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1. GENERAL DESCRIPTION

The PRD-2 control is a fast responding, single phase half wave 4 quadrant regenerative control. Two back-to-back SCRs are used to provide either positive or negative current to a DC motor. The control is available for use on both 115 or 230 VAC 50/60Hz input service. (Two simple balance adjustment settings must be changed in going from 50 to 60 Hz)

The PRD-2 control will automatically dictate whether the control is to act as a motor or a generator in order to satisfy a given speed command. For example, if the motor is running at a set speed and the speed potentiometer is quickly turned to the zero speed point, the motor will act as a generator and pump current back into the AC lines to quickly brake to zero speed. Pumping current back into the AC lines produces the braking torque required to reduce motor speed to zero. Both speed and direction of rotation are determined by the speed potentiometer setting. Polarity of the voltage at the speed potentiometer wiper determines direction of rotation; the magnitude of the voltage determines the speed.

The basic control is provided with many standard features. One of these features includes independently adjustable plus (+Lim) and minus (-Lim) current limit potentiometers. Each potentiometer can be adjusted to limit maximum motor currents from 0 to 200% rated armature current. Unless specified otherwise, the current limit potentiometers are both factory preset for a maximum motor current limit of 150%. IR compensation is also provided to enable good speed regulation (+/- 1% of base speed) as the motor is loaded from light to maximum armature current rated loads.

The PRD–2 comes equipped with a dual field capability to cover use with most motors. (See section on changing field voltage.)

A circuit board jumper is provided to allow a reduction in the speed error amplifier gain from the "Hi" position gain setting of 100,000 to the "Lo" position gain of 10. This jumper change along with adjusting the "+Bal" and "-Bal" potentiometers fully clockwise will introduce a dead band (approximately 2% of input signal range). This capability is very important in those applications that require "no creep" operation at zero speed.

A "% Torque" output terminal is also available to conveniently monitor armature current on a remote meter readout. The magnitude and direction of the current output can be read by connecting a meter to 1TB terminal 8 in respect to common. (The output resistance at this terminal is 470 ohms.)

The PRD–2 unit is protected against excessive current overloads by the fast responding PRD-2 current limit circuitry. In addition, the PRD-2 unit is protected against damage due to accidental wiring shorts or grounds by fast-acting rectifier –protection type fuse(s) inserted in the AC input line(s).

[In 115 volt controls only one fuse is provided. Therefore the unfused AC line must be the ground line.]

WARNING
IF FUSE REPLACEMENT BECOMES NECESSARY USE ONLY THE SPECIFIED FUSES. THE USE OF SUBSTITUTE FUSES MAY VOID THE CONTROL WARRANTY

TABLE - 1

MODEL	CONTROL VOLTAGE	CONTROL HP	NORMAL RMS INPUT CURRENT	RATED MOTOR CURRENT	SHUNT LINK REQ'D	FUSE TYPE 10 FU 14 FU	CONTROL GROUP
PRD2-16		1/6	6	2.2	C	A	
PRD2-20		1/5	7	3.0	E	A	
PRD2-33		1/3	10	4.3	H	A	1
PRD2-50	115	1/2	14	6.0	K	A	
PRD2-66		2/3	17	8.0	M	A	
PRD2 -34		1/3	6	2.2	C	B	
PRD2-51		1/2	8	3.0	F	B	
PRD2-67		2/3	10	4.3	H	B	2
PRD2-101	230	1	14	6.0	K	B	
PRD2-125		1 1/4	17	8.0	M	B	
PRD2 -200	230	1.9	25	11.3	Q	C	3

Fuse Type A - Shawmut A15 X 25 or IR SF15X 25
Fuse Type B - Shawmut A25 X 25 or IR SF25X25
Fuse Type C - Shawmut A25 X 30 or IR SF 25X30

Fuse Type 11FU and 13FU (all controls) -Litte1fuse 312/3AG 3 amp

2. PRD-2 SPECIFICATIONS

Input Voltage (single phase) ……..	115VAC +/- 10V, or 230 VAC +/- 20V
Input Frequency ……..	60 Hz (field adjustable to 50 Hz)
Horsepower Range ……..	115 VAC: 1/6 thru 2/3 HP 230 VAC: 1/3 thru 1 ¼ HP and 1.9 HP with specified motors
Output voltage to armature……	0-75 VDC (115V controls) 0-150 VDC (230V controls)
Output voltage to field …….	100 VDC (115 V Controls) (convertible to 50VDC) 2 amps max either voltage 200 VDC (230V Controls) (convertible to 100VDC) 2 amps max either voltage
Load Regulation for 100% load change:	
a) With armature feedback ……..	Adjustable to +/- 1% of base
b) With tachometer feedback …….	speed +/-.1% of base speed typical
Speed Range …….	0 to 100%
Speed Range for Specified Regulation ……	20 to 1
Torque limits (independently adjustable plus and minus limits) [+Lim and -Lim]……	0 to 200% of rated motor current
Speed Program voltage (voltage on terminal 1TB –C) to produce +/- 100% speed ……..	- / + 6VDC
Torque program voltage (terminal 6 of 1TB) to produce zero to preset speed……. ……	0 to +6VDC
Torque meter (%T) output voltage (1TB-8) for -100% to +100% torque (output resistance 470 ohms)……..	-1VDC to +1VDC
Maximum ambient temperature ……	40° C

3. INSPECTION:

Check for shipping damage. If damage is found, report it to the carrier immediately. Do not attempt to operate the drive if visible damage to the circuit board or other component exists.

4. INSTALLATION INSTRUCTIONS

These instructions apply to the basic open-chassis control unit.

4.1 Control Unit Mounting

4.1.1 Remove the two outermost screws at the top of the main circuit board and swing the circuit board forward to allow access to the metal base plate.

4.1.2 Drill six holes in the enclosure wall per the mounting dimensions shown on drawing A2001-000-EW.

4.1.3 Cover the mounting surface of the PRD-2 base plate with a thin coat of silicone grease (Dow Corning Compound #4 or equivalent) to facilitate heat transfer, and attach to the enclosure wall using six bolts (#8, #10, or 3/16" diam.). In NEMA 4 or NEMA 12 cabinets use neoprene washers under screw heads outside of cabinet.

4.1.4 Replace the two screws removed in step 4.1.1 above to again secure circuit board to base plate.

4.2 Motor Mounting

Do not connect motor shaft to gear reducer (or other loads) until after initial turn-on (step 4.5 following).

4.3 Input Service Current and Transformer Sizing

The PRD-2 is a single phase half-wave regenerative drive. With this type of control, AC input currents and isolation transformers (if Used), must be sized as given following.

The AC input current requirement for PRD-2 controls is approximately 24 amps per horsepower for 115 volt controls and 12 amps per horsepower for 230 volt controls.

When using an isolation transformer for either 115 or 230 volt controls, size the transformer for 6KVA per horsepower. (This number is approximately twice the calculated AC input current times line voltage as given above, but is necessary due to a DC saturation current flowing through the transformer. This DC current is inherent in single phase half-wave controls.)

4.4 Wiring

Wire the motor, control unit, disconnect switch, and speed potentiometer (or external signal voltage input) per A2001-000-EW (Basic External Wiring) drawing. Observe all notes on the drawing.

If the control unit is received with option circuit cards installed, additional wiring beyond that indicated on drawing A2001 -000-EW may be required. Refer to external wiring drawings in any options manual furnished with the control unit for the required additional connections.

4.5 Initial Turn-on

4.5.1 Before applying power, check AC input voltage to assure that it agrees with the voltage rating of the PRD-2 control unit (shown on the warning tag and on the control nameplate)

4.5.2 Check the PRD-2 nameplate ratings against the armature and field voltages shown on the motor nameplate. These should agree. IN NO CASE SHOULD THE FIELD OR ARMATURE VOLTAGES SHOWN ON THE MOTOR NAMEPLATE BE LOWER THAN THOSE SHOWN ON THE PRD-2 CONTROL UNIT NAMEPLATE. If the motor has dual voltage field windings, connect motor field for proper voltage as indicated on the PRD-2 control unit nameplate. To change the field voltage, refer to Section 8.

4.5.3 Turn-on, systems with speed potentiometers:
Connect speed potentiometer per the main diagram on drawing A2001-000-EW(center zero connection).

