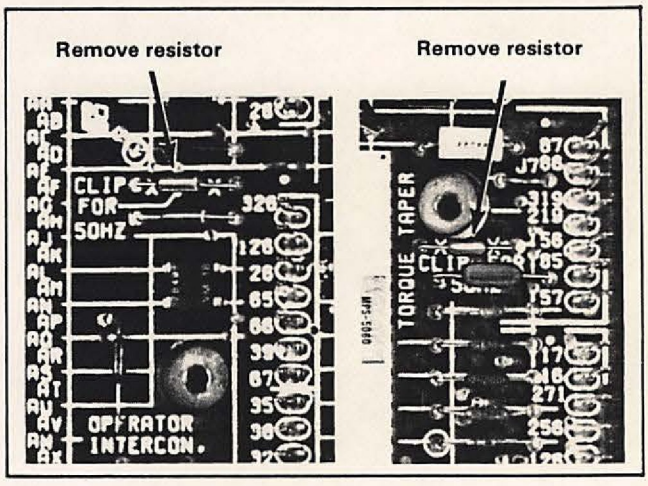


Figure 3.5 — 50-Hz Resistor Removal

3.6 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.C. Relate the left or center 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.C

HORSEPOWER CALIBRATION

MOTOR HP		MOTOR CURRENT/ PIN CONNECTIONS
115 VAC	230 VAC	
¼	½	2.5A
⅓	¾	3.7A
½	1	5A
¾	1½	7.5A
—	2	10A
—	3	15A
—	5	25A

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 it straight up and off the pin. Slide the connector straight down over the proper pin.

3.7 Regulation Mode Jumper — The FlexPak Plus controller offers three types of drive regulation. The first, which is factory shipped, is an armature voltage feedback (A).

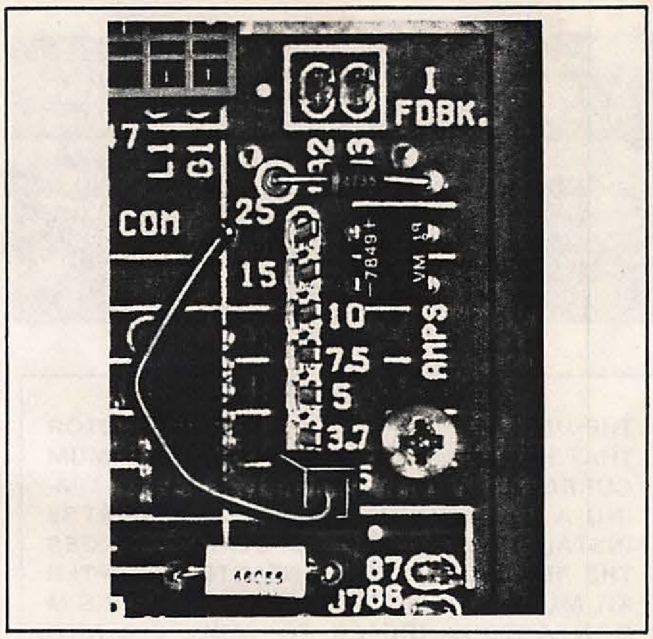


Figure 3.6 — HP/Current Scaling Pins

Optionally, the user may also use either tachometer feedback (T) regulation or counter EMF feedback (C). In order to use these two 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. (Refer to Figure 5.10.) Details of jumper placement are noted in Section 5.

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.

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 FLEXPAK 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, USER MUST DETERMINE IF A FIELD SUPPLY KIT IS PRESENT. (SEE FIGURE 5.15.) IF FIELD SUPPLY KIT IS PRESENT, THE FIELD SUPPLY KIT AND ITS WIRING MUST BE INSPECTED FOR DAMAGE. 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. REFER TO SYMPTOM 1 IN TABLES 6.B AND 6.C.

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% speed)
- Minimum speed (full CCW: zero speed)
- 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.

4.3.2 Maximum Speed (Voltage) — The Maximum Speed Potentiometer on the Regulator Module has been factory preset for 50% 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 50 to 100% of rated speed.

There are two methods for determining if the motor and driven equipment are operating at an acceptable maximum speed for the application.

- Tachometer
- Visual inspection of machine operation

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.**

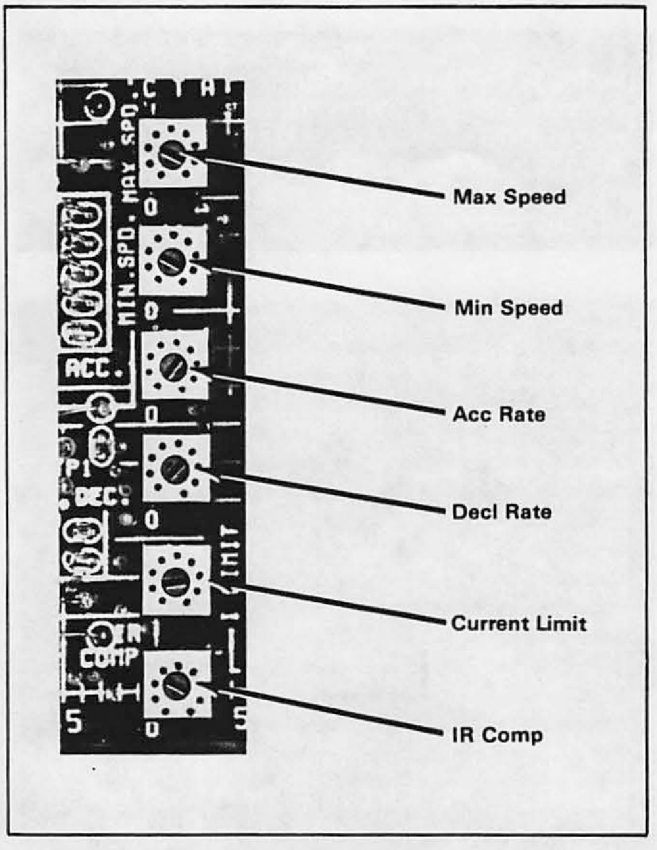


Figure 4.1 — Regulator Module Potentiometers

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.

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

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 zero speed. 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 zero to 50% of rated speed.

Again, the motor speed can be determined by a tachometer or by visual inspection of machine operation.

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 or CEMF 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
MODIFICATION KITS

5.0 General — A number of optional features in the form of Modification Kits are offered with the 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 5.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 FLEXPAK 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 thr ,h matching holes in the Modules that form part tl Kit. (Refer to Figure 5.1.)

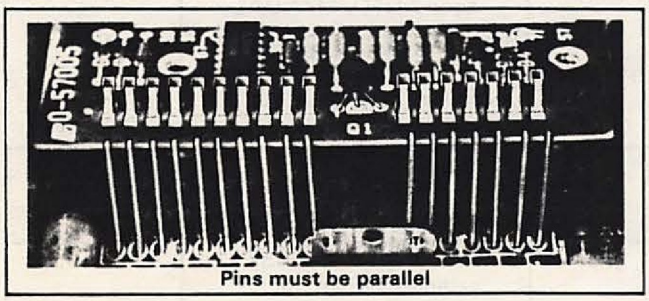


Figure 5.1 — Pin Alignment

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.

5.1 Auxiliary Panel — The Auxiliary Panel contains a-c line fuses, an M contactor, an Auxiliary Mounting Bracket and four screws for use with the Basic FlexPak Plus. The Auxiliary Mounting Bracket provides a mounting surface for the Automatic Reversing and Auxiliary M Contactor Kits.

To install the Auxiliary Panel, follow these procedures.

Step 1 — Follow this Step **only** if the Contactor Adapter Kit with a user-supplied M contactor is already installed. If this condition does not exist, proceed to Step 2.

Disconnect the user-supplied FM contactor (and user-supplied RM contactor if applicable). Remove the two harness connectors from the Regulator Module. Remove and discard the Contactor Adapter Kit (including the Auxiliary Mounting Bracket).

Step 2 — Orient the Auxiliary Panel over the Basic Controller aligning the mounting holes. Secure the Panel with the provided screws. (Refer to Figure 5.2.)

Step 3 — Connect leads 51 and 52 to terminals 51 and 52, respectively, on 1TB of the Basic FlexPak Plus. Connect leads 45 and 47 to terminals 45 and 47, respectively, on the Basic FlexPak Plus. Make sure connections are tight and well made.

Step 4 — Place the relay control harness connector over the Regulator pins marked FWD. (Refer to Figure 5.2.) Orientation is important: connect the orange wire with the pin called out as ORG 139. (Refer to Figure 6.4.)

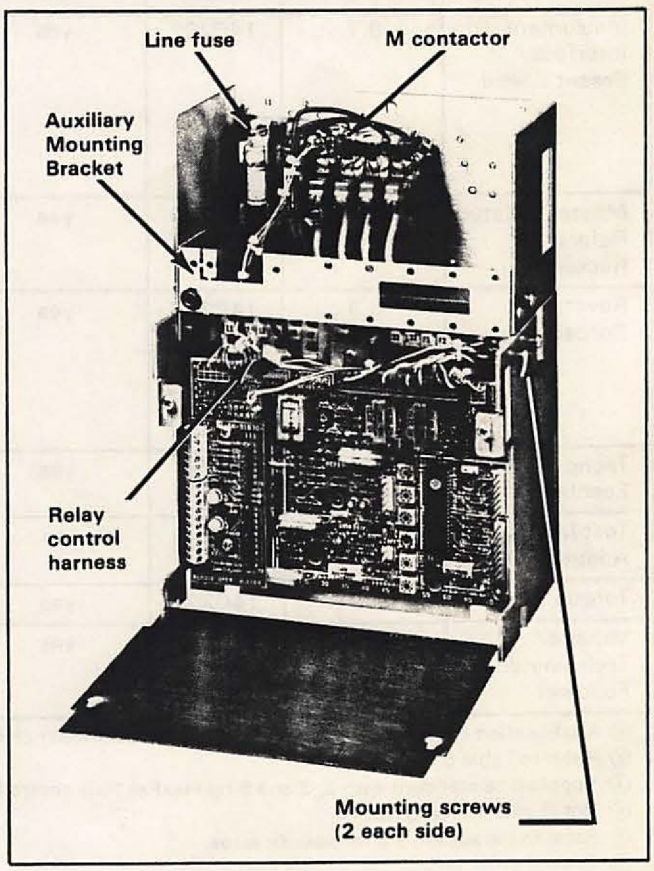


Figure 5.2 — Auxiliary Panel Mounting

5.2 Dynamic Braking — The standard FlexPak Plus controller allows a drive motor to coast to rest after the STOP switch is pressed. Optionally, a user may install a Dynamic Braking Kit. (Refer to Figure 5.3.) Its use allows a rapid, shockless stopping of the drive motor.

Dynamic Braking is **not** a mechanical holding brake. It will **not** hold the shaft in place, nor will it prevent the motor from turning once motion has stopped.

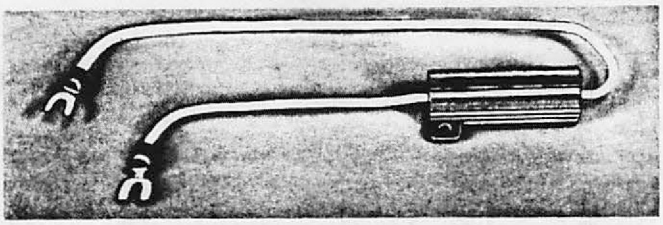


Figure 5.3 — Dynamic Braking Kit

Table 5.A

MODIFICATION KIT QUICK REFERENCE LIST

KIT	MANUAL PARAGRAPH NUMBER	MODEL NO.	CONTROLLER MODIFICATION ?①	ADDITIONAL OPTIONS REQUIRED ?	OPTIONS REQUIRED	ADDITIONAL USER-SUPPLIED PARTS?
Automatic Reversing	5.4	14C226	no	yes	• Auxiliary Panel • Reversing Contactor Kit	no
Auxiliary M Contact	5.10	14C219	no	yes	Auxiliary Panel	wire ② ④
Auxiliary Panel	5.1	14C80 thru 83	yes	no	None	no
Contactor Adapter Kit	5.14	14C276	no	no	None	M Contactor wire ④
Dancer Follower	5.12	14C230	yes	yes	Dancer Potentiometer	wire ②
Dynamic Braking	5.2	14C214 thru 16	no	yes	Auxiliary Panel	no
Field Supply ③	5.8	14C237	no	no	None	wire ⑤
Instrument Interface/ Preset Speed	5.7	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 ②
Master Isolated Reference Receiver ⑥	5.13	14C229	yes	yes	Master Isolated Reference Transmitter	wire ④
Reversing Contactor	5.3	14C218	yes	yes	• FORWARD/REVERSE selector switch on Operator Station (See Figure 3.4.) • Auxiliary Panel	no no
Tachometer Feedback	5.5	14C221	yes	no	None	wire ②
Test Meter Adapter	5.11	14C225	no	no	None	no
Torque Taper	5.9	14C224	yes	no	None	no
Voltage/ Tachometer Follower	5.6	14C223	yes	no/yes	May need AUTO/MANUAL selector switch	wire ②

① Modification here means that some work such as jumper placement, resistor clipping, or wiring reconnection, must be performed.
② Refer to Table 5.C.
③ Supplied as standard with 2, 3 and 5 hp FlexPak Plus controllers.
④ Not to exceed AWG No. 14.
⑤ Refer to Paragraph 5.8 for specific sizes.
⑥ Special order only.

The Dynamic Braking option is actually a resistor connected across the motor armature. It allows a motor to act as a generator; the rotating mechanical (kinetic) energy is converted into electrical energy that is dissipated in the form of heat by the Dynamic Braking resistor.

Note that the resistor is sized for infrequent stops. Thus, users must allow time between stops for heat dissipation.

When ordering the Kit, it is necessary to specify Part Numbers according to horsepower and voltage ratings. (Refer to Table 7.A.)

The Dynamic Braking Kit contains the resistor and two mounting screws. Mount the Kit in the upper right-hand corner of the Auxiliary Panel as shown in Figure 5.4. Wire the Dynamic Braking Kit according to Figure 5.5.

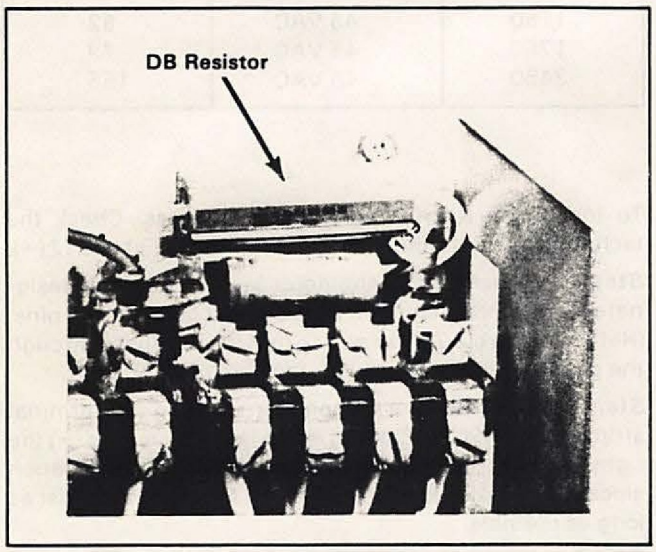


Figure 5.4 — Dynamic Braking Kit Installed

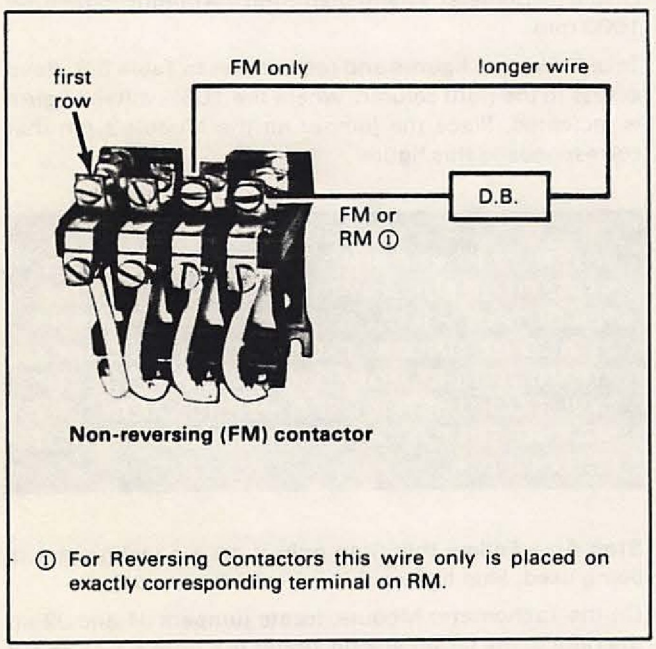


Figure 5.5 — Dynamic Braking Connections

5.3 Reversing Contactor — The standard FlexPak Plus controller offers unidirectional control. With an optional Reversing Contactor Kit and Auxiliary Panel, bidirectional operation (both forward and reverse) is possible. Motor direction is manually selected. Install the Auxiliary Panel onto the Basic Controller according to Paragraph 5.1. Mount the Reversing Contactor Kit on the right-hand side of the Auxiliary Panel with the three mounting screws provided. Connect the two power wiring harnesses and the control wiring harness as shown in Figure 5.6.

