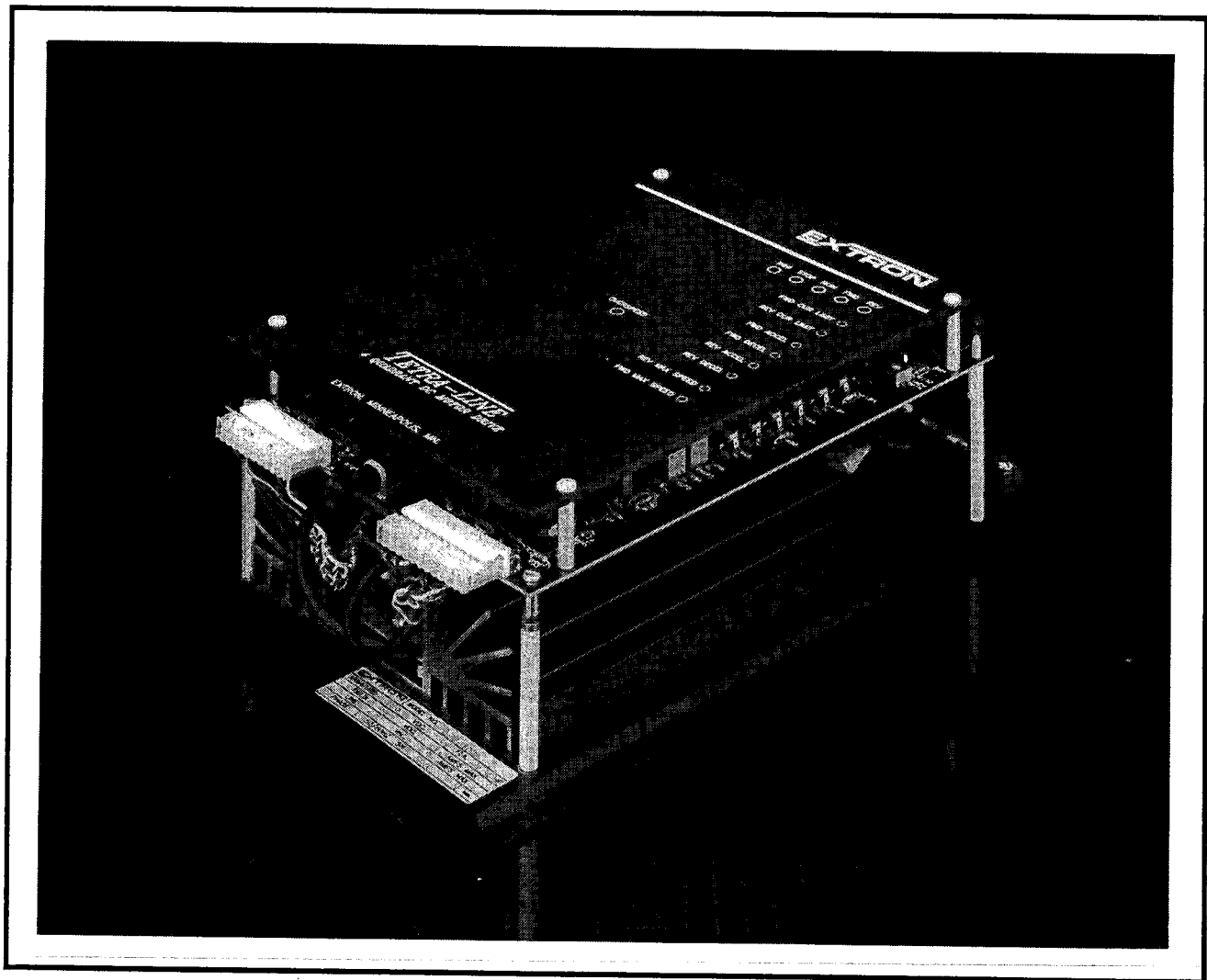


OPERATIONS AND MAINTENANCE MANUAL



TETRA-LINE
4 QUADRANT DC MOTOR DRIVE

Read this manual carefully for proper operation and setup before interconnecting the drive.

Notice:

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. The right is reserved to make changes at any time without notice. Copyright 1988, Extron Company.

TABLE OF CONTENT

1.0	General Description.....	3
1.1	Factory Preset.....	3
2.0	Technical Data.....	4
2.1	Ratings.....	4
2.2	Specifications.....	4
2.3	Ambient Temperature.....	5
2.4	Altitude.....	5
2.5	Air Contaminants.....	5
3.0	Installation.....	6
4.0	Operations and Adjustment Procedure.....	7
4.1	Unpack and Inspection.....	7
4.2	Pre-Installation User Calibration.....	7
4.2.1	Forward and Reverse Current Limit Potentiometers.....	8
4.2.2	Linear Accel/Decel Adjustments.....	9
4.2.3	Maximum Speed Settings in Forward and Reverse.....	9
4.3	Status LED Indicators.....	9
4.4	Mounting and Clearances.....	10
5.0	Installation Wiring.....	11
5.1	Detailed Calibration Instructions.....	11
6.0	Control Connection Information.....	12
6.1	System Block Diagram.....	12
6.2	Schematic - Power Section.....	12
6.3	Basic Motor and Line Connections.....	13
6.4	Optional Connections for Speed Command.....	14
6.5	Optional Connections for Current Limit.....	15
6.6	Optional Connections for Feedback Selection.....	16
7.0	Trouble Shooting.....	17
7.1	Trouble Shooting Block Diagram.....	17

8.0	Spare Parts List.....	18
9.0	Drive Accessories.....	18
9.1	Isolation Transformer.....	18
9.2	Armature Fusing.....	18
10.0	Drive Options.....	19
10.1	Mounting Diagram.....	19
10.2	P.C. Interface with Start/Stop Contactor and Dynamic Braking.....	20
10.2.1	Interconnection Information for P.C. Interface with Start/Stop Contactor and Dynamic Braking.....	20
10.3	P.C. Interface with Contactor Reversing and Dynamic Braking.....	21
10.3.1	Interconnection Information for P.C. Interface with Contactor Reversing and Dynamic Braking.....	21
10.4	Start/Stop with Dynamic Braking.....	22
10.4.1	Interconnection Information for Start/Stop with Dynamic Braking.....	22
10.5	Standard Contactor Reversing with Dynamic Braking.....	23
10.5.1	Interconnection Information for Standard Contactor Reversing and Dynamic Braking.....	23
10.6	Regen Stop with Armature Contactor and Dynamic Braking.....	24
10.6.1	Interconnection Information for Regen Stop with Armature Contactor and Dynamic Braking.....	24
10.7	P.C. Interface with Regen Stop, Armature Contactor and Dynamic Braking.....	25
10.7.1	Interconnection Information for P.C. Interface with Regen Stop, Armature Contactor and Dynamic Braking.....	25
11.0	Factory Service and Warranty Information.....	26

Customer service is very important to us. If there is ever a problem with this unit, please call (612)544-4197, or write: Extron, 8043 Lewis Road, Minneapolis, MN 55427.

1.0 General Description

Tetra-Line 200 is a thyristor type recuperative (regenerative) D.C. motor control that provides speed and or torque control for shunt wound or permanent magnet direct current motors of up to 5.6kw (7.5 HP) ratings.

It is intended for use on a single phase AC line operating at 120 or 240V, 50/60 Hz.

1.1 Factory Preset

- A) The Tetra-Line D.C. 420-100 drive comes factory preset and jumpered for 115 VAC, and motor EMF feedback. The Tetra-Line D.C. 420-200 and 420-300 drives come factory preset and jumpered for 230 VAC, and motor EMF feedback.
- B) Forward and reverse Max speeds are set at 90 VDC (115 VAC) and 180 VDC (230 VAC)
- C) Accel/decel ramps are set to minimum time
- D) Forward and reverse current limits are set per model as follows:
 - 420-100 12 Amps DC
 - 420-200 30 Amps DC
 - 420-300 45 Amps DC
- E) Overspeed cut-out is set for 90% of A.C. line voltage equaling D.C. armature voltage. Higher levels of armature voltage will cause blown line fuse and/or damage to SCR's.

2.0 Technical Data

2.1 Ratings

Model	HP @ 120V AC	HP @ 230V AC
420-100	1/8 - 1 HP	1/8 - 2 HP
420-200	-----	3 - 5 HP
420-300	-----	7 1/2 HP

Model	Full Load Motor Current	Output Power	Input Voltage
420-100	10A	0.8kW, 1 HP	120V, 50/60 Hz
-----	10A	1.6kW, 2 HP	240V, 50/60 Hz
420-200	25A	3.7kW, 5 HP	240V, 50/60 Hz
420-300	35A	5.6kW, 7.5 HP	240V, 50/60 Hz

2.2 Specifications

Description	115V AC operation	230V AC operation
Horsepower	1/8 HP - 1 HP	1/8 - 7 1/2 HP
AC line input voltage	115V AC +/- 10%	230V AC +/- 10%
Armature voltage	0-90V DC	0-180V DC
Field supply	100/50V DC	200/100V DC

AC line frequency	-	50 or 60 Hz
Service factor	-	1.0
Duty	-	Continuous
Max. load capability	-	150% for 1 minute
AC line protection	-	Semiconductor fuses
Operating ambient	-	0-40 C (32-104 F)
Relative humidity	-	Up to 95% non condensing
Altitude	-	No de-rating to 5,000 feet

Performance (95% load change)

Description	Speed regulation	Speed range
Motor EMF feedback	+/- 2%	30:1
Tach feedback	+/- 0.25%	50:1
Pulse tach feedback	+/- 0.15%	50:1

Accel/decel ramps	-	adjustable to 15 seconds (adjustable in both directions)
Current limit regulation	-	2% of nominal current
Response of drive control	-	2 ms loop.

