

Compumotor P Series Drive Operations Manual

P/N 88-003723-04

COMPUMOTOR CORPORATION

P-Drive Operator's Manual

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DESCRIPTION

Compumotor's P-Drive is a high performance microstepping motor drive. It uses a switchmode amplifier and power MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) in its power output section for maximum efficiency. The P-Drive is a "microstepping" drive. That is to say it gives a large number of small steps for each full step of the step motor it is driving. The standard resolution is 25000 steps per motor revolution, or 125 steps per full motor step of a 200 step motor.

The P-Drive can provide somewhat more power than Compumotor's M-Series Drives, although not as much as the I-Series Drives. It can provide as much as twelve amps intermintently per motor phase (two phase motor). This equates to a maximum of about 5,000 oz-in of torque using an P162-308 size motor connected in series.

Two features are included with the P-Drive which were previously unavailable. These are the GEARSHIFT and BOOST inputs.

GEARSHIFT allows a controller with a relatively low step frequency output capability to operate even a 25,000 step motor at full velocity by telling the P-Drive to lower the motor's resolution by a factor of 8 or 64 (factory setting = 8). Thus, the P-Drive motor may be microstepped into position but run at full velocity with a relatively low pulse rate.

BOOST increases the motor current from its set level to a factory preset level (up to twelve amps) for up to 20 seconds; boost is then disabled for 40 sec. This allows a momentary increase in motor torque.

Motor outputs and AC power inputs use industry standard screw terminal connectors for ease of installation and low mean time to repair. The Indexer connection is a female 25-pin 'D' connector.

INSPECTION

Your P-Drive should be inspected upon receipt for obvious damage to its shipping container. Report any such damage to the shipping company as soon as possible, as Compumotor cannot be held responsible for damage incurred in shipment. The P-Drive should then be carefully unpacked and inspected for the following items to be present and in good condition.

1. P-Drive unit
2. AC Power cable
3. Motor and motor cable
4. Connector, male 25-pin 'D', solder type with shell,
1 ea.
5. This manual

WARRANTY INFORMATION

Your P-Drive is warranted against manufacturing defects for one year from the date of purchase. Should you have questions about operating the P-Drive, your Compumotor representatives and distributors stand ready to support your individual needs. Call Compumotor Corporation at the number listed below to get the name, address and phone number of the Compumotor representative nearest you.

Should return of your Motor Controller be required to effect repairs or upgrades, do the following:

1. Get the serial number of the defective unit (and a purchase order for repair costs if the unit is out of warranty).
2. Call Compumotor for a Return Material Authorization number (RMA) at (800) 358-9068 except in California. In California, call collect at 707-778-1244.
3. Ship the unit to:
Compumotor Corporation
1179 N. McDowell Blvd.
Petaluma, CA 94928
Attn: RMA# xxxxxxxx

INITIAL FUNCTIONAL CHECK

In order to make a functional check of the P-Drive it is necessary to first attach motor, indexer and power leads to it as explained in the installation and hookup section, below. The indexer need not be used for an initial test, a square-wave generator may be attached to the Indexer inputs instead.

Using an indexer for functional check.

Compumotor offers a variety of Indexers which are compatible with the P-Drive. Performing a functional check using one of these indexers consists of the following steps:

1. Attach the motor/drive cable from the indexer to the P-Drive.
2. Set up the Indexer in accordance with its operator's manual.
3. To verify that the P-Drive is operating properly,
 - A. Attach a load to the rotor shaft which is about equal to the inertia of the motor. The inertia of the P106-178 motor is 44 oz-in², the P162-308 is 336 oz-in². This is easily accomplished by putting an appropriately sized drill chuck on the shaft. Be sure the motor shaft is free to rotate.
 - B. Apply power to the P-Drive (115 VAC).

Upon power up the P-Drive green STATUS LED should illuminate; the FAULT LED should remain off.

Set the indexer to perform a one rev/second counter-clockwise constant velocity move. A pulse rate of 25,000 steps per second will cause a 25,000 steps per revolution motor to rotate at the rate of one revolution per second in the counter-clockwise direction.

- C. All other inputs may be left unconnected.

By increasing the velocity setting of the indexer and issuing a new START command you will increase the rotational velocity of the motor. The drive will accept a step rate up to 750 kHz (30 RPS) without stalling the motor provided there is adequate inertia on the motor shaft and the motor has not been accelerated too quickly.

The direction of the motor can be changed by stopping the motor, changing the DIRECTION switch on the indexer, and issuing a new START command.

Using a square-wave generator instead of an indexer.

The positive or "hot" lead of the square-wave generator should be attached to the STEP+ input on P-Drive. Refer to Appendix A for pin connections. Ground from the frequency generator should be attached to STEP-. The output of the square-wave generator should be set to 3 volts peak to peak. There is a 220 ohm resistor and LED in series between the STEP+ and STEP- inputs. The current through these components should not exceed 20 mA for reliable operation.

To verify that the P-Drive is operating properly,

1. Attach a load to the rotor shaft which is about equal to the inertia of the motor. See 3A above for motor inertia. This is easily accomplished by putting an appropriately sized drill chuck on the shaft. Be sure the motor shaft is free to rotate.

2. Apply power to the P-Drive (115 VAC).

Upon power up the P-Drive green STATUS LED should illuminate; the FAULT LED should remain off.

Apply a one kHz square wave to the STEP inputs. This will cause a 25,000 steps per revolution motor to rotate at the rate of one revolution every 25 seconds in the counter-clockwise direction.

3. All other inputs may be left unconnected.

By increasing the frequency of the square wave you will increase the rotational speed of the motor. The motor should be able to accept up to 750 kHz (30 RPS) without stalling provided there is adequate inertia on the motor shaft and the motor has not been accelerated too quickly.

The direction of the motor can be changed by putting 20 mA of current through the DIRECTION+ and DIRECTION- inputs. Three volts applied to DIRECTION+ and signal ground applied to DIRECTION- will cause the motor to rotate in the clockwise direction. The motor will not be able to reverse direction instantly, however. It is necessary to slow the motor to less than one-half rev per second to allow a direction reversal without stalling the motor.

Checkout of the overdrive and gearshift inputs is not considered a portion of the basic functional checkout of the P-Drive. This is covered under the Operation section of this manual.