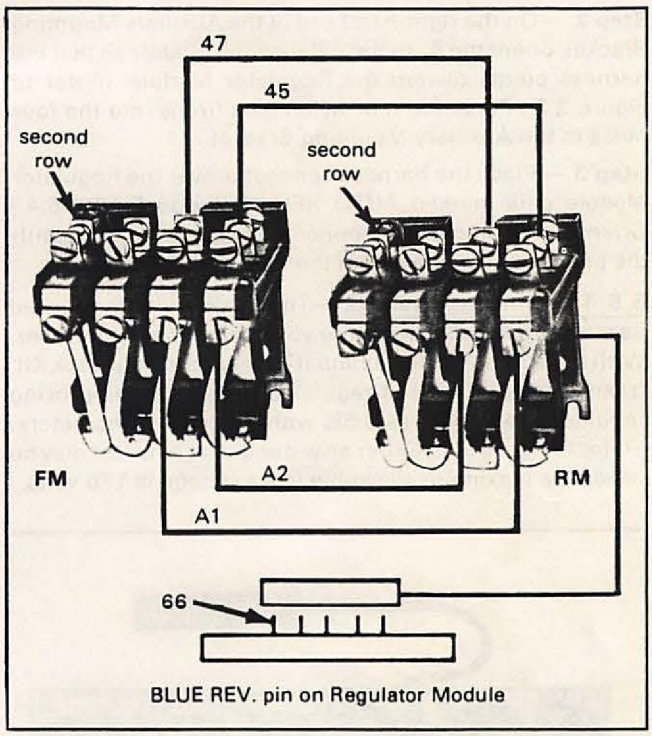


Figure 5.6 — Reversing Contactor Connections

5.4 Automatic Reversing — The optional Automatic Reversing Kit provides an **automatic** reverse-direction capability to the FlexPak Plus. Functionally, the Kit allows the controller to sequence off, and then immediately sequence on again, thereby providing a fast, automatic change of direction. This response may be caused by either an external switching signal or manually with a FORWARD/REVERSE selector switch. (Refer to Figure 5.7.)

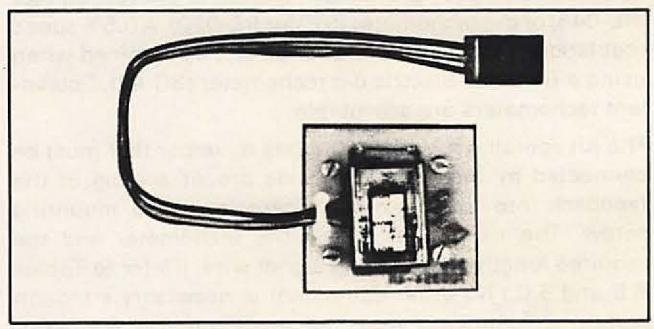


Figure 5.7 — Automatic Reversing Kit

The Kit contains a single Module with a fixed wire harness. However, its use requires that two other options also be used:

- Auxiliary Panel
- Reversing Contactor

No other parts are required, and no modifications need be made to the controller beyond those implied in the above two options.

To install the Kit, follow these procedures.

Step 1 — Install the Auxiliary Panel and the Reversing Contactor, as outlined in Paragraphs 5.1 and 5.3.

Step 2 — On the right-hand end of the Auxiliary Mounting Bracket, orient the Automatic Reversing Module so that the harness points toward the Regulator Module. (Refer to Figure 2.2.) Press the four nylon pins firmly into the four holes in the Auxiliary Mounting Bracket.

Step 3 — Place the harness connector over the Regulator Module pins marked AUTO REV. (Refer to Figure 6.4.) Orientation is important: connect the purple (40) wire with the pin called out as PUR on the Regulator Module.

5.5 Tachometer Feedback — The FlexPak Plus is supplied as standard as a d-c armature voltage feedback controller. With the addition of the optional Tachometer Feedback Kit, it can operate as a speed-regulated unit, thereby improving regulation to as little as 0.5% with specified tachometers. (Refer to Figure 5.8.) Either an a-c or d-c tachometer may be used. The maximum allowable input voltage is 175 volts.

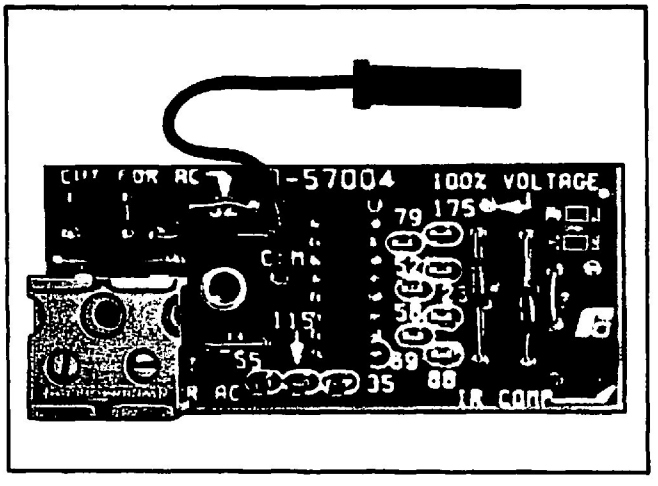


Figure 5.8 — Tachometer Feedback Kit

A 1% speed regulation with 95% load change can be obtained when using a Reliance Electric a-c tachometer (RE-045) or d-c tachometer (5 PY or RE-020). A 0.5% speed regulation with a 95% load change can be obtained when using a Reliance Electric d-c tachometer (BC-42). Equivalent tachometers are acceptable.

The Kit contains a Module that has a jumper that must be connected by the user to provide proper scaling of the feedback into the regulator. There is also a mounting screw. The user must supply the tachometer and the required lengths of specified signal wire. (Refer to Tables 5.B and 5.C.) No other equipment is necessary although certain adjustments must be made on the Regulator Module.

Table 5.B

TACHOMETER VOLTAGE SCALING

MOTOR BASE SPEED (rpm)	TACHOMETER (volts/1000 rpm)	100% VOLTAGE CONNECTION
1150	20 VDC	23
1750	20 VDC	35
1150	50 VDC	58
3450	20 VDC	69
1750	50 VDC	88
1150	100 VDC	115
3450	50 VDC	175
1750	100 VDC	175
1150	45 VAC	52
1750	45 VAC	79
3450	45 VAC	155

To install the Kit, follow these procedures. Check the tachometer to determine which wires are T1 (+) and T2 (—).

Step 1 — Orient the Tachometer Module over the designated area of the Regulator Module, just over the two pins. (Refer to Figure 2.2.) Lower it so that the pins pass through the guides in the Module. Use the screw to secure it.

Step 2 — Connect the tachometer wires to the terminal strip on the Module. Plus (+) is the left side, minus (—) the right. Do not strip off more than 1/8 inch (3 mm) of insulation since shorts occur at exposed points. Maintain the twist as long as possible.

Step 3 — Locate the black pig-tail jumper on the Tachometer Module. It is to be placed on one of ten pins on the Module. Exactly which depends on the voltage scaling factor. On the motor's nameplate, find the base speed (rpm). On the tachometer's nameplate, find the output voltage per 1000 rpm.

Take these two figures and relate them to Table 5.B. Read across to the right column, where the 100% voltage figure is indicated. Place the jumper on the Module's pin that corresponds to this figure.

DANGER

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

Step 4 — Follow this Step **only** if an a-c tachometer is being used. Skip to Step 5 if a d-c device is used.

On the Tachometer Module, locate jumpers J1 and J2 on the right of the terminal strip. (Refer to Figure 5.9.) Clip out and discard these jumpers for a-c operation.

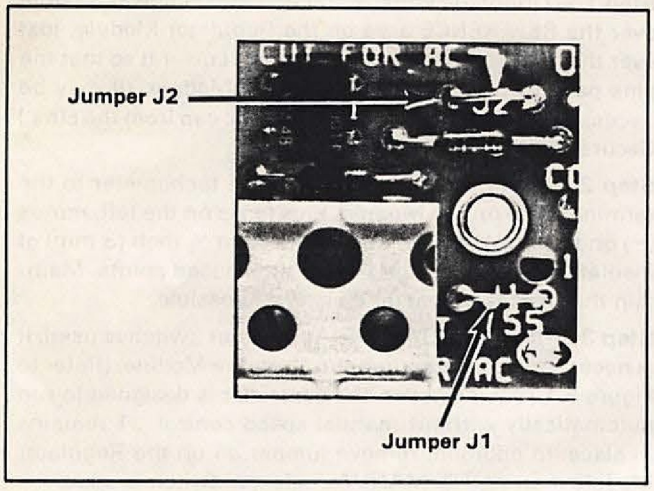


Figure 5.9 — Jumpers J1, J2

Step 5 — Since the IR compensation is **not** used with tachometer feedback, it is necessary to turn the IR Potentiometer fully CCW. (Refer to Figure 4.1.) If IR compensation is left in the circuit, erratic operation may result.

Step 6 — The Feedback Jumper on the Regulator Module must be connected for tachometer feedback. (Refer to Figure 5.10.) Place the Regulator Module's fixed black jumper on the pin marked T.

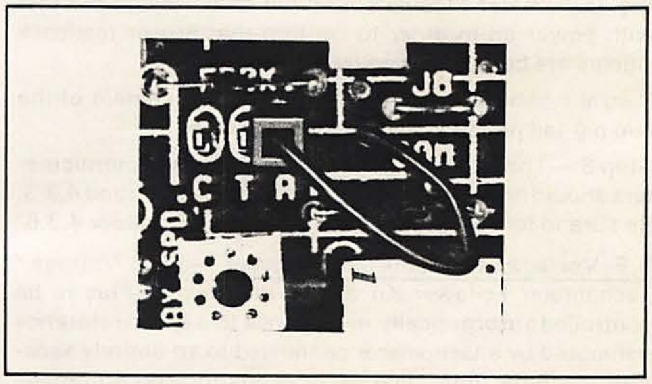


Figure 5.10 — Feedback Connection on Regulator Module

Step 7 — This Step assumes that the complete drive system, including the controller, has been successfully started

Table 5.C

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. 16 • 600 VAC rating • Insulation: poly-vinyl chloride (PVC) • Temperature range: 40°-105°C (104°-221°F) • Unshielded	• Any single conductor meeting N.E.C. required characteristics
SIGNAL WIRE			
Remote Operator Control Station: • SPEED pot • TORQUE pot	• Three-conductor • Twisted with two twists per inch	• Stranded copper (19 x 29) • AWG No. 16 • 600 VAC rating • Twist per foot: 24 (½-inch lay) • Insulation: poly-vinyl chloride (PVC) • Temperature range: 40°-105°C (104°-221°F)	• User may twist single conductors of required specifications • Reliance Part No. 417900-79X
• Tachometer Feedback • Instrument Interface • Voltage/Tachometer Follower	• Two-conductor • Twisted pair with two twists per inch		• User may twist single conductors of required specifications • Reliance Part No. 417900-76EAD

up and debugged according to Section 4 thru Paragraph 4.3.1. It is necessary to carry out a power-on test. Set the SPEED Potentiometer at approximately 25% of full rotation. Start the drive. It should run as set. If it accelerates to full speed, the tachometer is not providing a signal.

Stop the drive, turn off all power, and reverse the leads to the Tachometer Module's terminal strip. Repeat the test with power on in order to confirm that proper feedback signals are being received by the regulator.

If erratic behavior continues, check the placement of the two pig-tail jumpers against Steps 3 and 5.

Step 8 — The Maximum and Minimum Speed Potentiometers should now be adjusted to Paragraphs 4.3.2 and 4.3.3. Be sure to follow 4.3.4 and 4.3.5 but **do not follow** 4.3.6.

5.6 Voltage/Tachometer Follower — The Voltage/Tachometer Follower Kit allows the FlexPak Plus to be controlled **automatically** in response to a speed reference generated by a tachometer connected to an entirely separate machine unit. Ideal applications include automatic control systems where a "second" slave drive must closely follow the speed of a master drive, or machine. (Refer to Figure 5.11.)

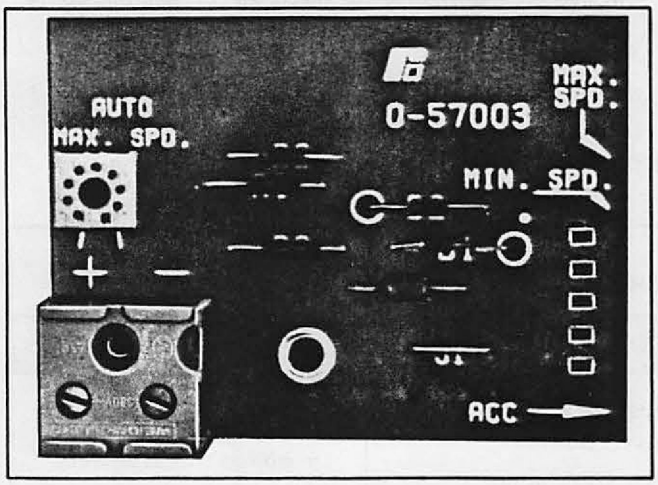


Figure 5.11 — Voltage/Tachometer Follower

The Kit is designed to accept an input signal of 25 to 250 VDC to obtain maximum speed. (The maximum permissible input voltage is 250 VDC.) The input impedance between terminals is approximately 80,000 ohms. Therefore, 100 VDC draw approximately 1.25 mA current from the voltage source.

The Kit contains the Module and a mounting screw. Although the FlexPak Plus can use the Kit for exclusive automatic speed control, if manual override control is needed, an AUTO/MANUAL selector switch must be used on the Operator Control Station. In the MANUAL position, the drive responds to the SPEED Potentiometer setting. In AUTO, it follows **only** the external signal and does not respond to manually input speed change commands.

The user must also supply required lengths of the specified signal wire. (Refer to Table 5.C.) No other equipment is necessary although some changes may be necessary on the Module.

Step 1 — Orient the Voltage/Tachometer Follower Module over the REFERENCE area on the Regulator Module, just over the five pins. (Refer to Figure 6.4.) Lower it so that the pins pass through the guides on the Module. (It may be necessary to remove a protective plastic cap from the pins.) Secure the Module with the screw.

