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APPENDIX

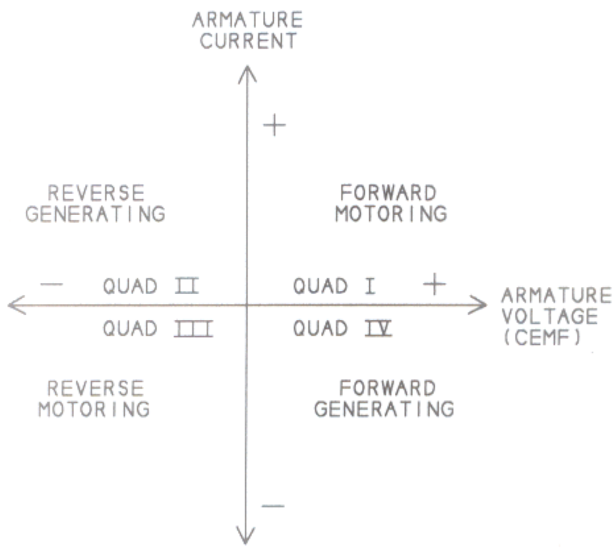
1. USING THIS MANUAL

The specifics in this manual apply to the open chassis version of the PRD12B unit. The PRD12B units furnished in enclosures are essentially identical to the open chassis units except for the sealed air shrouds installed around the heat sinks.

Polyspede furnishes custom-engineered PRD12B units which include customer-requested special features not covered in this manual. In every case, separate drawing sets are included with these systems. Follow the instructions on these drawings first and then consult this manual as necessary. These drawings are identified by the letter “M” followed by a number sequence.

If you need information that will help you adapt the PRD12B to your applications, turn to Sections 2.5 and 16 and formulate your own external wiring diagram. Before you do this however, check all of the detail blocks on external wiring schematic A2399-007-EW; this drawing is quite comprehensive and may include the wiring required for your application. This drawing (two sheets) is located in the appendix of this manual.

2. DESCRIPTION

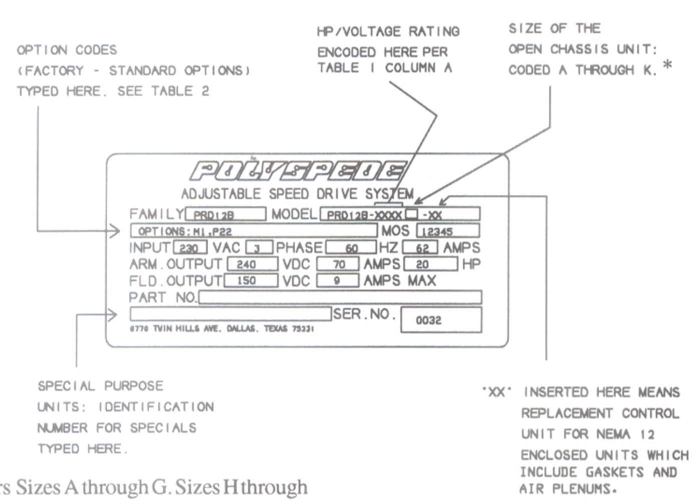


The above figure defines four-quadrant operation as provided by the PRD12B. Non-regenerative controls provide only Quadrant I operation, or if equipped with a reversing contactor, can provide Quadrant I and Quadrant III operation. Only regenerative controls such as the PRD12B can provide Quadrant II and Quadrant IV (generating) operation and contactorless reversing.

The PRD12B provides seamless transfer between quadrants with no torque or speed discontinuities.

2.1 <u>Nameplate Identification</u>

The nameplate is the primary identifier for factory service, replacement, and reorder purposes. Complete identification is normally provided by the model number, the option codes, and the number in the "MOS" block. If a number appears in the "PART NO" block, this number is also required.



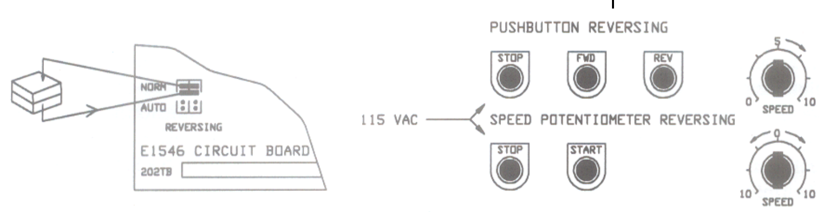
* - This manual covers Sizes A through G. Sizes H through K are described in addendums provided with the units.

Figure 1
Nameplate Description

2.2 General Features

The PRD12B is a high performance servo-grade regenerative control. Two 6-SCR back-to-back bridges are utilized to provide either positive or negative current to a DC motor. In servo type applications the PRD12B controls speed and direction of rotation according to the magnitude and polarity of an input voltage signal, with pushbutton-controlled starts and stops available. The PRD12B is not limited to servo applications, however. It will also directly accept (instead of input-voltage-polarity directional control) the familiar "STOP/FORWARD/REVERSE" pushbutton inputs. This pushbutton response emulates the Start-Stop response of earlier non-regenerative controls. Specifically, to reverse the motor an operator must first activate the "STOP" pushbutton wait for the motor to stop, and then activate the "REVERSE" pushbutton. Both the "FORWARD" and "REVERSE" pushbuttons are dead once the motor catastrophies that might occur in the external wiring.

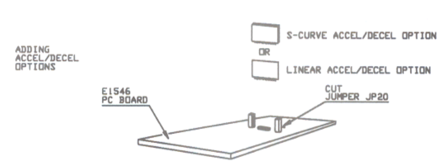
Thus the PRD12B can replace virtually any non-regenerative drive and will upgrade the performance of the connected machinery due to predictable stopping ties and ability to control overhauling loads. No dynamic braking resistors are needed to accomplish rapid stops. (Optional dynamic braking is available which shortens the coast down time for an "EMERGENCY STOP" or a "FAULT" trip; this optional dynamic braking is not operative during normal stops). Since the PRD12B does not require contactors for reversing, its size is generally smaller and its cost may be lower than that of a contactor-reversed non-regenerative control unit, particularly in higher horsepower sizes.



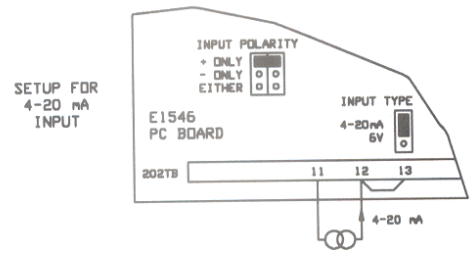
is started. While this can be a useful safety feature in operator-controlled machinery, it can be a cumbersome restraint in automatic machinery which performs frequent reversals. The PRD12B therefore provides a second mode which defeats this "wait for a stop" feature of its pushbutton logic; this provision is known as "AUTO-REVERSE". With the "AUTO-REVERSE" modification enabled, both the "FORWARD" and "REVERSE" pushbuttons are continually "live" and one-step motor reversal can be commanded from the appropriate pushbutton at any speed without the necessity of first executing a stop. This modification is a simple procedure for either factory or field enablement. (see 2.6.4).

In all arrangements the "STOP" pushbutton causes a regenerative stop either at a rate controlled by torque limit or by the deceleration ramp rate if the optional acceleration unit is included. Provision for an "EMERGENCY STOP" pushbutton which kills thyristor firing and causes a coast down stop is included. The pushbutton section uses the familiar 115 VAC logic which allows easy incorporation of the pushbuttons into 115 VAC ladder logic. Optically-isolated drivers provide electrical isolation of the 115VAC logic from the 12 VDC internal logic in the PRD12B thereby isolating it from

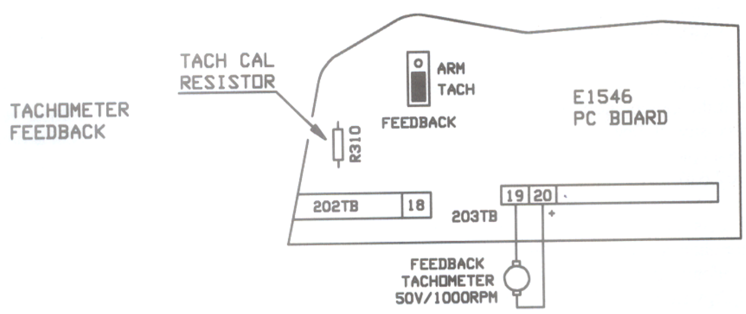
The standard PRD12B unit does not include an acceleration unit; motor speed follows the input voltage command directly with negligible time lag. Acceleration and deceleration rates are limited only by available motor torque which is in turn controlled by the PRD12B torque limit settings. This action is ideal for servo-related applications and for systems in which a computer or a programmable controller is to control acceleration and deceleration rate as well as speed. An optional acceleration/deceleration unit is available for applications in which speed changes must occur at potentiometer-adjusted controlled rates. This plug in option board is available in either a linear version in which speed increases and decreases occur at preset constant rates, or in an "S-Curve" version for softer starts and stops.



The standard PRD12B unit also includes a built–in 4-20 ma network which is selected by a circuit-board jumper labeled “INPUT TYPE”. When this jumper is moved to the “4-20MA” position the speed-control input terminals are converted to be responsive to a standard 4-20 ma process instrument output. If it is desired that the motor stop for signals less than 4 ma, a second circuit board jumper labeled “INPUT POLARITY” is set to the “+ONLY” position. If the second jumper is not set, the motor will reverse if the input current signal decreases below 4 ma.



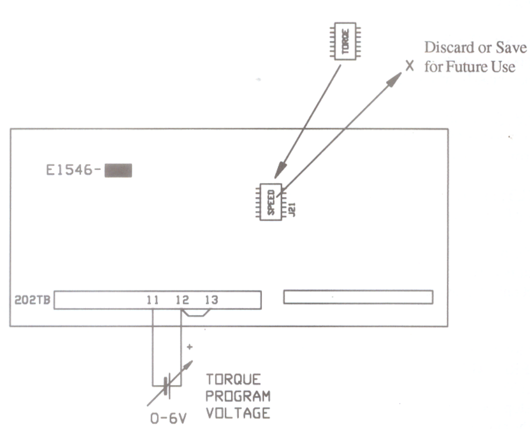
This built-in network does not include “SPAN” and “ZERO” adjustments nor does it include capability of alternately selecting operation from the speed potentiometer. If any of these features are required, the “External Signal follower” optional board (option SF2)should be added. When this board is added, the built-in network is not used and the “INPUT TYPE” jumper is set to the “6V” position. If protection against motor reversal at low signal level is required, the “INPUT POLARITY” jumper is set to the “+ONLY” position. Circuit provision for the tachometer feedback is a standard feature of the PRD12B. A circuit board jumper “ARM TACH” and a fixed tachometer network is provided. The tachometer network matches a 50 volts per 1000 RPM tachometer mounted on a 1750 RPM motor to the PRD12B. Other tachometer/motor base speed combination should be specified at time of purchase for factory installation of the required matching network. The optional network furnished is identified in the options block of the nameplate as option “T2” through “T8”.



The standard PRD12B includes a “SPEED” program plug inserted in socket J21 of the E1546 circuit board. Internal “+TORQ” and “-TORQ” potentiometers provide independent adjustment of positive and negative armature current limits. Additionally, “+MAX VOLTS” and “-MAX VOLTS” adjustment potentiometers provide independent adjustment of maximum attainable motoring speeds in the forward and reverse directions. All potentiometers are full range (0 to 100%); provision for mounting these potentiometers externally is included. Interesting and useful response patterns can be set up with these potentiometers. For example, if the “+MAX VOLTS” and “-MAX VOLTS” are both set to zero, motoring operation in either direction is prevented(the speed command will be ignored), but the motor shaft will apply retarding torque in either direction if it is rotated by externally-applied force (ie: only quadrant 2 and quadrant 4 operation is permitted). The motor thus acts as a brake, with its braking force controlled by settings of “+TORQ” and “-TORQ” potentiometers. Similarly, setting only the “-MAX VOLTS” potentiometer to zero prevents reverse motoring (quadrant 3 operation), but permits operation in the other three quadrants.

If an optional “TORQUE” program plug is inserted in socket J21, the speed command input terminals of the PRD12B are converted to torque command input terminals and the PRD12B becomes a torque-mode control. Torque-mode controls are useful in material winder/ unwinder and related applications in which connected machinery determines the motor speed. The control unit is expected to control tension in the material. The “TORQUE” plug is clearly identified by a label affixed to the plug. Additionally, the nameplate will display the option code “TM” (no option code for speed mode, option code “TM” for torque mode). The “+MAX VOLTS” and “-MAX VOLTS” potentiometers can be used as described in the previous paragraph to prevent motoring operation in one or both rotational directions. The internal “-TORQ” potentiometer is inoperative. The internal “+TORQ” potentiometer functions as a calibrating adjustments for the Torque Command signal.

TORQUE
PROGRAMMING
MODIFICATION



Field loss protection is a standard feature of the PRD12B. Circuitry that detects minimum acceptable field current of approximately 0.2 amperes will cause an immediate shut-down if motor field current drops below this level. An indicator LED located adjacent to the field terminal block is on when field current is above this minimum level; this indicator goes off and the system "FAULT" indicator flashes rapidly for currents below this level.

Fault protection against potentially damaging conditions is included in the PRD12B; a fault activates an LED indicator on circuit board E1546 which displays the type fault on a "first-fault" basis until the indicators are cleared by restarting the unit or by turning power off. Fault shutdown conditions are:

LINE LOSS: AC line loss (or single-phasing)

POWER SUPPLY: ±12 volt supplies very low.

OVER SPEED: AC line voltage too low for the actual armature voltage; danger of a generating fault.

IOT: Instantaneous Overcurrent Trip. Shuts down operation for excessive current peaks.

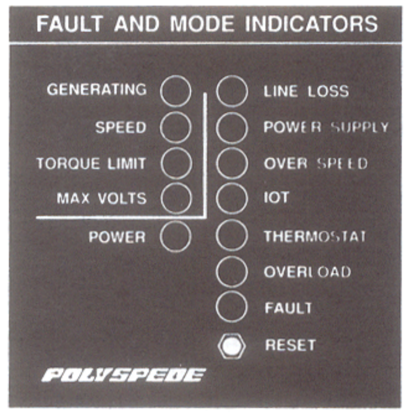
THERMOSTAT: Motor or control thermostat open (if so equipped). Flashes after thermostat cools to indicate that the motor can be restarted.

OVERLOAD: Inverse timed overload. Allows 1 minute of operation at 150% of rated current or longer times for lesser overloads. Flashes warning at rated armature current.

FAULT: Flashes slowly for any fault on this list. Flashes rapidly for field loss.

See Section 2.3 for complete descriptions of the fault detectors and indicators. Generally speaking, these circuits detect only extreme conditions and are not prone to false trips.

The motor generates to a stop for "THERMOSTAT" or "OVERLOAD" faults, or coasts to a stop for any other fault; if the dynamic braking option is provided, this coast-to-a-stop becomes a dynamically-braked stop. Additionally, the mode in which the PRD12B was operating prior to the fault is displayed by the fault and mode indicators. The standard fault and mode indicator lights mounted on circuit board E1546 of the PRD12B are automatically disabled when the plug from an optional remote fault and mode indicator panel is plugged into connector J20 on the E1546 circuit board. Fault and mode indications will then appear only at the remote fault and mode panel.



Although the PRD12B does not require contactors for reliable operation, an optional DC loop contactor is available which disconnects the armature from the control unit as motor speed nears zero following a normal stop command, or which immediately disconnects the armature in response to an emergency stop command. In the latter case the motor coasts to a stop, or if the dynamic braking option is included, does a dynamically-braked stop. In size A and B units, the contactor breaks both the A1 and A2 motor connections. In sizes C and larger, the contactor breaks only the A2 connection to the motor armature. In all sizes, the motor field remains connected continually.

The components in all PRD12B units are rated for 460 VAC service and a 460 VAC unit is readily convertible for use on 230 VAC. Similarly, a 230 VAC unit may be converted for use on 460 VAC (see Section 5.4). Remember, however, that such a change almost always requires a change out of the PRD12B current-monitoring shunt (on sizes A and B), or change out of the "SHUNT CAL" resistor on circuit board E1544 on size C and larger units. (This is because the rated armature current of a motor with a 500 volt armature is less than 1/2 the rated armature current of a motor of the same horsepower with a 240 volt armature; the shunt calibrates adjustments on the PRD12B unit to match a certain armature current).

Table 1, following, lists the horsepowers that may be obtained from each physical size of PRD12B (sizes are coded A through G). Note in this table that twice the horsepower may be obtained from a particular size PRD12B operated on 460 VAC as may be obtained from that same physical size unit operated on 230 VAC.

TABLE 1
CONTROL MODEL NUMBERS AND ELECTRICAL SPECIFICATIONS

A	B	C	D	E	F	G	H	J	K	L
MODEL PRD12B-	SIZE CODE	INPUT VAC	INPUT AMPS	ARMATURE OUT.			FIELD OUT.		202TB-18 VOLTS AT 100% I_A	WEIGHT * LBS./Kg.
				VDC	AMPS	HP	STD. VDC	OPT. VDC		
-30	A	230	10	240	11	3	150	(240)	2.10	17/7.7
-50	A	230	16	240	18	5	150	(240)	2.00	17/7.7
-75	A	230	25	240	28	7.5	150	(240)	2.00	17/7.7
-100	A	230	32	240	37	10	150	(240)	2.00	17/7.7
-150	B	230	46	240	53	15	150	(240)	2.00	21/9.5
-200	B	230	60	240	70	20	150	(240)	2.00	21/9.5
-250	C	230	76	240	88	25	150	(240)	2.07	43/19.5
-300	C	230	91	240	105	30	150	(240)	2.06	43/19.5
-400	D	230	119	240	138	40	150	(240)	1.84	49/22.2
-500	D	230	147	240	171	50	150	(240)	2.08	49/22.2
-600	F	230	175	240	204	60	150	(240)	2.00	74.5/33.8
-750	F	230	218	240	255	75	150	(240)	2.06	74.5/33.8
-1000	G	230	288	240	338	100	150	(240)	2.05	74.5/33.8
-31	A	460	5	500	5	3	300	-	1.67	17/7.7
-51	A	460	8	500	8.5	5	300	-	2.00	17/7.7
-76	A	460	11	500	13	7.5	300	-	2.00	17/7.7
-101	A	460	15	500	17	10	300	-	1.89	17/7.7
-151	A	460	22	500	25	15	300	-	1.79	17/7.7
-201	A	460	30	500	34	20	300	-	1.84	17/7.7
-251	B	460	36	500	41	25	300	-	1.91	21/9.5
-301	B	460	42	500	49	30	300	-	1.85	21/9.5
-401	B	460	56	500	65	40	300	-	1.86	21/9.5
-501	C	460	69	500	81	50	300	-	1.91	43/19.5
-601	C	460	83	500	97	60	300	-	1.90	43/19.5
-751	D	460	103	500	121	75	300	-	1.86	49/22.2
-1001	D	460	137	500	161	100	300	-	1.96	49/22.2
-1251	F	460	170	500	200	125	300	-	1.96	74.5/33.8
-1501	F	460	204	500	240	150	300	-	1.94	74.5/33.8
-1751	G	460	237	500	279	175	300	-	2.04	74.5/33.8
-2001	G	460	270	500	319	200	300	-	1.94	74.5/33.8

* - OPEN CHASSIS UNIT, WITH CONTACTOR OPTION

TABLE 2
STANDARD OPTIONS AND MODIFICATIONS

OPTION DESCRIPTION	P.C. ASS'Y USED	OPT. CODE	CORRESPONDING MANUAL SECT.
LINEAR ACCEL., 0.8-27 SEC (STANDARD)	E1548-111	A1	2.6.9
0.12-4 SEC (FAST)	E1548-112	A2	2.6.9
2.5-85 SEC. (EXTENDED)	E1548-113	A3	2.6.9
S CURVE ACCEL., 0.8-18 SEC (STANDARD)	E1548-911	AS1	2.6.10
0.12-3 SEC. (FAST)	E1548-912	AS2	2.6.10
1.6-35 SEC. (EXTENDED)	E1548-913	AS3	2.6.10
DC LOOP CONTACTOR			
SIZE A UNITS (THRU 10/20 HP)	-	M1	2.6.11
SIZE B UNITS (THRU 20/40 HP)	-	M2	2.6.11
SIZE C UNITS (THRU 30/60 HP)	-	M3	2.6.11
SIZE D UNITS (THRU 50/100 HP)	-	M4	2.6.11
SIZE F UNITS (THRU 75/150 HP)	-	M5	2.6.11
SIZE G UNITS (100/200 HP)	-	M6	2.6.11
ADD POSITION INTERFACE, 4-20 MA INPUT	E1491-22	P22	2.6.12
0-6 V INPUT	E1491-24	P24	2.6.12
0-10 V INPUT	E1491-25	P25	2.6.12
0-12 V INPUT	E1491-26	P26	2.6.12
REMOTE FAULT INDICATOR (OPEN CHASSIS UNITS)		RFI	2.6.18
ADD RUN AND FAULT RELAY BOARD	E4422-03	RY1	2.6.13
ADD DYNAMIC BRAKING, SIZE A	-	DB1	2.6.14
ADD DYNAMIC BRAKING, SIZE C	-	DB3	2.6.14
ADD DYNAMIC BRAKING, SIZE D	-	DB4	2.6.14
ADD DYNAMIC BRAKING, SIZE F	-	DB5	2.6.14
ADD DYNAMIC BRAKING, SIZE G	-	DB6	2.6.14
ADD FIELD ECONOMY (WITH CONTACTOR OPTION)	SIZES A & B	FE1	2.6.15
ADD FIELD ECONOMY (WITHOUT CONTACTOR OPTION)	SIZES A & B	FE2	2.6.15
ADD FIELD ECONOMY (WITH OR W/O CONTACTOR) SIZE	C OR LARGER	FE3	2.6.15
ADD EXT. SIGNAL FOLLOWER, 4-20 MA	E1542-523	SF2	2.6.16
10-50 MA	E1542-524	SF3	2.6.16
± 6V	E1542-511	SF4	2.6.16
± 10 V	E1542-511	SF4	2.6.16
4-20 MA, 12 MA ZERO	E1542-723	SF6	2.6.16
10-50 MA, 30 MA ZERO	E1542-724	SF7	2.6.16

TABLE 2 CONTINUED
STANDARD OPTIONS AND MODIFICATIONS

OPTION DESCRIPTION		P.C. ASS'Y USED	OPT. CODE	CORRESPONDING MANUAL SECT.
ADD ARM. VOLTAGE FOLLOWER	0-90 V	E1543-06	VF1	2.6.1
	0-180 V	E1543-06	VF1	2.6.1
	0-240 V	E1543-06	VF1	2.6.1
	0-500 V	E1543-07	VF2	2.6.1
ADD TACHOMETER FOLLOWER	6-20 VDC	E1543-01	TF1	2.6.1
	20-65 VDC	E1543-04	TF4	2.6.1
	65-200 VDC	E1543-05	TF5	2.6.1
ADD TACH. FEEDBACK		E1546-		
1750 RPM MOTOR, 50 V/1000 RPM TACH		X1XX	(STD.)	2.6.2
850 RPM MOTOR, 100 V/1000 RPM TACH		X1XX	(STD.)	2.6.2
3600 RPM MOTOR, 50 V/1000 RPM TACH		X2XX	T2	2.6.2
1750 RPM MOTOR, 100 V/1000 RPM TACH		X2XX	T2	2.6.2
2500 RPM MOTOR, 50 V/1000 RPM TACH		X3XX	T3	2.6.2
1150 RPM MOTOR, 100 V/1000 RPM TACH		X4XX	T4	2.6.2
1150 RPM MOTOR, 50 V/1000 RPM TACH		X5XX	T5	2.6.2
600 RPM MOTOR, 100 V/1000 RPM TACH		X5XX	T5	2.6.2
2500 RPM MOTOR, 7 V/1000 RPM TACH		X6XX	T6	2.6.2
1750 RPM MOTOR, 7 V/1000 RPM TACH		X7XX	T7	2.6.2
(OTHER RANGES SPECIFIED BY USER)		X8XX	T8	2.6.2
CONVERT TO TORQUE MODE	(J21)	E1546-X9XX	TM	2.6.3
ADD AUTO REVERSING		-	AR	2.6.4
ADD JOG SPEED (JOG 2) SEPARATE JOG SPEED		E1534-03	J2	2.6.5
ADD PRESET SPEEDS	7 EXTERNAL POTS	E1532-07	PS0	2.6.6
	3 INTERNAL, 1 EXTERNAL POT	E1532-31	PS3	2.6.6
	4 INTERNAL POTS	E1532-40	PS4	2.6.6
	6 INTERNAL, 1 EXTERNAL POT	E1532-61	PS6	2.6.6
	7 INTERNAL POTS.	E1532-70	PS7	2.6.6
CHANGE TO 240 V. FIELD (230 V CONTROLS)		E1551-12	(240)	2.6.7 *
CHANGE TO 50 HZ OPERATION		E1544-0X2	(50)	2.6.8 **

* - TYPED IN "FIELD OUTPUT" BLOCK ONLY ON NAMEPLATE
** - TYPED IN "HZ" BLOCK ONLY ON NAMEPLATE

2.3 Protective Shutdown Circuits

The PRD12B control includes as standard features (7) protective shutdown circuits. If any of these 7 faults occur, the drive will be shut down. The manner in which the drive shuts down varies depending on the type of fault. The following is a listing of the various fault modes: "IOT" (Instantaneous Overcurrent Trip), "LINE LOSS", "OSPD LO LN" (Over speed/Low Line), "PWR SUPL" (Power supply), "THERM" (motor or control thermo- stat), "OVERLOAD" and "FIELD". If a "LINE LOSS" "FIELD" (Field Loss), "OSPD LO LN", "PWR SUPL" or "IOT" fault occurs, the control immediately stops operation and the motor coasts to a stop. If an "OVERLOAD" or "THERM" fault occurs, the motor will be decelerated under PRD12B control until zero speed is reached, and then the control will be shut down. The manner in which the control will be decelerated under these conditions depends on whether or not an Accel/Decel unit has been furnished. If the control is not equipped with an Accel/Decel unit, the motor will decelerate in current limit to zero speed. If an Accel/Decel unit is present in the control, the motor will be decelerated at the rate set on the "DEC" potentiometer. In either case the control will be shut down after zero speed is reached. In addition to the fault LED indicators, LEDs are also provided for indicating the mode of operation of the control when a fault has not occurred. If a fault occurs, the mode LED that was illuminated just prior to the fault will remain on as a trouble-shooting aid until the fault is reset.

Operation of the "START" pushbutton resets the fault circuits and extinguishes all fault indicators; a separate "RESET" operation is not necessary. For all faults except "THERM" (thermostat), the motor may be restarted (in the same direction of rotation) without waiting for a complete stop provided the cause of the fault is no longer present. If a restart is not desired, the fault circuits can be reset and the indicators extinguished by operating the "RESET" switch on the remote fault and mode indicator panel (if so equipped)

The following section will discuss the fault indicator LEDs and how each indicator responds to a related fault condition.

2.3.1 IOT" (Instantaneous Overcurrent Trip)

This LED works off the electronic "Instantaneous Overcurrent Trip" fault circuit. Purpose: to minimize fuse blowing in the event of high current peaks caused by malfunction or equipment failure. This circuit is activated if the motor armature current peaks exceed approximately 230% of the normal torque-limit current peaks(sizes A and B), or 340% to 660% of normal torque-limit current peaks in size C and larger units (varies with size). SCR firing is immediately terminated and the "IOT" LED will illuminate steadily. In addition, the "FAULT " LED will blink at a 3 to 4 HZ frequency.

2.3.2 "LINE LOSS"

This LED is illuminated when one of the three phase line inputs drops below 55% of nominal voltage or when all lines drop below 75% of nominal voltage. SCR firing is killed and the "FAULT" LED will blink at a frequency of 3 to 4 HZ.

2.3.3 "OSPD LO LN"
(Overspeed/Low Line, or "OVERSPEED"

This protective shutdown circuit activates if motor armature voltage is too high relative to actual AC line voltage for fault-free generating action. Shutdown will occur only at or near full-speed operation, but may occur either because of armature voltage above rated value or because of line voltage far below nominal value while armature voltage is at rated value. If either combination activates this protective shutdown circuit, SCR firing is halted and the motor coasts to stop; the LED indictor glows steadily and the "FAULT" indicator blinks repetitively. With nominal AC line voltage, such a trip occurs at armature voltages in excess of approximately 584 VDC(292 VDC in 230 VAC controls). Alternatively, with rated armature voltage at the motor (motor operating at base speed), a trip will occur if AC line voltage drops below 395 VAC on 460 VAC lines, or below 190 VAC on 230 VAC lines. The circuitry is fast acting and will respond to one-cycle dips to these critical levels.

2.3.4 "PWR SUPL" (Power Supply)

If the output of the +/- 12 VDC power supplies in the control drops below about 8.5 volts, the control will be shutdown immediately. The "PWR SUPL" LED will be illuminated and the "FAULT" LED will blink at a frequency of 3 to 4 HZ.

2.3.5 "THERM"
(Motor or Control Thermostat)

This LED will illuminate when one or more normally-closed thermostat contacts in a series-connected string open. If a thermostat contact opens, the motor will decelerate to a controlled stop just as if the "STOP" pushbutton had been activated. The motor cannot be restarted until the faulted thermostat cools and its contacts reclose. When a thermostat fault occurs, the "THERM" LED glows steadily and the "FAULT" LED blinks. When the faulted thermostat cools, these two LEDs blink alternately indicating that the drive can be restarted

2.3.6 "OVERLOAD" (Motor Overloaded)

This is sometimes referred to as Inverse Timed Overload. The "OVERLOAD" LED will light when the armature current exceeds a level as set by the "OVERLOAD" potentiometer. In most cases the "OVERLOAD" potentiometer will be set so that the overload circuitry and the "OVERLOAD" LED will be activated when the motor current exceeds 100% of rated motor current. If the motor current overload is not relieved after a specified time as explained in Section 10.2.5, the control will shut down in the normal manner as described for the "STOP" function. At shutdown the "OVERLOAD" LED will remain illuminated and the "FAULT" LED will blink at the rate of approximately 3 to 4 HZ.

2.3.7 "FIELD" LED(Field Current Indicator)

The "FIELD" LED indicator is on anytime a field current greater than 0.2 amps is detected; it therefore indicates normal operation rather than a faulted condition. This indicator is located adjacent to the field terminal strip 301TB on the E1550 PC board. (All of the other fault indicators previously described are located on the E1546 PC board). When this circuit detects field currents lower than 0.2 amps, the "FIELD" LED will not be lit and the "FAULT" LED will blink rapidly (at about 2-1/2 times the normal rate) until a field current above 0.2 amps is reestablished. A restart operation is required.

2.3.8 "FAULT" LED

The "FAULT" LED will illuminate anytime any of the previously-explained 7 faults occur. Whenever an "IOT" "LINE LOSS", "OSPD LO LINE", "PWR SUPL", "THERM", or "OVERLOAD" occurs, the "FAULT" LED will blink at a frequency of 3 to 4 HZ. In addition, the LED indicating the fault that occurred will remain illuminated. Operation of the "FAULT" indicator is different if the field loss protection circuit is actuated. Under these conditions the "FIELD" LED on the E1550 board will go off and the "FAULT" LED will blink rapidly at about 2.5 times the normal rate. Since the remote fault and mode indicator panel(if so equipped) does not have a separate LED to identify a filed-loss fault, a rapidly-blinking "FAULT" indicator uniquely identifies a field-loss fault at the remote indicator panel.

2.4 Other PRD12B LED Indicators ("MODE" Indicators)

In addition to the "FAULT" indicators described in 2.3, the PRD12B has four LED indicators that describe the mode in which the drive system is operating when a fault is not present. These indicators are located on the E1546 (top) circuit board. Additionally these indicators (plus a "POWER" indicator) are repeated on the Fault And Mode indicator panel if so equipped. If a fault occurs, the mode indicator(s) that were illuminated prior to the fault remain illuminated to aid in trouble-shooting. The four mode indicators function as follows:

2.4.1. "SPD" – (Speed)

In speed-programed drives, this LED illuminates after the drive is started, provided that neither the "TORQ LIM" LED nor the "MAX VOLTS" LED is on. In torque-programed drives the "SPD" LED will not illuminate.

2.4.2 "TORQ LIM" – (Torque Limit)

In speed-programed droves this LED illuminates if armature current reaches the maximum value permitted by the settings of the "+TORQ" (positive armature current), or the "-TORQ" (negative armature current) potentiometers. Simultaneously the "SPD" indicator (if it was previously on) will turn off.

In torque-mode drives ("TORQUE" program plug in J21), the "TORQ LIM" indicator will illuminate continually regardless of the status of any of the other indicators.

2.4.3 "GEN" - (Generating)

This indicator comes on whenever the PRD12B is generating (returning power to the AC lines) When this indicator is not illuminated, the PRD12B is operating in a normal motoring mode (taking power from the AC liens). This indicator works in conjunction with the other three mode indicators; it does not normally turn any of them off when it comes on.

2.4.4 "MAX VOLTS" - (Maximum Armature Voltage)

NOTES

This indicator will come on if the load is such that motoring is occurring and armature voltage has reached the maximum permissible level set by the "+MAX VOLTS" (positive armature voltage) or "-MAX VOLTS" (negative armature voltage) potentiometers. This LED works as described for both speed-programed and torque-programed controls. Since the limit circuitry which drives this indicator does not prevent the rise of armature voltage beyond the "MAX VOLTS" limit when the system generating (such as might occur when a load is being lowered, or when holdback torque is being applied in a web-tensioning system), the "MAX VOLTS" indicator will not normally come on when the "GEN" indicator is on. When the "MAX VOLTS" LED does come on, it is an indication that the PRD12B is over-riding a prior mode of operation (either speed or torque control) in favor of regulating armature voltage to a preset maximum value. "MAX VOLTS" might come on in speed-programed drives if tachometer feedback is lost, or in torque-programed drives if the load is lost (again, only if motoring as opposed to generating action is occurring). When "MAX VOLTS" comes on, the mode indicator previously illuminated ("SPD" or "TORQ LIM" will go off in Speed-Programmed drives.

In tachometer feedback drives which are not equipped with a field regulator, the "MAX VOLTS" indicator may come on if the motor is operated at full speed with cold field windings. If so, the indicator will go off when the motor field windings reach normal operating temperature. Tachometer feedback is over-ridden until the "MAX VOLTS" LED goes off.

This characteristic of DC motor operation can be avoided by turning on AC power 30 minutes prior to actual operation to preheat the field windings, or by utilizing the optional field regulator.

2.5 Starting, Stopping And Reversing The PRD12B

Section 2.2 gives a general description of how the PRD12B responds to various pushbutton commands.

A high degree of user flexibility is built into the pushbutton interface, primarily to allow the PRD12B to respond to any combination of "START", "STOP", "FORWARD", "REVERSE" and "EMERGENCY STOP" operators of either the pushbutton or the maintained selector switch variety.

Although many methods may be used to control starting, stopping, and direction of rotation and speed, there are three basic types of control:

Type 1:

Forward and Reverse rotation is commanded by pushbuttons. Magnitude of speed (but not direction of rotation) is set by the speed potentiometer. Figure 2.1 and Figure I of External Wiring Diagram A2399-007-EW in the Appendix illustrate this method.

Type 2:
Only starting and stopping are commanded by pushbuttons. Both speed and direction of rotation are set by the speed potentiometer. Figure II of External Wiring Diagram A2399-007-EW in the Appendix illustrates this method of control.

Type 3:
Any combination of Types 1 and 2 except implemented with selector switches rather than pushbuttons. Figures 2.2 and 2.3 illustrate selector switch control.

The PRD12B uses 115 VAC logic in the pushbutton interface. This feature allows it to connect to a variety of existing operator control stations utilizing common 115 VAC logic. Accordingly, the PRD12B can be considered a drop-in replacement for older controls of either the regenerative or the non-regenerative variety.

Figure 2.1, following, is a block-diagram representation of PRD12B pushbutton logic used for Type 1 control. Note that an internal control transformer (T10) furnishes the 115 VAC excitation voltage to the pushbutton operators.

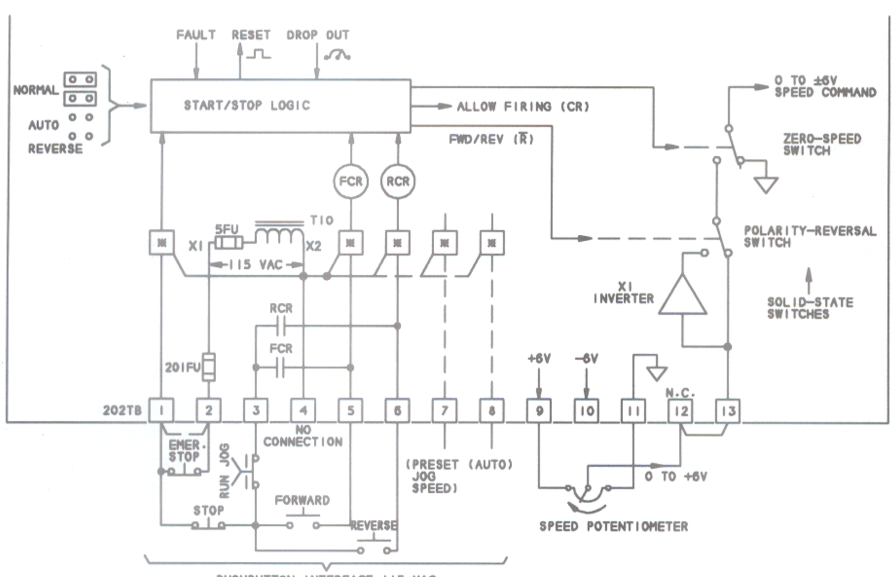


Figure 2.1
Simplified Schematic of PRD12B
Start/Stop/Direction - Control Logic

2.5.1 Technical Description: Start-Stop Circuitry

The following generalized technical description of how this interface works is intended to give the user insight into the various ways in which operators can be connected to achieve a desired result. Type 1 operation is assumed.

Figure 2.1 illustrates a familiar pushbutton arrangement and the internal circuitry to which the pushbuttons connect. Before proceeding with a detailed explanation, however, it is useful to note that the PRD12B controls forward and reverse operation internally by a solid-state polarity-reversing switch shown in simplified form above Terminal 13 in Figure 2.1. Similarly, stopping is performed by the internal solid-state Zero-Speed switch shown in simplified form, which simply reduces the speed command voltage within the control unit to zero. Note that both switches are in the wiper circuit of the speed potentiometer. Thus the primary internal function of the Start-Stop logic is to control these two switches. The switches in turn manipulate the input speed command to achieve starting, stopping and reversal. The other signals shown are supporting functions.

The two relays shown, "FCR" and "RCR" exist solely for the purpose of providing a contact closure to "seal" around the "FORWARD" and "REVERSE" pushbuttons shown in Figure 2.1 thereby latching them in the manner well known to electricians who install this type of equipment. The Start-Stop logic senses relay coil current to detect status of the two relays thereby generating the signals that control the Start-Stop logic. Although not shown in Figure 2.1, circuitry in the Start-Stop logic prevents "FCR" and "RCR" from activating simultaneously in the event that the "FORWARD" and "REVERSE" pushbuttons are held activated by an operator; only one relay will activate. The blocks marked * in Figure 2.1 are optically-isolated driver boards that accept a 115 VAC input signal from the pushbuttons and cause it to activate the 12 volt DC coils of "FCR" or "RCR" through an optically-coupled link.

The following describes what happens in response to various events as well as the purpose of the signals in Figure 2.1:

a) If a fault occurs, the relay ("FCR" or "RCR") that was previously activated is released. Neither relay can then be activated until the fault detectors are reset. Fault detectors and their associated LED indicators are described in Section 2.3. Activating either the "FORWARD" or the "REVERSE" pushbutton shown in Figure 2.1 will generate the "RESET" pulse shown and will restart the motor provided the fault no longer exists. Other methods of fault reset are given in (b), following.

b) The "RESET" pulse shown is generated when AC power is first turned on, when power is turned off and then back on, when a directional pushbutton is activated, or when the "RESET" pushbutton on the remote Fault and Mode indicator panel (if so equipped) is activated, or when the "RESET" terminal points on the E1546 circuit board are shorted (a service procedure only). The purpose of this pulse is to reset the fault detectors thereby allowing the drive to be restarted.

c) Activating the "STOP" pushbutton in the circuit of Figure 2.1 unlatches relay "FCR" or "RCR" in the conventional manner. This causes the Zero-Speed switch to activate thereby reducing the speed command voltage to zero. The motor will decelerate to nearly zero speed. (If desired, a same-direction restart can be done from the pushbuttons at any time during deceleration to abort the stop sequence). As zero speed is approached, a "DROP OUT" circuit (not shown) causes the "ALLOW FIRING" signal (labeled "CR" on the schematics) to go away thereby killing SCR firing and causing a brief motor coast to zero speed. The motor speed at which drop-out occurs is adjustable by the "DROP OUT" potentiometer on circuit board E1546. A contact on an optional "RUN" relay (not shown) may be used to set a mechanical brake via an external contactor if desired. The "RUN" relay releases at drop out.

d) Activating the "REVERSE" pushbutton sets the polarity-reversal switch shown in Figure 2.1 to the inverting position. This causes the 0 to +6v signal on the wiper of the speed potentiometer to be transmitted as a negative speed command. Since direction of motor rotation is controlled by the polarity of the speed command signal in the PRD12B, the motor will rotate in the reverse direction. The initial status of this switch is random when power is turned on. If the "AUTO-REVERSE" jumpers are set to the "AUTO" position, motor reversal may be commanded at any time from the pushbuttons. If these jumpers are set to the "NORMAL" position, a stop must be executed before a reversal is possible. (See Sections 2.2, 2.6.4, and 9.1).

e) Activating the "EMERGENCY STOP" pushbutton in Figure 2.1 unlatches relay "FCR" or "RCR" in the conventional manner. Additionally, the momentary removal of 115 VAC from 202TB Lug 1, acting through the optically-isolated driver board (*), causes a latch to be set in the Start-Stop logic. This in turn causes the "ALLOW FIRING" signal shown to go away; the motor will coast to a stop (this signal is called "CR" on the schematics). A reset pulse generated as described in (b) resets the latch and allows restarting (simply activating one of the directional pushbuttons will do it). It is important to use "EMERGENCY STOP" in conjunction with a fail-safe mechanical brake in applications such as hoists in which an overhauling load might overload the control and prevent a normal stop. A contact on the optional "RUN" relay, or an auxiliary contact on the optional contactor can be used to operate the mechanical brake though an external contactor. It is also good practice to include "EMERGENCY STOP" at any time the optional acceleration unit is included, so that the motor can be cut dead without waiting for deceleration to zero speed.

f) The "DROP OUT" signal is described in (c) and 10.2.6.

g) Function of the "AUTO REVERSE" jumper is described in 2.5.1(d), 2.2, 2.6.4, and 9.1.