Feedback Inputs

- D.C. tachometer - 7-200V D.C. Min. 100K ohm input impedance
- A.C. pulse tach - 1-24V A.C. Min. 100K ohm input impedance

Control Inputs

- Speed - 10K ohm potentiometer
+/- 5V D.C. Min. 200K ohm input impedance
+/- 10V D.C. Min 400K ohm input impedance
4-20 mA D.C. Max 250 ohm input impedance
- Current limit (Forward & Reverse) - 10K ohm potentiometers
+/- 5V DC 100K ohm Min. impedance
0 - 150% of nominal

2.3 Ambient Temperature

The electronics and components used in the Tetra-Line are rated for operation between 0 and 40 degrees C. (32 F to 104 F). Additional cooling should be used if ambients exceed these specifications.

2.4 Altitude

The Tetra-Line suffers no de-rating in performance below 5000 feet.

2.5 Air Contaminants

The Tetra-Line should be mounted in an area free of airborne contaminants. Dust, carbon and other airborne contaminants can be conductive and cause serious damage to printed circuit boards.

3.0 Installation

Before installing the control, read the motor nameplate. Check the HP rating, armature voltage, and field voltage data. Make sure that these ratings agree with the motor control identification. If the nameplate rating is different from control rating, consult the factory before installing the control.

The drive motor may be connected to the load through a gear reducer, belt or by direct coupling. When a motor is coupled through a gear reducer, make certain the C flanges are mated properly. Connect the gear reducer according to the manufacturer's instructions. If the motor is coupled to the load by belting, it is important that the sheaves be in line. Check belt tightness, a belt that is too loose will result in excessive slippage. Direct coupling is best accomplished by using a flexible coupling. A proper coupling will extend the life of the bearings in the motor.

Note: A properly connected, direct coupled load does not exert force on the motor shaft in any direction.

Refer to the connection diagrams or schematics furnished with the motor before connecting the motor to the control. P1 and P2 leads are usually for built-in motor thermostats. S1 and S2 leads are for a stabilized shunt winding. It is best to leave this disconnected. Motors with additional field leads marked F3 and F4 are for special field connections. Check motor manufacturer's supplied connection diagrams before operation.

The standard direction of the motor rotation is counter clockwise (CCW) looking at the end opposite the drive shaft. Extron supplied motors connected as shown in the connection diagrams, will rotate in the CCW direction.

The Tetra-Line should be mounted in a vertical position, allowing at least 4" clearance on all sides. Any other mounting position should be avoided since the natural flow of air will be impeded with consequent overheating and possible premature failure or reduced life of control components.

Local codes should be followed when installing the Tetra-Line. Signal lines should be isolated from all power lines to avoid noise pick-up.

Refer to the appropriate connection diagram provided with the control when making connections to the motor control.

1. Recheck all control and motor connections before applying power to the control. Make sure all connections are correct and secured tightly.
2. Set the speed potentiometer to zero.
3. Turn on the A.C. power
4. On start/stop or reversing models, depress the proper run button.
5. Slowly increase the speed potentiometer until the motor shaft turns. If the motor rotation is opposite to that desired, stop the motor and turn off the A.C. power and interchange the two armature leads.
6. Restart the control and adjust the motor control as indicated in the following sections.

4.2.1 Forward and Reverse Current Limit Potentiometers

Individual potentiometers are provided to set the current limit to the motor and are adjustable from 0-120% of nominal. Refer to Fig. 3 for potentiometer adjustment based on motor horsepower.

It is recommended that an ammeter be placed into the armature circuit as shown in Fig. 2. Adjust the current limit in both forward and reverse based on the motor horsepower from the chart below:

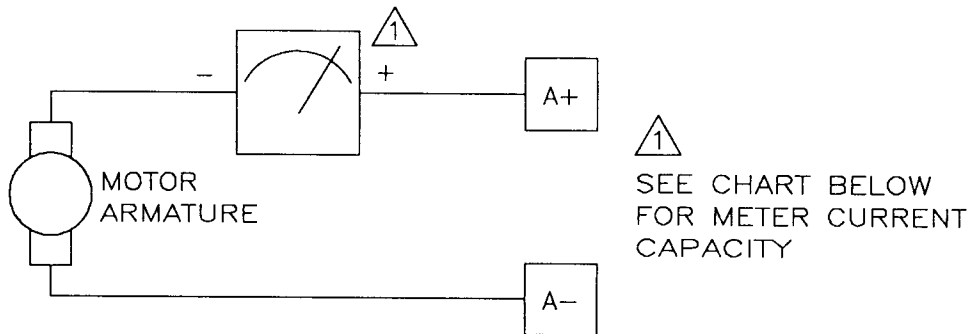


Fig. 2 - Motor Armature and D.C. Ammeter Monitoring Connections

HP	Current (nominal)	Current limit
1/8 (90)	1.25 Amps DC	1.5 Amps DC
1/4 (90)	2.5 Amps DC	3 Amps DC
1/3 (90)	3.75 Amps DC	4.5 Amps DC
1/2 (90)	5 Amps DC	6 Amps DC
3/4 (90)	7.5 Amps DC	9 Amps DC
1 (90)	10 Amps DC	12 Amps DC
1/4 (180)	1.25 Amps DC	1.5 Amps DC
1/3 (180)	1.9 Amps DC	2.3 Amps DC
1/2 (180)	2.5 Amps DC	3 Amps DC
3/4 (180)	3.75 Amps DC	4.5 Amps DC
1 (180)	5 Amps DC	6 Amps DC
1 1/2 (180)	7.5 Amps DC	9 Amps DC
2 (180)	10 Amps DC	12 Amps DC
3 (180)	15 Amps DC	18 Amps DC
5 (180)	25 Amps DC	30 Amps DC
7 1/2 (180)	37.5 Amps DC	45 Amps DC

Fig. 3 - Current Limit Settings

4.2.2 Linear Accel/Decel Adjustments

Linear acceleration - forward and reverse
Linear deceleration - forward and reverse

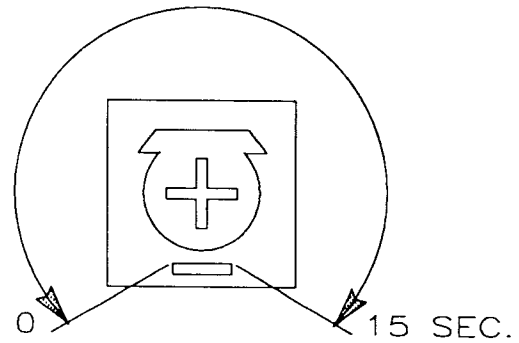


Fig. 4 - Potentiometer/accel-decel

Turn the potentiometer clockwise to increase the time duration. The potentiometer span is 0-15 seconds adjustable.

4.2.3 Maximum Speed Setting in Forward and Reverse

Individual potentiometers are provided to adjust the maximum speed in both forward and reverse. They have a range of 40-115% of the base motor speed.

Turn the potentiometer clockwise to increase the motor maximum speed.

Refer to Fig. 1 for potentiometer locations. Depending on the motor tested, the stability of the speed regulator may have to be adjusted. This is done by adjusting the trimmer R77 and if necessary by changing capacitor C49 and further R77 trimming.

4.3 Status LED Indicators

Status indicators are provided to assist the user during operation of the Tetra-Line drive. Indicators show the status of the drive. A description of each function is shown below.

Refer to Fig. 1 for status indicator locations.

Inhibit	-	Indicates the drive has been shut down via the disable circuit.
Stop	-	Indicates the drive has been given a stop command.
Run	-	Indicates the drive has been given a run command.
Forward	-	Indicates the drive is operating in the forward quadrant.
Reverse	-	Indicates the drive is operating in the reverse quadrant.
Overspeed	-	Indicates the drive has been given a stop command due to excessive armature voltage. (Rest by initiating disable function, or if an option is being used push the "Stop" button).

4.4 Mounting and Clearances

When mounting the control, refer to the Tetra-Line 200 dimension diagram Fig. 5. The heatsink fins have to be positioned vertically to enable a creation of a "Chimney effect" around the heatsink. The cabinet's bottom (for the same reason) must be a least 4" away from any obstructions. This becomes more important with local electrical codes to assure proper protection, chiefly to the operating personnel.

