Boston Gear®

Ratiotrol®

DC Motor Speed Control

P-3016-BG

Installation and Operation

Doc. No. 84980

VEL-CM Series 1/6 – 1 HP
VEH-CM Series 1 – 5 HP

Boston Gear

An Altra Industrial Motion Company

Table of Contents

Introduction

This manual contains installation, operation, and maintenance instructions for the Boston Ratiotrol VEL and VEH Series single-phase Adjustable Speed Motor Controllers. A parts list and illustrations are also included.
The -CM version of the VEL/H controls is a chassis mount construction intended for installation in the user's enclosure.

General Description

Ratiotrol VEL/H Controllers are general purpose industrial units which statically rectify single-phase AC line power to regulated DC for adjustable speed armature control of DC motors.
The -CM Chassis controls have all the features of the standard VEL/H controls including magnetic starting and circuit breaker. Only operator's devices – speed pot, run and stop pushbuttons – need be added, externally, to operate.

Motors

Motors may be shunt wound, stabilized shunt wound, or permanent magnet DC types. For maximum efficiency, the motor should be rated for operation from a NEMA Code K power source. See Table 1 for motor ratings.

Model Types

Controllers are available in eleven basic models:
1. VEL16 – VEL100:

115VAC
VEL16CM – 1/6 HP
VEL25CM – 1/4 HP
VEL33CM – 1/3 HP
VEL50CM – 1/2 HP
VEL75CM – 3/4 HP
VEL100CM – 1 HP

2. VEH100 – VEH300:

230VAC
VEH100CM – 1 HP
VEH150CM – 1-1/2 HP
VEH200CM – 2 HP
VEH300CM – 3 HP
VEH500CM - 5 HP

Basic Units

Standard VEL and VEH Controllers are basic RUN/STOP units. Other functional features may be incorporated by adding standardized option kits, available from stock.
All VEL/H options are suitable for use with -CM controls. Operator panel items such as jog-run or forward-reverse selector switches and jog pots require external mounting.

Operator's Control

An operator's panel, part no. 60158, is available from your Boston Gear Distributor. It can be installed in a control console as is, or in a NEMA 1 enclosure, part no. 63462. If the operator's controls are to be supplied by the user, the speed pot should be 5K 1/2 watt linear, and the pushbuttons are standard single contact types.

Controller Identification

Each controller contains a data label. This label identifies the controller, user connection terminals and maximum wire size, controller ratings, operation notes, and applicable options.

Section I

General Information

Ratings

1.	Horsepower Range	1/6 – 5 HP
2.	Power Source	1/6 – 1 HP, 115 VAC, 1-phase, 50 or 60 Hz. 1 – 5 HP, 230VAC, 1-phase, 50 or 60 Hz.
3.	115VAC Unit Output Voltages	
	Armature	0-90 VDC
	Field	50 VDC
4.	230VAC Unit Output Voltages	
	Armature	0-180 VDC
	Field	100 VDC
5.	Service Factor	1.0
6.	Duty	Continuous
7.	Overload Capacity (armature circuit) (Armature Circuit)	150% for 1 minute

Note: Internal load monitor provides automatic shut-down if current exceeds 120% for 80 seconds continuously.

Table I Drive Data – Full Load

Basic Model	AC Input - 1 Phase			DC Output				Motor - 1750 RPM	
	HP	Volts	Amps	KVA	Armature		Field		Torque	
					Volts	Amps	Volts	Amps	Lb In	Lb Ft
VEL16CM	1/6	115	3.3	0.4	90	2.2	50	2.0	6	0.50
VEL25CM	1/4	115	5.0	0.6	90	3.0	50	2.0	9	0.75
VEL33CM	1/3	115	6.0	0.7	90	3.6	50	2.0	12	1.00
VEL50CM	1/2	115	9.0	1.1	90	5.6	50	2.0	18	1.50
VEL75CM	3/4	115	13.0	1.5	90	8.1	50	2.0	27	2.25
VEL100CM	1	115	15.0	1.7	90	11.4	50	2.0	36	3.00
VEH100CM	1	230	7.2	1.7	180	5.5	100	2.0	36	3.00
VEH150CM	1-1/2	230	10.0	2.3	180	8.2	100	2.0	54	4.50
VEH200CM	2	230	15.0	3.5	180	11.6	100	2.0	72	6.00
VEH300CM	3	230	16.0	3.7	180	14.4	100	2.0	108	9.00
VEH500CM	5	230	27.5	6.3	180	25.0	100	2.0	180	15.00