2.5.2 Using Selector Switch Logic

Figures 2.2 and 2.3 illustrate the use of selector switches (in lieu of the pushbutton control utilized in Figure 2.1) to achieve Type 3 control as previously defined. The "AUTO REVERSE" option is not applicable with selector-switch directional control of the types shown in these two figures. When selector switches are utilized, the procedure for restarting after a fault is to move the selector to the "STOP" position, and then to return it to its original position. This will generate the necessary "RESET" pulse.

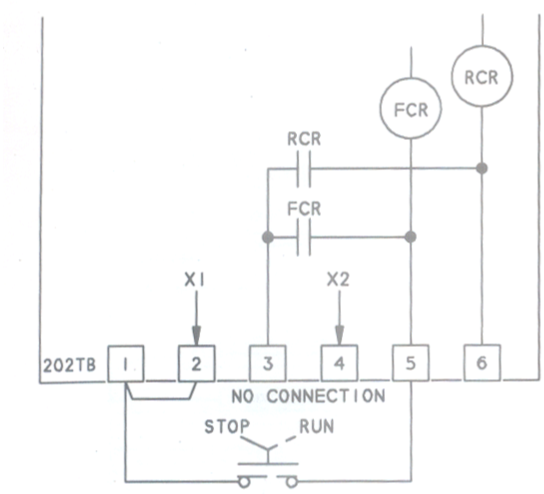


Figure 2.2
Simplest Unidirectional Selector Switch Logic

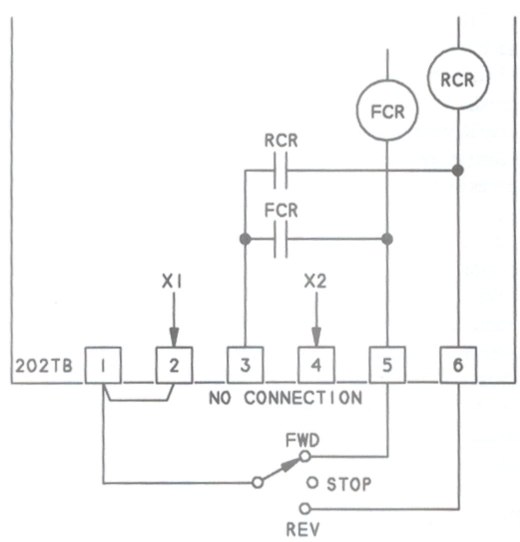


Figure 2.3
Simplest Forward/Reverse Selector Switch Logic

2.5.3 Capacity of The 115 VAC Transformer

The capacity as well as the excess capacity of the internal transformer (T10) is given in the following table. Excess capacity is the VA which is not used in the PRD12B and is therefore available for customer use. The primary consumers of transformer capacity within the PRD12B are the fans and the dc loop contactor (if so equipped)

Unit Size	X'fmr Size	Excess VA Available		Excess Inrush VA Available
		Open Chassis Units	Enclosed Units	
A	75VA	38	38	350
B	75VA	10	10	300
C	150VA	50	28	740
D	150VA	36	6	740
F	250VA	100	64	1,520*
G	250VA	113	64	1,520*

*Must not exceed 750 VA(50 ms.max.) inrush if taken from Terminal Block 202TB (limit of Fuse 201FU).

The "Excess VA Available" and Excess Inrush VA Available" in the table is available for customer use at 202TB Lugs 2 and 4 as shown in Figure 2.1. Any loads placed on the FCR and RCR relay contacts shown in Figure 2.1 must be limited to 22 VA with a maximum 300VA inrush. Use the contacts of the optional "RUN" relay to drive larger loads. On Size C and larger units, the 115 VAC is also made available at Terminal Block 4TB. 4TB thus serves as a second point at which excess VA capacity may be accessed by the user. Typically this second access point is used for driving enclosure fans, the starter for a motor cooling blower or a contactor for energizing a holding brake. Use an auxiliary contact on the PRD12B contactor to activate the added motor starter or contactor coil for the latter two applications. Use R-C type transient suppressors across the starter or contactor coils. Generally speaking, a size 1 or size 2 motor starter may be driven (check the manufacturer's coil specifications for sealed VA and inrush VA).

The user need not consider the number of pushbuttons or other operators in applications such as Figure 2.1 in that the VA used by the drivers indicated by the asterisk are included in the internal VA consumption of the PRD12B. If lighted operators are used, however, both the inrush and the steady-state consumption of the bulbs must be considered as user loads. The inrush of an incandescent indicator is about 15 times its steady- state VA drain unless it includes a limiting resistor or a voltage transformer.

If additional 100 cfm fans are used, these should each be considered as 22 VA loads with a 32 VA inrush.

The preceding table assumes that the PRD12B *does not include* the dynamic breaking option in Size C and larger units (this option requires a larger contactor). If dynamic braking is included, deduct 13,23,2, or 47 VA from the "Excess VA Available" of the Table for sizes C, D, F or G respectively.

Also, the preceding table assumes that the PRD12B *does include* the standard contactor option. If it does not, add 6, 12,32,32,53,or 53 VA to the "Excess VA Available" shown in the Table for sizes A, B, C, D, F or G respectively.

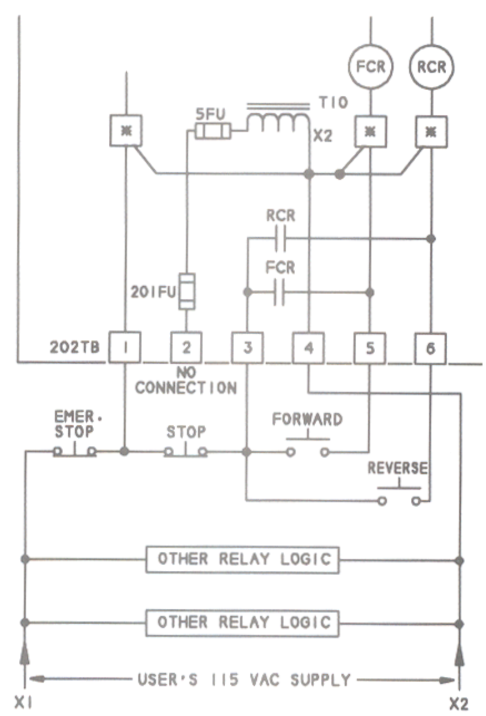


Figure 2.4
Start-Stop Logic Using An External 115VAC Su

2.5.4 Using an External 115 VAC Supply

Figure 2.4 illustrates incorporation of the PRD12B pushbutton into an existing 115 VAC logic ladder which has its own 115 VAC supply. X2 (the grounded side of the external supply must be connected to 202TB Lug 4. Do not make a connection between X1 of the external supply and 202TB Lug (which is connected to X1 of the internal supply). Figure 2.5 is a rearrangement of Figure 2.4 to portray the pushbutton interface in the familiar ladder format.

One reason for utilizing an external 115 VAC supply is user convenience, such as incorporation of the PRD12B pushbuttons into overall machine logic. Another reason is the limited capacity of the PRD12B internal 115 VAC supply (as specified in the table in Section 2.5.3).

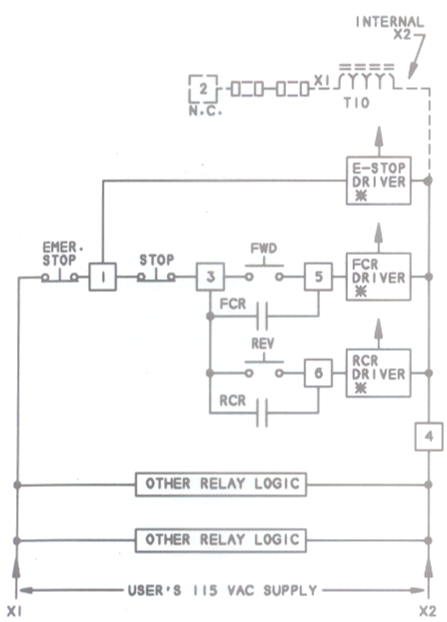


Figure 2.5
Logic of Figure 2.4 Redrawn in Ladder Form

2.5.5 <u>Adding "JOG"</u>

Refer to Figure 2.1. The RUN-JOG selector opens the latch path to 202TB lug 3 thereby requiring that a particular pushbutton be held activated for the motor to run. Jogging is accomplished at the speed set on the speed potentiometer. If the PRD12B is equipped with Option J2, jogging is accomplished at a separately-adjustable preset jog speed as described in Section 2.6.5 herein. The E1547 driver board described in that section is represented by the block connected to terminal 7 and marked (*) in Figure 2.1. The required external connections as well as a portion of the internal connections are shown on the External Wiring Diagram in the Appendix of this manual (Drawing A2399-007-EW, Figure I, Sheet 1). Technically, operation of the J2 option is as follows:

The Lug 12 to Lug 13 jumper on terminal block 202TB is omitted and the speed pot wiper voltage is routed from Lug 12 (which is a tie point with no connections to circuit board E1546) through the white wire shown to the normally closed contact of a relay on the JOG 2 option board. The JOG potentiometer wiper is connected to the normally open relay contact. The common wiper of the relay selects one or the other of these signals and routes it through a ribbon cable to connector J202 and through a circuit board trace on board E1546 to Lug 13 of 202TB. As is shown in Figure 2.1, the signal on Lug 13 is routed through the polarity-reversal switch and the zero-speed switch into the speed-command channel. Thus when the JOG2 option is installed no external connections should be made to Lug 13 of 202TB.All connections to Lug 13 are made internally. Operation of this option is further described in Section 2.6.5 herein. Note that the E1547 driver board (shown as * in Figure 2.1) is not furnished except when Option J2 is added. The Lug 7 channel is not operative until this board is plugged in.

2.5.6 <u>"AUTO" Input (202TB, Lug 8)</u>

A 115 VAC signal applied to Terminal 8 in Figure 2.1 is used to energize an AUTO relay on certain option boards. The internal path from Terminal 8 is not activated until the driver board marked (*) in Figure 2.1 is installed. This board is installed when those options which normally use an externally-connected MANUAL-AUTO selector switch are added.

Refer to Detail 11, Sheet 2 of External Wiring Diagram A2399-007-EW for typical wiring connections. In Detail 11, 115 VAC is applied to 202TB Lug 8 when the selector switch is in the "AUTO" position. This 115 VAC, acting through the E1547 driver board, activates the 12 VDC coil of an "AUTO" relay on the External Signal Follower option board. The form C contacts of this relay transfer the speed command input path of the PRD12B (Lug13of 202TB)from the speed potentiometer wiper to the output of the option board. The speed command signal routing is through the external wires shown in Detail 11 and not through traces on the E1546 circuit board.

The jumper between Lugs 12 and 13 of 202TB provides a means of interrupting the speed-command path for inserting another option (such as the Jog2 option) in series in this path. When the Jog2 option (as described in 2.5.5) is so added, jogging assumes the highest priority and jogging at the preset speed will interrupt any prior mode of operation.

The "AUTO" mode signal path functions similarly in all of the other details on drawing A2399-007-EW Sheet 2 except for Detail 13, Preset Speeds option. The Preset Speeds option board uses the output of the E1547 driver board as a logic signal input rather than a relay-drive signal. Also, routing of the speed command from the Preset Speeds option board to the speed command input terminal, Lug 13 of Terminal Block 202TB, is done in the ribbon cable which connects the Preset Speeds option board to the E1546 board. There should be no external connections to 202TB Lug 13. In some instances, a special version of an External Signal Follower board may be mounted under the E1532 Preset Speeds option board with its output feeding a speed command input channel of the Preset Speeds option board through external wiring. In this instance there would be no "AUTO" relay on the Follower board.

2.6 Standard Options And Modifications

Options and modifications described in this section have been predesigned for the PRD12B controls. Addition of these options does not change the mounting dimensions of the control.

2.6.1 Armature Voltage/Tachometer Follower (Options VF1,VF2,TF1,TF4, OR TF5)

The "ARMATURE VOLTAGE / TACHOMETER FOLLOWER" option is a factory or field installed option. It is compatible with all other options except the "EXTERNAL SIGNAL FOLLOWER" option. This option uses an E1543 PC board assembly that mounts on the top left side of the E1546 PC board. A ribbon cable plug connects the option to the E1546 board. An E1547 driver board is also plugged into connector J7 to activate the path to the "AUTO" relay located on the E1543 circuit board. When the "AUTO" relay is activated, speed is controlled by the follower signal; when it is not activated, speed is controlled by the speed potentiometer. See External Wiring Diagram A2399-007-EW, Sheet 2, Detail 12 for typical connections. There are 5 assembly variations of this option. The user should consult Option Table 2 when picking the proper option to use for the signal being followed. When using one of the tachometer follower options, TF1, TF4, or TF5, the tachometer signal should be isolated from the AC input lines. For armature voltage follower options, VF1 or VF2, line isolation of the armature voltage signal is not required. Signal voltages or armature voltages are wired to 701TB terminals 1 & 2 of the E1543 option board. (Apply the positive side of the voltage to be followed to terminal 1 of 701TB for forward rotation). See External Wiring Diagram A2399-007-EW, Sheet 2, Detail 12 for further information.

There are four adjustment potentiometers on this option board. They are "CMR", "ZERO", "GAIN", and "RATIO". The "CMR" potentiometer on the input differential amplifier stage is adjusted to maximize common mode noise rejection. The "GAIN" potentiometer adjusts for a maximum of 6 volts at the final output stage for maximum input voltage. The "ZERO" potentiometer adjusts for any offset in the output stage for zero input signal. The "ZERO" potentiometer can also be used to adjust for a fixed offset (up to 15% of rated voltage) in the output. The "RATIO" potentiometer is normally set fully clockwise, but may be adjusted clockwise by the user if desired to lower the tracking speed.

2.6.2 Tachometer Feedback (Options : Std, T2,T3,T4,T5,T6,T7, and T8)

Using tachometer feedback improves load regulation to ±0.1% of base speed and minimizes speed changes due to motor heating and line voltage variations. (The best that can be expected using armature voltage feedback is ±1% of base speed not including the effects of motor heating on speed). There are eight standard variations for this option. The proper option code selection is dependent on the motor/tachometer combination. Refer to Table 2 when matching option code to the application. It will be noted in Table 2 that the standard tachometer feedback network accommodates a 1750 RPM base speed motor using a 50V/1000RPM tachometer. This same standard network also accommodates an 850 RPM base speed motor using a 100V/1000RPM tachometer. For other motor/tachometer combinations the appropriate tachometer feedback option code should be specified when ordering the control.(The various tachometer feedback options vary only in the value of calibrating resistor R310 that is supplied on the E1546 circuit board).

Transferring from armature to tachometer feedback is easily done by means of moving a mini-jumper. The mini-jumper changes the connection at the "ARM-TACH" pins located on the E1546 circuit board directly under the "IR" potentiometer. In the armature voltage feedback position, the top and middle pins of the "ARM-TACH" selector are jumpered together with the mini-jumper. In the tachometer feedback position, the middle and bottom pins are connected with mini-jumper.(Refer to Detail 1, on drawing A2399-007-EW, for more information on the "TACH-ARM" mini jumper).

All controls that specify tachometer feedback are shipped from the Polyspede factory with this jumper set for armature voltage feedback. This is done so that voltage polarity of the tachometer feedback can be verified as shown on external wiring diagram A2399-007-EW, Sheet 1, Detail 1. After verifying the proper voltage polarity and executing a stop, the mini-jumper should be moved to the "TACH" position.

2.6.3 Convert to Torque Program Mode (Option TM)

Converting a PRD12B from Speed Programming to Torque Programming is easily accomplished by changing the patch plug that insets into connector J21 on the E1546 circuit board. See the Figure on page 2-4. With torque programming the motor armature current is being controlled rather than speed. The speed and direction of rotation of the motor is determined by the motor shaft load. Motor speed may go to any level up to the maximum level set by the "+MAX" (positive armature voltage limit) or "-MAX" (negative armature voltage limit). If set fully counterclockwise, the "± MAX" adjustments prohibit motoring operation in either direction. The "± MAX" limits are not active during generating mode of operation; armature voltage levels exceeding those set by the "± MAX" potentiometers can therefore occur during generation. Typical external connections are shown in Figure III of External Wiring Diagram A2399-007-EW, Sheet 1.

2.6.4 Auto Reversing (Option AR)

This option is compatible with all other standard options. It consists of moving two mini-jumpers from the "NORM" (normal) position to the "AUTO REVERSE" position as described in Section 9.1 herein. This modification is useful only if "STOP", "FORWARD" and "REVERSE" momentary pushbuttons or limit switches are used. With this modification the motor will reverse if the applicable pushbutton, "FORWARD" or "REVERSE" is momentarily activated. Without this modification, the "STOP" pushbutton must first be pressed before a reversal command is accepted by the PRD12B; additionally, the appropriate pushbutton must be activated after the motor stops before a reversal can occur. This modification simplifies certain limit switch applications on reversing machines, but is not recommended in cases where it might introduce operator hazard in manually-operated machinery.

2.6.5 Adjustable Jog Speed (Option J2)

This is a factory or field installed option. It is compatible with all other standard options except Preset Speeds. This option consists of an E1534 PC board assembly mounted on circuit board E1546 with snap-on nylon standoffs. Additionally, an E1547 driver board is plugged into connector J6. The jog speed board assembly includes a ribbon cable which it links to the E1546 PC board, a "JOG SPEED" potentiometer, a relay with form C contacts, and an LED "JOG" indicator. The potentiometer adjusts jog speed from 0-100% of base speed. Unless specified otherwise, the "JOG SPEED" potentiometer is set at the factory to 10% of full scale. When 115 VAC is applied to 202TB-7 of the E1546 PC board, the output of the E1547 driver board activates the relay and illuminates the "JOG" LED. The relay disconnects any other speed input and substitutes the jog speed command. Jogging at the preset speed is accomplished by holding the "FORWARD" or "REVERSE" pushbutton depressed. Refer to External Wiring Diagram A2399-007-EW, Sheet1, Figure 1 for typical connections. The "RUN-JOG" selector is not supplied with the J2 option in open-chassis controls.

When the Preset Jog Speed option (J2) is used in conjunction with the External Signal Follower or the Armature Voltage/Tachometer Follower option, the "JOG" command overrides all other speed commands and substitutes the preset jog speed command. Activation of "FORWARD" or "REVERSE" pushbuttons provide for jogging in either rotation.

2.6.6 Preset Speeds (Options PS0,PS3,PS4,PS6,PS7)

The Preset Speeds option is a 7-channel multiplexer which selects one of seven inputs as a speed command input to the PRD12B. This option board can accept only positive input signals (0 to +6VDC); reversing must be done with the "FORWARD" and "REVERSE" pushbuttons. Also, any external signals must be positive polarity only.

One type of application for this option would include speed control of multi-spindle drills in which a preset tool speed is automatically selected according to which spindle is rotated to the active position. Another type of application involves automatic cycling machines in which operations such as reverse traversing is at a preset rapid speed and in which set up is done by jogging forward or jogging reverse at separately preset low speeds. In this case option PS3 (Table 3) would provide the necessary three preset speeds plus an externally-set speed command to control normal operation.

Channel selection for the Preset Speeds option is accomplished either by user switches (as would be the case in the multi-spindle drill example), or by the status of selector switches and pushbuttons in the normal operator control station (as would be the case in the example of the automatic cycling machine). In the latter example, Jog-Forward, Jog-Reverse, and Run-Reverse speeds would be preset by three board-mounted potentiometers which are automatically selected depending on the position of the "RUN-JOG" selector switch and whether the "FORWARD" or the "REVERSE" pushbutton has been activated. Channel selection logic in the latter example is set up by plug-in jumpers on the Preset Speeds board. No additional contacts on the operator controls are required; only internal logic signals in the PRD12B are used. A combination of these two selection methods can also be used.

The circuit-board mounted speed potentiometers are full-range 1/2 inch diameter units with good setting resolution and with 10- division dials for readily locating a desired % of full-speed setting.

All seven channels are available with PS0, PS6, or PS7 options. Only four speed channels are supplied with the PS3 or PS4 options. Options PS0, PS3, and PS6, which are designed to accommodate external signals, have an eight place terminal block, 153TB, installed on the E1532 PC board to accept external signals. Terminal block 153TB is not supplied with options PS4 and PS7.. This option basically enables the user to program the system so that different speed-program voltages are automatically selected during different modes of operation. The speed-program voltages are preset by potentiometers between zero and +6 volts DC with respect to COM (202TB11 on the E1546 PC board).

TABLE 3 – PRESET SPEEDS OPTIONS

OPTION	DESCRIPTION	PC ASS'Y
PS0	7 speeds set by remote pots or external signals	E1532-07
PS3	4 speeds, 3 set by internal pots, and one controlled by external signal at 153TB terminal 4	E1532-31
PS4	4 internal speed pots	E1532-40
PS6	7 speeds, 6 set by internal pots, and one controlled by an external signal at 153TB terminal 7	E1532-61
PS7	7 internal speed pots	E1532-70

The Preset Speeds option provides a superior alternative to relay-contact logic which has been used in the past to accomplish the functions described. Relay contact logic often involves elaborate interlocking of the various relays to assure that only one speed command is selected at any given time and to set priority of the various commands. All such interlocking is taken care of electronically on the Preset Speeds option board. If conflicting inputs try to select two channels simultaneously, only the highest numbered channel will be selected. Additionally, the programmable logic provided with each channel permits functional changes without the necessity of rewiring.

This option is a factory or field installed option. Table 3 lists the five standard configurations of this option. Selection is dependent on requirements of the particular application.

Each speed channel is selected through four-input AND logic. The preset voltage corresponding to the selected speed channel is transmitted directly to the control circuitry on the E1546 PC board. At any time, the voltage programming the speed of the motor can be measured at 202TB-13(SPD), with respect to 202TB-11(COM), on the E1546 PC board. This option can be programmed by one of the following methods:

METHOD 1 consists of removing terminal block jumpers from 150TB and replacing them with maintained normally-open remote switches. Gold contacts are required if relays are used. Positions for wiring these switches are clearly marked as S1, S2, S3, etc. on the silkscreen of the E1532 PC board. For example, closure of the switch wired in the position marked S1 selects speed number 1. In this case, the motor speed is controlled by the setting of speed pot number 1 or external signal number 1 (as in the case of PS0). No program plugs are inserted for channels which are selected by switch closure.

METHOD-2 consists of programming the E1532 PC board so that conditions to select a certain speed channel are set by operator controls; namely the settings of the "MANUAL-AUTO" and "RUN-JOG" selector switches and the status of the "FORWARD" and "REVERSE" pushbuttons . Each speed channel has an eleven place programming strip to control its selection logic. Operator command functions are clearly marked on the silkscreen. Refer to Figure 2.6 a program plug at a related position on the programming strip. For Method 2, the jumpers on Terminal Block 150TB are left in place for all channels which are to be used, or cut to disable unused channels. (See figure A4 of "GUIDELINES FOR USING AND PROGRAMMING THE PRESET SPEEDS OPTION", in Section 16.5.3.

Ten program plugs are furnished with the preset speeds option; packets of ten additional program plugs are available from Polyspede Electronics and can be ordered separately if necessary (Berg Part No. 65474-001). Any operator command not exclusively enabled by placing the plugs is ignored by the "AND" logic; i.e., logic inputs not pinned "LOW" by the program plugs are automatically

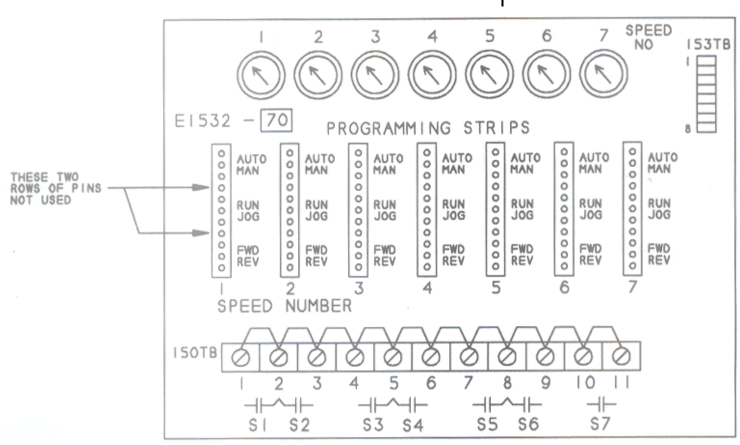


Figure 2.6
Preset Speeds Programming Strips

Conditions for selecting a speed channel are set by placing program plugs over appropriate pairs of pins on the designated programming strip. For instance, three program plugs placed at "JOG", "MANUAL", and "REVERSE" on the "SPEED NO 1" programming strip would cause the Speed potentiometer#1 to control reverse jogging speed when the "MANUAL-AUTO" selector is in the "MANUAL" position only. If the system has no "MANUAL-AUTO" selector switch, no program plug would be placed in the "MANUAL" position and Speed Potentiometer #1 would unconditionally control reverse-jogging speed. The program plugs thus prevent a channel from being selected unless the related operator control is in a certain position. If any particular operator is not used, do not place always "HI" and pulled up to +12 volts. The jumper strips on 150TB pull the related channel inputs "HI" to enable the channel.

METHOD 3 is a combination of Methods 1 & 2.Conditions set by operator commands and the closure of switches wired to 150TB determine whether a certain speed channel is enabled. Note that a speed channel is unconditionally disabled until the related switch closure occurs. When the switch closure is furnished, the channel is conditionally enabled, depending on placement of the program plugs and status of the operator controls.

There is another feature of this circuitry that deserves mentioning at this point. If during any mode of operation, conditions set up by any of the three methods described enable two or more speed channels simultaneously, then the speed pot which is selected will be the speed pot designated by the highest number. For example, if conditions prevail to enable speed channels number 3 and 7 simultaneously, then speed number 7 will be selected. This feature can be used to simplify programming in some applications.

The E1532 PC board has three LED indicators marked “1”, “2”, and “4” (not shown in Figure 2.6) The *sum* of the numbers represented by the LEDs which are *ON* indicates the selected speed channel number. For example if the LEDs marked “4” and “1” are both *ON*, channel 5 is the selected channel.

For further details see “Guidelines for using and Programming Preset Speeds Option” in Section 16.5.3.

2.6.7 Change to 240 Volt Field(230 VAC Input Controls Only) Option - [240]

This option is only available on 230 volt controls. The standard field voltage for 230 volt controls is 150 VDC. Some older vintage motors having 240 VDC armatures may require a 240 VDC field supply. If the control is purchased for use with an existing motor, check motor nameplate before ordering. Section 5.5 gives detailed instructions for field installation of this option should it become necessary. If the PRD12B includes a field regulator, check the supplementary manual furnished with the regulator to see if conversion to 240V output is possible.

2.6.8 Change to 50 HZ operation (Option – [50])

When it is necessary to operate on a 50HZ line, the control must be equipped with this modification. This modification, which can be performed in the field or at the Polyspede factory, consists of clipping the “CUT FOR 50 HZ” jumper that is designated on the silk screen of the E1546 PC board. Section 5.3 shows the jumper location and gives further details of the conversion.

2.6.9 Linear Accel/Decel (Options –A1, A2, A3)

The standard PRD12B is not supplied with adjustable linear acceleration and deceleration control. When this option is not installed, the motor will accelerate and decelerate in current limit to the speed commanded by the 0 to 6 volt speed command signal. For those applications that require adjustable acceleration and/or deceleration, a linear acceleration board can be added. This plug-in option board is easily added in the field if it was not ordered initially from the factory. All PRD12B controls are shipped from the factory with premounted side support rails and socket connector for the accel/decel option board. Installation consists of plugging the board into socket J1 on the E1546 circuit board and clipping jumper JP20, located adjacent to J1.

The linear acceleration/deceleration option board has independently adjustable acceleration and deceleration potentiometers; it is supplied in three different versions. The difference between versions is that the acceleration and deceleration times are adjustable over different ranges. The standard range (the A1 option) of this circuit board has accel/decel times adjustable from .8 to 27 seconds, zero to top speed. Option A2 has times adjustable from .12 to 4 seconds. Option A3 has times adjustable from 2.5 to 84 seconds. The option which is installed is identified by the PC board assembly number stamped on the circuit board as well as by the option code on the nameplate; see Table 2 for these identifiers. Field conversion between the A1 and A2 option ranges can be accomplished by changing the position of the plug-in “RANGE” jumper. This jumper, which is located adjacent to the “ACC” potentiometer, is in the “HI” position for the Option A2 range. The “RANGE” jumper is in the “HI” position for the A3 range; the A3 range is not field convertible.

The “ACC” and “DEC” potentiometers can be omitted from the circuit board and installed external to the control. Consult the Polyspede factory for details.

2.6.10 S-Curve Accel/Decel (Options –A, AS2, and AS3)

In some applications a linear acceleration and/or deceleration ramp may not be satisfactory. The S-Curve Acceleration unit rounds the linear ramps at the beginning and end to an “S” shape. Elevators and certain conveyor applications may require the S-Curve Acceleration option. When this option is specified, an additional board is used along with the E1548 linear acceleration board. This additional board, which plugs into a connector on the E1548 board, is an E1549 board that has the supplemental circuitry that works in conjunction with the basic linear acceleration board to re-shape the linear ramp.

Operation of this option is very similar to the linear acceleration options explained in Section 2.6.9. The S-Curve option is also supplied with separately adjustable acceleration and deceleration potentiometers. In addition, this option has two other potentiometer adjustments that permit a smoothing or rounding at the beginning and end of the acceleration ramp. The two adjustments are designated "Soft Start" and "Soft Finish". "Soft Start" is located on the E1549 PC board and "Soft Finish" is located on the E1548 PC board. (An additional potentiometer, designated the "Start Cal: potentiometer, is located on the E1549 board. This potentiometer is factory adjusted and should not be readjusted in the field).

The Polyspede S-Curve acceleration option provides a major advantage over competitive designs which use the double-integrator principle. In the double-integrator units, the "SOFT START" adjustment interacts with the "ACCEL" and "DECEL" adjustments making setup unnecessarily difficult. In the Polyspede design, adjusting the "S" shape does not affect the basic ramp slope set by the "ACCEL" and "DECEL" potentiometers, the undesirable interaction of adjustments is thus eliminated by design.

The following sketch indicates the effect of setting a higher or lower adjustment on the "SOFT START" and "SOFT FINISH" potentiometers to round off the beginning and end of the ramps. The customer should experiment to obtain the most desirable settings for each specific application. Turning these two potentiometers fully counterclockwise will eliminate the S Curve effect. In terms of order of adjustment, the "ACCEL" and "DECEL" pots are adjusted first for times less than the desired times to achieve the desired degree of start and finish smoothness. The full scale time is increased by ramp rounding at the start and finish, but the basic slope of the ramps between the rounded parts is unaffected as illustrated in Figure 3.

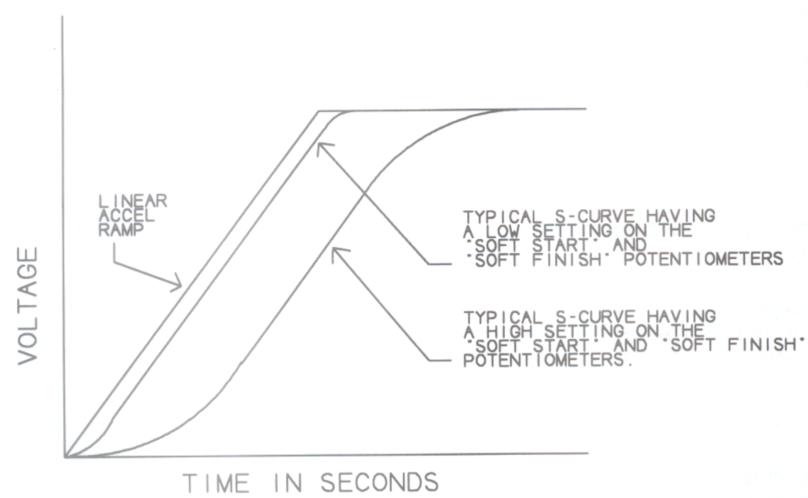


Figure 3
Typical Linear and S-Curve Ramps

2.6.11 DC Loop Contactor (Options – M1 Through M6)

The standard PRD12B control does not include an armature disconnect contactor; the armature of the motor is continually connected to the output of the control. When a DC loop contactor option is furnished, the armature of the motor is only connected to the output of the control when the motor is running. When a normal stop function is executed while the motor is running, the motor will decelerate to zero speed and the armature contactor will drop out. Refer to Table 1 for the proper option code to specify addition of the contactor; the option code depends on size of the control.

In PRD12B sizes A and B, the optional contactor disconnects both the A1 and A2 outputs of the control from the motor. Only the A2 output of the control is disconnected from the motor in Size C and larger units. The motor field remains connected to the control continually in PRD12B units of all sizes. Contactor operation is non-arcing in that current is interrupted by turning off SCR firing before contactor release. User addition of a DC loop contactor is not recommended in that a pair of voltage sensing wires in the PRD12B must continually remain connected in correct polarity to the motor output on the load side of the contactor.

2.6.12 Position Interface (Options - P22, P24, P25, P26)

Detail 14 of External Wiring Diagram A2399-007-EW Sheet 2 (in the Appendix) shows a typical valve positioning application for the Position Interface option board E1491. When this option board is installed on the control (on top of the E1546 regulator board) a position-command potentiometer connected as shown in Detail 14 is used in lieu of the normal speed potentiometer. The output of the position control board, which is 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 position. Process instrument or external voltage signals are used for position command when the "AUTO" relay is activated. The range required for the process instrument input determines the option code as specified in Table 2. The board includes provisions for a "MANUAL-AUTO" selector switch and end of travel limit switches. The option also includes adding an E1547 driver board at connector J7 to enable the channel to the "AUTO" relay on the E1491 option board. Application of 115 VAC to Lug 8 of terminal block 202B activates the "AUTO" relay which in turn transfers control from the manual position-command potentiometer to the process instrument shown in Detail 14.

2.6.13 Run and Fault Relay Board (Option –RY1)

The Run and Fault Relay Board will give drive status indication through contact closures that can be used by the customer. There are two relays, designated as the "RUN" and "FAULT" relays on this circuit board. One form C contact on each relay is brought out to a terminal strip for customer use. The relay contacts are rated for a 3 amp resistive load at 120 VAC with a maximum AC switching capacity of 360VA. For specific information on the operation of these two relays and the capabilities of the relay contacts refer to Detail 15 on Sheet 2 of External Wiring Diagram A2399-007-EW.

2.6.14 Dynamic Braking Option –DB1, DB3, DB4, DB5, & DB6)

This option includes a special DC Loop Contactor equipped with an added normally-closed power contact which connects an externally-mounted dynamic braking resistor across the motor armature when the contactor is not activated. In size A units dynamic braking is not offered in combination with the Field Economy option. Dynamic braking is not available in size B units due to the lack of compact contactors with a normally-closed power contact. With this option installed, dynamic braking resistors will be applied across the armature of the motor whenever the DC Loop Contactor is not energized. Terminals are provided for connecting the externally-mounted dynamic brake resistor unit. Since dynamic braking is not required for rapid stops in these regenerative controls, the primary function of this option is to shorten the coast-down which occurs following a fault or an operator-initiated emergency stop. Dynamic braking is not operative during normal stops, although the resistors are applied across the motor armature as the contactor drops out at essentially zero speed.

2.6.15 Field Economy (Options FE1, FE2, FE3)

With this option, the field voltage is reduced when motor speed reaches zero as detected by the drop-out circuit. Reducing field voltage during standby conditions increases field life by reducing field heating at times when the cooling fan on the motors is not moving air.

Field voltage reduction is accomplished by disconnecting one diode in the field bridge. A normally-open power pole on a contactor or relay is utilized to disconnect the diode. For 150VDC and 300 VDC fields, this achieves a 56% reduction in power dissipation at standby; for 240 VDC fields a 36% reduction is achieved. The way in which this option is added (and the option code assigned) depends on the size of the unit, and in size A & B units, whether the contactor option is also being added. The following is a summary of the available configurations:

Option FE1: Applicable to Size A and B units with contactor option also ordered. Consists of adding a third power contact to the existing DC loop contactor. Since the third power contact position is also required for the Dynamic braking option, the Field Economy option is not offered in conjunction with the Dynamic braking option in size A and B units.

Option FE2: Applicable to Size A and Size B units in which no contactor option is to be installed. Consists of adding a small contactor mounted in the space normally occupied by the DC loop contactor and utilizing one of its power poles to implement the Field Economy Option.

Option FE3: Applicable to Size C and larger units. Consists of adding a power relay in a pre-assigned mounting space that is separate from that occupied by the DC loop contactor. This modification is therefore not dependent on whether a DC loop contactor is also to be used. This option places no restrictions on the further addition of a Dynamic Braking Option.

2.6.16 External Signal Follower (Options –SF1,SF3,SF4,SF6 & SF7)

The "EXTERNAL SIGNAL FOLLOWER" option is a factory or field installed option. It is compatible with all other options except the "ARMATURE VOLTAGE/TACHOMETER FOLLOWER" option. This option uses an E1542-5xx PC board assembly that mounts on the top left side of the E1546 PC board. A ribbon cable plug connects the option to the E1546 board. An E1547 driver board is also plugged into connector J7 to activate the path to the "AUTO" relay located on the E1542 circuit board (See Section 2.5.6). When the "AUTO" relay is activated, speed is controlled by the follower signal; when it is not activated, speed is controlled by the speed potentiometer. See External Wiring Diagram A2399-007-EW, Sheet 2, Detail 11 for typical connections.

There are 5 assembly variations of this option. The user should consult Table 2 for selection of the proper option code to select for the level of the signal being followed. This option can be set up to accommodate the following inputs: 0 to +6V, 0 to +10V, 4-20MA, 10-50MA, 4-20MA with 12MA commanding zero speed, or 10-50MA with 30MA commanding zero speed.

There are three adjustment potentiometers on this option. They are "ZERO", "SPAN", and "RATIO". The "RATIO" potentiometer is normally set fully clockwise but may be adjusted counterclockwise to lower the tracking speed. The "ZERO" and "SPAN" adjustments work in conjunction with one another to adjust the input signal level at which zero motor speed occurs, and the input signal level at which maximum motor speed occurs (assuming unidirectional motor rotation).

All variations of this option (except those noted in 2.6.17) include a "MAN/AUTO" relay which is activated when 115VAC is applied to 202TB terminal 8. In addition, the "AUTO" LED on the E1542 PC board will illuminate. In the manual mode, the "MAN/AUTO" relay is de-energized and the motor speed is controlled by the "MANUAL SPEED" potentiometer wiper connected to 601TB-5. Refer to drawings E1542-500-ES, A2399-007-EW (Detail 11) and A2399-009-ES for more information on inputs and outputs on this PC board. The output of the External Signal board can be measured at 601TB-6 with respect to signal common at 202TB-11.

(This option should not be used if the external signal is floating at 230 or 460 volts with respect to earth ground.)

2.6.17 External Signal Follower Combined with Preset Speeds

Detail 16 of External Wiring Diagram A2399-007-EW, Sheet 2, illustrates this combination by example. A special assembly of the External Signal Follower is used when its output is used as input to preset speeds option board. The special assembly (identified on the External Signal Follower board as E1542-223, E1542-224, or E1542-211) is used to implement options SF12, SF13 and SF14 respectively for this application. These options accept 4-20 ma, 10-50 ma or voltage inputs of 0-6V or 0-10V in the order listed. In the Detail 16 example, the Terminal 6 output of the Follower board supplies input to Channel 4 of the Preset Speeds Board (described in 2.6.6 herein) at

153TB Terminal 4. Channel 4 would have a single program jumper in the "AUTO" position thus mandating that Channel 4 is unconditionally selected at any time the "MANUAL-AUTO" selector is in the "AUTO" position. For "MANUAL" mode (except for jogging), Pot 1 would control speed; Channel 1 would have two jumpers, "MANUAL" and "RUN" in place thus mandating that when the MANUAL-AUTO" selector is in the "MANUAL" position and the "RUN-JOG" selector is in the "RUN" position Pot 1 will be in control. Similarly, Pot 2 would control speed when the two referenced selector switches are in the "MANUAL" and "JOG" positions respectively. (Channel 2 would have program jumpers in the "MANUAL" and "JOG" positions).

Since a follower board and the Preset Speeds board would normally occupy the same mounting area, the boards are mounted stacked when this combination of options is furnished. The Preset Speeds board is mounted on top of the stack with hinged supports to allow wiring access to the terminal block of the follower board which mounts under the Preset Speeds board. As shown, the wiring required is minimal, but will vary according to the option code of the Preset Speeds board; therefore factory installation and setup of the two boards is recommended.

The special follower board shown does not have a "MANUAL –AUTO" select relay at its output since manual-auto selection is performed on the Preset Speeds board. Also the output of the special follower board is clamped so that it cannot swing negative since the Preset Speeds board cannot accept negative signals. For practical purposes, operation form the external signal is limited to one direction of rotation only. Both forward and reverse rotation, such as might be required for machine setup, can be achieved in the "MANUAL" mode by using "FORWARD" and "REVERSE" pushbuttons. The foregoing is intended as a description of operation of this particular pair of factory-installed options. It should not be interpreted s a tutorial for field installation of the options. Factory installation of the options boards is recommended.

2.6.18 <u>Remote Fault and Mode Indicator Panel</u>

A Fault and Mode indicator panel is provided on the enclosure door of all PRD12B units which are mounted by the Polyspede in standard enclosures. This panel is also available as an option for open chassis PRD12B units for installation by the user on user's enclosure door. The panel is 3.4" square and mounts in a 2-7/8" diameter hole(made with a standard 2-1/2" conduit punch) Typical mounting depth is 1/2" behind the enclosure door. Mounting is by four captive #6 screws on 2.6" centers. A gasket for maintaining integrity of seal of the enclosure is furnished. All mounting hardware is furnished. The panel connects to the top circuit board (E1546, connector J20) of the PRD12B by a ribbon cable which is captive at the Fault and Mode indicator panel. The standard length of the ribbon cable is 60"; lengths up to 99" are available. Four self-adhesive mounting clips are furnished for cable dressing.

The Fault and Mode indicator panel displays the seven faults and the four modes described in Sections 2.3 and 2.4 herein. Additionally, a "POWER" indicator and a "RESET" switch are included. All indicators are red LEDs. When the plug from this assembly is inserted in connector J20 on the PRD12B, the E1546 circuit board indicator lights are disabled and the LEDs on the Fault and Mode indicator panel are enabled.

2.7 Control Fusing

Please refer to Table 4 in selecting suitable replacement fuses. **WARNING:** Fuses 1FU, 2FU, 3FU and 4FU are fast-acting rectifier-protection fuses which must not be replaced with unapproved substitutes. Also Fuse 12FU is critical regarding both amperage rating and manufacturer; do not substitute. Note that the required amperage rating for fuse 12FU is different in 230VAC service and 460 VAC service in certain units.