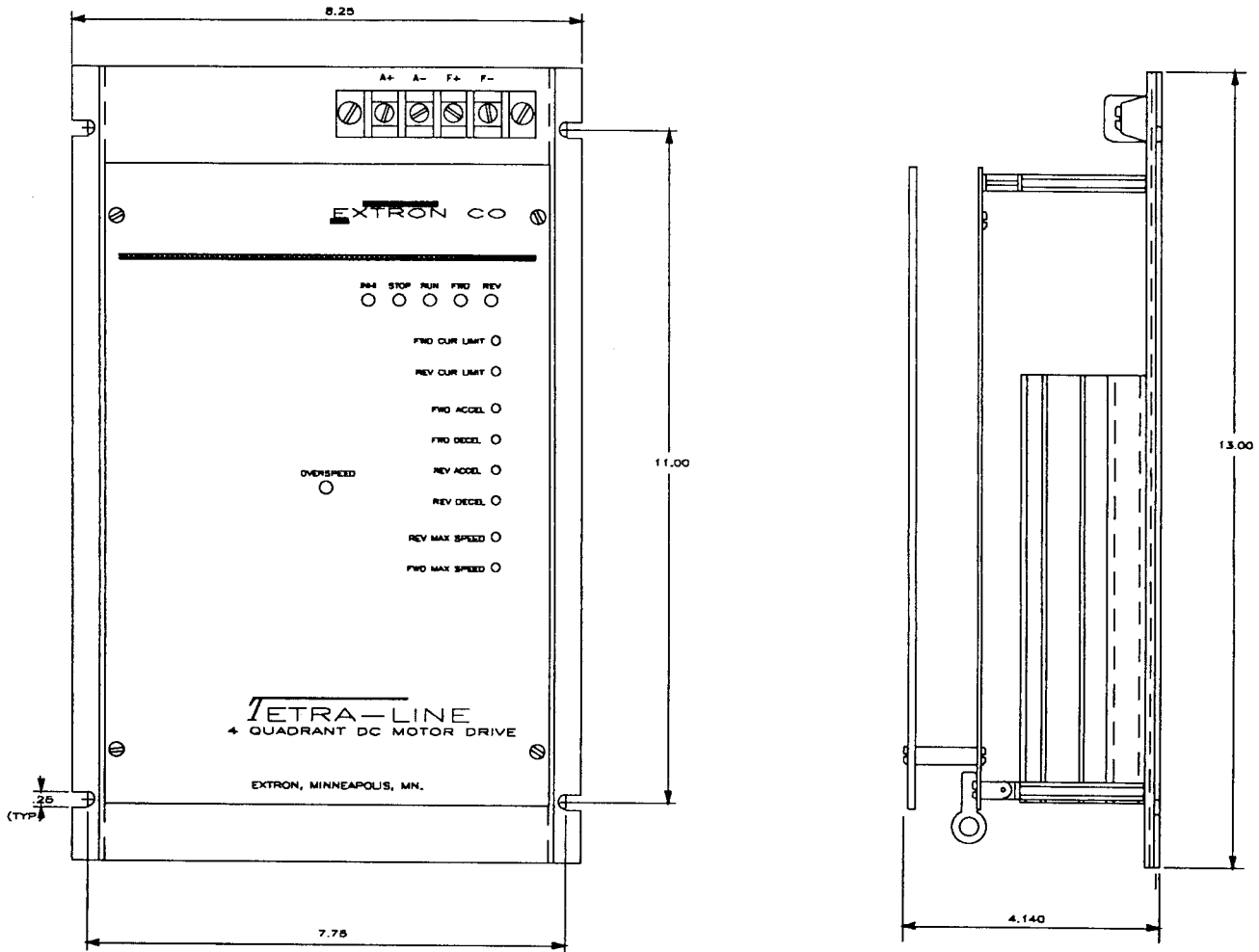


Fig. 5 - Mounting Dimensions

5.0 Installation Wiring

Wire the controller according to the connection diagrams. Recommended minimum wire sizing should be based on 150% of the full load motor current.

Protect the equipment by the installation of either a line circuit breaker or fuses of a proper size. A disconnect switch may be desired and/or required for the possible troubleshooting and by the electrical code.

Wiring Code: Follow local and national electric code recommendations for good wiring practice during installations.

A grounding lug is provided in the cabinet. Follow the electrical code to properly size the cable and for grounding procedures.

Be aware that changing the direction of the motor's shaft rotation can be accomplished by swapping either the armature or the field leads. The controller output is defined for the terminal A+ to become positive relative to the terminal A- in forward direction.

Beware: Motor connections should only be made with the power disconnected.

Shielded cable: The control circuit wiring should be made utilizing shielded cable.

Note: The cover removal is not necessary if the drive was ordered and factory tested for a specific motor.

5.1 Detailed calibration instructions

1. The installed cover allows only adjusting and setting parameters used for normal operation. If further calibration is required, the cover has to be unscrewed.
2. Secure the cover and the PC card in the normal position and unscrew the cover to access all adjustment potentiometers.
3. The following describes the method of full calibration with the cover removed. For the pot and jumper locations, refer to Fig. 1.
4. Jumper and Switch Selection. (Install only jumpers and switches called for)
5. Incoming Voltage Selection
 - A) For 115 VAC input install jumpers W1, W3, W7, W8, W9, and W10.
 - B) For 230 VAC input, install only W2.
6. Feedback Switch Selection (EMF, D.C. Tachometer, Pulse).
 - A) For EMF feedback install SW5 and SW9.
 - B) For D.C. tachometer feedback, install SW6 and SW8.
 - 1) For 7V/1000 RPM Tach install SW4.
 - 2) For 50V/1000 RPM Tach install SW3.
 - 3) For 100V/1000 RPM Tach install SW2.
 - 4) For 200V/1000 RPM Tach install SW1.
 - C) For pulse feedback, install SW7 and SW8.