Step 2 — Connect the wires from the tachometer to the terminal strip on the Module. Plus (+) is on the left, minus (—) on the right. Do not strip more than $\frac{1}{8}$ inch (3 mm) of insulation off since shorts occur at exposed points. Maintain the twisted character as long as possible.

Step 3 — If an AUTO/MANUAL selector switch is used, it is necessary to remove jumper J1 on the Module. (Refer to Figure 5.12.) If, however, the controller is designed to run automatically **without** manual speed control, J1 remains in place. In addition, remove jumper J4 on the Regulator Module if an AUTO/MANUAL selector switch is used.

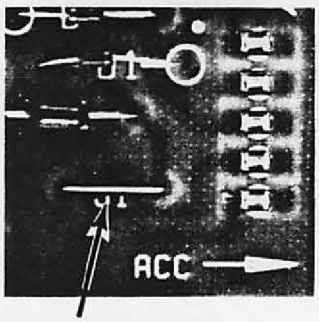


Figure 5.12 — Jumper J1

Step 4 — This Step assumes that the complete drive system, including the controller, has been successfully started up and debugged according to Section 4. It is now necessary to carry out a power-on test. Start the drive and place it in the AUTO mode, if so equipped.

With a small, insulated screwdriver, adjust the Auto Speed Calibration Potentiometer on the Tachometer/Follower Module until the drive reaches the desired speed in relation to the reference input signal being received.

DANGER
APPLICATION MUST NOT RELY ON ZERO SPEED/INPUT SETTING FOR SAFETY. SERIOUS OR FATAL INJURY MAY RESULT.

5.7 Instrument Interface/Preset Speed — The FlexPak Plus can **automatically** follow a milliampere signal from a process control instrument if the optional Instrument Interface/Preset Speed Kit is installed. (Refer to Figure 5.13.) Alternately, the Kit also permits the drive to run continuously at a preselected speed.

The Instrument Interface Module accepts a 0 to 5, 1 to 5, 4 to 20 or 10 to 50 mA signal, which may be grounded or ungrounded. The maximum input is 50 mA.

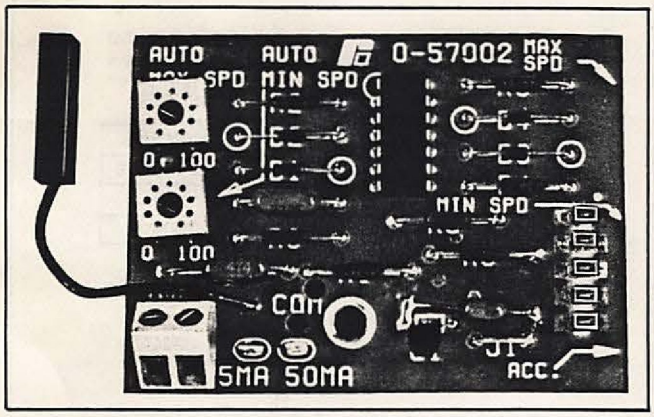


Figure 5.13 — Instrument Interface Kit

Typical applications include cases where the drive motor's speed must be controlled and varied as a function of such process variables as temperature, weight, fluid flow and pressure.

The Auto Minimum Speed Potentiometer on the Module can be set so that the drive runs at a preset minimum speed (up to 50%) with a minimum output signal from the process instrument. The Auto Maximum Speed Potentiometer on the Module can be set so that the drive runs at 50% to base speed with a maximum output signal from the instrument. Other relationships within these parameters are also possible, and they allow operation over a larger speed range than the 5:1 range provided by the process controller.

The Kit contains a Module that has a jumper that must be connected by the user to select one of two maximum input signals: 5 mA or 50 mA. There is also a mounting screw. The Kit may be used alone to provide full, automatic drive control, or it may be used with an optional AUTO/MANUAL selector switch on the Operator Control Station. This switch may be used to manually override the external d-c signal. (In the MANUAL position, the drive follows the SPEED Potentiometer on the Station.) The user supplies the required lengths of specified signal wire. (Refer to Table 5.C.) A process instrument controller, or other transducer with a d-c milliampere output, is also required.

***NOTE:** If the Operator Control Station contains an AUTO/MANUAL selector switch, it is necessary to remove jumper J1 from the Instrument Interface Module and J4 on the Regulator Module. (Refer to Figures 5.14 and 6.4.) Do this before placing the Module on the Regulator Module.*

DANGER
APPLICATION MUST NOT RELY ON ZERO SPEED SETTING FOR SAFETY. SERIOUS OR FATAL INJURY MAY OCCUR.

To install the Kit, follow these procedures. The following explanation assumes that the initial wiring was carried out.

Step 1 — Orient the Module over the dedicated area marked REFERENCE on the Regulator Module, just over the five pins. (Refer to Figure 6.4.) Lower it so that the pins pass through the guides on the Module. Use the screw to secure it.

Step 2 — Connect the external reference signal wires to the terminal strip on the Module. Plus (+) is on the left, minus (—) on the right. Do not strip more than ⅛ inch (3 mm) of insulation off since shorts could occur at exposed points. Maintain the twisted character as long as possible.

Step 3 — At this point refer to Paragraph **5.7.1** if the FlexPak Plus is to follow a **process instrument** controller signal. Refer to Paragraph **5.7.2** if the FlexPak Plus is to be set at a **preset speed** for continuous operation. The procedures differ.

5.7.1 Installing Instrument Interface — When the Kit is to be used as an instrument interface, follow these Steps.

Step 1 — Determine whether the maximum input signal is between 0 to 5 mA or 5 to 50 mA. Locate the black pig-tail jumper on the Module. (Refer to Figure 5.14.) Carefully place it on the directly corresponding pin, both of which are clearly marked.

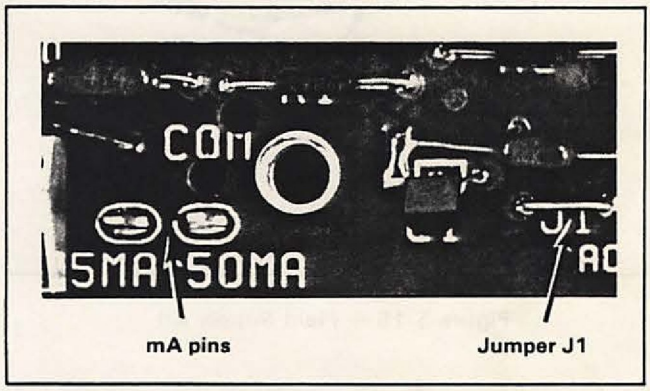


Figure 5.14 — Jumper J1, mA Pins

Step 2 — This Step assumes that the complete drive system, including the controller, has been successfully started up and debugged according to Section 4. It is now necessary to carry out a power-on test. Place the controller in the AUTO mode, if it is so equipped. Set the process instrument controller for minimum output. Locate the Auto Minimum Speed Potentiometer on the Interface Module. Using a small insulated screwdriver, adjust it for the desired minimum motor speed. (CCW decreases speed.)

Step 3 — Set the process instrument controller for maximum output. Locate the Auto Maximum Speed Potentiometer. Adjust it for the desired maximum motor speed. (CW increases speed.)

Step 4 — Since there is some interaction between these two potentiometers, at times it may be necessary to work back and forth to achieve precise adjustments.

5.7.2 Installing Preset Speed — When the Kit is to be used as a simple preset speed device, follow these Steps.

Step 1 — Make the same assumption as in Paragraph 5.7.1, Step 2.

Step 2 — Connect the black pig-tail jumper on the Interface Module to the 50 mA pin. (Refer to Figure 5.14.)

Step 3 — Locate the Auto Minimum Speed Potentiometer on the Interface Module. Turn it CW to the third dot which represents a one-third turn.

Step 4 — Place the controller in the AUTO mode, if so equipped. Locate the Auto Maximum Speed Potentiometer. Adjust it to obtain the desired preset speed. (CW increases speed, CCW decreases it.)

5.8 Field Supply — The Field Supply Kit provides full-wave field excitation for shunt-wound d-c motors. (Refer to Figure 5.15.) It may be optionally applied to controllers from ¼ thru 1½ hp. (It is a standard feature for 3 and 5 hp FlexPak Plus controllers.)

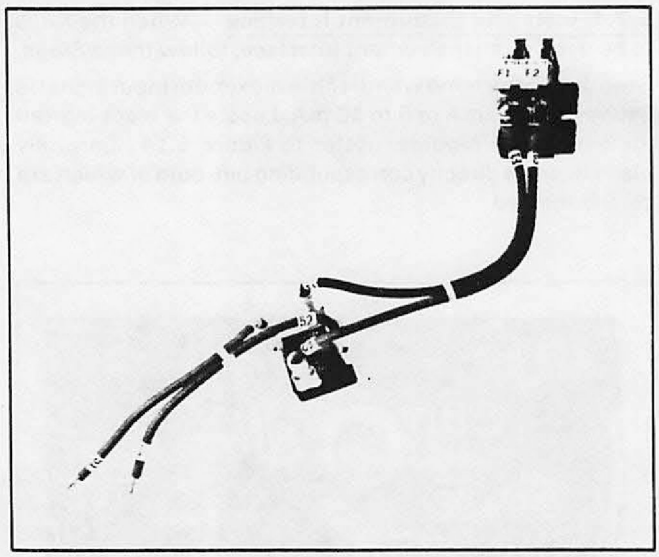


Figure 5.15 — Field Supply Kit

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

The Kit is an assembly consisting of a terminal block, a Field Supply Power Cube, two wire harnesses, and two screws. The user provides the F1/F2 conductors to the drive motor. No other equipment is required.

To install the Kit, follow these procedures.

Step 1 — Mount the Field Supply Power Cube on the right-hand edge of the terminal board bracket of the Basic Controller. Use the long taptite screw and nylon washer provided. Attach the F1, F2 terminal board to the terminal board labeled 32, 132.

Step 2 — Wire from the Field Supply Power Cube to terminals 51 and 52 on 1TB, as shown in Figure 5.16.

Step 3 — The user-supplied field wiring conductors should be drawn into the Chassis. Route them as indicated in Figure 3.4. Move them to the upper screws on 2TB and connect F1/F2 according to the label or Figure 5.16.

5.9 Torque Taper — The addition of the optional Torque Taper Kit to the FlexPak Plus controller allows fine adjustment of the slope and break point of the drive's speed-torque curve. (Refer to Figure 5.17.) It is ideal for cases where simple, center-driven winders and similar applications require a reciprocal speed-torque relationship to maintain constant tension as material builds up. In other words, a higher current limit (here, torque) setting is required for a decrease in motor speed due to a growing diameter. This relationship is shown in Figure 5.18.

① **Note:** The field supply voltages listed in Table 2.D are full wave supplies. For half voltage or half wave supply connect motor lead F1, to terminal 51 on 1TB and motor lead F2 to terminal F2 on 2TB.

A-C LINE VOLTAGE	FIELD SUPPLY VOLTAGE	
	HALF WAVE	FULL WAVE
115V	50	100
230V	100	200

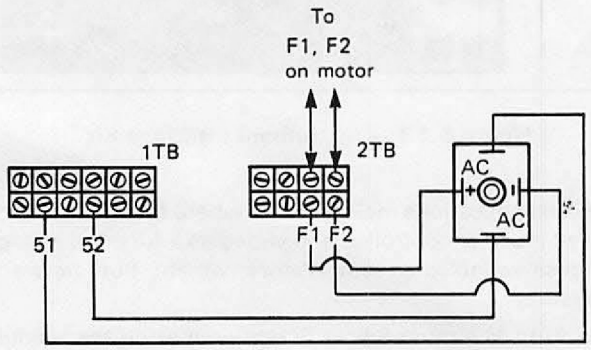


Figure 5.16 — Connecting Field Supply

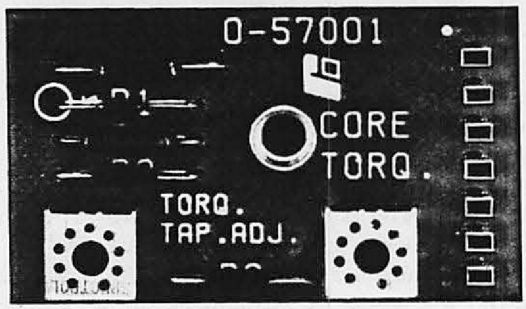


Figure 5.17 — Torque Taper Kit

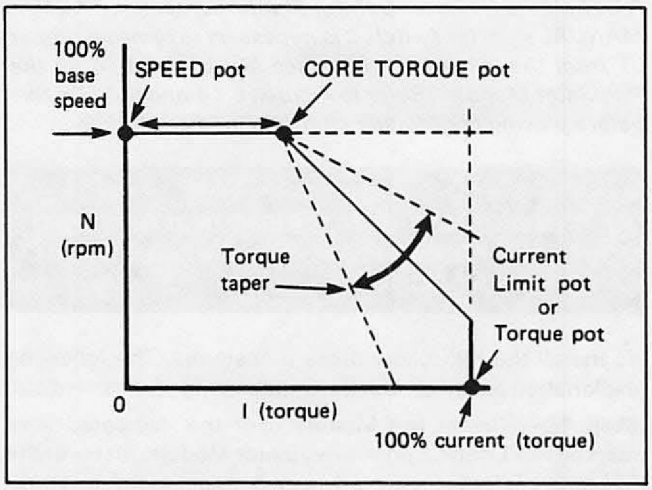


Figure 5.18 — Torque Curves

The Kit consists of a Module and a mounting screw. No other equipment is required. However, the SPEED Potentiometer and either the TORQUE Potentiometer or the Current Limit Potentiometer on the Regulator Module are used in conjunction with the two potentiometers on the Module.

To install the Kit and to make initial adjustments, follow these procedures.

Step 1 — Remove jumpers J7 and J8 on the Regulator Module. (Refer to Figure 6.4.)

Step 2 — Orient the Module over the area marked TORQUE TAPER on the Regulator Module, just over the seven pins. (Refer to Figure 6.4.) Lower it so that the pins pass through the guides in the Module. Use the mounting screw to secure it.

Step 3 — On the Regulator Module, adjust the Current Limit Potentiometer CCW to 100%, or lower, depending on the application. Remember that it is factory-shipped at 150%. Dot No. 4 is approximately 100%. (Refer to Figure 4.1.)

Step 4 — On the Torque Taper Module, turn the CORE TORQUE Potentiometer completely CCW. The core torque setting provides a minimum winding torque, or minimum strip tension, when the winding cycle begins.

Step 5 — On the Torque Taper Module, turn the Torque Taper Potentiometer completely CW. This assures that excessive tension will not develop as the first coil or package is wound.

Step 6 — This Step assumes that the complete drive system, including the controller, has been successfully started up and debugged according to Section 4. It is now necessary to carry out a power-on test. Thread the strip onto the winder and securely fasten it to the core. Remove all strip slack before the drive is restarted.

Step 7 — Set the SPEED Potentiometer for a safe maximum winder speed.

Step 8 — Start the drive. If the strip or web breaks immediately, stop it. Reduce the Current Limit Potentiometer setting on the Regulator Module. (CCW decreases current, here torque.)

If the strip does not immediately break, start the process and allow the winder to begin winding. Accelerate it to normal running speed. On the Torque Taper Module, adjust the CORE TORQUE Potentiometer to obtain the desired strip tension at the beginning of the coil. (CCW decreases, CW increases.)

Step 9 — As the coil or package increases in diameter, adjust the TORQUE TAPER Potentiometer on the Torque Module to maintain proper tension. (CCW increases current, here torque.) Adjust in small increments as the diameter grows.

An ammeter in the armature circuit is useful when adjusting both potentiometers on the Module. Observing the ammeter, which shows current, and the growing coil diameter gives visual confirmation that current (torque) is increasing too fast or slow in relation to the build-up.