TABLE 4 REQUIRED FUSING

Unit Size	HP Range	Line Voltage	1FU-3FU	4FU	5FU*	12FU (Littelfuse only)	
						460VAC Units	230VAC Units
A	3- 20	460VAC	A50P70	A50P70	1 AMP	FLQ 1/4	
A	3- 10	230VAC	A50P70	A50P70	1 AMP		FLQ 6/10
B	25- 40	460VAC	A50P100	A50P100	1 AMP	FLQ 1/4	
B	15- 20	230VAC	A50P100	A50P100	1 AMP		FLQ 6/10
C	50- 60	460VAC	A50P125	A50P150	2 AMP	FLQ 1	
C	25- 30	230VAC	A50P125	A50P150	2 AMP		FLQ 1
D	75-100	460VAC	A50P175	A50P200	2 AMP	FLQ 1	
D	40- 50	230VAC	A50P175	A50P200	2 AMP		FLQ 1
F	125-150	460VAC	A50P400	A50P400	3 AMP	FLQ 1-1/4	
F	60- 75	230VAC	A50P400	A50P400	3 AMP		FLQ 1-1/4
G	200	460VAC	A50P400	A50P400	3 AMP	FLQ 1-1/4	
G	100	230VAC	A50P400	A50P400	3 AMP		FLQ 1-1/4

* 5FU is a time delay fuse, Bussmann MDL or MDQ or Littelfuse 313.xxx series.

1FU through 4FU Manufacturer Cross Reference Chart

Gould-Shawmut Part No.	International Rectifier Part No.	Bussmann Part No.
A50P70	SF50P70	FWH70
A50P100	SF50P100	FWH100
A50P125	SF50P125	FWP125
A50P150	SF50P150	FWP150
A50P175	SF50P175	FWP175
A50P200	SF50P200	FWP200
A50P400	SF50P400	FWP400

On all units: 11FU & 13FU are 8 amp fuses, ATM8 (Gould-Shawmut) or KLK8 (Littelfuse). 201FU is a 2AG fuse, 2 amp, #225 002 Littelfuse.

	ITEM	SPECIFICATIONS
	INPUT VOLTAGE, THREE PHASE AC	230V +/- 20 VOLTS 460V +/- 40 VOLTS
	INPUT FREQUENCY	60 HZ 50 HZ OPTIONAL (JUMPER CONVERTIBLE)
	OUTPUT VOLTAGE ARMATURE	0 - 240VDC (230VAC INPUT) 0 - 500VDC (460VAC INPUT)
	OUTPUT VOLTAGE FIELD	150VDC (230VAC) (240VDC OPTIONAL WITH 230VAC INPUT) 300 VDC (460VAC INPUT)
	OVERLOAD CAPABILITY, 1 MINUTE	150% OF RATED CURRENT(EXCEPT SIZE D 50/100HP OPEN CHASSIS UNITS ARE ADJUSTED FOR 130% OF RATED)
	AMBIENT TEMPERATURE, MAXIMUM	40 C: ENCLOSED ISOFLOW UNITS 50 C: OPEN CHASSIS UNITS IN USER ENCLOSURE [SEE SECTION 5.1(3)]
REGULATION	LOAD REGULATION FOR 95% LOAD CHANGE	
REGULATION	WITH ARMATURE FEEDBACK	ADJUSTABLE TO +/- 1% OF BASE SPEED
REGULATION	WITH TACHOMETER FEEDBACK	+/- 0.1% OF BASE SPEED
REGULATION	WITH ARMATURE FDB. & FIELD REGULATOR	+/- 0.1% OF BASE SPEED
REGULATION	LINE REGULATION, FOR +/- 20 V CHANGE, 230VAC OR +/- 40 V CHANGE 460 VAC	
REGULATION	WITH TACHOMETER FEEDBACK	+/- 0.1 % OF BASE SPEED
REGULATION	WITH ARMATURE FEEDBACK	+3.5%, - 2.5% OF SET SPEED (DEPENDS ON MOTOR)
REGULATION	ARMATURE FDB. WITH FIELD. REGULATOR	+/- 1% OF BASE SPEED
REGULATION	SPEED CHANGE WITH TEMPERATURE	
REGULATION	DUE TO CONTROL UNIT	TYPICAL: LESS THAN 1% OF BASE SPEED
REGULATION	DUE TO MOTOR	VARIES WITH MOTOR, BUT LESS THAN +/- 1% IF OPTIONAL FIELD REGULATOR IS PROVIDED
INPUT SIGNALS – SPEED MODE DRIVES	SPEED SET	
INPUT SIGNALS – SPEED MODE DRIVES	POTENTIOMETER REVERSED DRIVES	-6V TO +6V AT TERMINAL 13, 202TB
INPUT SIGNALS – SPEED MODE DRIVES	PUSHBUTTON REVERSED DRIVES	0 TO +6V AT TERMINAL 13, 202TB
INPUT SIGNALS – SPEED MODE DRIVES	ALTERNATE: PROCESS CONTROL INPUT UNIDIRECTIONAL ROTATION	4 TO 20 MA AT TERMINAL 13, 202TB "INPUT" JUMPER SET TO "4 TO 20MA" "INPUT POLARITY" JUMPER SET TO "+ONLY"
INPUT SIGNALS – SPEED MODE DRIVES	TORQUE LIMIT	
INPUT SIGNALS – SPEED MODE DRIVES	INTERNAL POTS: "+TORQ" & "-TORQ"	ZERO TO 200%
INPUT SIGNALS – SPEED MODE DRIVES	EXTERNAL POTS: TERMINAL 14 ON 202TB	ZERO TO +6V FOR 0 TO 150% RATED TORQUE
INPUT SIGNALS – TORQUE DRIVES	TORQUE SET	-6V TO + 6V AT TERMINAL 13, 202TB
INPUT SIGNALS – TORQUE DRIVES	SPEED LIMIT SET: EFFECTIVE ONLY IN MOTORING OPERATION	
INPUT SIGNALS – TORQUE DRIVES	INTERNAL POTS: "+MAX" & "-MAX"	ZERO TO RATED ARMATURE VOLTAGE
INPUT SIGNALS – TORQUE DRIVES	EXTERNAL SIGNAL,TERMS. 15 & 16, 202TB	0 TO +6 V
PUSHBUTTON INPUTS	STOP, START, (REGENERATIVE STOP)	STANDARD 3 WIRE 115VAC LOGIC
PUSHBUTTON INPUTS	STOP, E-STOP, START (COASTING E-STOP)	4 - WIRE 115VAC LOGIC
PUSHBUTTON INPUTS	STOP, FORWARD, REVERSE, (REGENERATIVE STOP)	STANDARD 4 WIRE 115VAC LOGIC
PUSHBUTTON INPUTS	STOP, E-STOP, FORWARD, REVERSE, (COASTING E-STOP)	5 - WIRE 115VAC LOGIC
PUSHBUTTON INPUTS	JOG, COMBINED WITH ANY OF THE PRECEDING	115VAC LOGIC
PUSHBUTTON INPUTS	JOG, AT PRESET SPEED	115VAC LOGIC; REQUIRES PLUG-IN I/O MODULE AND JOG-SPEED OPTION BOARD
PUSHBUTTON INPUTS	AUTO	115VAC LOGIC; REQUIRES PLUG-IN I/0 MODULE FOR SELECTING MANUAL SPEED INPUT OR THE OUTPUT OF AN OPTION CARD FOR SPEED CONTROL.
OUTPUT SIGNALS	SPEED, TERMINAL 17 ON 202TB	0 TO +/- 5V = 0 TO 100% SPEED; (22 OHM SERIES PROTECTIVE RESISTOR)
OUTPUT SIGNALS	CURRENT (+IA), TERMINAL 18 ON 202TB	0 TO +/- 2V = 0 TO 100% ARMATURE CURRENT (390 OHM SERIES PROTECTIVE RESISTOR)

4. MOTOR SELECTION

DC motors specified for use with type C power supplies are suitable for use with regenerative controls, provided the motor does not have a series of compensating field ("stabilized shunt" motors; see Section4.1) Also, a motor intended for use on a power supply operating from 460VAC lines should have a 500 VDC armature (not a 550 VDC armature).

Polyspede offers matched motor/control combinations which eliminates the necessity of the user considering these factors when selecting a motor. The following information is for the benefit of those who may wish to mate a PRD12B control unit to an existing motor.

4.1 Compensating Fields

Motors which have series compensating fields (S1 and S2 leads brought out) are generally not suitable for use with regenerative controls. These motors are also referred to as stabilized shunt motors. These are effectively compound motors which require that armature current flow in one direction only for stable operation. If a motor with a series compensating field is connected to a PRD12B control unit, no connection should be made to the S1 and S2 leads; the control should be connected directly to the A1 and A2 motor leads to eliminate the compounding and the attendant unidirectional characteristic. These motors, when so connected, may run satisfactorily or they may exhibit unstable operation (hunting) if the motor was heavily compounded. If unstable operation is observed and the instability cannot be cured by adjusting "IR" fully counterclockwise, the motor is not satisfactory for use with regenerative controls. Please note also, that connecting the S1 and S2 leads will cure the instability for one direction of current flow into the motor, but will make it worse for current flow in the opposite direction. Since direction of current flow can reverse in a regenerative control in response to motor loading, the net result of connecting the S1 and S3 leads will be to make the instability problem worse.

If a motor with series compensating field is found to operate satisfactorily with the PRD12B with no connection to the S1 and S2 leads, it maybe used for loads of about 95% of its nameplate rating. The approximate 5% derating is due to lower full-load torque caused by the absence of the series field.

Exception: The preceding applies to applications which require reversing of the motor or regenerative braking. If neither of these characteristics are required, the application is a *non-regenerative one,* and the PRD12B can be converted as follows to operate motors with series compensating fields (stabilized shunt motors):

(1) Turn the "-TORQ" potentiometer on the E1546 circuit board fully counterclockwise. This assures that current can flow in one direction only in the motor armature.
(2) Use the "FORWARD" pushbutton circuit and use a positive polarity speed command.
(3) Connect the armature and series field according to the motor manufacturer's instructions, with A1 positive.

When the PRD12B is so equipped, the motor/control combination will perform as if the motor were being driven by an non-regenerative control with one exception: if the motor shaft is rotated in the reverse direction by externally applied force, it will apply an opposing force (reverse generating action).

These procedures will generally apply when the PRD12B is used to replace a failed non-regenerative control in an application that does not require reversing or regenerative braking. If the motor is replaced at a later date with one that is not of stabilized shunt design, the "-TORQ" potentiometer can be turned back to its original setting to establish full regenerative capability of the system.

4.2 Armature Voltage Rating

The required armature voltage rating is 500 VDC(for 460 VAC) or 240 VDC(for 230 VAC). A motor with a 550 VDC armature may be used with 460 VAC PRD12B units which are adjusted for a maximum500 VDC output. The motor will be capable of 100% rated torque, but only 91% of rated speed. The re-rated horsepower will therefore be 9% less than that indicated on the motor nameplate. The output of the PRD12B must not be adjusted higher than 520 VDC at full load to avoid this derating. To do so may cause generating faults and attendant blowing of the line fuses.

5. USING THE PRD12B

This section is intended as an aid to the OEM or User in incorporating PRD12B units into his equipment.

5.1 Enclosure Selection

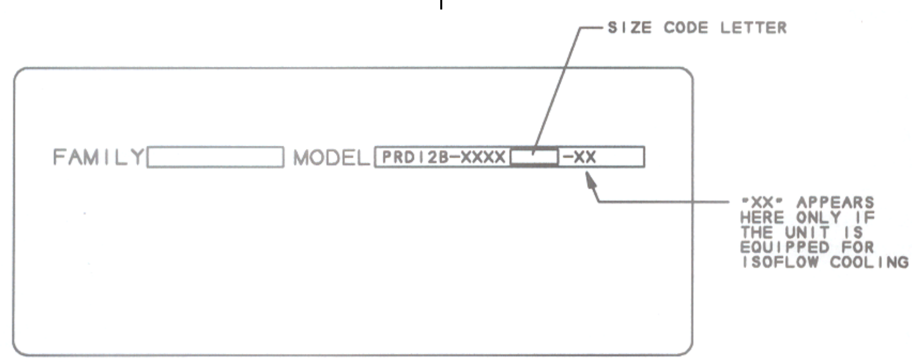
Polyspede offers PRD12B units housed in NEMA 12 enclosures of compact size. These compact enclosure sizes are made possible by Polyspede's IsoFlow™ cooling in which forced air passes over cooling fins of the heat sinks without entering the interior cavity of the enclosure. In these IsoFlow-cooled units, only the wattage dissipation in wiring, fuses, etc. contribute to interior heating of the enclosure, while the major part of the wattage dissipation of the power semiconductors is removed by the outside air stream. These factory-packaged controls have provision for a significant quantity of user-mounted equipment such as small motor starters, relays and circuit boards on an optional door-mounted panel. The use of these pre-packaged control units is recommended to avoid the necessity of the user making the tedious thermal calculations or guesses as to suitable enclosure size and configuration. Enclosure sizes of these totally enclosed units are given in the Polyspede PRD12B product bulletin.

The open chassis version of the PRD12B unit must be mounted in the user's enclosure by the user. The required enclosure size is primarily determined by the size code of the control unit which is given (vs. horsepower) in Column B of Table 1. This size code also appears on the control nameplate as shown above.

These open chassis units are furnished in four basic configurations. The descriptions and general rules for use of each configuration are as follows:

1) Size A open chassis unit are constructed on a flat base plate which is intended for mounting directly to the rear wall of a 20" X 20" x 12" or larger non-ventilated enclosure. These units are not fan cooled; cooling is by conduction from the flat base plate to the rear wall of the enclosure. If the enclosure is wall mounted, there should be at least 1-1/2" air circulation space between the enclosure rear wall and the mounting surface.

Alternatively, the control unit may be panel mounted within the enclosure. If this is done, the (non-ventilated) enclosure size should be increased to 30" X 24" X 8" for 20hp460 VAC or 10hp230 VAC units.



Lower hp Size A units may be placed in non-ventilated 20"X20"X 12" or 24"X20"X8" enclosures.

As another alternate, the Size A open chassis units of all hp ratings may be panel mounted in a forced-air ventilated enclosure 20"X20"X8". The ventilating fan is to move outside air through the enclosure and should be of 100 CFM or greater rating.

Finally, Size A open chassis units may be panel mounted in large enclosures which also house other equipment. The ultimate criteria is that the air temperature in the enclosure near the PRD12B unit should not exceed 60 degrees C (140F), and the temperature of the PRD12B base plate under the SCR modules should not exceed 95C.

The latter condition is generally met if the former condition is met.

*2) **Size B open chassis units*** maybe mounted in non-ventilated NEMA 12 or NEMA 4 enclosures size 36"X30"x8" or 30"X30"X12". These units may alternately be mounted in smaller enclosures if a 100 CFM fan is utilized to circulate outside air through the enclosure. If the Size B open chassis units are mounted in a larger enclosure with other equipment, enclosure air temperature should not exceed 60C.

3) Size C and larger open chassis units that are not equipped with IsoFlow™ gasketing are fan cooled and are generally unsuitable for use in sealed enclosures unless a heat exchanger is utilized. These units are normally mounted in an enclosure that is force-ventilated with air drawn from outside of the enclosure. Maximum enclosure temperature is 60 C for Size C units or 55 C for size D and F units, or 50C for size G units.

4) ***Size C and larger open chassis units equipped with IsoFlow™cooling :*** These units are specified by adding a -XX suffix to the normal open-chassis part number. These ISoFlow open chassis units are equipped with air plenums for rear-intake/rear-exhaust air flow thereby permitting outside air to be blown across the heat sinks without passing this air to the interior of the enclosure. For single drive systems, it is highly recommended that Polyspede pre-packaged controls be utilized instead of purchasing the IsoFlow open chassis units. However, for multiple drives mounted in a single enclosure or for cases in which the PRD12B must be integrated into a larger system in an enclosure, the following guidelines apply.

These IsoFlow units maybe used to minimize the heat being dumped into the user's enclosure by the PRD12B thereby reducing the amount of forced ventilation required to maintain acceptable maximum enclosure temperature. Alternately they may be used to allow non-ventilated NEMA 12 or NEMA 4 operation of the user enclosure. Use the enclosure sizing specified on the Polyspede product bulletin for IsoFlow-cooled enclosed controls s a starting point of sizing the enclosure. Additional enclosure volume must be provided to compensate for additional heat loads due to the user's equipment also installed in the enclosure.

The IsoFlow open chassis units are intended for direct mounting to the enclosure rear wall. It is therefore preferable to select an enclosure that does not use stiffeners on this surface. Enclosures made by Rittal and other European manufacturers are preferable to those made by Hoffman in that the larger Hoffman enclosures may have stiffeners spot welded to the rear wall. If the enclosure selected does have stiffeners, they may be removed by grinding the spot welds with a cutoff wheel. See also Section 7.1 under "INSTALLATION".

If it is not practical to mount the PRD12B IsoFlow unit directly to the enclosure wall, it may be panel mounted. Selective cutting of any stiffeners is required. Detail B of Drawing A2399-007-MD in the Appendix illustrates this mounting method. Self-adhesive adaptor rings must be installed between the enclosure wall and the panel. Panel mounting adaptor kits containing the adaptor rings are available from Polyspede and should be ordered separately if panel mounting is opted.

A minimum of 1- 1/2" of free air space must be provided behind the enclosure for air intake and exhaust.

Layout inside of the enclosure: If the PRD12B is mounted by the user in an enclosure with other equipment all signal wiring connecting to terminal strip 202TB should be routed separately from other wiring inside of the enclosure and should be routed in a separate conduit externally. In additional all contactors and control relays in the enclosure should include transient voltage suppressors connected across the coils.

In no case should service transformers be mounted in an enclosure with control units. Losses in the transformer will raise cabinet temperatures to levels that are unacceptable.

5.2 Input Service Requirements

The AC line voltage must agree with that specified in the "INPUT" block on the control nameplate. (See Section 5.4 for conversion of the control unit if the two do not match). If the control is to be operated on 230 VAC the AC line voltage applied to the control should remain within the nominal rating +/-20 volts. If the control is to be operated on 460 VAC the AC line voltage should remain within the nominal rating +/-40 volts. Voltages that fall below the specified minimums can cause internal regulated voltages to become unregulated thereby causing certain inaccuracies in operation. Excessively low voltage will cause the control to automatically shut down due to “LINE LOSS” shutdown circuitry. Voltages that exceed the maximum limits can cause excessive wattage dissipation, cause primary fuses for the control transformer to blow, or in the case of the 460VAC controls, may cause damage to protective devices such as MOVs (transient suppressors) in the control.

5.3 <u>Conversion To 50 Hz</u>

The PRD12B can be ordered from the factory set up to operate on 50 HZ input power. When this option is specified, the control will be identified by a “50” in the “HZ” block on the nameplate on the control. In many cases the control will not be ordered with a 50HZ setup since the control is to be initially tested in the USA before being sent to another country for use on 50HZ. The change can be made at the job site to convert from 60 HZ to 50 HZ operation by cutting one jumper on the E1544 board. After this jumper is cut no further adjustments are normally required, assuming reasonable frequency accuracy of the 50HZ source. The following Figure 4 shows the approximate location of the “CUT FOR 50HZ” jumper on the E1544 board. It will be necessary to unfasten the upper board (E1546) and to hinge it out of the way to access the E1544 circuit board.

E1544 circuit board.

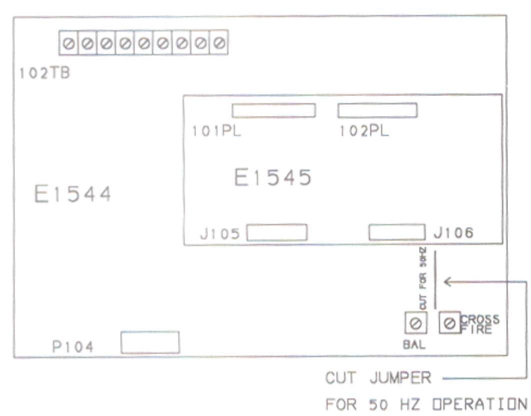


Figure 4
Conversion from 60 to 50 Hz. Operation

5.4 <u>460 VAC to 230 VAC Input Voltage Change (or visa versa)</u>

All PRD12B controls are convertible for operation on either 230 VAC or 460 VAC input. Before connecting an input voltage which differs from the voltage for which the control unit was originally nameplated it is mandatory that certain things be done to the control. Failure to do this will cause drive damage. The things that need to be done are:

1) Change the Control Transformer (T10) jumpers per Figure 5.1.

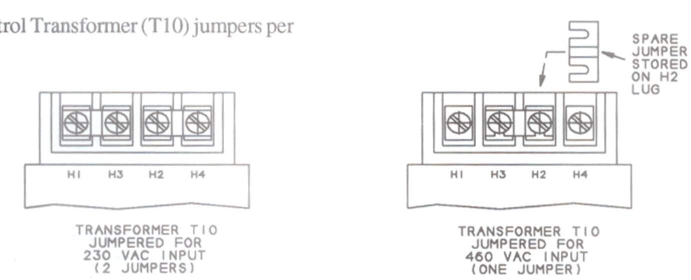
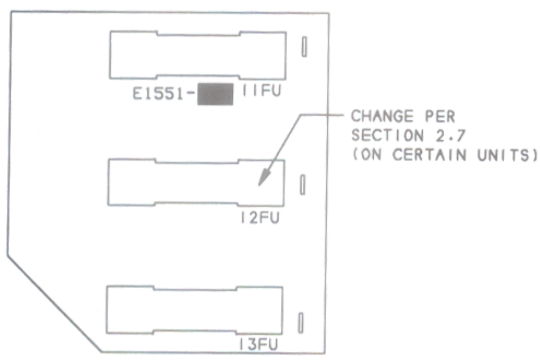


Figure 5.1
Proper Placement of Transformer (T10) Input Jumpers

2.) Change fuse 12FU, middle fuse on E1551 circuit board, per Table 4 of Section 2.7. This change is necessary in some sizes and is not necessary in others.

Figure 5.2
Change 12FU, Transformer Input Fuse



5.5 <u>Conversion From 150 VDC to 240 VDC Motor Field</u>

The standard voltage for 230 VAC input controls is 150 VDC. Some motors with 240 VDC armatures, especially those of older vintage, have 240 VDC fields. If the field voltage rating of the motor is known at the time the control is ordered, the control can be factory-equipped for this field voltage. If this was not done or if the field voltage requirement of the motor has changed since the control was ordered, the field supply can be modified at installation to produce the required voltage. It is assumed that the assembly originally supplied is an E1551-X11 field supply board. The right-most “1” indicates that the assembly furnishes 150 VDC when using 230 VAC input or 300 VDC when using 460 VAC input. The digit represented by “X” relates only to attached wire lengths and is not pertinent to the conversion procedure.

3.) Change the two voltage selection jumpers located on the E1546 PC board (see Section 9.3).

4.) Change the current shunt link (Size A & B units) or change the plug-in “SHUNT CAL” resistor(Size C and larger units). See Sections 12.1 and 12.2 respectively.

5) If the conversion is from 230 VAC to 460 VAC, the field supply output must be set up for 150 VDC (not 240VDC) prior to conversion. Reverse the steps of Section 5.5 if necessary so that the field output is 150/300 VDC. If the unit is equipped with a field regulator, readjust per the related manual addendum.

6.) Change the nameplate information. See Section 12.3 for instructions related to the horsepower change. Using the procedures given in 12.3, change additional nameplate blocks to reflect the new AC line voltage, new armature voltage and new field voltage.

Jumper JP401 is omitted and jumper JP403 is supplied on the standard E1551-X11 assembly. Conversion to a 240 VDC output consists of adding jumper JP401 and removing jumper JP403. Refer to schematic E1551-10-ES. Refer to Figure 5.3 for the approximate location of jumpers JP401 and JP403. Use #18 AWG bus wire to make the JP401 jumper connection; wrap the wire around the tubular terminals on the foil side (underside) of the board and solder. After the conversion has been made, change the right-most digit in the white identification block from a “1” to a “2”; the new identification number will thus be “E1551-X12”.If the board is to be changed from a 240 VDC output to a 150 VDC output (or 300 VDC field with 460 VAC input), the steps above should be reversed.

WARNING: <u>Only one jumper must be in place. If both jumpers are in place simultaneously fuses will blow.</u>

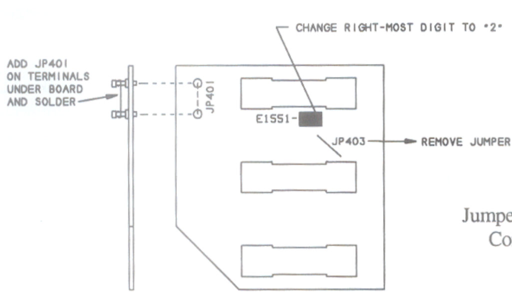


Figure 5.3
Jumper Placement on E1551 PC board to Convert to 240VDC Field Voltage

5.6 Eliminating Field Loss Protection

All PRD12B controls come equipped with field loss protection. The control will automatically shut down if field currents lower than 200 milliamps are detected. In most cases this is a desirable feature. There may, however, be cases in which a user wishes to defeat this protective feature. Jumpering terminals 3 and 8 located on 204TB of the E1546 PC board will defeat field loss protection. Use #18 or #20 AWG insulated wire. Strip off approximately 1/4 inch and insert the stripped ends in terminals 3 and 8 of 204TB. The wires that were originally connected to these terminals can be left in place or disconnected and taped to avoid shorting to adjacent components or equipment. Figure 6 below illustrates this procedure.

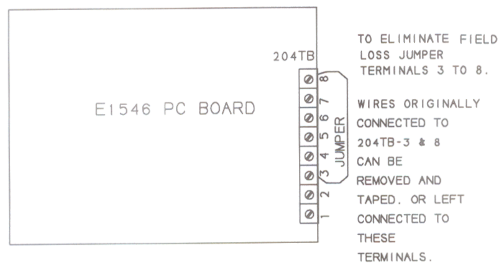


Figure 6
Eliminating Field Loss Protection

6. INSPECTION

Check for shipping damage. If damage is found, report it to the carrier immediately. Do not attempt to operate the drive system if visible damage to the PRD12B exists.

7. INSTALLATION

7.1 Mounting Open Chassis Units

Mount the open chassis unit in a suitable enclosure. Determine the size code of the unit to be mounted from the nameplate (see the sample nameplate in Section 5.1); also note whether the unit uses IsoFlow™ cooling. Section 5.1 gives guidelines for sizing the enclosure. Drawing A2399-007-MD in the Appendix gives mounting dimensions. Process as follows:

1) All Units Not Equipped With IsoFlow™: Mount per the appropriate Figure of Drawing A2399-007-MD (Appendix) in an enclosure sized according to the guidelines of Section 5.1, parts (1) through (3). Do not punch the large "Note 1" holes indicated on drawing A2399-007-MD and disregard Details A and B. If the unit is Size A, determine from Section 5.1 part (1) whether it should be mounted directly to the enclosure or if it may be panel mounted and mount it accordingly.

2)Units Equipped With IsoFlow™ Cooling: The open-chassis IsoFlow units are readily identifiable visually in that you cannot see the fan blades from the top side of the chassis due to the air-intake plenums. These units use closed-path rear-entry/rear-exhaust of the cooling air. Read Section 5.1 part (4) concerning the selection of an enclosure that does not have internal stiffeners on the rear wall. If possible, mount the PRD12B unit directly to the enclosure rear wall to eliminate the need for the panel mounting adaptors shown in Detail B of drawing A2399-007-MD.

Use the full-size mounting template furnished with the unit to determine the best mounting location for the PRD12B. Install per Figure 3,4 or 5 and Note 1 of A2399-007-MD . Note that a hole punch is required. If rear-wall stiffeners interfere with hole locations, cut and remove the stiffeners to provide a flat surface to 1" beyond the perimeter of the required ventilation holes. All gasketing including the seal ring shown in Detail A is furnished with the IsoFlow version of the PRD12B; thus no additional parts are needed when direct mounting to the enclosure rear wall is utilized. Note, however, that if panel mounting is utilized, a panel-mounting adaptor kit will be needed to form the air passage between the panel surface and the enclosure rear wall as shown in Detail B; the kit is available from Polyspede.

Provide a minimum of 1-1/2" space behind the enclosure for air flow when it is placed into service.

7.2 Mounting Enclosed Units

This section refers to units furnished by Polyspede in NEMA 12 or NEMA 4 enclosures; they normally utilize IsoFlow™ cooling.

Be sure and use the mounting feet furnished with these units; they provide the necessary 1-1/2" clearance behind the enclosure for air intake/air exhaust. Also, leave 4" minimum unobstructed space above and below the enclosure for airflow.

7.3 Wiring Procedure

Refer to "Typical External Wiring Diagram" A2399-007-EW in the Appendix. Figure I Page 1 of this drawing indicates three separate wiring runs identified as "Conduit 1", "Conduit 2", and "Conduit 3", containing the AC input lines, the motor power wiring and signal wiring respectively. Keep these wiring runs separate both inside of the enclosure and externally. Observe all of the notes on this drawing regarding shielding and grounding. Size the power wiring per National Electric Code using the amperages of Table 1 of drawing A2399-007-EW as a guide. All wire lugs in the PRD12B are of the wire-clamp type which do not require lugging of wires. Lugs for the power connections are generally adequate for accommodating the full range of wire sizes that might be selected except in the case of extreme oversizing of the external power wires.

After making the basic wiring connections shown in either Fig. I, Fig. II or Fig. III of Drawing A2399-007-EW, look at the nameplate "OPTIONS" block to determine what options are included which might require additional connections. Make these additional connections per Details 1 through 15 of Drawing A2399-007-EW. See Section 2.1 for nameplate information and Table 2 for description of the options.

If the unit is a customer special unit, it will be identified by an "M" followed by five digits in the "PART NO." block of the nameplate (See Figure 1, Section 2.1). A special external wiring diagram is furnished with these units. If this is the case, use the special external wiring diagram for wiring the unit rather than Drawing A2399-007-EW. The special external wiring diagram will be identified as "MXXXXX-XXX-EW" and will be shipped as a loose document; it will not be inserted in the manual.

8. INITIAL TURN-ON PROCEDURE

If the drive system includes a speed reducer, fill reducer with the specified lubricant before startup (see tags on reducer). Reducers are shipped without lubricant even when they are factory installed on motors. Also check coupling (if so equipped) to see if it is a type that requires lubrication.

Before turning on AC power, use an ohmmeter to check for continuity to ground (panel) from the following points:

L1,L2 and L3 lugs
A1 and A2 lugs
F+ and F- lugs on 301TB

Motor should be connected for the above tests. No reading should be less than 100K ohms.

Assure that the AC input service is of correct voltage; the input service voltage must agree with the voltage shown in the "INPUT" block of the nameplate. If disagreement is noted, refer to Section 5.4 for information on how to convert the control to accept the available AC line voltage. Also check the armature voltage rating on the motor nameplate; it must be 240 VDC for 230 VAC services or 500 VDC for 480 VAC services.

Check the "HZ" block on the PRD12B nameplate and be sure it agrees with the AC input service (50 or 60 HZ). If nameplate shows "60 HZ" and service is 50 HZ, perform the steps in Section 5.3 to convert the control for 50HZ use.

The control is now ready for an operational test. Turn AC power on. Look at the "FIELD" indicator light (adjacent to the "-F" field wire connection). It should be illuminated, assuming that a motor field is connected.

Note: One or more of the fault indicator lights will also come on momentarily when AC power is turned on, but should go off in about 1/2 second. This is normal.

Be sure that the "TACH-ARM" mini jumpers are set to the "ARM" position. This should be done even if the control will ultimately be used in the tachometer feedback mode. This will enable verification of proper tachometer voltage feedback polarity as explained in Section 2.6.2.

Set the speed potentiometer for zero speed and press the "FWD" pushbutton (or equivalent contact) to initiate a forward start command. The "SPD" indicator light on circuit board E1546 (or on remote indicator panel) should come on. Only the "SPD" (and "POWER" indicator should be on.

Adjust the speed potentiometer off of its zero setting. The motor should start to rotate. Check for correct operation of the speed potentiometer. If motor does not rotate in the desired direction, press the "STOP" pushbutton, turn AC power off and reverse the A1 and A2 motor connections. If the speed potentiometer is wired for unidirectional operation, and if the speed potentiometer controls speed normally except motor runs at full speed when the potentiometer is fully counterclockwise, press the "STOP" pushbutton, turn the power off and reverse the two outer leads of the speed potentiometer (terminals 1 & 3).

If the PRD12B is not equipped with an acceleration option, the "TORQ LIM" indicator light will come on and the "SPD" LED will go off if setting of the speed potentiometer is abruptly changed. This is normal; the LEDs are indicating that electronic current-limit circuitry is limiting inrush current into the motor as it accelerates or decelerates. The previous explanation assumes that the drive is speed programed. If the PRD12B is a _torque programed_ drive (identified by a "TORQUE" program plug at J21 on the E1546 circuit board), the indicator lights will respond differently as follows: The "TORQ LIM" indicator will be on continually and the "SPD" indicator will be off continually. The "MAX VOLTS" indicator will come on if motor speed is allowed to go to maximum value, such as would occur with no shaft load on the motor. Also the potentiometer referred to will be a _torque potentiometer_ rather than a speed potentiometer as described in Section 2.6.3.

If the drive is speed programmed, adjust the "IR" potentiometer as described in Section 10.1.1. Exception: if tachometer feedback is to be utilized do not adjust "IR" but do verify tachometer polarity per Detail 1 of Drawing A2399-007-EW, and then move the "FEEDBACK" jumper to the "TACH" position.

This section has given a very brief set of guidelines on initially starting up a basic PRD12B. If any problems were encountered in the previous paragraphs that cannot be resolved, refer to Section 13 "Troubleshooting" for aid in locating the problem. In addition, if the control is supplied with any options refer to the specific section covering that option for more details and information.

9. SETUP OF MINI-JUMPERS (On E1546 Circuit Board)

There are a several mini-jumpers that are supplied on the E1546PC board. These mini-jumpers are used to customize the way in which the PRD12B responds to its inputs; the jumpers must be correctly placed to assure the desired response. The following sections will explain the proper positioning of these jumpers.

9.1 <u>"Norm-Auto Reverse" Mini-Jumper</u>

There are two mini-jumpers that must be moved simultaneously in order to select "Normal" or "Auto" reversing. These two mini-jumpers are located on the left edge of the E1546 circuit board; they determine whether or not "Auto Reversing" is active on the control. Typically, these jumpers would only have an effect if reversing is being accomplished through the use of "Forward" and "Reverse" pushbuttons or "Forward" and "Reverse" momentary contact closures. With auto reversing, the motor will reverse if the applicable operator switch, "FORWARD" or "REVERSE", is momentarily activated while the control is running the motor in the opposite direction. When auto reversing is not active (called the normal mode of operation: "NORM") the operator must wait for the motor to "STOP" before a reversal command will be accepted, or alternately an operator may hold the pushbutton activated until the motor stops to accomplish a reversal. The "Auto Reverse" modification can simplify certain limit-switch applications on reversing machines, but it is not recommended in cases where it might introduce an operator hazard.

The standard PRD12B control is shipped from the factory with these two mini-jumpers set for "Norm" (normal) operation unless the "AR" option was specified on the order. This can be easily changed in the field to add Auto Reversing or vice versa. The following sketch shows the position of the two mini-jumpers when properly set up for either the "NORM" or "AUTO REVERSE" positions on the E1546 PC Board.

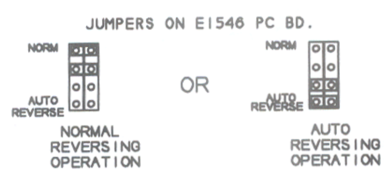


Figure 7
Setup of the Mini-Jumpers For "Normal" or "Auto" Reversing Operation

9.2 <u>"Input Polarity" Signal Jumper</u>

One mini-jumper is used to select whether the PRD12B will accept only positive input signals, only negative input signals, or either polarity of signal. This mini-jumper is located in the lower left quadrant of the E1546 PC Board below the "DEAD BAND" and "DROP OUT" potentiometers. If "+ONLY" is selected, all negative signals at the input of the drive, which is 202TB-13 with respect to control common (202TB-11), will be ignored and treated as if the level were zero. In the same manner if "-ONLY" is selected, all positive signals at the input to the drive will be ignored and treated as if the level were zero. If "Either" is selected, signals of either polarity will be processed through the control. This feature is useful in conjunction with 4-20 ma external signal inputs to prevent unwanted motor reversal when the signal falls below 4 ma.

The above paragraph concerning the setting of the Input Polarity Jumpers applies to both speed and torque programmed drives.

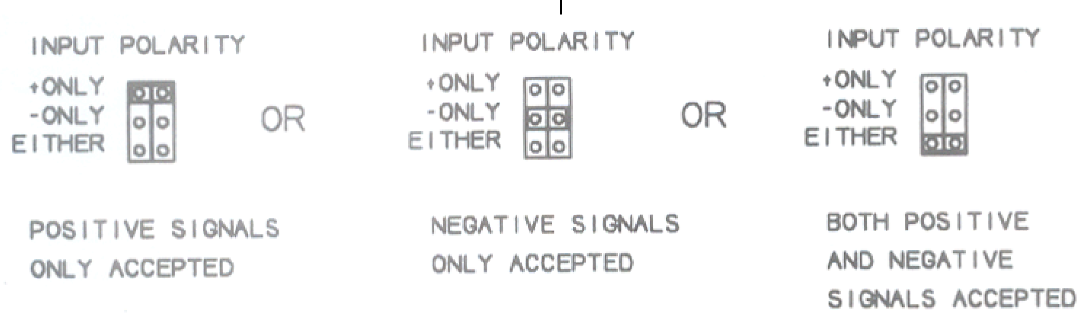


Figure 8
Setup of Input Polarity Jumpers To Restrict Motor Reversal

9.3 AC Input Voltage Selection

There are two jumpers that must be set properly depending the value of the ac input voltage. The left-most of these two jumpers is located below the "MAX" potentiometer. The right-most is located 2" above lug 23 of Terminal Block 203TB. Converting the E1546 board for use with either of the two line voltages indicated is easily accomplished by rearranging jumper placement on the 3 pin jumper strips. (Note that other changes to the PRD12B unit as outlined in Section 5.4 are also necessary). The following Figure 9 shows the proper position of the two jumpers when using either 230 VAC or 460 VAC three phase input.

Figure 9
Input Voltage Mini-Jumpers Placement For 230VAC or 460VAC Operation

9.4 Type of Input Signal
A mini-jumper designated "INPUT TYPE" is located directly above terminal 13 of 202TB on the E1546 circuit board. This mini-jumper selects the type of input signal that can be used to program motor speed (or motor torque, if the control unit is so equipped). The control is typically programed by a zero to six volt level. There are some applications, however, that may use a 4 to 20 ma reference signal. To accommodate this type of signal, simply move this mini-jumper to the 4-20 ma position as shown in the following figure.

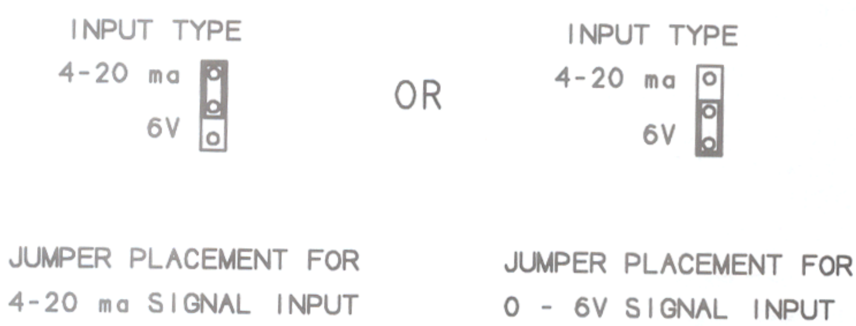


Figure 10.1
Mini-Jumper Placement Depending on Type of Signal Input

9.5 "Feedback" Jumper

This mini-jumper is located below the "IR" potentiometer. It is used to select either standard armature voltage feedback or optional tachometer feedback from a motor-mounted analog tachometer. See Detail 1 of External Wiring Diagram A2399-007-EW regarding verification of tachometer polarity before placing the jumper in the "TACH" position. Position the jumper for the desired type of feedback according to the following figure:

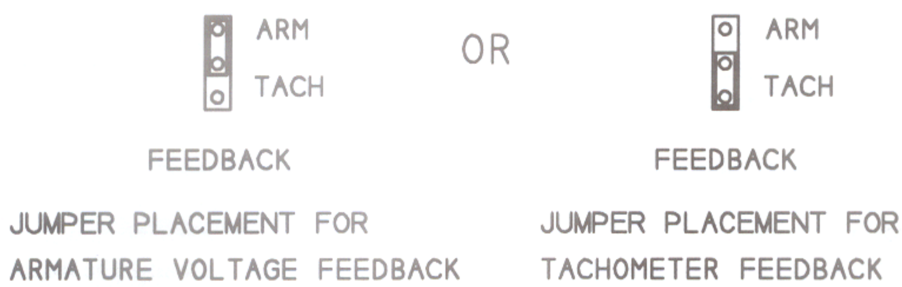


Figure 10.2
Mini-Jumper Placement for Armature or Tachometer Feedback

10. BOARD ADJUSTMENTS, BASIC PRD12B

Before leaving the factory, all PRD12B controls are thoroughly tested to verify proper control performance. All of the adjustments on the control are factory preset; the following potentiometers are the ones that commonly require field readjustment; adjust them per the referenced Section:

"IR", per Section 10.1.1 (on the E1546 circuit board).
"MAX", per Section 10.1.3 (on the E1546 circuit board)
"DEAD BAND", may be. Read Section 10.1.2 (on the E1546 circuit board).
"ACC" and "DEC" potentiometers if the Accel/Decel option board is included. See Section 11.1 or 11.2.

If other options are included they will be listed on the control nameplate. Locate the option in Section 11 and adjust potentiometers on the option board as required.

Certain specialized applications such as winders and unwinders may benefit from adjustment of the "+/-MAX VOLTS" potentiometers or the "+/-TORQ" potentiometers. See Sections 10.2.8 and 10.2.9 or Sections 10.2.1 and 10.2.2.

10.1 Field Adjustments on the E1546 PC Board

10.1.1 "IR"

If the drive is to be used with tachometer feedback, leave the "IR" potentiometer set at the fully counterclockwise factory setting (adding "IR" compensation may cause instability in tachometer feedback systems). If the drive is to be used with armature voltage feedback, adjust the "IR" potentiometer clockwise until satisfactory load regulation is obtained using one of the three methods given in the following text. The "IR" adjustment compensates for losses in the motor armature when the motor is loaded. The "DEAD BAND" potentiometer should be fully counterclockwise while adjusting "IR".

a. Shaft Stiffness Method–Set the speed potentiometer for zero speed. Grasp the motor shaft and rotate it. (If a shaft coupling is exposed, grasp it with a shop cloth and rotate it. Otherwise remove the fan cover and rotate the fan blade, but do not apply excessive pressure to the blades. Use adequate precautions). If "IR" is set too low, the motor will apply very little torque to oppose your rotating motion; adjust the "IR" potentiometer clockwise. The "IR" potentiometer is correctly adjusted when the shaft feels very "stiff" and strongly opposes your turning motion. The "IR" potentiometer is set too far clockwise if the motor actually starts to rotate backwards against the force you are applying.

b. Machine Loading Method – If the preceding method is not practical because of motor accessibility, operate the PRD12B at low speed and load the machine which the PRD12B is driving. (For example: If the machine is a conveyor, place a weight on the conveyor). If the machine slows down when it is loaded, adjust the "IR" potentiometer clockwise and repeat the test. The "IR" potentiometer setting is correct when little or no slowdown occurs as the machine is loaded. (Caution:-The machine should not speed up when it is loaded. If it does, "IR" is set too far clockwise. Also the machine loading used must not be severe enough to cause the "TORQ LIM" LED to turn on).

c. Instability method – If neither of the preceding methods are practical, operate the machine and turn the "IR" potentiometer clockwise until instability occurs (the "TORQ LIM" LED will blink off and on). Turn the "IR" potentiometer counterclockwise until operation is again smooth and the blinking stops, then turn "IR" a little further counterclockwise (about 20% of the setting). This is approximately the correct setting.