Turn AC power on; motor will start. Slowly rotate potentiometer from one extreme to the other. Motor will reverse when potentiometer is in the center of its travel and will run at full speed forward when potentiometer is at one end of its travel or full speed reverse when potentiometer is at the opposite end of its travel. Check for smooth operation throughout the speed range. If operation is satisfactory, skip to Section 5, " Installation Adjustment."

4.5.4 Turn-on, systems with no speed potentiometer:

If the control unit contains a position interface or external signal circuit board (both are located above the potted modules on the control unit), this procedure does not apply. See separate options manual for instructions. If system is not of this special type, identify and disconnect all wiring leading to the terminal board 1TB, lugs A, B, C, and D. Attach one end of a wire jumper under lug C. (Use an insulated wire jumper; do not touch lugs or ground jumper during this test). Turn power on and touch the loose end of the jumper to lug A. Motor will accelerate to full forward speed. Now move the loose end of the jumper to lug B. Motor will rapidly decelerate, reverse, and accelerate to full reverse speed. Now touch the loose end of the jumper to lug D. Motor will rapidly decelerate to approximately zero speed. If operation is satisfactory, turn power off, remove the jumper and reconnect external wiring to lugs A,B,C, and D of 1TB

5. INSTALLATION ADJUSTMENT

Eight adjustment potentiometers are located on the main circuit board. All potentiometers except the one labeled "IR" are preset at the factory and need no further adjustment in normal installations using armature voltage feedback. On controls using tachometer feedback, the IR potentiometer must be set fully counterclockwise. (The "Max" speed adjustment may have to be reset in the field. Refer to Section 6.6 for readjusting the "Max" potentiometer.

5.1 Normal Adjustment Procedure

Adjust the "IR" trim potentiometer as follows. Motor should not be coupled to a gear reducer or to any external load. Turn on AC power. Rotate the "IR" potentiometer clockwise until the motor begins to hunt (becomes unstable). Rotate the "IR" potentiometer counterclockwise until hunting stops. Then decrease the "IR" trim potentiometer setting a slight additional amount (about 20% of the span between the stable setting and the zero setting).

5.2 Special Adjustment Procedure (if deadband around zero speed is desired)

Normal adjustment procedure gives no deadband around zero speed setting (e.g., any slight rotation of the speed pot off the zero setting or any small change in the input speed signal will cause the motor to rotate). This sensitive response is ideal for closed loop applications. In some open loop applications, however, the slight forward or reverse speed creep that may develop when the speed signal is actually at zero is undesirable. The following additional adjustments will prevent motor creep by creating a +/- 2% (of full scale) dead band around the zero speed setting.

To create a deadband, rotate the "+Ba1" and "-Ba1" potentiometers fully clockwise. Turn power off and move the yellow jumper located in the center of the main circuit board from "Hi" to "Lo" position. Turn power on and operate control normally. The crossfire hum which is normally present at zero speed setting will no longer be present .

6 FUNCTIONAL DESCRIPTION OF ADJUSTMENT POTENTIOMETERS

With the exception of the "IR" adjustment and the "Max" adjustment in tach feedback controls, all other trim potentiometers are factory adjusted and should normally not be disturbed unless the analog module is replaced. The function of each adjustment is described here for reference only.

6.1 "Torque Zero"

Sets the zero point of the external "% Torque" meter (if used) and the internal torque limit circuitry.

6.2 "Zero"

Causes motor speed to be "zero" when input voltage (between lugs C and D of 1TB) is zero.

6.3 "+Lim"

Sets the maximum positive current (current flowing out of terminal A1 to motor) which the control can deliver. This adjustment is referred to as the "+Torque" limit. Clockwise rotation of the pot increases available current.

6.4 "-Lim"

Sets the maximum negative current (current flowing into terminal A1 from motor) which the control can deliver. This adjustment is referred to as the "- Torque" limit. Clockwise rotation of the pot increases available current.

6.5 "IR"

Boosts armature voltage as motor shaft load is increased so as to hold speed constant. Clockwise rotation of the pot gives better load regulation. Settings too far clockwise cause motor speed to increase as motor load increases, and may cause unstable operation.

6.6 "Max"

Sets the maximum armature voltage which the control will provide when the speed pot is adjusted to maximum setting. The "Max" trim potentiometer is factory preset for 150 volts maximum armature voltage (230 VAC controls) or for 75 volts armature voltage (115 VAC controls). On controls that use tachometer feedback this adjustment may need to be reset in the field. Clockwise rotation of the trim potentiometer increases maximum armature voltage and maximum motor speed. Voltages lower than factory setting maybe adjusted, but increasing the setting to provide higher voltages may result in erratic motor operation, especially if AC line voltage is low, and is therefore not recommended.

6.7 "+ Bal" and "-Bal" Potentiometers

Sets the amount of crossfire (alternate positive and negative current pulses) which occurs when the speed command is zero. This in turn determines small-signal response of the PRD-2 control. Rotating both trim potentiometers clockwise eliminates the crossfire and causes a deadband. Rotating both trim potentiometers counterclockwise **increases** crossfire and increases sensitivity to small speed signal changes. The factory setting provides adequate sensitivity for good servo response in most motors. Replacement of the firing module does not necessitate readjustment of these two potentiometers.

7. ADJUSTMENTS FOR 50 HZ OPERATION

If the control was shipped from the factory adjusted for use on 60 Hz single phase service, the "+Ba1" and "-Ba1" adjustments will have to be reset or excessive crossfire will occur on 50 Hz power use. Turn both balance potentiometers fully clockwise to eliminate all crossfire and introduce a deadband. In many applications this will give satisfactory control response even though a small deadband has been introduced. In those applications that require optimum control response the procedure as outlined in the next paragraph should be followed.

With power off, move the yellow jumper in the center of the E1489 board to the "Ba1" position. Turn the "+Ba1" and "-Ba1" potentiometer initially fully clockwise. With the motor connected to the control, apply power to the control. Connect a voltmeter that can read DC millivolts to 1TB-8 in respect to 1TB-1. Adjust the –Ba1 potentiometer slowly in the counterclockwise direction. Set so that the meter reads approximately -15 millivolts. Now adjust the +Ba1 potentiometer so that the meter reads zero again. Shut off power and place the yellow jumper in the "Hi" position. The control is now ready for normal operation.

8 CHANGING THE FIELD VOLTAGE

Unless specified when ordered, PRD-2 Controls are supplied with full field voltage (100 VDC on 115 VAC controls, and 200 VDC on 230 VAC controls) at terminals F1 and F2 of terminal strip 10TB. In those applications that require half field voltage, the voltage can quickly be changed in the field by means of a soldering iron. Use a soldering iron intended for PC board use having a maximum 600 degrees F. tip.

With power off, remove the two screws on the top side of the E1489 PC board when viewed with the 10TB terminal strip on the bottom. The PC board should now be able to be pivoted downward uncovering the bottom circuit components. Unsolder the wire jumper in the tubular test terminal that is used for connection of full field voltage on the E1508 PC board. Resolder this wire to the tubular terminal on the other side which is used to supply half field voltage. When the unit is re-energized, the field voltage should now read, nominally, 50VDC for 115 VAC controls and 100 VDC for 230 VAC controls. Again as for full field voltages, maximum current capability of the supply is 2 amps.

9. OPTIONS AND MODIFICATIONS

The following features are not included on standard PRD-2 units, but may be specified at time of purchase and installed as factory installed options.

9.1 Acceleration –Deceleration Option

The acceleration option should be specified if adjustable acceleration and deceleration times are desired. The standard PRD 2 accelerates and decelerates a motor at rates limited only by the torque limit settings. The resultant rapid response is desirable for many servo and closed loop positioning applications. The acceleration option board should be added for applications in which longer acceleration and deceleration times are required for proper system response. Three different acceleration board assemblies are available enabling various time adjustment ranges. When this plug-in circuit is added, acceleration and deceleration times which result from a 0 to 100% step change in the speed potentiometer setting may be adjusted from .15 seconds to 11 seconds, or .3 seconds to 14 seconds, or .07 seconds to 5 seconds depending on which acceleration option is specified.

Internal logic on this board cause the acceleration time potentiometer ("ACC") and the deceleration time potentiometer ("DEC") to correctly and independently regulate acceleration and deceleration times, regardless of direction of motor rotation.