6.0 Control Connection Information

6.1 System Block Diagram

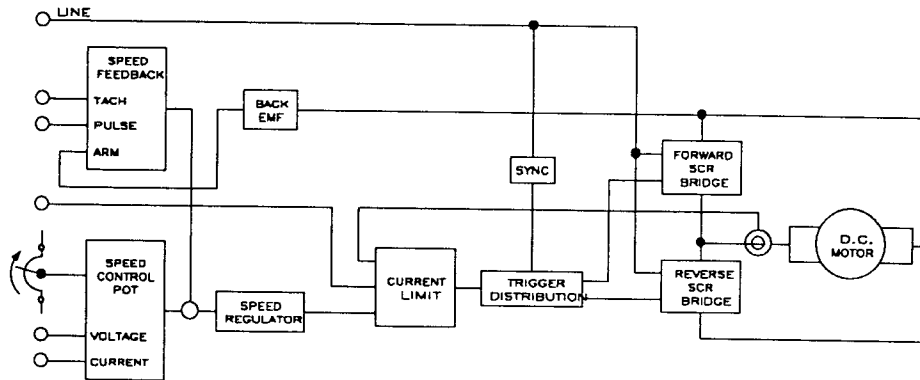


Fig. 6 - System Block Diagram Tetra-Line 200

6.2 Schematic - Power Section

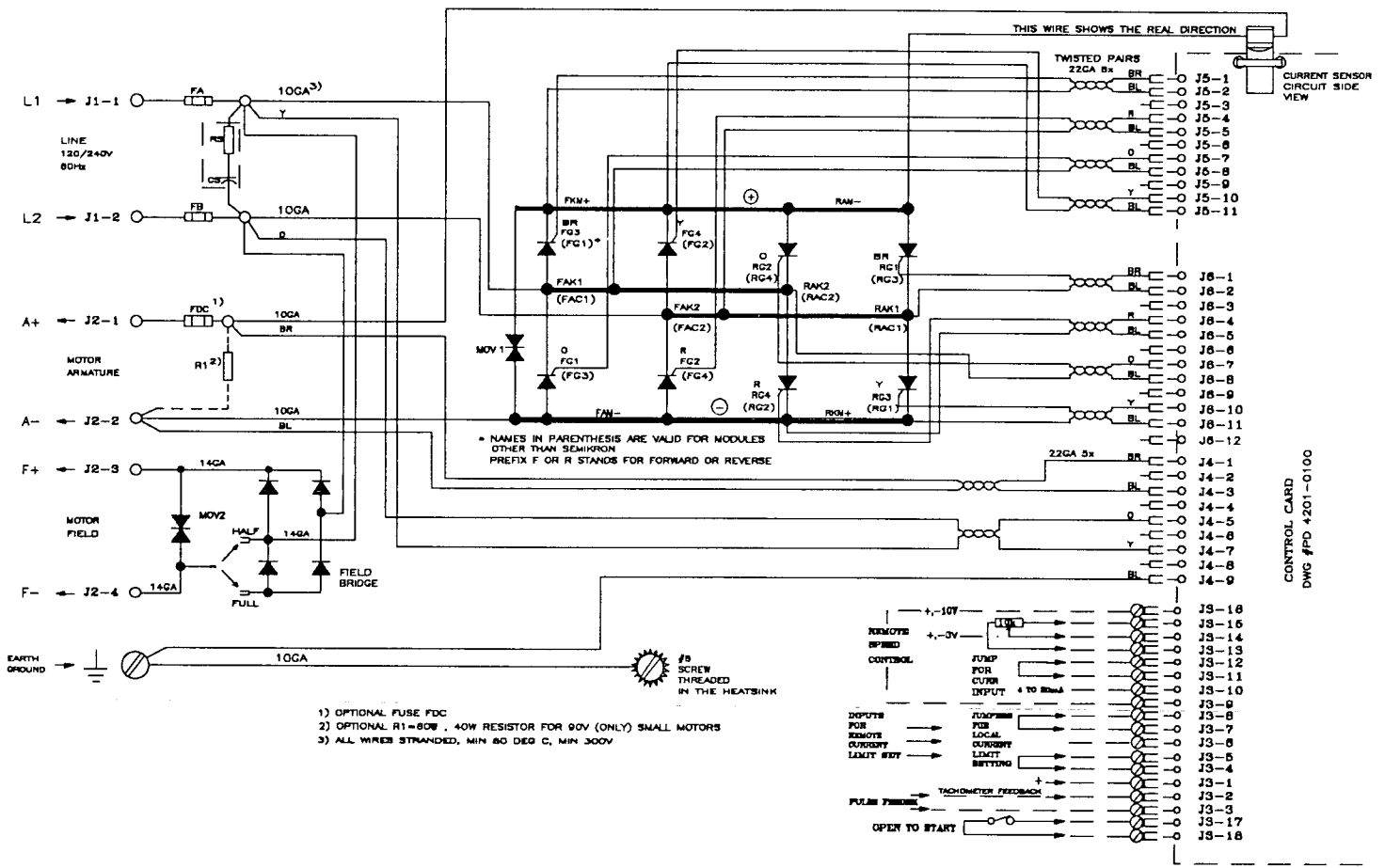


Fig. 7 - Schematic Diagram Power Section Tetra-Line 200

6.3 Basic Motor and Line Connections

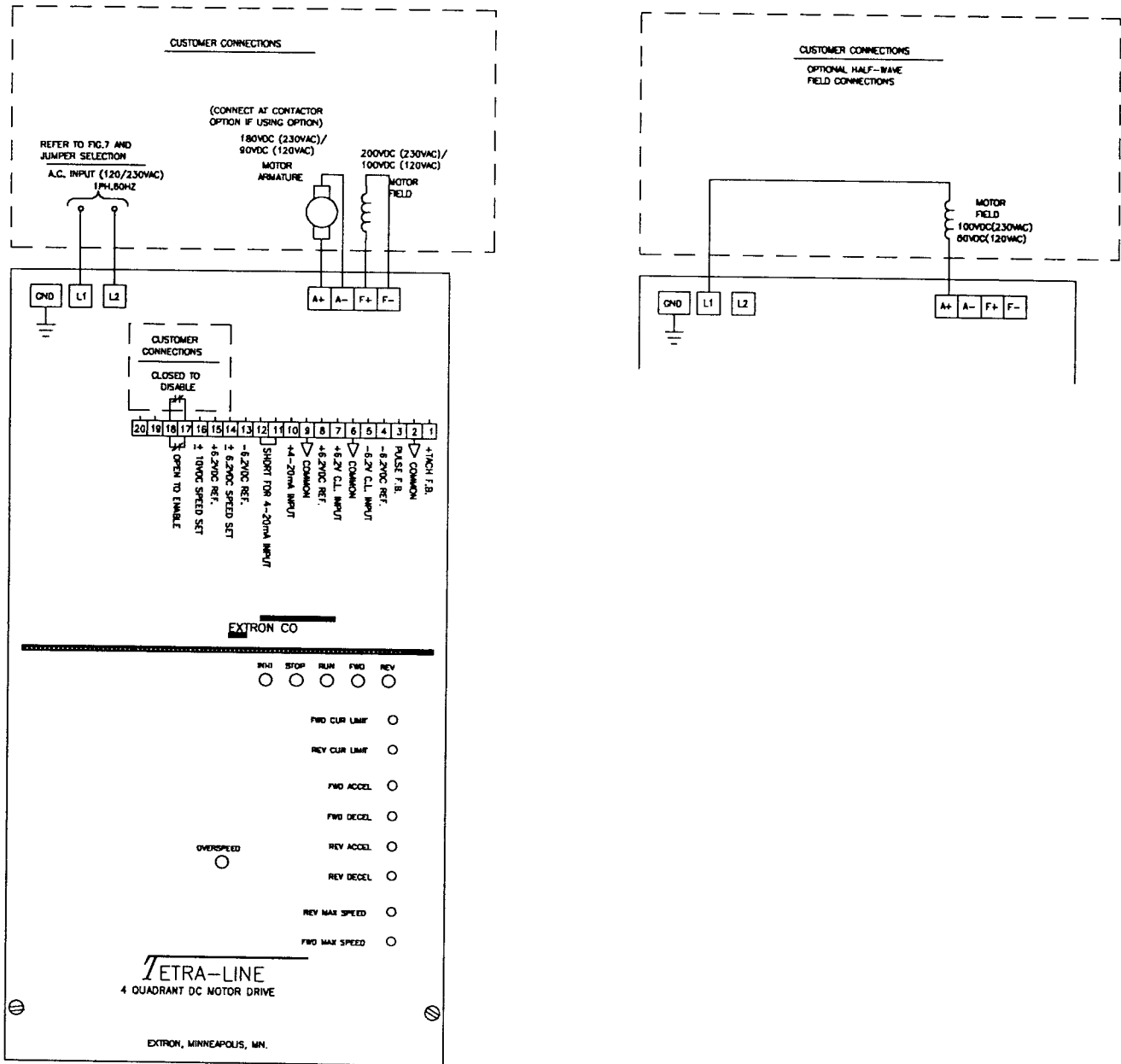


Fig. 8 - Basic Motor and Line Connections Tetra-Line 200

6.4 Optional Connections for Speed Command

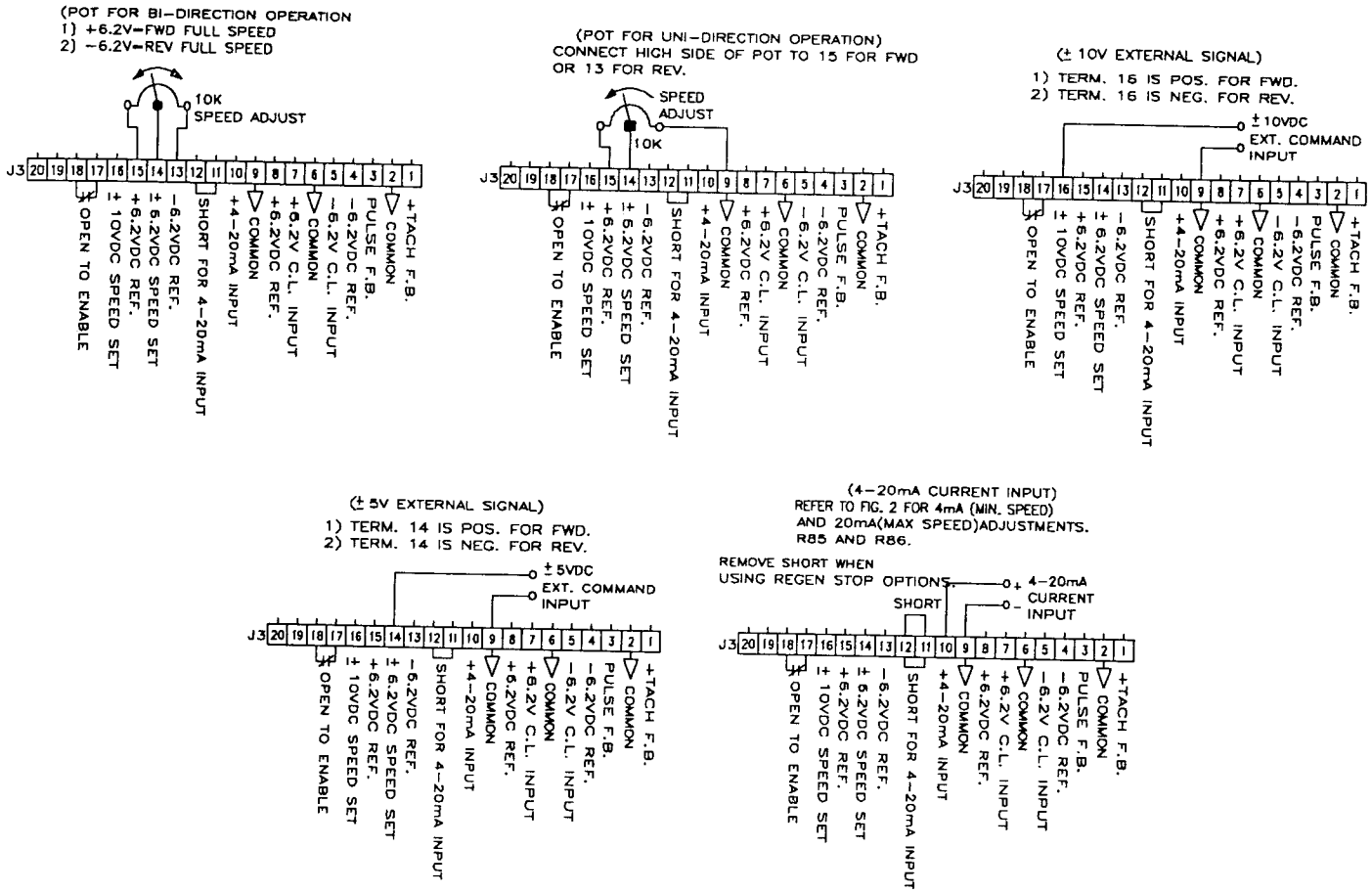


Fig. 9 - Optional Connections for Speed Commands

6.5 Optional Connections for Current Limit

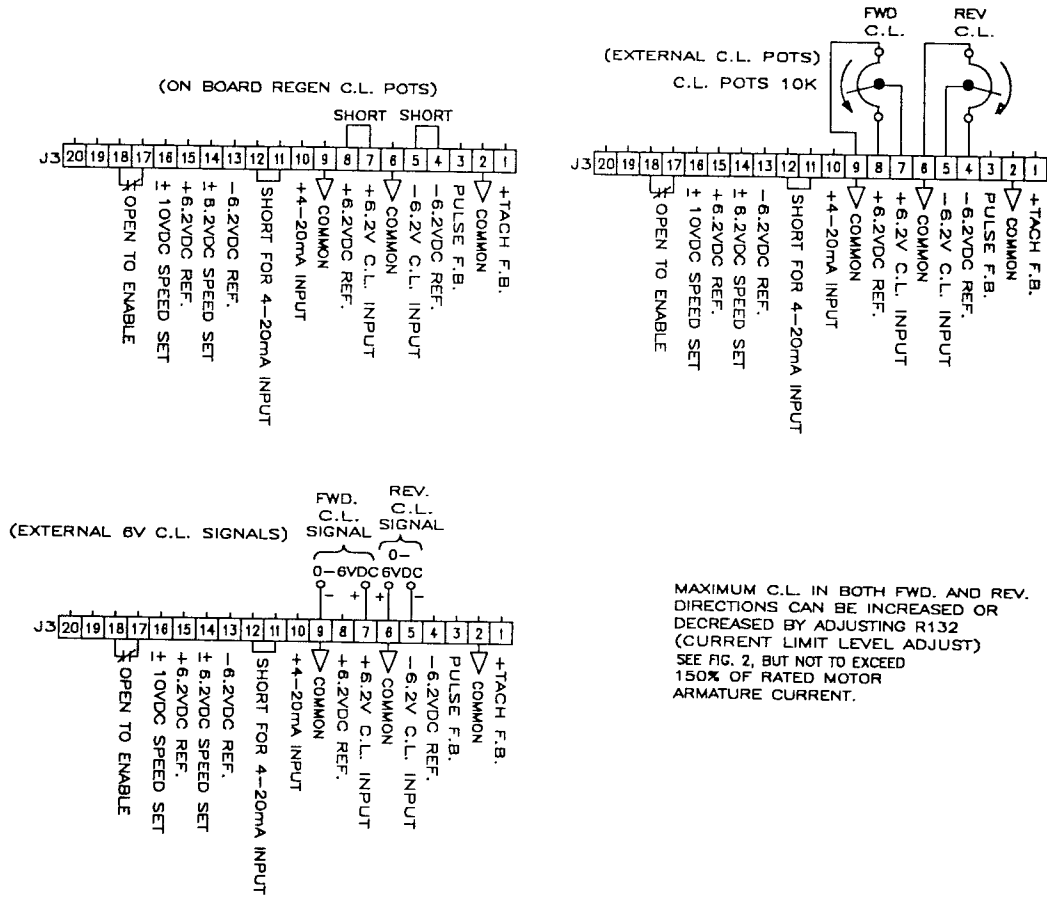


Fig. 10 - Optional Connections for Current Limit

6.6 Optional Connections for Feedback Selection

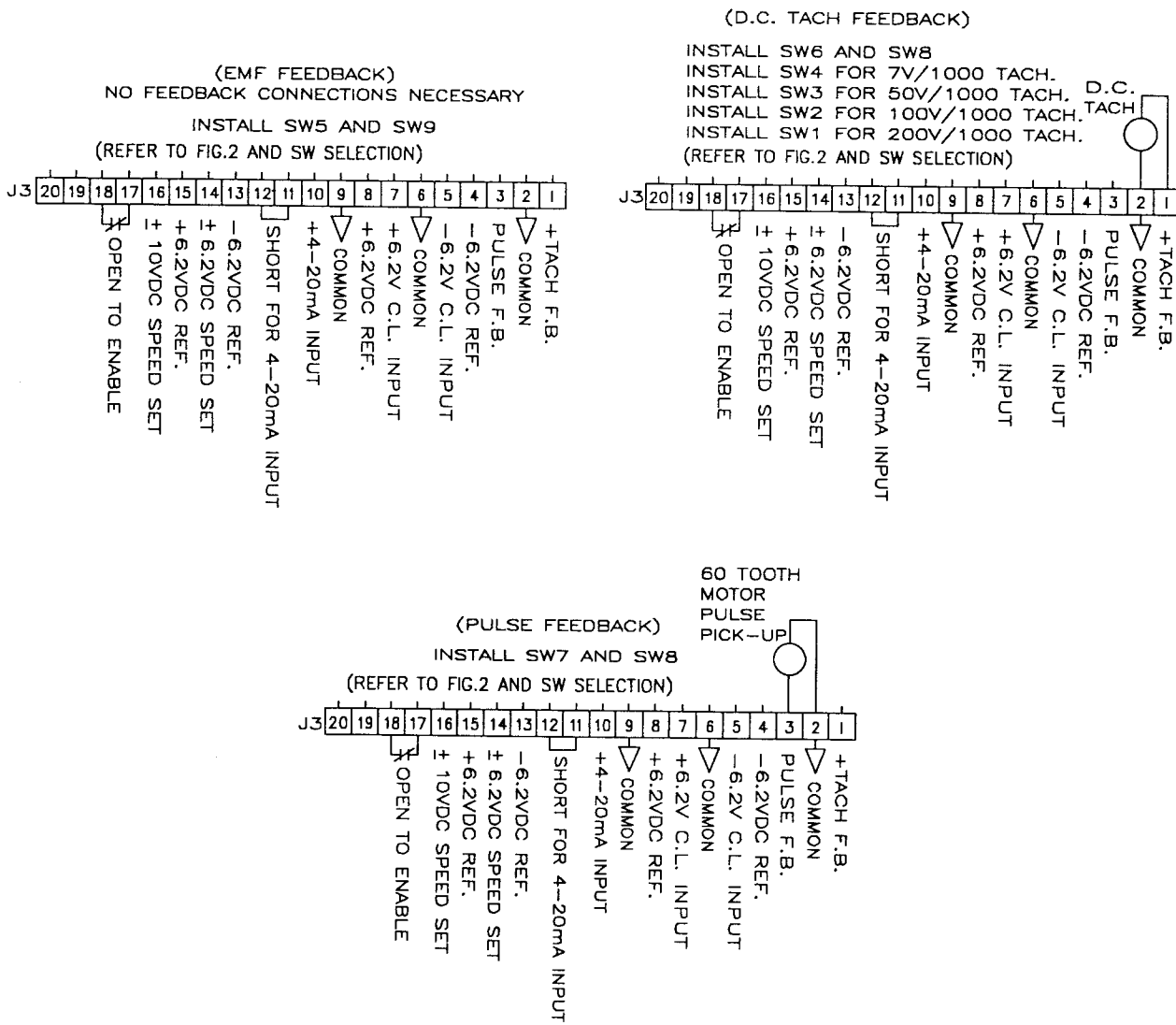


Fig. 11 - Optional Connections for Feedback Selections

7.0 Trouble Shooting (Refer to Fig. 12)

It is not expected that the user is going to troubleshoot the PC card, therefore the flow chart in Fig.12 describes only the possible faults of the power portion circuitry. The PC card is listed as a spare part.

Silicon controlled rectifiers (SCR's or thyristors) and silicon rectifiers (diodes) are used in the power output stage of this motor drive.

A superfluous test of the SCR's can be performed with a basic digital volt-OHM-meter (VOM). A device failure is usually a complete short or sometimes an open circuit between the anode and cathode. During the VOM test, it is best to disconnect both the gate and the anode leads. The VOM will show a clear short in both directions (Anode to cathode and vice versa). If the thyristor is open (or good) the VOM will read a resistance over 100K Ohm in both directions. An open SCR however, will not fire during operation and consequently the maximum DC output voltage will be reduced.