If instability cannot be made to occur, set "IR" 30% to 50% clockwise and check machine for satisfactory operation in actual service.

10.1.2 "DEAD BAND"

Leave this potentiometer set fully counterclockwise (no deadband) for most applications. If your application requires absolutely no creeping of the motor for zero speed command, adjust this potentiometer clockwise until the desired immunity to creep is achieved. Remember, however, that inserting dead band removes zero-speed hold-back torque(the motor shaft can spin freely) when the input signal is in the deadband. Dead band should thus not be used in hoist applications or other applications in which the load might be dropped unless a mechanical brake is also utilized. The amount of dead band can be adjusted from zero (fully counterclockwise) to

.83% of top speed (fully clockwise). For example, if you are using a speed potentiometer to command speed and the "DEAD BAND" potentiometer is turned fully clockwise, the drive would not respond to the first .83% of the total potentiometer rotation. In high resolution servo applications where the motor must respond faithfully to low speed commands, dead band should not be used. This adjustment should be made after adjusting the "IR" potentiometer.

10.1.3 "MAX"

The "MAX" potentiometer sets the maximum armature voltage that occurs in response to a maximum speed command. "MAX" is factory preset at the following maximum armature voltages: 480 VDC to 500 VDC for 460 VAC input controls and typically 240 VDC for 230 VAC input controls. The adjustment is inoperative in controls that use the torque programming mode (ie: a "TORQUE" programming plug in J21). To readjust, apply maximum speed command at 202TB-13 (typically +/-6V), and adjust for desired maximum motor speed. Do not readjust "MAX" until motor is at operating temperature (typically 45 minutes of operation). Do not exceed 520 VDC (460VAC units) or 260 VDC(230VAC) units under full-load conditions.

10.2 Occasionally-Used Adjustments (E1546)

The "+TORQ", "-TORQ", "ZERO", "OVERLOAD", "DROP OUT", "STAB", "+MAX VOLTS", AND "-MAX VOLTS" potentiometers are preset at Polyspede and in most cases they do not require readjustment. If a specific application does require resetting any of these potentiometers refer to the following instructions for guidelines in adjusting.

In making voltage measurements place the +lead of a DC voltmeter on the specified terminal block lug or test point and the other meter lead on 203TB-21 or 22 (common).

10.2.1 "+TORQ"

This potentiometer adjusts current limit (Torque Limit) for positive armature currents. To readjust, start the motor and monitor 202TB-17(+SPD). Adjust the polarity of the speed command, if necessary, to give a positive voltage at 202TB-17. Begin loading the motor until the "TORQ LIM" LED comes on. With the motor loaded so that the "TORQ LIM" LED is on, measure the voltage at 202TB-18. This voltage indicates the armature current as follows:

**100% rated current = 2.0 volts nominal (1.79 to 2.08 volts range per Table 1, Column K)

*130% rated current = 2.6 volts nominal (Size D open chassis units)

* 150% rated current = 3.0 volts nominal (2.69 to 3.12 volts range)

* Factory setting for Speed Programed Drives

**Factory setting for Torque Programed Drives

"Rated current" is the current shown as "ARMATURE OUTPUT AMPS" on the control nameplate and also in Table 1, Section 2.2 of this manual. The exact voltage at 202TB-18 at 100% rated armature current is given in Column K of Table 1.

Readjust the "+TORQ" potentiometer until the meter reads the desired voltage. Do not set higher than approximately 3.0 volts (150% rated current) without factory approval. When the TM (Torque Programming) Option is specified this potentiometer calibrates the output current for both positive and negative current and the "-Torq" potentiometer becomes non-functional.

10.2.2 "-TORQ"

This potentiometer adjusts current limit (Torque Limit) for negative armature currents. To readjust, proceed exactly as outlined under "+TORQ" except adjust the speed command, if necessary, to give a negative voltage at 202TB-17 (+SPD). This adjustment is not operational when the TM (TORQUE PROGRAMMING) option is present.

10.2.4 "ZERO"

This potentiometer is factory preset so that armature voltage is zero when the speed command is zero. To adjust, start the control. Set the speed command to zero volts and temporarily tie 202TB-13 (Input) and 202TB (Common) together. With a DC voltmeter, monitor 202TB-17 and adjust the "ZERO" potentiometer until the DC voltmeter reads zero volts. This adjustment is not applicable when the TM (Torque Programming) option is installed.

10.2.5 "OVERLOAD"

The "OVERLOAD" potentiometer sets the point at which the inverse timed overload circuitry becomes active. The purpose of the overload circuitry is to shut the drive down after a certain period of time if armature current exceeds 100% rated motor current. The length of time which the motor is permitted to run is inversely proportional to the percentage by which armature current exceeds rated motor current. That is, the greater the overload, the quicker the shutdown.

The “OVERLOAD” potentiometer is factory preset so that the overload circuit becomes active when armature current slightly exceeds rated motor current. In some cases it might be desirable to have the timing circuit become active at an armature current less than rated motor current. To readjust, load motor until desired maximum motor current is reached. With motor loaded, turn the “OVERLOAD” potentiometer counterclockwise until the “OVERLOAD” LED just begins flashing. Once this is done, the new overload circuit activation point is set. Do not set an activation point greater than 100% of rated motor current without consulting Polyspede.

TABLE 6

% of rated current above the “overload” activation point	Time Before Shutdown
50%	1 Minute
25%	2 Minutes
12.5%	4 Minutes
6.25%	8 Minutes

10.2.6 <u>“DROP OUT”</u>
This potentiometer sets the point at which, while the drive is decelerating during a normal stop, the DC loop contactor will de-energize (drop out), or the point at which SCR firing is killed if the contactor option is not included. The factory preset point is normally near the fully counterclockwise position. Turning this potentiometer clockwise will cause the armature contactor to drop out at a higher speed or higher armature voltage level. In controls which use armature voltage feedback, the “IR” potentiometer should be accurately set before attempting to adjust the “DROP OUT” potentiometer. If optimum setting of “IR” is not achieved, it may be necessary to set the “DROP OUT” potentiometer further clockwise than the factory setting to assure reliable contactor drop out after a stop, especially for overhauling loads.

In torque-programed drives, contactor drop out (or firing drop out) occurs (following a stop command) as soon as armature current nears zero value; this may or may not be at zero speed.

10.2.7 <u>“STAB”</u>
The factory setting for this potentiometer is 40% to 50% clockwise and should not need readjustment. This adjustment affects drive stability and should not be readjusted unless drive response is not satisfactory. Rotating the “STAB” potentiometer counterclockwise gives snappier (but possibly underdamped) response. Clockwise rotation gives more sluggish overdamped response. Consult the Polyspede factory before adjusting.

10.2.8 <u>“+MAX VOLTS”</u>
This adjustment is set for the maximum positive armature voltage level that the drive is allowed to reach during monitoring operation. It is factory preset to 530 VDC (on 460 VAC controls) or 265 VDC (on 230 VAC controls). And should not be readjusted except to achieve specialized uses described in the following paragraphs. Do not adjust clockwise from factory settings. In tachometer feedback systems, the “MAX VOLTS” clamps (both “+MAX VOLTS” and “-MAX VOLTS”) set an absolute armature voltage limit in the event that the tachometer feedback loop is lost, or if full speed operation with cold field windings is attempted. In torque-programed systems, these clamps set an absolute speed limit for no-load motoring operation.

If this adjustment is set fully counterclockwise it will prevent motoring operation in one direction (the direction that results from positive armature voltage). This method of adjustment is useful in certain material winders which must be capable of applying either assisting torque or retarding torque, but which should not rotate in the reverse direction in the event of material breakage.

If both the “+MAX VOLTS” and “-MAX VOLTS” potentiometers are set fully counterclockwise, motoring operation in <u>either</u> direction is prevented, but generating operation in response to overhauling loads is permitted. If this setup is used, the motor functions as a passive brake which is unable to rotate its shaft, but will apply retarding torque against any external load that rotates its shaft, in either direction. The amount of torque applied is determined by the settings of the “+TORQ” or “-TORQ” potentiometers, or by the setting of an external torque limit potentiometer if provided.

10.2.9 <u>“-MAX VOLTS”</u>
This adjustment sets the maximum negative

armature voltage level that the drive is allowed to reach during monitoring operation. It is factory preset to -530 VDC (on 460 VAC controls) or -265 VDC (on 230 VAC controls), and should not be readjusted except to achieve the specialized responses described in the previous paragraph. Setting this adjustment fully counterclockwise prevents motoring operation in the direction that results from negative armature voltage. Do not adjust clockwise from factory settings.

10.3 Adjustments on the E1544 Board (Factory Preset Adjustments)

The "I_A NULL", "CROSSFIRE", and "BALANCE" adjustments are critical to the proper operation of the PRD12B. These potentiometers are adjusted at the factory and under no circumstances should these setting be tampered with. If readjustment becomes necessary please contact Polyspede. There are no adjustments on this board that require user adjustment except in conjunction with board repairs. The "SHUNTCAL" resistor on this circuit board may be replaced in conjunction with a line voltage conversion or a horsepower conversion as described in Sections 5.4(4) and 12.2. The function of each potentiometer is described for reference purposes in the following sections:

10.3.1 "I_A NULL"

This potentiometer is adjusted to eliminate any offset in the Armature Current Isolator circuit. That is, with zero armature current, the "I_A NULL", potentiometer sets zero volts at the output of the Armature Current Isolator as measured at test point "I_A" or at 202TB-18.

10.3.2 "CROSSFIRE"

The "CROSSFIRE" potentiometer sets the firing angle of the SCRs at zero phase voltage. With normal setting, the forward and reverse bridges are firing alternately at very small conduction angles in response to zero input voltage at test point TP9.

10.3.3 "BALANCE"

The PRD12B uses two voltae controlled oscillators (VCO's) in its firing control circuitry. One of the VCO's responds to negative phase voltages at TP9 and the other VCO responds to positive phase voltages at TP9. The "BALANCE" adjustment calibrates the two VCO's to operate at the same frequency when the voltage at test point TP9 is zero volts, thereby producing zero average motor current as the two bridges crossfire. (For voltages other than zero at TP9, the frequency of one VCO increases while the frequency of the other VCO decreases).

11. BOARD ADJUSTMENTS, OPTION BOARDS

11.1 Adjustments on the Linear Accel/Decel Option (E1548 PC Board, Options A1, A2,A3)

There are two adjustments on this board; both are intended for field adjustment. The "ACC" potentiometer sets the time required to accelerate from zero speed to full speed; adjust the potentiometer clockwise to increase this time. The "DEC" potentiometer sets the time required to decelerate from full speed to zero speed; adjust the potentiometer clockwise to increase this time. The adjustments are independent of each other, there is no interaction of the adjustments. This unit also controls acceleration and deceleration to these same rates when the speed setting is changed.

The standard A1 option, identified as a -111 assembly on the circuit board, provides an adjustment range of 0.8 seconds to 27 seconds, which is adequate for most applications. This range is field convertible to the A2 option range which provides better adjustment resolution for very short acceleration/deceleration times (.12 seconds to 4 seconds). Move the plug-in "RANGE" jumper from the "HI" position to the "LO" position to make the conversion. The "RANGE" jumper is located adjacent to he "ACC" potentiometer. See Section 2.6.9 for further details.

11.2 Adjustments on the S-Curve Acceleration Option (E1548 and E1549 PC boards, OptionsAS1, AS2, AS3)

The following four potentiometers are intended for field adjustment: "ACC", "DEC", "SOFT START", "SOFT FINISH". With the "SOFT START" and "SOFT FINISH" potentiometers set fully counterclockwise, adjust the "ACC" and "DEC" potentiometers clockwise to increase time until the respective acceleration and deceleration times are somewhat less than the desired final times. Then adjust the "SOFT START" and "SOFT FINISH" potentiometers clockwise until the desired smoothness near the beginning and end of acceleration and deceleration cycles is achieved. Note that in the deceleration cycle the "SOFT START" adjusts smoothness at the beginning of deceleration, and "SOFT FINISH" adjusts the smoothness as motor speed approaches zero during a stop.

Although there is no direct interaction between the four adjustments. Adding "SOFT START" does increase the total time required to reach full speed in that it causes the acceleration rate to initially be much lower than that set on the "ACC" potentiometer, with the acceleration rate increasing progressively until the rate is equal to that set on the "ACC" potentiometer. Similarly, as speed approaches a final value, the "SOFT FINISH" potentiometer adjustment stretches out the time required to "ease into" the final speed, thereby again increasing the total time required to reach final speed.

Visually, the S-Curve unit is distinguished from the Linear unit in that the S-Curve unit consists of two circuit boards sandwiched in a back-to-back configuration. The standard adjustment range is 0.8 to 18 seconds (plus soft start and soft finish times). The standard option is further identified by E1548-211 identification on the E1548 circuit board and an "Option AS1" notation on the nameplate. See Table 2 for other time adjustment ranges that are available. The standard adjustment range is field convertible to a 0.12 to 3 second range by moving the "RANGE" jumper to the "LO" position. See Section 2.6.10 for further technical details.

11.3 Adjustments on the Adjustable Jog Speed Board – (E1534 PC Board, Option J2)

This board has only one adjustment: the "JOG" speed potentiometer. The jog speed is adjustable from 0 to 100% of base speed. The "JOG" potentiometer is preset at the factory to 10% of base speed and may be readjusted by the user to any desired speed. Clockwise rotation of the "JOG" potentiometer increases the jog speed.

11.4 Adjustments on the Preset Speeds Board (E1532 PC Board, Options PS0, PS3, PS4,PS6,or PS7)

Unless additional documentation is furnished with the control indicating special factory modifications to the E1532 board, all internal speed pots are capable of adjusting from 0 to 100% of base speed. All internal speed potentiometers on the Preset Speeds board are factory preset fully counterclockwise to zero speed. Adjustments must be made by the user to obtain the desired speeds. Clockwise rotation of a preset speed pot increases the related speed setting. (For information on usage, refer to the section "Guidelines for using and Programming the Preset Speeds Option" in Section 16.5.3 of this manual. For further technical details, see Section 2.6.6.

11.5 Adjustments on the Armature Voltage/Tachometer Follower Options (E1543 PC Board, Options VF1, VF2,TF1,TF4, & TF5)

If the motor connected to the PRD12B is required to reverse when the input signal to the follower option board reverses, the "INPUT POLARITY" jumper on the E1546 board must be in the "EITHER" position. If the motor must not reverse, set the jumper to the "+ONLY" position.

The E1543 board has four adjustment potentiometers and one gain-setup mini-jumper. The "CMR" potentiometer is factory set to maximize common mode voltage rejection. This potentiometer should not require re-adjustment. The "ZERO", "GAIN", and "RATIO" potentiometers are customer adjustments. The proper adjustment procedures are explained in the following paragraphs. Before proceeding with these three adjustments, place the "GAIN SELECT" jumper in the "LOW" position. Adjustments should be made before the unit is started, so that the motor will not be rotating during adjustment.

11.5.1 "ZERO" and "GAIN" Adjustments

Temporarily adjust the "GAIN" potentiometer to the mid-range of its rotation. With zero input volts, adjust the "ZERO" potentiometer for zero voltage between 703TP and 704TP. Apply maximum input voltage between terminals 1 and 2 of Terminal Block 701TB and adjust the "GAIN" potentiometer until 6 volts is read between 703TP and 704TP. If it is not possible to achieve six volts, repeat this step from the beginning with the "GAIN SELECT" jumper in the "HIGH" position. This completes normal adjustment of these two potentiometers. (If it is desired to have an offset voltage at the output when there is zero input, reduce the input voltage to zero and adjust for the desired offset at the output.)

11.5.2 "RATIO" Adjustment

After calibrating for a 0 to +6 VDC output level at 703TP with respect to 704TP (Common), the "RATIO" potentiometer can be adjusted during service to cause the motor driven by the PRD12B to run at a lower speed than that normally commanded by the input signal; the "AUTO" LED must be illuminated when making this adjustment. The "RATIO" potentiometer is normally left fully clockwise.

11.6 Adjustments on the External Signal Follower Board (E1542-5xx Board, Options SF2,SF3,SF4,SF6, and SF7)

This multi-purpose board may be set up for many different modes of operation. Adjustment for the most common mode of use, in which motor speed is to increase as the input signal increases in magnitude, is described in 11.6.1, following. **Adjustment procedure 11.6.1 will be used in most applications.** Adjustment for an alternate method of use, in which motor speed is to decrease as the input signal increases in magnitude, is described in 11.6.2. Section 11.6.3 describes adjustment for a third mode of use in which motor speed is zero at the midpoint of a process instrument current range. With this set up, the motor rotates in one direction for input currents higher than the midpoint, or in the opposite direction for input currents lower than the midpoint. (Midpoint current is 12 ma for the 4-20 ma range, or 30 ma for the 10-50 ma range).

11. 6.1 "SPAN" and "ZERO" Adjustments (Options SF2-SF4, for Output Directly Proportional to input)

The "INPUT POLARITY" jumper on the E1546 board must be in the "+ONLY" position for this application. Motor speed will increase as the input signal increases. (If motor speed is to decrease as the input signal increases, set up per 11.6.2)

Before beginning these adjustments, the two mini-jumpers designated "INPUT RANGE" and "MODE" should be checked as to their proper position. The "MODE" jumper must be in the "NORMAL" position for this application. For options SF2 or SF3, the "INPUT RANGE" mini-jumper should be in the "4-20MA" or "10-50MA" position respectively. Connect the current source to 601TB-1 & 2 so that the current enters terminal 1.

For option SF4, both mini-jumpers should be in the "VOLTS" position. If the external signal is a 0 to 6 volt level, connect it to terminals1 & 2 of 601TB such that terminal 1 is positive with respect to terminal 2. If the external signal is a 0 to 10 volt level, connect it to terminals 3&4 of 601TB such that terminal 3 is positive with respect to terminal 4.

Connect a meter between test points 605TP and 604TP. Apply minimum external signal at the input terminals. Adjust the "ZERO" potentiometer slowly from the fully counterclockwise direction until zero volts is read between these two test points. Supply maximum external signal at the input terminals. Adjust the “SPAN” potentiometer for +6 volts between 603TP with respect to 604TP.

The “RATIO” potentiometer in most cases will be left fully clockwise, but may be turned down in service to reduce tracking speed.

Energize the “MAN/AUTO” relay by jumpering 202TB terminal 2 to 202TB terminal 8 to test actual control of motor speed by the external signal. (If the “AUTO” LED on the option board does not illuminate, check to be sure an E1547 driver board is plugged in at connector J7).

11.6.2 “SPAN” and “ZERO” Adjustments (Options SF2-SF4, for Output Voltage inversely Proportional to input)

The “INPUT POLARITY” jumper on the E1546 board must be in the “+ONLY” position for this application. Motor speed will decrease as the input signal increases. (If motor speed is to increase as the input signal increases, set up per 11.6.1)

Before beginning these adjustments, the two mini-jumpers designated “INPUT RANGE” and “MODE” should be checked as to their proper position. The “MODE” jumper must be in the “INVERSE” position for this application. For options SF2 or SF3, the “INPUT RANGE” mini-jumper should be in the “4-20MA” or “10-50MA” position respectively. Connect the current source to 601TB-1 & 2 so that the current enters terminal 2.(this is reversed with respect to the polarity marks on the circuit board)

For option SF4, both mini-jumpers should be in the “VOLTS” position. If the external signal is a 0 to 6 volt level, connect it to terminals 1 & 2 of 601TB such that terminal 2 is positive with respect to terminal 1. If the external signal is a 0 to 10 volt level, connect it to terminals 3 & 4 of 601TB such that terminal 4 is positive with respect to terminal 3 (both of these will be reversed with respect to the polarity marks on the circuit board).

Connect a meter between test points 605TP and 604TP. Apply maximum external signal at the input terminals. Adjust the “ZERO” potentiometer slowly from the fully counterclockwise direction until zero volts is read between these two test points. Supply maximum external signal at the input terminals. Adjust the “SPAN” potentiometer for +6 volts between 603TP with respect to 604TP.

The “RATIO” potentiometer in most cases will be left fully clockwise, but may be turned down in service to reduce tracking speed.

Energize the “MAN/AUTO” relay by jumpering 202TB terminal 2 to 202TB terminal 8 to test actual control of motor speed by the external signal. (If the “AUTO” LED on the option board does not illuminate, check to be sure an E1547 board is plugged in at connector J7).

11.6.3 “SPAN” and “ZERO” Adjustments (Options SF6 and SF7, for zero speeds at mid point of the external current signal)

The “INPUT POLARITY” jumper on the E1546 board must be in the “EITHER” position for this application. Motor speed will be zero at 12ma input for 4-20 ma inputs, or at 30 ma for 10-50 ma inputs. The Motor will rotate in one direction for input currents higher than the midpoint or in the opposite direction for currents less than the midpoint current.

Set the “MODE” jumper to the “NORMAL” position. Set the “INPUT RANGE” jumper to the “4-20MA” position for option SF6 or to the “10-50MA” position for option SF7.. Connect the current source to 601TB-1 & 601TB-2 so that the current enters terminal 1.(this agrees with the polarity marks on the circuit board)

Connect a meter between test points 605TP and 604TP. Apply midpoint current at the input terminals (12 ma for 4-20 ma input range or 30 ma for 10 -50 ma input range). Adjust the “ZERO” potentiometer slowly until zero volts is read between these two test points. Supply maximum external signal at the input terminals (20 ma or 50 ma). Adjust the “SPAN” potentiometer until the meter reads +6 volts.

Now reduce input current to minimum level (4 ma or 10 ma). The voltage between the two test points should now read -6 volts.

The “RATIO” potentiometer in most cases will be left fully clockwise, but may be turned down in service to reduce tracking speed.

Energize the "MAN/AUTO" relay by jumpering 202TB terminal 2 to 202TB terminal 8 to test actual control of motor speed by the external signal. (If the "AUTO" LED on the option board does not illuminate, check to be sure an E1547 driver board is plugged in at connector J7).

12. CONVERSION TO ANOTHER HORSEPOWER

PRD12B units are assigned a size code letter that defines the maximum horsepower rating of the unit (see Section 5.1 for location of the size code letter on the nameplate). Table 7 lists these letter codes as groups and shows the horsepower range covered by each group. Any unit in certain group can be converted to any other horsepower listed in Table 7 in that same group. The conversion procedure for Size A and Size B units differ from the conversion procedure used for Size C and larger units. Accordingly two sets of conversion instructions are included in the following text. Basically, the shunt link itself is changed on Size A and B units, while the "SHUNT CAL" resistor is changed on Size C and larger units to accomplish the horsepower change. <u>If a change in line voltage (from that nameplated on the control) is also required, perform the procedures of Section 5.4 before making the following changes.</u>

12.1 Changing the Current Shunt (MSH)

This procedure applies only to Size A and Size B units (see Table 7 for the horsepower ranges involved). The shunt links are identified by a current rating scribed on the barrel of one of the lugs. Select the correct shunt link from Table 7 and install it in place of the existing shunt link. Refer to Figure 11 for proper mounting sequence of the new link. It is mandatory that all washers, lugs and hardware items be replaced in their original order. The order of the wire lugs is: power wire, shunt link, and sense wire. Make the nameplate changes described in Section 12.3.

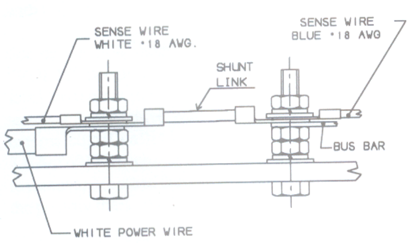


Figure 11
Shunt Link Mounting Detail
(Size A & B Units)

12.2 Changing the "SHUNT CAL" Resistor

This procedure applies only to Size C and larger units. As is shown in Table 7, a shunt of a fixed current rating covers all of the horsepowers listed for a given size unit. The output of the shunt is calibrated to match a given horsepower by changing the "SHUNT CAL" resistor . Select the correct "SHUNT CAL" resistor from Table 7 and install it in place of the existing "SHUNT CAL" resistor. Figure 12 illustrates this procedure. It will be necessary to loosen three screws on the top circuit board (E1546) to allow it to hinge outward to access the "SHUNT CAL" resistor which is mounted on the lower circuit board (E1544). Using long-nose plyers, carefully unplug the resistor by rocking the "fast-on" connectors back and forth and unplugging each end a little bit at a time to avoid breaking the resistor when it becomes fully disengaged. Plug in the new "SHUNT CAL" resistor. Make the nameplate changes described in Section 12.3.

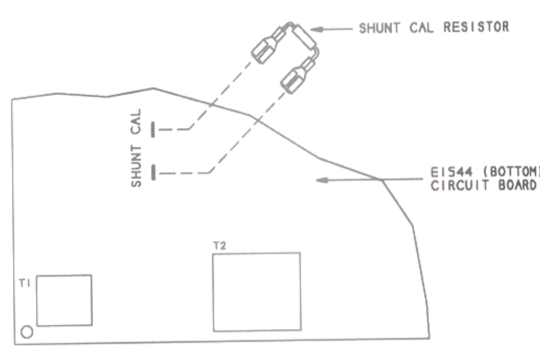


Figure 12
"SHUNT CAL" Resistor Replacement

12.3 <u>Change in Nameplate Information</u>

After the horsepower conversion has been made, it is necessary to change the information in the following four nameplate blocks:

1) INPUT AMPS
2) ARM. OUTPUT AMPS
3) ARM. OUTPUT HP
4) MODEL (the numbers following "PRD12B" and receding the size code letter)

Locate the correct information in Table 7 and insert in the proper nameplate blocks (refer to Figure 1 if necessary). This can be done by typing or lettering the correct information on narrow white paper strips and overlaying the existing information; use transparent tape to attach. Strips cut from self-adhesive paper labels such as those made by Avery are suitable for this purpose.

It is important to update nameplate information when field modifications such as these are made to assure delivery of exact replacement parts on future orders. If the nameplate information is not updated, it will be necessary to repeat the modifications on any replacement parts ordered from nameplate information.

HORSEPOWER SIZE CONVERSION TABLE
TABLE 7

GROUP NO.	HP SIZE	INPUT VOLTS	MODEL NO. SUFFIX	SHUNT RATING	"SHUNT CAL" RESISTOR	INPUT AMPS	ARM OUTPUT	"ARM OUTPUT AMPS"
A	3	230VAC	-30	13	8.25K	10	240VDC	11
	5	230VAC	-50	18	8.25K	16	240VDC	18
	7.5	230VAC	-75	28	8.25K	25	240VDC	28
	10	230VAC	-100	37	8.25K	32	240VDC	37
	3	460VAC	-31	6	8.25K	5	500VDC	5
	5	460VAC	-51	8.5	8.25K	8	500VDC	8.5
	7.5	460VAC	-76	13	8.25K	11	500VDC	13
	10	460VAC	-101	18	8.25K	15	500VDC	17
	15	460VAC	-151	28	8.25K	22	500VDC	25
	20	460VAC	-201	37	8.25K	30	500VDC	34
B	15	230VAC	-150	53	8.25K	46	240VDC	53
	20	230VAC	-200	70	8.25K	60	240VDC	70
	25	460VAC	-251	43	8.25K	36	500VDC	41
	30	460VAC	-301	53	8.25K	42	500VDC	49
	40	460VAC	-401	70	8.25K	56	500VDC	65
C	25	230VAC	-250	200	30.9K	76	240VDC	88
	30	230VAC	-300	200	20.5K	91	240VDC	105
	50	460VAC	-501	200	30.9K	69	500VDC	81
	60	460VAC	-601	200	20.5K	83	500VDC	97
D	40	230VAC	-400	200	9.31K	119	240VDC	138
	50	230VAC	-500	200	680 ohm	147	240VDC	171
	75	460VAC	-751	200	9.31k	103	500VDC	121
	100	460VAC	-1001	200	680 ohm	137	500VDC	161
F	60	230VAC	-600	400	20.5K	175	240VDC	204
	75	230VAC	-750	400	11.3K	218	240VDC	255
	125	460VAC	-1251	400	20.5K	170	500VDC	200
	150	460VAC	-1501	400	11.3K	204	500VDC	240
G	100	230VAC	-1000	400	680 ohm	288	240VDC	338
	200	460VAC	-2001	400	680 ohm	270	500VDC	319

13. TROUBLE SHOOTING A PRD12B CONTROL

Procedures contained in this section are intended to assist the user in identifying whether a problem is due to the DC motor, the PRD12B Control, or to wiring external to the PRD12B unit. Procedures for locating faulty circuit boards and modules are also given. Identify the problem area by using the procedures contained in this section. If the problem is in the PRD12B control, either replace the entire unit or repair it by replacing the faulty sub-assembly as specified in the sections following.

13.1 Occasional Fuse Blowing

Occasional fuse blowing can be caused by intermittent shorts to ground in the DC motor or in the motor wiring. Check motor connections, especially those in the motor conduit box. Blow carbon dust out of the motor using an air hose. Inspect all wiring including motor brush pigtails. Check motor per Section 15.

Occasional fuse blowing can also be caused by power failures and input voltage transients. This type of fault must be corrected in the power distribution system. Look for wire clippings, loose washers, etc., around the fuses and SCR modules.

13.2 Repetitive Fuse Blowing

If fuses blow repetitively, the problem must be isolated and corrected before further trouble-shooting can be done. Repetitive fuse blowing is usually the result of the same problems as are listed for occasional fuse blowing, but may also be due to a faulty PRD12B control circuit board or a failed SCR module. The most common failures are in the E1551 field supply circuit board or in an SCR module. The simple tests given in Sections 13.3, 13.3.1 and 13.3.2 will usually locate the failed component.

WARNING

DO NOT REPLACE FUSES WITH UNAPPROVED SUBSTITUTES. INCORRECT FUSES WILL ALSO BLOW, BUT WILL PROBABLY ALLOW FAILURE OF AN SCR MODULE OR OTHER COMPONENTS BEFORE BLOWING. REPAIR COST WILL BE INCREASED AND WARRANTY MAY BE VOIDED. SEE SECTION 2.7 FOR APPROVED FUSES TYPES

13.3 Quick Test for Failed E1551 Circuit Board of Failed SCR Module.

Turn power off at the AC disconnect or circuit breaker which feeds the PRD12B control. Disconnect the motor field wiring at terminal block 301TB (to the left and under the AC line Connections). Disconnect the red, brown and orange wires from circuit board E1551 by removing the fast-on connectors from terminals T11, T12 and T13 on the circuit board, Temporarily remove the center fuse, 12FU. Use a multimeter set to measure ohms to make the following tests. (A Simpson 260 multimeter set to the RX100 scale or a digital multimeter set to the 20,000 ohm range may be used).

13.3.1 Test For Failed E1551 Field Supply Board

With wires removed from Terminals T11, T12 and T13 on the E1551 circuit board, check resistance from T11 to T12, T11 to T13, and T12 to T13. Reverse polarity of the test leads by interchanging them at the meter. Repeat the three resistance tests. All of the tests will normally give "open" readings (resistance greater than 20,000 ohms). If any reading is below 200,000 ohms, check to be sure that the motor field is disconnected and that fuse 12FU is removed. If so, replace the E1551 circuit board with a known good board which has the same assembly number stamped in the block following the "E1551" primary identification. Repeat the tests. When satisfactory readings are obtained, proceed with 13.3.2.

13.3.2 Test For Shorted SCR Modules

Test with modules at room temperature. With wires still removed from Terminals T11, T12 and T13, use a multimeter set up per 13.3 to make the following additional resistance checks. Connect one meter lead to the meter shunt (MSH). Touch the other lead to the lower end of line fuse 1FU. Repeat for 2FU and then 3FU. Reverse the meter leads and repeat the three readings. Readings above 200K ohms are normal. Readings of 20K ohms or less indicate a suspected module failure as follows:

Low Reading at:	Suspected Module Failure:
1FU	Module 1
2FU	Module 2
3FU	Module 3

Test the remaining three modules as follows. Attach the first multimeter lead to Armature lug A2 if the PRD12B does not have the contactor option (no contactor under the fuse plate). If the PRD12B does have the contactor option, attach the first multimeter lead to the high-current wire that connects the modules to the contactor. (This wire is labeled either “5”, “51”, “52” or “53”). With the first multimeter lead so installed, touch the other multimeter lead to the lower end of line fuse 1FU. Repeat for 2FU and then 3FU. Reverse the meter leads and repeat the three readings. All readings should be well above 200K ohms. Reading of 20K ohms or less indicate a suspected module failure as follows:

Low Reading at:	Suspected Module Failure:
1FU	Module 4
2FU	Module 5
3FU	Module 6

Use the following Figure to locate the modules suspected of failure.

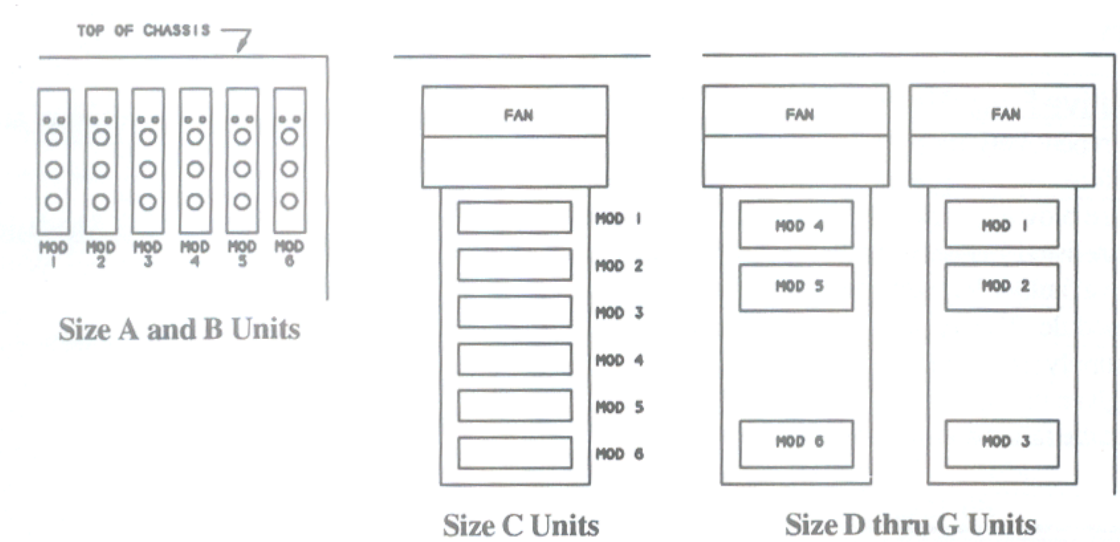


Figure 13
Module Locations
(Select Applicable Configuration)

Remove any suspect modules and replace with modules known to be good. Please note the order in which lugs, bus bars, washers and other hardware are removed and install in the same order when the module is replaced. See Section 14.1 for module mounting instructions. If desired, any suspect modules may be bench tested per Section 13.7 to further verify that they have failed. Discard any modules known to be faulty.

After replacing suspect modules, repeat the tests of Section 13.3.2. When all readings are satisfactory, reconnect the brown, red and oranges wires to terminals T11, T12 and T13 and reinstall fuse 12FU. Reconnect the motor field wires and any other wiring that was disconnected during trouble shooting. Test all fuses and replace any blown ones with identical good fuses.

Please Note that certain infrequently-occurring module faults such as voltage breakdown will not be detected by the previous ohmmeter checks. If fuse blowing continues, factory repair of the PRD12B unit is recommended.

13.4 Retest After Repair

Turn power off. Replace any blown fuses. Hinge the top circuit board (E1546) outward to allow access to the SCR gate connectors 101PL and 102PL on the E1545 circuit board. Unplug these two connectors to prevent SCR firing. Temporarily remove fuse 12FU. Be sure that the loose plugs are not shorted to anything. Apply AC power. If all prior repairs are satisfactory, no fuses should blow. The preceding tests verify that the modules and the E1551 field supply board are probably good. Continue to 13.5, following.

13.5 Test Transformer T10 and Connected Loads

Connectors 101PL and 102PL should be disconnected for this test as they were for the previous test of Section 13.4. Turn AC power off and reinstall fuse 12FU. Turn power on. If no fuses blow, skip to Section 13.6. If fuse 12FU blows, check Section 2.7 of this manual to assure that the correct fuse is being used; also be sure that the correct AC voltage is being applied for the primary jumpering on transformer T10. If all is correct, turn power off and replace 12FU with a good fuse and temporarily remove fuse 5FU (the secondary fuse for transformer T10). Turn power on. If fuse 12FU blows transformer T10 is faulty. Turn power off, replace transformer T10, and retest. Replace fuses 5FU and 12FU and turn power on. If either 5FU or 12FU blows, the connected secondary load on transformer T10 is at fault. Progressively disconnect fans, circuit board E1544, and other loads until the fault is found. (Refer to Schematic A2399-007-ES or A2399-010-ES to assist you in wire tracing).

When all is satisfactory, reinstall connectors 101PL and 102PL. At this point, you may elect to put the PRD12B back into service to check for satisfactory operation, or to perform the following tests to verify satisfactory functioning of the major PRD12B circuit boards.

13.6 Functional Tests with Light Bulb Load

In the following tests, a light bulb load is used to replace the motor armature. The purpose of the tests is to verify correct functioning of the major circuit boards without the hazard of fuse blowing that might occur as the result of misfires into a low-impedance load. Connectors 101PL and 102PL must be connected for the following tests. Also all blown fuses must be replaced. Perform the following tests only after correcting any problems which caused fuse blowing in Sections 13.4 and 13.5.

1) Turn power off. Disconnect motor armature and field leads if not already disconnected from the PRD12B control. Connect light bulbs in the armature circuit as shown in Figure 14. Make sure that the “ARM/TACH” mini-jumper is in the “ARM” position. (Refer to Section 9.5 for location of this jumper.) Be sure that Lugs 1 & 2, Lugs 12 & 13, Lugs 14,15 & 16 and Lugs 28,29 & 30 of terminal blocks 202TB and 203TB) are jumpered together by either metal straps or operator controls. Also, if the PRD12B does not have the contactor option, Lugs 30 and 31 must be jumpered. Temporarily defeat field loss protection (Section 5.6). Turn power on and start the PRD12B control. Vary the speed command from zero to maximum. Brightness of the bulbs should vary from zero to maximum. (Maximum armature voltage will be approximately 240 VDC on 230 VAC controls and 500 VDC on 460 VAC controls.)

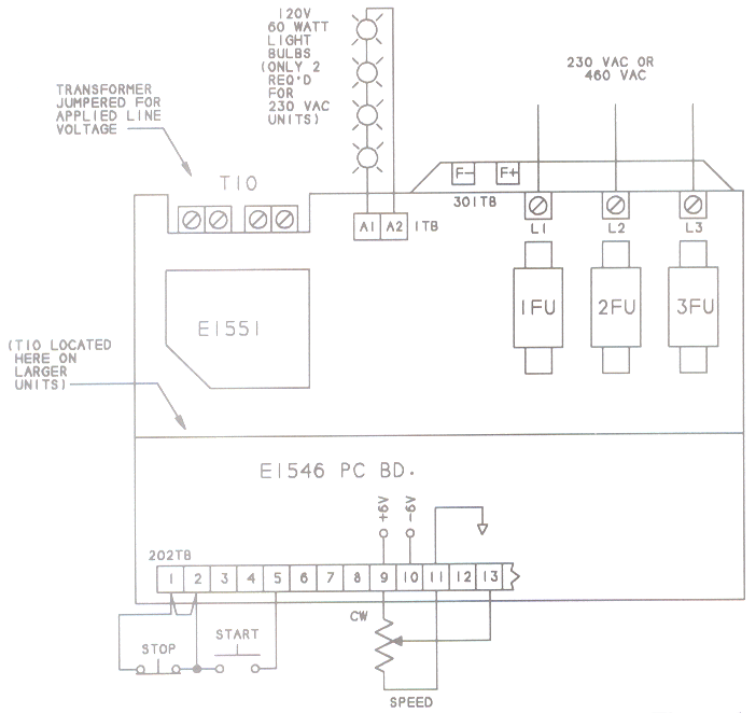


Figure 14
Checking Circuit Boards

2) If the bulbs do not light as indicated in Step 1, the problem is a defective E1544, E1545, or E1546 PC board. The following steps are intended to assist you in identifying which board is defective.

3) Check the speed potentiometer for correct connection. The voltage at 202TB-13 should vary from zero to +6 volts dc as the speed potentiometer is rotated clockwise. Check for correct connection of the START pushbutton. The SPEED indicator LED on the E1546 circuit board should come on and stay on when the START pushbutton is activated. Also check to be sure that none of the fault indictor LEDs on board E1546 are on (the right column of LEDs). If a remote fault and mode indicator panel is included (a plug will be inserted in connector J20), observe the fault indicator LEDs on the remote panel. If any faults are displayed the fault must be located and corrected before further testing can be done. If operation as described in (1) cannot be attained, check power supply voltages per (4), following, and then perform the tests described in (5) to further isolate the source of the problem.

4) Check Power Supply Voltages per Section 13.11 herein. (All power supplies except the +/- 6 volt supplies are located on bottom circuit board E1544. Therefore most indicated repairs will be to board E1544).

5) Further Tests; Bulbs Do Not Burn: The following assumes that the tests of (3) and (4) have been made and that the results are satisfactory. Check the "CR" (Clamp Release) signal as follows on both boards. Connect meter common lead to terminal block 202TB lug 11. Connect the other meter lead to the cathode (banded end) of diode D221. D221 is located near the upper left corner of board E1546. Alternately operate the START and STOP pushbuttons. The meter reading should go to +12 volts DC when the START pushbutton is activated. If it does not, be sure the FAULT indicator is not blinking; if it is not, replace the E1546 circuit board and retest. Now move the meter lead that was on D221 to the undotted end of resistor R115 on lower circuit board E1544. (R115 is located 1-1/2" above and 1" to the right of connector J103).Repeat the preceding test. If the meter reading does not go to +12 volts when the START pushbutton is activated, check the ribbon cable that connects to J103. Inspect plugs on both ends of the cable for bent or broken pins. Replace if necessary.

If the CR signal at resistor R115 is correct but the bulbs still do not burn, test the voltage at tubular test terminal TP9 with respect to the COM test terminal. Both test terminals are located on bottom board E1544 and are about 2" to right of transformer T2. This voltage should vary from zero volts to negative 6 volts as the speed potentiometer in Figure 14 is rotated from zero to the full clockwise position. If this voltage is not as stated, the problem is probably on the E1546 circuit board or in the inter-board ribbon cable. If this voltage is as stated and the bulbs do not burn, the problem is probably in the E1544 board or the E1545 board.