***NOTE:** Depending on the amount of torque taper desired and the size of the coil or package being wound, the drive may go into current limit. However, **at no time** should the Current Limit Potentiometer on the Regulator Module be set higher than 100% of the nameplate rating on the motor.*

5.10 Auxiliary M Contacts — With the optional Auxiliary M Contactor Kit, the ON/OFF status of the FlexPak Plus is able to be interlocked with user-supplied devices. (Refer to Figure 5.19.) Typical applications include pilot/indicator lights, alarms, and interlocking with other control circuits dependent on the drive system.

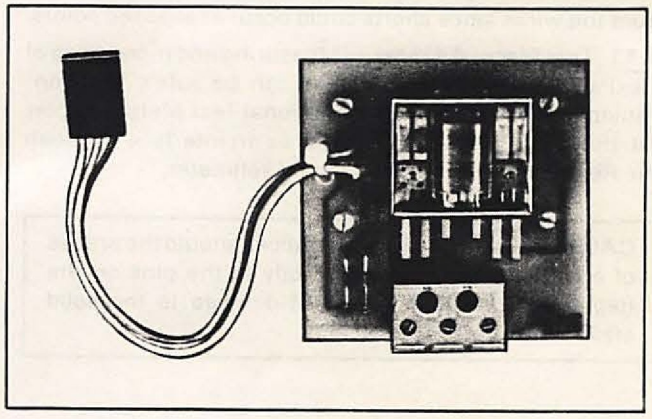


Figure 5.19 — Auxiliary M Contactor Kit

The Kit provides a single pair of Form C contacts, one normally open (NO) and one normally closed (NC). Both share a common terminal. (Refer to Figure 5.20.) These contacts function whether the controller is unidirectional (forward only) or bidirectional (forward/reverse).

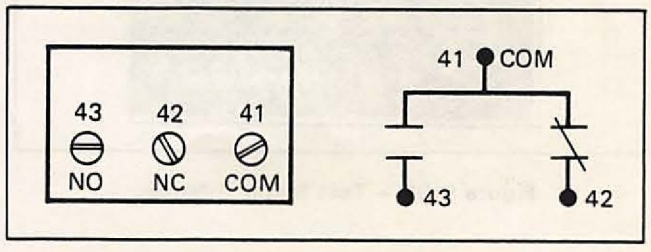


Figure 5.20 — External Wiring, Auxiliary M

The Kit contains only a Module that has a wire harness attached. However, the Auxiliary Panel is also required.

Users supply the wiring to external devices. Size is dependent on the specific application. It should not exceed AWG No. 14.

The maximum rating of each contact is 1 ampere at 30 VDC (resistive) or 0.5 ampere at 120 VAC (resistive).

Under **no** circumstances should these contacts be used to control brakes or other power loads.

To install the Kit, follow these procedures.

Step 1 — Fit the Auxiliary Panel onto the Basic Controller according to Paragraph 5.1.

Step 2 — Mount the Auxiliary M Contactor Module on the center of the Auxiliary Mounting Bracket. (Refer to Figure 2.2.) Note that orientation is important. The overhanging edge of the assembly **must** hang over the Regulator Module. Then snap the assembly into the Bracket.

Step 3 — Connect the three-wire harness to the Regulator Module. Locate the letters AUX. M printed on the Module near a three-pin connector. (Refer to Figure 6.4.) The connector fits on the bayonet pins. Note that the yellow (39) wire **must** connect with the pin marked YEL 39 on the Regulator Module.

Step 4 — Route external wiring to the Module's terminal block. Do not strip more than ¼ inch (6 mm) of insulation from the wires since shorts could occur at exposed points.

5.11 Test Meter Adapter — Measuring and monitoring of FlexPak Plus regulator voltages can be safely and conveniently carried out with the optional Test Meter Adapter Kit. (Refer to Figure 5.21.) It acts as an interface between the Regulator Module and a user's voltmeter.

CAUTION: Under no circumstances should the probes of a meter be connected directly to the pins on the Regulator Module. Permanent damage to the solid state components can occur.

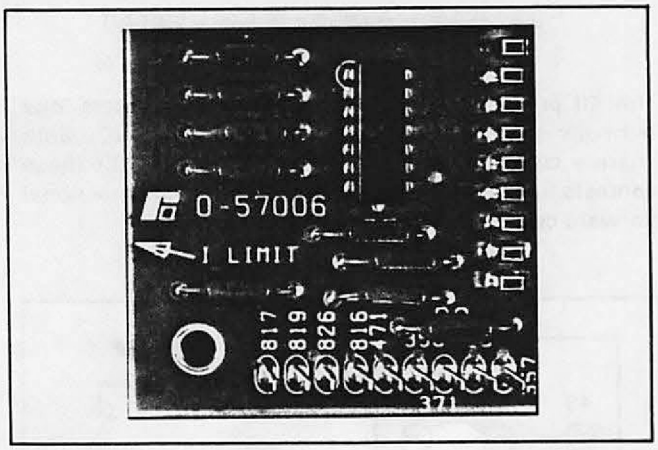


Figure 5.21 — Test Meter Adapter

The Kit contains a Module and a mounting screw. Except for the voltmeter, no other equipment is necessary. The meter should be a multimeter having a sensitivity of 20,000 ohms per volt, minimum. (Simpson Model 260, Triplett Model 630, or equivalents are acceptable.)

To install and use the Kit, follow these procedures.

Step 1 — Orient the Test Meter Adapter Module over the area on the Regulator Module marked TEST, just over the nine pins. (Refer to Figure 6.4.) Lower it so that the pins pass through the guides on the Module. Use the screw to secure it.

Step 2 — For use, refer to Table 5.D where the function is shown in relation to the test terminals to be used. The normal operating voltages are also shown.

5.12 Dancer Follower — The Dancer Follower Kit allows the FlexPak Plus to be controlled **automatically** in response to a speed reference generated by a line speed signal and trimmed by a Dancer Potentiometer. Applications include web process lines where a drive must closely follow or maintain the position of a dancer.

Table 5.D

TEST ADAPTER TERMINALS, READINGS

FOR FUNCTION:	USE TERMINALS:	NORMAL INDICATION (VDC):
Unregulated +20 VDC Power Supply	+456 −357	16-28
Unregulated −20 VDC Power Supply	−471 +357	16-28
Regulated +11.2 VDC Power Supply	+356 −357	10.8-11.5
Regulated −11.2 VDC Power Supply	−371 +357	10.8-11.5
LVTU (linear voltage time unit) Input	+826 −357	0-8.0
Major Loop Feedback	−819 +357	0-4.0
Two Driver Outputs	−816, −817 +356	On 10 VDC scale, increase of approx. 1 VDC occurs when drive is started.

The Kit contains the Dancer Follower Module and a mounting screw. (Refer to Figure 5.22.) Although the FlexPak Plus can use the Kit for exclusive automatic speed control, if manual override control is needed, an AUTO/MANUAL selector switch must be used on the Remote Operator Control Station. In the MANUAL position, the drive responds to the SPEED Potentiometer setting. In AUTO, it follows **only** the external signals and does not respond to manually input speed change commands.

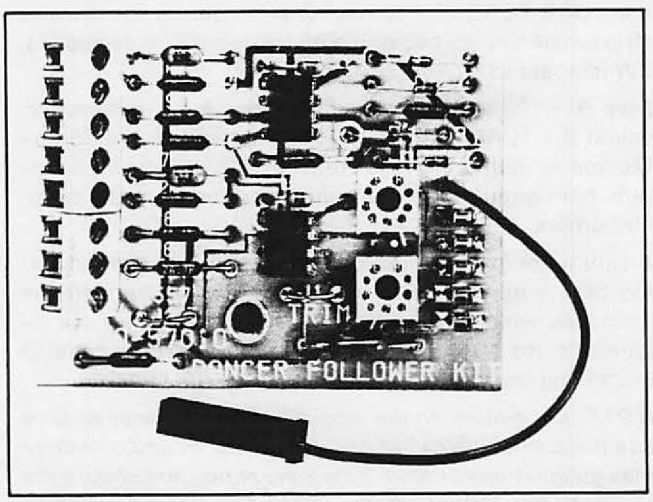


Figure 5.22 — Dancer Follower Module

The Kit is designed to accept a line speed input signal of 4 to 10 VDC to obtain maximum speed. The input impedance between the line speed input terminals 57 and 726 is approximately 25,000 ohms. The Dancer Potentiometer will provide up to a 20% trim to the line speed signal.

The user must supply the required lengths of the specified signal wire. (Refer to Table 5.C.) A Dancer Potentiometer and an optional Dancer Position Potentiometer are also to be supplied by the user.

To install the Kit, follow these procedures.

Step 1 — Refer to Figure 6.4 and note the heavy border area in the center of the Regulator Module marked REFERENCE. This is the area where the Dancer Follower Module is to be mounted. Place the Dancer Follower Module in the proper orientation so the pin guides on the Module are aligned over the set of five pins on the Regulator Module. Lower the Dancer Follower Module so the pins pass through the pin guides and the mounting spacer seats in the mounting hole. (It may be necessary to remove a protective plastic cap from the pins.) Secure the Module with the supplied screw.

Step 2 — Connect the black pig-tail jumper of the Dancer Follower Module to pin 319 on the Regulator Module. (Pin 319 is the third pin down in the group of pins marked TORQUE TAPER.)

Step 3 — Using a twisted pair, connect the external line speed input to the terminal strip of the Dancer Follower Module. The plus (+) wire is connected to terminal 726 and the minus (—) wire is connected to terminal 57.

***NOTE:** Do not strip more than 1/8 inch (3 mm) of insulation off the ends of the wires because a short circuit could occur at any point where the bare wire is exposed. Maintain the twisted configuration of the two wires as long as possible.*

Step 4 — Using three twisted wires, connect the user supplied 5K ohm Dancer Potentiometer to the terminal strip of the Dancer Follower Module. The speed increase side of the potentiometer connects to terminal 556 and the speed decrease side connects to terminal 571. The potentiometer wiper is connected to terminal 919.

Step 5 — If an optional Dancer Position Potentiometer is used (supplied by user), connect the "up" side of the potentiometer to terminal 726 of the Dancer Follower Module and the "down" side to terminal 557. Connect the potentiometer wiper to terminal 926. Also cut and remove jumper J2 and the 26.7K resistor (R6) on the Dancer Follower Module. (Refer to Figure 5.23.)

Step 6 — If an AUTO/MANUAL selector switch is used on the Operator Control Station, remove jumper J1 of the Dancer Follower Module. (Refer to Figure 5.23.) If, however, the controller is to run automatically **without** manual speed control, leave J1 in place.

Step 7 — This Step assumes that the complete drive system, including the controller, has been successfully started and debugged according to Section 4. It is now necessary to conduct a power-on test.

Start the drive and place it in the AUTO mode, if so equipped. With the line speed reference at maximum value, adjust the MAX SPEED TRIM Potentiometer on the Dancer Follower Module for maximum motor speed. If the optional Dancer Position Potentiometer is installed, place it in the mid-range.

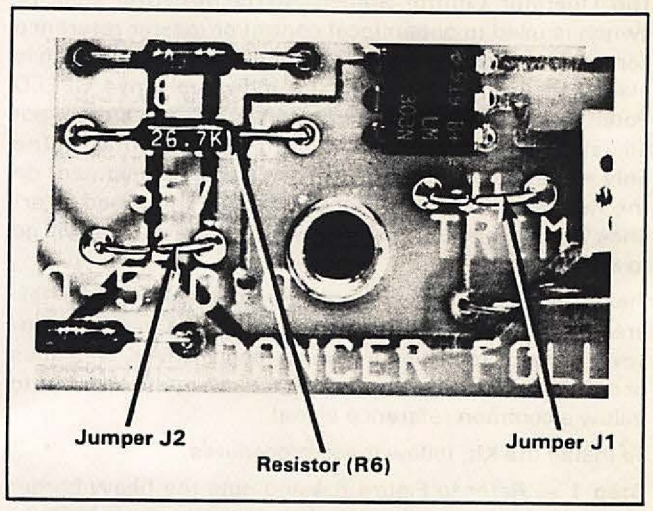


Figure 5.23 — Jumpers J1, J2 and Resistor (R6)

Turn the GAIN Potentiometer of the Dancer Follower Module fully counterclockwise for minimum Dancer Potentiometer response. Turn the GAIN Potentiometer clockwise in small increments to increase the Dancer Potentiometer response.

DANGER
APPLICATION MUST NOT RELY ON ZERO SET/ INPUT SETTING FOR SAFETY. SERIOUS OR FATAL INJURY MAY RESULT.

5.13 Master Isolated Reference Receiver — The Master Isolated Reference Receiver Kit may be added to special order FlexPak Plus controllers. This Kit allows the FlexPak Plus to receive and decode a PWM speed reference signal from the Master Isolated Reference Transmitter. The Receiver Kit consists of two printed circuit boards: a Switch Receiver Module and a Reference Receiver Module which are mounted on the FlexPak Plus Regulator Module. (Refer to Figure 5.24.)

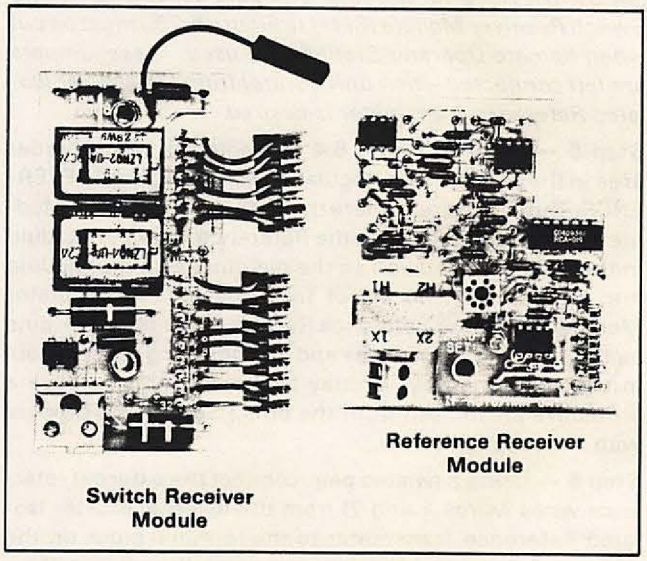


Figure 5.24 — Master Isolated Reference Receiver Kit

The Operator Control Station AUTO/MANUAL selector switch is used to obtain local control or master reference control of the individual drive. When the selector switch is placed in the AUTO mode, the individual drive SPEED Potentiometer automatically is converted into a draw pot adjustment for precise trim control between drives. The only adjustment requirement is a zero set adjustment on the Reference Receiver Module. Should the speed reference wires become disconnected, the FlexPak Plus will go to zero speed.

FlexPak Plus controllers controlled by Master Isolated Reference are ideally suited for non-reversing multiple conveyor drives, proportional pumps, feeder drives, web lines or other similar operations which require multiple drives to follow a common reference signal.

To install the Kit, follow these procedures.

Step 1 — Refer to Figure 6.4 and note the heavy border area at the extreme left-hand side of the Regulator Module. This is the area where the Switch Receiver Module is to be mounted. First, remove the Remote Operator Adapter Module. Then, place the Switch Receiver Module in the proper orientation so the two connectors are aligned over the two sets of pins (marked GRN 28 and RED 32). Carefully, slowly and gently press the connectors down on the pins until they bottom. Then, connect the black pig-tail jumper of the Switch Receiver Module to pin 40 on the Regulator Module. (Pin 40 is the left-hand pin of the group marked AUTO REV.).

Step 2 — Fold the PC board over the top of the two connectors so the mounting spacers fit into the mounting holes.

Step 3 — Connect the external start-stop wires (wires 189 and 288) from the external Master Isolated Reference Transmitter to the terminal block on the Switch Receiver Module in the controller cabinet.