A damaged thyristor usually exhibits irregular gate to cathode resistance (normal resistance of the gate to cathode junction is between 20 to 40 ohm with the VOM's positive lead connected to the gate).

The diodes can be tested for anode to cathode resistance in a similar manner as the thyristors. They do not have gate leads, so disconnection of them is not applicable.

7.1 Trouble Shooting Block Diagram

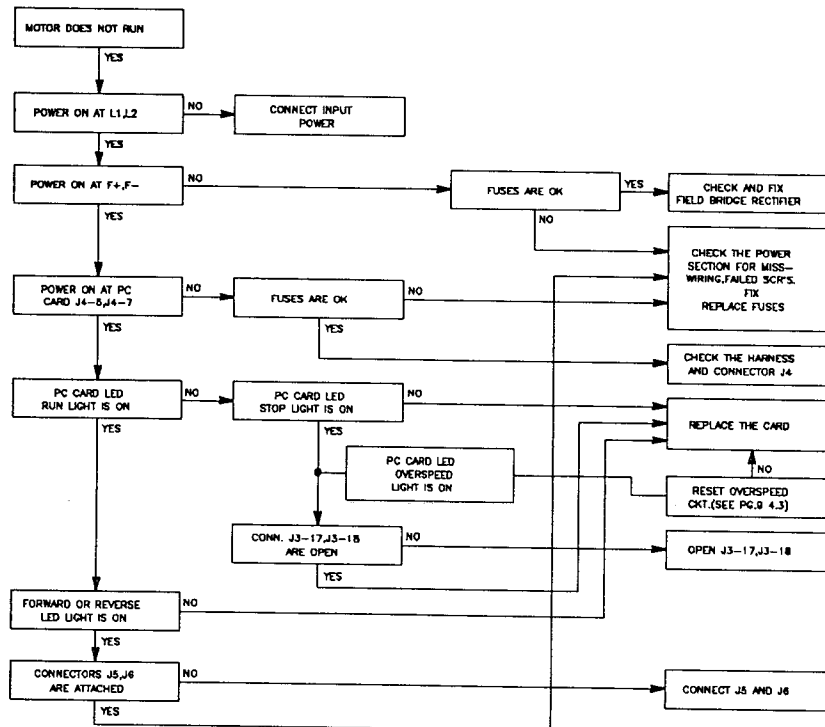


Fig. 12 - Trouble Shooting Block Diagram

8.0 Spare Parts List

Part Number	Description
5112-0205	Semiconductor fuse FWX 30, 30A, 250V For Tetra-Line 200 model 420-100
5112-0302	Semiconductor fuse FWH 100, 100A, 250V For Tetra-Line 200 models 420-200, 420-300
4834-0900	Forward or reverse SCR bridge, 40A, 800V
4844-0700	Field bridge rectifier, 10A, 600V
1691-0101	Thermal heatsink to SCR bridge foil interface
PC4200-0100	Plexiglass cover
PD4201-0100	Printed circuit card

9.0 Drive Accessories

9.1 Isolation Transformer

The use of SCR control circuitry with adjustable-speed drives has resulted in a need for isolation transformers specifically designed to meet the demanding requirements of SCR drives. Symmetrically placed taps and added coil bracing minimize mechanical forces caused by the often severe SCR drive duty cycles. These features also help protect the transformer from the regenerative nature and more frequent short circuits associated with SCR drives. Isolation transformers also reduce line-pollution feedback resulting from SCR firing circuits.

Selection and Interconnection

Transformer Ratings

HP	KVA Rating
1/8	.25 KVA
1/4	.5 KVA
1/2	1 KVA
3/4	1.5 KVA
1	2 KVA
1 1/2	3 KVA
2	4 KVA
3	6 KVA
5	10 KVA
7 1/2	15 KVA

9.2 Armature Fusing (Factory installed option - see price list)

This option should be specified at the time of order.