INSTALLATION AND HOOKUP**1. Mounting****A. Panel Mount**

The P-Drive has "L" brackets notched to accept screws on either end to facilitate mounting to flat panel surfaces. The unit should be securely mounted to prevent it from moving unexpectedly, as this could cause an unsafe condition to occur, and could lead to damage to the P-Drive. The P-Drive should be mounted so that its heat sink fins run vertically to allow for adequate convection cooling.

CAUTION

The high voltage connections--both 110 VAC line power and motor drive power--have voltages present on them which are hazardous to personnel and could damage other electrical equipment. Caution should be used in the installation and operation of the P-Drive so that this danger is minimized. The P-Drive has been provided with a safety-interlock cover to prevent this from occurring. It is recommended that the safety-interlock cover be used in all installations of the P-Drive.

B. Cooling

The P-Drive should be mounted in an area that will allow air to circulate over its heat sink. Sufficient cooling may be derived from convection cooling at operation up to five amps of continuous motor current output, provided the P-Drive is mounted in free air (preferably with its heat sink aligned vertically). The P-Drive must be actively cooled at any average motor current above 5 amps. An optional fan kit is available for this purpose. In a normal factory environment this will seldom be a problem. The P-Drive is designed to operate in an environment ranging from 0°F to 122°F (0 to 50°C).

In a confined environment, however, the P-Drive should always be actively cooled with forced air such that the heat sink temperature never exceeds 140°F (65°C) at any current level.

2. Wiring**A. Motor Connections**

The wiring between the motor and P-Drive should be done with great care as there are life threatening voltages on the motor when energized.

Motor connections are made by stripping the motor lead back approximately 3/16 of an inch, inserting the bare portion into the screw terminal block on the P-Drive and tightening down the

adjacent screw. The block (also called a connector) may be removed from the P-Drive while the wires are being attached.

Connect phase A+ to phase A+ on the motor and so on for the four motor leads. The shield for the motor wires is connected to the AC GND line.

NOTE: The motor connector is generally wired to the motor cable when delivered from the factory. If not, refer to Appendix D for wiring information.

Measure for continuity between the motor leads prior to applying power to the P-Drive! The P-Drive cannot properly drive the motor if there is a short or an open on any of its leads. Refer to the table below for the proper resistance readings.

MOTOR RESISTANCE TABLE FOR SERIES* CONNECTED MOTORS

Connection	P106-178	P162-308
A+ to A-	4 ohms	0.5 ohms
B+ to B-	4 ohms	0.5 ohms
A+ to B+	>10 Mohms	>10 Mohms
Shield to A+ or B+	>10 Mohms	>10 Mohms

*--multiply resistance values by 0.25 for parallel connection.

The motor may be wired in either series or parallel, depending on the needs of the application. A series wired motor will deliver more peak torque, but torque drops quickly as velocity increases. A parallel wired motor typically maintains its (lower than series) torque to a higher velocity. Refer to Appendix D for more information on how to wire the motor.

The P-Drive current may need to be adjusted if the motor is changed from series to parallel or vice versa. Contact the factory for further details about configuring the P-Drive for situations other than those provided for at the factory.

B.1. Series vs. Parallel

Motors for the P-Drive are normally connected in parallel as delivered from the factory. This allows the motor to be operated at higher velocities than would otherwise be possible. It is possible to connect the motors for series operation in the field. This results in higher torque at low velocities, but the maximum attainable velocity is reduced. For specific information on the torque capabilities of the motors, refer to the Compumotor catalog.

Appendix D contains the information required for field configuration of either series or parallel connection of the motors.

A.2. Long Motor Cables

The P-Drive may be separated from the motor by up to 100 feet.

The wire used should be at least 18 gauge for typical applications. 16 gauge wire should be used for applications where the motor is to be more than 50 feet from the P-Drive. In no circumstance should the motor be mounted further than 100 feet from the P-Drive, as this will adversely affect performance.

A.3. Using Conduit

Long runs of motor-driver interconnection wiring should be run through a suitable conduit. As the P-Drive is provided from the factory, the motor is wired on one end and the P-Drive screw-terminal connector on the other. To pass the motor wiring through conduit it will be necessary to disconnect one end of the wiring or provide user wiring for custom cable lengths. Each wire should be carefully marked as to its end point before being disconnected so that it will not be misconnected later. Appendix A shows the pin connections at the P-Drive and Appendix D shows the motor connections.

B. Line Power Connections

AC power is connected via the four terminal connector. The wires should be connected as follows,

115 VAC single-phase power,

<u>P-Drive</u>	<u>Wire color</u>
120 VAC LINE	Black (blue)
120 VAC NEUT	White (brown)
n.c.	
AC GND	Green (green with yellow)

115 VAC three-phase power,

<u>P-Drive</u>	<u>Function</u>
120 VAC 1	120 VRMS, line 1
120 VAC 2	120 VRMS, line 2
120 VAC 3	120 VRMS, line 3
AC GND	Earth ground (green or green with yellow)

150 VDC power,

<u>P-Drive</u>	<u>Function</u>
Positive DC	+150 VDC (red)
Negative DC	DC return (black)
n.c.	
AC GND	Earth ground (green or green with yellow)

Be careful to ensure that the leads do not short to one another and there are no loose strands that are not captured by the terminal connection for each lead.

C. Indexer Connections

STEP+ and STEP- both must be connected to run the motor. DIRECTION+ and DIRECTION- need only be connected if the motor need be run bi-directionally. The motor will run counter-clockwise if left disconnected. SHUTDOWN+ and SHUTDOWN- must be connected if the motor is to be shutdown remotely without powering down the drive. If a Compumotor indexer is used a pre-fabricated indexer to P-Drive cable is provided with the indexer.

D. Configuration Jumpers and Switches

The P-Drive has several user selectable options such as motor current, motor resolution and stand-by operation. The options are selected by a switch bank and two Berg jumpers located under the P-Drive end plate, next to the Indexer connector. Remove the four screws which hold the end plate in place for access. The table below outlines the function of each switch and jumper. Refer to Appendix B for switch location drawings.

NOTE

The motor current adjustment selection is preset at the factory and should not be changed without prior approval from the factory. It is possible to damage the motor or the P-Drive or both if an improper current is selected.

<u>Switch bank</u>	
<u>No.</u>	<u>Function</u>
1--8	Amps \
2--7	Amps \
3--6	Amps /
4--5	Amps /
5--4	Amps /
6--3	Amps /
7--A2	_Motor resolution selection. Note 2
8--A1	/

Note 1 Only one of the current selection switches may be on at a time. These switches are preset at the factory for optimum performance. All switches set to OFF gives 2 A.

