
Boston Gear[®]

Ratiotrol DC Adjustable Speed Control

Installation and Operation

Doc. No. 83548

VED
1/6 - 5 HP



An Altra Industrial Motion Company

General Information

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General Information

Introduction

This manual contains installation, operation, and maintenance instructions for the Boston Gear VED Series Digital DC Adjustable Speed Single Phase Motor Controllers 1/6 - 5 HP.

These Controllers comply with applicable standards established by the National Electrical Code and NEMA for industrial motor and control equipment. Each controller is Underwriters Laboratory Listed.

General Description

These Controllers are microcontroller based, software configured units which convert AC line power to DC for adjustable-speed armature control of DC motors.

Table 1. Model Matrix

Models	Function			Configuration		Operator Controls		
	Unidirectional Run-Stop Jog	Unidirectional Run-Stop-DB jog	Run-Stop DB Jog-Rev.	Open Chassis	Enclosed Package	Membrane (1) Switch Panel		Push Button Remote Station
						Local Integral	Remote (2) Station	
VED100C VED300C VED500C	X			X				
VED100M VED300M VED500M	X				X	X		
VED100MR VED300MR VED500MR		X	X		X	X		
VED100B VED300B VED500B	X				X		X	
VED100BR VED300BR VED500BR		X	X		X		X	
VED100BP VED300BP VED500BP	X				X			X
VED100BPR VED300BPR VED500BPR		X	X		X			X
VED100C (3) VED300C VED500C	X			X			X	
VED100CR VED300CR VED500CR		X	X	X			X	
VED100CP VED300CP VED500CP	X			X				X
VED100CPR VED300CPR VED500CPR		X	X	X				X
VED100	1/6 - 1 HP, 115V Single-Phase, 50 or 60 Hz							
VED300	1/3 - 3 HP, 230V Single-Phase, 50 or 60 Hz							
VED500	1/6 - 1 HP, 115V or 1/2 - 5 HP, 230V, Single-Phase, 50 or 60 Hz							

NOTES

- Panel includes membrane push switches for RUN, JOG, STOP, FASTER, SLOWER, FORWARD, REVERSE, and a liquid crystal display (LCD). (Reverse push switch only works on reversing controllers.)
- Remote station must be ordered separately, see Option MCS1.
- These chassis controllers require an AC contactor ahead of the controller and a run speed potentiometer to be functional units, unless the membrane remote station is used as shown in the matrix

General Information

Motor Selection

The motor can be shunt wound, or permanent magnet DC type. For maximum efficiency, the motor should be rated for operation from a NEMA Code K power source. See Table 3 for motor ratings.

Ratings

1. Analog Reference Power Supply (Isolated)5 VDC

- 2. Circuit Breaker Interrupting Capacity6000 Amps
- 3. DutyContinuous
- 4. Motor Speed Potentiometer5K Ohms, 1/2W
- 5. Overload Capacity (Armature Circuit)
150% for 1 Minute
- 6. Control Voltage (Isolated24 VDC
- 7. Operating VoltagesSee Table 2
- 8. Power SourceSee Table 3
- 9. Horsepower rangeSee Table 3
- 10. Service factor1.0

Table 2. Operating Voltages

Controller	Power Source (single-phase)	Output VDC		Control Reference Voltage	Magnetic Control Voltage
		Armature	Field		
VED100	115V, 50 Or 60 Hz	0 - 90	50	5VDC	24VDC
VED300, VED500	230V, 50 Or 60 Hz	0 - 180	100		

Table 3. Typical Application Data

Component			Ratings									
Rated Horsepower (HP)			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	5
Rated Kilowatts kW			0.124	0.187	0.249	0.373	0.500	0.746	1.120	1.492	2.238	3.730
1-Phase AC Input (Full Load)	Line Amps	115V Unit	3.9	5.0	6.0	8.7	12.4	15.8	----	----	----	----
		230V Unit	----	----	----	4.2	5.9	8.8	1.26	17.0	20.0	30.0
	KVA		0.48	0.58	0.71	1.0	1.4	2.0	3.0	4.0	5.0	8.0
DC Output (Full Load)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	----	----	----	----
		180V	----	----	----	2.6	3.8	5.5	8.2	11.6	15.1	24.0
	Motor (1) Field Amps	50V	2.0	2.0	2.0	2.0	2.0	2.0	----	----	----	----
		100V	----	----	----	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Full-Load Torque (lb-ft) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0	15.0
Minimum Transformer KVA For Voltage Matching or Isolation			0.5	0.75	0.75	1.0	1.5	2.0	3.0	5.0	5.0	10.0
Controller Weight in pounds (Kgs)	Open Chassis Models							9.8	(4.45)			
	Enclosed Models							11.4	(5.17)			

Note: 1. Does not apply to permanent-magnet motors.

Operating Conditions

1. Altitude (Standard)1000 Meters (3300 Ft) Max
2. Ambient Temperature (1) . . .0-40° C (32° F-104° F)
3. Line Frequency Variation ± 2 Hz of Rated
4. Line Voltage Variation $\pm 10\%$ of Rated
5. Relative Humidity95% Noncondensating

Note: (1) 55° C (131° F) maximum in enclosed areas where open chassis controllers are mounted.

Performance Characteristics

1. Controlled Speed Range . .0 to Motor Base Speed
2. Displacement Power Factor87%
(Rated Speed/Rated Load)
3. Efficiency (Rated Speed/Rated Load)
 - a. Controller98%
 - b. Drive (Controller w/motor, Typical)84%
4. Speed Regulation (See Table 4) - Regulation percentages are of motor base speed under steady-state conditions.

Adjustments

1. Acceleration/Deceleration (1)
 - a. Time0.2-100 Seconds
 - b. Rate500%-1% Per Second

Note: (1) Adjustments are logarithmic for fine adjustment of fast rates.

Acceleration and deceleration are linear and independently adjustable.

2. Torque Limit . . .0-150% Of Full-Load Motor Torque
3. IR (Load) Compensation0-18% Boost
4. Jog Speed0-100% Of Motor Base Speed
5. Maximum Speed . . .0-100% Of Motor Base Speed
6. Minimum Speed . . .0-100% Of Motor Base Speed

Table 4. Speed Regulation Characteristics

Regulation Method	Variable				
	Load Change 95%	Line Voltage $\pm 10\%$	Field Heating Cold-Normal	Temperature $\pm 10^\circ$ C	Speed Range
Standard Voltage Feedback with IR Compensation	2%	$\pm 1\%$	5-12%	$\pm 2\%$	50:1
Analog Speed Feedback w/TG3, TG50A, or TG35D Tach	0.2%	$\pm 0.2\%$	0.2%	$\pm 0.5\%$	500:1
Option 24E Digital Speed Feedback with incremental Quadrature Encoder	0.0%	0.0%	0.0%	0.0%	500:1

Installation

Installation Guidelines

1. **Controller Mounting** - The Controller may be mounted in either of two positions; vertically with the circuit breaker at the right side, or horizontally with the circuit breaker at the top.

Multiple Controllers may be mounted side by side, as close to each other as the mounting feet will allow. However, if the Controller enclosure has cover hinges (Option 50), 4 inches (102mm) clearance must be provided on the hinged side of the enclosure to accommodate the swing of the cover.

The minimum clearance at the top and bottom may be as narrow as the conduit fittings allow.

The Controller must be mounted in a location free from vibration.

2. **Cooling** - A natural convection flow of air is required over the pins on the back of the Controller to dissipate the heat generated by the Controller. Allow 4 inches (102mm) clearance on all sides from solid objects which block the flow of air to the pins.

The air surrounding an enclosed Controller must not exceed 40° C (104° F) and the air surrounding an open-chassis Controller must not exceed 55° C (131° F). Minimum air temperature is 0° C (32° F) for enclosed and open chassis Controllers

3. **Controller Enclosure** - The standard Controller enclosure is TENV, but is not sealed to prevent seepage of oil or other liquids. Option 27 provides a flexible boot for the circuit breaker and a gasket for the Operator Control Panel, which converts the enclosure to NEMA Type 3, 4 and 12 standards.

The enclosure base is made of die-cast aluminum with a powder epoxy finish. The enclosure cover is made of Noryl, which is not affected by most water-based solutions, detergents acids and bases. However, the Cover may be softened by heptane, acetone, and other halogenated and aromatic hydrocarbons, so install the Controller in a location free from these substances.

4. **Operator Controls** - The standard Membrane Operator Panel (MP1) may be located in the enclosure cover or it may be located remotely, provided Option MSC1 is used. Additional STOP buttons may be used with the MP1 panel provided they are

connected as shown in Figure 2 (Page 18).

Therefore, from more than one remote location, Option P (Pushbutton Interface) must be used with multiple conventional pushbutton remote stations.

5. **Line Starting** - The controller can be operated without the MB1 Panel or any other operator control station. In this mode of operation, the motor runs when AC line power is applied to the Controller Line Terminals (L1 and L2), and stops when power is removed. Motor speed may be adjusted with the internal MIN SPD potentiometer or by a Potentiometer connected to Terminal Board TB2. The Line Starting mode is enabled by clipping Jumper W1 from the Controller Logic Board and following the instructions in Figure 2 (Page 18).
6. **Line Supply** - The Controller circuit breaker has an interrupting capacity of 5,000 amperes. Therefore, the Controller should not be connected to a line supply capable of supplying more than 5,000 amperes short-circuit current. Short-circuit current can be limited by sizing the input supply transformer at 50 KVA or less, or by using correctly sized current limiting fuses in the supply line ahead of the Controller. Do not size the transformer less than the minimum transformer KVA listed in Table 3 (Page 4).