In the foregoing, before diagnosing an E1546 circuit board as bad, be sure that the problem is not due to a defective ACC/DEC option that is plugged into the E1546 board. To verify if the problem is the ACC/DEC board, temporarily unplug this board and use a wire jumper to connect the JP20 terminals on the E1546 PC board. If light bulb intensity can then be controlled by the varying the speed potentiometer, the ACC/DEC option board maybe faulty. Replace with a known-good board, remove the JP20 jumper wire, and repeat the tests.

6) Complaint of Rough Operation: The drive may also shut down on "IOT" faults (Instantaneous Overcurrent Trip) when the control is running a motor. Control operation is otherwise ok. This is difficult to diagnose by looking at the light bulbs; it will show up mainly when running a motor. Use an oscilloscope to observe the voltage wave from across the bulbs. CAUTION: THIS VOLTAGE IS HOT WITH RESPECT TO THE AC LINES. In a properly working control the waveforms repeat every 2.75 milliseconds. If the waveform is not as stated, the problem could be due to a faulty E1545 Pulse Generator board, SCR modules that are not firing, or a faulty E1544 circuit board. To further narrow this down, reconnect the oscilloscope to monitor the pulses at connector J106 pins 2,3,4,5,6 and 7, and also connector J106 pins 1,2,3,4,5 and 6. J105 and J106 are located on the E1545 (middle) circuit board. All readings are made with the scope common clip connected to the "COM" test terminal located to the right of transformer T2 on the E1544 circuit board. The pulses are 12 volts amplitude; there is no shock hazard. You should observe pulse pairs spaced at 2.75 milliseconds which repeat every 16.7 milliseconds (with 60 hz line frequency) at each of the 12 points measured. If so the E1544 circuit board is ok.

7) After completing tests with the light bulb load, re-enable field loss protection by reversing the procedures of Section 5.6.

8) Board Replacement:

a)Replacement of E1544 Circuit Board: Do not adjust any potentiometers on the replacement board. The three adjustments on this board, "IA NULL", "BAL", and "CROSSFIRE", are preset at the factory; the settings are critical and should not be changed.

b) Replacement of E1545 Circuit Board: There are no adjustments on this circuit board.

c) Replacement of E1546 Circuit Board: Several potentiometers will probably have to be readjusted on the replacement board. Commonly, the "MAX" speed adjustment and "IR" require adjustment. Occasionally the "STAB" and "DROP OUT" potentiometers may require adjustment. Refer to Section 10 for more details on adjustments for this board. Observe any "DO NOT ADJUST" stickers that may be in place.

13.7 Bench Testing of SCR Modules

SCR modules may be tested for voltage breakdown or shorted SCR's as shown in Figure 15. All jumpering and termination can be done with 18 AWG wire terminated with lugs. Threads in the power modules may be SAE or Metric depending on the manufacturer of the module; therefore, use only the screws furnished with the modules to make connections. Use adequate safety precautions to prevent a shock hazard. Test on an insulated pad to avoid accidental grounds. None of the light bulbs should burn. If lights burn, the module is faulty and requires replacement. Figure 15 shows three different physical configurations of the modules; type (a) is used in the smaller controls; types (b) and (c) are used on larger controls.

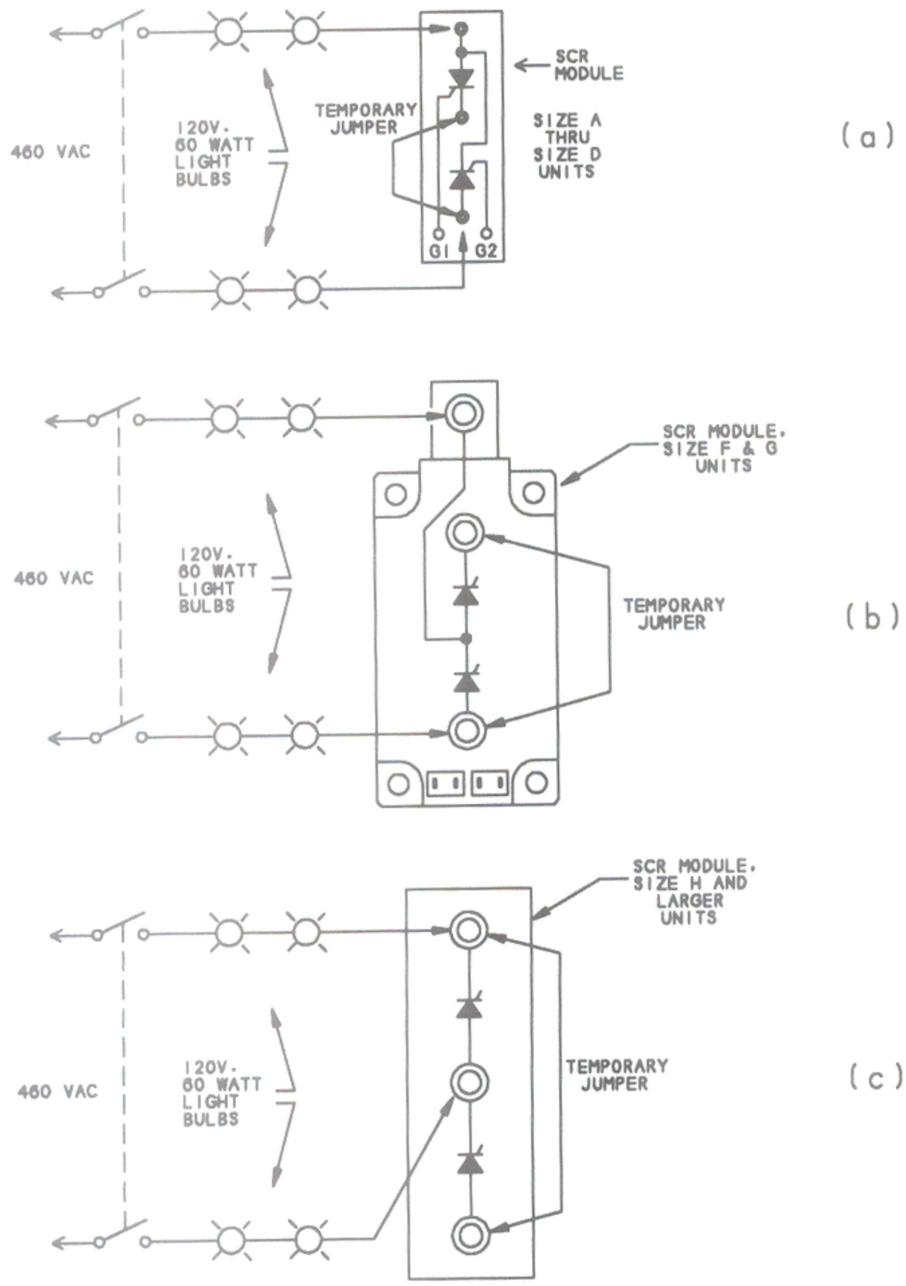


Figure 15
Module Tests for Shorts

Before installing new modules or required-installing the old modules, examine gate pins G1, & 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 material with a small screwdriver.

If shorted modules are found in a PRD12B unit, also check the 1.0 ohm gate resistors, R151, R157, R153, R159, R155, R161, R169, R163, R171, R165, R173, and R167 on the E1545 Pulse Generator Board. Some types of module failures may cause these resistors to open thus preventing the replacement module from working. Replace any of the resistors that read significantly greater than one ohm, or replace the entire E1545 circuit board.

13.8 Procedure If Motor Does Not Run

1) If a fault indicator LED, such as " IOT" or "LOW LINE" is on, pressing a Forward or Reverse pushbutton should get things started. If pressing the Forward or Reverse pushbutton does not clear the fault, the fault may still be present. This would be the case if the unit tripped out on low line and the low line condition was still present when the "Start" pushbutton was pressed.

2) If the drive has been started and the "SPD" Led is on, but the motor will not run, check the speed command voltage at 201TB-13 in respect to common 201TB-11. (It is assumed that the drive in question is a speed programmed drive). This voltage should be +6 or -6volts DC for full speed in one direction or the other. If this voltage is absent and the speed potentiometer is being used as shown wired on drawing A2399-007-EW for the speed reference, check the voltages at terminal 201TB-9& 10 in respect to common (202TB-11). These voltages should be +6 volts and -6 volts respectively. If these voltages are present, the problem could be in the external wiring or the speed potentiometer may be defective. If this is not the problem, make sure that someone has not inadvertently set the "+MAX VOLTS" AND "-MAX VOLTS" potentiometers fully counterclockwise. These were set at the factory to limit armature voltage in each direction to the voltages stated in sections 10.2.8 and 10.2.9.

3) Again assume a speed programmed drive. The control is energized and the "SPD" LED is not on, but the "TORQ" LED is on. The motor maybe jammed under these conditions. Verify, if possible, with power off to see if the motor shaft is jammed. If the motor is not jammed and is not overloaded, verify that the "+Torq" and "-Torq" potentiometers have not been turned fully counterclockwise. Typically these adjustments are set at the Polyspede factory to limit current in the motor to 150% of rated current. This should correspond to a rotation of approximately 75% of full potentiometer rotation.

4) If all appears normal in the preceding steps but the motor still will not run, again verify that the "FAULT" indicator is not blinking. Start the PRD12B control, and set full speed command either +6V or -6V. Measure the voltage at the non-dotted end of resistor R334. This voltage should be fairly close to +6 or -6 volts depending on the polarity of the voltage input. If this voltage is near zero and all previous steps have checked OK, check for a defective ACC/DEC option board (if the PRD12B unit is equipped with this option). To check this, temporarily remove the ACC/DEC option board and place a jumper between the tubular terminals marked "JP20". If the control now becomes functional, replace the ACC/DEC board with a new unit. Remember to remove the JP20 jumper after reinstalling the new ACC/DEC option board.

If the problem persists, replace the E1546 PC board with a known-good board. Be sure that all essential jumpers on the terminal blocks of the replacement board are installed (see Section 13.6, Step 1 for the jumper list). If the problem remains the same as before replacement, it is likely that the problem is either in the ribbon cable that connects the E1546 (top) board to the E1544 (bottom) board or in the E1544 board itself.

At this point, you have the option of either replacing both the ribbon cable and the E1544 circuit board, or of going back to Section 13.6 and performing the applicable tests of Step (5) to further isolate the problem. If you choose the later option, disregard instructions to "replace the E1546 circuit board" or to "replace the ACC/DEC option board" if you have already made these replacements. Also, you may choose to leave the motor connected rather than to connect light bulbs as a load, and to observe motor rotation rather than observing light bulb intensity.

13.9 Procedure if Motor Over Speeds

The most probable causes of this malfunction are loss of speed feedback signal, speed command voltage excessively high, motor field voltage low, or motor field wired improperly.

1) Check the speed command voltage between terminals 202TB-13 in respect to 202TB-11. This voltage should be in the 0 to 6 volt DC range. If an external signal is being used to control speed and operation is normal, except maximum speed is slightly higher than desired, readjust the "Max" potentiometer per Section 10.1.3. (It should be remembered that on standard Speed and Torque programed drives the "+Max Volts" and "-Max Volts" potentiometers have been programed to limit the armature voltage to the values specified in Sections 10.2.8 and 10.2.9 herein.)

2) Check the armature voltage feedback path as follows. (If the PRD12B control uses tachometer feedback, go to Step 3). Be sure that the “Tach/Arm” mini-jumper selector on the E1546 PC board is in the “ARM” position. This is accomplished when the middle and top end pins of this 3 pin vertical jumper strip are connected together by means of a small mini-jumper. (This jumper is located below the "IR" potentiometer). Check to see that the two 18 gauge wires that are connected to the A1 and A2 lugs on the fuse plate have not come loose and that the lug screws are not seated on wire insulation. Also be sure that the yellow #18 AWG wire is connected to the A1 lug and that the green #18 wire is connected to the A2 lug. On the other end, the yellow wire connects to 102TB-4 and the green wire connects to 102TB-5. Make sure that these wires are not clamped on their insulation at 102TB.

3) Check tachometer feedback signals as follows. (If the PRD12B control does not use tachometer feedback, skip this step and proceed to step 4). Problems may be due to tachometer shaft looseness in coupling, tachometer wires reversed or loose, wrong tachometer volts output, or intermittent “Tach/Arm” mini-jumper connections. The most common faults are mechanical problems in the tachometer coupling.

Move the “Tach/Arm” mini-jumper selector on the E1546 PC board to the "Arm" position and recheck the control. (Armature voltage feedback is operational when the middle and top pins of the 3 pin vertical jumper strip are connected together by means of the mini-jumper. Tachometer feedback is operational when the middle and lower pins are jumpered together). If operation is satisfactory in the "Arm" position, the problem is most likely in the tachometer or tachometer wiring. Turn power off and clean the jumper pins. If the mini-jumper itself is in question, replace the mini-jumper and set for “Tach” feedback. If the system has operated satisfactorily in the past, the problem is probably due to slippage in the tach coupling. Tighten all set screws in the coupling and inspect for mechanical damage due to misalignment. If the system has not operated before, verify that the polarity of tachometer voltage is correct. Terminal 203TB-20 must be positive in respect to 203TB-19 when the speed reference at 202TB-13 is positive with respect to 202TB-11 and the “FWD” direction has been selected. (Refer to Detail 1 on drawing A2399-007-EW for more information on correct tachometer polarity). To verify correct tachometer polarity transfer back to armature voltage feedback.

If the system does not operate correctly with the “Tach/Arm” switch set to the “Arm” position, perform the tests in Step 2 above to locate the problem.

4) Measure the field voltage output of the PRD12B unit at terminals F- and F+ on the E1550 Field Loss and Snubber Board. Compare the measured voltage with the field rating on the motor nameplate. Also check for correct connection of the motor field wires. Incorrect field voltage will cause over speed only in systems using armature voltage feedback. (In tachometer feedback systems the control will try to run the motor at the correct speed but an incorrect field voltage can cause reduced output torque capabilities of the motor).

13.10 <u>Procedure To Check For Unstable Operation</u>

The following is a check list of possible causes and cures for unstable operation:

1) “IR” potentiometer is set too far clockwise. Readjust “IR” per Section 10.1.1. Note : The “IR” potentiometer must be fully counterclockwise when using tachometer feedback.

2) Tachometer shaft or coupling is wobbling (tach feedback systems only). This problem can be checked by connecting the “Tach/Arm” mini-jumper selector for the “Arm” position. If operation is smooth, problem is most likely in the tachometer and/or coupling.

3) The motor has a series compensating which has been connected(S1 and S2 leads). Solution: Disconnect the series field and make connection only to the armature wires at the motor. See Section 4.1 for other suggestions if the motor is of this type.

13.11 <u>Power Supply Voltage Checks</u>

All but two of the power supplies that are used on the E1544, E1545 or E1546 PC boards are located on the E1544 PC board. The voltages are supplied to the E1546 PC board through the 5-wire cable that connects P104 to P204. A +36 volt power supply voltage generated on the E1544 board is fed to the E1545 Pulse Generator board through connector J105 on the E1545 board. The E1546 board generates +6 VDC and -6 VDC for use as the speed potentiometer reference voltages.

a) Test the bipolar 6 volt power supplies:

Attach the meter common lead to terminal block 202TB-11. Measure the voltages at lugs 9 and 10 of the terminal block. These voltages should be +6 volts dc and -6 volts dc respectively. (6.2 ±0.3 volts including tolerance). If these voltages are abnormal, disconnect any external wiring going to lugs 9 and 10 of the terminal block and retest. If voltages are then normal, the fault is in the external wiring and not in the PRD12B.

b) Test the bipolar 12 volt power supplies: These voltages are tested on 204TB, the miniature 8 place terminal block located in the lower right corner of the E1546 (top) circuit board. Place the common lead of the meter on 204TB terminal 3. Measure the voltage at terminal 5 and then at terminal 2. These voltages should measure +12 volts and -12 volts respectively. If these voltages are ok skip (c), following, and go to (d). (Tolerance: 12 ± 0.6volts).

c) Test the bipolar 12 volt power supplies directly on E1544 (bottom board): Turn power off and unplug both ends of the cable connected to connector J204 at the lower left corner of board E1546 to disconnect the 12 volt supplies from the top board. Also disconnect both ends of the ribbon cable which connects the two boards. Hinge the top board out of the way and connect the common meter lead to the “COM” test terminal located to the right of transformer T2. Turn power on and probe the “+12V” and “-12V” test terminals with the other meter lead. These test terminals are located near the lower right corner of board E1544. If the readings are unsatisfactory the E1544 (bottom) board is defective. Replace it.

If the readings were satisfactory in this test, either one of the cables or the E1546 (top) board is defective. Turn power off and connect the two cables to the bottom board at J103 and P104. Leave the other ends of the cables loose, but protect the pins against shorting. Turn power on. If the ±12 volt power supplies (measured on the E1544 bottom board) were ok in the previous step but are now out of tolerance, one of the cables is defective; locate and replace it.

If the readings are satisfactory, but become unsatisfactory when the loose ends of the cables are plugged into J203 and P204 on the E1546 (top) circuit board, then something on the E1546 (top) circuit board is overloading the power supplies. (Caution: always turn power off before inserting or removing plugs). Before replacing the E1546 circuit board, turn power off and disconnect all external wiring connected to the board. Disconnect and identify any wires connected to the miniature terminal block (204TB) and unplug any option cables at J202, J208, or J20. Reapply power and retest the ± 12 volt supplies at 204TB as described in (b), preceding. If the supplies are still out of tolerance, replace the E1546 board and retest.

d) Test the 36 volt power supply: The pulses that fire the SCRs are generated from this power supply. Connect the voltmeter across resistor R98 to measure this voltage. R98 is located on the bottom circuit board (E1544) about 2 inches to the right of transformer T2. This is an unregulated supply and the voltage will normally be higher than the nominal 36 volts dc. If the voltage is absent or very low, turn power off and unplug the E1545 board from the E1544 board. Turn power on and retest. If the voltage is now ok the E1545 board is faulty and is loading the power supply on the E1544 board. Replace the E1545 board with a known-good board and retest. If the 36 volt supply output was also abnormal after the E1545 board was unplugged, then the E1544 board required replacement.

e) Test the “HOT” ± 12 volt power supplies: These supplies are connected only to the current signal isolator and the IOT detector circuits. The supplies are located on circuit board E1544 (bottom board). They are not routed to any other board. USE EXTREME CAUTION when making measurements on the “HOT” supplies. The common of these power supplies has direct connection to the AC lines! Electrical shock hazard as well as the danger of equipment damage exists.

Hinge the top board out of the way. Place voltmeter on an insulating pad and carefully connect the common lead of the voltmeter to terminal block 102TB, lug 7 (on the E1544 board). Probe the “-12B” tubular test terminal with the other meter lead. This test terminal is located near the lower left corner of board E1544 (bottom board). Now probe the “+12B” test point which is located on the Cathode of diode D19 (about 1 inch above the “-12B” terminal).

If either of these supply voltages vary significantly from the nominal 12 volts, replace the E1544 circuit board and retest. (Tolerance: 12 ± 0.6 volts).

Table 13-9

14. REPAIRING THE PRD12B

14.1 Replacing SCR Modules

The following assumes that faulty modules have been verified and physically located within the control unit by the procedure given in Section 13.3.2. Turn ac power off before performing any of the following operations. All operations are performed from the top side of the PRD12B unit; it is not necessary to access the rear of the panel to replace modules. The disassembly operations necessary to gain access to the modules vary according to size of the PRD12B unit as follows:

Unit Size	Disassembly Operations
A or B	Disconnect ac line, motor armature, and motor field wiring from the fuse plate. Remove four screws and fold the fuse plate outward to gain access to modules
C thru G	It will be necessary to move the printed circuit board stack aside to gain access to the some of the modules. To do this, remove four screws that attach the metal plate on which the circuit boards are mounted. Move the plate upward or to the left as necessary to access module mounting screws or bolts. It may be necessary to identify and disconnect user wiring from the printed circuit board terminal blocks, depending on the routing of this wiring.

Use Figure 16 as a guide for replacing modules. The bolts or screws that attach the modules to the heat sink are SAE dimensioned. The hardware that attaches bus bars or lugged electrical connections to the top of the module is generally metric, but may be SAE for modules manufactured in the USA. Because of this potential discrepancy, use the screws or bolts furnished with the replacement module for electrical connections.

Remove the faulty module(s); keep track of the order in which lugs, washers and bus bars were removed so that the original hardware stack can be duplicated on re-installation. Also note orientation of any lugs that might short to adjacent parts if they are improperly oriented during reinstallation.

Cleanliness is important when replacing the modules. Use a clean cloth to remove all old thermal grease from the heat sink surface. Apply a thin coat of new thermal grease of the type specified in Figure 16 to the mounting surface of the new module. Assure that no grit, brush bristles or particles contaminate the grease. Some units may use a greaseless mounting pad; if so, do not reuse the original pad. Obtain a replacement pad from the factory or discard the pad and use the specified thermal grease.

Install the new module; assure that hardware is installed in the correct order as noted during removal. Tighten screws and/or bolts to the torques specified in Figure 16.

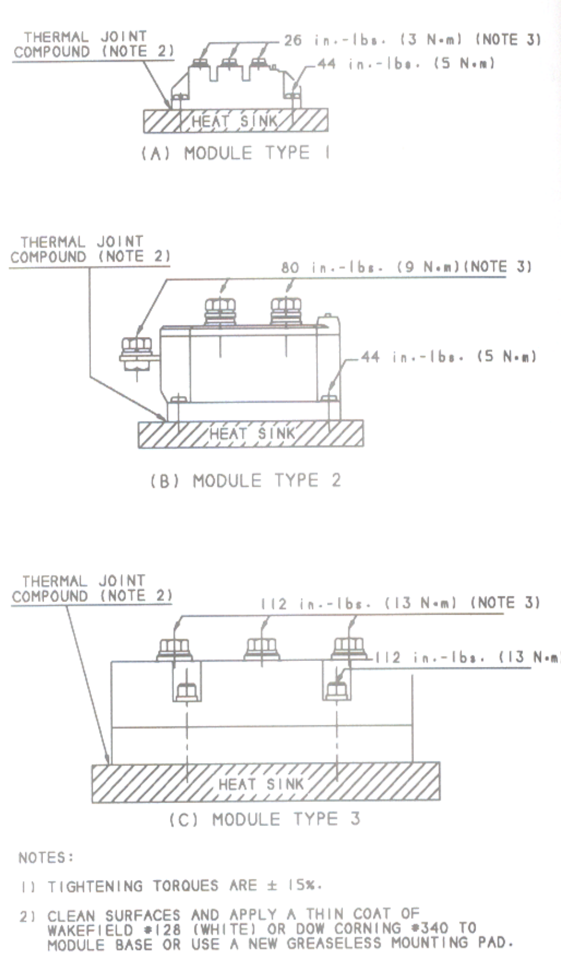


Figure 16
Module Replacement

14.2 Fuse Replacement

Fuses 11FU, 12FU, 13FU, 5FU and 201FU are the cartridge type that snap into fuse clips. With ac power off, locate the blown fuse by in-circuit tests using an ohmmeter set to the lowest resistance scale. Refer to Table 4 for replacement fuse types. Replace any blown fuses using standard procedures. Note that the center fuse(12FU) on circuit board E1551 is not the same amperage rating as the two outer fuses(11FU and 13FU) even though the fuses are visually identical. Do not mix these fuses. Fuses 1FU, 2FU, 3FU and 4FU are silver-link rectifier-protection fuses. See section 2.7 for approved replacement types. Do not use unapproved substitutes. With ac power off, locate the blown fuse by in-circuit tests using an ohmmeter set to the lowest resistance scale. Remove any blown fuses by removing one hex nut and associated washers from each mounting stud. Do not remove any washers or lugs below the fuse. Replace blown fuses and tighten the hex nuts securely.

14.3 Replace Circuit Board E1546 (top circuit board)

Compare the number stamped in the white block following the "E1546" notation on the original circuit board with that of the replacement board. If there is a disagreement, contact the factory. In some cases field modifications are possible to correct discrepancies. Do not install a replacement board until numbering discrepancies are resolved.

Remove the original E1546 board as follows. Disengage the connector from plug P204 and disengage ribbon connector 203PL. Be careful not to bend any of the pins on 203PL. Disconnect the white and grey factory wires from lugs 3 and 8 respectively on terminal block 204TB. Identify and remove all user wiring connected to the circuit board terminal blocks. Inspect the metal jumpers on terminal blocks 202TB and 203TB of the original board and compare with replacement board. If jumpers are missing on the replacement board or differ from the original board, move jumpers from the original board to the replacement board.

Remove the screws, nuts, and associated washers that attach the E1546 circuit board. Lift board E1546 off.

Remove the following items from the original circuit board and install on the replacement board in identical locations:

a) One nylon spacer under the circuit board.

b) Metal nameplate and associated spacers.

c) Plug-in acceleration option board if so equipped. Check the wire jumper labeled "Cut To Add ACCEL Unit" on the replacement board. This jumper must be cut on the replacement board if an acceleration board is moved from the original board, or alternately must not be cut if an acceleration board is not installed.

d) Any option boards and mounting hardware located under the nameplate or elsewhere on the E1546 board.

e) The program plug from J28, if there is no program plug in the replacement board, or if the program plugs are labeled differently.

14.4 Replace Circuit Board E1545 (middle circuit board)

Remove two or three mounting screws (as applicable) which secure the top board (E1546); hinge the top board aside to allow access to the E1545 circuit board. Note that the hinged spacers upon which the E1546 board are mounted are secured with hex nuts; do not remove the nuts. Remove only the screws (Phillips or slotted head) that secure the top board to the spacers which are not hinged.

Unplug the connectors which are plugged into 101PL, and 102PL at the top of board E1545.

Complete the removal of the E1545 circuit board as follows: Release the locking blades on five mounting spacers by squeezing with long-nose pliers and then moving the board outward so that the mounting hole in the circuit board holds the locking blade in the released position. Carefully disengage connectors J105 and J106 from their mating pins by moving the E1545 board further outward; the board can then be removed.

Install the new E1545 circuit board by reversing the preceding steps. At this date, there are no assembly variations of the E1545 circuit boards, so comparison of identification marks on the original circuit board with those on the replacement board is not necessary.

14.5 Replace Circuit Board E1544 (bottom circuit board)

Remove the screws and the hex nuts which fasten the top board (E1546) to the metal mounting spacers and hinged spacers. Move the top board aside. Unplug the connectors which are plugged into 101PL and 102PL at the top of board E1545. Unplug connectors P104 and 103PL. Disconnect wiring from 102TB.

Unscrew the metal spacers from the mounting studs which project through board E1544. Carefully remove the lock washer from each stud. Lay out the hinged spacers in order to assure that they are replaced on the same stud from which they were removed. Now remove board E1544 with middle board E1545 still mounted on it. Remove the "piggy back" E1545 board with its mounting spacers attached by releasing the plastic locks under the E1544 board. Squeeze each lock with long-nose pliers and push it through its mounting hole in board E1544; also disengage the pins from connectors J105 and J106 by applying force to separate the two boards.

Inspect the replacement E1544 circuit board. Be sure that a "Shunt Cal "resistor plugged into the terminals (if it is not, remove the "Shunt Cal" resistor from the original circuit board and plug it into the replacement board; the "Shunt Cal" resistor is located 3" above plug P104). Compare the identification digits stamped on each board in the white block adjacent to the "E1544" notation on the board. These stamped digits must agree; if they do not, consult the factory before proceeding. The boards are field modifiable, but instructions are required.

After determining suitability of the replacement circuit board, install the E1545 board which was removed in the prior steps on the replacement E1544 board by carefully guiding connector pins into J105 and J106 and then snapping five plastic spacers into mating holes on the replacement E1544 circuit board.

Install the replacement E1544 board on the six mounting studs. Thread the six mounting spacers onto the mounting studs which project through the circuit board, being sure that the hinged spacers are installed on the same studs from which they were removed. Tighten the hinged spacers until the threaded stud on top of the hinge points at a fixed spacer on the opposite side of the circuit board to align the hinge for proper hinging action. . Plug mating connectors into P104 and J103, being careful not bend the pins on plug P103; be sure the pins are all in holes before applying pressure. Attach wires to terminal block 102TB.

Install top board E1546 on the mounting spacers by reversing the steps used during removal. Install the hex nuts on the hinged spacers first and check for proper hinging action before installing the screws on the fixed spacers.

14.6 <u>Replace Circuit Board E1551 (fused field supply board)</u>

Be sure that ac power is off. Unplug all wires which are connected to the board by fast-on connectors. The white/red and the white/black/orange wires are captive. Cut cable ties as necessary while following these wires to their termination point on the primary screws of transformer T10. Disconnect the two wires at transformer T10. Unscrew four mounting screws which fasten circuit board E1551 to mounting spacers and remove the circuit board with the two captive wires attached.

Inspect the replacement circuit board. The digits stamped in the white block located to the right of the "E1551" notation must be identical to the corresponding numbers on the original circuit board. Pay particular attention to the last digit; a "2" at this location indicates that the board is for a 240 volt motor field. See Section 5.5 if there is a discrepancy in this digit. The first digit of a 3-digit number stamped in the white block indicates the length of the captive wires.

Once suitability of the replacement board is verified, remove fuses from the original board, test, and install them on the replacement board. Be sure that the center fuse (12FU) is installed in the center clips of the replacement board. This is a lower amperage fuse than the other two. See Section 2.7 for correct fuse types if replacement of any fuse is required.

Install the replacement board. Reconnect all wires. Install new cable ties along the route of the two captive wires.

14.7 <u>Replace Circuit Board E1550</u>

This circuit board is located under the fuse plate in the vicinity of the ac line fuses. Be sure that ac power is off. Disconnect the motor field wires from terminal block 301TB of this circuit board. Disconnect the white and grey twisted pair from terminals at the lower right corner of the board. Remove four mounting screws from the top side of the fuse plate to allow removal of the circuit board (the mounting spacers will be captive on the circuit board). The circuit board will still be attached to the control unit by five captive (soldered) wires. Proceed as follows to remove these wires at their termination points.

Remove the three ac line fuses 1FU, 2FU and 3FU. Note that the brown, red and orange wires that are soldered to the circuit board are terminated, along with two other wires of the same color code, on the lower mounting studs for the three line fuses. Remove one hex nut from each stud. Lift lugs and washers from each stud paying particular attention to the number of washers removed and the order in which the lugs are installed as well as the orientation of the lugs so that they can be correctly re-installed. Lift off the brown, red and orange wires that connect to circuit board E1550 and cut cable ties as necessary to free the wires from adjacent wiring. Now trace the white and white/yellow wires from board E1550 to the power modules. Remove the bolt or screw that attaches these wires to the modules, noting the order of hardware and the orientation of the wire lugs. Clip cable ties as necessary to free the two wires.

The faulty E1550 circuit board may now be removed. Compare the digits stamped in the white block following the “E1550” notation on the replacement board with the digits stamped on the original board. They should agree. In the case of this particular board, the digits primarily specify the lengths of the attached wires and the size of the terminating lugs. If there is a disagreement between the digits stamped on the replacement board and the original board, it can usually be resolved by removing the wires from the original board and soldering them to the replacement board. Compare appearance of the two boards to be sure that everything else appears to be identical.

When suitability of the replacement board is verified, install it by reversing the operations performed in removal. Be sure that the nuts on the lower fuse studs are securely tightened against the lugs of the three color-coded wires, and that the correct number of washers are installed on each stud. (The fuses are leveled by the number of washers used). Re-install the ac line fuses and reconnect the motor field wires.

15. TROUBLE-SHOOTING, MOTOR

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

a) Shorts To The Frame - Using a megger set to the voltage indicated below to check leakage resistance from motor frame to the A1 and A2 leads and to the motor field leads. Resistance readings less than those shown below 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 several times after rotating armature by hand.

Armature Voltage Rating	Set Megger to(volts)	Minimum Leakage Resistance
240	**400**	**10,000 ohms**
500	**800**	**20,000 ohms**

b) **Open or Shorted Field -** Check resistance between motor field leads. The table below gives typical resistance readings that should be observed in motors in the 3 hp to 200hp range. The minimum resistances apply to the higher horsepower motors, while the maximum resistances apply to the lower horsepower motors. The resistances are therefore intended as guidelines only. For fields with more than one winding the windings should be correctly connected before making the resistance measurements.

Field Voltage Rating	Typical Min. Resistance	Typical Max. Resistance
150	**8 ohms**	**125 ohms**
300	**30 ohms**	**500 ohms**
240	**20 ohms**	**300 ohms**

c) 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 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.

16. SYSTEMS DESIGN USING THE PRD-12-B

The following guidelines and examples are presented to provide the users with a better understanding of some of the major features of the PRD12B that can be used by machine designers to satisfy many complex design requirements.

Regenerative drives open entire new fields of application when compared to the traditional non-regenerative DC drive. The most obvious of these in the conventional speed-control category is elevator service in which the motor must provide holdback torque when the car is being lowered or when it is stopping. The motor will be generating under these conditions. In this same category is hoist duty where holdback torque must be provided during load lowering. Other workhorse applications include those involving frequent starts and stops and driving high-inertia loads. Most of these examples are straightforward speed-control applications not covered by example herein.

The largest gain of the PRD12B, in new fields of application, however, is in bi-directional torque control rather than in speed control. Examples of the types of applications that might use torque-programed drives include material winders, material unwinders, long conveyors that use multiple drive points, test stand loading of hydraulic or electric motors, and replacement of eddy current or friction brakes. In these applications the speed of the DC motor to which the PRD12B is connected is determined by the machine to which the DC motor is coupled and not by the PRD12B control. Additionally, thee are a number of applications in which the PRD12B exercise s normal speed control during part of a machine cycle and torque control during another part of the machine cycle. One such application is illustrated in Section 16.3.4. It is important to note that the DC motor is the prime mover of choice for these torque controlled applications. In spite of the recent advances in AC motor speed control, the AC motor is not an effective replacement for a DC motor driven by a well-designed regenerative control in applications where the basic need is for torque control rather than speed control. Accordingly, over one half of the application examples in this section relate to torque control.

In the following examples the terms "Torque Limit" and "Current Limit" are used interchangeably in that the torque produced at the shaft of a DC motor is directly proportional to the armature current in the motor; limiting armature current therefore also limits motor shaft torque. Similarly, "Torque Programed Drive" means that armature current is programed rather than speed.

Sections 16.2 and 16.4 provide a more detailed description of speed-programed controls, torque-limit programming and torque-programed controls. The PRD12B provides the user with the ultimate in flexibility; the unit is convertible from a speed-programed unit to a torque-programed unit by changing program plug as described on Page 2.4 of this manual.

16.1 <u>Description of Operation</u>

The PRD12B is programed by connections which the user adds to Terminal Block 202TB on the E1546 board of the PRD12B control. Sections 16.2.1 and 16.2.2 are devoted to describing the input characteristics of the various terminals on 202TB when the unit is equipped with a "SPEED" program plug. Similarly, Sections 16.4.1 through 16.4.3 are devoted to describing the input characteristics of these same terminals when the unit is equipped with a "TORQUE" program plug.

The following two sections describe the metering outputs of the PRD12B unit which may also be used as a command voltage in the follower applications such as those described in Sections 16.3.3. and 16.5.2.

16.1.1 <u>Speed Meter Output(202TB-17)</u>

Voltage at this terminal in respect to common 203TB-22 indicates direction and magnitude of the motor speed independent of whether the drive is being used in a speed or torque programed mode.

If armature voltage is utilized as speed feedback in the drive, the output voltage at 202TB-17 is proportional to armature voltage minus IR compensation. If "IR" is optimized, the voltage at the speed meter terminal is a true speed indicator within accuracy and stability limits of motor Kv (voltage constant, volts/radian/sec). The output varies from approximately 0 to 6 volts as the voltage varies form zero to 250 VDC on the armature if the control is set to run on 230 VAC input. The output also varies from 0 to 6 volts as the voltage varies from zero to 500 VDC if the control is set to run on 460 VAC input. The polarity of the signal changes depending on whether the armature output terminal A1 is positive or negative in respect to terminal A2. If A1 is positive in respect to A2, the polarity at 202TB-17 in respect to 203TB-22 will also be positive. If of the opposite polarity, the voltage will be negative.

If tachometer feedback, calibrated as described in Section 2.6.2 is utilized, the voltage at terminal 202TB-17 will be as described in the previous paragraph, but once metering is calibrated to this signal, the output signal is a direct indication of motor speed only dependent on inherent accuracy of the tachometer.

The output voltage at terminal 17 is well filtered and is suitable for use as a command voltage for follower units, for speed level detection, or for speed meter readout. The output resistance at terminal 17 is 22ohms. Motor speed is not affected by external loading at terminal 17.

16.1.2 <u>"IA" Current Output (202TB-18)</u>

Voltage at this output terminal indicates the polarity and magnitude of the armature current independent of whether the drive is operating in a speed or torque programed mode. The output voltage at terminal 202TB-18 in respect to 203TB-22 is approximately 2 volts when rated current (as given on the nameplate of the control) is flowing in the motor armature. Polarity is negative when armature current is positive (flowing out of terminal A1). See Table 1, Section 2.2 for precise scale factors of the voltage at Terminal 18.

Terminal 202TB-18 is a convenient place to monitor armature current since the signal is isolated from the actual armature current. Accuracy of the readout is 2% or better. The output resistance at terminal 18 is 390 ohms. Torque limit settings are not affected by external loading to terminal 18. The voltage at terminal 18 is lightly filtered to remove most of the carrier frequency form the current signal isolator. If this signal is used in a torque follower application, it may be necessary to add some external smoothing networks; polarity inversion is also necessary.

16.2 <u>Speed Programed Drives</u>

The standard PRD12B is a speed programed unit with full-range torque limit adjustment. The direction of motor rotation is determined by the polarity of the speed command voltage while the speed of the motor is determined by the magnitude of the speed command signal.

The <u>*magnitude*</u> of the torque limit setting may be adjusted by the internal potentiometers, by an external torque limit potentiometer, or by an external voltage signal (0 to +6 VDC). Thus the torque limit is also programmable. Programming the torque limit effects only the magnitude (value) of armature current which may flow. The actual direction of current flow (and thus of motor shaft torque) is determined by a combination of the polarity of the speed command voltage and the nature of the motor shaft load. (Note: In applications where programmable torque control is needed, if control of both <u>*magnitude*</u> and <u>*direction*</u> of motor shaft torque is required, a torque-programed PRD12B is needed. For comparison purposes, you may wish to skip ahead to Section 16.4 which describes Torque Programed Drives).

The following sections 16.2.1 through 16.2.2 further describe the use of the primary (speed) program input and the secondary (torque limit) program input and associated adjustments as they relate to speed-programed PRD12B units.

16.2.1 <u>Speed Command Input (202TB -13)</u>

The speed programed PRD12B control can be programed from either a unipolar or bipolar 0 to 6 volt signal. In addition, the standard control can be programed from a 4 to 20 ma signal. A mini-jumper designated as "INPUT TYPE" must be set in the proper position depending on the type of signal being used. Refer to Section 9.4 for more details on setting this jumper. When using the bipolar input signal, the polarity of the signal at terminal 202TB-13 determines the direction of motor rotation and the magnitude determines how fast the motor will run. Positive input polarity voltage at 202TB-13 commands terminal A1 to be positive in respect to terminal A2 if the control is energized through the Forward pushbutton as shown on drawing A2399-007-EW. Negative input polarity voltage at 202TB-13 commands terminal A1 to be negative in respect to terminal A2 if the Forward pushbutton activates the drive. (The polarity of voltage between lugs A1 and A2 reverses from what is stated above if the control is actuated with the Reverse pushbutton as shown on A2399-007-EW.) The maximum level of 6 volts with either polarity will typically command a maximum voltage of 240 VDC (230 VAC input controls) or 500 VDC (460 VAC input controls) per the normal factory setting of the "Max" speed potentiometer setting when using armature voltage feedback and when no IR compensation is used. The input resistance at this terminal is 100K ohms.

16.2.2 Torque Limit Command Input (202TB-14)

The PRD12B control is supplied with internal "-Torq" and "+Torq" potentiometers. The setting of these potentiometers commands the magnitude of armature current at which the PRD12B will stop regulating speed and will start regulating current. At this "crossover" point the PRD-12B begins to act as a constant-current device and the motor delivers constant torque rather than running at regulated speed.

The voltage applied at terminal 14 is furnished to the clockwise end of both the "+Torq" and "-Torq" potentiometers. In most cases this voltage is +6 volts. This voltage is obtained by jumpering terminal 14 to 15 on 202TB. In some applications it may be desirable to have remote adjustability of the "+Torq" and "-Torq" limit settings. Figure 17 shows both the standard connection and the optional remote torque limit connection. (Refer to Detail 3 on A2399-007-EW for additional hook-up information of the torque limit program terminal.) The standard control has its "+Torq" and "-Torq" potentiometers adjusted to limit maximum motor current to 150% rated current. If an external "Torque Limit" potentiometer is used, the external potentiometer can be used to adjust the torque limit point from zero to 150%rated motor current. (The exception is "D" size 50/100 HP open chassis controls. These units have "+Torq" and "-Torq" adjusted for 130% of rated current.) It can be noted from Figure 17, however, that the internal "-Torq" and "+Torq" potentiometers serve as calibration adjustments for the external potentiometer. It may be desirable in some applications to reset the internal "+Torq" and "-Torq" potentiometers so that the external "Torque Limit" potentiometer, if used, would be able to adjust only 0 to 100% of rated motor current. (Since the "+Torq" and "-Torq" potentiometers adjust the maximum current capability from 0 to approximately 200% of rated current with 6 volts applied to the clockwise side of the potentiometer, a setting of approximately mid-point (50% full rotation) should set a maximum of 100% rated current.)

The input resistance of the torque limit circuits as viewed from terminal 14 of 202TB in respect to common which is 202TB-11 is approximately 25K ohms or greater depending on the actual setting of the "+Torq" and "-Torq" potentiometers.