Operating Conditions

1. Line Voltage Variation — ±10% of rated
2. Line Frequency Variation — ±2 Hertz of rated
3. Ambient Temperature* — 0 to 50 degrees C (32 to 104 degrees F)
4. Altitude (standard) — 1000 meters (3300 feet) maximum

* Temperature inside enclosure in which control is mounted should not exceed 55 degrees C.

Performance Characteristics

1. Speed Range (controlled) – 0 to motor base speed
2. Speed Range At Rated Torque and Regulation – 30:1
3. Efficiency (maximum speed)
   a. Controller SCR regulator – 97%
   b. Complete drive (controller with motor, typical) – 80%
4. Displacement Power Factor (maximum speed) – 86%
5. Acceleration (standard) – By current limit
6. Speed Regulation (*see Table 2*) – Regulation percentages are of motor base speed under steady-state conditions.

Table 2 – Speed Regulation Characteristics

Regulation Method	Variable			
	Load Change 95%	Line Voltage ±10%	Field Heating *(1)* Cold/Normal	Temperature ±10ºC
Standard Voltage Feedback with IR Compensation	2-3%	2%	5-12%	1%
Optional Speed (tach) Feedback	0.5%	0.5%	0.5%	0.5%

(1)Does Not Apply to Permanent Magnet Motors.

Standard Features

1. Power Conversion ---– NEMA Code K semiconverter power bridge consisting of two SCR's, two diodes and a freewheeling diode. Power bridge is an integrated, encapsulated component. (*See Figure 5, page 21*)
2. Reference Power Supply – +10 VDC regulated, with respect to common.
3. Feedback – CEMF voltage with adjustable IR compensation.
4. Control Transformer – 24 VAC secondary isolates all operator controls and magnetic control logic from the AC power source for operator protection. (*See Transformer T1, Figure 5, page 21*)
5. Motor Contactor – Provides positive disconnection of motor armature from the controller output, and undervoltage protection. A phase-off circuit ensures that the contactor does not make or break DC. (*See Figure 5, page 21*)
6. Motor Overload – Positive motor protection by an electronic nonadjustable current (load) monitor. This circuit shuts down the drive when the motor armature current exceeds 120% for 80 seconds. An optional current (load) monitor (Option Kit Cat. No. 60177) is available which provides an adjustable trip range and an adjustable time delay range. This option provides a relay with one set of Form C, 2 ampere (120 VAC – 28 UDC) contacts which can be used to signal audible or visual alarms, or auxiliary control devices, e.g., lubrication pumps, fans, valves.
7. AC Line Disconnect – Provided by a single-pole, magnetic-trip only circuit breaker with a 5000 ampere interruption capacity. (*See Figure 5*) An optional two-pole circuit breaker (Option 30, Kit Cat. No. 60169) is available which opens both lines of the input supply.
8. Line Transient Protection – Provided by a metal oxide varistor (MOV) suppressor across the AC input line. (*See RV1 on Figure 5*)
9. UL Listed – File E60208

Adjustments

The following adjustment potentiometers are located on the standard circuit boards in the controller. (*See Figure 5*)

1. Maximum Speed – 60 to 100% of motor base speed
2. Minimum Speed – 0 to 30% of motor base speed
3. IR (load) Compensation – 0 to 100% of rated load
4. Current Limit – 50 to 150% of full-load torque

Options

Standardized pre-engineered optional equipment can be supplied with Controllers at additional costs. *See Section VI* for option listing.

Section II

Installation

Mounting Instructions

See Figures 1 & 2, pages 17 & 18

1. Comply with the following mounting requirements:
   a. Mount the enclosure in a vertical position, allowing four (4) inches minimum clearance on all sides, for maximum cooling efficiency.
   b. Fasten the enclosure securely on a level surface.
   c. Shock and excessive vibration are detrimental to controller performance and life. Vibration can cause general deterioration of connections, and component damage. Therefore, shock-mount the controller if it is subjected to external vibrations.
2. If the motor is to be foot mounted, bolt the motor to a firm, flat foundation. If the foundation is not flat, use shims to prevent strain when tightening the bolts. If the motor is to be connected directly to a machine, be sure of correct alignment. Pulleys and couplings must slip freely onto the motor shaft.