Do not use power factor correction capacitors on the supply line to the Controller.

A 20-joule metal oxide varistor (MOV) is connected across the Controller line terminals. If higher energy transients are present on the line supply, additional transient suppression will be required.

Connect the white wire (common) of a 115 VAC line to Terminal L2, and connect the Controller Base to earth ground using the ground screw located near the top conduit entry hole in the Controller Base.

If rated line voltage (see Table 2, page 3) is not available, a line transformer will be required. While an auto-transformer may be used for voltage transformation, it will not isolate the Controller from the line supply. For advantages of using an isolation transformer, see Guideline 7.

7. **Isolation Transformer** - While not required, an isolation transformer can provide the following advantages.

- a. Reduce the risk of personal injury if high voltage drive circuits are accidentally touched.
 - b. Provide a barrier to externally generated AC supply transients. This can prevent Controller damage from abnormal line occurrences.
 - c. Reduce the potential for damaging current if the motor armature, field or motor wiring become grounded.
8. Branch Circuit Protection - The National Electrical Code requires that a two-pole disconnect switch be installed in the AC line supply to the Controller. The Controller circuit breaker is a single-pole device that protects the Controller and motor from excessive current. An optional two-pole circuit breaker, (Option 30) is available which interrupts both sides of the line. Neither of these circuit breakers should be considered as branch circuit protection. However, the existing branch circuit may provide the required protection. Refer to the National Electrical Code and local codes.
9. Grounding - Connect the green or bare (ground) wire of the line supply to the ground screw located near the top conduit entry hole in the Controller base.

The motor frame must also be grounded.

Personal injury may occur if the Controller and motor are not properly grounded.

10. Wiring Practices - The power wiring must be sized to comply with the National Electrical Code, CSA, or local codes. Refer to the Controller data label for line and motor current ratings.

Signal wiring refers to wiring for potentiometers, tachometer generators, and transducers. Control wiring refers to wiring for operator controls.

If unshielded wire is used for signal and control wiring, it may be run in a common conduit, but not in the same conduit as the power wiring. In an enclosure, unshielded signal and control wiring must be kept separate from power wiring and only cross at 90° angles.

If shielded wire (such as Alpha 2422 - two conductor, 2423 - three conductor, 2424 four conductor) is used for the signal and control wiring, it may be run

in the same conduit with the power wiring. Connect the shields to chassis ground (ground screw on the Controller Base) and tape the opposite ends of the shields.

Two 3/4-14 NPT threaded holes are provided, one each in the top and bottom of the Controller Base for conduit entry.

11. Tachometer Feedback - The Controller derives CEMF from armature voltage and uses this as feedback to provide the performance shown in Table 4 (page 5). Improved performance can be obtained with tachometer feedback. Tachometer feedback requires a DC tachometer generator with an output of 7-150 volts* at rated motor speed. The tachometer generator must be tightly coupled to the motor shaft to achieve the performance shown in Table 4.

The built-in tachometer feedback only operates in the forward direction of motor rotation. If tachometer feedback is required for reverse operation or if a two-phase AC tachometer generator is used, Option 24A is required.

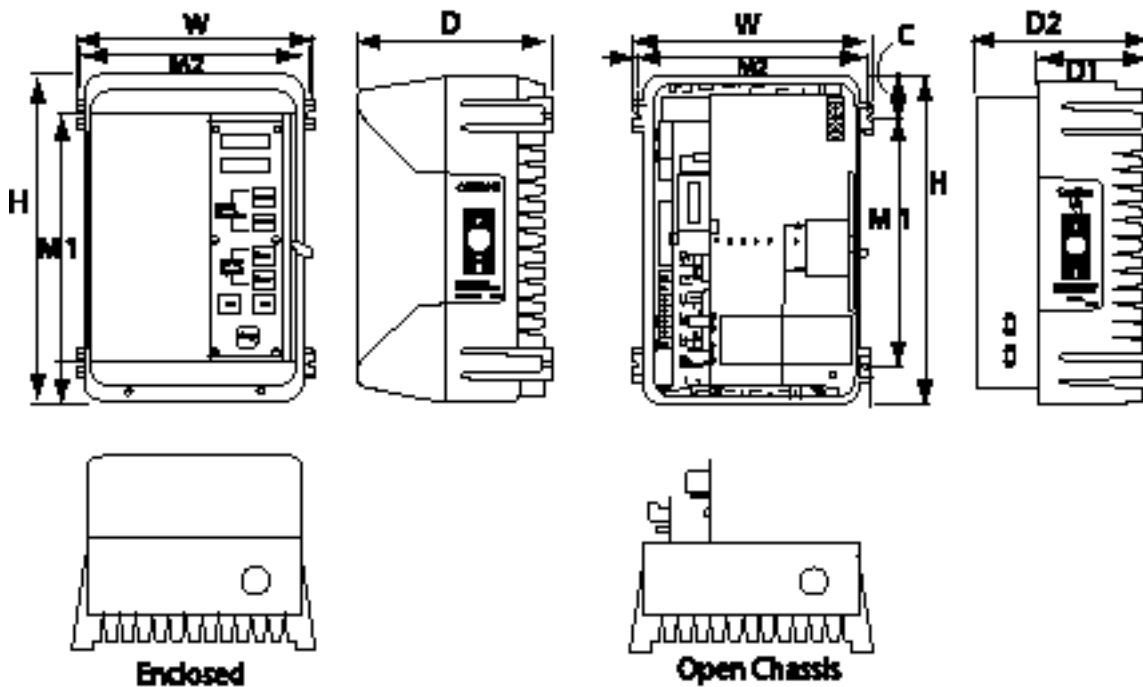
Note: * 151-220 volts at rated motor speed for non UL applications.

12. Options - This equipment manual is for use with the basic Controller. If options are installed in the Controller, they will be identified on the Controller data plate. The instruction sheets supplied with the options should be reviewed before the Controller is installed.

Installation

Installation

1. Remove the Controller Cover (if used), unless the Cover is hinged (Option 50).
2. Check the Controller and motor data plates to be sure they are electrically compatible.
3. Be sure the Controller has been calibrated correctly for the motor being used. Calibration is performed by clipping resistance wires from the Controller Power Board according to the table in Figure 2 (page 20).
4. Mount the Controller. Mounting dimensions are shown in Figure 1, below.
5. Install conduit and connect Wires L1, L2, A+, A-, F+, and F- and any other wiring shown in the option instruction sheets (if applicable).
6. Install the Controller Cover (if used), carefully plugging MP1 (if used) into connector J3 on the Controller Logic Board.
7. The weight for the VED100 and VED300 enclosed controllers is 11.4 lbs (5.17 Kg). The open chassis versions weigh 9.8 lbs (4.45 Kg)



Model	Dimensions, Inches (mm)							
	H	W	D	D1	D2	M1	M2	C
VED100	12.1	9.0	7.3	4.1	6.5	9.3	8.6	1.3
VED300	(307)	(228)	(185)	(104)	(165)	(236)	(218)	(25)
VED500	16	10.8	8.1	4.25	7.8	10.7	9.6	2.7
	(406)	(274)	(206)	(108)	(198)	(272)	(244)	(69)

Figure 1. Controller Mounting Dimensions

Initial Start-Up

1. Remove the Controller cover (if used). Prevent stress on the cable connected to the MP1 Panel if used by unplugging the cable from Connector J3 on the Controller Logic Board.
2. Be familiar with all options installed in the Controller by reviewing the instruction sheets supplied with the options. Be sure the Controller and options are configured correctly for the application.
3. Be sure all wiring is correct and all wiring terminals are tightened securely.
4. Be sure the correct resistance wires have been removed from the Controller Power Board. Refer to the table in Figure 2 (page 18).
5. Be sure the AC supply voltage to the Controller agrees with the Controller data plate rating.
6. The Controller will not operate with the motor disconnected. Therefore, if the machine should not operate at this time, uncouple the motor from the machine.
7. The potentiometers in the Controller are factory set as follows:

Potentiometer	Setting	Description
Accel	1/3 CW	5 Second ramp
Torque Limit	Fully CW	150% Torque
Decel	1/3 CW	5 Second ramp
IR Comp	Fully CCW	0% Boost
Max Speed	Fully CW	100% Speed
Max Speed Tach (1)	Fully CCW	Tach Feedback
Min Speed	Fully CCW	0% Speed

NOTE: (1) If tachometer is used, the MAX SPD TACH potentiometer must be adjusted.

The potentiometer settings in the above table will provide satisfactory operation for most applications. If different settings are required, refer to "Adjustment instructions" starting on page 12.

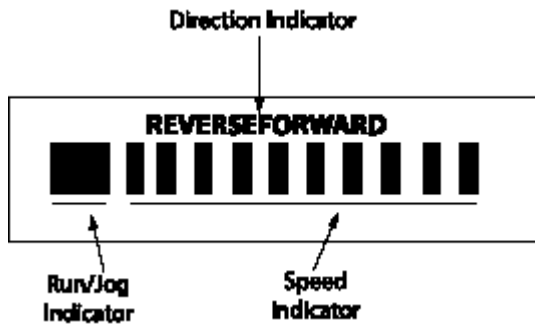
8. If the Control has an MPI Panel, plug it into Connector J3 on the Logic Board.
9. If the Controller has a cover, place it on the Controller base and secure it with the four cover screws.
10. Turn-on the AC line power to the Controller and then turn on the Controller circuit breaker. When the Controller is first energized, it will be in the Forward mode, and run and jog speeds will be at zero. Run and jog speeds can be preset without running the motor. Refer to the "Operation" section for instructions (Page 10).
11. Check motor rotation by pushing the RUN button and then the FASTER button. Stop the motor by pushing the slower button until the motor stops and then push the STOP button. If motor rotation is opposite to that desired, turn off the AC supply to the Controller and then interchange the armature leads at the motor connection box or at the Controller terminal board.
12. Refer to the "Operation" section for operation instructions.