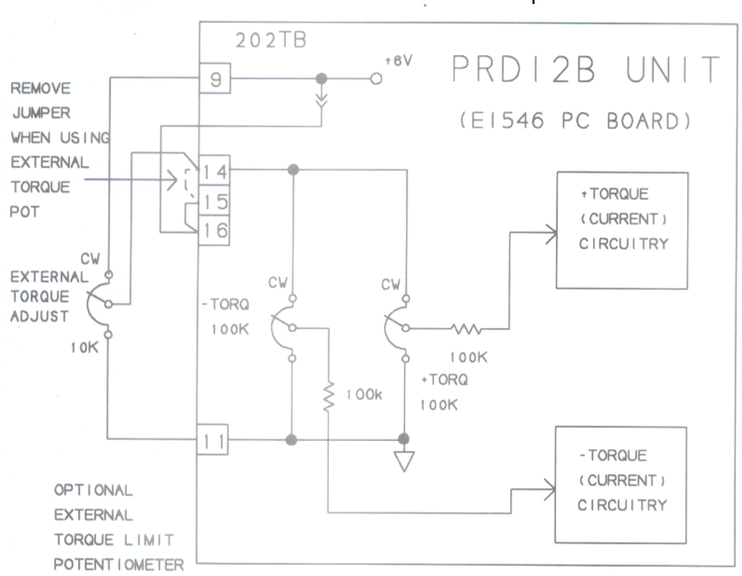


Figure 17
Simplified Torque Command Circuitry Depicting Internal and External Torque Adjust Potentiometers

16.2.3 <u>Maximum Armature Volts</u>

The "+Max Volts" and "-Max Volts" potentiometers are factory set and should not be readjusted in the field except to decrease maximum allowable armature voltage. These potentiometers set the maximum armature voltage at to the values specified in Sections 10.2.8 and 10.2.9 herein. When these levels are reached, both the speed and torque regulator loops are disconnected and neither loop regains control until the armature voltage falls below these maximum limits. On most speed programed drives it will be desirable to leave these settings at the maximum permissible levels to permit normal operation. In some cases it may be desirable to remotely vary the armature voltage limits to values less than the factory setting. This is easily accomplished through the use of the hook-up shown in Figure 18, following. (Detail 4 on A2399-007-EW External Wiring also shows the proper connections to the "+Max Volts" and "-Max Volts" potentiometers.)

When external "+Max" and "-Max" potentiometers are added as shown in Figure 18, the internal potentiometers should be left at their factory settings so that the range of control of the external pots is as stated earlier in this section.

A single "±Max Volts" external potentiometer can be used to control both speed clamps if terminals 15 and 16 are jumpered.

16.3 <u>Speed programed Applications</u>

Basic topics such as pushbutton operators, directional control using a speed potentiometer, tachometer feedback and basic external signal control are well covered in Section 2.5 herein as well as in the various details of External Wiring Diagram A2399-007-EW in the Appendix; these topics will therefore will not be further covered in this section. Instead, the following application examples were selected to give the user insight into moderately complex systems such as multiple drive systems, material winders and the advantageous use of the programmable torque limit feature of the PRD12B.

The material unwinder example of Section 16.3.5 demonstrates the use of the *<u>programmable torque limit</u>* feature of a Speed Programed PRD12B. When the PRD12B is used as shown, the motor acts as a passive brake, very similar to an eddy-current brake (except performance is superior in that torque can be applied at zero speed).

By contrast, the next section, "Torque Programed Drives" will illustrate using a *<u>true torque programed</u>* PRD12B in this same material winder application. (See Section 16.5.1). When a true torque programmed drive is used, the motor functions as a *<u>torque motor</u>* rather than a brake, thereby providing superior performance under dynamic conditions such as acceleration and decelerating as explained. Comparative reading of these two sections will clearly illustrate this difference as well as the versatility of the PRD12B .

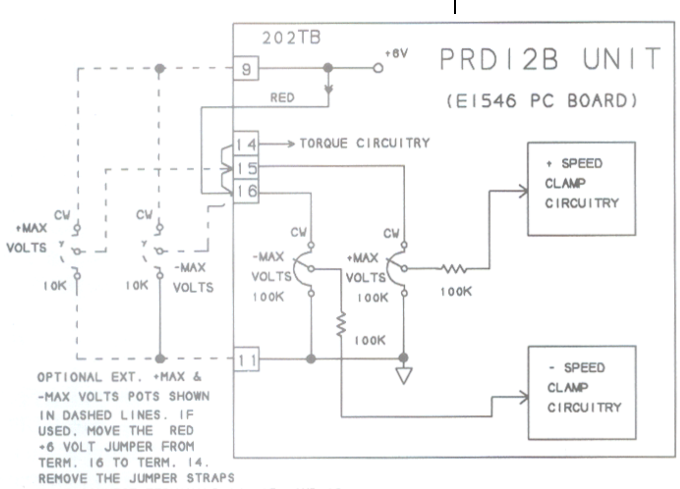


Figure 18

Simplified Speed Clamp Circuitry Showing Internal and Optional External "+Max Volts" and "-Max Volts" Potentiometers

16.3.1 External Signal Control of Speed

External signals from a variety of sources can be used in lieu of a speed potentiometer to control motor speed.
Refer to external wiring diagram A2399-007-EW, Details2, 11, 12, 13 and 14.

Suitable external signal sources, among others, include the following:
a) Process Instrument
b) Polyspede's MicroLoc Microprocessor Controller with D/A Converter
c) Programmable Logic Controller or Computer with Analog Output.
d) Polyspede Master Acceleration Unit
e) Polyspede Master Reference Unit

The external signal should be a smooth DC voltage, 0 to 6 volt range, and of the polarity required for desired direction of rotation. Internal signal isolation in the PRD12B eliminates the need for external signal isolation, but if the external voltage source in the example cannot tolerate an earth ground on its output lead, then the normal earth ground connection to 202TB-21 or 22 should be removed. This will allow the signal common of the PRD12B to float.

For external voltage sources with outputs higher than the required 6 volts, provide an external voltage divider. The input resistance of the PRD12B should be included in the calculations for the divider.

The control is also capable of being speed controlled with a 4 to 20 MA signal without any extra optional equipment. This is accomplished by proper placement of the "INPUT TYPE" mini-jumper as explained in Section 9.4 of this manual. For other process signals such as 1 to 5 MA, 10-50 MA, etc., it is recommended that an external signal interface board be purchased from Polyspede Electronics. This external signal board will provide the required calibration resistor and circuitry for converting a current span signal to the required 0 to 6 volt level.

Long leads between an external signal source and the PRD12B should be shielded and should not be routed in conduit with the power wiring.

16.3.2 Multiple Drives, Single Speed Command

Figure 19 illustrates one way in which a group of PRD12B units can be operated from a single speed potentiometer. The ±6 volt power supplies in PRD12B No. 1 are used to excite the "Master Speed Setter" potentiometer so that it can command either forward or reverse speed. The "Trim" networks shown at each PRD12B input provide means for trimming speed of any unit downward by approximately 9%. The internal "MAX" potentiometers can be used for additional up/down trim of speed.

The PRD12B units should not be equipped with an acceleration option. If adjustable coordinated acceleration and deceleration times are desired, the speed input lines should be driven by a Polyspede master acceleration unit in lieu of the potentiometer shown. If one drive changes speed due to torque limit, the speed of the other drives is not affected. As many as six PRD12B units may be connected as shown in Figure 19 without causing excessive non-linearity in the "Master Speed Setter" potentiometer. Such non-linearity does not affect speed tracking between the drives, but does cause dial divisions on the master speed potentiometer to be an imprecise indication of the speed being set. Isolation transformers are not required since the signal commons of all the drives are isolated from the AC lines. The signal lines in Figure 19 may alternatively be driven by an external voltage signal in lieu of the potentiometer. (Remove the grounding wire from 203TB-22 in all of the PRD12B units except one to avoid ground loops.)

Trim potentiometers of higher value may be used for greater trim range. Potentiometers with 100K ohm resistance will give a 50% downward speed trim, but adjustment resolution is decreased and maximum interaction increases from 0.05% to 0.25% of set speed.

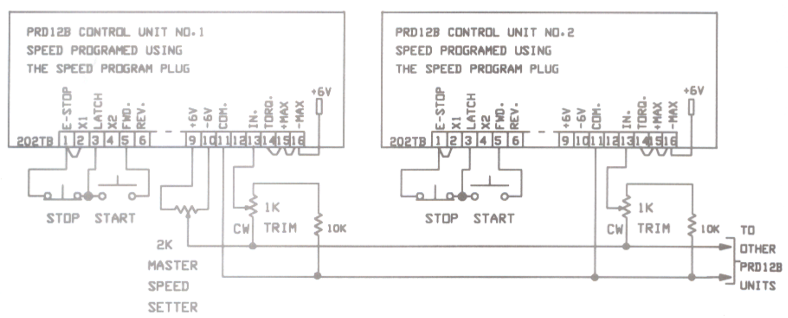


Figure 19
Multiple Controls Coordinated With a Single Speed Command Signal

16.3.3 Multiple Drives with Speed Slaving Between Sections

If the lead unit in Figure 20 changes speed for any reason including slowdown due to torque limit, all slave units will faithfully track its speed change. This is true because the output voltage at 202TB-17 of the lead unit is proportional to speed regardless of the mode of operation (see Section 16.4). If the lead unit is equipped with an acceleration option, the slave units should not include the acceleration option since they will accelerate at the rate set by the lead unit.

Terminal 13 on 202TB of the lead unit may be driven by an external 0 to +6 volt signal in lieu of the "Speed Adjust" potentiometer shown.

It is not necessary to reverse armature connections of the lead motor to achieve the same direction of rotation in the lead and slave motor. This is because the voltage at terminal 17 ("Meter" output) and terminal 13 ("Speed" input) on 202TB are of the same voltage polarity on the PRD12B control. Remove the grounding wire from 203TB-22 on the follower control to avoid a ground loop.

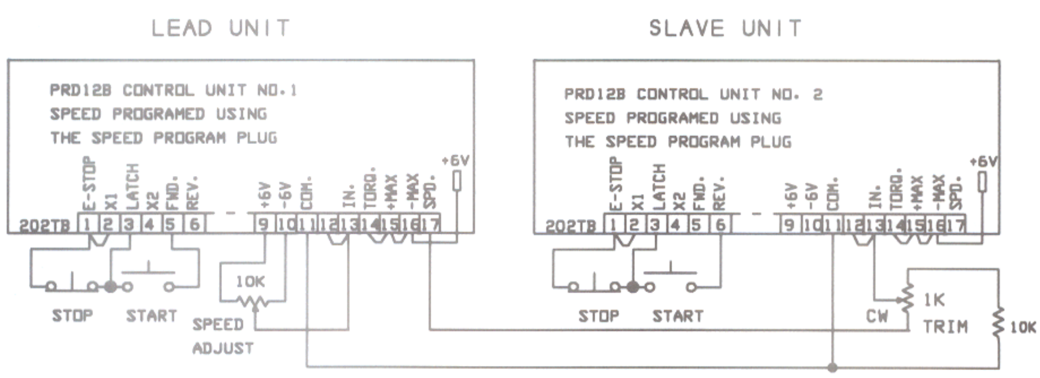


Figure 20
Multiple Drives with Speed Slaving Between Sections

16.3.4 Speed Control With Part-Time Torque –Limit Control

Refer to Figure 17 in section 16.2.2 for typical connections and an explanation of adding an external torque potentiometer. The external adjustment range extends to zero and the internal potentiometers ("+Torq" and "-TORQ") can be used to calibrate the full scale range of the external potentiometer. (These potentiometers can limit the maximum current from 0 to 200%. Typically the internal potentiometers are set to limit the current to 150% of rated current. This corresponds to approximately 75% of full rotation on these potentiometers.)

Figure 21 illustrates one way in which external torque (force) control can solve a machine design problem. In Figure 21 the car is to drive forward until it nears the material stack, then it must slow down. As the pickup head contacts the material stack, the car is to stop, but the pickup head must push up against the material stack with controlled holding force. The holding force prevents back-away until a signal is received to reverse. At this time the car is to back away carrying a sheet of material.

In a typical implementation of this cycle a programmable controller is used to activate various speed in either the forward or reverse mode of operation. This application could be accomplished in a variety of ways including the use of the Preset Speeds Option shown, and FWD and REV contacts to control direction. The method shown in Figure 21 depicts four possible speed settings, two in the forward direction and two in the reverse direction. Each direction would have a high and low speed mode of operation. Therefore, the programmable controller would be adjusted so that as the car approaches the material stack at a low speed it contacts the switch as shown in Figure 21. As the limit switch activates, the voltage at 202TB terminal 14 is reduced from + 6 volts to the voltage preset on the "Holding Torque" potentiometer wiper. This reduces the torque limit setting from 150% of rated torque to a lower preset value. With a forward speed command still present, the PRD12B operates in a torque limit mode and the car pushes against the material stack with a forced determined by the setting of the "HOLDING FORCE" potentiometer. This force is applied until a reverse speed command causes the car to back away at which time full torque again

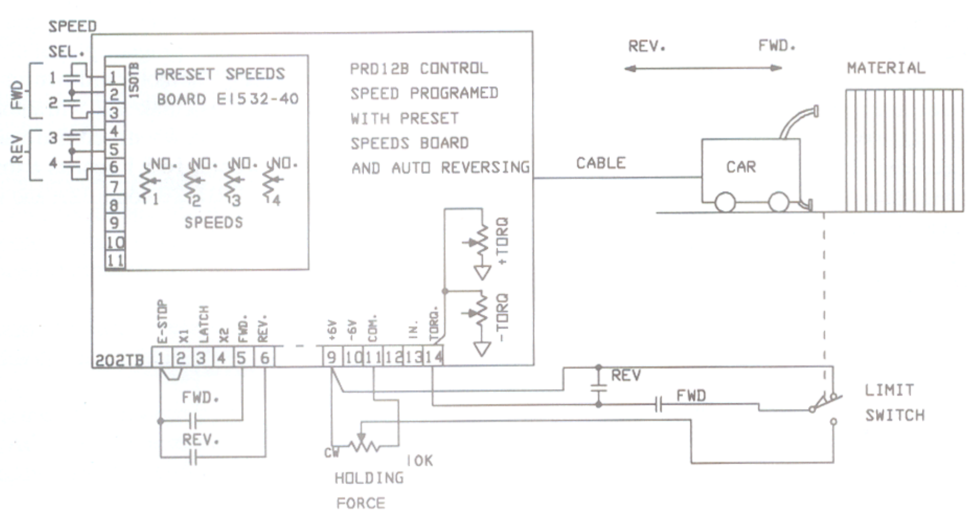


Figure 21
Material Transport System

becomes available. All contacts designated "FWD" or "REV" are either part of the programmable controller or are closed by the programmable controller at appropriate times. The "REV" contact should be closed anytime a reverse speed is commanded. The "FWD" and "REV" contacts shown in the limit switch circuit are necessary because the voltage connected to 202TB-14 supplies voltage to both the "+Torq" potentiometer (forward motoring current limit) and "-Torq" potentiometer (reverse motoring current limit); this voltage must be restored to +6 volts during back-away to assure adequate torque.

If the "HOLDING FORCE" potentiometer is set so that the motor furnishes less than the rated torque, the "OVERLOAD" light on the PRD12B unit will not come on while holding force is being applied and there is no possibility of an overload shutdown while awaiting a reverse command. (Limit switch contacts and any other contacts used directly in the +6 volt path must be of the dry-circuit type, typically gold-flashed contacts).

16.3.5 Material Unwinder (Torque Limit Programming)

In the material unwinder shown in Figure 22 speed is programmed to zero (202TB-13 is connected to 202TB-11 common); therefore, the motor will not turn unless its shaft is rotated by an externally-applied force. As the process machine pulls material from the feed spool, it rotates the DC motor shaft. Circuitry in the PRD12B senses that speed is not zero and causes the motor to apply an opposing torque in an attempt to satisfy the zero-speed command. Unable to regulate speed, the PRD12B automatically switches into torque limit mode and regulates torque at the value commanded by the external torque limit potentiometer, which in this case is labeled "Tension Adjust". With "IR" correctly adjusted, the crossover to torque control occurs at a very low speed, typically 1% to 2% base speed or 17 to 35 rpm if a 1750 RPM motor is used. The PRD12B and DC motor act very much like an eddy current brake, except power is returned to the ac lines rather than being dissipated as heat, thereby reducing the machine operating cost and energy consumption. Also, low speed performance is greatly improved. If a speed reducer is used in a setup such as Figure 22, it must be a helical reducer or a reducer with a non-locking ratio.

Several methods might be used to make the potentiometer shown in Figure 22 self-adjusting. A rider arm sensing roll size could be coupled to a potentiometer to change its setting as the roll changes size in order to maintain constant tension in the material. A sonic sensor and associated circuitry could also be used to effectively measure the size of the roll. The circuitry in the sonic sensor would then program a voltage in place of the tension potentiometer wiper signal in order to maintain constant tension.

The setup of Figure 22 provides performance superior to that of an eddy current brake, but like an eddy current brake it cannot aid in accelerating heavy feed spools up to speed to prevent excessive web tension during startup. Also it cannot provide assisting torque (motoring torque) to aid in unwinding material. If either of these characteristics is desired, a PRD12B can be changed to a torque programmed drive by replacing the "SPEED" program plug at J21 with a "TORQUE" program plug. The motor will then function as a torque motor rather than as a brake and will automatically provide motoring assistance when needed to maintain desired web tension. (Section 16.5.1 depicts a torque-motor application using a PRD12B control set and wired for torque programming.)

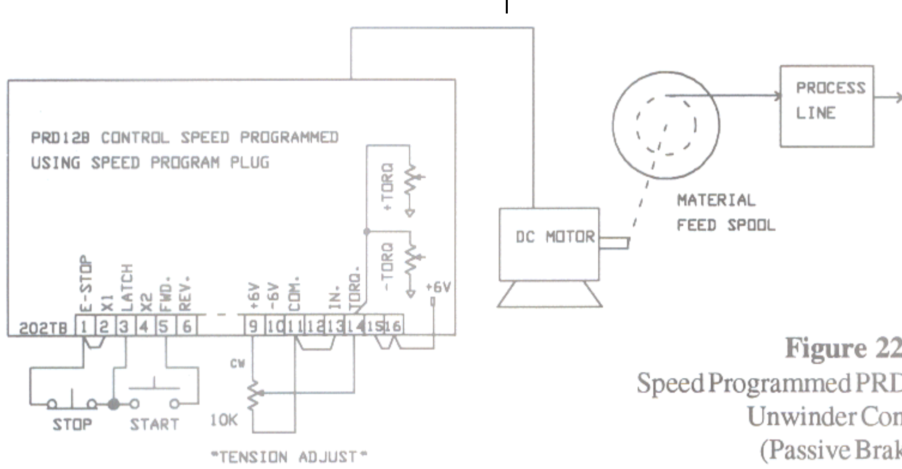


Figure 22
Speed Programmed PRD12B Material Unwinder Control
(Passive Brake)

16.3.6 Eddy Current Brake Replacement

Figure 23 illustrates a hydraulic motor test stand which previously used an eddy-current brake to load the hydraulic motor being tested. In the figure, the eddy-current brake has been replaced with a DC motor and the brake control unit has been replaced by a PRD12B equipped with a field regulator. The DC motor functions as a passive brake by virtue of the connections to Terminal Block 202TB. These connections are essentially the same as those shown in Figure 22. The reason that the motor functions as a passive brake with these connections is explained in the first paragraph of Section 16.3.5.

In Figure 23, the armature-current metering output at Terminal 18 is used to drive a meter labeled "LOAD TORQUE". Armature current in the DC motor is directly proportional to motor shaft torque since the field regulator holds field current constant. It is therefore possible to provide the meter shown to measure the load torque being applied to the hydraulic motor under test. The reading will contain a small error due to brush and windage friction in the DC motor, both of which provide a small amount of loading to the hydraulic motor when no armature current is flowing. This error can be corrected by zero and scale division corrections on the meter face when it is laid out to read lb. ft. of torque. Windage and friction torques are determined by causing the PRD12B to spin the motor at various speeds with no shaft load and measuring the armature current at each speed. A small linearity error due to armature reaction will also be present.

This conversion, originally prompted by environmental regulations requiring costly reclaiming and recirculating of the cooling water required by the eddy-current brake, produced a number of additional advantages:

a) Loading to much lower speeds than could be achieved by the eddy current brake.

b) Electrical power savings: The PRD12B returns power to the AC lines thereby reducing the cost of electric power. The eddy current brake wastes power by converting it to heat.

c) Elimination of a torque-metering coupling by utilizing armature-current monitoring.

d) Eliminating the need for a second test stand to test pumps. Connections to the PRD12B are reconfigured to drive the DC motor as a motor rather than causing it to function as a brake. The DC motor then drives the pump being tested, a feat which eddy current brakes cannot accomplish. When used in this mode, a second "LOAD TORQUE" meter with opposite scale corrections is connected to monitor torque delivered to the pump.

Although hydraulic motors and pumps were used in this example, the same test stand arrangement is currently in use to test electric motors or generators of either the AC or DC variety and their associated electronic control units.

16.3.7 DC Motor Test Stand

The PRD12B can be used to perform heat runs or endurance testing on a DC motor without coupling the motor to a load. This is done by using the inertia of the motor itself as a load. A speed programmed PRD12B is used. The speed potentiometer is set for full speed. An external "TORQUE LIMIT" potentiometer, connected per Figure 17, is provided. The PRD12B is equipped with the "Auto-Reversing" option (see Section 2.6.4) and is not equipped with an acceleration option board. A timer is used to alternately activate the "Forward" and "Reverse" pushbutton circuits. An adjustable timer with a 1 second or 2 second full-scale range should be adequate for most industrial duty motors. A "Load Current" meter, as described in the previous section, is provided.

This test stand works by repetitively accelerating the motor under test in current limit (torque limit) to nearly full speed forward and then accelerating it to nearly full speed reverse, also in torque limit. In practice, the timer is started and the external "TORQUE LIMIT" potentiometer is adjusted until the desired armature current is flowing in the motor during acceleration and deceleration. The timer is then adjusted until the motor reaches about 90% of full speed in each direction of rotation before reversing. Thus the motor is continually accelerating or decelerating in current limit. The armature current reverses with each timing cycle, but in terms of magnitude, current remains continually at the value set on the "TORQUE LIMIT" potentiometer, thus providing constant loading of the DC motor under test. When making heat-run tests by this method, the variable amount of cooling air must be taken into account if the motor is self ventilated.

When utilizing this method of testing, the cost of electrical power used for testing is reduced by typically 85% to 92% in that you pay only for the heat loss in the motor and the control unit, and not for the heat loss in a loading device. (Conventional loading devices consist of an eddy current brake or a resistive load connected to a drive generator). The power savings occur because in the inertial test stand, the motor under test is taking power from the AC lines half of the time (when motor is accelerating), but is returning power to the AC lines during the remaining time (when motor is generating during deceleration). Incidentally you need not be concerned about establishing a high demand factor that increases the cost of electrical power in subsequent periods of low power usage. Demand meters do not register the short bursts of power taken from the AC lines during acceleration even if the bursts are at a 50% duty cycle (as will be the case in this application). Demand meters register the net power usage that occurs during a relatively long sampling period. To realize the projected power savings, you need only be sure that there is enough power usage from other loads connected to the power meter to absorb the energy which is returned to the AC lines during deceleration of the motor under test. This regenerated energy cannot run the power meter backwards in that these meters are typically racheted.

The somewhat higher initial cost of this system is offset by only one or two of the listed advantages. The remaining advantages are free.

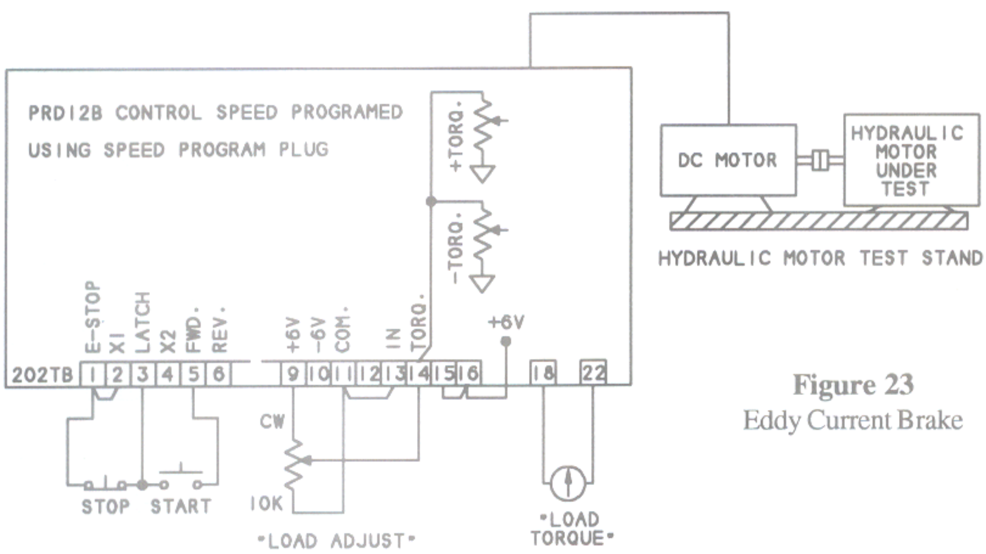


Figure 23
Eddy Current Brake

16.4 Torque Programed Drives

Torque Programed Drives are used in applications in which speed of the DC motor is set by connected machinery and the motor is required to apply either assisting torque or retarding torque against the connected load. Material winders or unwinders and conveyor torque-assist drives (as illustrated in Figure 26, the slave unit) are typical of this class of applications. A standard PRD12B becomes a torque-programed drive when a “TORQUE” plug in inserted in connector J21 (either a factory or a field procedure). When the PRD12B is so equipped, the connected DC motor functions as a torque motor and no control of speed is exercised except as a protective limit.

The primary command input of these torque-programed drives accepts a bipolar voltage command, the polarity of which commands either assisting or retarding torque while the magnitude of the command determines the amount of torque furnished to the load by the motor. It is this bipolar characteristic of the command input that distinguishes Torque Programed Drives from Speed Programed Drives that use torque-limit programming (examples of which appear in Section 16.3); the latter can only limit whatever torque is being applied externally to the motor shaft and accordingly cause the motor to act as brake rather than as a torque motor in winder applications. Figure 25 and 22 and the associated text illustrate torque-motor action and adjustable braking action respectively.

When the “TORQUE” program plug is in place, the PRD12B becomes a torque-programed drive and its basic architecture is changed. The primary command input signal at Lug 13 of terminal block 202TB on the E1546 circuit board will now command the magnitude and direction of current flow in the armature of the DC motor, but not the direction of rotation or the speed of the motor (unless the motor shaft is unloaded or lightly loaded). The "+TORQ" potentiometer on the E1546 board acts as a scale factor adjustment for the primary torque command originating at 202TB-13. The potentiometer labeled "MAX" on circuit board E1546 in inoperative. The "-TORQ" potentiometer is also inoperative. The "FORWARD" and "REVERSE" pushbuttons now control direction of current flow to the motor (the "REVERSE" pushbutton is usually omitted). All connections to Lug 14 of 202TB, including the normal jumper which connects Lug 14 to Lug 15, are removed. The only direct control of speed which the PRD12B exercises is through the "+MAX" and "-MAX" speed clamps which will limit speed of the motor only during motoring operation which occurs if there is little or no load on the motor shaft (as might occur in the event of material breakage in winders or unwinders). In this event, the unit "crosses over" into speed-limit mode and regulates speed until external forces increase the motor shaft load to the point that the torque command can again be satisfied. Note that reverse rotation of winder spools such as might occur in the event of material breakage can be prevented by setting the appropriate "+MAX" or "-MAX" potentiometer to zero. These speed clamps are not operative during generating operation; accordingly, torque programmed drives should not be used in hoist-type applications in which speed-runaway is possible.

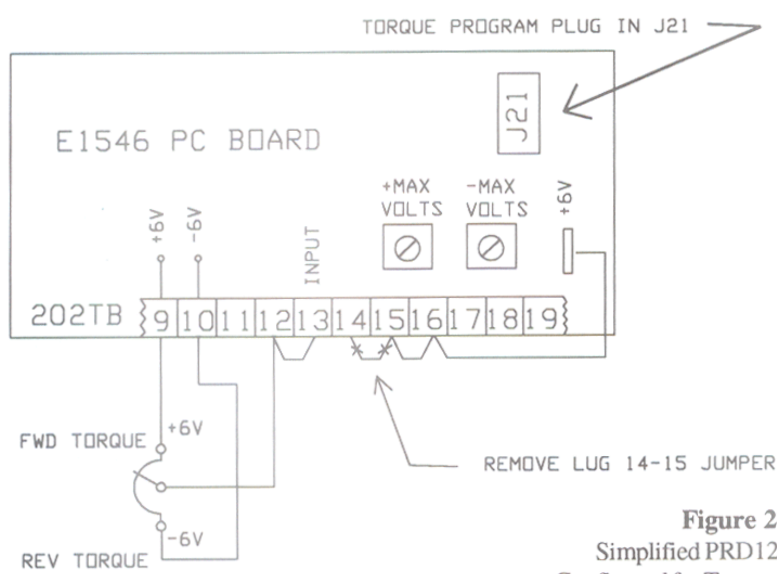


Figure 24
Simplified PRD12B Control
Configured for Torque Programming

16.4.1 Torque Program Command Input (202TB-13)

With the torque program plug in place, 202TB-13 changes from a speed program input terminal to a torque program input. The voltage that can be applied to this terminal is between -6V to +6V. A 0 to +6V signal will cause terminal A1 to be positive in respect to terminal A2 if the motor is permitted to operate in motoring mode with the "Forward" command actuated. (Motoring mode is achieved if there is no shaft load). A 0 to -6V signal will cause terminal A1 to be negative in respect to terminal A2 if the motor is permitted to operate in motoring mode with the "Forward" command actuated. If the control is energized in the "Reverse" command mode, everything explained in the previous several sentences is reversed as far as polarities are concerned.

In using the torque programming mode option it is also possible to use a 4 to 20 ma input signal. The "INPUT TYPE" mini jumper selector must be in the 4 to 20 ma position. The "INPUT POLARITY" jumper should be in the "+ ONLY" position. Operation of the control will be as given above for the 6 volt input signal.

Calibration of the torque program signal is done through the use of the "+Torq" potentiometer located on the E1546 PC board. With +6V, -6V, or +20 ma at terminal 13 of 202TB the "+Torq" potentiometer scales the maximum amount of motor current produced by a given reference signal input regardless of polarity of the signal input. For instance if the "+Torq" potentiometer is adjusted to limit current to 100% rated current with +6 volts present at 202TB-13, current will be limited to 100% of rated current in the opposite direction when -6 volts is applied to this terminal. It should be remembered that +2 volts or -2 volts as read at terminal 18 on 202TB in respect to 203TB-22 [common] corresponds to minus or plus 100% of rated motor current regardless of the setting of the "+Torq" potentiometer. When torque programming is being used the "-Torq" potentiometer is inoperable.

With torque programmed drives the "Torq Lim" Led is illuminated all the while the drive is operational. (It will remain illuminated even if the drives should go into a maximum armature volts limiting mode as explained in Sections 16.4.2 and 16.4.3). If maximum armature voltage is reached as set in either direction, the "Max Volts" LED will illuminated in addition to the "Torq Lim" LED.

16.4.2 "+Max Volts" Speed Setting (202TB-15)

In some torque programed drives the speed is permitted to go to uncontrolled levels. In the PRD12B maximum speed is limited by the "+Max Volts" and "-Max Volts" potentiometers during motoring operation. The "+Max Volts" speed potentiometers sets the maximum permissible armature voltage that the motor is capable of motoring at when +6 volts is furnished at the "+Max" terminal 202TB-15. In many applications the factory arrangement, which limits armature voltage to a value slightly above rated armature voltage, is satisfactory.

In some applications it may be desirable to remotely change the armature voltage limit. For example it may be desirable to limit the maximum speed at which a torque programmed section can run to a value slightly above the actual speed of the process line. An external voltage furnished to terminal 202TB-15 can do this. This could be accomplished in the same manner as for a speed programed control. Refer to Figure 18 in Section 16.2.3. The variable external voltage between terminals 202TB-15 and 203TB-22 (common) should vary between 0 to +6 volts approximately. When the armature voltage reaches the level as programed at this terminal, the "+Max Volts" LED will be illuminated.

16.4.3 "-Max Volts" Speed Setting (202TB-16)

The "-Max Volts" potentiometer setting works in a similar fashion to the way the "+Max Volts" potentiometer works as explained in the previous Section 16.4.2. The difference is that it will control the maximum armature voltage of the opposite polarity. The "-Max Volts" potentiometer sets the maximum armature voltage when A1 is negative in respect to A2. If connections are made for torque programming this would typically occur when a negative voltage is programed at 202TB-13, motoring operation is occurring, and the control is energized through the forward terminal 202TB-5. As explained for the "+Max Volts" potentiometer in the previous section, this can be a fixed setting. The factory-installed jumper straps connect +6VDC to 202TB terminal 16 to accomplish this. (It should be noted that although this is the "-Max Volts" clamp, the voltage used to calibrate this setting is a positive 6 volts as was used for the "+Max Volts" setting.)

The "-Max Volts" clamp maybe remotely adjusted to cover application requirements mentioned in the preceding section.

See Figure18 in Section 16.2.3 for the required external connections. In some applications it may be desirable to limit motor rotation in the direction controlled by this potentiometer to zero. In this situation the "-Max Volts" potentiometer should be turned fully counterclockwise. This will prevent the motor from rotating in a direction opposite to its normal direction of rotation (for motoring loads).

16.5 Torque Programed Drive Applications

16.5.1 Material Unwinders

In Figure 25 a process machine pulls material from a spool at a speed which is determined by the process machine. The DC motor is to (tension too high) delivers a positive signal to terminal 13 of 202TB. The forward speed limit "+Max " is set for base speed of the motor by connecting 202TB-15 to +6 Volts as shown. This allows the PRD12B to deliver either positive or negative current (torque) to the motor as long as rotation is forward and as long as forward speed is not above base speed. The negative speed limit input 202TB-16 is also connected to +6 volts, but the limit is set for zero speed by rotating the "-Max" potentiometer fully counterclockwise. This unconditionally prevents the control and motor from driving the spool in the reverse rotation if material breakage occurs.

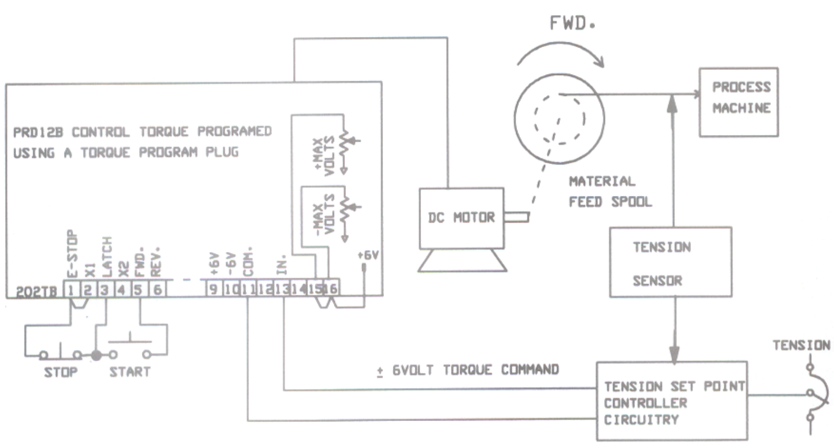


Figure 25
Torque Programmed Material Unwinder Control

provide either assisting or hold-back torque as required to maintain tension in the material at the desired value. The Tension Setpoint Controller compares measured tension in the material web with desired tension set by the "TENSION" potentiometer and generates a voltage error signal which commands torque of the magnitude and direction required to maintain tension at the desired value. Figure 25 defines forward rotation. For the convention shown armature connections to the motor must be such that terminal A1 of the PRD12B is positive with respect to terminal A2 during forward rotation. Connections to the setpoint controller must be such that a command for assisting torque

If the tension sensor is arranged so that material breakage always causes a *"tension too low"* signal, then the spool will stop when material breakage or end-of-material conditions occur. The spool stops because a "tension too low" condition delivers a negative torque command signal to 202TB-13 which asks for reverse torque (hold-back torque). Since the spool is no longer rotated by the process machine, torque of this polarity decelerates the spool to zero speed and attempts to drive it in the reverse direction. As the spool reaches zero speed, however, the reverse speed limit clamp ("-MAX VOLTS"), which is set for zero speed, assumes control and the torque command at terminal 13 of 202TB is disregarded. Thus the net effect is that material breakage causes the motor to brake to a stop and remain stopped, thereby eliminating the need for a separate material breakage detector.

The “Stop” pushbutton on the PRD12B must be activated before rethreading material, or the motor will apply hold back torque as material is threaded through the tension sensor.

The application just explained is classified as a “Torque Motor” application as contrasted to the “passive brake” application of Section 16.3.5 because either a retarding or assisting torque can be furnished. In the “passive brake” application only holdback torque could be furnished.

16.5.2 Torque Slave Application

In Figure 26 the conveyor transports material down a grade. Conveyor design requires multiple drive points to minimize stress on the drive chain. Systems such as this require one speed programmed drive (shown as the “Lead” drive) which determines direction of rotation and speed of the system. All other drives are torque programmed (torque slaves) to assure load sharing and to avoid fighting between the drives for speed control. The voltage at terminal 18 of 202TB of the speed-programed PRD12B is directly proportional to armature current in the lead motor, but must be increased in amplitude, filtered and inverted to be useful for a command signal. Two volts (negative) at rated motor current is present at this terminal. The Polyspede interface amplifies this level to 6 volts and inverts it. When correctly set up each of the slave drives in Figure 26 furnishes torque equal to that being furnished by the lead drive. All motors are forced to run at identical speeds by virtue of the common mechanical link. Reversal of armature leads in the lead motor is not necessary because of the signal inversion provided by the Polyspede Interface. The “Torque Set” potentiometer shown allows trimming of the slave torque command to adjust the desired amount of torque furnished by the slave unit for a specific amount of torque furnished by the lead unit.

The speed limit clamp potentiometers (“+Max Volts” and “-Max Volts”) perform no useful function in this application, but must be set higher than maximum system speed by connecting to +6 volts as shown. The factory settings of these potentiometers is high enough so that during normal operation these speed clamp limits will not be activated.

In the event of abnormal conditions (such as a pinion breaking), however, the control automatically prevents motor overspeed by activating either the “+Max Volts” or “-Max Volts” speed clamp circuitry.

Systems such as the one Figure 26 should be equipped with a failsafe mechanical brake and an independent overspeed sensing device to apply the brake. Runaway speed could otherwise occur as a result of power failure, of overloading the conveyor, or as a result of protective tripout of one of the PRD12B units.

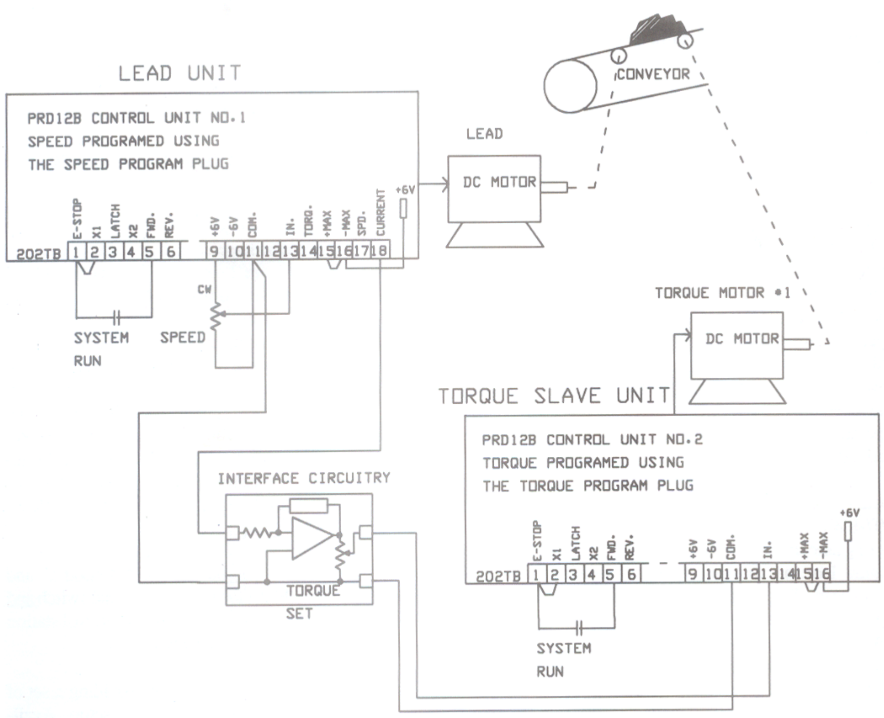


Figure 26
Torque Slave Conveyor System Application

16.5.3 GUIDELINES FOR USING AND PROGRAMMING THE PRESET SPEEDS OPTION

The preset speeds option board allows a user to set as many as seven different speeds on potentiometers located on this circuit board. Only one of the potentiometers will be connected to the speed input of the PRD12B unit at any given time. The selection logic is programed by plug-in jumpers which the user installs. The potentiometer that is to control motor speed is selected either by a switch closure provided by the user, or by the status of selector switches and pushbuttons in the operator control station (a RUN-JOG selector, a MANUAL-AUTO selector and the FORWARD and REVERSE pushbuttons). No additional wiring to the operator control station is required; circuitry in the PRD12B provides status information to the preset speeds board. Input from additional operations in the operator control station (such as the "THREAD" operator shown in Figure A5) can also be added as described in Example A5.

Detail 13 of the PRD12B External Wiring Diagram A2399-007-EW (in the Appendix of this manual) illustrates typical wiring associated with the preset speeds option. See also Figure I of this drawing which illustrates connections between the directional pushbuttons and the PRD12B. The operator controls shown furnish logic-level signals to the "AUTO", "MAN", "RUN", "JOG", "FWD" and "REV" pins on the programming strips located of the preset speeds option board.

In **"Method 1"** usage of the preset speeds board, jumper plugs are inserted on the pins of the programming strips. These jumper plugs determine which potentiometer is connected to the speed input of the PRD12B according to the status of operations in the operator control station. Example A3 herein illustrates this method. In Figure A3, the first jumper plug placed on programming strip number 1 (in the "JOG" position) prevents Pot number 1 from being selected unless the "RUN JOG" selector is in the "JOG" position. The second jumper plug shown on programming strip#1 opposite the "FWD" legend places a second restriction that the "FORWARD" pushbutton must also be held activated for Pot 1 to be selected. Thus with the two jumper plugs installed as shown, Pot #1 controls forward jogging speed. Figure A3 through A5 illustrate various other combinations of jumper placement. Note the close agreement between names assigned to the pots and the placement of jumpers that control the selection of the pot. Basically, a well selected name tells you where to place the jumpers on the related programming strip. For example, the three-word name (AUTO RUN REVERSE) of Pot 3 in Figure A5 tells you to place three program jumpers on programming strip #3 in the locations shown.

If no jumper plugs are placed on programming strip 1, Pot 1 would be continually selected unless it is de-selected by opening the circuit between Lugs 1 and 2 on Terminal Block 150TB (labeled "S1"). Under these conditions, Pot #1 would be selected or de-selected by closing or opening the circuit between Lugs 1 and 2. This leads us to the "Method 2" way of potentiometer selection.

In **"Method 2"** usage of the preset speeds board, jumper plugs are not placed on the programming strips. Instead external switches are connected to Terminal Block 150TB to control which speed pot is connected to the speed input of the PRD12B. Figure A1 illustrates this method. Make-before-break action of the switches is permissible. Simultaneous closure of two or more switches does not cause malfunction. Read the Example 1 text for further explanation.

Figure 2 illustrates a combination of "Method 1" and "Method 2" use in which closure of an external switch and the position of an operator in the operator control station determine which speed pot is selected.