9.2 Signal Isolator Option

The signal isolator option should be specified anytime it is desirable or mandatory that the speed signal input be isolated from the control AC input lines. An example of a requirement for a signal isolator would occur if two or more drives were run from a master reference signal. Another instance where a signal isolator is either mandatory or certainly advisable is when programming speed from an external signal source. The external signal source in many cases is earth grounded.

The signal isolator board is available in two different assemblies. A voltage level of 0 to 6 volts or 0 to 50 millivolts input will give a 0 to 6 volt output if the appropriate signal isolator assembly is used. (The 0 to 50 millivolts input signal isolator is most often used in torque follower applications. In these applications the control would in most cases by used with the torque programmed option as discussed in Section 9.5.)

9.3 Position Interface Option

The position interface option board is utilized in applications such as valve positioners, or X-ray table positioners. When this option board is installed, a speed potentiometer is **not** connected. The output of the position control board (a position error signal) acts as a speed command signal and causes the motor to automatically drive in the direction required to force agreement

between the "Position Command" potentiometer setting and the "Position Feedback" potentiometer. Process instrument or external voltage signals can also be used for position command. This option includes provision for a "Manual–Auto" switch and end-of-travel limit switches which will inhibit further motor rotation when actuated.

9.4 DC Tachometer Feedback

The PRD-2 is capable of using tachometer feedback. If tachometer feedback is to be used, this should be specified at the time of control purchase. In addition, the base speed and DC tachometer output voltage must also be specified if motor and tachometer are not purchased along with the control.

When tachometer feedback is used, two resistors will be mounted between terminals 1 and 3, and 2 and 3 of the PRD2 1TB terminal strip. In addition, the jumper that is normally present between terminals 4 and 5 of 1TB is removed. Instead a jumper is connected between terminals 3 and 5 of 1TB. The tachometer feedback resistors are selected so that approximately 6 volts appears at terminal 3 in respect to terminal 1 when the motor is running at top speed. When the speed input to 1TB-C is negative in respect to common, the voltage at 1TB-2 in respect to 1TB-1 (terminals where the tachometer is connected) must be positive. Incorrect polarity hookup of the tachometer voltage will cause the motor to run away and go to top speed.

9.5 Torque Programmed Drive

This modification is useful in some material winder applications. Specifics of this modification are covered in a separate manual. The standard AM-1 analog module in the PRD-2 unit is replaced with an AM-2 analog module. The normal "Speed Command" input (1TB-C) becomes a "Torque Command" input which commands both magnitude and direction of torque. The "+Lim" and "-Lim" adjustments which normally function as torque (current) limit adjustments become speed limit adjustments which limit magnitude of speed, but do not dictate direction of rotation.

10. MOTORS USED WITH PRD-2 CONTROLS

Due to the half wave nature of the PRD-2 controls, motors that are designed for use with single phase full wave control require re-rating for use on a PRD-2 control.

As an example of this re-rating, a 1HP motor, as rated for use on a single phase full wave control, when used on a PRD-2 control would be re-rated in current by a factor of .75 and in speed by a factor of .83. The effective horsepower on this motor when used on a PRD-2 control is 2/3HP. These same re-rating factors can be applied to all the motors used with PRD-2 controls.

When a motor is purchased from Polyspede Electronics for use with a PRD-2, the above re-rating factors have already been done. Therefore, if a 2/3HP control is ordered with motor, the motor supplied will indicate 2/3HP on its nameplate since it already has been re-rated by Polyspede Electronics.

Lastly, the 1.9HP PRD2-200 control must be used on motors having an armature inductance of 8 millihenries or greater. Lower inductance motors will cause RMS input currents larger than the control is capable of handling. The motors catalogued by Polyspede for use with PRD2-200 controls meet this requirement. (A minimum armature inductance is not a requirement on lower horsepower PRD-2 controls, but motors used must be properly re-rated as given in the previous paragraph.

11. CHANGING CONTROL HORSEPOWER SIZES

Although there are at least 11 distinct models, the PRD-2 is in actuality broken down into three major control groups. Within each group and between some groups, control horsepower sizes can be changed by substituting an appropriate shunt link. The following is a listing of the three groups in which horsepower can be varied.

Group 1 PRD2-16 through PRD2-66, 115V (1/6 through 2/3HP)

Control can be used on 1/6 through 2/3 HP, 115V applications.

Group 2 PRD2-34 through PRD2-125, 230V (1/3 through 1¼ HP)

Control can be used on 1/3 through 1¼ HP, 230V applications.

Group 3 PRD2-200, 230V (1.9 HP)
Control can be used on 1/3 through 1¼HP, 230V applications if needed.

When changing shunt links, it is mandatory that the new shunt be mounted in the same sequence to the board standoffs. The shunt link should be positioned first on the standoffs and the other hardware mounted next. Select the shunt link from Table I, page 2 of this manual.

12. TROUBLE SHOOTING GUIDELINES

The majority of major malfunctions which are normally encountered in using the PRD-2 control can be summarized as stated below:

a) Motor does not run or runs in only one direction.
b) Motor runs unstably.
c) Motor runs only at top speed or over speed.
d) System blows fuses or breakers repeatedly.

The following sections will indicate possible problem areas and some of the most likely causes. Comments pertain to a standard open chassis PRD-2 unless otherwise noted.

12.1. Motor does not run

12.1.1 Check that proper AC voltage is present at input terminals L1 and L2.

12.1.2 Check if any control fuses are blown. Replace any blown fuses.

12.1.3 Check speed reference input at 1TB terminal C. Does voltage vary from 0 to + or -6 volts, or from -6V to +6V as potentiometer is rotated between the two extremes of rotation? If voltages are not proper, refer to drawing A2001-000-ES and A2001-000-EW. Measure that -6V and +6V are available on terminals 1TB-A and B in respect to common (1TB –D).

12.1.4 Check that jumpers are present between 1TB-4 and 5, 1TB 6 and 7, 1TB-K1 and K2,and 10TB –M1 and M2. (In some systems applications, some permanent jumpers may be replaced with contact closures. Refer to specific special customer schematics for details)

12.1.5 Check that the patch plug is firmly in place, and that patch plug number is proper for the control as being used. That is, does the patch plug number coincide with the plug to be used as indicated on drawing A2001-001-ES for the various options the control is using. (The patch plug is designated as 2PL)

12.1.6 Check that the yellow jumper is in either the “Lo” or “Hi” position. If the jumper is in the “Ba1” position, the motor will not turn. The “Ba1” position is used only when setting the “+Ba1” and “-Ba1” potentiometers. During normal running, the “Hi” position mode is normally used. This position gives a very high speed error amplifier gain and therefore good regulation. The “Lo” gain position is normally used with tachometer feedback systems where zero speed creep is not permissible. This “Lo” setting along with the proper “+Ba1” and “-Ba1” settings will achieve this zero speed condition.

12.1.7 Check that the +Lim and –Lim potentiometers have not been turned fully counterclockwise With the +Lim and –Lim potentiometer wipers approximately at 75% full clockwise rotation, the controls will be programmed for approximately a maximum current of 150% rated motor current. A fully counterclockwise setting will program for zero motor current..

12.1.8 If control is equipped with a signal isolator acceleration unit and/or position interface board, the problem may be in the options boards. Refer to schematic A2001-001-ES and the schematics of the various option boards and see of outputs are proper for the various inputs. If patch plug #1 is available, the signal isolator and/or acceleration options can be bypassed by removing the patch plug supplied and substituting patch plug #1. If the position interface or external signal options are supplied, 5PL should be unplugged. Hook up a zero center speed pot as shown in A2001-000-EW, and check proper control operation.

12.1.9 Check for proper field voltage at 10TB-F1 and F2. Voltage should be 100 VDC or 50 VDC for 115V controls, or 200 VDC or 100 VDC for 230V controls. If field voltage checks, remove power from the control and disconnect the field connections. Check resistance as given in motor tests. Missing field winding can cause high motor currents without producing output torque. (This step does not apply to PM motors).

12.2 Motor runs unstably

12.2.1 If motor speed oscillates, decrease the IR setting. Refer to Section 6.5 for proper set-up of the IR potentiometer. (In tachometer feedback controls, this adjustment must be fully counterclockwise.)

12.2.2 Measure field voltage present at 10TB terminals F1 and F2. Voltage present must correspond with motor field hook-up and requirements.