Note 2 The motor resolution may be selected by setting switch bank switches 7 and 8 (labeled A2 and A1 on the printed circuit board).

<u>Motor resolution</u>	<u>A2</u>	<u>A1</u>
25,000 steps per rev	ON	ON
50,000 steps per rev	ON	OFF
12,500 steps per rev	OFF	ON
200 steps per rev	OFF	OFF

Berg Jumpers: Stand-by disable

There is one berg jumper with three pins accessible behind the Indexer end mounting plate of the P-Drive. The three pins determine whether the motor current is reduced to stand-by power (2 amps) when motor pulses have not been received by the P-Drive for about one second: with the jumper on the right two pins (JU5) the motor goes into stand-by automatically, with the jumper on the left two pins (JU65) the motor remains at the set motor current no matter how long the motor is stopped. Refer to Appendix B for more information.

3. Fuses

The P-Drive is internally protected against most problems associated with motor shorts or opens, and high and low line conditions. If a fuse does fail in the P-Drive the drive has probably failed.

The fuses may be replaced with fuses of the same size and rating, but if they fail again, refer service to the factory (see section on inspection and warranty information).

F2-4 are 10A fuses (Schurter, 5 x 20 P/N 634.1516)
 F1 is a 1 A fuse (Schurter, 5 x 20 P/N 001.2514)

The P-Drive uses four fuses. Three for AC power, F2-4, and one for the low voltage power supply, F1. Should the P-Drive fail to function at all, check each of the 120 VAC LINE fuses (F2-4).

NOTE

Examining the AC power fuses will require partial disassembly of the P-Drive enclosure. A continuity tester will be required to verify fuse integrity. Refer to Appendix B for the appropriate drawings.

4. Environmental Considerations

The mounting location for the motor and driver must be free from all liquids and protected from all chips and dust. The motor is not suitable for explosive atmospheres, vacuum beyond 0.01 torr, or life-support equipment. The bearings in the motor are not sealed and must be protected from contaminants.

Allowable ambient conditions for the motor and driver are 32 to 122 degrees Fahrenheit (0 to 50 degrees Celsius) and 20 to 90% humidity (non-condensing). The system can operate from 32 to 150 degrees Fahrenheit (0 to 70 degrees Celsius).

At no time should the motor case temperature exceed 255°F (125°C).

Coil any excess motor cable at the driver and secure it with a cable tie. This cable carries high voltage (150 VDC) and all wire runs must conform to all applicable local electrical codes and OSHA requirements.

OPERATION

1. Introduction

The following sections outline how to operate the P-Drive. Although every effort has been made to provide enough information to successfully (and easily) operate the P-Drive, there are bound to be omissions and errors. If you find any errors or you think that something should be added to the manual, call Compumotor or one of its representatives to get the information you need.

To check to see if the P-Drive is operating at all, refer to the "Initial Functional Check" section of this manual.

2. Visual Indicators

There are two LED (light emitting diode) indicators on the indexer connector end of the P-Drive. One indicates if a DRIVE FAULT has occurred, the other indicates operational status.

A FAULT occurs any time the P-Drive shuts itself down because of an internally sensed error condition. This is most likely to occur as a result of over heating (the P-Drive has a built in temperature sensor), a short circuit in the output wiring (overcurrent), or the AC line input voltage is too low. A DRIVE FAULT will clear itself once the fault condition is removed.

The STATUS LED illuminates when the drive has AC power applied to it and is ready for operation.

3. Indexer Inputs

The indexer inputs provide the normal control signals for the P-Drive. All of the indexer inputs require 15-20 mA drive currents. Following is a functional description of how each is used.

A. Step Input

The STEP input causes the motor position to be incremented one microstep. By applying STEPs at various rates the motor is made to rotate at proportional velocities. STEP pulses applied first slowly, and then more quickly have the effect of accelerating the motor. Attempting to accelerate the motor too quickly can cause the motor to stall.

B. Direction Input

The DIRECTION input (as you might guess) controls the direction of rotation of the motor. When this signal is not activated the motor shaft rotates counter-clockwise as viewed from the flange end of the motor. The motor shaft rotates clockwise if the DIRECTION input is activated.

C. Remote Power Shutdown (RPS) Input

Activation of the REMOTE POWER SHUTDOWN (RPS) input causes the P-Drive to stop putting current through the motor. This will allow the motor to freewheel and as such is intended to allow manual positioning of the load or to keep the P-Drive from interfering with sensitive electronics in the immediate vicinity.

RPS is not intended to act as an emergency stop for the motor. If RPS is used in this fashion the motor will very likely move beyond its desired stopping position at the risk of endangering property and life.

D. Overdrive Input

The OVERDRIVE input causes the motor to increase the current to the motor from its normal operating current to a higher level (this factory set level can be up to 12A, the P-Drive maximum) for 20 seconds maximum. There the P-Drive automatically disables boost for 40 seconds.

This feature should only be used to enable the motor to accelerate at rates it cannot achieve otherwise. It should never be used continuously.

E. Gearshift Input

The GEARSHIFT input is a method of lowering the resolution of the motor so that indexers which cannot produce the high pulse rates required to slew a microstepped motor can still control the P-Drive.

When activated, the P-Drive lowers the resolution of the motor by a factor of 8 or 64 (factory adjustable and set to 8 at the factory). The motor may then be operated at low velocity with full microstepping precision and then run at full speed at one-eighth or one-sixtyfourth of what would be the normal input STEP rate. For a motor with a resolution of 25,000 steps per revolution this means the top STEP pulse rate would drop from 750,000 pulses per second to 93,750 pulses per second or 11,719 pulses per second, depending on whether the divide by 8 or 64 option had been selected.

4. Indexer Outputs, The Drive Fault Output

The DRIVE FAULT output is activated when the motor or P-Drive is sensed as being in an over-temperature condition, over-current condition, or low AC line input voltage. Once the condition causing the fault has been cleared, normal operation will resume shortly, without operator intervention.

5. Motor Compatibility

The P-Drive is designed to be compatible with at least the following motor sizes:

Compumotor
Model number

P106-178
P162-308

The model number reflects the size of the motor in millimeters. Thus the P106-178 is 106 mm wide and 178 mm long. The P106-178 is normally double shafted, the P162-308 is normally single shafted.