Operation

Power On/Off

The POWER ON/OFF switch is a circuit breaker which connects and disconnects the AC line supply, and protects the Controller and motor from electrical faults. If the circuit breaker trips, reset it by turning it off and then back on. Repeated tripping indicates an electrical fault (short or ground) which must be corrected.

MP1 Operator Control Panel



Direction Indicator

The Direction Indicator shows which direction the motor will rotate when the RUN or JOG button is pushed. It also indicates power is applied to the Controller.

Run/Jog Indicator

The RUN/JOE Indicator segment energizes when the Controller is in the Run or Jog mode.

Speed Indicator

The SPEED Indicator ten-bar segments indicate speed in 9.4% increments, i.e., when the first segment is energized, the speed is between 9.4% and 18.8% of maximum speed. When 18.8% speed is exceeded, the second segment energizes. When all ten segments are energized, speed is between 94% (10 X 9.4%) and 100%. If more precise speed indication is required, see Option 44 (Digital Meter).

Whenever power is applied to the Controller, but it is not in the Run or Jog mode, the segments show the preset run speed, i.e., the speed the motor will rotate if the RUN button is pushed. The preset jog speed is displayed when the STOP button is pushed. When the RUN or JOE button is pushed, the segments indicate actual speed. When the STOP button is pushed, while the motor is rotating, the segments continue to indicate

actual speed while the motor decelerates. When the motor reaches zero speed the segments show the preset run speed again.

If the preset speed is set to zero and the RUN or JOE button is not pushed, none of the segments will energize. Under this condition of zero preset speed, if the RUN or JOE button is pushed, the RUN/JOE Indicator energizes, providing an indication that a motion command has been given, but the preset speed is zero.

The display also indicates when the Controller is limiting motor torque by flashing all segments.

Forward/Reverse

All MP1 Operator Control Panels have FORWARD REVERSE buttons. When built, each Panel has a jumper (W1) on the MP1 Printed Circuit Board which closes the FORWARD button and prevents the Reverse mode from being enabled. As a result, MP1 supports unidirectional operation, locking the Controller in the Forward Mode with neither the FORWARD or REVERSE button having any effect on Controller operation. The Forward Direction Indicator always energizes when power is applied to the Controller, indicating the Controller is in the Forward mode.

When Jumper W1 is clipped from MP1, it removes the short from the FORWARD button and allows MP1 to select either the Forward or Reverse mode of operation. Jumper W1 is clipped when Option R (Armature Reversing) is installed.

When power is applied to the Controller, the Forward mode is selected automatically. This is indicated by the Forward Direction Indicator. To rotate the motor in the forward direction, push the RUN or JOE button. The Controller remains in the Reverse mode until it is stopped and the FORWARD button is pushed or power is removed and re-applied. The direction can only be changed when the Controller is stopped by pushing the STOP button. Pushing the opposite direction button when in the Run or Jog mode has no effect.

If Option R is installed and reverse rotation is desired, push the REVERSE button. This puts the Controller in the Reverse mode, as indicated by the Reverse Direction Indicator. Then to rotate the motor in the reverse direction, push the RUN or JOE button. The Controller remains in the Reverse mode until it is stopped and the FORWARD button is pushed or power is removed and re-applied. The direction can only be

changed when the Controller is stopped pushing the STOP button. Pushing the opposite direction button when in the Run or Jog mode has no effect.

Faster

The FASTER button increases the preset speed when the motor is stopped and increases actual motor speed when the Run or Jog mode is selected. The rate of speed change is preset by the internal ACCEL potentiometer.

When the FASTER button is quickly pushed and released, speed increases by 0.4%. Pressing the button for more than 0.5 second causes acceleration at the rate preset by the ACCEL potentiometer.

Slower

The SLOWER button decreases the preset speed when the motor is stopped, and decreases actual motor speed when the Run or Jog mode is selected. The rate of speed change is preset by the internal DECEL potentiometer.

When the SLOWER button is quickly pushed and released, speed decreases by 0.4%. Pressing the button for more than 0.5 second causes deceleration at the rate preset by the DECEL potentiometer.

Jog

The motor rotates at the preset jog speed as long as the JOG button is pressed. Forward and reverse jog speeds are individually adjustable. Jog speed is changed by pushing the FASTER or SLOWER button while pressing the JOG button.

The preset jog speed (forward or reverse) may be changed without running the motor by selecting the desired direction and then pushing the FASTER or SLOWER button while pressing the STOP button. The rate of speed change is preset by the internal ACCEL and DECEL potentiometers. The Controller remembers the preset forward and reverse jog speeds even when power is turned off.

Run

When the RUN button is pushed, the motor rotates at the preset run speed until the STOP button is pushed. Forward and reverse run speeds are individually preset.

Preset run speeds may be changed without running the motor by pressing the FASTER or SLOWER button and observing the segments on the Speed Indicator until the desired speed is indicated. The FASTER and SLOWER buttons also change the speed when the motor is running. The rate of speed change is preset by the internal ACCEL and DECEL potentiometers. The Controller remembers the last run speed, even when power is turned off.

Stop

Pushing the STOP button removes power from the motor armature, allowing the motor to coast to a stop. Option R provides dynamic braking when the STOP button is pushed.

If the STOP button is pressed when motor speed is zero, the Speed Indicator displays preset jog speed.

If a controller fault occurs, the Controller may be reset by pressing the STOP button for more than 2-1/2 seconds.

Maintenance

General

1. Keep the Controller dry and free of dust, dirt, and debris. No parts require periodical replacement.
2. Periodically check all wire terminals and be sure they are tightened securely.
3. Check components for damage due to over heating or breakage. All damaged and/or faulty components must be replaced for satisfactory operation.
4. The MP1 Printed Circuit Board has a long life lithium battery for powering the memory that stores preset speeds. When the battery is depleted, the Controller will operate normally except the preset speeds will be zero when power is applied to the Controller. See Table 7 (page 29) for the part number of a replacement battery.
5. Maintain the motor according to maintenance instructions supplied by the motor manufacturer.

Adjustment Instructions

Be sure the motor is at normal operating temperature, usually achieved within 30 minutes of operation from a cold start. Motor speed can change up to 15% as motor temperature changes from cold to hot.

Acceleration (adjustable .2 to 100 seconds)

1. Preset run speed at maximum.
2. Push the RUN button and observe the time required for the motor to reach maximum speed.
3. Adjust the ACCEL potentiometer to obtain desired rate. Full CCW rotation produces minimum acceleration time.

Deceleration (adjustable .2 to 100 seconds)

1. With the motor running at maximum speed, push and hold the SLOWER button and observe the time required for the motor to reach minimum speed.
2. Adjust the DECEL potentiometer to attain the desired rate. Full CCW rotation produces minimum deceleration time.

IR Compensation

The IR COMP potentiometer is factory set at zero (full CCW) for satisfactory operation with most motors. If the motor speed decreases when the motor load increases, proceed as follows:

1. Re-check the resistance wires on the Controller Power Board to be sure the Controller is calibrated correctly for the motor being used. See Figure 2 on page 18.
2. If tachometer feedback is used and Jumper W3 has been removed from the Controller Logic Board, disconnect the tachometer generator from the Controller.
3. If the motor is shunt wound, run it at rated base speed. If the motor is a permanent magnetic type, run it at about 500 RPM.
4. Turn the IR COMP potentiometer CW slowly until motor speed becomes stable.

Maximum Speed, Armature Feedback

(adjustable 0-100% of motor base speed)

1. If tachometer feedback is used and Jumper W3 has been removed from the Controller Logic Board, disconnect the tachometer generator from the Controller.
2. Turn the MAX SPD potentiometer fully CW, this provides 90 VDC armature voltage with a 115 VAC line and 180 VDC with a 230 VAC line.
3. Run the motor at maximum speed and turn the MAX SPD potentiometer CCW for the desired maximum speed.

Maximum Speed, DC (Tachometer)

(for unidirectional controllers only)

1. Be sure the IR COMP and MAX SPD potentiometers have been adjusted correctly.
2. Refer to the data plate on the tachometer generator and determine the voltage generated at maximum motor speed.

3. Connect a DC voltmeter to the tachometer generator leads and rotate the motor to determine the polarity of the tachometer signal.
4. Connect the negative lead of the tachometer generator to Terminal 5 on Controller Terminal Board TB2. Connect the positive lead to TB2 Terminal 7 (7-22V), 8 (23-70V), or 9 (71-150V), based on the tachometer generator voltage at maximum motor speed. Terminal 9 can also be used for voltages of 151-220V DC for non UL applications.
5. Set the MAX SPD TACH potentiometer at 50%.
6. Connect the voltmeter across the tachometer generator leads.
7. Run the motor at maximum speed and record the voltmeter reading.
8. Stop the motor and clip Jumper W3 from the Controller Logic Board.
9. Run the motor at maximum speed and adjust the MAX SPD TACH potentiometer so that the voltmeter reads the same voltage as that recorded in step 7.

NOTE: Tachometer feedback is operative in the forward direction only unless Option 24A (Feedback Mode) is used. Or unless, DC generators TG35D56C or TG35D140TC are used.