12.2.3 On systems using tachometer feedback, unstable operation can result if the coupling between motor and tachometer is slipping. Transfer the control back to armature voltage feedback. If operation is smooth, the problem is probably in the tachometer. (To transfer back to armature voltage feedback, remove the jumper between 1TB-3 and 5, and connect a jumper between 1TB terminals 4 and 5.)

12.2.4 Motors with series fields are not suitable for use on regenerative drives. If such a motor is used, connections to the series field (S1 and S2 leads) must be omitted for stable operation. If omission of these connections does not result in stable operation, the motor cannot be used.

12.3 Motor runs Only at Top Speed or Overspeed

12.3.1 Check that the voltage at 1TB-C varies between the -6 volt to + 6 volt limits as the external speed potentiometer is rotated between extremes of travel.

12.3.2 In controls using armature voltage feedback, a jumper must be present between 1TB terminals 4 and 5.

12.3.3 In controls using tachometer feedback, a jumper must not be present between 1TB terminals 4 and 5. In addition, tachometer voltage polarity must be proper. The voltage at 1TB-2 in respect to 1TB-1 (common) must be positive when the input voltage to 1TB-C is negative.

12.3.4 If the above steps 12.3.1 through 12.3.3 check, the problem may be in the option boards if supplied. To find out if problems are in the options, refer to Section 12.1.8.

12.3.5 If the above steps 12.3.1 through 12.3.4 prove negative, check for proper field voltage and resistance per Section 12.1.9. An open field or very low field voltage on very light loads can cause excessive motor speeds even with low armature voltage.

12.4 Control Blows Fuses Occasionally or Repeatedly

12.4.1 Initially, visually inspect the control for loose washers, wire clippings, etc. around the fuses and SCRs or SCR module. Check that terminal and snap-on connections are tight.

12.4.2 With power off, thoroughly check the DC motor and all DC motor wiring. Check motor connections, especially those in the motor conduit box. Refer to Section 13 for motor checks.

12.4.3 If fuses 11FU and 13FU on the E1508 PC board blow, check that the proper fast-blow 3 amp fuse is being used. With power off, check that the motor field is not shorted. With the motor field disconnected from the control, field resistance should not measure lower than 25 ohms on 50 VDC fields, 50 ohms on 100V fields or 100 ohms on 200V fields.

With the field still disconnected from the control, also check that diodes D201 through D204 are not shorted. Refer to Section 14.1 and Figure 1a for proper checks.

12.4.4 If main input fuses 10FU and/or 14FU blow (14FU only provided on 230V controls), the problem may be defective SCRs. Temporarily disconnect the connection to the two discrete SCRs, or the power cube module on 1.9 HP controls, and check the SCRs. Refer to Sections 14.2 and 14.3, and also Figures 1b and 1c. Replace defective SCRs.

12.4.5 If field diodes and SCRs check properly, remove all external wiring such as A1, A2, F1, F2, speed pot, connections, etc. Check that none of the external wiring is shorted to itself or earth ground.

12.4.6 If all previous checks are negative, the problem is probably on the main E1489 PC board, or the Analog or Firing plug-in modules. If the Analog and/or Firing modules are available, these may be tried to rectify the problem. If not or the problem has positively been determined to be in the E1489 PC board, return to the Polyspede factory for repair. (If a new Analog module is substituted, it may be necessary to slightly readjust some of the potentiometer as described in Section 6.)

13. **TROUBLESHOOTING THE MOTOR**

The following tests will be helpful in pinpointing possible motor problems. Before making any tests, turn power off and disconnect the armature and field lead from the control.

13.1 Shorts to the Frame

Using a Megger set for 400 volt test potential, check leakage resistance from motor frame to the A1 and A2 leads and to the motor field leads. Readings less than 10,000 ohms indicate possible problems. A dead short indicates need for immediate repair. Checks for dead shorts may be made with an ohmmeter or a continuity tester if a Megger is not available. Retest while rotating armature by hand.

13.2 Open or Shorted Field

Check resistance between motor field leads. Resistance should not be less than 100 ohms or greater than 1200 ohms for fields connected for 200 VDC operation. For 100VDC fields, the resistance should not be lower than 50 ohms, and for 50VDC fields, field resistance should not be lower than 25 ohms.

13.3 Open Armature

An ohmmeter between A1 and A2 should indicate a resistance of less than 10 ohms. Rotate the motor shaft very slowly, while observing the ohmmeter. Because of the residual magnetism in shunt field motors or the field in permanent magnet motors, a CEMF will be produced by rotating. This will cause the ohmmeter readings to change during rotation. Therefore, after moving the shaft a small amount, stop and check the resistance reading. A high resistance reading at any position of the motor shaft when it is stopped is a trouble indication. Armature opens are usually the result of bad brushes, burned commutator segments, or severed wires.

14 SEMICONDUCTOR TESTS

14.1 Field Diode Checks (all controls)

Refer to Figure 1a for checkout of field diodes. Temporarily remove the motor field from the control. There are four diodes (D201 through D204) that must be checked on the E1508 PC board. Use a Simpson 260 or equivalent for checkout. Place the plus lead of the motor on the anode of the diode D201 and the minus lead on the cathode. With these connections and the meter on the RX1 scale, a reading of 5-15 ohms will be obtained. Reverse the meter leads to the diode and the meter will read an open since the reverse resistance will be at least several hundred K ohms. Repeat this procedure for diodes D202, D203, and D204. If any of the diodes are found to be defective, the control should be returned to the factory for repair since these diodes are not considered field replaceable.

14.2 Discrete SCR Testing

(Applies to all horsepower controls except the 1.9HP, 230V control)

The discrete SCRs are isolated stud devices. The red wire to each device is the anode. The yellow wire is the cathode and the green wire is the gate. Simple tests with an ohmmeter cannot conclusively show than an SCR is good, but shorted or open SCRs can be detected. Check one SCR at a time by removing the 3 leads of the SCR connected to the E1508 PC board. Reconnect the three leads which are color coded to the PC board before proceeding to check the other SCR. Refer to Figure 1b.

Place the plus lead of the meter on the anode of diode and the negative lead on the cathode. The Simpson 260 or equivalent meter should read several hundred ohms. The same high resistance should be read when the meter leads are reversed.

Now connect one lead of the meter to gate and the other lead to the cathode. With the gate positive in respect to the cathode, the meter should read 10 ohms to approximately 50 ohms. With the meter polarity reversed the resistance should be from approximately 40 to 15.

Replace any defective SCRs with good devices. If replacing an SCR, use a thermal compound such as Dow Corning Compound DC-4 or equivalent between mounting surfaces of the SCR and heatsink.. Also check that the 3.9 ohm gate resistors R133 and R134 are good and have not opened.

14.3 Power Cube SCR Testing

(Applies to 1.9 HP, 230V [PRD2-200] controls only)
The power cube on the PRD2-200 control contains both SCRs. Temporarily remove all wires and the shorting bar on the power cube. Mark the wires so that they can be properly replaced. Refer to Fig 1c.

With the meter connected to an SCR anode and cathode as shown in Figure 1c, the meter should read high resistance independent of the meter lead polarity. Resistance read using a Simpson 260 or equivalent will at least be several hundred K ohms. Now connect one meter lead to the cathode and the other lead to the gate of an SCR. Using a Simpson 260 or equivalent on the RX1 scale, a resistance of approximately 10 to 150 ohms should be read independent of meter polarity. Resistance may vary as the polarity of the meter on the gate and cathode connections is varied, but should fall to within this resistance range.

Repeat the above procedure for the other SCR. Replace the SCR module if either SCR is found to be faulty. Use thermal compound such as Dow Corning Compound DC-4 for good thermal transfer between the base of the power module and the mounting surface. Before installing a new module or replacing the leads on the old module, examine the gate pins G1 and G2. These pins should be free of potting compound and other contamination all the way to the bottom of the pin well. Scrape off any foreign matter with a small screwdriver. Also check that the 3.9 ohm SCR gate resistors R133 and R134 are good.