The preset speeds option is useful for providing a set of easily-selected speeds to simplify machine setup. Availability of preset jog, thread and reverse speeds eliminates the necessity of the operator readjusting the main speed potentiometer for each operation performed during setup. This option is also useful for controlling automatic machine operation. For example, the setup shown in Figure A5 might be used with an automatic cycling machine which must execute a rapid return to a starting location at any time a "REVERSE" is signaled. The setups illustrated in Figures A1 and A2 are useful for providing a series of speed changes in response to contact closures originating in a mechanical timer or a programmable controller. The basic setup of Figure A1 has been used with a six-spindle drill press in which the switch closures shown are a function of which spindle is rotated to the active position. The potentiometers are preset such that the tool chucked in a spindle turns

turns at optimum cutting speed when the spindle is rotated to the active position. Also a preset "back out" (reverse) speed is provided for the spindle which performs tapping operations. (This is done by adding jumper plugs to two of the programming strips and enabling both of them with the tapping-spindle switch).

The following figures and examples are intended as a programming guide. It is suggested that the user read all of the following examples before programming the preset speeds option board, since the examples progressively add new ideas and rules.

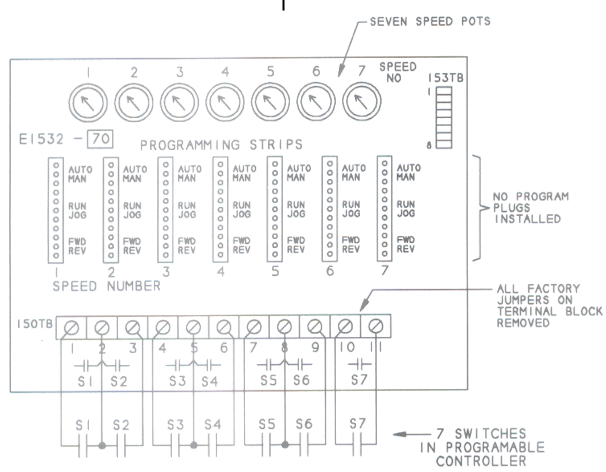


Figure A1
Seven Preset Speeds Selected by a Programmable Controller (or a 7-switch timer).

Example A1: This is a straightforward application in which closures of the external switches connected to terminal block 150TB on the preset speeds board select which speed pot on the board will be connected to the speed input of the PRD12B . No program jumpers are placed on the programming strips since selection of a given speed pot is to be independent of the settings of operators in the operator control station. As was explained in the previous text, it is not necessary for one of the switches to open before the next switch closes. If two or more of the switches are closed simultaneously, the option board recognizes only the highest-numbered switch as being closed. For example if switches S2, S3and S4 were all closed, pot number 4 would be selected as if only a switch 4 closure had occurred.

Although the switch closures are shown as being furnished by a programmable controller, they might also be switches in a rotary-cam type timer. Alternately they might be switches located on a multi-spindle drill press that are activated depending on which spindle is rotated to the active position. In this case the pots are preset so that the tool in each spindle turns at optimum cutting speed.

The switch wiring shown can be simplified in that terminals 2, 5, 8 and 10 are all connected to +12 VDC originating from the PRD12B. See Figure A2 in which all switches are powered from terminal 2.

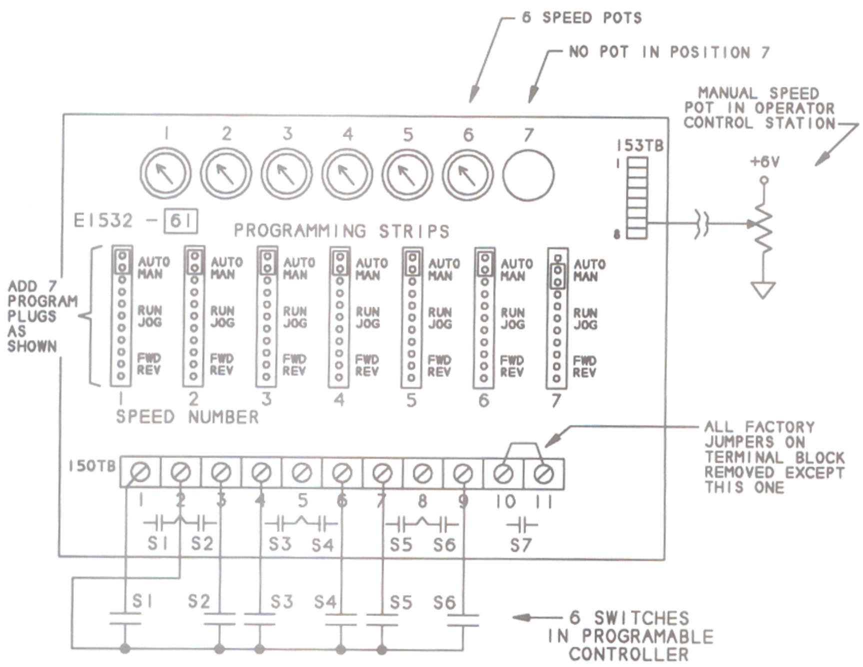


Figure A2
Six Preset Speeds Selected by a Programmable Controller (Auto mode).
One Manual Speed Pot Active in Manual Mode.

Example A2: This application is identical to Example A1 except a manual speed potentiometer is added and the programmable controller contains only six switches rather than seven. When the “MANUAL-AUTO” selector in the operator control station is in the “MANUAL” position, motor speed is controlled by the speed pot in the operator control station regardless of whether any switch closures are occurring in the programmable controller. When the “MANUAL-AUTO” switch is in the “AUTO” position, the switches in the programmable controller select one of the six speed potentiometers on the preset speeds board to control motor speed.

The action described occurs regardless of the position of the “RUN-JOG” selector (if one is included), and regardless of whether the “FORWARD” or “REVERSE” pushbutton is activated since no program plugs are placed at corresponding locations on the program strips shown. If a “RUN-JOG” selector is included on the operator control station, you would probably want to prevent an operator from trying to jog the motor when the programmable controller is in control. Additional program jumper plugs could be placed on the “RUN” pins of the first six programming strips to accomplish this.

The jumper shown between terminals 10 and 11 is necessary. Any channel without either a switch contact or a jumper on 150TB will be continually de-selected. Thus without the jumper in place, Channel 7 would be dead and the manual speed potentiometer could not be accessed. In some cases it is necessary to omit the jumper on Terminal Block 150TB to “kill” an unused channel as will be illustrated in Example A4.

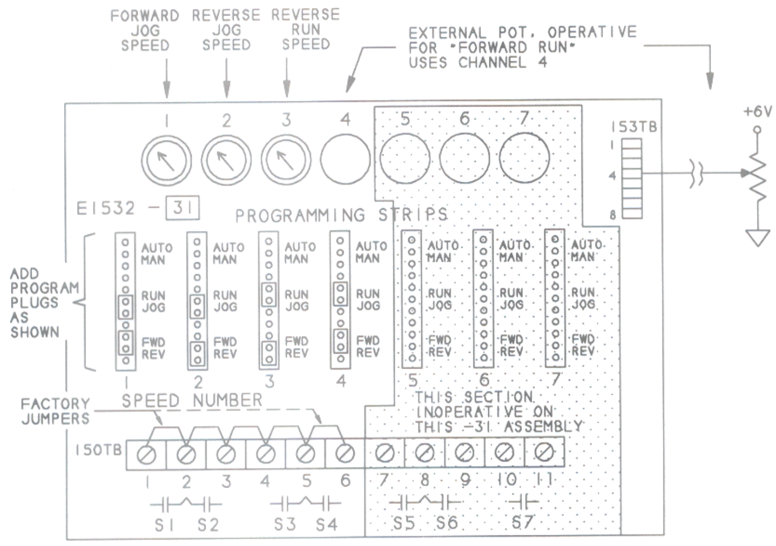


FIGURE A3

Preset "FORWARD JOG", "REVERSE JOG", AND "REVERSE RUN" Speeds. Externally-Set "FORWARD RUN" Speed.

Example A3: Figure A3 illustrates a different method of selecting which potentiometer is connected to the speed input of the PRD12B . The setup shown provides independently-adjustable FORWARD and REVERSE jog speeds as well as independently adjustable FORWARD and REVERSE run speeds. In this example, no switches are connected to Terminal Block 150TB; instead, the status of operators in the operator control station determine which speed pot is selected.

In Figure A3, Pot 1 controls forward jogging speed. This pot becomes active at any time the “RUN-JOG” selector in the operator control station is in the “JOG” position and the “FORWARD” pushbutton is held activated. This condition is set up by placing jumpers in the “JOG” and the “FWD” positions of Program Strip #1 as shown in Figure A3. Similarly, Pot 2 is set up to control reverse-jogging speed by placing jumpers on Program Strip #2 in the “JOG” and the “REV” positions as shown. With jumpers so placed, Pot 2 becomes active when the “RUN JOG” selector is in the “JOG” position and the “REVERSE” pushbutton is held activated. Pot 3 is set up by the two jumper plugs shown on Programming Strip #3 to control motor speed when the “RUN-JOG” selector is in the ‘RUN” position and the “REVERSE” pushbutton is activated. Pot 4 (the external pot) is similarly set up by the two jumpers shown on Programming Strip #4 to control motor speed when the “RUN JOG” selector is in the “RUN” position and the “FORWARD” pushbutton is activated.

Any external potentiometer such as the one shown in Figure A3 must be connected to a channel in which the board-mounted potentiometer is omitted. Thus for the E1532-31 assembly shown in Figure A3, the external potentiometer should be connected only to Channel 4. The external signal input to Channel 4 is Lug 4 of Terminal Block 153TB as shown. (The +6v and common connections of the external speed potentiometer are made at the main terminal block 202TB as shown in the External Wiring Diagrams for the PRD12B unit). The factory-installed metal jumper strip which shorts Lugs 1 through 6 of Terminal block 150TB must be left in place so that all four channels are activated.

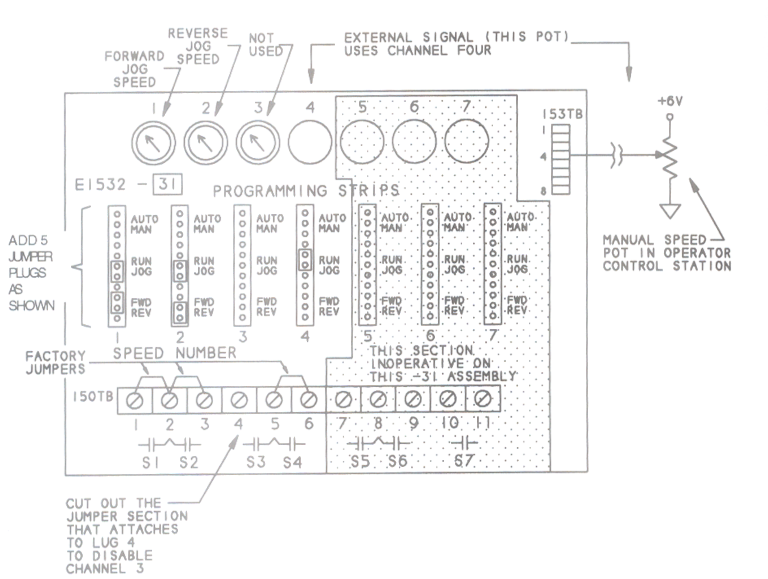


Figure A4
Preset "FORWARD JOG", "REVERSE JOG"
Externally-Set "FORWARD RUN" Speed.

Example A4: This example is identical to Example A3 except Speed Pot #3 is not used and the external speed pot controls either forward or reverse speed when the “RUN JOG” selector is set the “RUN” position. This example is included to illustrate how to handle an unused channel.

Speed Pots 1 and 2 are programed the same as in Example A3. Since Channel 4 (Pot 4) does not have a jumper plug at either the “FWD” or the “REV” position, the external pot will be selected to control motor speed at any time the “RUN JOG” selector is in the “RUN” position regardless of which directional pushbutton is activated. No jumper plugs are placed on the programming strip for Pot 3 (the unused pot). This means that unless we do something to disable Channel 3, Pot 3 will be continually selected regardless of the position of any of the switches in the operator control system. To prevent this unwanted action, remove the jumper that connects to Lug 4 of Terminal Block 150TB. This is the same thing as opening switch position S3. It will disable Pot 3 and prevent it from being selected under any condition. To disconnect Lug 4, remove the 6-place metal jumper strap and break off the part that fits under the Lug 4 screw. Reinstall the jumper strap.

***IMPORTANT RULE*:** Any speed pot channel which is not used must be disabled by removing the jumper lug from the switch position on Terminal Block 150TB that relates to the unused channel. For example S1 relates to Speed Pot 1, S2 relates to Speed Pot 2, etc.

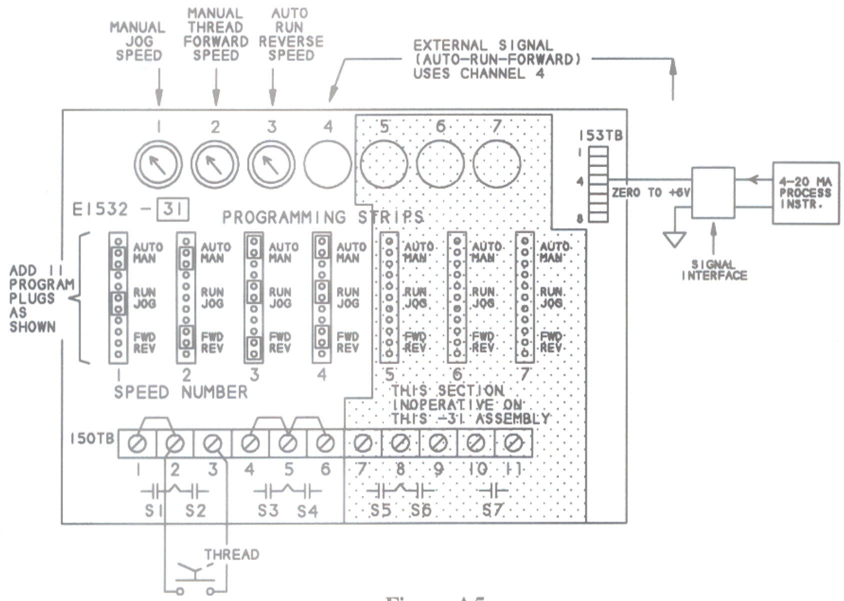


Figure A5
Preset "MANUAL JOG", "MANUAL THREAD FORWARD", and "AUTO RUN REVERSE".
An External Signal Controls "AUTO RUN FORWARD" Operation

Example A5: This example is similar to Example A3 except it introduces two new elements. The system portrayed in Figure A5 has a “MANUAL AUTO” selector switch in the operator control station (not shown) in addition to a three-position “RUN-JOG-THREAD” selector switch. Only the “THREAD” contact of this switch is shown in Figure A5. Operation from “FORWARD” or “REVERSE” pushbuttons is also included as was the case in Example A4.

In operation, Speed Pot #1 (“JOG SPEED”) and Speed Pot #2 (“THREAD SPEED”) are to be active only when the “MANUAL AUTO” selector is in the “MANUAL” position. Assuming that this selector switch is in the “MANUAL” position, Pot #1 will become active when the “RUN-JOG-THREAD” selector is in the “JOG” position regardless of whether the “FORWARD” or the “REVERSE” pushbutton is activated (the absence of a jumper plug in either the “FWD” or the “REV” position on Program Strip #1 establishes this “don’t care” condition). Speed Pot #2 is a different situation. Material can be threaded into the machine only when it is running in the forward direction. Therefore a jumper plug is inserted at the “FWD” location on Program Strip #2 so that Pot #2 (“THREAD SPEED”) can become active only if the “FORWARD” pushbutton is activated. Since the PRD12B does not provide an internal path for a “THREAD” signal, the “THREAD” section of the “RUN-JOG-THREAD” selector switch is connected between Lugs 2 and 3 of Terminal Block 150TB. This connection enables Channel 2 only when this selector switch is in the “THREAD” position. The two jumper plugs plus the switch shown for Channel 2 thus establish the required condition that Speed Pot #2 is activated only when the respective selectors are in the “MANUAL” and “THREAD” positions and only when the “FORWARD” pushbutton is activated.

Channels 3 and 4 function in the manner described in Example A3, except the additional restriction is added that the “MANUAL AUTO” selector switch must be in the “AUTO” position for either channel to become active. Additionally, the external speed potentiometer shown in Example A3 is replaced with the process instrument input shown in Figure A5. As in Example A3, Speed Pot #3 controls reverse running speed while the Channel 4 input controls running speed in the forward direction, a common arrangement in cycling machines to implement a preset rapid return to a starting point.

Although Figure A5 shows the “THREAD” deck of the selector switch as being connected directly to Lugs 2 and 3 of 150TB, it would better in practice to have the selector switch drive a 115VAC relay (the contacts of which would be connected to Lugs 2 and 3) since the other contact decks on this same selector switch are excited with 115VAC.

The signal interface block shown in Figure A5 converts the 4-20 ma process instrument signal to a zero to +6 VDC level. ***It is essential that this signal not go negative.*** Negative inputs to the Preset Speeds option board will cause malfunction.

This example was included to illustrate a high level of complexity in which all three jumper positions are used on some of the programming strips and in which a function switch (“THREAD”) is included in the operator control station which was not anticipated in the original design of the preset speeds board.

SUMMARY

This selection is intended to give abbreviated guidelines for selection of the appropriate Preset Speeds option board and programming of the board to operate according to a set of rules that the user determines.

1) See PRD12B External Wiring Diagram A2399-007-EW, Figure I and Detail 13 for connections between the operator control station and the PRD12B. Be sure that E1547-01 driver boards are installed in connectors J6 and J7 per the note on Detail 13. If operators, other than those shown in Figure 1 and Detail 13 are present in the operator control station, see Example A5 for appropriate connections.

2) Select the appropriate assembly variation of the E1532 circuit board according to how many preset speeds are needed and whether one or more of these are to be controlled by external pots or external signals. See Table 2 of this manual for the available selections.

3) Disarm any unused speed channels by removing the associated jumper section on Terminal Block 150TB. See Example A4.

4) If the preset speeds are to be selected only according to the status of operators in the operator control station, place jumper plugs (furnished) at appropriate locations on the programming strips on the preset speeds option board. Placing a jumper plug prevents selection of a given preset speed unless the corresponding operator in the operator control station is set to the position indicated by the legend adjacent to the jumper plug. See Example A3, A4 and A5. If user-furnished switches are to select the preset speeds, connect them to Terminal Block 150TB. See Example A1. User switches must close to select a preset speed. Combinations of these two methods may also be used in which a user-furnished switch must close and operators in the operator control station must be set to certain positions. See Examples A2 and A5.

5) If external signals are used in lieu of the board-mounted speed pots, connect the external signal to the correct lug on Terminal Block 153TB. Lug 1 is the input to Channel 1, Lug 2 is the input to Channel 2, etc. The common connection for the external signals is 202TB lug 11. External signals can be connected only to channels in which the board-mounted speed pot is omitted (channel 4 or channel 7 except for option PS0 which accepts external signals on all 7 channels). The signal must be positive polarity only. Handle any required speed reversals through the Forward and Reverse pushbutton circuits. See Detail 13 of External Wiring Diagram A2399-007-EW for correct wiring of any external speed potentiometers.

6) Priority circuitry built into the preset speeds option board prevents the simultaneous connection of more than one speed command to the PRD12B speed input. In case of conflicting inputs or faulty placement of jumper plugs, only the highest-numbered channel of the simultaneously selected channels is connected. This characteristic allows the use of make-before-break switches and in some cases it can be used to simplify programming,

7) After programming is completed, label the potentiometers on the Preset Speeds option board to clearly indicate the function of each channel. Figure A6 illustrates typical labeling. Print or type the function names on 3/8" x 1-1/4" self-adhesive labels. Use Avery S620 labels, available in office supply stores.

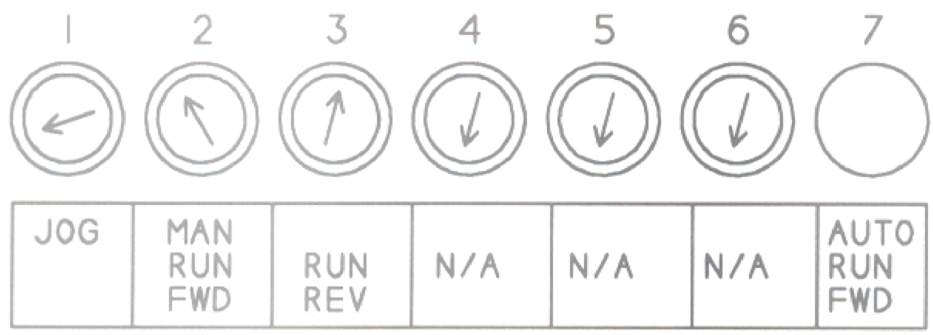


Figure A6
Labeling

17. MAINTENANCE

17.1 Control Maintenance

Periodically blow dust off of the heat sinks. Use an air hose and direct the air flow opposite the normal airflow direction (see arrow on fan). For IsoFlow units, blow air into the discharge holes located in the rear wall of the enclosure near the bottom of the enclosure. Since there is only 1-1/2 inch clearance behind these units, it may be necessary to attach a length of flexible hose or tubing to the end of the blow gun to direct air into the discharge holes. Periodically inspect all cooling fans to assure that they are operative. If the PRD12B unit is mounted in an enclosure equipped with fans which draw outside air into the enclosure (non IsoFlow), clean the filters at least monthly.

17.2 Motor Maintenance

Inspect motor brushes regularly. Polyspede recommends replacement when brushes are worn to one-third original length or at regularly scheduled intervals.

Motor brush life is related to motor speed, loading, cycling rate, ambient temperature, and other variables not controlled by Polyspede. Therefore, only guidelines can be given concerning inspection intervals. Experience has shown that each application has its own wear rate. Measuring the brushers after each three months of operation during the first year will give an indication of the specific wear rate. After three sets of brushes have been used, remove the motor armature for checking by a competent motor repair shop for possible commutator refacing.

Armature bearings are sealed and require no additional lubrication. Replacement should be performed by a reputable service shop if bearings become noisy.

Occasional cleaning of motor vent holes or removal of fan guard to remove dust accumulation from fans is the only additional maintenance required.

17.3 Speed Reducer Maintenance

a) Reducers are shipped without lubricant. Fill reducer with specified lubricant before startup (See tags on reducer or refer to manufacturer's manual).

b) Use type and grade oil specified on the gear reducer nameplate. Keep in mind proper viscosities for various temperatures.

c) Keep oil at proper level.

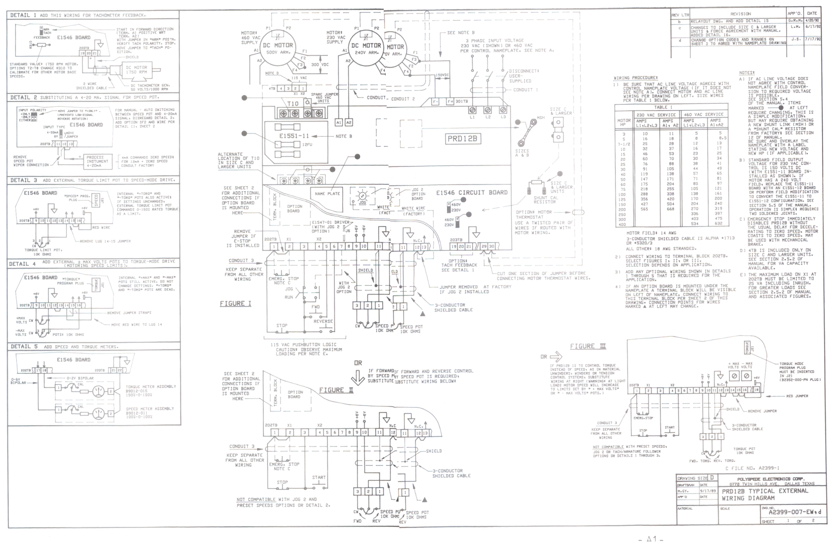
d) Drain, flush, and refill reduction unit after initial run-in period

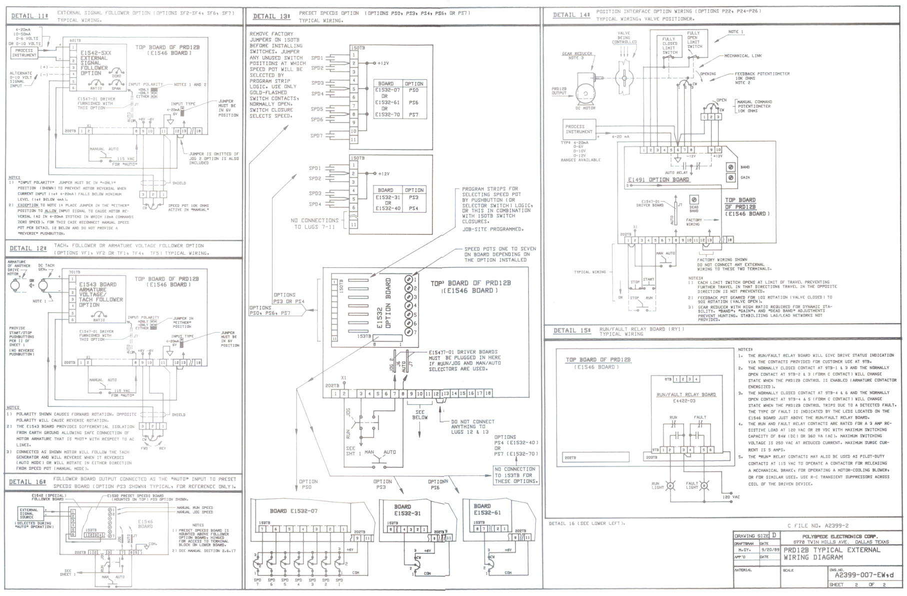
e) Replace shaft seals at first sign of leakage not only to avoid damage due to loss of lubricant, but also to eliminate the possible entrance of contaminants into the housing.

f) If detailed instructions for assembly and disassembly of a particular unit are required, contact the speed reducer manufacturer for this information.

g) If the drive is connected by a coupling which requires lubricating, the coupling should be checked on start-up and semi-annually.

APPENDIX


POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
PRD12B TYPICAL EXTERNAL
WIRING DIAGRAM
DWG.NO. A2399-007-EW,d
SHEET 1 OF 2
C FILE NO. A2399-1
FIGURE I
FIGURE II
FIGURE III
E1546 CIRCUIT BOARD
PRD12B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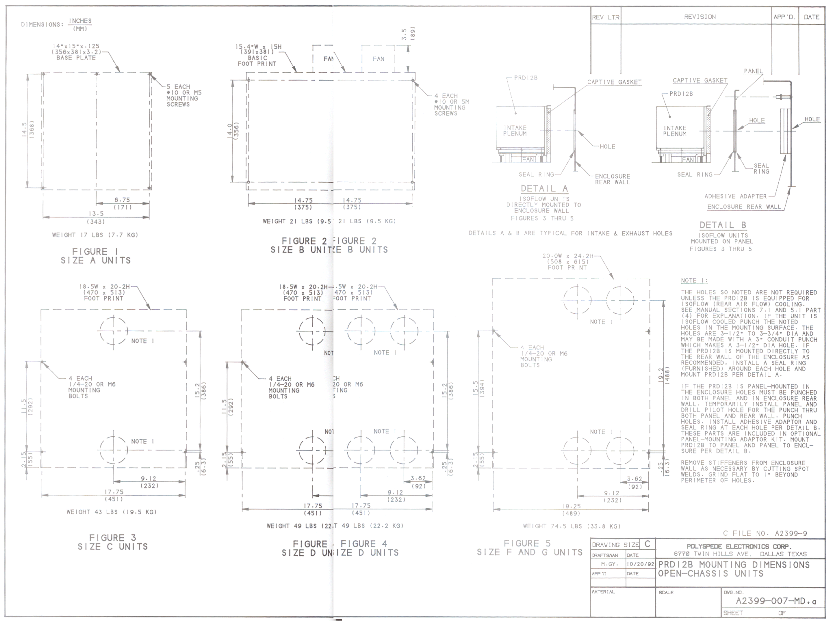
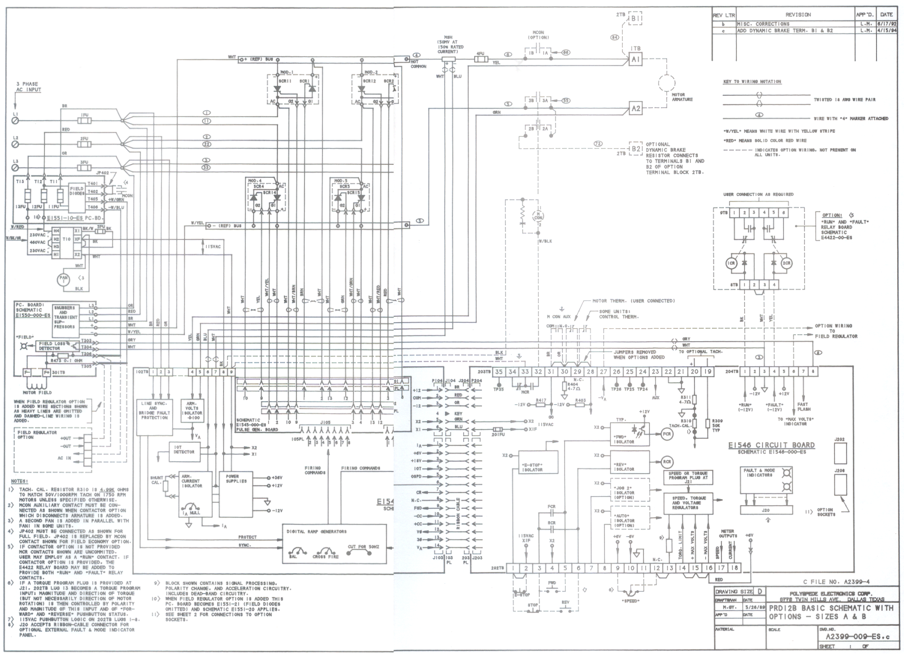
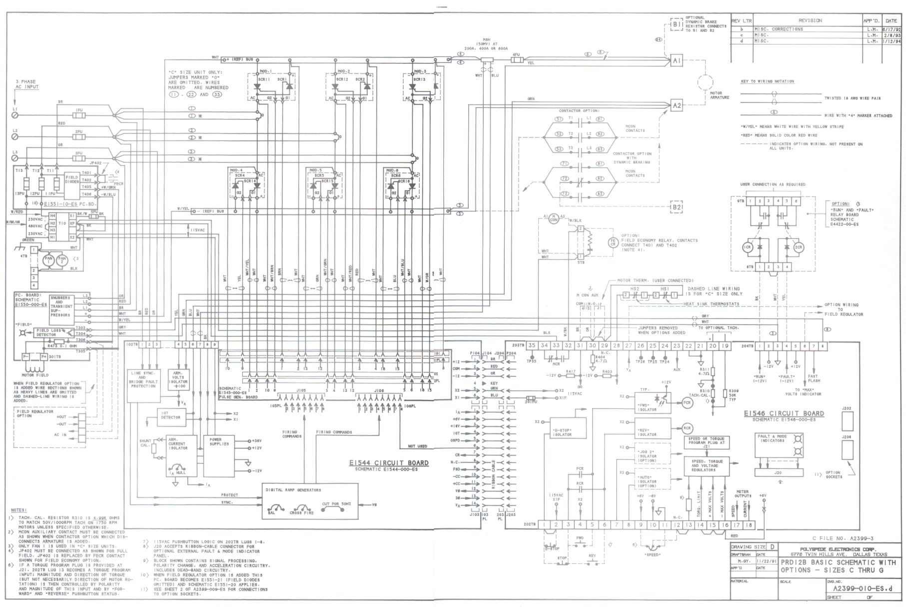
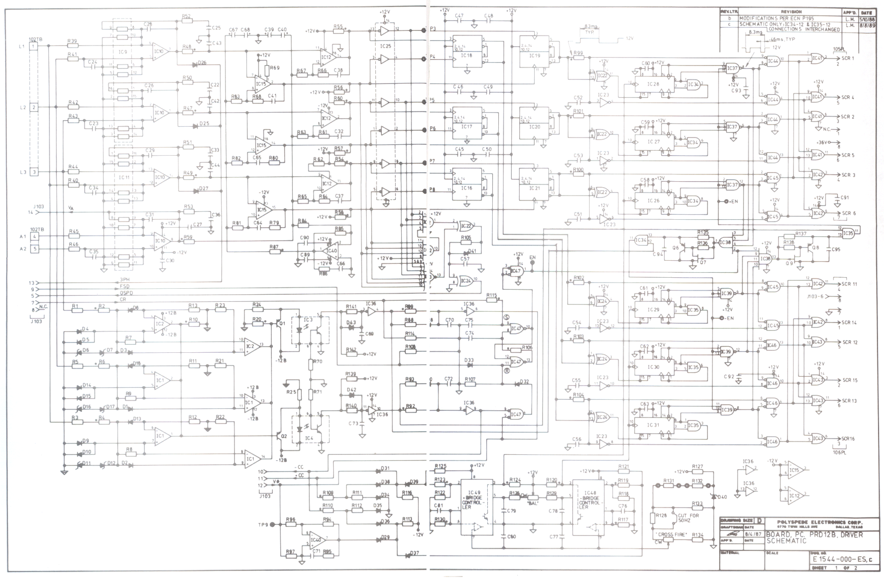
PRD12B TYPICAL EXTERNAL WIRING DIAGRAM
DWG.NO. A2399-007-EW,d
SHEET 2 OF 2

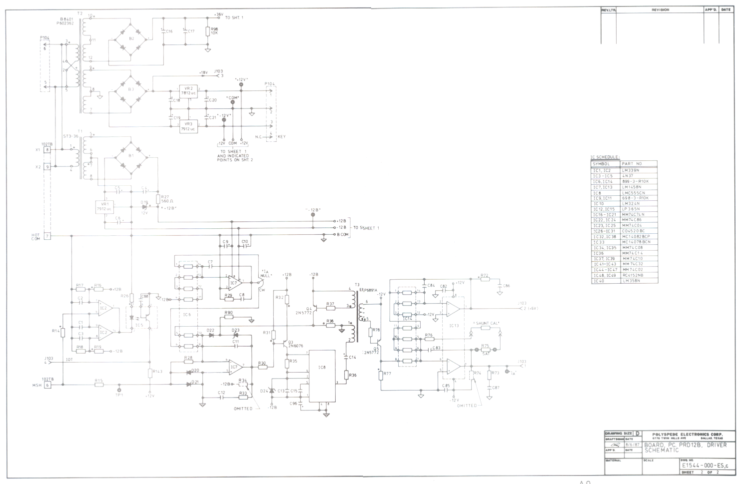


DIMENSIONS: INCHES / (MM)
14"x15"x.125 (356x381x3.2) BASE PLATE
5 EACH #10 OR M5 MOUNTING SCREWS
14.5 (368)
6.75 (171)
13.5 (343)
WEIGHT 17 LBS (7.7 KG)
FIGURE 1
SIZE A UNITS
15.4"W x 15H (391x381) BASIC FOOT PRINT
FAN
FAN
3.5 (89)
4 EACH #10 OR 5M MOUNTING SCREWS
14.0 (356)
14.75 (375)
WEIGHT 21 LBS (9.5 KG)
FIGURE 2
SIZE B UNITS
REV LTR
REVISION
APP'D.
DATE
PRD12B
CAPTIVE GASKET
INTAKE PLENUM
FAN
HOLE
SEAL RING
ENCLOSURE REAR WALL
DETAIL A
ISOFLOW UNITS DIRECTLY MOUNTED TO ENCLOSURE WALL
FIGURES 3 THRU 5
PANEL
CAPTIVE GASKET
PRD12B
INTAKE PLENUM
FAN
HOLE
HOLE
SEAL RING
SEAL RING
ADHESIVE ADAPTER
ENCLOSURE REAR WALL
DETAIL B
ISOFLOW UNITS MOUNTED ON PANEL
FIGURES 3 THRU 5
DETAILS A & B ARE TYPICAL FOR INTAKE & EXHAUST HOLES
18.5W x 20.2H (470 x 513) FOOT PRINT
NOTE 1
4 EACH 1/4-20 OR M6 MOUNTING BOLTS
11.5 (292)
15.2 (386)
2.15 (55)
.25 (6.3)
9.12 (232)
17.75 (451)
WEIGHT 43 LBS (19.5 KG)
FIGURE 3
SIZE C UNITS
18.5W x 20.2H (470 x 513) FOOT PRINT
NOTE 1
4 EACH 1/4-20 OR M6 MOUNTING BOLTS
11.5 (292)
2.15 (55)
3.62 (92)
9.12 (232)
17.75 (451)
WEIGHT 49 LBS (22.2 KG)
FIGURE 4
SIZE D UNITS
20.0W x 24.2H (508 x 615) FOOT PRINT
NOTE 1
4 EACH 1/4-20 OR M6 MOUNTING BOLTS
15.5 (394)
19.2 (488)
2.15 (55)
.25 (6.3)
3.62 (92)
9.12 (232)
19.25 (489)
WEIGHT 74.5 LBS (33.8 KG)
FIGURE 5
SIZE F AND G UNITS
NOTE 1:
THE HOLES SO NOTED ARE NOT REQUIRED UNLESS THE PRD12B IS EQUIPPED FOR ISOFLOW (REAR AIR FLOW) COOLING. SEE MANUAL SECTIONS 7.1 AND 5.1 PART (4) FOR EXPLANATION. IF THE UNIT IS ISOFLOW COOLED PUNCH THE NOTED HOLES IN THE MOUNTING SURFACE. THE HOLES ARE 3-1/2" TO 3-3/4" DIA AND MAY BE MADE WITH A 3" CONDUIT PUNCH WHICH MAKES A 3-1/2" DIA HOLE. IF THE PRD12B IS MOUNTED DIRECTLY TO THE REAR WALL OF THE ENCLOSURE AS RECOMMENDED, INSTALL A SEAL RING (FURNISHED) AROUND EACH HOLE AND MOUNT PRD12B PER DETAIL A.
IF THE PRD12B IS PANEL-MOUNTED IN THE ENCLOSURE HOLES MUST BE PUNCHED IN BOTH PANEL AND IN ENCLOSURE REAR WALL. TEMPORARILY INSTALL PANEL AND DRILL PILOT HOLE FOR THE PUNCH THRU BOTH PANEL AND REAR WALL. PUNCH HOLES. INSTALL ADHESIVE ADAPTOR AND SEAL RING AT EACH HOLE PER DETAIL B. THESE PARTS ARE INCLUDED IN OPTIONAL PANEL-MOUNTING ADAPTOR KIT. MOUNT PRD12B TO PANEL AND PANEL TO ENCL-SURE PER DETAIL B.
REMOVE STIFFENERS FROM ENCLOSURE WALL AS NECESSARY BY CUTTING SPOT WELDS. GRIND FLAT TO 1" BEYOND PERIMETER OF HOLES.
C FILE NO. A2399-9
DRAWING SIZE C
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
DRAFTSMAN
DATE
M.GY.
10/20/92
APP'D
DATE
PRD12B MOUNTING DIMENSIONS
OPEN-CHASSIS UNITS
MATERIAL
SCALE
DWG.NO.
A2399-007-MD.a
SHEET
OF

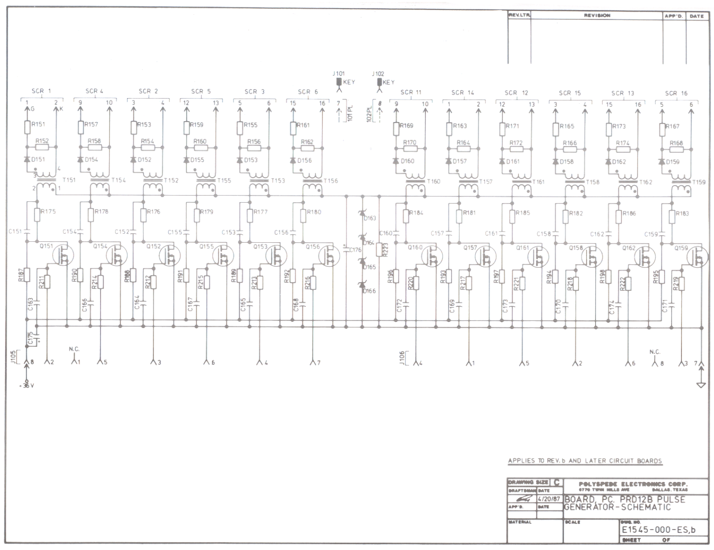

E1546 CIRCUIT BOARD
SCHEMATIC E1546-000-ES
SPEED OR TORQUE PROGRAM PLUG AT J21
SPEED, TORQUE AND VOLTAGE REGULATORS
FAULT & MODE INDICATORS
J202
J208
J20
OPTION SOCKETS
METER OUTPUTS
TORQ. LIMIT
+ MAX VOLTS
- MAX VOLTS
SPEED
CURRENT
+6V
RED
C FILE NO. A2399-4
DRAWING SIZE D
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
DRAFTSMAN
DATE
M.GY.
5/26/89
APP'D
DATE
PRD12B BASIC SCHEMATIC WITH OPTIONS - SIZES A & B
MATERIAL
SCALE
DWG.NO.
A2399-009-ES.c
SHEET 1 OF

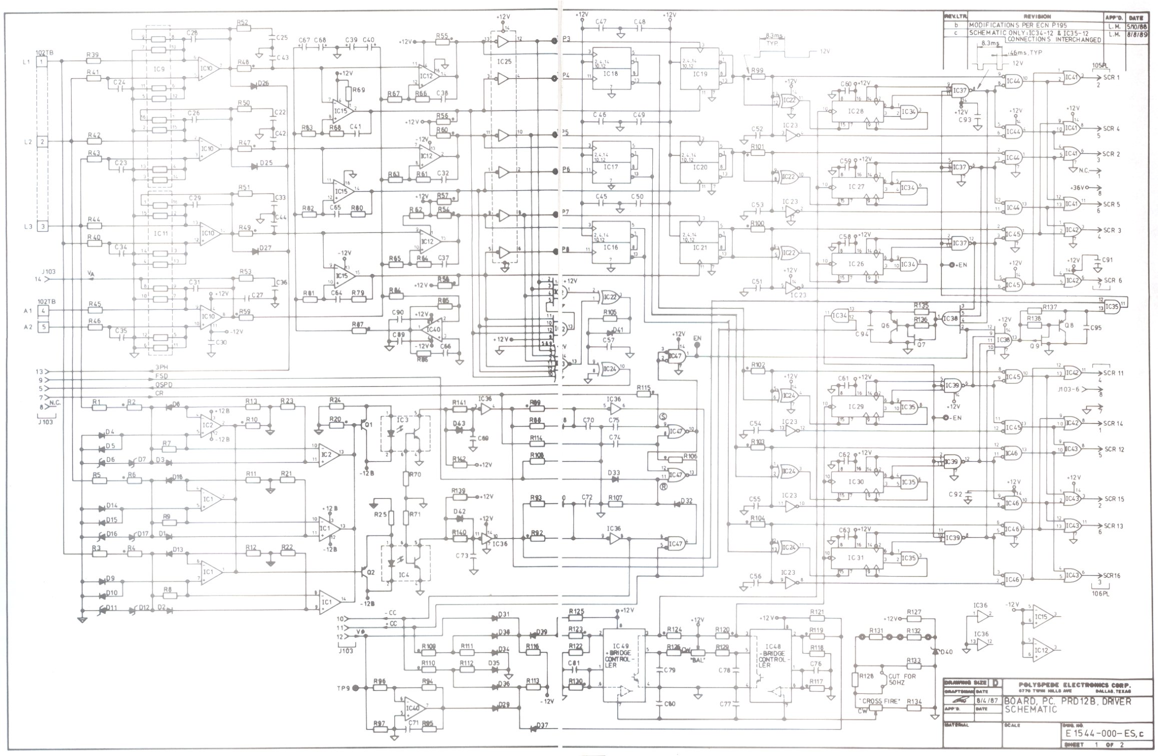

E1546 CIRCUIT BOARD
SCHEMATIC E1546-000-ES
E1544 CIRCUIT BOARD
C FILE NO. A2399-3
DRAWING SIZE D
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
M.GY. 11/22/91
PRD12B BASIC SCHEMATIC WITH
OPTIONS - SIZES C THRU G
A2399-010-ES.d