10.0 Drive Options

10.1 Mounting Diagram

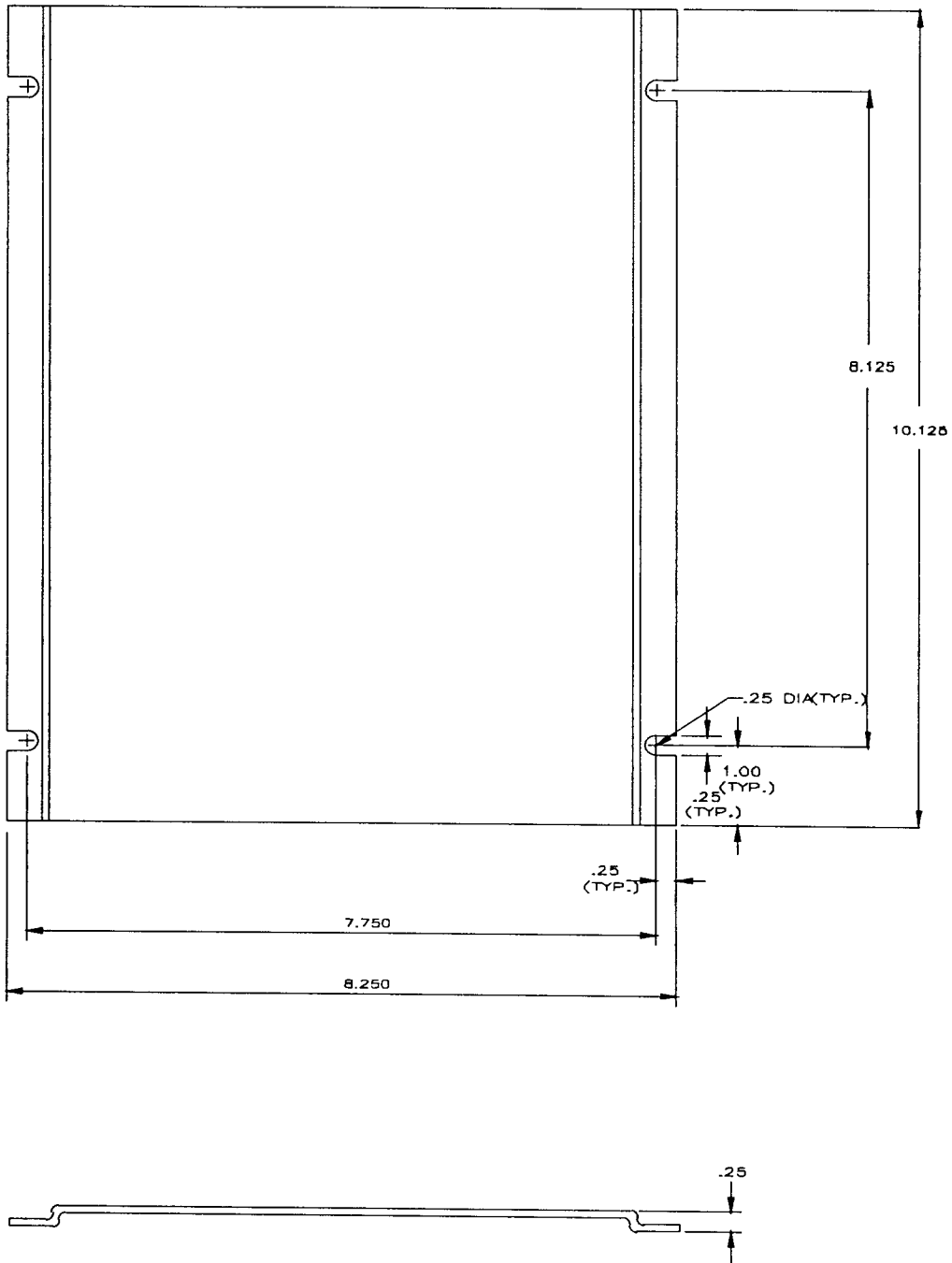


Fig. 13 - Option Card Mounting Dimensions

10.2 P.C. Interface with start/stop contactor and Dynamic Braking

P.C. Interface with Start/Stop Contactor and Dynamic Braking is a separate chassis mount option that inter-wires to the Tetra-Line. It provides a contactor for disconnecting the motor armature from the armature output of the Tetra-Line. When the armature contactor is disabled, a brake resistor is connected across the motor armature for Dynamic Braking. The armature contactor and the Tetra-Line are enabled by applying 120 VAC from an external source such as a PLC to the option. When A.C. power is applied to the Tetra-Line and the armature contactor is enabled, a set of isolated relay contacts close providing a closed circuit for "Talk back" to the PLC or other logic. (See Fig. 14 connection diagram).

Part Number Selection:

Part Number	Horse Power Range	Voltage
4217-0100	1/4 - 1 HP	120 VAC
4217-0200	1/4 - 2 HP	230 VAC
4217-0300	3 - 5 HP	230 VAC
4217-0400	7 1/2 HP	230 VAC

10.2.1 Interconnection Information for P.C. Interface with Stop/Start Contactor and Dynamic Braking

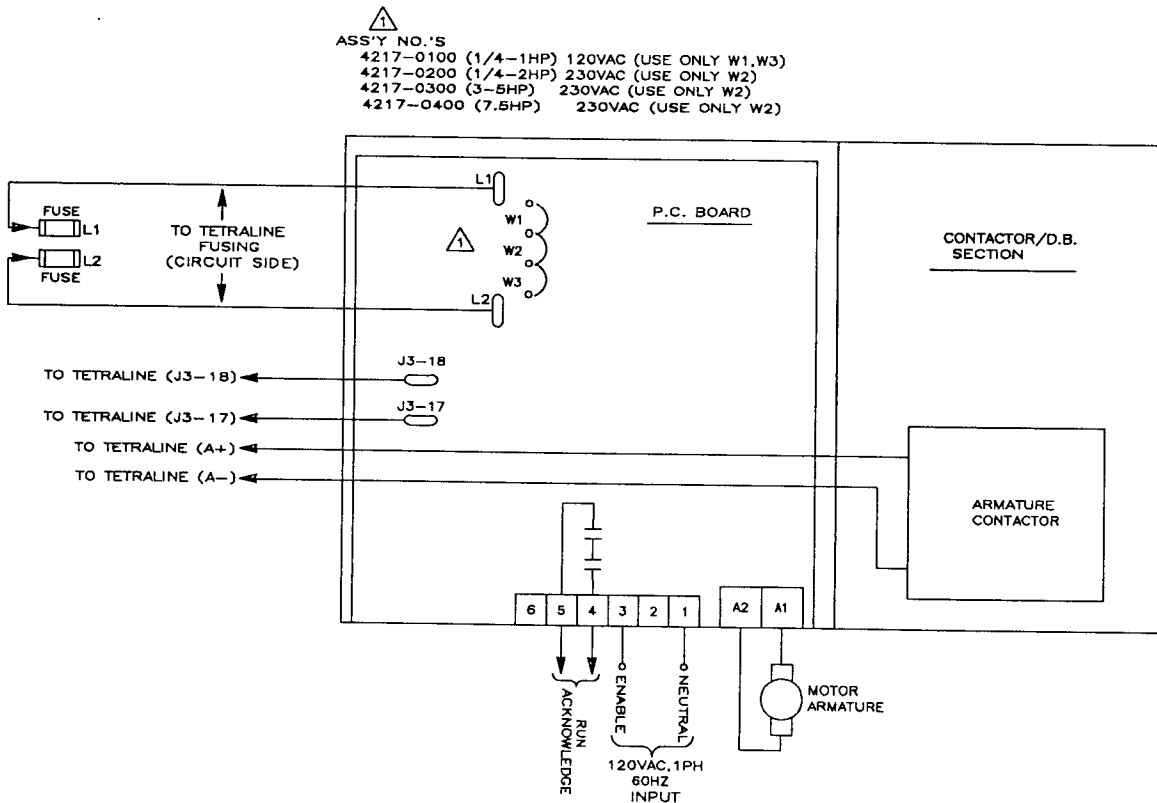


Fig. 14 - Interconnection Information

10.3 P.C. Interface with Contactor Reversing and Dynamic Braking

P.C. Interface with Contactor Reversing and Dynamic Braking is a separate chassis mount option that inter-wires to the Tetra-Line. It provide contactors for reversing the motor rotation and for disconnecting the motor armature from the armature output of the Tetra-Line. It has an anti-plug circuit so that the opposite direction contactor can not be enabled until the motor has approched almost zero speed. When the armature contactors are disabled, a brake resistor is connected across the motor armature for Dynamic Braking. The armature contactors and Tetra-Line are enabled by applying 120 VAC from an external source such as a PLC to the appropriate inputs of the option. When A.C. power is applied to the Tetra-Line and the forward or reverse contactor is enabled a set of isolated relay contacts close (for the appropriate contactor) providing a closed circuit for "Talk back" to the PLC or other logic. (This option allows the motor to be reversed by using a single polarity command signal to the Tetra-Line). (This option can not be used with D.C. Tach feedback, consult factory). See Fig 15 connection diagram.