Step 4 — Mount the Remote Operator Adapter Module on top of the Switch Receiver Module and secure the two PC boards with the two long screws provided.

NOTE: The external start-stop wires from the Master Isolated Reference Transmitter (wires 189 and 288) must be connected to the Switch Receiver Module (Refer to Step 3.) before mounting the Remote Operator Adapter Module on the Switch Receiver Module. Jumpers J1 and J2 on the Switch Receiver Module (Refer to Figure 5.25.) must be cut when Remote Operator Stations are used. These jumpers are left connected when only control from the Master Isolated Reference Transmitter is desired.

Step 5 — Refer to Figure 6.4 and note the heavy border area in the center of the Regulator Module marked REFERENCE. This is the area where the Reference Receiver Module is to be mounted. Place the Reference Receiver Module in the proper orientation so the pin guides on the Module are aligned over the set of five pins on the Regulator Module. Lower the Reference Receiver Module so the pins pass through the pin guides and the mounting spacer seats in the mounting hole. (It may be necessary to remove a protective plastic cap from the pins.) Secure the Module with the supplied screw.

Step 6 — Using a twisted pair, connect the external reference wires (wires 1 and 2) from the external Master Isolated Reference Transmitter to the terminal block on the Reference Receiver Module in the controller cabinet. Connect wire 1 to terminal 1 and wire 2 to terminal 2.

NOTE: Do not strip more than 1/8 inch (3 mm) of insulation off the ends of the wires because a short circuit could occur at any point where the bare wire is exposed. Maintain the twisted configuration of the two wires as long as possible.

Step 7 — If an AUTO/MANUAL selector switch is included in the Operator Control Station, cut jumper J1 on the Reference Receiver Module. (Refer to Figure 5.26.)

Step 8 — With the MASTER Speed Potentiometer on the Master Isolated Reference Transmitter set at zero, depress the START pushbutton on the Master Isolated Reference Transmitter. Adjust the ZERO SET Potentiometer on the Reference Receiver Module to obtain zero speed of the drive motor.

DANGER

ALTHOUGH ZERO SET ADJUSTMENT ON THIS KIT ALLOWS FOR ADJUSTMENT DOWN TO ZERO SPEED, THIS ZERO SPEED SETTING MUST NOT BE USED WHERE THE OPERATOR MAY RELY ON A MAINTAINED ZERO SPEED. ELECTRICAL NOISE, IMPROPER WIRING, POWER LINE, OR MALFUNCTIONING COMPONENTS MAY CAUSE THE DRIVE TO TURN ON WHILE AT THE ZERO SPEED SETTING.

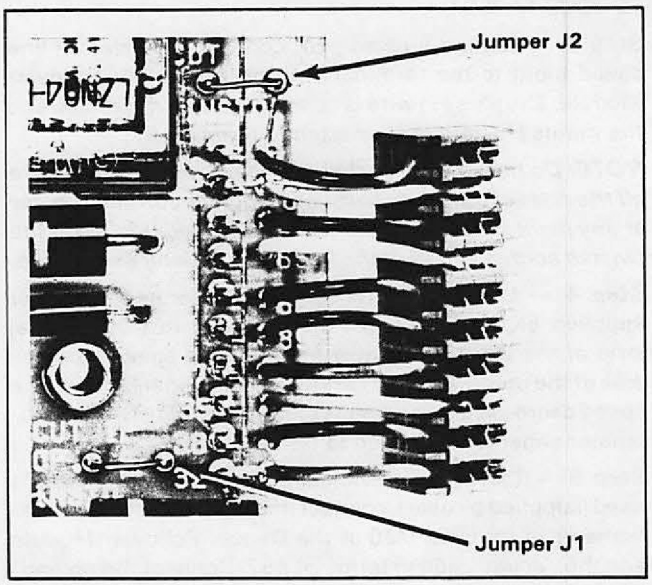


Figure 5.25 — Jumpers J1 and J2 on Switch Receiver Module

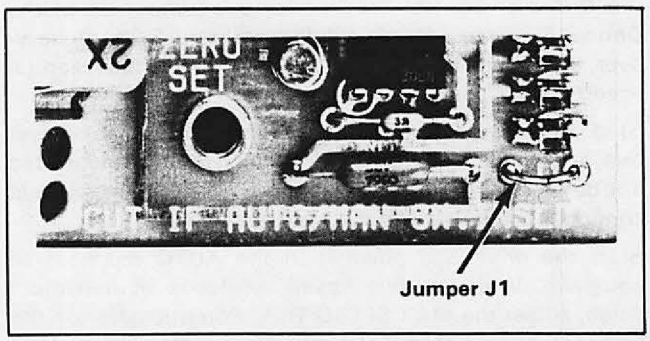


Figure 5.26 — Jumper J1 on Reference Receiver Module

5.14 Contactor Adapter — The Contactor Adapter Kit provides a means of connecting the user-supplied M contactor (and optional user-supplied reversing M contactor) to the Basic FlexPak Plus Controller. Refer to Paragraph 2.4.4 for M contactor specifications.

The Kit is an assembly consisting of an Auxiliary Mounting Bracket, a power terminal strip, two wire harnesses and four screws.

To install the Kit, follow these procedures.

Step 1 — Orient the Auxiliary Mounting Bracket (Refer to Figure 5.2.) over the Basic Controller aligning the mounting holes. Secure the Bracket with the provided washers and screws. Make sure the washer teeth are firmly embedded in the Chassis to provide proper ground.

Step 2 — Orientation of the harness connectors is important. Place the left harness connector over the Regulator pins marked FWD with the orange (139) wire with the pin called out as ORG 139. Place the other harness connector over the Regulator pins marked REV with the blue (66) wire with the pin called out as BLU 66. (Refer to Figure 6.4.)

Step 3 — Wire the user-supplied M contactor (and optional user-supplied reversing contactor) to the kit terminal strip according to Figure 5.27.

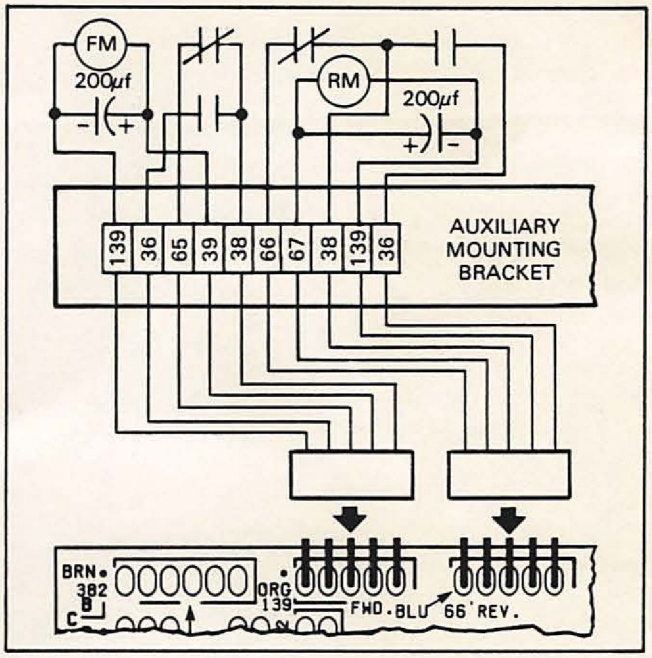


Figure 5.27 — Connecting User-Supplied FM and RM Contactors

Section 6
TROUBLESHOOTING

6.0 General — This Section details troubleshooting information for the FlexPak Plus controller. Its organization is as follows:

- General troubleshooting concepts (Paragraphs 6.1, 6.2, 6.3 and 6.4)
- Specific symptom/probable cause/recommended procedures (Paragraph 6.5)
- Reference schematics of the controller (Paragraph 6.6)

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

DANGER
THE FLEXPAK 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 6.1), incoming a-c line problems (Paragraph 6.2), motor problems (Paragraph 6.3) and mechanical problems (Paragraph 6.4).

6.1 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 5 may be used to uncover wiring problems in the optional Modification Kits.

6.2 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 115 **or** 230 VAC.
- 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.) Refer to Table 3.A.
- A-c conductors must be of adequate size for the application. Refer to Table 3.A.
- 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 (115/230 VAC) in relation to the FlexPak Plus controller.

6.3 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 Complete Controller (terminals 45 and 47 at the Basic Controller) as test points.

6.4 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.

6.5 Controller Malfunctions — Tables 6.B and 6.C present 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.

Note that Reliance Electric color codes the wires to aid the identification of pin numbers, that is, locations. Table 6.A is a listing of these number-color combinations. These colors will be helpful in the following troubleshooting procedures.

6.6 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.

Included are the following drawings:

- Figure 6.1 which is a simplified control circuit schematic for a unidirectional (forward only) controller.
- Figure 6.2 which is a simplified control circuit schematic for a bidirectional (forward/reverse) controller.
- Figure 6.3 which is a timing chart for the relay control sequencing used with this controller.

- Figure 6.4 which is a copy of the screen used to mark the Regulator Module. It is useful in identifying locations on the board. Note that areas where optional Modification Kits fit are marked with heavy lines.
- Figure 6.5 which is a schematic for the controller.
- Figure 6.6 which is a schematic for the Modification Kits.
- Figure 6.7 which may be used to locate major assemblies in the controller. It also lists various technical data although all of this information is included in other parts of the manual.

Table 6.A

COLOR CODING SYSTEM

COMPONENTS	NO.	COLOR
Relay Wire Harness (Forward)	139 36 65 39 38	ORANGE GREEN BLACK YELLOW BROWN
Relay Wire Harness (Reverse)	66 67 38 139 36	BLUE GRAY BROWN ORANGE GREEN
Thermostat Harness	32 132	RED ORANGE
Gate Harness	47 45	BLACK YELLOW
Auto Reverse	40	PURPLE
Auxiliary M	39	YELLOW

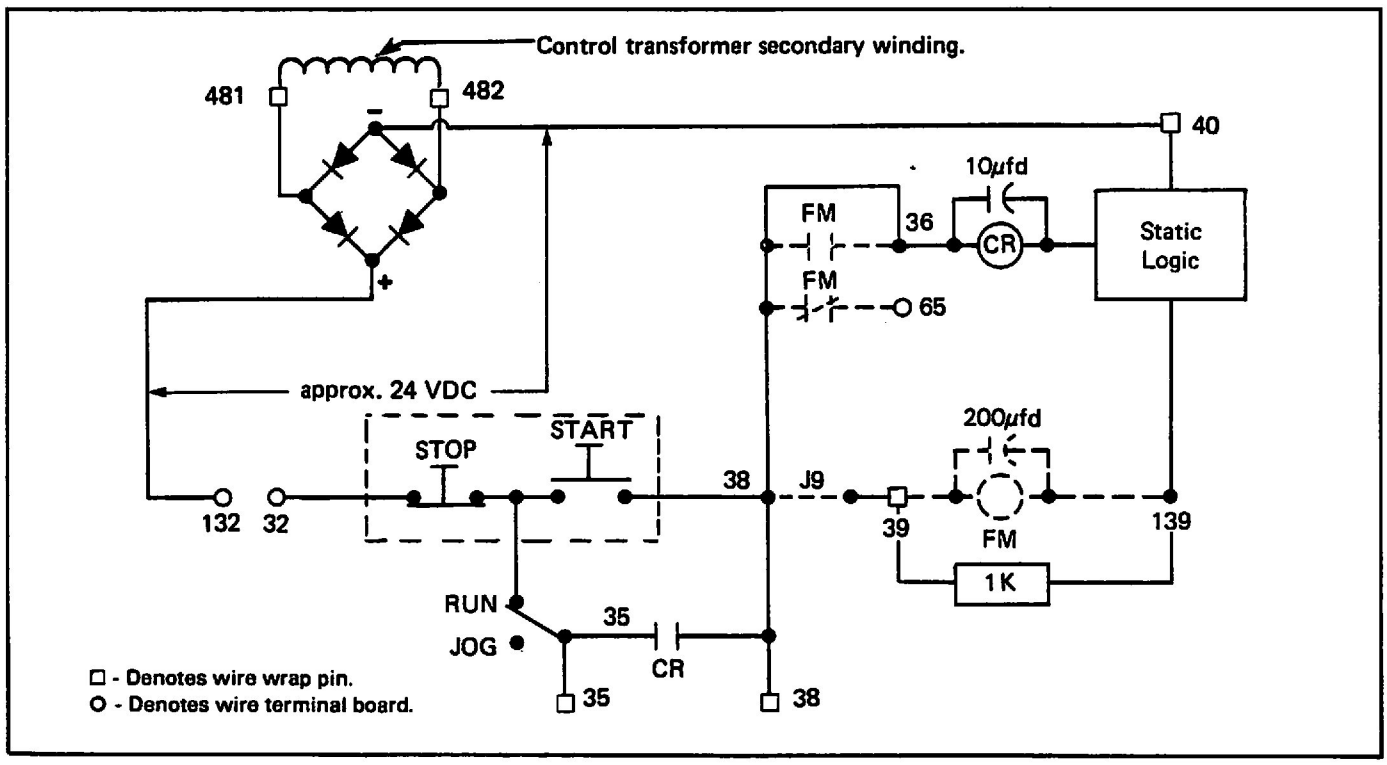


Figure 6.1 — Unidirectional Control Circuit (simplified)

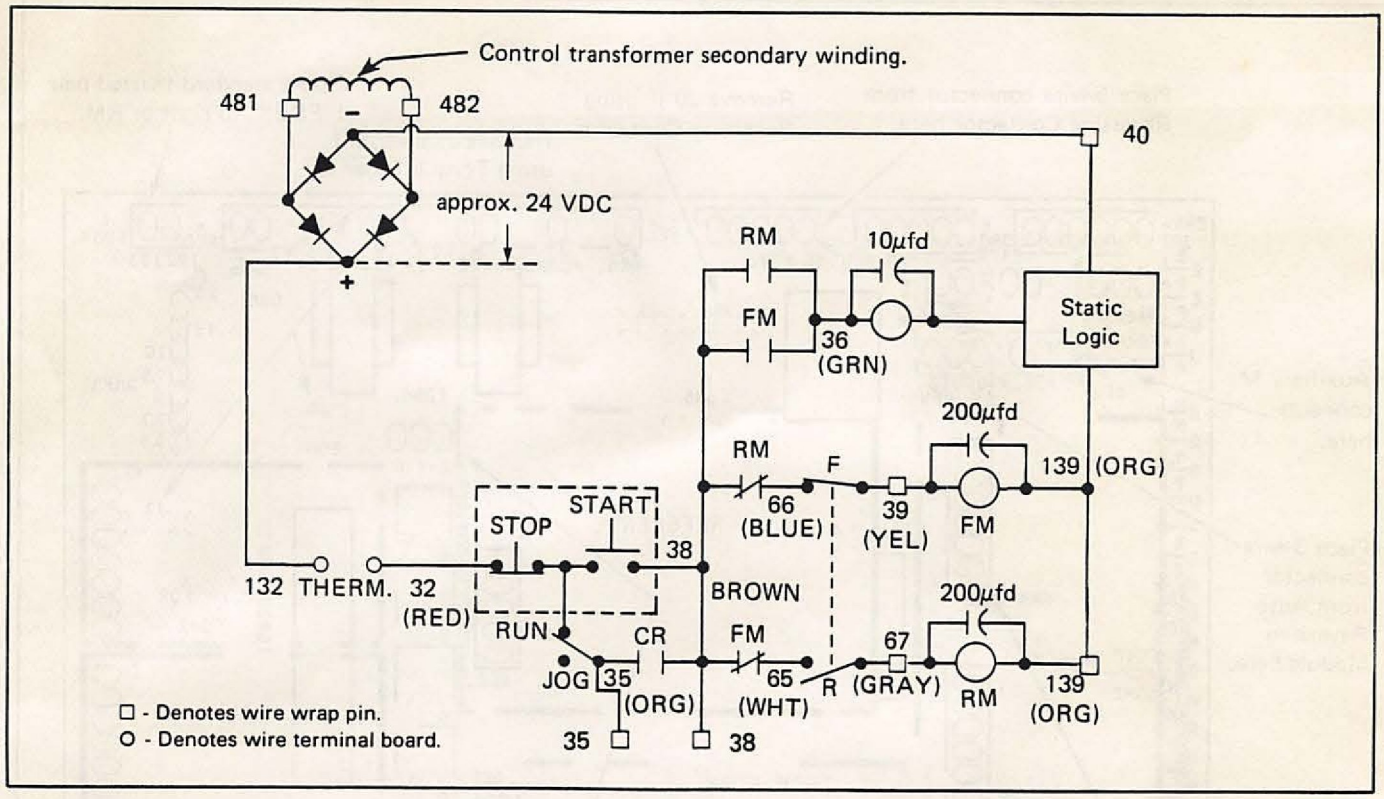


Figure 6.2 — Bidirectional Control Circuit (simplified)