Minimum Speed

(adjustable 0-100% of motor base speed)

1. Turn the MIN SPD potentiometer fully CCW for zero speed.
2. Push the RUN button and adjust the MIN SPD potentiometer for the desired minimum speed.

Torque Limit

(adjustable 0-150% of Full-load motor Torque)

1. Turn the TORQUE LMT potentiometer fully CW to limit motor torque at 150% of rated.
2. Turn the TORQUE LMT potentiometer CCW to reduce motor torque.

NOTES:

- a. The MP1 display flashes when motor torque is being limited.
- b. An external 5K ohm TORQUE LIMIT potentiometer can be used as shown in Figure 2 (page 20). Jumper W2 must be clipped from the Controller Logic Board if external torque limit is desired.

Maintenance

Table 5. Troubleshooting

	Indication	Possible Cause	Corrective Action
1.	AC POWER ON/OFF circuit breaker trips immediately when turned on	Wiring faulty or incorrect	Check all external wiring terminating in the Controller. Correct accordingly.
		Circuit, component or wiring grounded.	Remove unwanted ground.
		Two or more SCR's shorted	Replace SCR's or Power Board
		Field supply shorted	Replace field supply diodes or Power Board.
		Shunt field shorted or grounded	Repair or replace motor.
		Power Board failure	Replace Power Board.
2.	AC POWER ON/OFF circuit breaker trips when a Start function is initiated	Logic Board failure	Replace Logic Board.
		SCR or Diode D1 shorted	Replace shorted device or Power Board
		Motor shorted or grounded	Repair or replace motor.
3.	AC POWER ON/OFF circuit breaker trips while the motor is running	Logic Board failure causing SCR's to turn on fully	Replace Logic Board.
		Motor overloaded	Check shunt field current. (1) Low shunt field current causes excessive armature current. If field current is adequate, check for a mechanical overload. If the unloaded motor shaft does not rotate freely, check motor bearings. Also check for shorted armature. Correct accordingly.
		Loose or corroded connection. Wiring faulty, incorrect, or grounded.	Check AC POWER ON/OFF circuit breaker terminals and all terminals, connections, and wiring between the line, Controller, and motor.
		Motor shorted or grounded	Repair or replace motor.
		SCR and/or Diode D1 break-in down (shorting intermittently)	Replace faulty device or Power Board.
		Logic Board failure causing SCR false firing or misfiring	Replace Logic Board.

Maintenance

Indication	Possible Cause	Corrective Action
4. AC POWER ON/OFF circuit not tripped, but motor won't run	AC line open	Be sure external disconnect switch is turned-on and rated AC line voltage is applied to Controller
	Operator controls inoperative or connected incorrectly	Repair accordingly.
	MAX SPD potentiometer set at zero	See "Adjustment Instructions."
	ACCEL potentiometer set at a very low rate	See "Adjustment Instructions."
	Motor failure	Repair or replace motor.
Logic or Power Board failure.	Replace faulty board	
5. Minimum speed excessive	MIN SPD potentiometer misadjusted	See "Adjustment Instructions."
	Logic Board failure	Replace Logic Board
6. Motor won't reach top speed	Low line voltage	Check for rated line voltage, $\pm 10\%$, on AC line terminals.
	Motor overloaded	Check shunt field current. (1) Low shunt field current causes excessive armature current. If field current is adequate, check for a mechanical overload. If the unloaded motor shaft does not rotate freely, check motor bearings. Also check for shorted armature. Correct accordingly.
	MAX SPD potentiometer misadjusted	See "Adjustment Instructions."
	MP1 Panel failure	Replace MP1.
	Logic or Power Board failure	Replace faulty board.
7. Unstable speed	AC line voltage oscillating	Observe line voltage with voltmeter or oscilloscope. If oscillations occur, correct line power problem.
	Oscillation load connected to the motor	Correct condition accordingly. Turning IR COMP potentiometer CCW may minimize condition. See "Adjustment Instructions."

Maintenance

	Indication	Possible Cause	Corrective Action
	Unstable speed (cont)	Motor failure	Check motor brushes, replace if needed. REpair or replace motor.
		IR compensation misadjusted	See "Adjustment Instructions."
		Tachometer generator or coupling faulty	Repair accordingly.
8.	Line and armature current excessive	Motor overloaded	Check shunt field current. (1) Low shunt field current causes excessive armature current. If field current is adequate, check for mechanical overload. If the unloaded motor shaft does not rotate freely, check motor bearings. Also check for shorted armature. Correct accordingly.
9.	Shunt field current insufficient (1)	Open shunt field winding or wiring to the shunt field	Check motor shunt field and associated circuitry for loose connection or broken wire. Repair accordingly.
		Field supply failure	Replace field supply diodes or Power Board.
10.	Shunt field current excessive (1)	Field supply failure	Replace field supply diodes or Power Board
		Shunt field windings shorted	Measure shunt field resistance and compare with motor rating. Repair or replace motor.
11.	Motor thermal guard open (if used)	Ventilation insufficient	Free the motor intake and exhaust screens from dirt, dust, and debris.
		Excessive load at low speed	Reduce load.
		Line and motor armature current excessive	See Indication 8.
		Motor overheating from friction	Check for misalignment. Realign motor.
		Shorted motor windings or faulty bearings.	Repair motor.

NOTE: (1) Does not apply to permanent-magnet motors.

General

Options are available for the Controllers which increase the functional use of the basic Controller. Table 6 lists all available options. Section VII gives detailed descriptions of these options.

Options, with the exceptions of #32 & #CSA, can be added to the basic controller at any time. Each option consists of all required components, mounting hardware, and installation instructions and applicable drawings.

See Table 6 for the Allowable Option Combinations.

Table 6. Allowable Option Combinations

Option Group	Option Number	Option Code	Description	Remarks
A	27	XK (3)	NEMA 3, 4, 12 Enclosure Modification	Enclosure Options - Choice of any or all within this group may be combined with options selected from any other group.
	50	XK (3)	Hinge, Enclosure Cover	
A1	B	XK	Cover Kit, Blank	Options used to convert open chassis units into enclosed package controllers. Choice of one within this group. Combine with all other options.
	M	XK	Cover with MP1 Operator Panel	
B	25	XK (1)	Follower, Process Control Signal	Input Options - Choice of one within this group. Can be combined with options from all other groups
	14	XK (1)	Follower, External AC/DC Signal	
	25C	XK (4)	Follower, AC Current Transducer	
	22L	XK (1)	Follower, Serial Link RS422 (Computer Control)	
	22P	XK (1)	Parallel (BCD) Digital Input	
	22A	XK (1)	AC or DC Generator Follower	
	25S	XK (1)	Follower, External Reference (Isolator)	
	22D	XK (1)	Pulse Follower	
	22E	XK (1)	Digital Encoder Feedback	
C	24A	XK (1)	AC or DC Generator Feedback	Feedback Options - Choice of one within this group. Can be combined with options from all other groups.
	24D	XK (1)	Pulse Feedback	
	24E	XK (1)	Digital Encoder Feedback	
D	18	XK (1)	Torque Taper	Winder Options - Choice of one within this group. Can be combined with all other options except Groups B and C
	36A	XK (1)	Constant Tension Winder	
	36B	XK (1)	Constant Tension Winder	
E	30	XK (2)	Two-Pole Circuit Breaker	Power Options - Choice of any or all within this group. May be combined with all other options.
	32	X	Full-Wave Field Supply	
	R	XK (2)	Armature Reversing and/or Dynamic Brk.	
	52	XK (1)	Power Supply, Auxiliary	
F	12A	XK (1)	Auxiliary Contacts	Auxiliary Control Options Choice of any or all within this group may be combined with all other options.
	12B	XK (1)	Programmable Auxiliary Output Contacts	
	15	XK (1)	Programmable Speed/Torque Control	
G	MCS1	XK (3)	Remote Control (with MP1 Panel and Buffers)	Operator Control Options - Option P may be combined with all other options except #MCS1 and #44. Option #44 is used with Option #MCS1 or any unit with a MP1 operator panel. May be combined with any other option except option P.
	P	XK (1)	Pushbutton Interface	
	44	XK (5)	Digital Meter for MP1 Panel	
H	CSA	X	CSA Certification	Miscellaneous Options - Choice of any or all. May be combined with options from any other group.
	53	XK (1)	Signal Bus support guide	
	54	XK (1)	Signal Bus Extender Cable	
	55	XK (1)	Computer Monitor	

Notes:

Code: X Factory installed
XK Factory installed or filed kit

(1) Signal Bus plug-in addition
(2) Internally mounted pre-wired
(3) Externally mounted