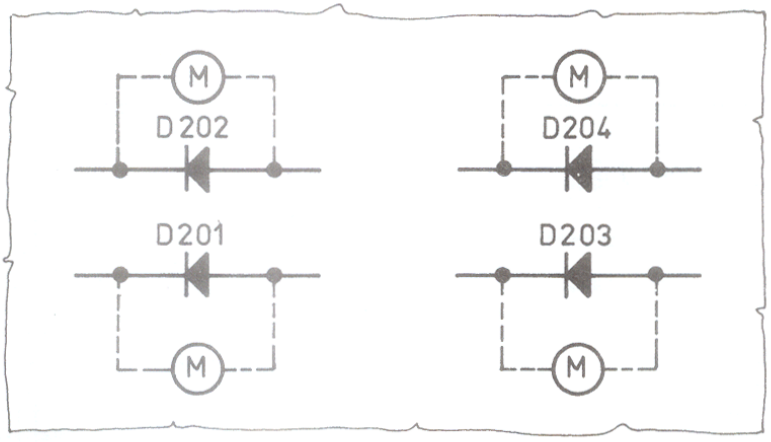


FIGURE 1a
DIODE SEMICONDUCTOR CHECKS
ON E1508 PC.BD. (ALL PRD2 CONTROLS)

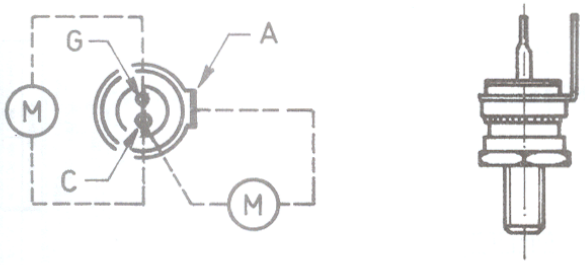
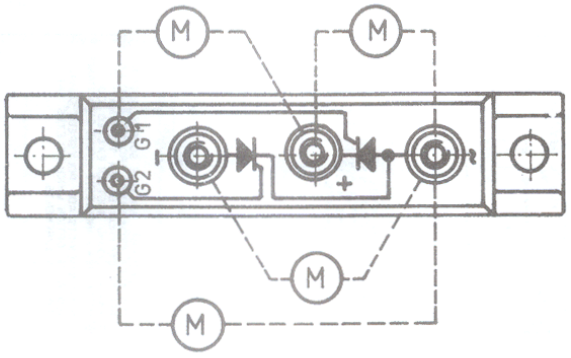
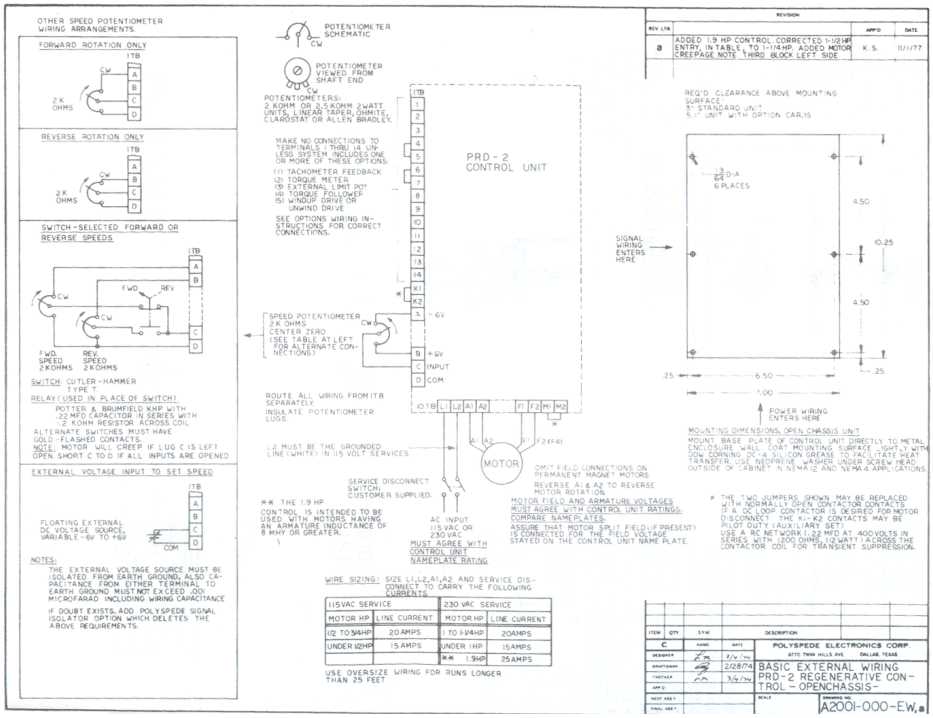


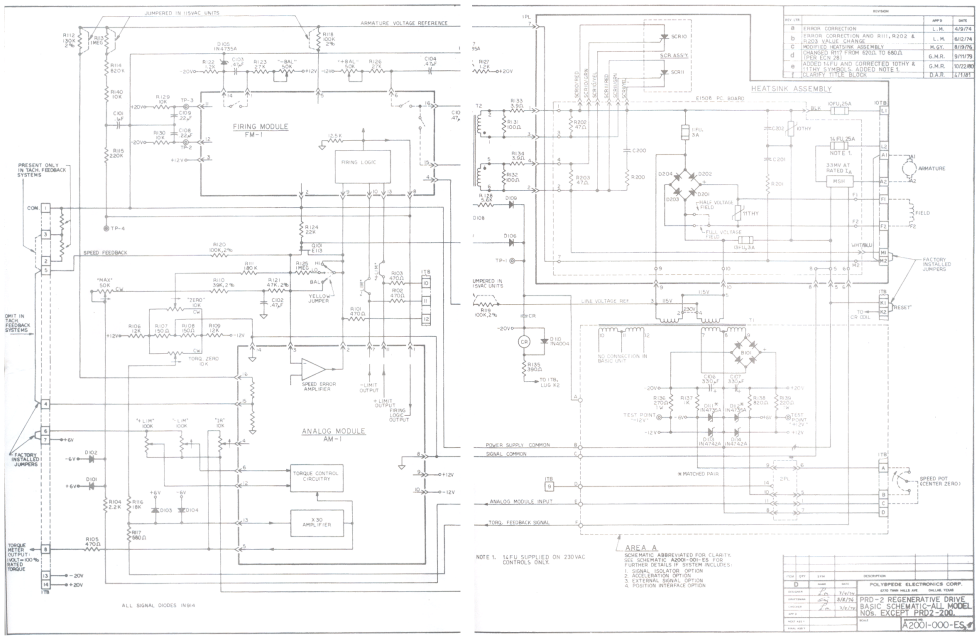
FIGURE 1b
DISCRETE SCR TEST POINTS
(ALL PRD2 CONTROLS EXCEPT PRD2-200)