6. Automatic Stand-by Operation

The P-Drive has the capability to operate the motor in a stand-by mode. In this mode the current to the motor is reduced to a fraction of the normal operating current. This mode may be used to reduce motor heating in thermally sensitive applications and to reduce motor torque when the motor is stationary when full torque is not required.

The feature is automatic when enabled. The motor current is then automatically reduced to standby a few seconds after the motor stops moving. As soon as motion command pulses are sent to the motor the drive returns the motor to its full preset current.

The Automatic Stand-by is enabled and disabled by installing jumper JU-5 or JU-6, respectively. The jumper is found on the the main printed circuit board of the P-Drive. Refer to Appendix B for its location.

7. Line Power Considerations

The 120 VAC input to the P-Drive is not isolated by a transformer. To provide isolation, power to the P-Drive should be routed through an isolation transformer (i.e., 1:1 voltage ratio) with a power rating of 1000 VA.

An isolation transformer with line filtering capabilities will also insulate sensitive equipment on the same power line from the noise induced in the power line by the switchmode amplifiers in the P-Drive.

240 VAC 3-phase operation requires a 2:1 step-down transformer.

8. The Fan Kit

The P-Drive may be ordered with a fan kit. The fan mounts on the P-Drive allowing the drive to provide more current to the motor under all operating conditions. The fan kit is supplied standard with the P162-308, but is optional with the P106-178. The fan kit is recommended for motor operation averaging higher than 5 amps, and for ambient temperature conditions exceeding 85°F (30°C).

9. Selecting Motor Resolutions

The P-Drive has four internal resolutions available as delivered from the factory. The standard P-Drive gives you the choice of 25,000; 50,000; 12,500; and 200 steps per motor revolution. These motor resolutions are selected by removing the motor connector end plate. Refer to Configuration Jumpers and Switches section for details.

10. Selecting the Proper Motor Current

The P-Drive normal motor current can be set from 2 to 8 amps continuous output (boost increases the output to 12 amps for 20 seconds maximum).

WARNING

Only one current selection switch may be on at a time. Damage to the P-Drive can result from improper switch settings.

Refer to the configuration jumpers and switches section for more information.

11. The Connector Safety Cover

The connector safety cover is provided to protect both the drive and the user from harm. Potentially life threatening voltages exist on both the motor and AC line connectors.

WARNING

Remove AC line power prior to disconnecting either the AC line power connector or the motor connector. To do otherwise could damage the P-Drive.

SPECIFICATIONS**Physical Description**

P-Drive Height: 4.75 inches (12.00 cm)

P-Drive Length: 12.00 inches (30.48 cm)

P-Drive Width: 8.00 inches (20.32 cm)

P-Drive Weight: 10 lbs (4.5 kg) without motor

14 lbs (6.4 kg) without motor, with shipping
container

Environmental

Operating temperature: 32°F to 122°F (0°C to 40°C) when
actively cooled.

Humidity: 0-95%, non-condensing.

Electrical**Input power:**

Configuration 1: Single phase power
Voltage: 105-125 VAC, single phase.
Frequency: 47-66 Hz.
Current: 10 amps maximum continuous

Configuration 2: Three phase power
Voltage: 105-125 VAC, three phase.
Frequency: 47-66 Hz.
Current: 10 amps maximum continuous

Configuration 3: DC power
Voltage: 100 to 160 VDC
Frequency: 0 Hz (DC)
Current: 10 amps maximum continuous

Output power: (to motor)

Voltage: 160 V peak, sinusoidal
Frequency: 0-1.5 kHz
Current: 2.0 amps to 8.0 amps per phase in 1.0 amp
increments, with 10 amps peak in OVERDRIVE.

Inputs and Outputs

Motor: 7 connection screw terminal block.

A+ Output. Phase A+ to motor. Return on A-.

A LINK Output. Open connection, goes no where on P-Drive printed circuit assembly. Allows connection of motor in series by inserting end of each of the two filars.

A- Output. Return for phase A+.

AC GND Output. Shield for motor phase wires. Connected to motor casing.

B+ Output. Phase B+ to motor. Return on B-.

B LINK Open connection, goes no where on P-Drive printed circuit assembly. Allows connection of motor in series by inserting end of each of the two filars for the phase.

B- Output. Return for phase B+.

Power: (All inputs) 4 connection screw terminal block.

115 VAC single-phase power,

<u>P-Drive</u>	<u>Wire color</u>
120 VAC LINE	Black (blue)
120 VAC NEUT	White (brown)
n.c.	
AC GND	Green (green with yellow)

115 VAC three-phase power,

<u>P-Drive</u>	<u>Function</u>
120 VAC 1	120 VRMS, line 1
120 VAC 2	120 VRMS, line 2
120 VAC 3	120 VRMS, line 3
AC GND	Earth ground (green or with yellow)

150 VDC power,

<u>P-Drive</u>	<u>Function</u>
Positive DC	+150 VDC (red)
Negative DC	DC return (black)
n.c.	
AC GND	Earth ground (green or with yellow)

Indexer: 25 pin 'D' connector, female

STEP+ Input. Optically isolated current loop input. 15 mA, 500 nS pulse, minimum; 1 MHZ maximum. Rising edge of current pulse causes microstep.

STEP- Input. Return for Step+.

DIRECTION+ Input. Optically isolated current loop input. 20 mA nominal. Must be held active at least 10 microseconds prior to rising current edge of STEP+.

DIRECTION- Input. Return for STEP+.

RPS+ Input. Optically isolated current loop input. 20 mA nominal. Presence of current on RPS (Remote Power Shutdown) causes current to be removed from the motor phase outputs.

RPS- Input. Return for RPS+.

GEARSHIFT+ Input. Optically isolated current loop input. 20 mA nominal. Presence of current reduces motor resolution by factor of either 8 or 64, depending upon ROM setting (normally set to 8 at the factory).

GEARSHIFT- Input. Return for GEARSHIFT+.

DRIVE FAULT+ Output. 20 mA nominal current output. Absence of current indicates a drive fault condition. (Shorted outputs, overtemperature, etc...)

DRIVE FAULT- Output. Return for DRIVE FAULT+.

FAULT RESET+ Input. Optically isolated current loop input. 20 mA maximum. Presence of current clears a SLIP FAULT

FAULT RESET- Input. Return for FAULT RESET+.