(4) Signal bus plug-in with externally mounted C.T.
(5) Plug-in

Drawings

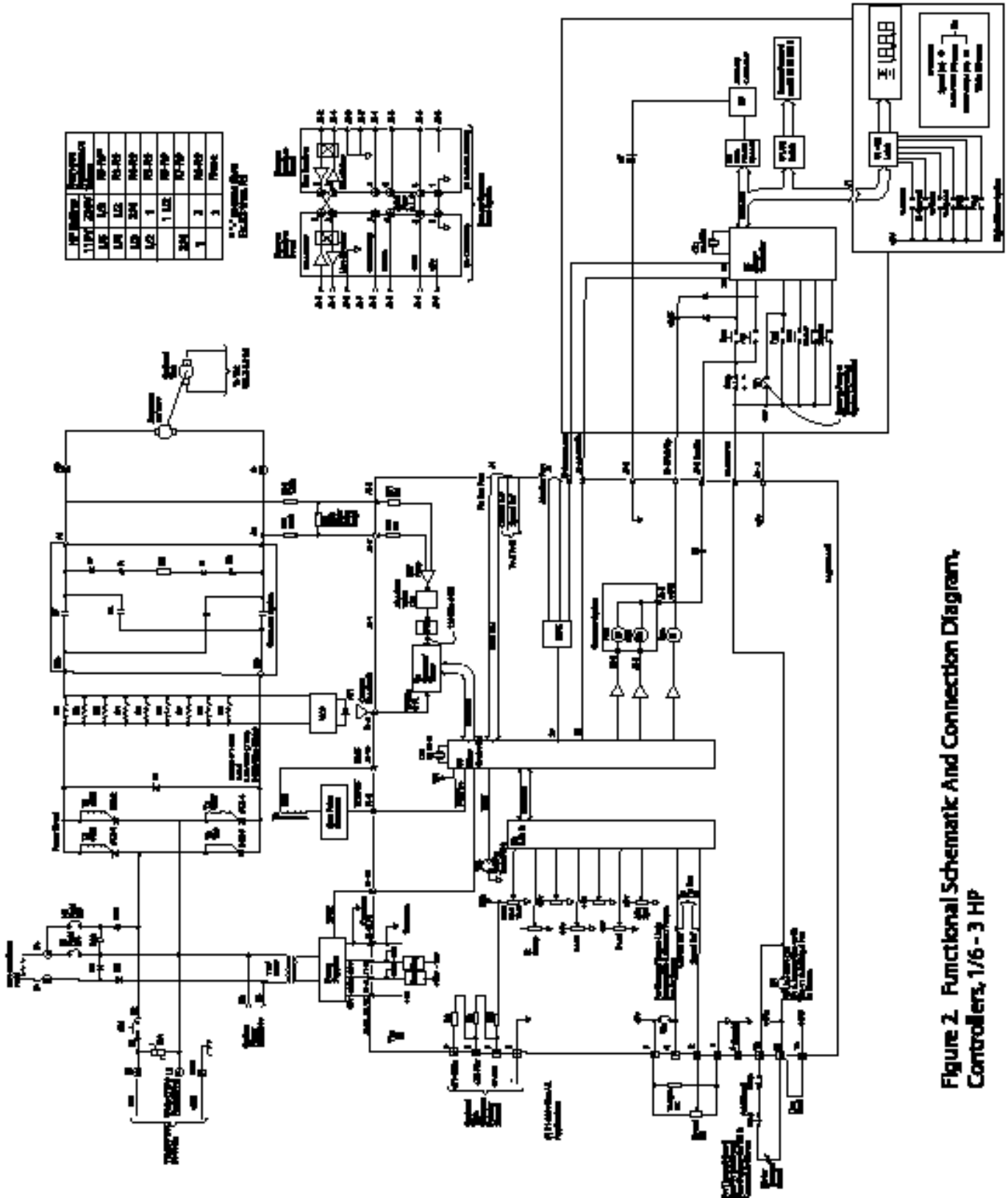


Figure 2. Functional Schematic And Connection Diagram, Controllers, 1/6 - 3 HP

Drawings

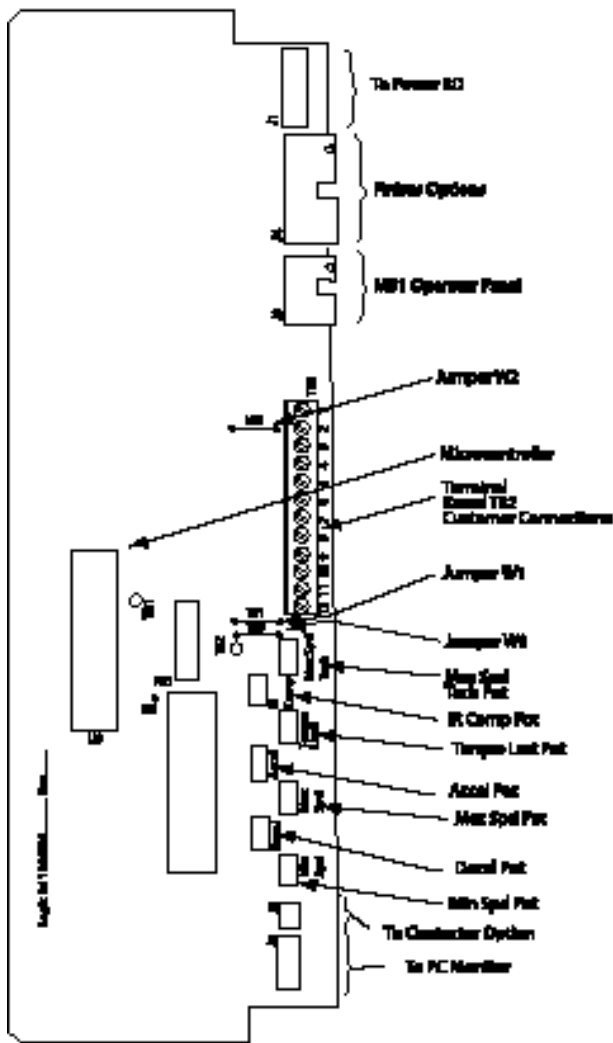


Figure 3. Logic Board

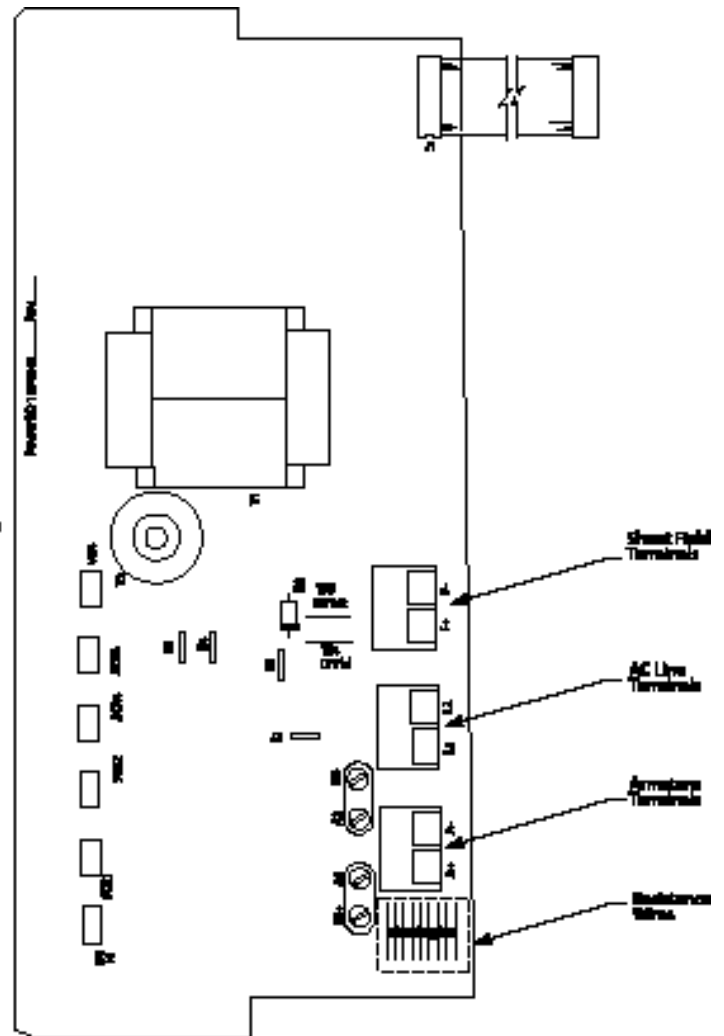


Figure 4. Power Board, 1/6 - 3 HP

Option Descriptions

The versatility of the VED controllers is further extended by the addition of standardized optional features. Most of the options listed are dedicated for use with the Signal bus option port which is standard in all units. This unique bus structure forms a common data highway along which all digital information is multiplexed, combined with analog data and transmitted to/from the connected options and the regulator microprocessor. Table 6 lists the options in the functional groups along with information on allowable option combinations.

Option B Cover Kit, Blank

Option provides an enclosure cover, blank (without operator controls) for field conversion of an open chassis model into an enclosed, package model for remote control.

Option CSA CSA Certification

Provides a conformal coating on the power and logic circuit boards, special dielectric provisions for power devices, and tool operable cover fixing hardware as necessary to meet CSA standards. This option must be factory installed where a CSA approval label is added to the units.

Option R Armature Contactor, Reversing (R) And Or Dynamic Braking

This option is required whenever unidirectional contactor operation with or without dynamic braking is required. Included are double-pole armature reversing contactors and a DB resistor for rapid deceleration. The direction of motor rotation is controlled by FWD-REV membrane push switches in the Model MP1 operator control panel.

Reversing includes software configured antiplug protection. The drive must be stopped by the STOP pushbutton before a reverse command may be given. Drive motor is then restarted in the new direction of rotation by pushing the Run push switch.

Included is software configured antiplug logic to prevent restarting the controller until the braking cycle is complete, preventing a potentially damaging electrical surge and mechanical stress.

Dynamic Braking provides exponential rate braking of the DC motor armature. Braking is initiated by disconnecting the armature from the rectified power source and reconnecting it to a DB resistor. This is accomplished by normally-closed contacts which are mechanically interlocked with the normal run contacts. The DC motor, thus connected, functions as a generator with the kinetic energy of the armature and machine load dissipated as heat by the resistor. The resistor is selected to provide initial braking torques as listed in the following Table:

Component	Ratings										
	(HP)	1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3	5
Rated Horsepower	115V Unit	300	215	170	110	75	60	----	----	----	----
	230V Unit	----	----	----	460	315	220	290	205	160	100
Braking Torque %	115V Unit	9	6	5	5	4	4	----	----	----	----
	230V Unit	----	----	----	5	4	4	3	3	2	2
Stops per Minute	115V Unit	9	6	5	5	4	4	----	----	----	----
	230V Unit	----	----	----	5	4	4	3	3	2	2

Option Descriptions

The DB resistor is rated for stopping a typical load a maximum number of stops per minute from top speed as shown in the table. A typical load is defined as:

1. Not exceeding rated-load torque.
2. External load inertia (beyond the motor shaft) not exceeding that of the motor armature.