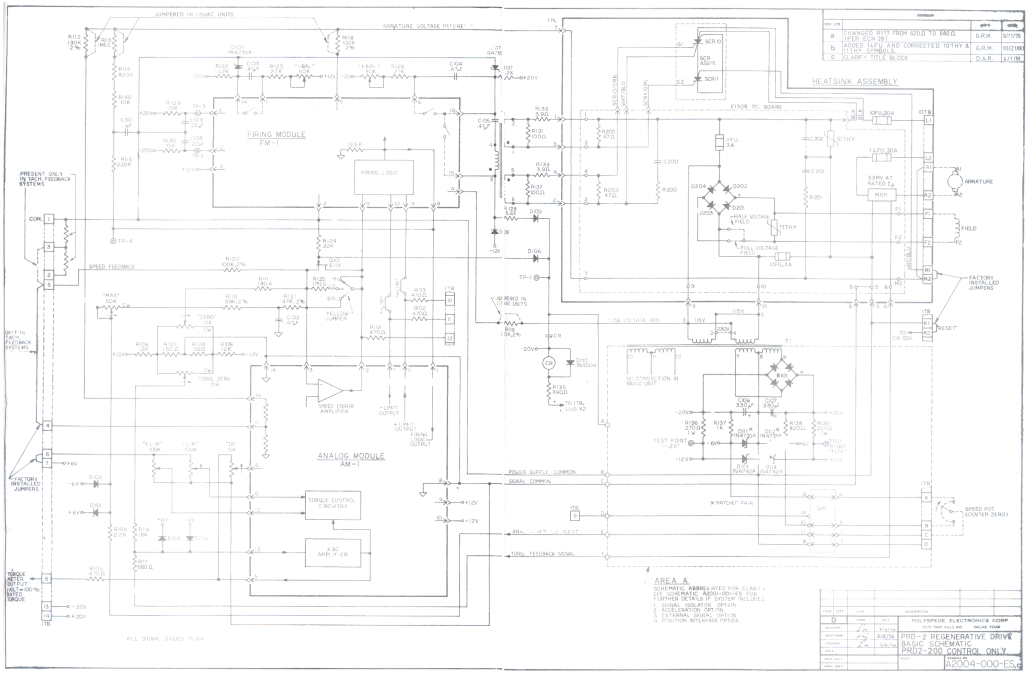


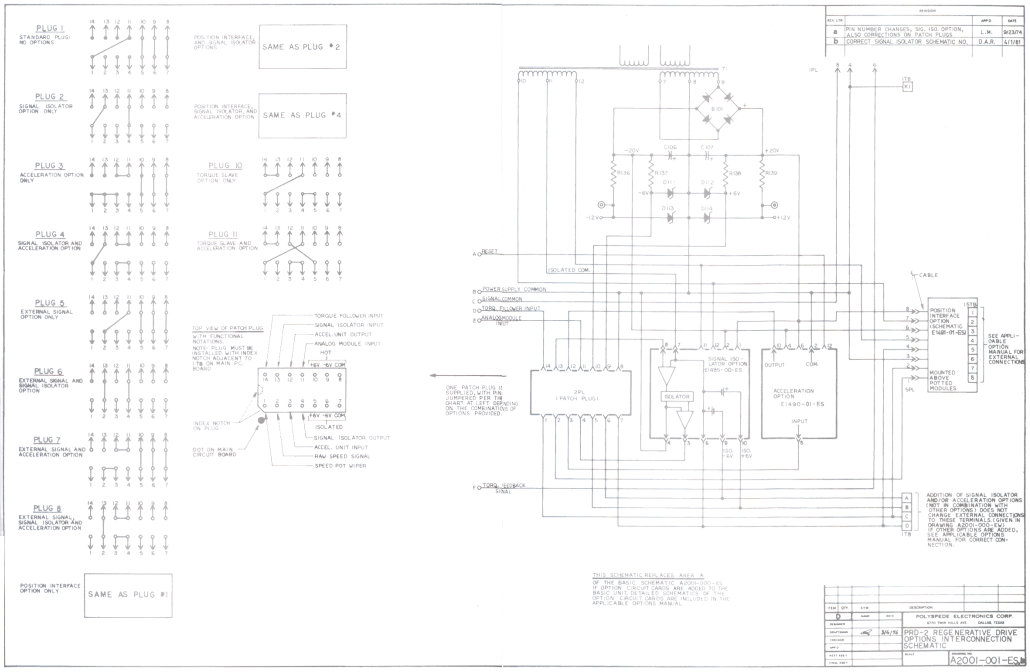
(TOP VIEW OF THE SCR MODULE)

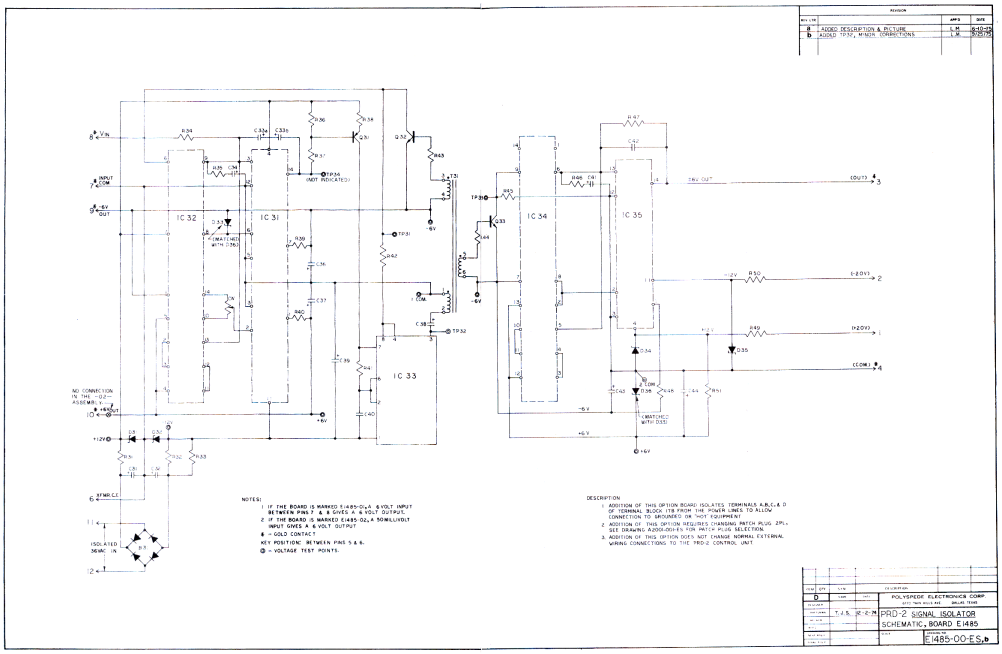
FIGURE 1c
POWER MODULE TEST POINTS
(PRD2-200 CONTROL ONLY)