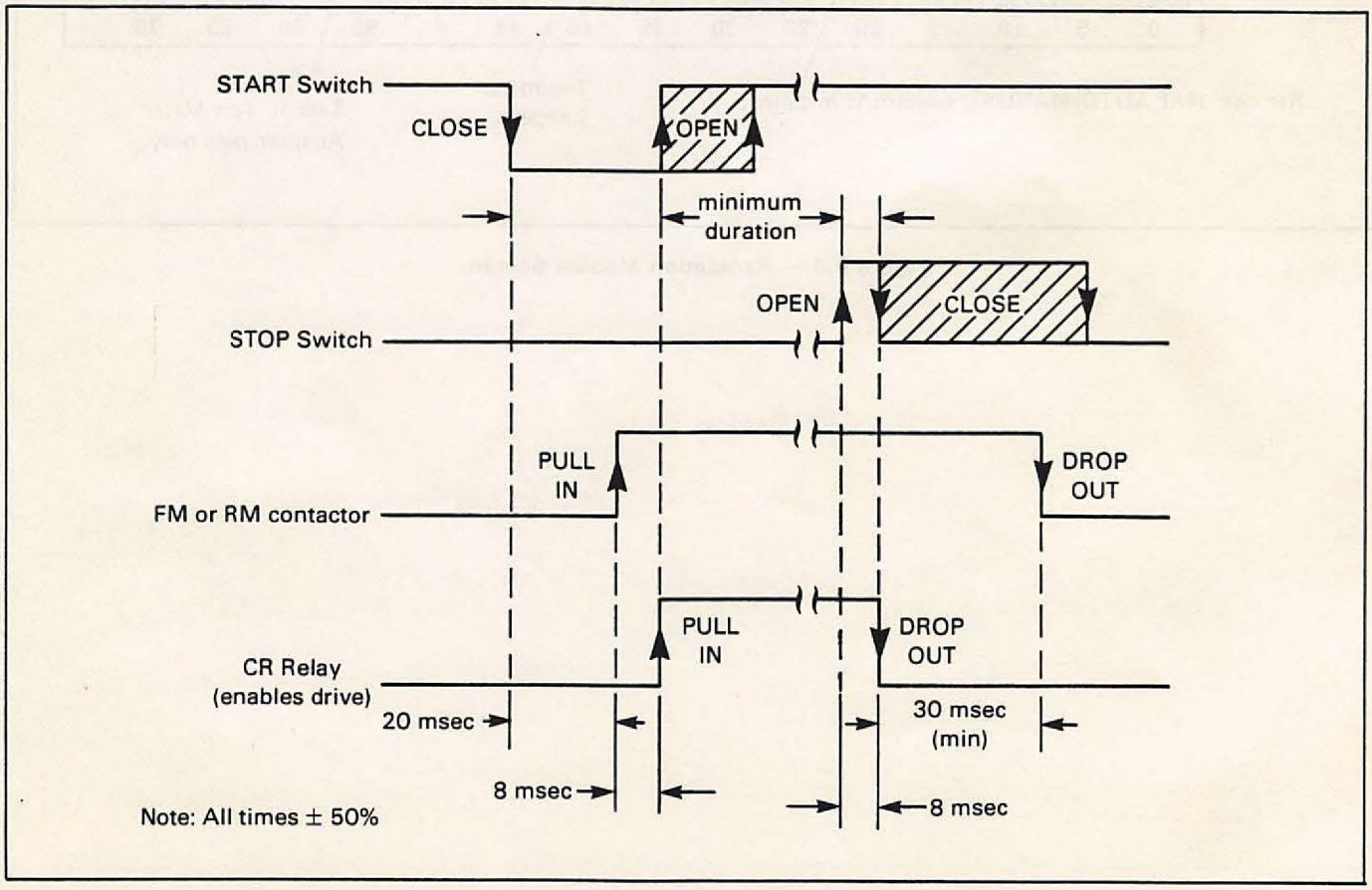


Figure 6.3 — Relay Control Sequencing

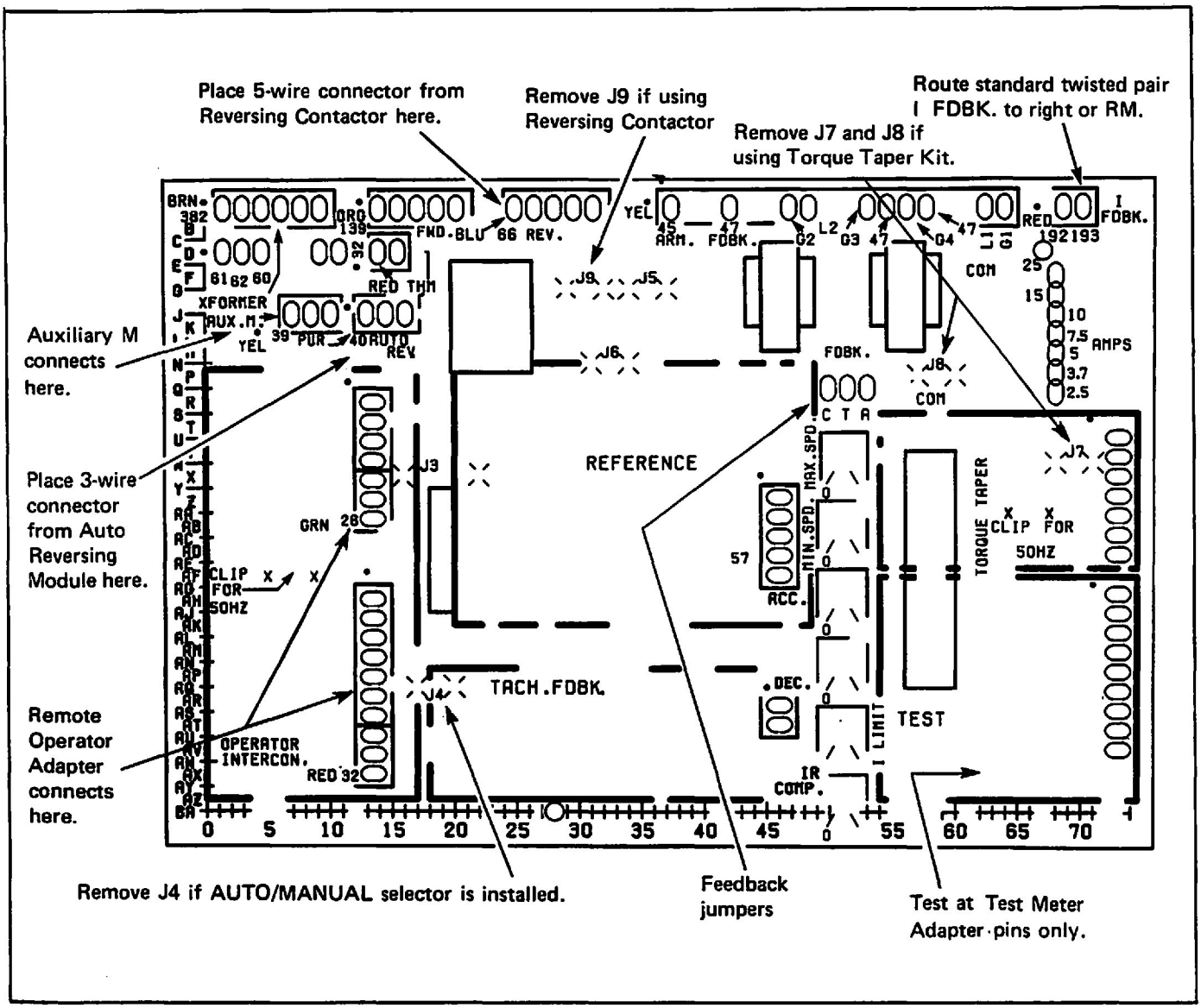


Figure 6.4 — Regulation Module Screen

Table 6.B

TROUBLESHOOTING SUGGESTIONS FOR THE BASIC 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, USER MUST DETERMINE IF A FIELD SUPPLY KIT IS PRESENT. (SEE FIGURE 5.15.) IF FIELD SUPPLY KIT IS PRESENT, THE FIELD SUPPLY KIT AND ITS WIRING MUST BE INSPECTED FOR DAMAGE. AFTER RE-APPLYING POWER TO THE DRIVE, THE FIELD VOLTAGE MUST BE RE-CHECKED FOR PROPER VOLTAGE AT MOTOR TERMINALS F1, F2. IF THIS VOLTAGE IS BELOW 90% OF THE FIELD VOLTAGE SPECIFIED ON THE MOTOR NAMEPLATE, THE DRIVE MUST NOT BE STARTED UNTIL PROPER VOLTAGE IS OBTAINED. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN OVERSPEEDING THE MOTOR AND/OR THE MACHINERY COUPLED TO THE MOTOR SHAFT AND POSSIBLE FATAL INJURY.** ☐ Remove a-c power at the disconnect. ☐ Remove leads to L1, L2, 45, 47 and, if used, F1, F2, on **incoming** side of controller's 1TB and 2TB. (Refer to Figure 3.4.) ☐ Open the power disconnect switch. ☐ Check for a ground condition at L1/181, L2/182, 45, 47, F1 and F2. Do this at controller (internal) side of 1TB and 2TB. If a ground is discovered, check wiring connections on POWER ON/OFF circuit breaker or fuse block and power disconnect. Also check connection to 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 45, 47 and, if used, 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 45, 47, 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 Kit.	☐ Replace Diode Bridge in Field Supply Kit. Inspect wires and connections to Field Supply Kit. Replace all damaged wires and connectors.
2. Drive motor does not start.	Main a-c line disconnect not closed; or fuse blown; or no power applied ahead of disconnect.	☐ Check disconnect switch, fuses in it, and voltage on line.
	Drive interlocks preventing operation.	☐ 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 FlexPak Plus controller terminals 32 and 132 on 2TB.	☐ Check connections to thermostat: at drive motor P1, P2; at controller 32, 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 FlexPak Plus controller terminals 32 and 132 on 2TB.	☐ Check connections to external overload. ☐ Check for open overload. Make a resistance check to overload. (It should read a short, or low resistance, if it is closed.)
3. Drive motor does not run, but CR pulls 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.** (The jumper is removed when the AUTO/MANUAL switch is installed.) ☐ Check the SPEED potentiometer on the Control Station. First, open the power disconnect switch. ☐ Connect a volt-ohmmeter to the Regulator Module Remote Operator Adapter inputs. Connect one lead to terminal 28. Connect the other to terminal 20. (Refer to Figure 3.4 for a Remote Station.) ☐ For proper operation, the reading should be 5K ohms. ☐ Disconnect the VOM lead from terminal 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 6.B

TROUBLESHOOTING SUGGESTIONS FOR THE BASIC CONTROLLER (continued)

SYMPTOM	PROBABLE CAUSE	RECOMMENDED PROCEDURES
4. Drive motor does not run, but CR pulls 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 FlexPak 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-ohmmeter to test pin 357 on the Test Meter Adapter Module. ☐ Connect the second lead to test pin 356 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 readings are obtained, replace the Regulator Module. ☐ Next, check the reference voltage input signal. (This changes in direct proportion to an increase of SPEED potentiometer voltage caused by a turning of the dial.) ☐ Connect one lead of a volt-ohmmeter to pin 357 on the Test Meter Adapter Module. ☐ 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. ☐ 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.
5. Drive motor does not run with CR relay picked up and SPEED potentiometer properly operating. (Use this procedure only if controller does not have optional Test Meter Adapter Kit.)	No output from Power Cube.	☐ Examine armature wiring. First, open the power disconnect switch. ☐ Check armature wiring for loose connections. ☐ Turn a-c power on again. **DANGER** THE PROCEDURE DESCRIBED HERE IS PERFORMED WITH LIVE A-C VOLTAGE APPLIED TO THE 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-ohmmeter to terminals 45 and 47 on 1TB. (Refer to Figure 3.4.) ☐ 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 45 and 47 should be 0 to 90 VDC for 115 VAC controllers. It should be 0 to 180 for 230 VAC controllers. ☐ If no reading is obtained across 45 and 47, it may be necessary to replace the Power Cube and/or the Regulator Module. In order to determine which, read on.
	Regulator Module suspected because no output reading at 45, 47.	☐ Test the Regulator Module for firing pulses. ☐ Open the power disconnect switch. ☐ Locate on the Regulator Module a connector near the edge directly above the Maximum Speed potentiometer. (Refer to Figure 6.4.) This connector has four sets of twisted red and white wires going into it. ☐ Gently lift the connector off the pins. Move it aside to a position where it cannot cause shorts or grounds. ☐ Connect the leads of the VOM to pins L1 and G1. (These pins are identified on the Module.) Refer to Figure 6.4. ☐ Restore power to controller. ☐ Place the START/STOP switch in the START position. ☐ Turn the SPEED potentiometer to 10. ☐ The reading on the VOM should be ½ VAC for proper operation. ☐ If this reading cannot be obtained, replace the Regulator Module. ☐ In turn, repeat this same test with pins L2/G2, 47/G3, 47/G4.
	Power Cube suspected because no output reading at 45, 47.	☐ Establish that the Power Cube is receiving pulse inputs at the connector on the Regulator Module. (Refer to "Regulator Module suspected," Symptom 5.) ☐ If the Power Cube is receiving pulses yet there is no reading across 45 and 47, determine that the main contacts on the M contactor are closing. ☐ In order to check the contacts, replace the drive motor with a light bulb on the armature wiring at 1TB. (On 230 VAC controllers use two light bulbs in series.) ☐ If the light does not light, replace the Power Cube.

Table 6.B

TROUBLESHOOTING SUGGESTIONS FOR THE BASIC CONTROLLER (continued)

SYMPTOM	PROBABLE CAUSE	RECOMMENDED PROCEDURES
6. Drive motor does not run with CR relay picked up and SPEED potentiometer properly operating. (Use this procedure **only** if controller has optional Test Meter Adapter Kit.)	No gate firing pulses.	☐ Turn off power to the controller at the main disconnect. ☐ Connect a volt-ohmmeter lead to test pin 356 on the Test Meter Module. ☐ Connect the second lead to test pin 817. ☐ Restore power to the 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. ☐ Place the START/STOP switch in the START position. ☐ On the +10 VDC scale of the volt-ohmmeter, an increase of approximately +1 VDC should be noted. ☐ Turn off power to the controller. ☐ Reconnect the volt-ohmmeter to test pins 356 and 816. ☐ On the +10 VDC scale of the volt-ohmmeter, an increase of approximately +1 VDC should be noted. ☐ If voltage readings increase, the Power Cube is receiving pulses to its SCRs. ☐ Make a last check of wiring to the Power Cube. ☐ If wiring is correct, replace the Power Cube.
7. 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 at terminals 32 and 35. When the switch is in the RUN position, a short should be read.