Part Number Selection:

Part Number	Horse Power Range	Voltage
4227-0100	1/4 - 1 HP	120 VAC
4227-0200	1/4 - 2 HP	230 VAC
4227-0300	3 - 5 HP	230 VAC
4227-0400	7 1/2 HP	230 VAC

10.3.1 Interconnection Information for P.C. Interface with Contactor Reversing and Dynamic Braking

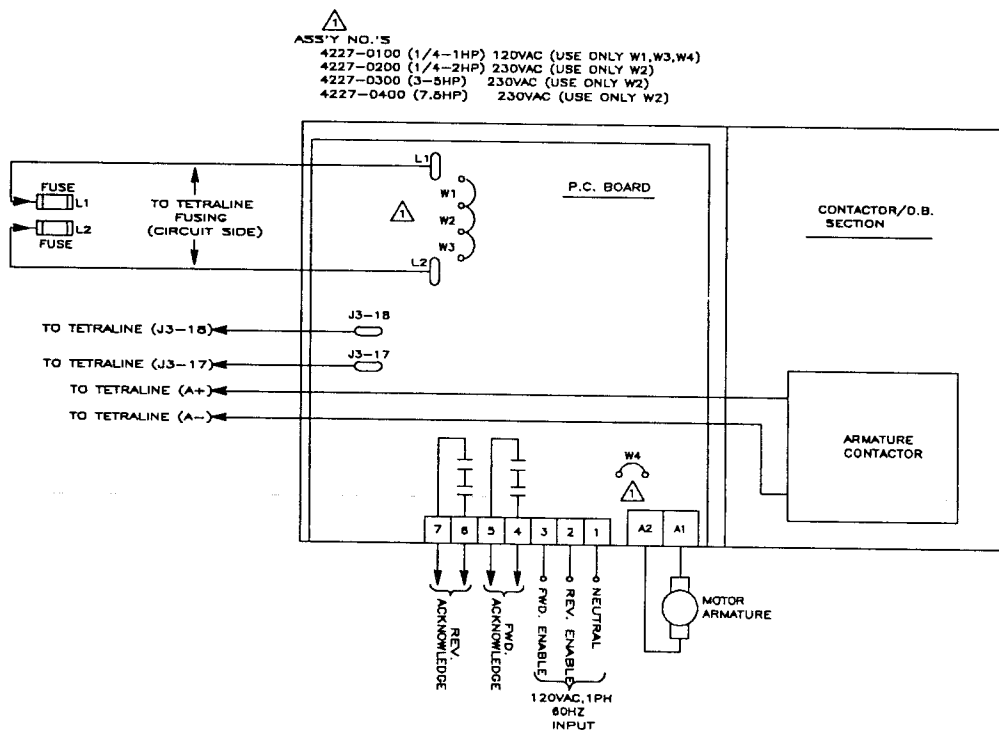


Fig. 15 - Interconnection Information

10.4 Start/Stop with Dynamic Braking

Standard Start/Stop Contactor and Dynamic Braking is a separate chassis mount option that inter-wires to the Tetra-Line. It provides a contactor for disconnecting the motor armature from the armature output of the Tetra-Line. When the contactor is disabled, a brake resistor is connected across the motor armature for Dynamic Braking. The armature contactor and Tetra-Line are enabled and disabled by momentary pushbutton operators or a maintained isolated relay contact in place of the seriesed pushbuttons. (See Fig. 16 connection diagram).

Part Number Selection:

Part Number	Horse Power Range	Voltage
4237-0100	1/4 - 1 HP	120 VAC
4237-0200	1/4 - 2 HP	230 VAC
4237-0300	3 - 5 HP	230 VAC
4237-0400	7 1/2 HP	230 VAC

10.4.1 Interconnection Information for Standard Start/Stop Contactor and Dynamic Braking

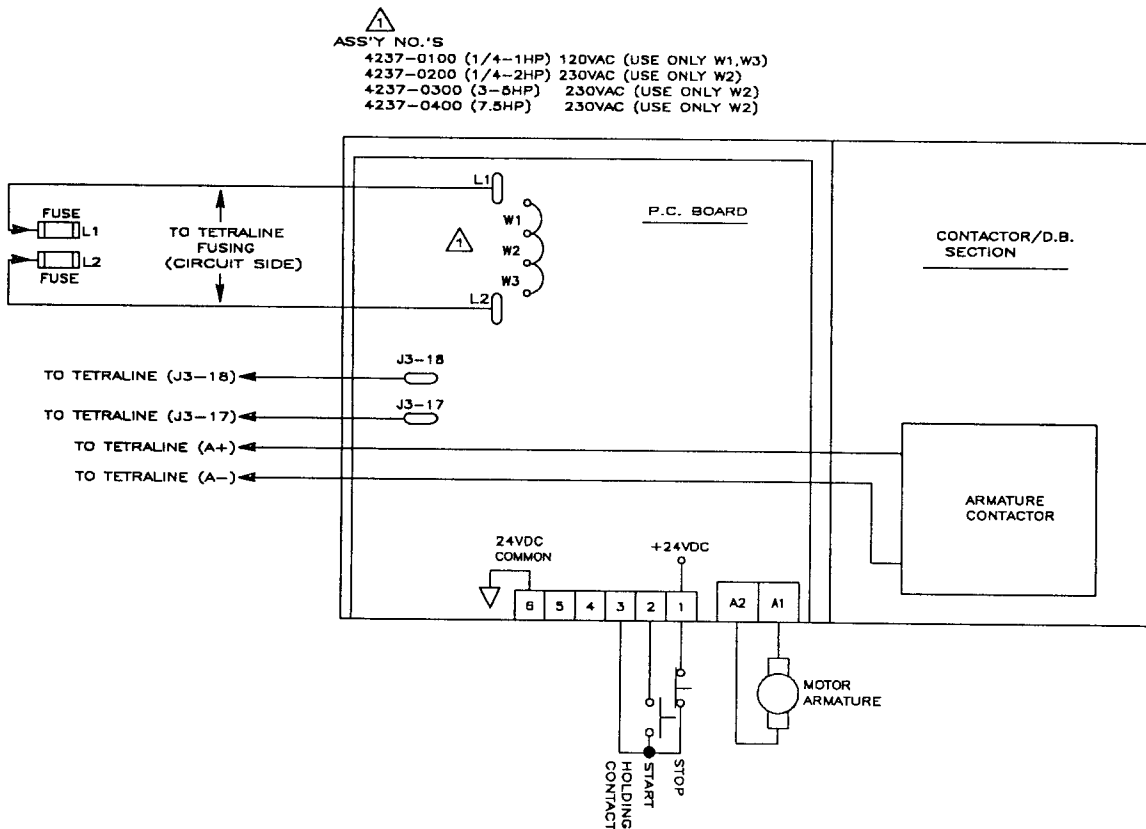


Fig. 16 - Interconnection Information

10.5 Standard Contactor Reversing and Dynamic Braking

Standard Contactor reversing and Dynamic Braking is a separate chassis mount option that interwires to the Tetra-Line. It provides contactors for reversing the motor rotation and disconnecting the motor armature from the armature output of the Tetra-Line. It has an anti-plug circuit so that the opposite direction contactor can not be enabled until the motor has approached almost zero speed. When the contactors are disabled, a brake resistor is connected across the motor armature for Dynamic Braking. The armature contactors and Tetra-Line are enabled and disabled by momentary pushbutton operation or maintained isolated relay contacts in place of the appropriate seriesed pushbuttons. (This option allows the motor to be reversed while using a single polarity command signal to the Tetra-Line). (This option can not be used with D.C. Tach feedback - consult factory). (See Fig. 17 connection diagram).

Part Number Selection:

Part Number	Horse Power Range	Voltage
4247-0100	1/4 - 1 HP	120 VAC
4247-0200	1/4 - 2 HP	230 VAC
4247-0300	3 - 5 HP	230 VAC
4247-0400	7 1/2 HP	230 VAC

10.5.1 Interconnection Information for Standard Contactor Reversing and Dynamic Braking.

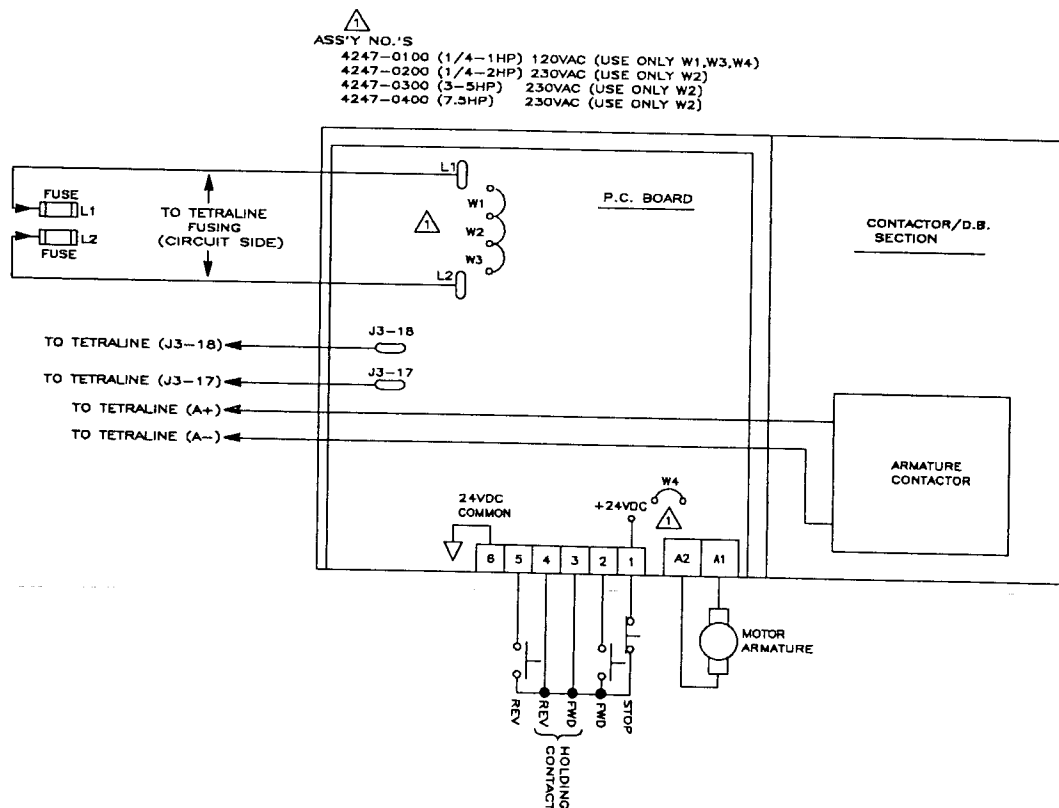


Fig. 17 - Interconnection Information

10.6 Regen Stop with Armature Contactor and Dynamic Braking

Regen Stop with Armature Contactor and Dynamic Braking is a separate chassis mount option that inter-wires to the Tetra-Line. It provides a contactor for disconnecting the motor armature from the armature output of the Tetra-Line. When the contactor is disabled, a brake resistor is connected across the motor armature for Dynamic Braking. The armature contactor and Tetra-Line are enabled and disabled by momentary pushbutton operators or a maintained isolated relay contact in place of the seriesed pushbuttons. When "Stop" is initiated, a pilot relay gives a "Zero" speed command to the Tetra-Line and the motor is commanded to zero speed by regenerative braking. After an interval of time (which is adjustable from .5 to 5 sec.) the armature contactor is disabled. Isolated auxiliary contacts are provided for the "Regen Stop" and "Armature Contactor" functions. (See Fig. 18 connection diagram).