High inertia loads may extend braking times beyond the wattage rating of the DB resistor. Dynamic braking is not a holding brake: it will not prevent a motor at rest from rotating.

Option R consists of a circuit board containing two double pole armature contactors and a separate dynamic braking resistor. This option is a standard factory installed feature of all models with an "R" suffix in the model number or it may be easily installed in the field.

Option MCS1 Remote Control Kit

Option includes a model MP1 membrane push switch operator control panel in a remote control station housing along with two buffer amplifiers - one to be mounted within the controller base and the other in the operator station. These are necessary to buffer and filter sensitive control signals from ambient electrical disturbances which could impair the safety and reliability of the controller. The Option permits operation from a single operator control station mounted up to 328 feet (100m) from the drive controller.

NOTE: (1) While only one full function MP1 station may be used for each controller, multiple, normally closed stop pushbuttons may be used.

Option P Pushbutton Interface Kit

This option permits the use of standard industrial push-buttons such as Boston Gear's RCSI, or other commercial equivalents instead of the Model MP1 membrane panel with push switches. Motor speed adjustments is by a 5K ohm, 1/2w potentiometer.

This option permits run-stop control from multiple pushbutton stations which is not practical using the Model MP1 membrane panel. A 24 VDC, isolated power source permits operation from remote stations located 328 feet (100M) from the drive controller.

Additionally, this option also provides a controlled

(ramp) stop capability. This may be useful when machine and process line applications require smooth controlled linear deceleration on a pushbutton stop command. A software configured voltage sensing circuit keeps the controller in a run mode until a preset minimum speed is attained.

This option is frequently combined with Reversing (Option R) which then provides two stopping modes: Emergency and Controlled Linear Rate. The operator station must include two separate STOP pushbuttons for this purpose. The EMERGENCY STOP pushbutton is commonly provided with a mushroom head.

Frequently, this option will also be combined with Option 15 in order to provide independent control of the speeds of various functions such as jog and reverse.

This option consists of a small printed circuit board which mounts within the chassis base and communicates with the controller via the Signal bus.

Option P is standard factory installed feature of all models with a BP, CP, BPR, or CPR model number suffix, such as Model VED100BP, VED100CP, VED100BPR, VED100CPR, etc. or it can be installed in the field.

Option 12A Auxiliary Contacts

Provides two form C relays with one normally-open and one normally-closed contact rated 1 am, 120 VAC or 28 VDC. One relay is energized with a Forward Run command and the other relay is energized with the Reverse contactor (reversing controllers only). Contacts may be used to signal external circuits.

This option consists of a circuit board which mounts in the chassis and a ribbon cable which connects to the Signal bus.

Option 12B Programmable Auxiliary Output Contacts

This versatile option provides two (2) Form C relays each with one normally open and one normally closed contact rated 1 amp, 120 VAC or 28VDC. The relays may be programmed to individually energize whenever:

1. A preset motor speed is attained, adjustable 0-100% of motor base speed. or
2. A preset torque (Current) level is attained, adjustable 0-150% of rated current.

Option Descriptions

Hysteresis is adjustable to establish pick-up and drop-out points.

Terminals are provided for connection of the output contacts to external indicating and control devices.

Each Option 12B will provide a choice of either motor current or motor speed sensing. Multiple Option 12B circuits will be required whenever both current and speed sensing are desired or whenever additional output contacts/set points are necessary.

This Option consists of a small circuit board which mounts in the chassis base and communicates with the controller via the Signal bus.

Option 14 Follower, External AC/DC Signal

Provides necessary matching, isolation signal conversion and filtering as required to adjust the speed of the drive (or drives) from an external signal source. This Option permits full range speed control from an external 0 to 115 VAC (or 0-150VDC) adjustable signal source manually controlled by a potentiometer, variable auto-transformer (AC only) or some other suitable means.

This option is required for each controller which is to be controlled by the external AC/DC signal.

When using this option the normal drive run speed setting device functions as a ratio setting when following the external signal. The maximum ratio is 150%. This option is useful for multiple section machines where a definite speed relationship must be maintained between sections, while the entire machine is varied over a specified speed range by a common manual speed control device.

This option consists of a small plug-in circuit board which inserts into the input connector of the control board.

This option does not include the external AC/DC signal source.

Option 15 Programmable Preset Speed/Torque Program Control

This option offers exceptional application flexibility whenever it is necessary to select a combined total of

up to five preset motor speeds, and/or preset motor armature current (torque) reference levels in either Forward or Reverse (with Option R) directions of rotation. Included are four independent circuits, each of which is programmable by individual DIP switches for selecting a choice of one of the functions listed:

1. Forward-Run Speed or Current
2. Reverse-Run Speed or Current
3. Forward-Jog Speed or Current
4. Reverse-Jog Speed or Current

Four integral reference adjustment potentiometers permit setting the motor speed from zero to base speed, and zero to 150% current. If none of the four preset circuits are selected, control reverts to a default circuit which can provide a fifth programmable potentiometer adjustable speed or current. When desired, external potentiometers may be used to establish the operating preset reference levels. The programmed speed or current settings may be selected by external pushbuttons, relay contacts, programmable control, etc., operating from the internal 24VDC source or an external source of this level.

Multiple Option 15 circuits may be used when greater than five preset references are desired.

This option consists of a small printed circuit board which inserts into the chassis base and communicates with the controller via the Signal bus.

Option 18 Torque Taper

Center-driven winders ideally require a reciprocal speed torque relationship (constant horsepower) to maintain constant tension throughout the range of material build-up as illustrated by figure A. Acceptable performance can be economically achieved for many applications with an inverse-linear speed torque relationship provided by the option. Tension control accuracy of approximately 20% can normally be maintained from empty to full roll over a 2:1 build ratio at a fixed production machine speed as shown in figure B & C.

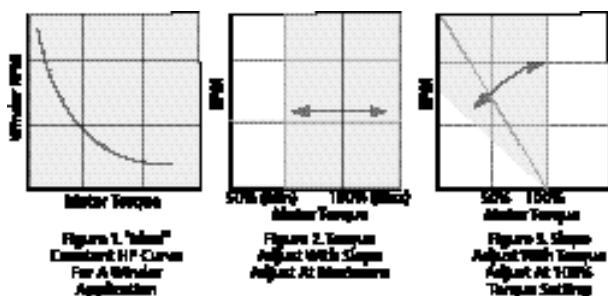
Use caution in the selection of motors for center driven wind-up applications where torque loads increase in inverse proportion to motor speed. Web break or other process material detectors are recommended to prevent a dangerous overspeed should the process material break.

Option Descriptions

Option 18 normally provides acceptable performance in applications where the material being wound travels at a constant speed during winder roll build-up. If the process is such that the speed of the material being wound varies during winder roll build-up or if more accurate tension control is desired, see Option 36.

Option 18 can also be used for constant torque applications where conventional operation of the current limit is required and remote mounting of the torque (current) potentiometer is desired. When used in this manner, the Slope adjustment is set for a vertical cut-off of motor (maximum setting) torque (current). See Figure B.

This option consists of a small circuit board which mounts in the chassis base and communicates with the controller via the Signal bus.



Option 22A Follower, AC or DC Tachometer Generator

Intended for automatic control systems where it is necessary for the drive to follow the speed of a preceding drive unit or rotating machine coupled to an AC single-phase or 2-phase or DC tachometer generator with either output polarity. The tachometer voltage signal provides the speed reference for the "follower" drive.

Adjustments are provided to adapt the unit to a wide range of system requirements. Included are independent adjustments for:

Tach Scaling - Adjustable to interface the tachometer generated voltage with the required controller reference voltage.

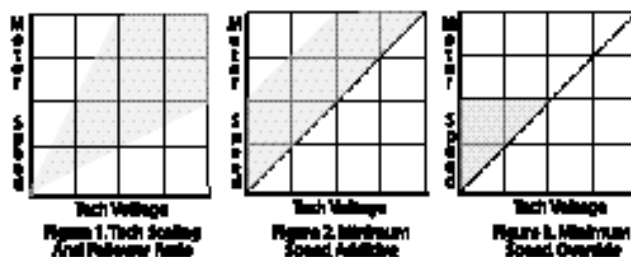
Follower Ratio (Optional) - Adjustable to permit tracking the tachometer signal voltage at a plus or minus ratio. See Figure A. The Follower Ratio potentiometer is mounted in the operator control panel.

Offset - Adjustable to permit tracking the tachometer signal at a fixed (+ or -) offset. Potentiometer is mounted on the option circuit board. See Figure B.

Minimum Speed (Override) - Adjustable by an optional potentiometer which is used to establish a minimum drive speed independent of tachometer signal voltage. The Motor Speed control may also be used as a manual speed setting control when no tachometer signal is present. See Figure C.

A MANUAL/FOLLOWER selector switch input is provided in order to select the MP1 operator panel when in manual mode.

Series VED controllers include internal isolation permitting the reference common to be directly connected with other drive (s) without utilizing line isolation transformers.