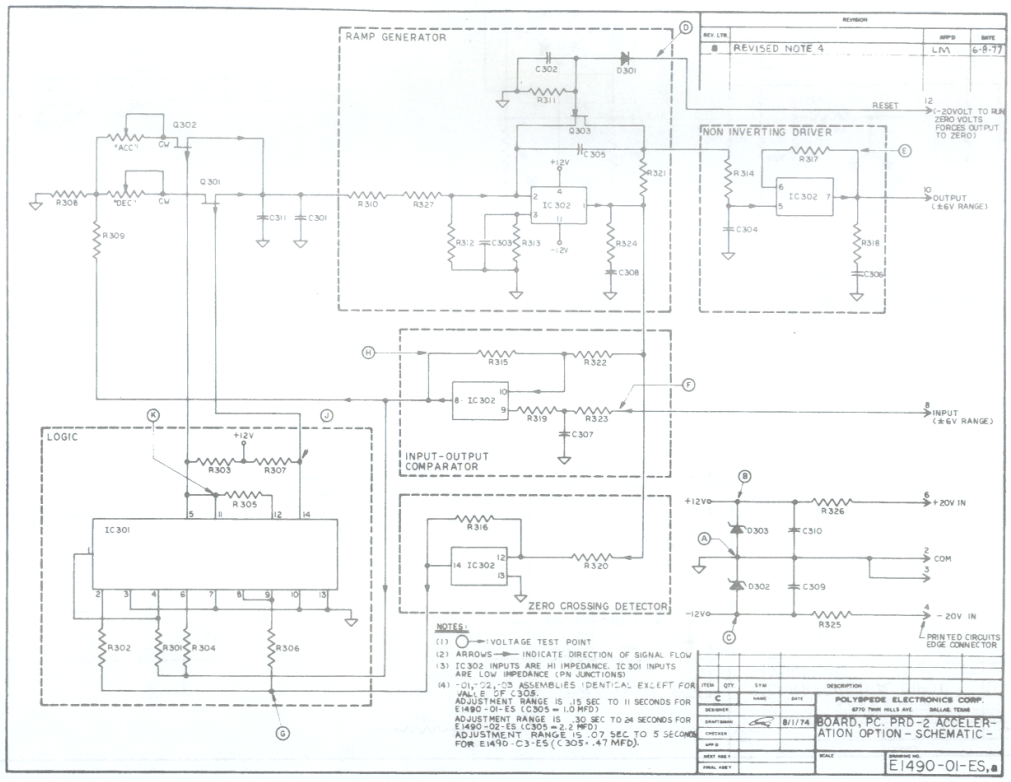

OTHER SPEED POTENTIOMETER WIRING ARRANGEMENTS.
FORWARD ROTATION ONLY
REVERSE ROTATION ONLY
SWITCH-SELECTED FORWARD OR REVERSE SPEEDS.
SWITCH: CUTLER-HAMMER TYPE T
RELAY (USED IN PLACE OF SWITCH):
POTTER & BRUMFIELD KHP WITH .22 MFD CAPACITOR IN SERIES WITH 1.2 KOHM RESISTOR ACROSS COIL.
ALTERNATE SWITCHES MUST HAVE GOLD-FLASHED CONTACTS.
NOTE: MOTOR WILL CREEP IF LUG C IS LEFT OPEN. SHORT C TO D IF ALL INPUTS ARE OPENED.
EXTERNAL VOLTAGE INPUT TO SET SPEED
FLOATING EXTERNAL DC VOLTAGE SOURCE, VARIABLE -6V TO +6V
NOTES:
THE EXTERNAL VOLTAGE SOURCE MUST BE ISOLATED FROM EARTH GROUND, ALSO CAPACITANCE FROM EITHER TERMINAL TO EARTH GROUND MUST NOT EXCEED .001 MICROFARAD INCLUDING WIRING CAPACITANCE
IF DOUBT EXISTS, ADD POLYSPEDE SIGNAL ISOLATOR OPTION WHICH DELETES THE ABOVE REQUIREMENTS.
POTENTIOMETER SCHEMATIC
POTENTIOMETER VIEWED FROM SHAFT END
POTENTIOMETERS: 2.KOHM OR 2.5 KOHM 2 WATT UNITS, LINEAR TAPER, OHMITE, CLAROSTAT OR ALLEN BRADLEY.
MAKE NO CONNECTIONS TO TERMINALS 1 THRU 14 UNLESS SYSTEM INCLUDES ONE OR MORE OF THESE OPTIONS:
(1) TACHOMETER FEEDBACK
(2) TORQUE METER
(3) EXTERNAL LIMIT POT
(4) TORQUE FOLLOWER
(5) WINDUP DRIVE OR UNWIND DRIVE
SEE OPTIONS WIRING INSTRUCTIONS FOR CORRECT CONNECTIONS.
PRD-2 CONTROL UNIT
SPEED POTENTIOMETER 2K OHMS CENTER ZERO (SEE TABLE AT LEFT FOR ALTERNATE CONNECTIONS)
-6V
+6V
INPUT
COM
ROUTE ALL WIRING FROM ITB SEPARATELY
INSULATE POTENTIOMETER LUGS
L2 MUST BE THE GROUNDED LINE (WHITE) IN 115 VOLT SERVICES
SERVICE DISCONNECT SWITCH. CUSTOMER SUPPLIED.
** THE 1.9 HP CONTROL IS INTENDED TO BE USED WITH MOTORS HAVING AN ARMATURE INDUCTANCE OF 8 MHY OR GREATER.
AC INPUT 115 VAC OR 230 VAC MUST AGREE WITH CONTROL UNIT NAMEPLATE RATING
MOTOR
OMIT FIELD CONNECTIONS ON PERMANENT MAGNET MOTORS
REVERSE A1 & A2 TO REVERSE MOTOR ROTATION.
MOTOR FIELD AND ARMATURE VOLTAGES MUST AGREE WITH CONTROL UNIT RATINGS: COMPARE NAMEPLATES.
ASSURE THAT MOTOR SPLIT FIELD (IF PRESENT) IS CONNECTED FOR THE FIELD VOLTAGE STATED ON THE CONTROL UNIT NAME PLATE.
WIRE SIZING: SIZE L1,L2,A1,A2 AND SERVICE DISCONNECT TO CARRY THE FOLLOWING CURRENTS
115 VAC SERVICE
MOTOR HP | LINE CURRENT
1/2 TO 3/4HP | 20 AMPS
UNDER 1 2HP | 15 AMPS
230 VAC SERVICE
MOTOR HP | LINE CURRENT
1 TO 1-1/2HP | 20AMPS
UNDER 1HP | 15AMPS
** 1.9HP | 25AMPS
USE OVERSIZE WIRING FOR RUNS LONGER THAN 25 FEET
REQ'D CLEARANCE ABOVE MOUNTING SURFACE 5" STANDARD UNIT 5.7" UNIT WITH OPTION CARDS
SIGNAL WIRING ENTERS HERE
6 PLACES
4.50
10.25
4.50
.25
6.50
.25
7.00
POWER WIRING ENTERS HERE
MOUNTING DIMENSIONS, OPEN CHASSIS UNIT
MOUNT BASE PLATE OF CONTROL UNIT DIRECTLY TO METAL ENCLOSURE WALL. COAT MOUNTING SURFACE LIGHTLY WITH DOW CORNING DC-4 SILICON GREASE TO FACILITATE HEAT TRANSFER. USE NEOPRENE WASHER UNDER SCREW HEAD OUTSIDE OF CABINET IN NEMA 12 AND NEMA 4 APPLICATIONS.
* THE TWO JUMPERS SHOWN MAY BE REPLACED WITH NORMALLY OPEN CONTACTOR CONTACTS. IF A DC LOOP CONTACTOR IS DESIRED FOR MOTOR DISCONNECT THE K1-K2 CONTACTS MAY BE PILOT DUTY (AUXILIARY SET). USE A RC NETWORK (.22 MFD AT 400 VOLTS IN SERIES WITH 1200 OHMS, 1/2 WATT) ACROSS THE CONTACTOR COIL FOR TRANSIENT SUPPRESSION.
REVISION
REV. LTR. | | APP'D | DATE
a | ADDED 1.9 HP CONTROL, CORRECTED 1-1/2HP ENTRY IN TABLE, TO 1-1/4HP. ADDED MOTOR CREEPAGE NOTE THIRD BLOCK LEFT SIDE | K.S. | 11/1/77
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE DALLAS, TEXAS
BASIC EXTERNAL WIRING PRD-2 REGENERATIVE CONTROL - OPEN CHASSIS -
A2001-000-EW,a

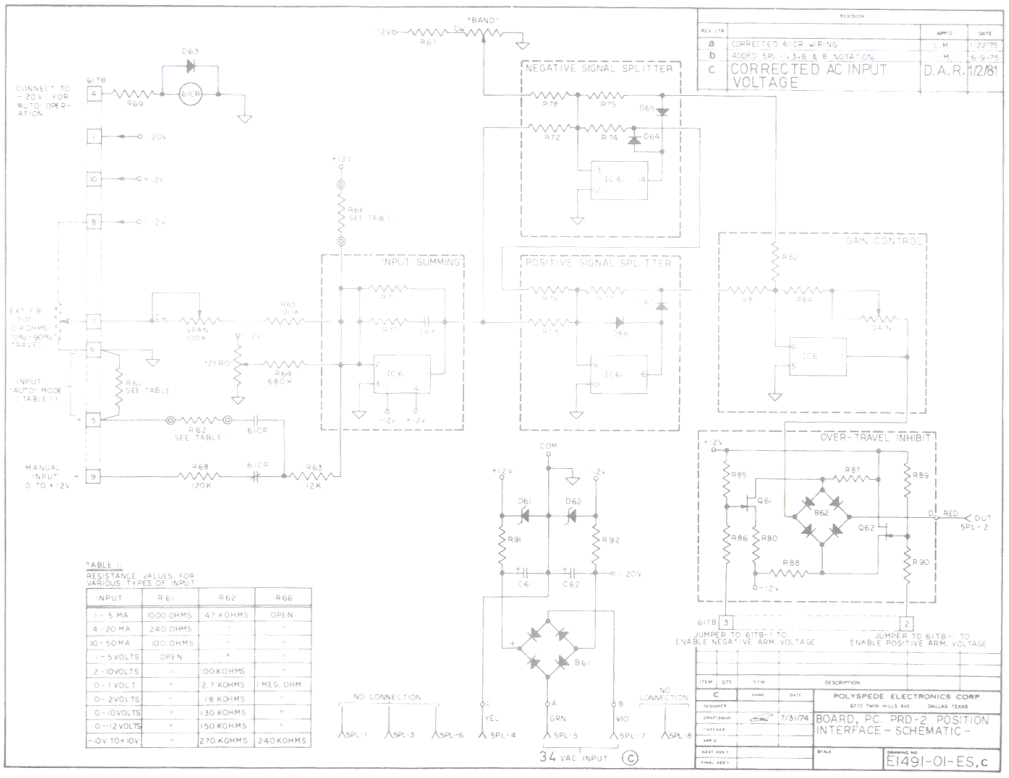

FIRING MODULE
FM-1
ANALOG MODULE
AM-1
HEATSINK ASSEMBLY
R1509 PC BOARD
ARMATURE
FIELD
SPEED ERROR AMPLIFIER
TORQUE CONTROL CIRCUITRY
X 30 AMPLIFIER
SPEED POT (CENTER ZERO)
FACTORY INSTALLED JUMPERS
POWER SUPPLY COMMON
SIGNAL COMMON
ANALOG MODULE INPUT
TORQ. FEEDBACK SIGNAL
AREA A
PRO-2 REGENERATIVE DRIVE
BASIC SCHEMATIC-ALL MODEL NOS. EXCEPT PRD2-200
A2001-000-ES