BOOST+ Input. Causes motor current to be boosted to maximum.

BOOST- Input. Return for BOOST+

APPENDIX ACONNECTOR LISTING

MOTOR CONNECTOR 7 Connection screw terminal block.

1 -- A+	Red
2 -- A LINK	N.C.
3 -- A-	Black
4 -- AC GND	Shield
5 -- B+	Blue
6 -- B LINK	N.C.
7 -- B-	Orange

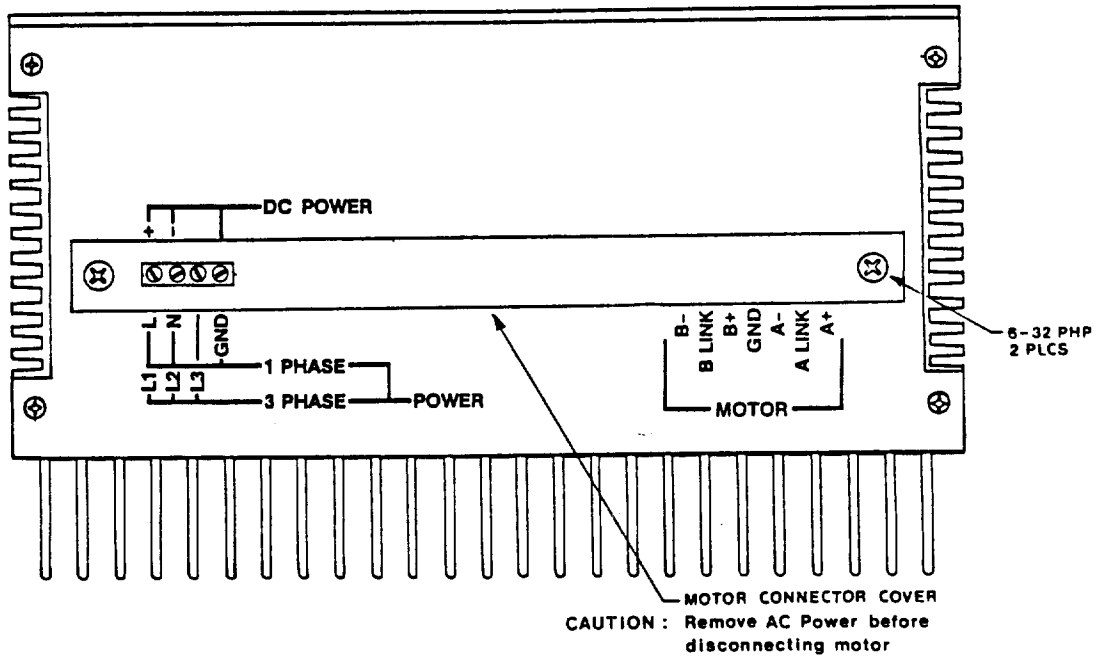
POWER 3 Connection screw terminal block.

	<u>Single phase</u>	<u>Three phase</u>	<u>DC</u>
1 --	120 VAC LINE	120 VAC Line 1	+150 VDC
2 --	120 VAC NEUT	120 VAC Line 2	+150 VDC RETURN
3 --	n.c.	120 VAC Line 3	n.c.
4 --	AC GND	AC GND	Earth ground

INDEXER 25-pin 'D' connector, female.

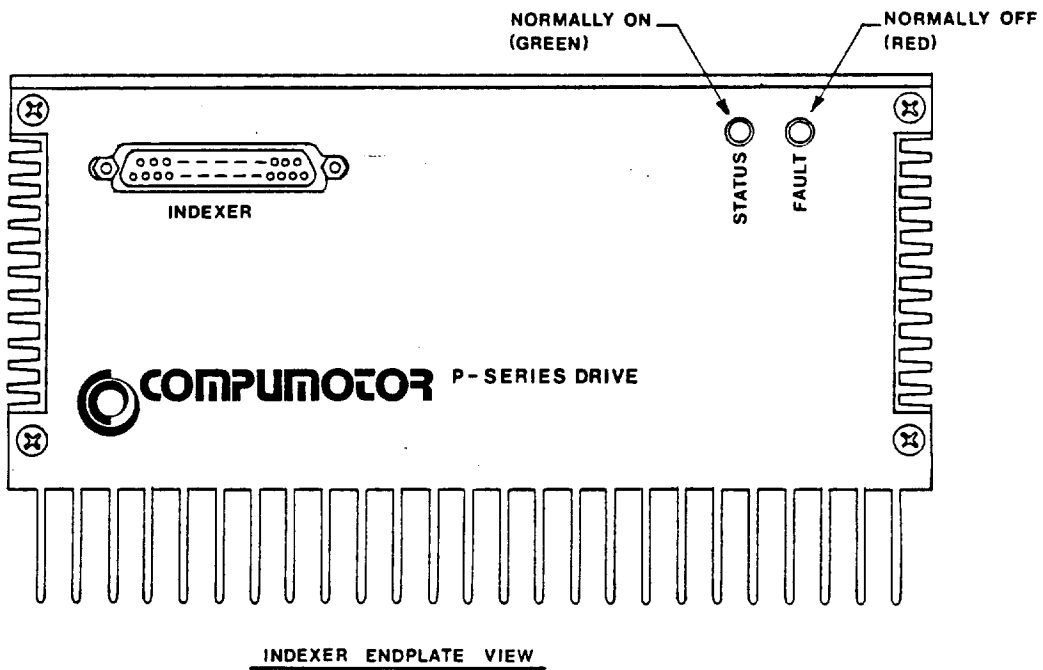
1 --	STEP+	Red
2 --	DIRECTION+	Green
3 --	N/A	N.C.
4 --	N/A	N.C.
5 --	SHIELD	Shield
6 --	GEARSHIFT-	Orange
7 --	FAULT RESET+	Red/Black
8 --	MOTOR/DRIVER +5 VOLTS	N.C.
9 --	DRIVE FAULT+	Black/White
10 --	N/A	Red/White
11 --	BOOST+	Blue/White
12 --	RESERVED	N.C.
13 --	N/A	N.C.
14 --	STEP-	Black
15 --	DIRECTION-	White
16 --	REMOTE POWER SHUTDOWN+	Blue
17 --	REMOTE POWER SHUTDOWN-	White/Red
18 --	GEARSHIFT+	Orange/Black
19 --	FAULT RESET-	White/Black
20 --	N/A	N.C.
21 --	DRIVE FAULT-	Black/Red
22 --	N/A	Red/Green
23 --	BOOST-	Blue/Red
24 --	N/A	N.C.
25 --	N/A	N.C.