Table 6.C

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.	**DANGER** IF CIRCUIT BREAKER HAS TRIPPED OR FUSES HAVE CLEARED, USER MUST DETERMINE IF A FIELD SUPPLY KIT IS PRESENT. (SEE FIGURE 5.15.) IF FIELD SUPPLY KIT IS PRESENT, THE FIELD SUPPLY KIT AND ITS WIRING MUST BE INSPECTED FOR DAMAGE. AFTER RE-APPLYING POWER TO THE DRIVE, THE FIELD VOLTAGE MUST BE RE-CHECKED FOR PROPER VOLTAGE AT MOTOR TERMINALS F1, F2. IF THIS VOLTAGE IS BELOW 90% OF THE FIELD VOLTAGE SPECIFIED ON THE MOTOR NAMEPLATE, THE DRIVE MUST NOT BE STARTED UNTIL PROPER VOLTAGE IS OBTAINED. FAILURE TO FOLLOW THIS PROCEDURE COULD RESULT IN OVERSPEEDING THE MOTOR AND/OR THE MACHINERY COUPLED TO THE MOTOR SHAFT AND POSSIBLE FATAL INJURY. ☐ Remove a-c power at the disconnect. ☐ Remove leads to L1, L2, A1, A2 and, if used, F1, F2, on incoming side of controller's 1TB and 2TB. (Refer to Figure 3.4.) ☐ Open the power disconnect switch. ☐ Check for a ground condition at L1/181, L2/182, A1, A2, F1 and F2. Do this at controller (internal) side of 1TB and 2TB. If a ground is discovered, check wiring connections on POWER ON/OFF circuit breaker or fuse block and power disconnect. Also check connection to 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, if used, 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 Kit.	☐ Replace Diode Bridge in Field Supply Kit. Inspect wires and connections to Field Supply Kit. Replace all damaged wires and connectors.
2. Drive motor does not start.	Main a-c line disconnect not closed; or fuse blown; or no power applied ahead of disconnect.	☐ Check disconnect switch, fuses in it, and voltage on line.
	Drive interlocks preventing operation.	☐ 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 FlexPak Plus controller terminals 32 and 132 on 2TB.	☐ Check connections to thermostat: at drive motor P1, P2; at controller 32, 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 FlexPak Plus controller terminals 32 and 132 on 2TB.	☐ Check connections to external overload. ☐ Check for open overload. Make a resistance check to overload. (It should read a short, or low resistance, if it is closed.)
3. In non-reversing, controllers only. . . Controller's M contactor not picking up when START switch is pressed (closed).		☐ Open the power disconnect switch. ☐ Examine M contactor for firm seating. ☐ On the M contactor, connect an ohmmeter on the brown (location 38) and black (location 65) wires. A short should be read. ☐ Connect the ohmmeter on the orange (location 139) and yellow (39) wires. The reading should be approximately 230 ohms. ☐ If these readings cannot be obtained, replace the M contactor. (Refer to Table 7.A.)
4. In reversing controllers only. . . Controller's M contactor not picking up when START switch is pressed (closed).	FORWARD/REVERSE switch malfunction.	☐ Examine Remote Operator Adapter on Regulator Module for firm seating and proper wiring and pin connections. (Refer to Figure 6.4.) ☐ Test FORWARD/REVERSE switch. Use basic technique outlined above for the START/STOP switch. Here test 39 (purple) against 66 (blue) and 65 (white) against 67 (gray).
	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 500 ohms if it is operating properly. ☐ Without changing test points, place the switch in the REVERSE position. The reading should be about 500 ohms if it is operating properly. If a short is observed, remove jumper J9 and repeat the test. ☐ If a 500-ohm resistance reading cannot be obtained when the switches are open, the M contactor is malfunctioning and must be replaced.

Table 6.C

TROUBLESHOOTING SUGGESTIONS FOR THE COMPLETE CONTROLLER (continued)

SYMPTOM	PROBABLE CAUSE	RECOMMENDED PROCEDURES
5. M contactor picks up but remains in only when START pushbutton is pressed and held in.	RUN/JOG switch is in JOG postion.	☐ Place the RUN/JOG switch in the RUN position.
	CR relay not picking up.	☐ Connect a volt-ohmmeter on the Remote Operator Adapter. Place it on terminal 35. ☐ Connect the second probe to connection 139 (orange wire) connected to the FlexPak Plus M contactor. ☐ The reading should be +24 VDC for normal operation. (Refer to Figure 6.5 to see the logic of this test.) ☐ Next, shift the probe from terminal 35 to terminal 38 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. (Refer to Figure 6.5 to see the logic of this test.) ☐ Press the START/STOP switch to STOP, and then START. A 24 VDC (approximate) reading should continue to appear. If it does not, the CR relay is not picking up. In this case, replace the Regulator Module.
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.	☐ 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.) ☐ Check the SPEED potentiometer on the Control Station. First, open the power disconnect switch. ☐ Connect a volt-ohmmeter to the Regulator Module Remote Operator Adapter inputs. Connect one lead to terminal 28. Connect the other to terminal 20. (Refer to Figure 3.4 for a Remote Station.) ☐ For proper operation, the reading should be 5K ohms. ☐ Disconnect the VOM lead from terminal 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.
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.	☐ First check the main power supplies. This must be done with power applied to the FlexPak 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-ohmmeter to test pin 357 on the Test Meter Adapter Module. ☐ Connect the second lead to test pin 356 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 readings are obtained, replace the Regulator Module. ☐ Next, check the reference voltage input signal. (This changes in direct proportion to an increase of SPEED potentiometer voltage caused by a turning of the dial.) ☐ Connect one lead of a volt-ohmmeter to pin 357 on the Test Meter Adapter Module. ☐ 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. ☐ 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.
8. Drive motor does not run with M contactor picked up and SPEED potentiometer properly operating. (Use this procedure only if controller does **not** have optional Test Meter Adapter Kit.) Continue this symptom on next page	No output from Power Cube.	☐ Examine armature wiring. First, open the power disconnect switch. ☐ Check armature wiring for loose connections. ☐ Turn a-c power on again. **DANGER** **THE PROCEDURE DESCRIBED HERE IS PERFORMED WITH LIVE A-C VOLTAGE APPLIED TO THE 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-ohmmeter to terminals A1 and A2 on 1TB. (Refer to Figure 3.4.) ☐ 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 A1 and A2 should be 0 to 90 VDC for 115 VAC controllers. It should be 0 to 180 for 230 VAC controllers. ☐ If no reading is obtained across A1 and A2, it may be necessary to replace the Power Cube and/or the Regulator Module. In order to determine which, read on.

Table 6.C

TROUBLESHOOTING SUGGESTIONS FOR THE COMPLETE CONTROLLER (continued)

SYMPTOM	PROBABLE CAUSE	RECOMMENDED PROCEDURES
8. Drive motor does not run with M contactor picked up and SPEED potentiometer properly operating. (continued)	Regulator Module suspected because no output reading at A1, A2.	☐ Test the Regulator Module for firing pulses. ☐ Open the power disconnect switch. ☐ Locate on the Regulator Module a connector near the edge directly above the Maximum Speed potentiometer. (Refer to Figure 6.4.) This connector has four sets of twisted red and white wires going into it. ☐ Gently lift the connector off the pins. Move it aside to a position where it cannot cause shorts or grounds. ☐ Connect the leads of the VOM to pins L1 and G1. (These pins are identified on the Module.) Refer to Figure 6.4. ☐ Restore power to controller. ☐ Place the START/STOP switch in the START position. ☐ Turn the SPEED potentiometer to 10. ☐ The reading on the VOM should be ½ VAC for proper operation. ☐ If this reading cannot be obtained, replace the Regulator Module. ☐ In turn, repeat this **same** test with pins L2/G2, 47/G3, 47/G4.
	Power Cube suspected because no output reading at A1, A2.	☐ Establish that the Power Cube is receiving pulse inputs at the connector on the Regulator Module. (Refer to "Regulator Module suspected," Symptom 8.) ☐ If the Power Cube is receiving pulses yet there is no reading across A1 and A2, determine that the main contacts on the M contactor are closing. ☐ In order to check the contacts, replace the drive motor with a light bulb on the armature wiring at 1TB. (On 230 VAC controllers use two light bulbs in series.) ☐ If the light does not light, replace the Power Cube.
9. Drive motor does not run with M contactor picked up and SPEED potentiometer properly operating. (Use this procedure **only** if controller has optional Test Meter Adapter Kit.)	No gate firing pulses.	☐ Turn off power to the controller at the main disconnect. ☐ Connect a volt-ohmmeter lead to test pin 356 on the Test Meter Module. ☐ Connect the second lead to test pin 817. ☐ Restore power to the 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.** ☐ Place the START/STOP switch in the START position. ☐ On the +10 VDC scale of the volt-ohmmeter, an increase of approximately +1 VDC should be noted. ☐ Turn off power to the controller. ☐ Reconnect the volt-ohmmeter to test pins 356 and 816. ☐ On the +10 VDC scale of the volt-ohmmeter, an increase of approximately +1 VDC should be noted. ☐ If voltage readings increase, the Power Cube is receiving pulses to its SCRs. ☐ Make a last check of wiring to the Power Cube. ☐ If wiring is correct, replace the Power Cube.
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 at terminals 32 and 35. When the switch is in the RUN position, a short should be read.

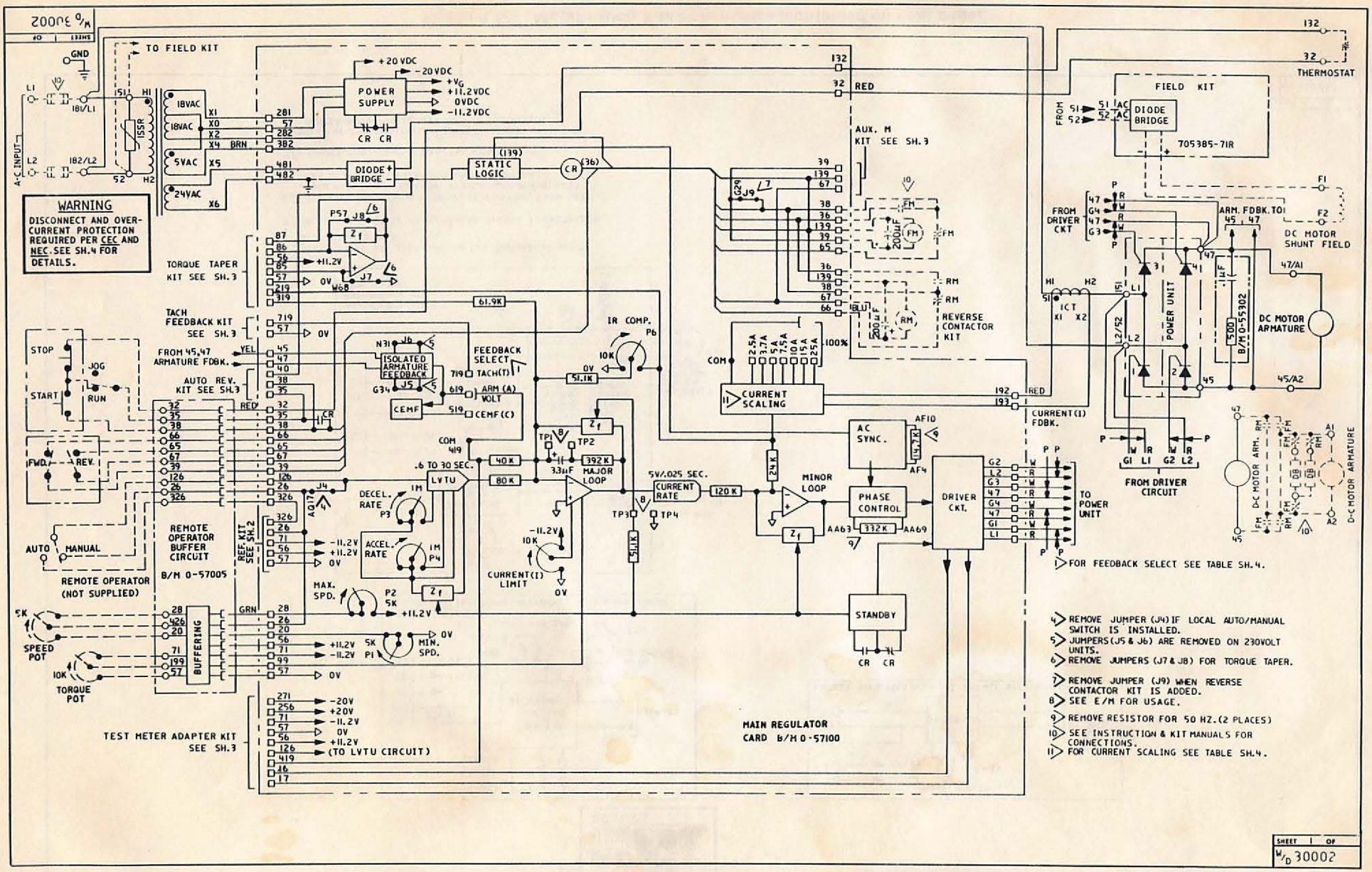
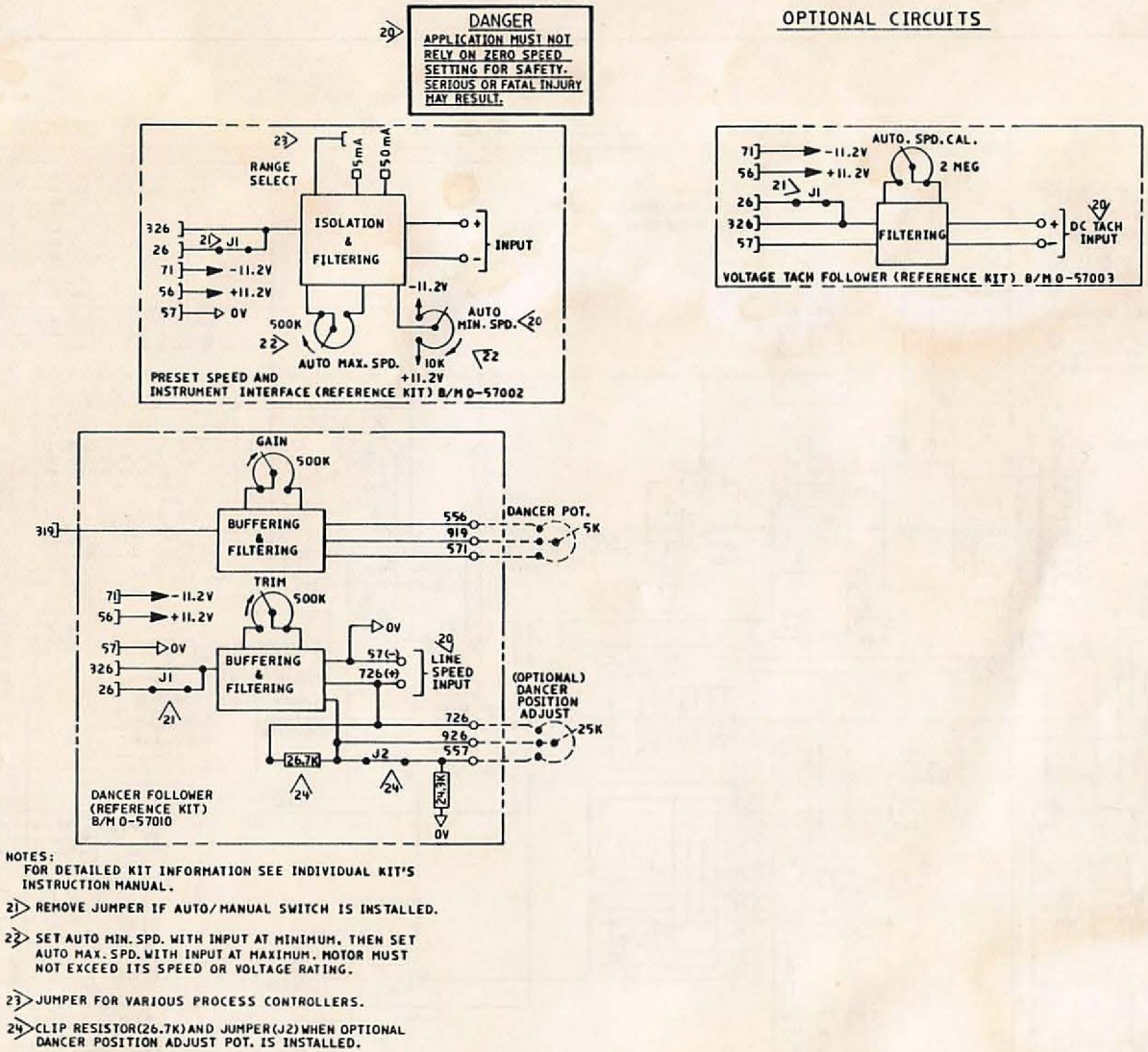


Figure 6.5 — Controller Schematic



NOTES:
FOR DETAILED KIT INFORMATION SEE INDIVIDUAL KIT'S INSTRUCTION MANUAL.