FIRING MODULE
FM-1
ANALOG MODULE
AM-1
HEATSINK ASSEMBLY
R1509 PC BOARD
ARMATURE
FIELD
SPEED ERROR AMPLIFIER
TORQUE CONTROL CIRCUITRY
X 30 AMPLIFIER
SPEED POT (CENTER ZERO)
FACTORY INSTALLED JUMPERS
POWER SUPPLY COMMON
SIGNAL COMMON
ANALOG MODULE INPUT
TORQ. FEEDBACK SIGNAL
AREA A
PRO-2 REGENERATIVE DRIVE
BASIC SCHEMATIC
PRD2-200 CONTROL ONLY
A2004-000-ES


PLUG 1
STANDARD PLUG/ NO OPTIONS
PLUG 2
SIGNAL ISOLATOR OPTION ONLY
PLUG 3
ACCELERATION OPTION ONLY
PLUG 4
SIGNAL ISOLATOR AND ACCELERATION OPTION
PLUG 5
EXTERNAL SIGNAL OPTION ONLY
PLUG 6
EXTERNAL SIGNAL AND SIGNAL ISOLATOR OPTION
PLUG 7
EXTERNAL SIGNAL AND ACCELERATION OPTION
PLUG 8
EXTERNAL SIGNAL, SIGNAL ISOLATOR AND ACCELERATION OPTION
POSITION INTERFACE OPTION ONLY
SAME AS PLUG #1
POSITION INTERFACE AND SIGNAL ISOLATOR OPTION
SAME AS PLUG #2
POSITION INTERFACE, SIGNAL ISOLATION AND ACCELERATION OPTION
SAME AS PLUG #4
PLUG 10
TORQUE SLAVE OPTION ONLY
PLUG 11
TORQUE SLAVE AND ACCELERATION OPTION
TOP VIEW OF PATCH PLUG WITH FUNCTIONAL NOTATIONS
NOTE: PLUG MUST BE INSTALLED WITH INDEX NOTCH ADJACENT TO TB ON MAIN PC BOARD
INDEX NOTCH ON PLUG
DOT ON MAIN CIRCUIT BOARD
TORQUE FOLLOWER INPUT
SIGNAL ISOLATOR INPUT
ACCEL UNIT OUTPUT
ANALOG MODULE INPUT
HOT
+15V -15V COM
ISOLATED
SIGNAL ISOLATOR OUTPUT
ACCEL UNIT INPUT
RAW SPEED SIGNAL
SPEED POT WIPER
ONE PATCH PLUG IS SUPPLIED WITH PIN JUMPERED PER THE CHART AT LEFT DEPENDING ON THE COMBINATIONS OF OPTIONS PROVIDED
2PL (PATCH PLUG)
ISOLATOR
SIGNAL ISO-LATOR OPTION E1485-00-ES
ACCELERATION OPTION E1490-01-ES
OUTPUT
COM
INPUT
ISO -15V
ISO +15V
ISOLATED COM
POWER SUPPLY COMMON
SIGNAL COMMON
TORQ FOLLWER INPUT
ANALOG MODULE INPUT
TORQ FEEDBACK SIGNAL
RESET
CABLE
POSITION INTERFACE OPTION (SCHEMATIC E1481-01-ES)
MOUNTED ABOVE POTTED MODULES
SEE APPLI-CABLE OPTION MANUAL FOR CONNECTIONS
ADDITION OF SIGNAL ISOLATOR AND/OR ACCELERATION OPTIONS RESULTS IN COMBINATION WITH OTHER OPTIONS THAT MAY REQUIRE CHANGE EXTERNAL CONNECTIONS TO THESE TERMINALS (GIVEN IN THE APPLICABLE OPTIONS MANUAL OF OTHER OPTIONS ARE ADDED). SEE APPLICABLE OPTIONS MANUAL FOR CORRECT CONNECTION
THIS SCHEMATIC REPLACES AREA A OF THE BASIC SCHEMATIC A2001-00-ES IF OPTION CIRCUIT CARDS ARE ADDED TO THE BASIC UNIT. DETAILED SCHEMATICS OF THE OPTION CIRCUIT CARDS ARE INCLUDED IN THE APPLICABLE OPTIONS MANUAL
REVISION
REV. LTR
APP'D
DATE
B
PIN NUMBER CHANGES, SIG. ISO. OPTION, ALSO CORRECTIONS ON PATCH PLUGS
J. M.
9/23/74
D
CORRECT SIGNAL ISOLATOR SCHEMATIC NO.
D.A.R.
4/17/81
POLYPHASE ELECTRONICS CORP.
PRO-2 REGENERATIVE DRIVE OPTIONS INTERCONNECTION SCHEMATIC
A2001-001-ES


IC 31
IC 32
IC 33
IC 34
IC 35
NOTES:
1. IF THE BOARD IS MARKED E1485-01-6 6 VOLT INPUT BETWEEN PINS 7 & 8 GIVES A 6 VOLT OUTPUT.
2. IF THE BOARD IS MARKED E1485-02-4 50 MILLIVOLT INPUT GIVES A 6 VOLT OUTPUT
◉ = GOLD CONTACT
KEY POSITIONS BETWEEN PINS 5 & 6.
⊙ = VOLTAGE TEST POINTS.
DESCRIPTION
1. ADDITION OF THIS OPTION BOARD ISOLATES TERMINALS A,B,C & D OF TERMINAL BLOCK 11B FROM THE POWER LINES TO ALLOW CONNECTION TO GROUNDED OR "HOT" EQUIPMENT.
2. ADDITION OF THIS OPTION REQUIRES CHANGING PATCH PLUG ZP1- SEE DRAWING A2001-001-ES FOR PATCH PLUG SELECTION.
3. ADDITION OF THIS OPTION DOES NOT CHANGE NORMAL EXTERNAL WIRING CONNECTIONS TO THE PRO-2 CONTROL UNIT.
POLYSPEDE ELECTRONICS CORP
PRO-2 SIGNAL ISOLATOR
SCHEMATIC, BOARD E1485
E1485-00-ES,b


RAMP GENERATOR
NON INVERTING DRIVER
INPUT-OUTPUT COMPARATOR
ZERO CROSSING DETECTOR
LOGIC
IC 301
IC 302
RESET
OUTPUT (±6V RANGE)
INPUT (±6V RANGE)
+20V IN
COM
-20V IN
PRINTED CIRCUITS EDGE CONNECTOR
REVISED NOTE 4
POLYPEDE ELECTRONICS CORP.
BOARD, PC. PRD-2 ACCELERATION OPTION - SCHEMATIC -
E1490-01-ES,a


REVISION
REV. LTR
a CORRECTED 61CR WIRING
b ADDED SPL-3,6 & 8 NOTATION
c CORRECTED AC INPUT VOLTAGE
APP'D
DATE
D.A.R. 1/2/81
"BAND"
NEGATIVE SIGNAL SPLITTER
POSITIVE SIGNAL SPLITTER
INPUT SUMMING
GAIN CONTROL
OVER-TRAVEL INHIBIT
CONNECT TO -20V FOR AUTO OPERATION
MANUAL INPUT 0 TO +12V
INPUT "AUTO" MODE "TABLE I"
SEE TABLE
61CR
61TB
JUMPER TO 61TB-1 TO ENABLE NEGATIVE ARM. VOLTAGE
JUMPER TO 61TB-2 TO ENABLE POSITIVE ARM. VOLTAGE
NO CONNECTION
34 VAC INPUT
TABLE I
RESISTANCE VALUES FOR VARIOUS TYPES OF INPUT
INPUT | R61 | R62 | R66
1 - 5 MA | 1000 OHMS | 47 KOHMS | OPEN
4 - 20 MA | 240 OHMS | " | "
10 - 50 MA | 100 OHMS | " | "
1 - 5 VOLTS | OPEN | " | "
2 - 10VOLTS | " | 100 KOHMS | "
0 - 1 VOLT | " | 2.7 KOHMS | 1 MEG. OHM
0 - 2VOLTS | " | 18 KOHMS | "
0 - 10VOLTS | " | 130 KOHMS | "
0 - 12VOLTS | " | 150 KOHMS | "
-10V TO +10V | " | 270 KOHMS | 240 KOHMS
POLYSPEDE ELECTRONICS CORP
870 TWIN HILLS AVE DALLAS TEXAS
7/31/74
BOARD, PC. PRD-2 POSITION INTERFACE - SCHEMATIC -
DRAWING NO. E1491-01-ES,c