Option 22D Follower, Digital Pulse

This option provides signal conditioning for accepting a signal from a magnetic pulse pick-up mechanically coupled to a preceding drive motor, rotating machinery or various static pulse generators permitting the drive to follow at an adjustable ratio.

Two modes of operation are provided: Manual and Follower, as selected by the MANUAL/FOLLOWER Switch. In the Manual mode, the MP1 MOTOR SPEED Faster-SLOWER switches control motor speed. In the Follower mode, the motor follows the digital pulse

Option Descriptions

signal, and the optional MOTOR SPEED potentiometer functions as the follower ratio adjust potentiometer.

The signal conditioner circuit board accepts the output of any one of the following devices:

Magnetic pulse pick-up capable of providing 1000-2500 pulses/second at motor base speed. A 60 tooth gear on a 1750 RPM motor generates 1750 PPS.

**Option 22L
Serial Link (Computer Control)**

This provides the capability of two way-communication and direct control by computer via an RS422 link. This bypasses all on-board potentiometer adjustments and permits computer control of all operating parameters; Speed, Torque, Direction of Rotation, Current Limit, Acceleration/Deceleration Rate, Run-Stop-Jog- and Reversing commands, Min-Max speeds, while permitting remote interrogation by the computer of these and other operational data such as the First Fault Annunciator described in Option 44. Provision is included for manual operator safety stop circuit by-passing the computer and a watch-dog circuit which will automatically stop the drive in the event of failure of the microprocessor or communications link.

The serial link is expandable for the individual or simultaneous control of up to 32 drive units in a system.

The option consists of a small printed circuit board which mounts in the chassis base and communicates with the controller via the Signal bus. This option must be used in conjunction with Option 52, Power Supply, Auxiliary. Host computer software to suit individual system requirements is not included in this option.

**Option 22P
Parallel (BCD) Digital Input**

Allows precise motor speed or motor armature current (torque) setting by a BCD thumbwheel switch or other external, parallel digital reference. Inputs are buffered for reliable operation in industrial environments. Motor speed may be 0-100.0% and current 0-150.0% by tenths. An optional "Data Enter" feature may be implemented with a N.O. pushbutton so thumbwheel changes are not read until the pushbutton is depressed.

One Option is required for each pair of thumbwheel adjustable parameters (See following table)

Option 22P circuits may be used when three or more parameters must be thumbwheel adjustable.

Adjustable Parameter	Thumbwheel Switches-Qty Required
Speed Reference	1
Current Reference	1
Acceleration/Deceleration	2
Min/Max Speed	2

Option consists of a small printed circuit board which mounts within the chassis base and communicates with the controller via the Signal bus. Option does not include the thumbwheel switch (s), enter pushbutton, or other digital reference.

**Option 24A
Feedback Mode, AC Or DC Tachometer Generator**

VED Series units include as standard the capability to accept a signal from a feedback tachometer if it is; (a) a unidirectional application and/or (b) the tachometer signal is DC. All other applications will require this option which provides voltage scaling and terminals for accepting a signal from an AC (2-phase only) or DC tachometer generator (either polarity), mechanically coupled to the drive motor armature. The tachometer signal defeats the IR compensation circuitry in the drive controller making the unit directly sensitive to motor speed. This results in expanded speed range, improved speed regulation with load changes, and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor field heating and other operating variables. See Table 4, Speed Regulation Characteristics, showing performance with various tachometers.

**Option 24D
Feedback, Digital Pulse**

Provides signal conditioning for accepting a signal from a magnetic pulse pick-up mechanically coupled to the drive motor armature. The magnetic pulse pick-up must provide a minimum of 1750 pulses per second at motor speed (60 tooth gear on a 1750 RPM motor). The pulse pick-up signal defeats the IR compensation circuitry in the drive controller, making the unit directly sensitive to motor speed. Speed range is limited to 35:1 with a 1750 RPM motor, 20:1 with a 1150 RPM motor and 45:1 with a 2400 RPM motor.

Option Descriptions

Option 24D (Cont'd)

The option results in improved speed regulation with load changes (equal to DC tachometer feedback) and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor filed heating and other variables.

Option 24D consists of a small printed circuit board which mounts in the base chassis and communicates with the controller via the Signal bus. This option does not include the magnetic pulse pick-up or other signal source.

**Option 25
Follower, Process Control Signal**

Provides necessary impedance matching circuitry to interface a customer supplied DC (current mode) signal source with the drive controller reference input. Typical applications are those where motor speed or current (torque) must be controlled as a function of a process variable such as temperature, weight, flow, pressure, etc. In many applications the reference signal is obtained from a process instrument controller or other commercially available transducer with a DC milliamper output. Devices of this type normally provide signal levels compatible with requirements listed in the table:

Follower Input Requirements

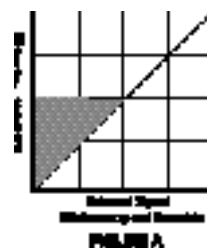
Current Signal Range (ma) DC	Follower Input Impedance (Ohms)	Voltage Signal Required (Volts) DC
0-5	1K	5.0 VDC
0-20	250	
0-50	100	
1-5	1K	
4-20	250	
10-50	100	

Included are suitable adjustments for linear transfer of instrument output current to motor speed. The adjustments will normally be set so minimum transducer signal results in minimum or zero motor speed and maximum signal produces maximum motor speed. Also provided is an adjustment to extend or compress the transducer signal output so a 5:1 transducer output signal range, for example, could provide a 10:1 or 20:1 drive speed range, included are individual potentiometer adjustments for:

Minimum Speed (Override) - Used to establish a minimum drive speed independent of the external reference signal. The MP1 operator panel is also used as a manual speed setting control when no external reference signal is present. See Figure A. A Manual/Follower selector switch selects between automatic and manual control operation.

Series VED controllers include internal DC isolation permitting the reference common to be directly connected to a process controller with a grounded output signal without the requirement for a signal isolator or AC line power isolation transformers. Multiple controllers (up to 3) may also be connected directly to a common process controller without further isolation.

This option consists of a small circuit board which mounts in the chassis base and communicates with the controller via the Signal bus.

**Option 25C
Follower, AC Current Transducer**

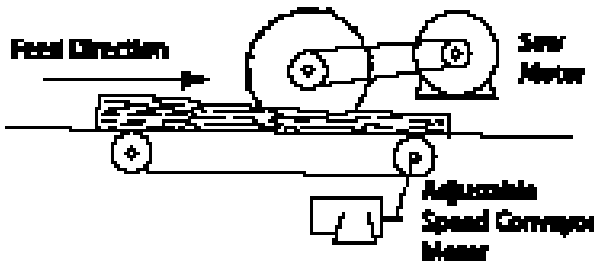
Intended for automatic control systems where it is necessary for the drive speed to follow an AC signal proportional to the load current of an AC constant speed, induction motor. Typical examples are conveying systems where the material feed rate has a direct influence over the loading of the AC motor i.e. : the carriage or conveyor feeding logs to a saw powered by an AC motor.

In order that a proper current transformer may be supplied it is necessary that nameplate data such as horsepower, voltage, full load current, etc. be provided from the AC motor.

The following illustration shows an application which requires an inverse relationship between AC motor load current and the follower drive motor speed.

Option Descriptions

Option 25C (Con't)



This option may also be programmed for a direct relationship where the follower drive would increase in speed with increasing AC motor load current. Included are independent controls and adjustments for:

Auto/Manual Selector Switch - Selects the operation function. When the switch is in Auto position, the drive functions as an AC current follower unit. When the MANUAL function is selected, the separately furnished Motor Speed potentiometer provides speed adjustment of the DC motor at a ratio from 0 to 100% of the AC input signal.

Normal/Invert Slide Switch - Selects the operation mode. When the switch is in NORMAL position, the speed of the DC drive motor varies directly proportional to the load current drawn by the AC motor. When the switch is in INVERT position the speed of the DC drive motor varies inversely proportional to the AC motor load current, i.e., when the load of the AC motor increases causing it to draw more current, the DC motor speed decreases.

Threshold - Since AC motors draw significant current even when unloaded, a threshold adjustment is provided to enable minimizing drive response below this point. An LED is provided to signal that the threshold has been exceeded and the drive begins to track proportionately.

Offset - Sets the maximum motor speed for the INVERT mode of operation.

Current Scaling - Matches the range of the AC input signal to the input signal range requirements of the controller.

Integration Rate - Sets the response rate of the system when the AUTO function is selected.

Proportional Gain - Sets the Gain to enhance stability when the AUTO function is selected.

Ratio - Controls speed as a ratio of reference in the auto mode or may be wired as a manual speed control.

Min Speed Clamp - Sets independent manual or min. speed control without affecting ratio.

This option consists of:

- Toroidal current transformer for separate mounting by the user for sensing AC motor load current.
- A small circuit board which mounts in the chassis base and communicates with the controller via the Signal bus.

Option 25S Follower, External Reference (Isolator)

Provides a means of controlling motor speed or current (torque) by an external DC voltage reference signal. The circuit includes internal isolation permitting direct connection to a hot signal source riding upon a floating voltage such as a shunt or speed potentiometer (500 VDC maximum) in the armature circuit of another DC drive controller.

Multiple motor applications typically involve a master speed regulated drive which establish the speed of the system and one or more current regulated follower drive units which may follow at adjustable ratios up to 150%. The follower units obtain their current reference signal from the master controller. Typical applications include:

- Load sharing between two or more drive units with their motors mechanically coupled.
- Load sharing between two or more drive units coupled by the process material itself such as steel bar stock being pulled by multiple drive units through separately powered sections of a machine.
- Tension control of a web of process material being transferred between sections of a multiple section machine.