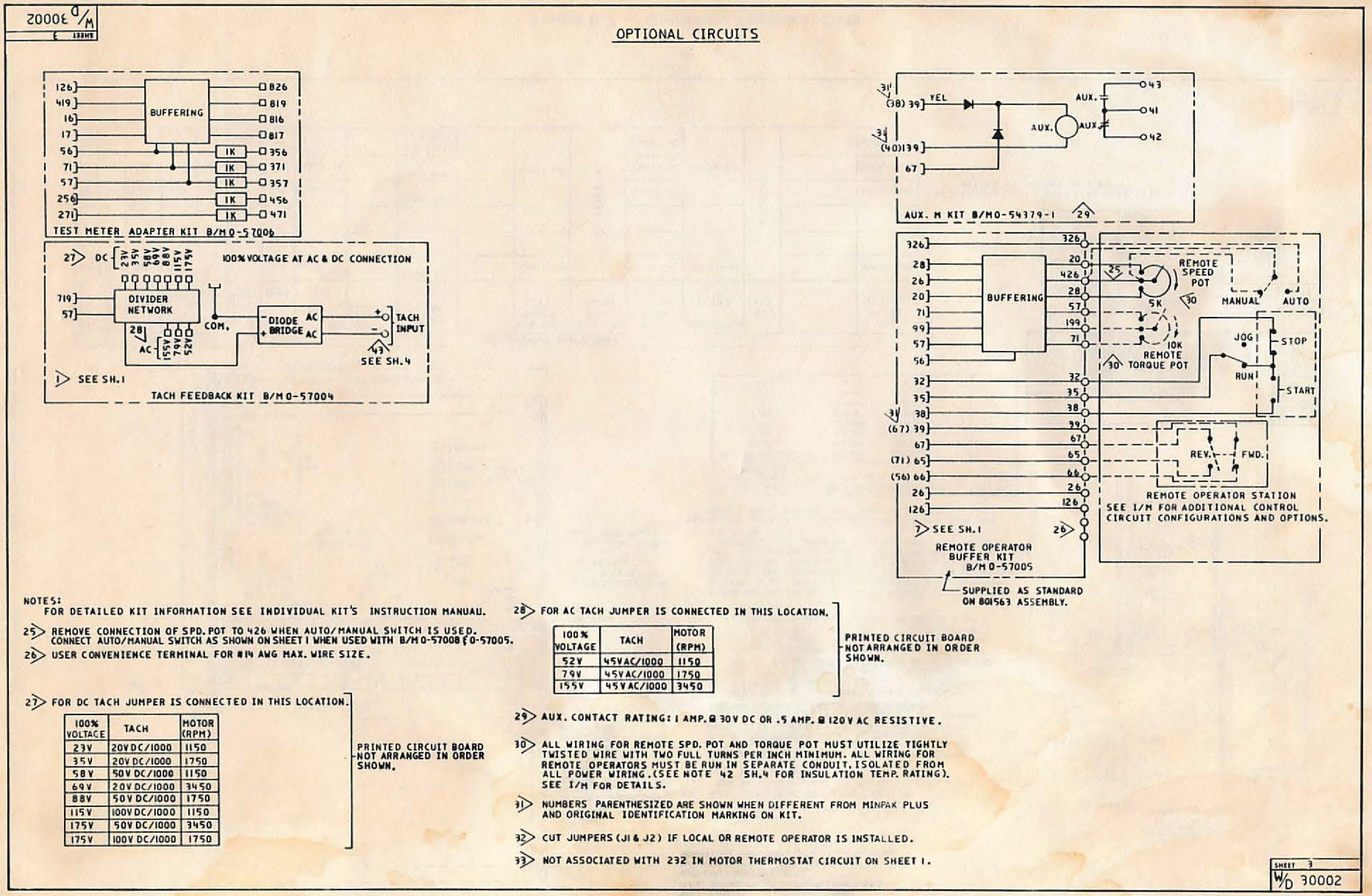
21 REMOVE JUMPER IF AUTO/MANUAL SWITCH IS INSTALLED.

22 SET AUTO MIN. SPD. WITH INPUT AT MINIMUM, THEN SET AUTO MAX. SPD. WITH INPUT AT MAXIMUM. MOTOR MUST NOT EXCEED ITS SPEED OR VOLTAGE RATING.

23 JUMPER FOR VARIOUS PROCESS CONTROLLERS.

24 CLIP RESISTOR(26.7K) AND JUMPER(J2) WHEN OPTIONAL DANCER POSITION ADJUST POT. IS INSTALLED.

Figure 6.6 — Modification Kits Schematics (continued on next page)



NOTES:
FOR DETAILED KIT INFORMATION SEE INDIVIDUAL KIT'S INSTRUCTION MANUAL.

25> REMOVE CONNECTION OF SPD. POT TO 426 WHEN AUTO/MANUAL SWITCH IS USED. CONNECT AUTO/MANUAL SWITCH AS SHOWN ON SHEET 1 WHEN USED WITH B/M 0-57008 & 0-57005.

26> USER CONVENIENCE TERMINAL FOR #14 AWG MAX. WIRE SIZE.

27> FOR DC TACH JUMPER IS CONNECTED IN THIS LOCATION.

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

PRINTED CIRCUIT BOARD NOT ARRANGED IN ORDER SHOWN.

28> FOR AC TACH JUMPER IS CONNECTED IN THIS LOCATION.

100% VOLTAGE	TACH	MOTOR (RPM)
52V	45VAC/1000	1150
79V	45VAC/1000	1750
155V	45VAC/1000	3450

PRINTED CIRCUIT BOARD NOT ARRANGED IN ORDER SHOWN.

29> AUX. CONTACT RATING: 1 AMP. @ 30V DC OR .5 AMP. @ 120V AC RESISTIVE.

30> ALL WIRING FOR REMOTE SPD. 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 42 SH.4 FOR INSULATION TEMP. RATING). SEE I/M FOR DETAILS.

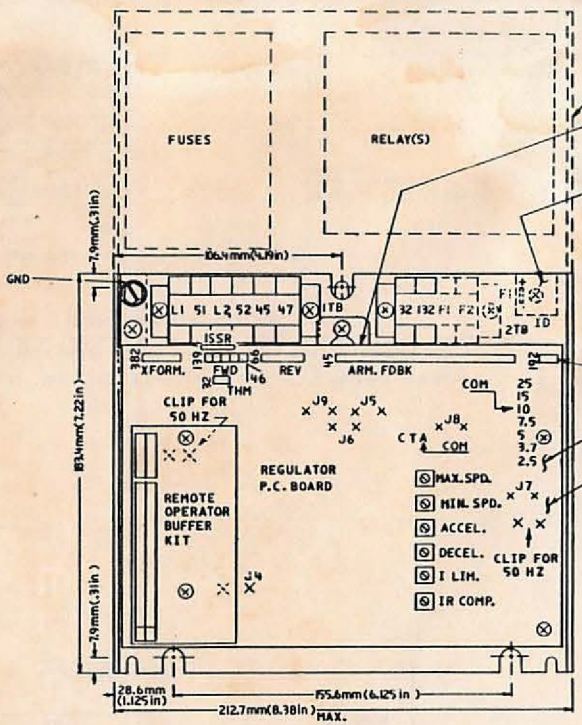
31> NUMBERS PARENTHESIZED ARE SHOWN WHEN DIFFERENT FROM MINPAK PLUS AND ORIGINAL IDENTIFICATION MARKING ON KIT.

32> CUT JUMPERS (J1 & J2) IF LOCAL OR REMOTE OPERATOR IS INSTALLED.

33> NOT ASSOCIATED WITH 232 IN MOTOR THERMOSTAT CIRCUIT ON SHEET 1.

SHEET 3
W/D 30002

Figure 6.6 — Modification Kits Schematics (continued from prior page)



MOUNTING DATA

WEIGHT: 4.08 kg(9.0 lb)
MAX. PROJECTION: 151.1 mm (5.95in)
MAX. SWING PROJECTION: 165.1mm(6.5 in)
W/D OPTIONS: SEE NOTE.
MOUNTING HOLES: 5.53mm(.218in) DIA.
MOUNTING HARDWARE SIZE: 4.83mm(.190in)

42> MAX. USER'S WIRE SIZE: #8AWG COPPER
MIN. 75°C INSULATION ≤3 HP (GR'S "RB, SB, & SC")
MIN. 90°C INSULATION 5 HP (GR'S "SD")

43> ALL WIRING FOR AUTO REF. AND 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 42 FOR INSULATION TEMP. RATING, AND I/M FOR INSTALLATION REQUIREMENT.

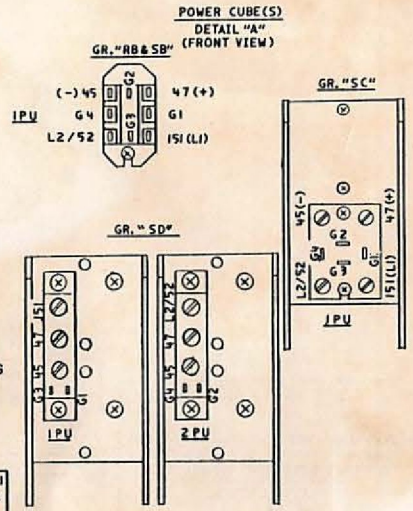
44> A) AN EXTERNAL, U/L LISTED, FUSED DISCONNET OR CIRCUIT BREAKER IS REQUIRED TO PROVIDE NEC OR CEC DISCONNECT AND OVERCURRENT PROTECTION ON UNITS RATED FOR MORE THAN 1 HP.

B) MAXIMUM PERMISSIBLE AVAILABLE SYMMETRICAL RMS SHORT CIRCUIT POWER SUPPLY CAPACITY ON UNITS WITH EXTERNAL U/L LISTED, DISCONNECT DESCRIBED IN (A) AND SET UP FOR MORE THAN 1 HP: 5,000 A.

45> WHEN INSTALLING REPLACEMENT POWER CUBE(S), APPLY A VERY THIN, UNIFORM THICKNESS FILM OF DOW #111 TO MOUNTING SURFACE. FILM IS TOO THICK IF IT SQUEEZES OUT AROUND POWER CUBE(S) AFTER POWER CUBE(S) ARE TORQUED DOWN. START THE MOUNTING SCREWS CAREFULLY INTO EXISTING THREADS AND THEN TORQUE 25 TO 35 IN/LBS.

46> REMOVE AND REPLACE WITH CONNECTOR (SUPPLIED WITH AUX. PANEL) WHEN OPTIONAL AUX. PANEL IS INSTALLED.

POWER CUBE(S) DETAIL "A" (FRONT VIEW)



CURRENT SCALING: CONNECT JUMPER FROM COM TO MOTOR CURRENT RATINGS PER VOLTAGE & HP RATINGS SPECIFIED BELOW.			SEE SH.1 FOR REF. NOTE
MOTOR CURRENT	115 VAC	230 VAC	11
2.5A	1/4 HP	1/2 HP	
3.7A	1/3 HP	3/4 HP	
5A	1/2 HP	1 HP	
7.5A	3/4 HP	1 1/2 HP	
10A	——	2 HP	
15A	——	3 HP	
25A	——	5 HP	

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

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

47> REMOVE LUGS & BARE LEAD ENDS .38 INCH BEFORE INSTALLING ON 1TB.

WIRING DIA. 30002	REF. ASSY 801563	PANEL RATING <44 MAX. RATED HP	AC INPUT VOLTS	AC INPUT AMPS	DC OUTPUT VOLTS	DC OUTPUT AMPS	CURRENT TRANSFORMER ICT	CURRENT TRANSFORMER	POWER CUBE <45		CONTROL TRANSF. (1T)	REGULATOR P.C. BOARD	FIELD DIODE (1D)	SUPPRESSOR (1SSR) 47>	RC CARD		AUX. PANEL (OPTIONAL)
RB	RB	3/4	115	10.5	90	7.5	64670-17R		701819-9X		411027-61R	0-57100 <45	——	411026-4X	0-55302		801592-36RB
SB	SB	1 1/2	230	10.5	180	7.5	64670-17R		701819-9AC		411027-61S		——				801592-36SB
SC	SC	3	230	21	180	15	64670-17S		701819-10AC				701819-17AC	411026-4AC			801592-36SC
SD	SD	5	230	35	180	25	64670-17T		701819-19AC (2 REQ'D)				701819-17AC				801592-36SD

Figure 6.7 — Controller Technical Data

Section 7
REPLACEMENT PARTS

7.0 General — Users should consider maintaining a stock of spare parts. Table 7.A lists the more common parts along with part numbers and quantities actually used in the controller.

Table 7.A

REPLACEMENT MODULES

PART DESCRIPTION	QUANTITY PER CONTROLLER	MODEL NUMBER	PART NUMBER
Regulator Module	1	14C248	0-57100
Current Transformer (1 CT)			
¾ and 1½ hp	1	14C256	64670-17R
2 and 3 hp	1	14C257	64670-17S
5 hp	1	14C258	64670-17T
Power Cube			
¼ to ¾ hp 115 VAC	1	14C250	701819-9X
½ to 1½ hp 230 VAC	1	14C251	701819-9AC
2 and 3 hp 230 VAC	1	14C252	701819-10AC
5 hp 230 VAC	2	14C253	701819-19AC
M Contactor (Optional)	1	14C274	69326-25R
Fuse (K5 Dual Element)			
¼ to ¾ hp 115 VAC	1	—	64676-1W
½ to 1½ hp 230 VAC	2	—	64676-1W
2 and 3 hp 230 VAC	2	—	64676-1Y
5 hp 230 VAC	2	—	64676-1AC
MOV Surge Suppressor			
115-volt drives	1	14C270 ①	411026-4X ②
230-volt drives	1	14C271 ①	411026-4AC ②
Control Transformer			
115-volt drives	1	14C260	411027-61R
230-volt drives	1	14C261	411027-61S
Output R-C Assembly	1	14C275	0-55302
Dynamic Braking			
¼ to ½ hp 115 VAC	1	14C214	705385-61R
2 to 3 hp 230 VAC	1	14C214	705385-61R
¾ hp 115 VAC	1	14C215	705385-61S
½ to 1½ and 5 hp 230 VAC	1	14C216	705385-61T
Field Supply	1 Kit	14C237 ①	701819-17AC ②

① Model Number replacement modules are complete assemblies containing mounting hardware and electrical connectors.
② Part Numbers describe the discrete component only and do not include mounting hardware.

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