CAUTION **Never hammer the pulleys, couplings, or motor shaft, nor overtighten drive belts or timing chains. Bearing damage could result.**

Wiring Instructions

Refer to the data label to be sure the input voltage and frequency to the controller comply with its rating. A surge suppressor (varistor) protects the controller from normal line transients and surges. However, to prevent problems from high-energy transients and large surges, observe the following:

1. Place the controller on a feeder line separate from that supplying large inductive loads.
2. If the input power to the controller comes directly from a transformer, always switch power ON and OFF between the transformer secondary and the controller.

CAUTION **Never make or break power in the transformer primary. Transients could be generated which could damage the controller.**

3. If the controller must be fed from an AC circuit which also supplies highly inductive loads, additional suppression may be required to limit transients or surges to 150% of peak line voltage.

CAUTION **Never use power factor correction capacitors on the input line to the controller. These capacitors can damage the solid-state components.**

The wire size of the input power and motor wiring can be determined from Table 1 and the controller data label.

CAUTION **1. Do not use wire larger than #12 AWG. Oversize or solid wire, as well as oversize screwdrivers for electrical connections, can break terminal board barriers.**
2. All wiring must comply with the national and local electrical codes.

All external wiring for low voltage signal sources, e.g., potentiometers, tachometer generators, transducers, should be run in separate conduit from all other wiring. Use twisted wire (5 to 6 twists per foot) or shielded cable. Maintain the separation of power and signal wiring within the enclosure.

CAUTION **Pickup from unwanted signals can cause erratic operation and/or controller damage.**

AC Power Connections

Connect the AC input power wires to controller Terminals L1 and L2 on Terminal Board TB1. (*See Figure 5*)
If one of the power wires is a neutral wire (grounded potential), connect the hot wire (H) to Terminal L1 and the neutral wire (N) to Terminal L2. Connect the controller Ground Screw (GND) to an earth ground according to applicable electrical codes. Ground Screw (GND) is located near the bottom of the controller enclosure. (*See Figure 5*)

CAUTION **If the neutral wire (Terminal L2) is not grounded, the controller remains electrically "hot" when the AC power ON/OFF switch is turned off.**

Motor Connections

Check the connection diagram supplied on or with the motor. If the motor has dual voltage shunt fields, connect the field terminal straps (or leads) for low field voltage.
Connect the motor field and armature terminals (or leads) to controller Terminals F+, F-, A+, and A-, respectively, on Terminal Board TB1.

CAUTION **Do not ground the motor wiring. Grounded wiring can cause controller damage.**

Connect the motor thermal overload, if applicable, to Terminals 2 and 3 on Terminal Board TB2. Be sure to remove the jumper wire from Terminals 2 and 3 if a thermal overload is used. (*See Figure 5*)

Initial Startup

Before energizing the controller for the first time, be familiar with any installed options. See the option selection table on the controller data label.

The controller has been factory tested and adjusted with a motor under simulated operating conditions. Therefore, startup adjustments should not be needed. However, the following startup procedure should be performed for proper operation, system compatibility, and safety.

1. Be sure all interconnection wiring is correct, and all wiring terminations are tightened securely. Wiring errors and accidental grounds can cause controller and/or motor damage.
2. For 50 Hertz operation, be sure the 60 Hz jumper wire is removed (cut out) from the control board. (*See Figure 5*)
3. Turn the MOTOR SPEED potentiometer fully counterclockwise to zero.
4. If so equipped, place the RUN/JOG switch in RUN position and the FWD/REV switch in FWD position.
5. Couple the motor to the machine (load).
6. Turn on the AC input power and the AC POWER ON/OFF switch.
7. Depress the RUN button, and slowly turn the MOTOR SPEED potentiometer clockwise until the motor rotates. If motor rotation is opposite to that desired, stop the motor with the STOP button, turn off the AC POWER ON/OFF switch and the AC input power, and interchange the motor armature leads.