APPENDIX B



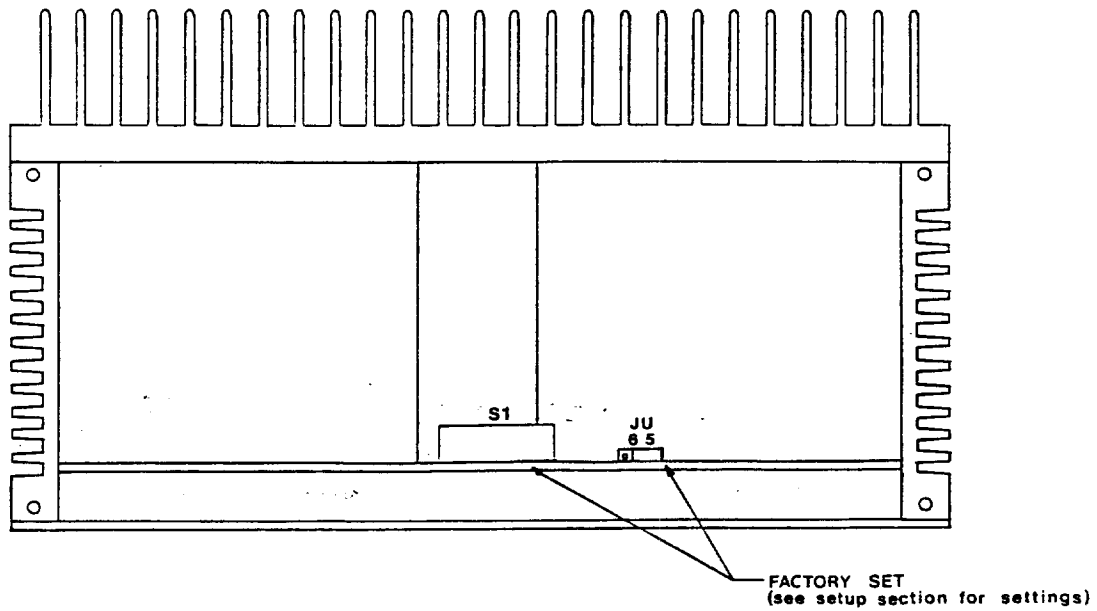
P-DRIVE MOTOR END PLATE DRAWING

APPENDIX B - cont'd



P-DRIVE INDEXER ENDPLATE DRAWING

APPENDIX B - cont'd

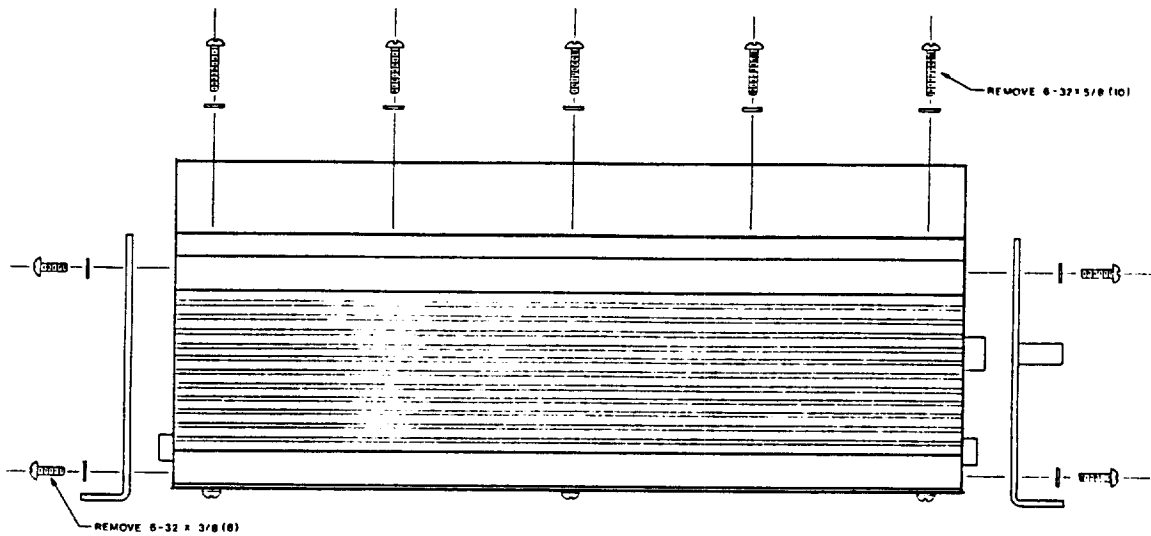


MOTOR CONNECTOR
END PLATE VIEW

NOTE: End plate has
been removed

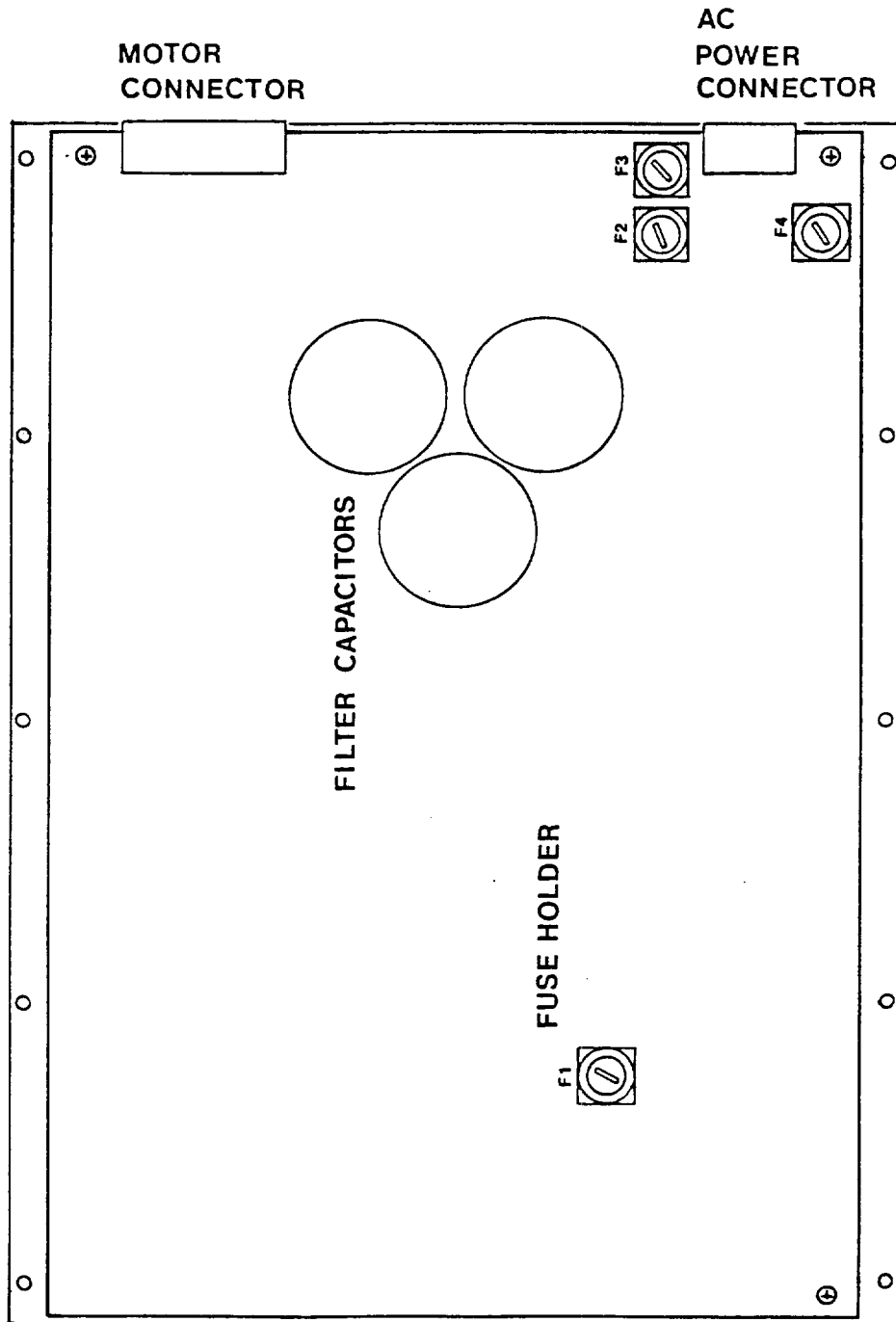
JUMPER AND SWITCH LOCATION DRAWING