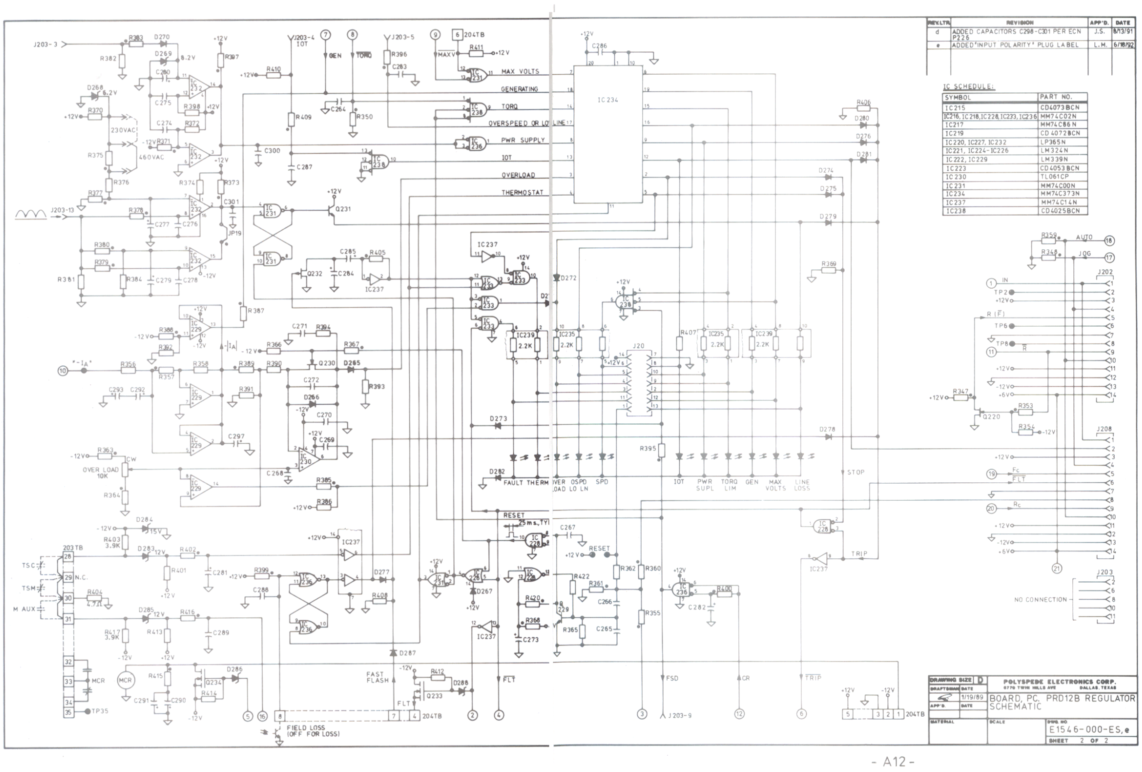

POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE DALLAS, TEXAS
DRAWING SIZE D
8/4/87
BOARD, PC. PRD12B, DRIVER
SCHEMATIC
E 1544-000-ES, c
SHEET 1 OF 2

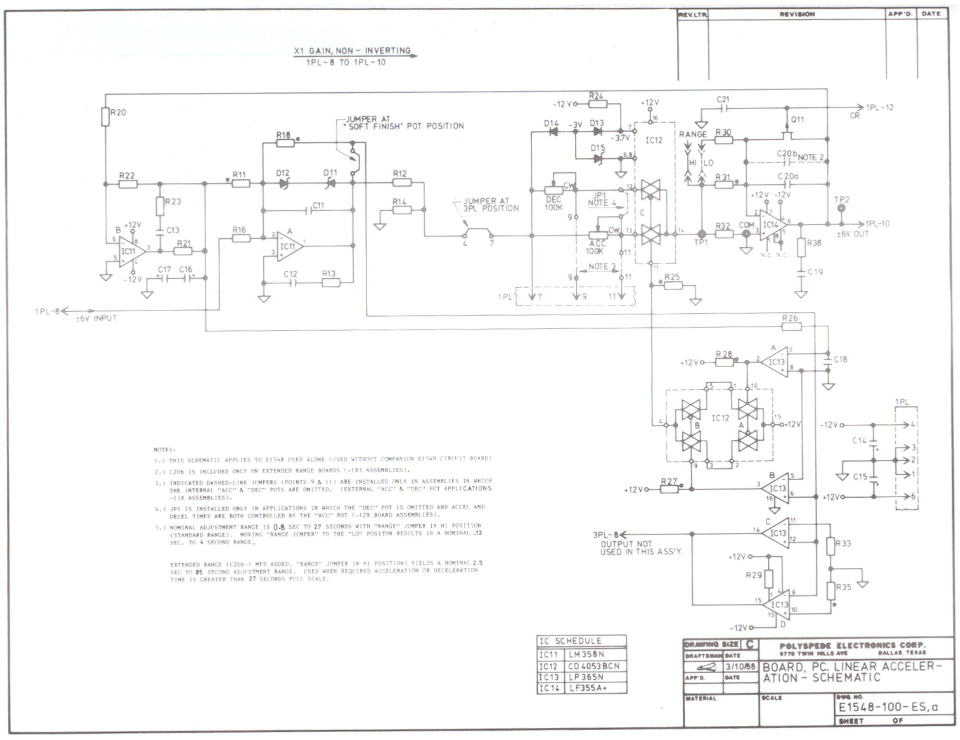

POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE DALLAS, TEXAS
DRAWING SIZE D
DRAFTSMAN
DATE
8/6/87
APP'D.
DATE
BOARD, PC, PRD12B, DRIVER SCHEMATIC
MATERIAL
SCALE
DWG. NO.
E1544-000-ES,c
SHEET 2 OF 2

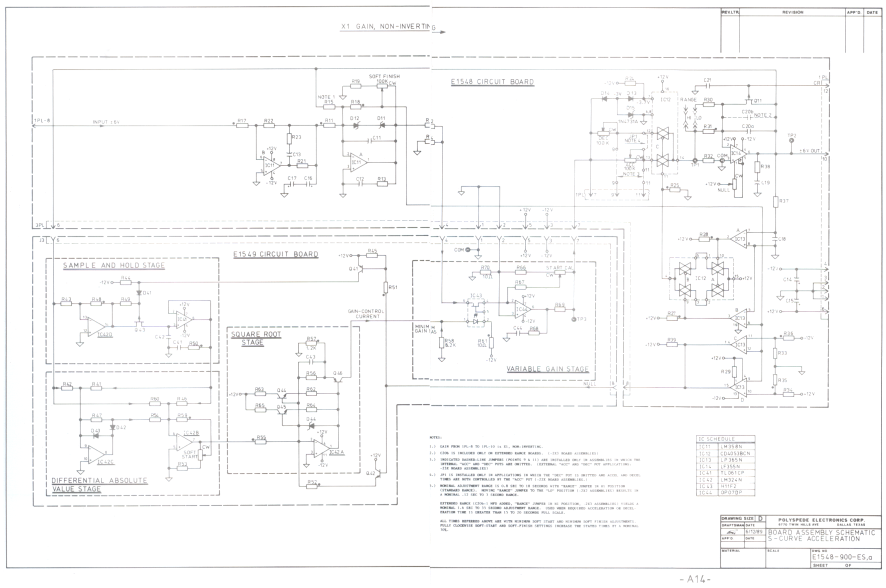
– A9 –

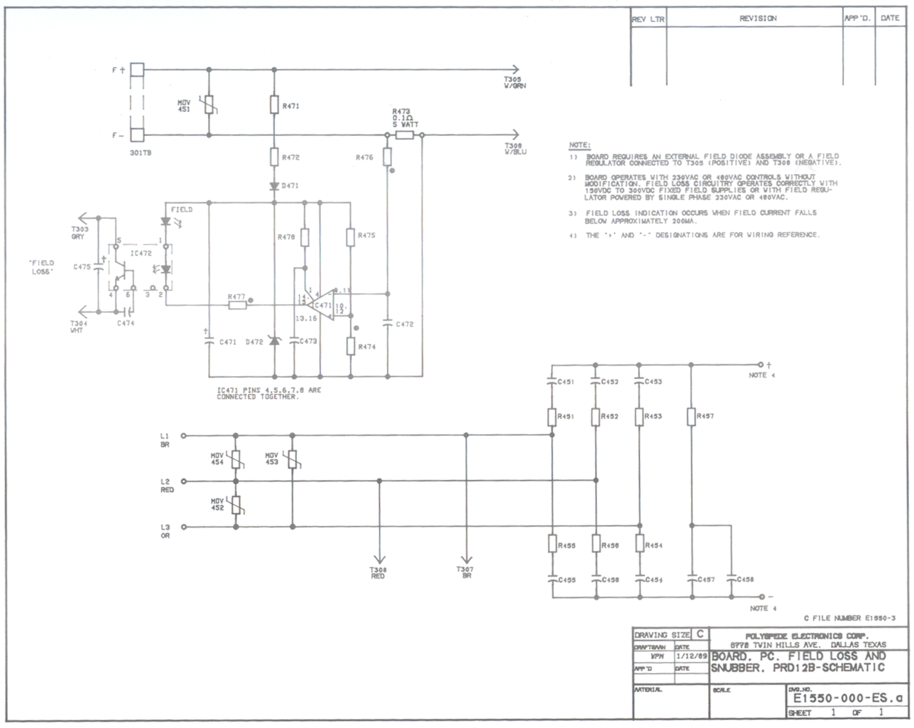

APPLIES TO REV. b AND LATER CIRCUIT BOARDS
DRAWING SIZE C
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE DALLAS, TEXAS
DRAFTSMAN
DATE
4/20/87
APP'D.
DATE
BOARD, PC. PRD12B PULSE
GENERATOR - SCHEMATIC
MATERIAL
SCALE
DWG. NO.
E1545-000-ES,b
SHEET OF

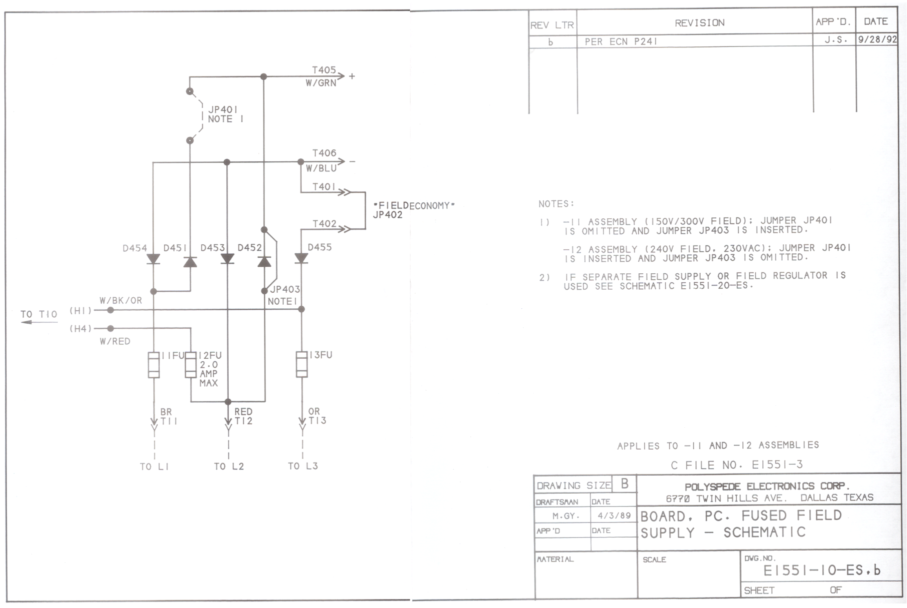

POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE
DALLAS, TEXAS
DRAWING SIZE D
DRAFTSMAN
DATE 8/4/87
APP'D.
DATE
BOARD, PC. PRD12B, DRIVER
SCHEMATIC
MATERIAL
SCALE
DWG. NO.
E 1544-000-ES, c
SHEET 1 OF 2




X1 GAIN, NON - INVERTING
1PL-8 TO 1PL-10
JUMPER AT "SOFT FINISH" POT POSITION
JUMPER AT 3PL POSITION
1PL-8
±6V INPUT
±6V OUT
3PL-8
OUTPUT NOT USED IN THIS ASS'Y.
NOTES:
1.) THIS SCHEMATIC APPLIES TO E1548 USED ALONE (USED WITHOUT COMPANION E1549 CIRCUIT BOARD)
2.) C20b IS INCLUDED ONLY ON EXTENDED RANGE BOARDS (-1X3 ASSEMBLIES).
3.) INDICATED DASHED-LINE JUMPERS (POINTS 9 & 11) ARE INSTALLED ONLY IN ASSEMBLIES IN WHICH THE INTERNAL "ACC" & "DEC" POTS ARE OMITTED. (EXTERNAL "ACC" & "DEC" POT APPLICATIONS -13X ASSEMBLIES).
4.) JP1 IS INSTALLED ONLY IN APPLICATIONS IN WHICH THE "DEC" POT IS OMITTED AND ACCEL AND DECEL TIMES ARE BOTH CONTROLLED BY THE "ACC" POT (-12X BOARD ASSEMBLIES).
5.) NOMINAL ADJUSTMENT RANGE IS 0.8 SEC TO 27 SECONDS WITH "RANGE" JUMPER IN HI POSITION (STANDARD RANGE). MOVING "RANGE JUMPER" TO THE "LO" POSITON RESULTS IN A NOMINAL .12 SEC. TO 4 SECOND RANGE.
EXTENDED RANGE (C20b-1 MFD ADDED, "RANGE" JUMPER IN HI POSITION) YIELDS A NOMINAL 2.5 SEC TO 85 SECOND ADJUSTMENT RANGE. USED WHEN REQUIRED ACCELERATION OR DECELERATION TIME IS GREATER THAN 27 SECONDS FULL SCALE.
IC SCHEDULE
IC11 LM358N
IC12 CD4053BCN
IC13 LP365N
IC14 LF355A+
DRAWING SIZE C
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE DALLAS, TEXAS
3/10/88
BOARD, PC. LINEAR ACCELER-ATION - SCHEMATIC
E1548-100-ES,a




REV LTR
REVISION
APP'D.
DATE
NOTE:
1) BOARD REQUIRES AN EXTERNAL FIELD DIODE ASSEMBLY OR A FIELD REGULATOR CONNECTED TO T305 (POSITIVE) AND T308 (NEGATIVE).
2) BOARD OPERATES WITH 230VAC OR 460VAC CONTROLS WITHOUT MODIFICATION. FIELD LOSS CIRCUITRY OPERATES CORRECTLY WITH 150VDC TO 300VDC FIXED FIELD SUPPLIES OR WITH FIELD REGULATOR POWERED BY SINGLE PHASE 230VAC OR 460VAC.
3) FIELD LOSS INDICATION OCCURS WHEN FIELD CURRENT FALLS BELOW APPROXIMATELY 200MA.
4) THE "+" AND "-" DESIGNATIONS ARE FOR WIRING REFERENCE.
IC471 PINS 4,5,6,7,8 ARE CONNECTED TOGETHER.
NOTE 4
C FILE NUMBER E1550-3
DRAWING SIZE C
POLYSPEDE ELECTRONICS CORP.
6778 TWIN HILLS AVE. DALLAS TEXAS
DRAFTSMAN
DATE
WPM
1/12/89
BOARD. PC. FIELD LOSS AND SNUBBER. PRD12B-SCHEMATIC
APP'D
DATE
MATERIAL
SCALE
DWG.NO.
E1550-000-ES.a
SHEET 1 OF 1


REV LTR
REVISION
APP'D.
DATE
b
PER ECN P241
J.S.
9/28/92
T405
W/GRN
JP401
NOTE 1
T406
W/BLU
T401
T402
FIELD ECONOMY
JP402
D454
D451
D453
D452
D455
JP403
NOTE1
W/BK/OR
TO T10
(H1)
(H4)
W/RED
11FU
12FU
2.0
AMP
MAX
13FU
BR
T11
RED
T12
OR
T13
TO L1
TO L2
TO L3
NOTES:
1) -11 ASSEMBLY (150V/300V FIELD): JUMPER JP401 IS OMITTED AND JUMPER JP403 IS INSERTED.
-12 ASSEMBLY (240V FIELD, 230VAC): JUMPER JP401 IS INSERTED AND JUMPER JP403 IS OMITTED.
2) IF SEPARATE FIELD SUPPLY OR FIELD REGULATOR IS USED SEE SCHEMATIC E1551-20-ES.
APPLIES TO -11 AND -12 ASSEMBLIES
C FILE NO. E1551-3
DRAWING SIZE B
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
DRAFTSMAN
DATE
M.GY.
4/3/89
APP'D
DATE
BOARD, PC. FUSED FIELD SUPPLY - SCHEMATIC
MATERIAL
SCALE
DWG.NO.
E1551-10-ES.b
SHEET
OF

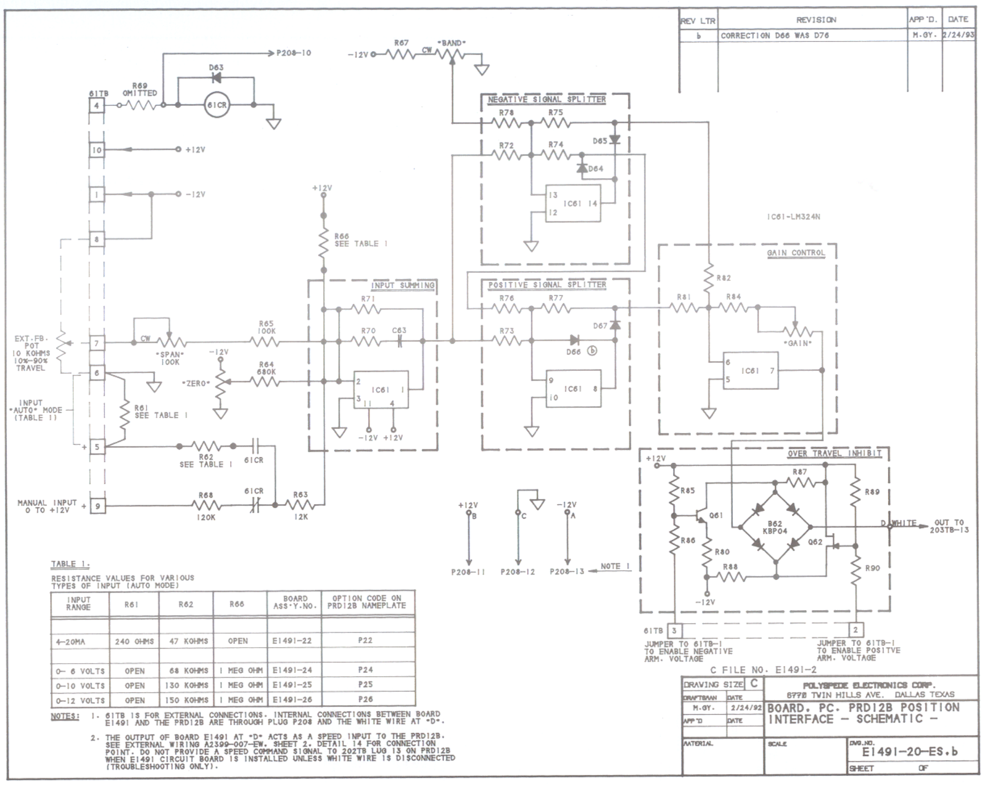
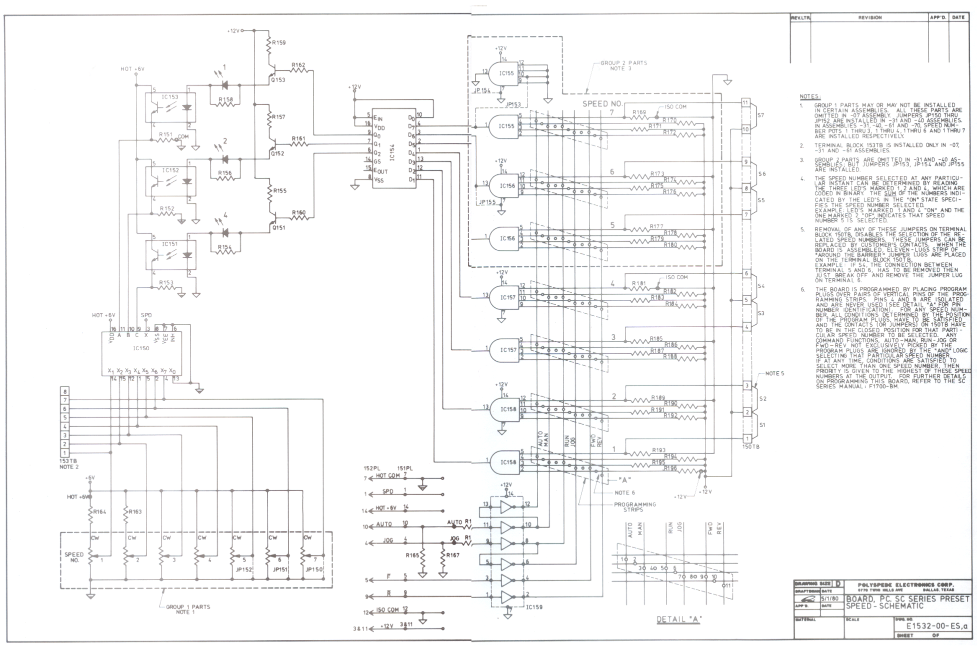


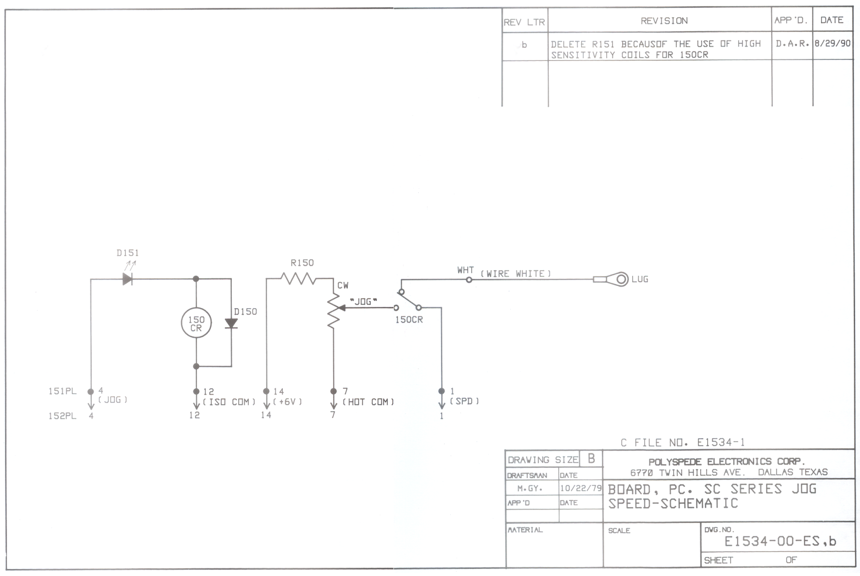
TABLE 1.

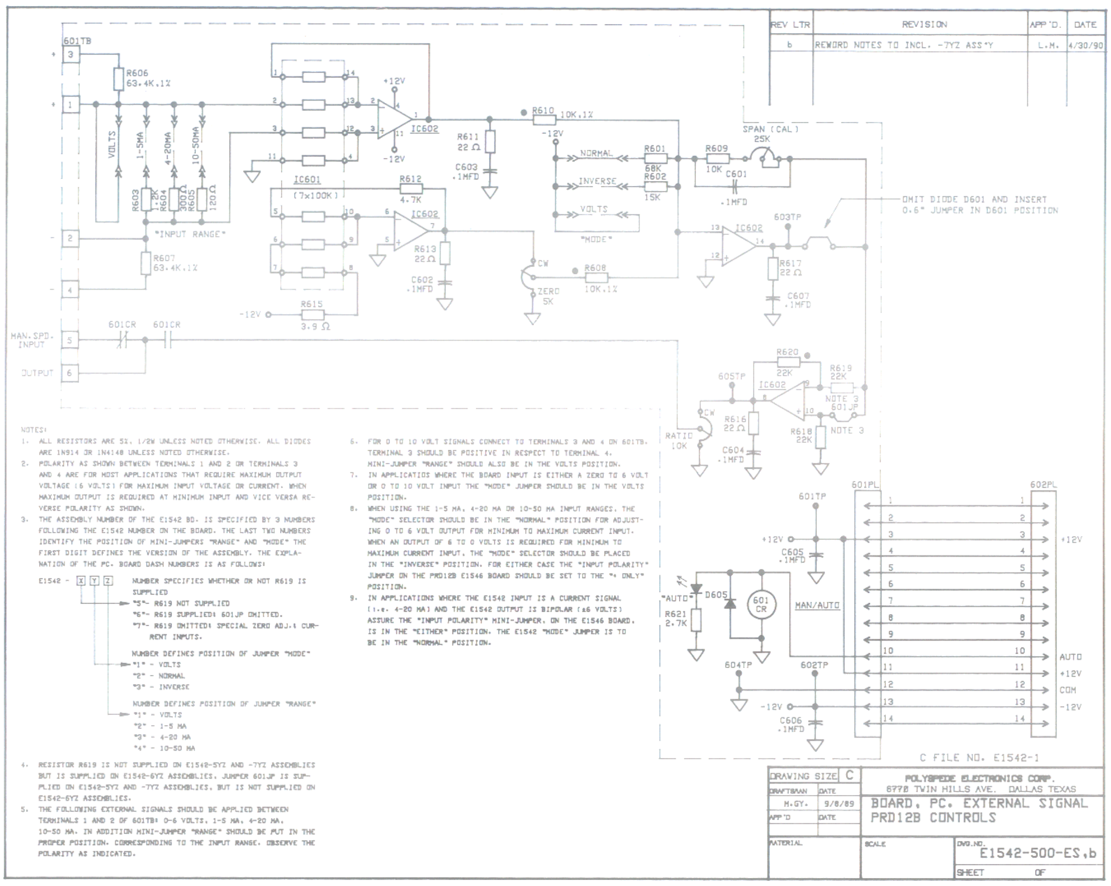
RESISTANCE VALUES FOR VARIOUS TYPES OF INPUT (AUTO MODE)

INPUT RANGE	R61	R62	R66	BOARD ASS'Y.NO.	OPTION CODE ON PRD12B NAMEPLATE
4-20MA	240 OHMS	47 KOHMS	OPEN	E1491-22	P22
0- 6 VOLTS	OPEN	68 KOHMS	1 MEG OHM	E1491-24	P24
0-10 VOLTS	OPEN	130 KOHMS	1 MEG OHM	E1491-25	P25
0-12 VOLTS	OPEN	150 KOHMS	1 MEG OHM	E1491-26	P26

NOTES:
1. 61TB IS FOR EXTERNAL CONNECTIONS. INTERNAL CONNECTIONS BETWEEN BOARD E1491 AND THE PRD12B ARE THROUGH PLUG P208 AND THE WHITE WIRE AT "D".
2. THE OUTPUT OF BOARD E1491 AT "D" ACTS AS A SPEED INPUT TO THE PRD12B. SEE EXTERNAL WIRING A2399-007-EW, SHEET 2, DETAIL 14 FOR CONNECTION POINT. DO NOT PROVIDE A SPEED COMMAND SIGNAL TO 202TB LUG 13 ON PRD12B WHEN E1491 CIRCUIT BOARD IS INSTALLED UNLESS WHITE WIRE IS DISCONNECTED (TROUBLESHOOTING ONLY).


POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE DALLAS, TEXAS
DRAWING SIZE D
DRAFTSMAN DATE 5/1/80
APP'D. DATE
BOARD, PC. SC SERIES PRESET SPEED - SCHEMATIC
MATERIAL
SCALE
DWG. NO. E1532-00-ES,a
SHEET OF
DETAIL "A"
SPEED NO.
GROUP 1 PARTS NOTE 1
GROUP 2 PARTS NOTE 3
PROGRAMMING STRIPS
NOTES:


REV LTR
REVISION
APP'D.
DATE
b
DELETE R151 BECAUSOF THE USE OF HIGH SENSITIVITY COILS FOR 150CR
D.A.R.
8/29/90
D151
R150
WHT
(WIRE WHITE)
LUG
CW
"JOG"
150CR
D150
150 CR
151PL
152PL
4 (JOG)
4
12 (ISO COM)
12
14 (+6V)
14
7 (HOT COM)
7
1 (SPD)
1
C FILE NO. E1534-1
DRAWING SIZE B
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
DRAFTSMAN
DATE
M.GY.
10/22/79
APP'D
DATE
BOARD, PC. SC SERIES JOG SPEED-SCHEMATIC
MATERIAL
SCALE
DWG.NO.
E1534-00-ES,b
SHEET
OF



REV LTR
REVISION
APP'D.
DATE
b
REWORD NOTES TO INCL. -7YZ ASS'Y
L.M.
4/30/90
NOTES:
1. ALL RESISTORS ARE 5%, 1/2W UNLESS NOTED OTHERWISE. ALL DIODES ARE 1N914 OR 1N4148 UNLESS NOTED OTHERWISE.
2. POLARITY AS SHOWN BETWEEN TERMINALS 1 AND 2 OR TERMINALS 3 AND 4 ARE FOR MOST APPLICATIONS THAT REQUIRE MAXIMUM OUTPUT VOLTAGE (6 VOLTS) FOR MAXIMUM INPUT VOLTAGE OR CURRENT. WHEN MAXIMUM OUTPUT IS REQUIRED AT MINIMUM INPUT AND VICE VERSA REVERSE POLARITY AS SHOWN.
3. THE ASSEMBLY NUMBER OF THE E1542 BD. IS SPECIFIED BY 3 NUMBERS FOLLOWING THE E1542 NUMBER ON THE BOARD. THE LAST TWO NUMBERS IDENTIFY THE POSITION OF MINI-JUMPERS "RANGE" AND "MODE" THE FIRST DIGIT DEFINES THE VERSION OF THE ASSEMBLY. THE EXPLANATION OF THE PC. BOARD DASH NUMBERS IS AS FOLLOWS:
E1542 - X Y Z
NUMBER SPECIFIES WHETHER OR NOT R619 IS SUPPLIED
"5"- R619 NOT SUPPLIED
"6"- R619 SUPPLIED; 601JP OMITTED.
"7"- R619 OMITTED; SPECIAL ZERO ADJ.; CURRENT INPUTS.
NUMBER DEFINES POSITION OF JUMPER "MODE"
"1" - VOLTS
"2" - NORMAL
"3" - INVERSE
NUMBER DEFINES POSITION OF JUMPER "RANGE"
"1" - VOLTS
"2" - 1-5 MA
"3" - 4-20 MA
"4" - 10-50 MA
4. RESISTOR R619 IS NOT SUPPLIED ON E1542-5YZ AND -7YZ ASSEMBLIES BUT IS SUPPLIED ON E1542-6YZ ASSEMBLIES. JUMPER 601JP IS SUPPLIED ON E1542-5YZ AND -7YZ ASSEMBLIES, BUT IS NOT SUPPLIED ON E1542-6YZ ASSEMBLIES.
5. THE FOLLOWING EXTERNAL SIGNALS SHOULD BE APPLIED BETWEEN TERMINALS 1 AND 2 OF 601TB: 0-6 VOLTS, 1-5 MA, 4-20 MA, 10-50 MA. IN ADDITION MINI-JUMPER "RANGE" SHOULD BE PUT IN THE PROPER POSITION, CORRESPONDING TO THE INPUT RANGE. OBSERVE THE POLARITY AS INDICATED.
6. FOR 0 TO 10 VOLT SIGNALS CONNECT TO TERMINALS 3 AND 4 ON 601TB. TERMINAL 3 SHOULD BE POSITIVE IN RESPECT TO TERMINAL 4. MINI-JUMPER "RANGE" SHOULD ALSO BE IN THE VOLTS POSITION.
7. IN APPLICATIOS WHERE THE BOARD INPUT IS EITHER A ZERO TO 6 VOLT OR 0 TO 10 VOLT INPUT THE "MODE" JUMPER SHOULD BE IN THE VOLTS POSITION.
8. WHEN USING THE 1-5 MA, 4-20 MA OR 10-50 MA INPUT RANGES, THE "MODE" SELECTOR SHOULD BE IN THE "NORMAL" POSITION FOR ADJUSTING 0 TO 6 VOLT OUTPUT FOR MINIMUM TO MAXIMUM CURRENT INPUT. WHEN AN OUTPUT OF 6 TO 0 VOLTS IS REQUIRED FOR MINIMUM TO MAXIMUM CURRENT INPUT, THE "MODE" SELECTOR SHOULD BE PLACED IN THE "INVERSE" POSITION. FOR EITHER CASE THE "INPUT POLARITY" JUMPER ON THE PRD12B E1546 BOARD SHOULD BE SET TO THE "+ ONLY" POSITION.
9. IN APPLICATIONS WHERE THE E1542 INPUT IS A CURRENT SIGNAL (i.e. 4-20 MA) AND THE E1542 OUTPUT IS BIPOLAR (±6 VOLTS) ASSURE THE "INPUT POLARITY" MINI-JUMPER, ON THE E1546 BOARD, IS IN THE "EITHER" POSITION. THE E1542 "MODE" JUMPER IS TO BE IN THE "NORMAL" POSITION.
MAN.SPD. INPUT
OUTPUT
601CR
R615
3.9 Ω
-12V
OMIT DIODE D601 AND INSERT 0.6" JUMPER IN D601 POSITION
SPAN (CAL)
25K
NORMAL
INVERSE
VOLTS
"MODE"
"INPUT RANGE"
ZERO
5K
RATIO
10K
MAN/AUTO
AUTO
+12V
COM
-12V
C FILE NO. E1542-1
DRAWING SIZE C
DRAFTSMAN
DATE
M.GY.
9/8/89
APP'D
DATE
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
BOARD, PC. EXTERNAL SIGNAL
PRD12B CONTROLS
MATERIAL
SCALE
DWG.NO.
E1542-500-ES,b
SHEET
OF

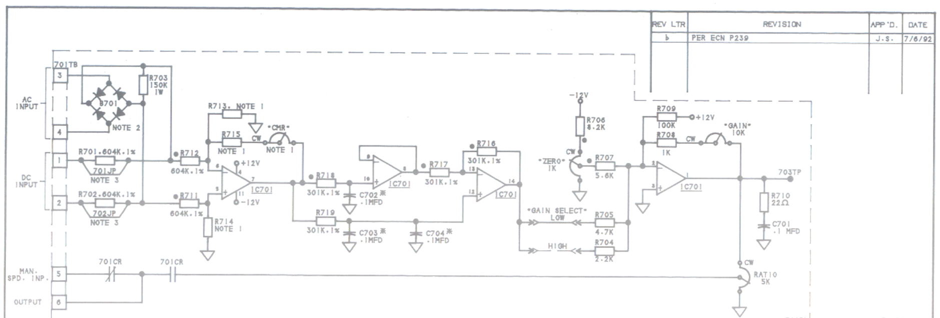


TABLE 1.
COMPONENT VERSUS ASSEMBLY TABULATION

USE	OPTION CODE	ASSEMBLY	INPUT VOLTAGE RANGE	VALUE OF R713	VALUE OF R714	VALUE OF R715	VALUE OF "CMR"
TACHOMETER FOLLOWER	TF1	E1543-01	6-20 VDC	OPEN	100K	51.2K	100K
	TF2	E1543-02	20-65 VDC OR 25-75 VAC	53.6K	25.5K	40.2K	25K
	TF3	E1543-03	65-200 VDC OR 75-230 VAC	15.0K	7.5K	10.0K	10K
	TF4	E1543-04	±20-65 VDC	53.6K	25.5K	40.2K	25K
	TF5	E1543-05	±65-200 VDC	15.0K	7.5K	10.0K	10K
ARMATURE VOLTAGE FOLLOWER	VF1	E1543-06	0-90 VDC OR 0-180 VDC OR 0-240 VDC	10K	4.99K	8.25K	5K
	VF2	E1543-07	0-500 VDC OR 0-550 VDC	10K	4.99K	8.25K	5K

R713, R714 & R715 ARE 1% RESISTORS

NOTES:

1. RESISTORS R713, R714, R715 AND "CMR" POTENTIOMETER VARY AS A FUNCTION OF ASSEMBLY NUMBER. REFER TO TABLE 1.
2. BRIDGE B701 AND RESISTOR R703 ARE ONLY SUPPLIED ON ASSEMBLIES E1543-02 & -03.
3. JUMPERS 701JP AND 702JP ARE SUPPLIED ON ALL ASSEMBLIES EXCEPT THE E1543-07 ASSEMBLY. RESISTORS R701 AND R702 ARE SUPPLIED ON THE E1543-07 ASSEMBLY.
4. THE "GAIN SELECT" JUMPER IS USED TO CHANGE THE MAXIMUM GAIN OF THE FINAL AMPLIFIER STAGE. THE "LOW" GAIN SETTING WILL PERMIT A MAXIMUM ADJUSTABLE GAIN OF "2". THE "HIGH" GAIN SETTING WILL PERMIT A MAXIMUM ADJUSTABLE GAIN OF "5". INITIALLY START WITH THE "GAIN SELECT" MINI-JUMPER IN THE "LOW" GAIN POSITION. THE "GAIN" POTENTIOMETER SHOULD BE ADJUSTED SO THAT WITH MAXIMUM INPUT VOLTAGE SIX VOLTS APPEARS AT 703TP IN RESPECT TO 704TP. IF SIX VOLTS CANNOT BE ACHIEVED IN THE "LOW" GAIN MODE, MOVE THE MINI-JUMPER TO THE "HIGH" POSITION AND READJUST FOR SIX VOLTS WITH MAXIMUM INPUT VOLTAGE. THE "ZERO" POTENTIOMETER SHOULD BE ADJUSTED SO THAT WITH ZERO INPUT, ZERO VOLTS APPEARS AT 703TP IN RESPECT TO 704TP.
5. TACHOMETER FOLLOWER OPTIONS TF1 THROUGH TF5 MUST BE USED WITH A TACHOMETER SIGNAL THAT IS FLOATING IN RESPECT TO EARTH GROUND.

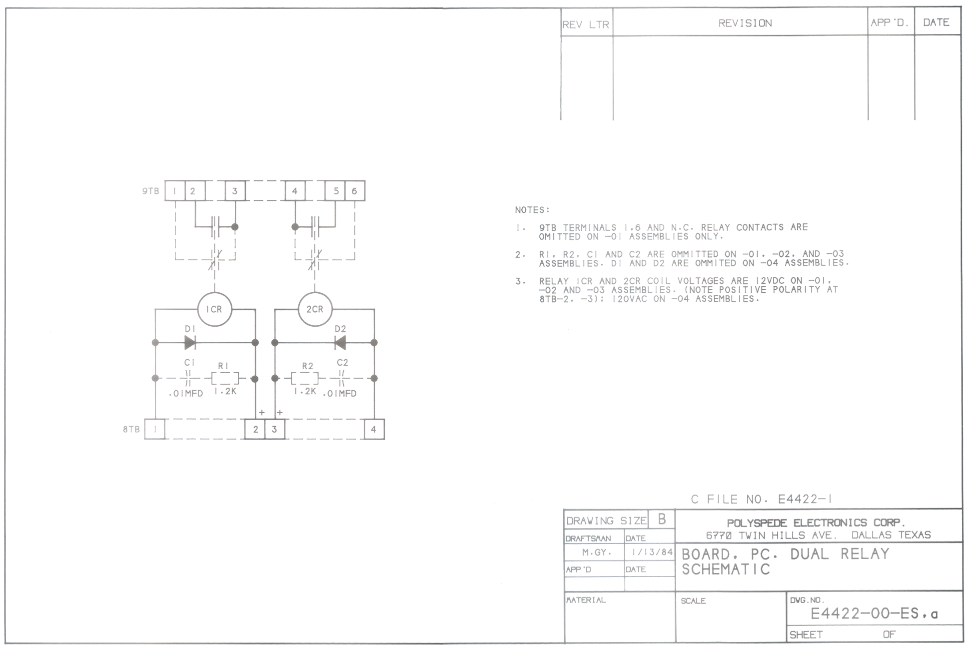
ALL RESISTORS ARE 1/2 WATT EXCEPT R703
ALL RESISTORS HAVE 5% TOLERANCE EXCEPT AS MARKED.

* - CAPACITORS C702, C703, & C704 ARE MATCHED TO WITHIN ± 2.5%

IC701-LM348

C FILE NO. E1543-2

DRAWING SIZE C		POLYSPEDE ELECTRONICS CORP. 6770 TWIN HILLS AVE. DALLAS TEXAS	
DRAFTSMAN M.GY.	DATE 7/6/92	BOARD, PC, ARMATURE VOLTAGE/ TACHOMETER FOLLOWER, PRD12B AND HP SERIES CONTROLS	
APP'D	DATE		
MATERIAL		SCALE	DWG.NO. E1543-00-ES.b SHEET OF


REV LTR
REVISION
APP'D.
DATE
9TB
1
2
3
4
5
6
1CR
2CR
D1
D2
C1
R1
R2
C2
.01MFD
1.2K
1.2K
.01MFD
+
+
8TB
1
2
3
4
NOTES:
1. 9TB TERMINALS 1.6 AND N.C. RELAY CONTACTS ARE OMITTED ON -01 ASSEMBLIES ONLY.
2. R1, R2, C1 AND C2 ARE OMMITTED ON -01, -02, AND -03 ASSEMBLIES. D1 AND D2 ARE OMMITED ON -04 ASSEMBLIES.
3. RELAY 1CR AND 2CR COIL VOLTAGES ARE 12VDC ON -01, -02 AND -03 ASSEMBLIES. (NOTE POSITIVE POLARITY AT 8TB-2, -3); 120VAC ON -04 ASSEMBLIES.
C FILE NO. E4422-1
DRAWING SIZE B
POLYSPEDE ELECTRONICS CORP.
6770 TWIN HILLS AVE. DALLAS TEXAS
DRAFTSMAN
DATE
M.GY.
1/13/84
APP'D
DATE
BOARD, PC. DUAL RELAY
SCHEMATIC
MATERIAL
SCALE
DWG.NO.
E4422-00-ES.a
SHEET
OF