CAUTION **Never use line switching to start and stop the motor. Resulting transients may cause controller damage.**

8. Turn the MOTOR SPEED potentiometer fully clockwise to 100 and observe motor rotation. The motor should run at its rated (base) speed.
9. Turn the MOTOR SPEED potentiometer fully counterclockwise to zero and depress the STOP button.

Section III

Operation

Power ON/OFF

To energize (turn on) the controller, place the AC POWER ON/OFF switch in ON position. Conversely, to de-energize (turn off) the controller, place the switch in OFF position. The AC POWER ON/OFF switch is a circuit breaker which not only connects and disconnects the AC input power, but also protects the controller and motor form electrical faults. If the circuit breaker trips, reset it by turning it OFF, then ON. If the circuit breaker retrips, an electrical fault is indicated which must be corrected. See the Troubleshooting Table in Section IV.

CAUTION

1. **Continual resetting of the circuit breaker could damage the controller.**
2. **Never use the circuit breaker to start and stop the motor. Controller damage could result.**

WARNING **If line terminal L2 is hot, the controller remains electrically "hot" when the circuit breaker is turned off.**

Run

To start the motor, depress the RUN button, and the motor will accelerate to the setting of the MOTOR SPEED potentiometer.

Stop

To stop the motor, depress the STOP button, and the motor will stop at a rate proportional to the motor load. If the controller contains dynamic braking (Option "D", Cat. No. 60159), the motor will dynamically brake to a rapid stop. Dynamic braking provides exponential rate braking of the motor armature, which occurs when the circuit opens between the controller and the motor armature, and a Resistor (DB) connects across the armature. This is accomplished by a contact, interlocked with the normal run contact.

When a Stop (dynamic braking) function is initiated, the motor functions as a DC generator and feeds its counter EMF through Resistor DB where it is dissipated as heat. This opposes motor rotation, thereby stopping the motor. Resistor DB is rated to provide initial braking torques as shown in Table 4.

Table 4 – Dynamic Braking Characteristics

Component	Unit	Rated Horsepower								
		1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
Braking Torque %	115V	300	215	170	100	75	60	—	—	—
	230V	—	—	—	—	—	220	145	105	85
Stops Per Minute	115V	9	6	5	5	4	4	—	—	—
	230V	—	—	—	—	—	4	3	3	2

CAUTION **High inertia loads may extend braking time beyond the wattage rating of the resistor.**

Option "D", Cat. No. 60159 also provides an Antiplug Relay (APR) which picks up immediately after the motor starts and drops out immediately before the motor stops. An APR contact, connected in the run/stop logic, prevents restarting the motor until the braking cycle is complete.

Speed Control

Motor speed is directly proportional to the setting of the MOTOR SPEED potentiometer. This potentiometer may be adjusted while the motor runs or may be preset at any position before the motor is started. The speed range of the controller is limited only by the limitations of the motor.

Reversing

To reverse motor rotation on reversing controllers (Option "R", Kit No. 60160), depress the STOP button, place the FWD/REV switch in the opposite position, and depress the RUN button. The motor will accelerate to the setting of the MOTOR SPEED potentiometer. Forward and reverse speeds are identical.

NOTE:
The FWD/REV switch contains a center position interlock, which requires a momentary relaxation of pressure before the reverse position can be engaged.
This center position causes a Stop function, and an antiplug circuit prevents the motor from being restarted while the motor is braking until a safe speed for reversing is attained.

Jogging

To jog the motor on controllers with jog capabilities (Option 9, Kit No. 60166), place the RUN/JOG switch in JOG position and jog the motor with the RUN button. Jog is momentary, causing motor rotation only while the RUN button is held depressed. Release the RUN button to stop the motor.

Inoperative Controller

If the motor stops and/or won't start, check for a tripped AC POWER ON/OFF switch. If tripped, reset the switch. If the switch retrips, *see the Troubleshooting Table in Section IV*.

If the switch is not tripped, the internal current monitor may have shutdown the drive. The standard current monitor will shutdown the controller and motor if the motor armature current exceeds 120% of rated for 80 seconds of continuous operation. To reset the controller, depress the STOP button, remove the overload, and depress the RUN button to restart. Repeated shutdown indicates a continual overload (mechanical or electrical) which must be removed. *See the Troubleshooting Table in Section IV*.