APPENDIX B - cont'd



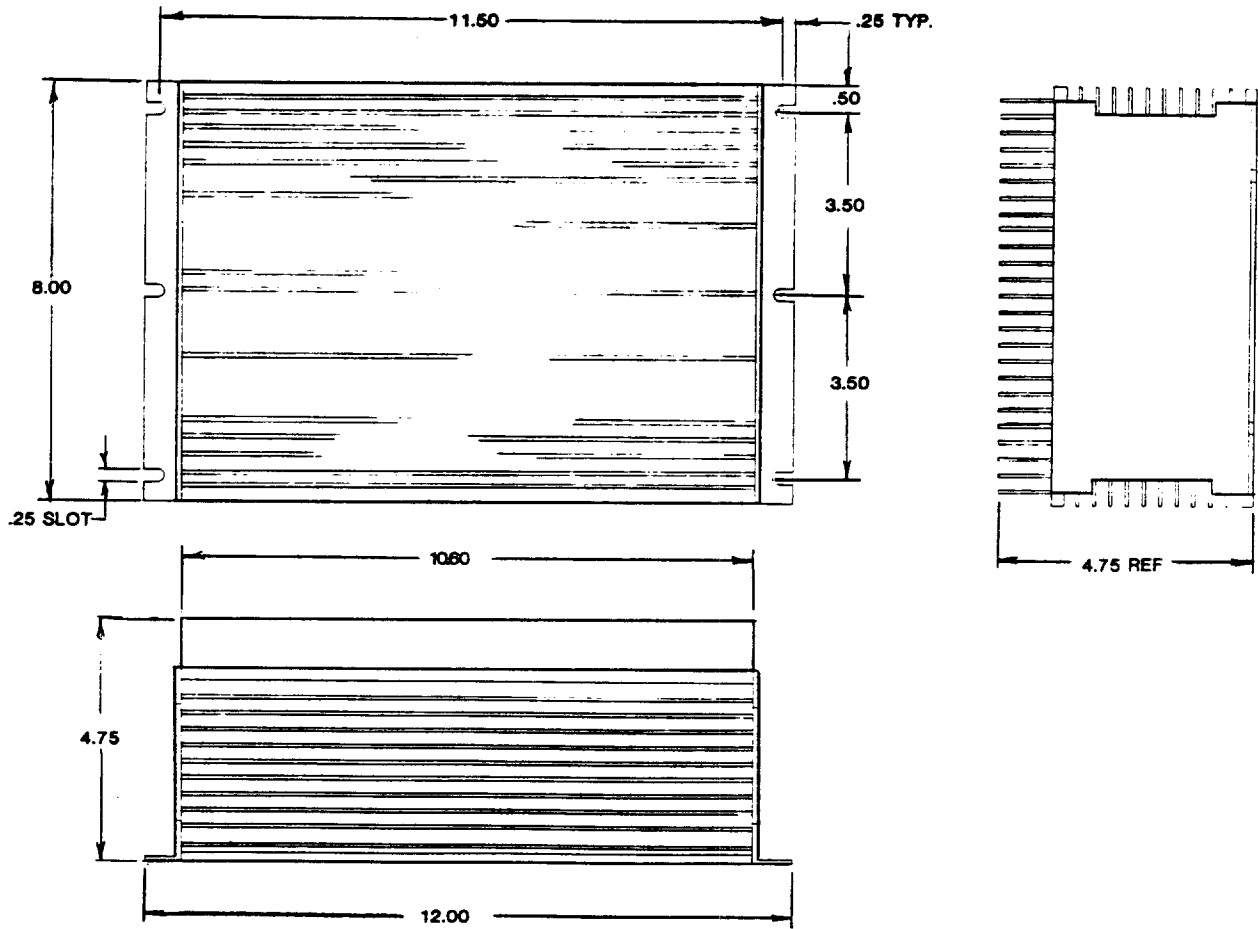
P-DRIVE COVER REMOVAL DRAWING

APPENDIX B - cont'd



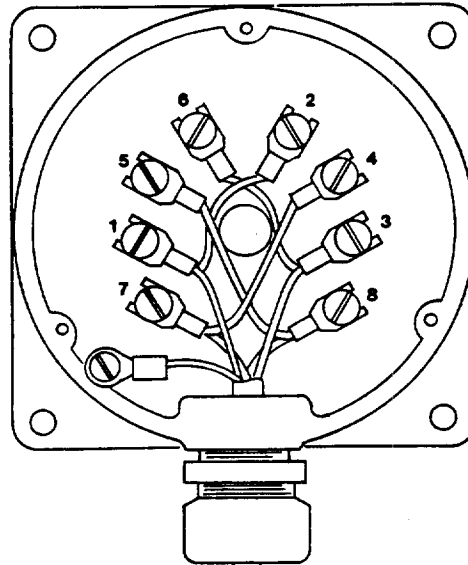
FUSE LOCATION DRAWING

APPENDIX C

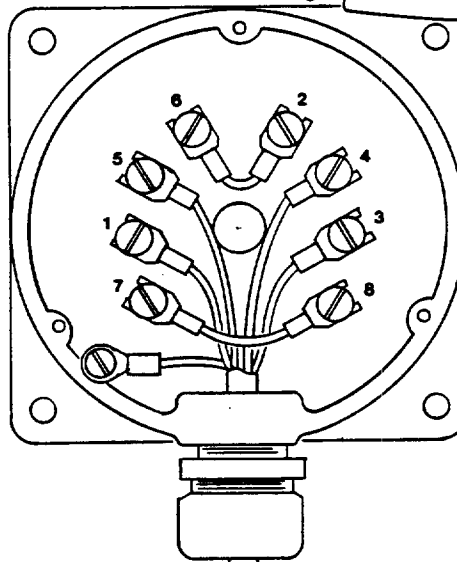


P-DRIVE DIMENSIONAL DRAWING

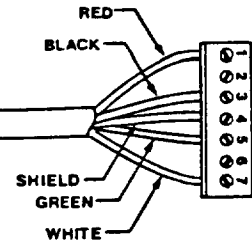
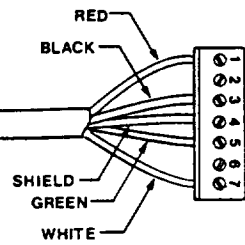
APPENDIX D