Part Number Selection:

Part Number	Horse Power Range	Voltage
4257-0100	1/4 - 1 HP	120 VAC
4257-0200	1/4 - 2 HP	230 VAC
4257-0300	3 - 5 HP	230 VAC
4257-0400	7 1/2 HP	230 VAC

10.6.1 Connection Information For Regen Stop with Armature Contactor and Dynamic Braking

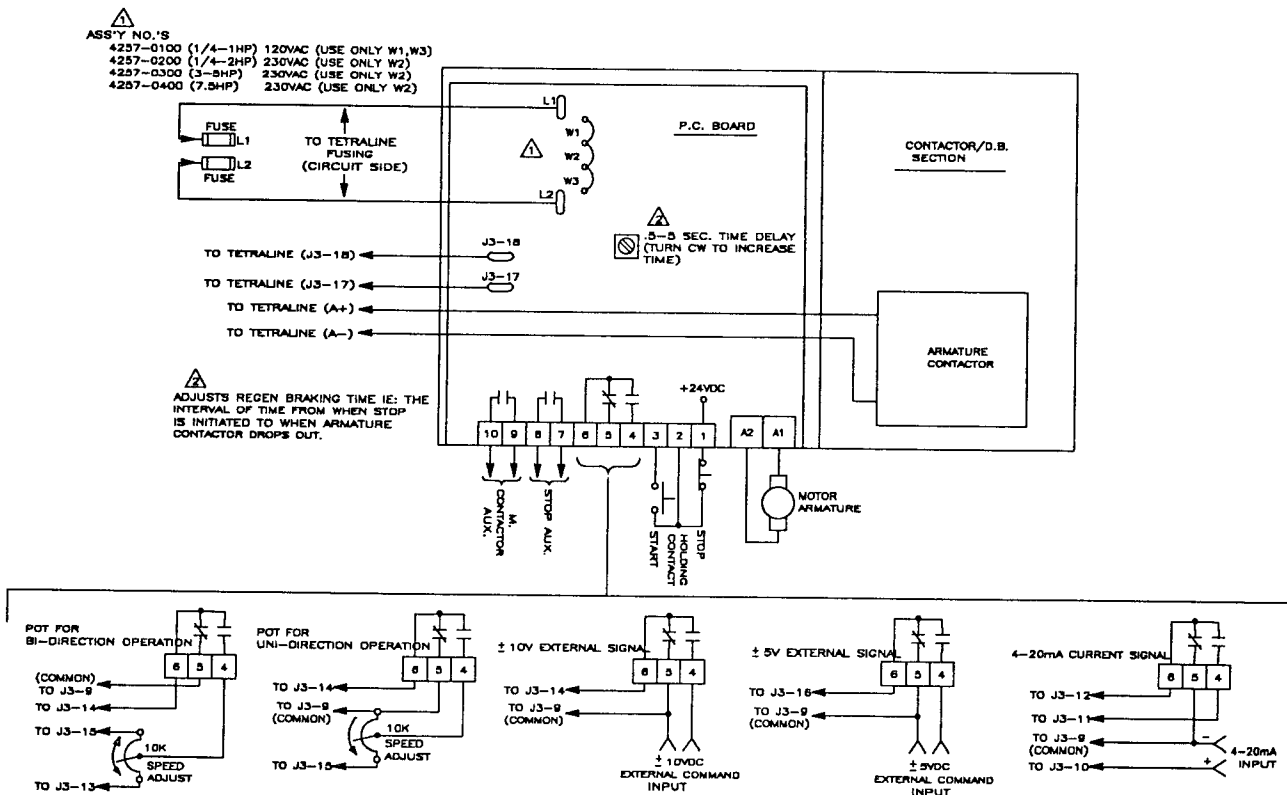


Fig. 18 - Inter-connection Information

10.7 P.C. Interface with Regen Stop, Armature Contactor and Dynamic Braking.

P.C. Interface with Regen Stop, Armature Contactor and Dynamic Braking is a separate chassis mount option that inter-wires to the Tetra-Line. It provides a contactor for disconnecting the motor armature from the armature output of the Tetra-Line. When the contactor is disabled, a brake resistor is connected across the motor armature for Dynamic Braking. The armature contactor and Tetra-Line are enabled by applying 120 VAC from an external source such as a PLC to the option. When stop is initiated by removal of the 120 VAC input, a pilot relay gives a "Zero" speed command to the Tetra-Line and the motor is commanded to zero speed by regenerative braking. After an interval of time, (which is adjustable from .5 to 5 sec.), the armature contactor is disabled. Isolated relay contacts are provided for the "Regen Stop" and "Armature Contactor" functions. These contacts are each seriesed with another contact for A.C. power status to the Tetra-Line. When main A.C. power is applied to the Tetra-Line, and the armature contactor enabled, these contacts close providing a "talk back" to the PLC or other logic. (See Fig. 19 connection diagram).

Part Number Selection:

Part Number	Horse Power Range	Voltage
4267-0100	1/4 - 1 HP	120 VAC
4267-0200	1/4 - 2 HP	230 VAC
4267-0300	3 - 5 HP	230 VAC
4267-0400	7 1/2 HP	230 VAC

10.7.1 Interconnection Information for P.C. Interface with Regen Stop, Armature Contactor and Dynamic Braking.

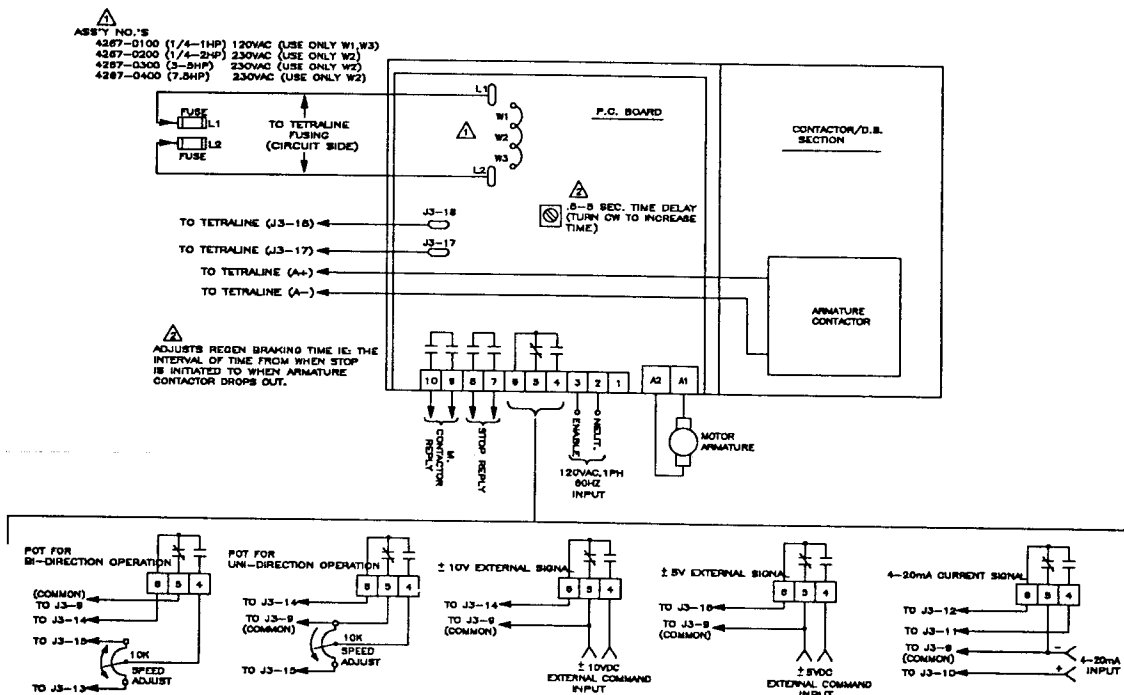


Fig. 19 - Interconnection Information

11.0 Factory Service and Warranty Information

Extron provides complete service for all products offered. Please contact your local Distributor or Representative for Return Authorization Procedures.

A Return Authorization Number is required to process your unit quickly and return it to service. Service for units beyond the warranty period is available at standard published rates. Quotes on service costs are available upon request.

EXTRON COMPANY WARRANTY

Extron warrants to the original purchaser all equipment and products manufactured by it and bearing its name to be free of defects in material and workmanship under normal use and service for a period of twelve (12) months from date of purchase from Extron. This warranty is applicable only if the Extron product and/or equipment is installed, operated and maintained in accordance with factory recommendations and procedures.

In the event the Extron product and/or equipment is found to be defective within the above stated twelve (12) month period, Extron will repair or replace defective parts if the product or equipment is shipped prepaid to Extron's factory and if such product and/or equipment is found by Extron's inspection to be truly defective in workmanship or material. Extron will return-ship such repaired product and/or equipment prepaid within the continental United States. If Extron's inspection does not disclose any defect in workmanship or material, repairs will be made at a reasonable charge.

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Notes