Section IV

Maintenance

WARNING **1. Controllers contain high voltage which can cause electric shock resulting in personal injury or loss of life.**

2. Never clean or repair the controller or motor with the AC input power on.

3. When the circuit breaker is off, components within the controller remain at line potential until the AC input power is turned off.

General

VEL/H Controllers require very little maintenance, other than an occasional visual inspection and, if necessary, external cleaning. They must be kept dry and reasonably free from dust, dirt, and debris. No parts require periodic replacement.
Maintain the motor according to maintenance instructions supplied by the motor manufacturer.

Visual Inspections

1. Be sure all wires are fastened securely.
2. Check components for damage due to overheating or breakage. All damaged and/or faulty components must be replaced for satisfactory operation.

Adjustment Instructions

All Controllers have been factory tested and adjusted under load. No adjustments should be required for normal operation. However, if circuit boards are replaced, or if factory adjustments are changed, the following adjustments can be made. All adjustments must be made in strict conformance to the instructions given herein. If, during any step of the adjustment procedure, it is not possible to attain the stated result, stop the motor, turn off the AC input power and refer to the Troubleshooting Table (*Table 5*).
Refer to Figure 4 for the location of the internal adjustment potentiometers.

Preliminary

1. Be sure the controller and motor are at operating temperature, usually achieved within 30 minutes from a cold start.
2. Check the motor shunt field voltage on TB1 Terminals F+ and F-. If rated line voltage is 115 VAC, the shunt field voltage should be 50 VDC, ±5 VDC. If rated line voltage is 230 VAC, the shunt field voltage should be 100 VDC, ±10 VDC.

Minimum Speed

1. Turn the MOTOR SPEED potentiometer fully counterclockwise.
2. Depress the RUN button, and slowly turn the MIN SPEED potentiometer (R1) clockwise until the motor starts to turn.
3. Turn MIN SPEED potentiometer (R1) counterclockwise until the motor stops.
4. If desired, minimum speed can be increased to 30% of motor base speed.

Maximum Speed

1. Depress the RUN button, and turn the MOTOR SPEED potentiometer fully clockwise.
2. Turn the MAX SPEED potentiometer (R59) until the motor runs at rated (base) speed. If a tachometer is unavailable, connect a DC voltmeter across the motor armature, and adjust MAX SPEED potentiometer (R59) until the voltmeter records rated armature voltage.
3. If desired, maximum speed can be decreased to 60% of motor base speed.

CAUTION **Do not exceed rated armature voltage or base speed. Overvoltage and resulting overspeed can damage the motor.**

IR Compensation

IR compensation is factory adjusted and sealed for 3% maximum speed change with a 95% load change throughout the motor speed range. Therefore, readjustment should not normally be necessary. However, if the following facilities are available, readjustment can be performed. To adequately adjust IR compensation, an adjustable load is required that can be applied and removed while the motor is running. In addition, a close reading tachometer is needed to record speed changes. If these facilities are unavailable, do not readjust IR compensation. If, during this adjustment procedure, motor speed becomes unstable or oscillates (hunts), slowly turn IR COMP potentiometer (R9) counterclockwise until the hunting stops.

1. Turn IR COMP potentiometer (R9) fully counterclockwise.
2. Remove the load from the motor and depress the RUN button.
3. Turn the MOTOR SPEED potentiometer until the motor runs at the maximum speed of the desired speed range, normally rated motor base speed. Record motor speed.
4. Apply load to the motor until it draws rated armature current. (See Table 1 for motor current ratings.) Note the speed change.
5. Turn IR COMP potentiometer (R9) until the motor returns to the speed recorded in Step 3.
6. Remove the load and repeat Step 3.
7. Repeat Steps 4, 5 and 6 until desired speed regulation is attained.

Current Limit

The current limit prevents excessive armature current and resulting excessive line current by limiting armature current at 150% of rated. Since the current limit is factory adjusted and sealed, readjustment should not be performed unless an application requires a lower limit of armature current, e.g., limiting torque or accelerating high inertia loads.