This option consists of a small circuit board which mounts in the chassis base and communicates with the controller via the Signal bus.

Option 27 Enclosure Modification, NEMA Type 3, 4, 12

Provides a gasket for the operator panel (in local control models) and a protective cover on the circuit breaker to convert the standard enclosure to NEMA Type 3, 4, and 12.

The modified unit is suitable for operation in non-hazardous applications where it may be subjected to splashing water, seepage water, hose directed water, severe condensation and dust.

Option 30 Circuit Breaker, 2-Pole

The standard circuit breaker used in these controllers is a single-pole design, this option provides two-pole interrupting capabilities enabling both incoming lines to be disconnected.

The circuit breaker provides a means of disconnecting the AC input power to the controller and automatic instantaneous trip protection from a peak load.

Option 32 Field Supply, Full-Wave

Provides a full-wave excitation source for the field of a shunt-wound DC motor. Enables the use of 100 VDC field motors with 115 VAC controller or 200 VDC field motors with a 230 VAC controller.

This option must be factory installed.

Option 36 Constant tension/Constant Velocity Winder

This option provides a choice of two selectable modes:

a. Constant Tension (Centerwind Torque) Control Mode

This option offers a more sophisticated solution to controlling the tension of center driven winders than Torque Taper, Option 18. Tension control is more accurate since this option produces a reciprocal speed-torque relationship which closely matches the ideal constant horsepower curve required to maintain constant tension.

This option has provisions to accept a signal proportional to web speed from either a tachometer

generator driven from the production machine speed feeding the winder or a potentiometer ganged to the production machine speed control. Tension control accuracy of better than 20% can normally be maintained from empty to full roll, and the control automatically compensates for changes in production machine speed.

Use caution in the selection of motors for center-driven windup applications where torque loads increase in inverse proportion to motor speed. Also, web break or other process material detectors are suggested to prevent a dangerous overspeed should the process material break.

B. Constant Velocity Winder Mode

This option provides an economical but accurate method of automatically controlling the tension of process material in strip, web, wire or cable form as wound by a center driven winder.

The option requires the use of a DC tachometer generator coupled to the process material by nip rolls, a pressure roller or capstan in a manner that will provide a continuous feedback of the velocity of the process material.

A manually set MOTOR SPEED potentiometer establishes the desired line speed of the process material. As material builds up on the sinder core, the diameter increases which would tend to increase the line speed of the material. This will produce a higher voltage output from the tachometer generator which will cause the drive motor and winder to slow down to maintain a constant velocity and uniform winder tension.

Should a break occur in the process material, this option will automatically transfer to an adjustable minimum take up speed to minimize damage to the product winder machinery.

Use caution in the selection of motors for center driven windup applications where torque loads increase in inverse proportion to motor speed.

Both constant tension and constant velocity winder modes require a tachometer generator which provides 7 to 150VDC at motor maximum and/or base speed. Alternately the constant tension winder may use a 5K ohm potentiometer ganged to the production machine speed control. These items are not included with the option.

Option Descriptions

This option consists of a small circuit board which mounts within the chassis base and communicates with the controller via the Signal bus.

Option 44 Digital Meter

Option provides a 3 1/2 digit LCD meter for mounting and a plug-in interconnection within a dedicated space in the MP1 operator control panel. The meter expands the operational versatility of any unit by monitoring important operating parameters and by annunciating faults.

1. **Operating parameters displayed:**
 - a. Power-percent of rated
 - b. Armature current- percent of rated
 - c. Armature voltage-percent of rated
 - d. Motor speed-percent of rated
 - e. Motor RPM-direct reading in RPM for 1750 motors only.

A DIP switch permits programming the meter for continuous display of any one of the parameters listed. Alternately, any two or more parameters may be selected for sequential display at 12 second intervals.

2. Fault Annunciators

In the event the drive shuts down due to a fault it is displayed in the form of an error code. Error codes include:

- a. **Armature Feedback Loss (EO1)**
Indicates that the correct armature feedback signal has not been received by the microprocessor.
- b. **Current Feedback Loss (EO2)**
Indicates that the correct current feedback signal has not been received by the microprocessor.
- c. **Half Wave Firing (EO3)**
- d. **Overvoltage (EO4)**
120% or greater Line Voltage
- e. **Undervoltage (EO5)**
85% or less Line Voltage
- f. **Controller Overload (EO6)**
Armature Current 120% for 90 seconds

- g. **Signal Bus Communication Error (EO7)**
Determines that a connected option fails to respond with expected data.
- h. **Membrane Operator Panel Communication Error (EO8)**
Operator panel serial link determines that a MP1 Membrane Operator Panel is connected but fails to respond with expected data.
- i. **Controller Overcurrent (EO9)**
Armature current exceeds 150%
- j. **Motor Overtemperature (E10)**
- k. **Motor Rotor Locked (E11)**
Overload trip
- l. **Motor Overspeed (E12)**
Shutdown whenever counter EMF is 120% of nominal base speed armature voltage.
- m. **Tach Loss (E13)**
When speed (voltage) from a feed back tachometer differs from armature feedback voltage by 20% or more the controller will switch to armature voltage feedback. When the speed from the tach is restored to within 10% of armature feedback the tach signal is again used. A STOP is not initiated with this fault indicator.
- n. **Controller To Panel Communication Error (E33)**
- o. **Battery Failure (E34)**
MP1 lithium battery is exhausted. Only operator preset adjustments in MP1 such as Run Forward or Reverse speeds, Jog speeds etc. will be lost under this condition.

Option 53 Signal Bus Support Guide

This option consists of a Signal bus guide insulating circuit board edge guide/support plus necessary attachment hardware. While one Signal bus is guide supplied with each Signal bus option installed in a VED chassis, two are required whenever the option is installed on a baseplate adjacent to the controller. See also Option 54 for the necessary Signal bus extender cable required for this purpose.

Option Descriptions

Option 54 Signal Bus Extender Cable

Provides a 12 inch lone, extender ribbon cable to enable mounting the Signal bus option outside of chassis.

Option 55 Computer Monitor

Provides a very useful means of obtaining operational data from a VED controller using any IBM compatible computer for continuous monitoring, test, and diagnostic purposes. Enables monitoring (with plain language designations) over 25 essential controller parameters:

1. Preset Adjustments (displayed in percent)
 - a. Maximum Motor Speed
 - b. Minimum Motor Speed
 - c. Acceleration Rate
 - d. Deceleration Rate
 - e. I.R. Compensation
 - f. Current Limit
2. Reference Input (displayed in percent)
 - a. Speed Reference
 - b. Current Reference
3. MP1 Operator Control Panel
 - a. Direction of Operation Selected
 - b. Speed Presets (displayed in percent)
 - c. Run Forward
 - d. Run Reverse
 - e. Jog Forward
 - f. Jog Reverse
4. Measured Dynamic Parameters (displayed in percent except as noted)
 - a. Armature Voltage
 - b. Armature Current
 - c. Counter EMF
 - d. Tachometer (Optional) Input
 - e. Speed Feedback
 - f. Current Offset
 - g. Line Frequency (displayed in Hz)
 - h. Error Bus Data
 - i. Tachometer Offset
 - j. Input Status (Bit Parameters)
 - k. Motor Status (Bit Parameters)
 - l. Error Flags - First Fault Annunciator

See option 44 for parameters monitored
5. Fault Description - See Option 44 for Error Code and parameters monitored.

Output is an optically coupled and isolated

RS232/RS422 link limited to a maximum distance of 50 feet (RS232) or 4000 feet (RS422). Operation is at 2.4K baud which provides an update approximately every two seconds.

This option includes an option circuit board and a 5 1/4" floppy disk containing the required software. The option board mounts in a slot located within the controller chassis which is connected to the controller via a dedicated serial port connector provided for this purpose.

This is a read only monitor. See Option 22L when the ability to also control the unit from a computer is desired.

Section VIII Parts List

Table 7. Parts List

Description	Boston Gear Part Number		
	115 VAC		230 VAC
	1/5-1 HP	1/2-3 HP	5 HP
Battery	65891	65891	65891
Circuit Breaker	65892	65892	65892
Logic Board	65894	65894	65894
Power Board	65895	65896	65897
Power Device Kit (4 SCR's 1 Diode	65898	66002	66028

Section IX Software Enhancements

Boston Gear reserves the right to extend the VED product line by adding new options and features, which may require microcontroller program (software) enhancements. Therefore, earlier versions of the microcontroller may not support more recently developed options and features.

The microcontroller has a part number that identifies the program version, e.g., 105536MOS-V1.0. In this example, the program version is 1.0.

The instruction sheet supplied with each option describes limitations, if any, imposed by earlier versions of the microcontroller program.

If the Controller will not support a desired option, contact Boston Gear.

Warranty

Boston Gear warrants that products manufactured or sold by it shall be free from defects in material and workmanship. Any products which shall within two (2) years of delivery, be proved to the Company's satisfaction to have been defective at the time of delivery in these respects will be replaced or repaired by the Company at its option. Freight is the responsibility of the customer. The Company's liability under this limited warranty is limited to such replacement or repair and it shall not be held liable in any form of action for direct or consequential damages to property or person. The foregoing limited warranty is expressly made in lieu of all other warranties whatsoever, express, implied and statutory and including without limitation the implied warranties of merchantability and fitness.

No employee, agent, distributor, or other person is authorized to give additional warranties on behalf of Boston Gear, nor to assume for Boston Gear any other liability in connection with any of its products, except an officer of Boston Gear by a signed writing.



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