PARALLEL WIRING 106-178
(normal factory connection)

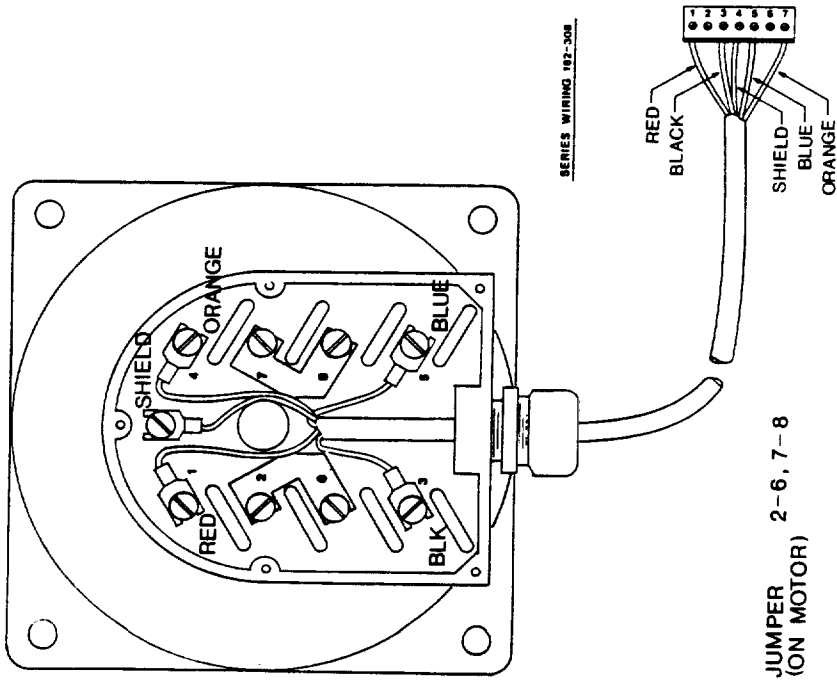
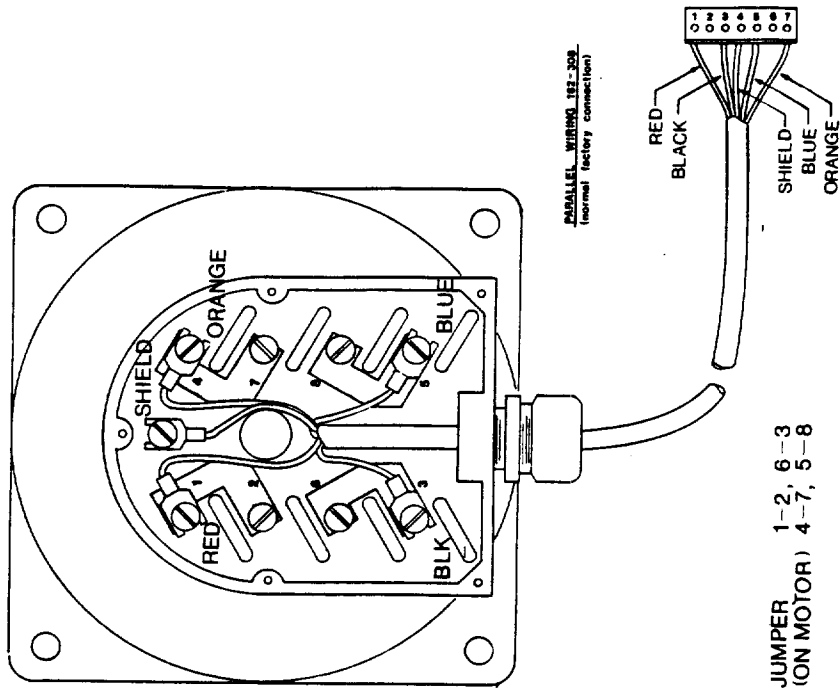


SERIES WIRING 106-178



P106-178 MOTOR CONNECTION DRAWING

APPENDIX D--cont'd



P162-308 MOTOR CONNECTION DRAWING

WARNING !

**REMOVE AC POWER PRIOR TO DISCONNECTING
THE LINE POWER CONNECTOR
OR THE MOTOR CONNECTOR**