1. Turn off the AC input power and connect a DC ammeter, with a rating of at least twice rated armature current, in series with the armature. Observe correct polarity when connecting the ammeter. (*See Table 1 for motor current ratings*.)
2. Turn the CURRENT LIMIT potentiometer (R12) fully counterclockwise.
3. Connect maximum load to the motor.
4. Turn on the AC input power and the AC POWER ON/OFF switch.
5. Turn the MOTOR SPEED potentiometer fully clockwise.
6. Depress the RUN button, and slowly turn CURRENT LIMIT potentiometer clockwise (R12) while the motor is accelerating until the ammeter records the desired armature current.

CAUTION **Do not turn potentiometer (R12) past the factory setting in the increase direction.**
Resulting excessive current could damage the controller and motor.

To obtain a particular percentage of rated output torque, set the armature current at a percentage of rated armature current; e.g., 50% torque is obtained with 50% rated armature current.

Section IV
Maintenance

Troubleshooting

Most electrical failures are caused by incorrect connections, overload, or the accumulation of dirt, dust, or moisture. Dirt and dust deposits limit the transfer of heat from the solid-state components. Moisture, usually caused by either "wash-down" or condensation, can cause insulation failures and short circuits. Be sure the controller is clean and dry before doing troubleshooting.

CAUTION **Be sure the AC input power is turned-off before working in the controller.**

If repeated circuit breaker tripping and/or power bridge failures occur, check the AC input power for transients (high level spikes) or rapid power fluctuations.

If a circuit board fails, check all inputs to the board for proper values before replacing the board.

Use standard troubleshooting procedures, e.g., continuity checks, to detect faults in relay and switching logic and operator controls.

Table 5 – Troubleshooting

Indication	Possible Cause	Corrective Action
1. AC POWER ON/OFF switch 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.
	Power Bridge BR1 shorted	Replace BR1
	Power board failure	Replace power board.
	Control board failure	Replace control board.
	Shunt field shorted or grounded	Repair or replace motor.
2. AC POWER ON/OFF switch trips whenmotor starts to turn	Power Bridge BR1 shorted	Replace BR1.
	Motor shorted or grounded	Repair or replace motor.
	Control board failure causing SCR's to turn-on fully	Replace control board.
3. AC POWER ON/OFF trips while motor is running	Overload	Check shunt field current. Insufficient shunt field current causes excessive armature current. If field current is OK, check for mechanical overload. If the unloaded motor shaft does not rotate freely, replace motor bearings. Also check for shorted armature. Correct accordingly.
	Loose or corroded connection. Wiring faulty, incorrect or grounded	Check AC POWER ON/OFF switch 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 breaking down (intermittently shorting) in Power Bridge BR1	Replace BR1.
	Control board failure causing SCR false firing or misfiring	Replace control board.

Table 5 – Troubleshooting (con't)

Indication	Possible Cause	Corrective Action
4. AC POWER ON/OFF switch Tipped, but motor won't run	AC line open	Be sure external disconnect not switch or circuit breaker is turned-on and rated AC power is applied to controller.
	Operator controls or relay logic inoperative	Repair accordingly.
	MOTOR SPEED potentiometer failure	Replace potentiometer.
	Motor failure	Repair or replace motor.
	Control, input or power board failure	Replace faulty board.
5. Minimum speed excessive	High line voltage	Check for rated line voltage, ±10%, on controller AC line terminals.
	MIN SPEED potentiometer (R1) misadjusted	See "Adjustment Instructions".
	Power Bridge BR1 shorted	Replace BR1.
	Control or input board failure	Replace faulty board.
6. Motor does not attain top speed	Low line voltage	Check for rated line voltage, ±10%, on controller AC line terminals.
	Overload	Check shunt field current. Insufficient shunt field current causes excessive armature current. If field current is OK, check for mechanical overload. If unloaded motor shaft does not rotate freely, replace motor bearings. Also check for shorted armature. Correct accordingly.
	MOTOR SPEED potentiometer failure	Replace potentiometer.
	MAX SPEED potentiometer (R59) misadjusted	See "Adjustment Instructions".
	CURRENT LIMIT potentiometer (R12) misadjusted	See "Adjustment Instructions".
	Control or input board failure	Replace faulty board.
	Power Bridge BR1 failure	Replace BR1.
7. Motor runs at fast speed only	Power Bridge BR1 failure	Replace BR1.
	Control board failure	Replace faulty board.
	Feedback circuit open	Check for open Resistance Wire (R1-R9) and feedback board. Repair accordingly.
8. Unstable speed	AC line voltage oscillating	Observe line voltage with voltmeter oscilloscope. If oscillations occur, contact electrician or local utility company.
	Oscillating load connected to the motor	Correct condition accordingly. Turning IR COMP potentiometer (R9) counterclockwise may minimize condition.
	Motor failure	Check motor brushes, replace if needed. Repair or replace motor.

Table 5 – Troubleshooting (con't)

Indication	Possible Cause	Corrective Action
8. Unstable speed (continued)	IR compensator misadjusted	See "Adjustment Instructions".
	SCR(s) misfiring or false firing and/or control board.	Replace Power Bridge BR1
9. High, unstable speed, low torque	Armature and field connections interchanged	Check controller-to-motor wiring.
	Power Bridge BR1 failure	Replace BR1.
10. Top speed only 1/2 (approximately) of motor base speed and motor noisy (possible half-waving)	Power Bridge BR1 failure	Replace BR1.
	Faulty control board	Replace control board.
11. Motor surges when starting board. Contact	Open or faulty K1 Relay contact	Replace Relay K1 or the power must close between starts.
	Power Bridge BR1 breaking down (shorting intermittently)	Replace BR1.
	Faulty control board	Replace control board.
12. Line and armature current excessive	Overload	Check shunt field current. Insufficient shunt field current causes excessive armature current. If field current is OK, check for mechanical overload. If unloaded motor shaft does not rotate freely, replace motor bearings. Also check for shorted armature. Correct accordingly.
13. Shunt field current insufficient associated	Open shunt field winding or wiring to the shunt field	Check motor shunt field and circuitry for loose connection or broken wire.Repair accordingly.
	Power Bridge BR1 failure	Replace BR1.
14. Shunt field current excessive	Power Bridge BR1 failure	Replace BR1.
	Shunt field windings shorted	Check shunt field current and/or measure shunt field resistance and compare with motor data plate. Repair or replace motor.
15. Motor thermal switch open (if used)	Ventilation insufficient	Free the motor intake and exhaust screens from dirt, dust and debris.
	Motor armature drawing excessive current	Check shunt field current. Insufficient shunt field current causes excessive armature current. If field current is OK, check for a mechanical overload. Correct accordingly. Motor fields should be connected for low voltage.
	Motor overheating from friction	Check for misalignment. Realign motor.
	Shorted motor windings or faulty bearings	Repair motor.

Table 6 – VEH-CM Series

Designation	Description	Boston Part No *		
		115 VAC	230 VAC	
		1/6-1 HP	1-3 HP	5 HP
C1	Capacitor	60274	60274	60274
C2, C3	Capacitor	60275	60275	60275
CB1	Circuit Breaker	60237	60237	69700
MF	Contactor	60261	60261	69701
MR	Contactor**	60264	60264	69701
–	Control Board	60208	60208	60208
D1-D9	Diode	63717	63717	63717
–	Feedback Board	60212	60212	60212
–	Input Board	60211	60211	60211
–	Power Board	60209	60210	69854
BR1	Power Bridge	60229	60228	69702
APR	Relay**	60263	60263	60263
K1	Relay	60262	60262	69703
DB	Resistor**	60265	60265	60265 (2 used)
T1	Transformer	60259	60259	60259
RV1	Varistor	60877	60878	60878

*Note: * Substitution of parts will void UL Listing*
*** Option Component*

Section VI

Options

Table 7 – Options

Any single controller can have one option from each option group A, B, C and D and any or all of the group E options, except Option No. 36, centerwind torque control, which utilizes both input and feedback circuitry and thus cannot be used with any input options (Group B). All options are available factory installed or as kits for field installation.

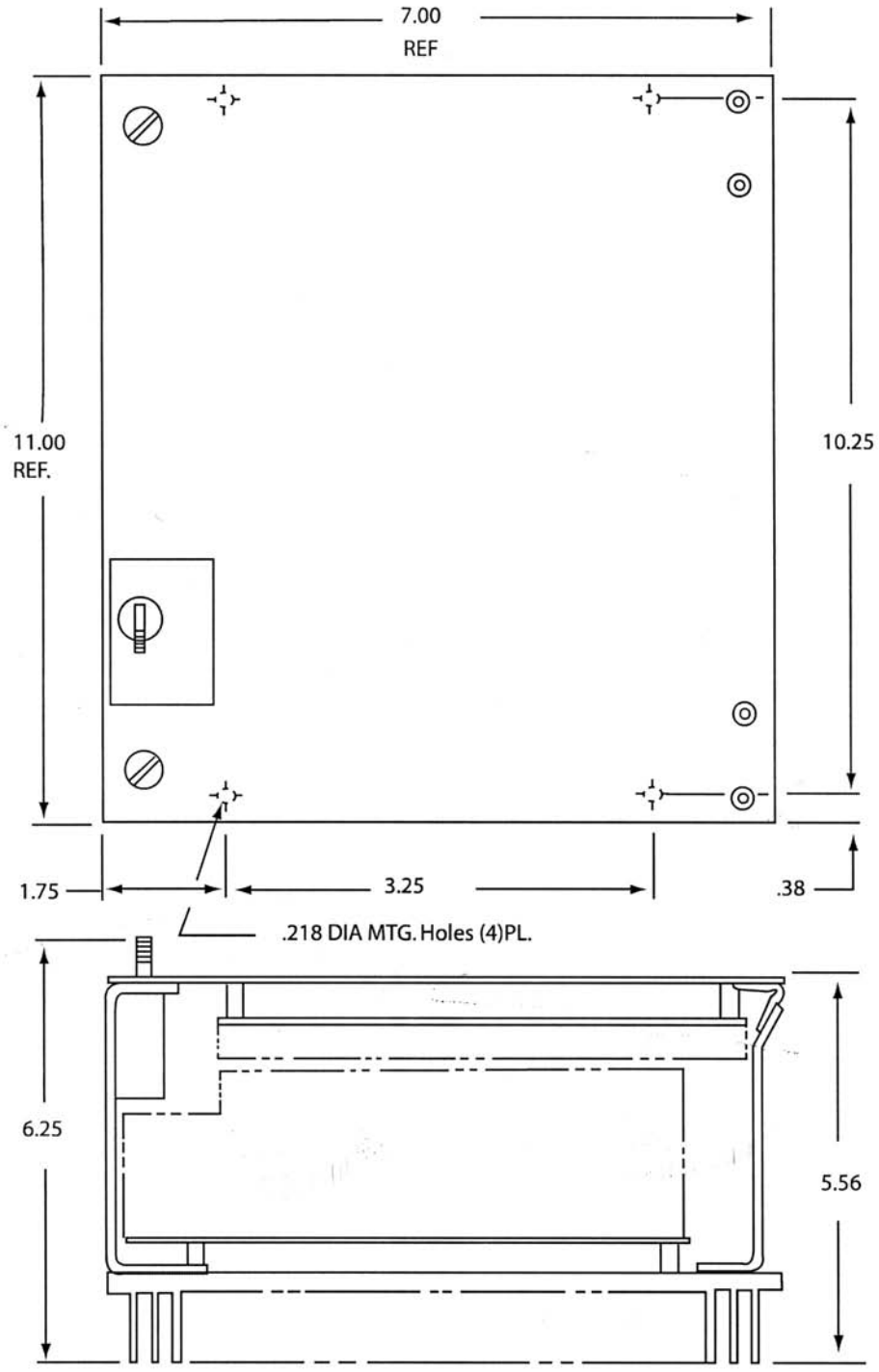
Option Group	Option No.	Cat. No.	Description
A – Switching Options	"D"	60159	Dynamic Braking
	"R"	60160	Reversing, Selector Switch *
	9	60166	Jog, Selector Switch
B – Input Options	14	60170	Master Override Board
	17	60161	Adj. Linear Accel/Decel
	22	60163	Tach. Follower
	25	60165	Ext. MA Signal – Isolated
	33	60176	Speed Pot Isolation
	35	60173	Follower, Master Isol. Ref.
C – Feedback Options	18	60164	Torque-Taper
	24	60162	Tach. Feedback
	36	60175	Centerwind Torque Control**
D – Miscellaneous	31	60177	Load Monitor
	32	60180	Full Wave Field Supply

* *Includes Option D, Dyn. Braking*

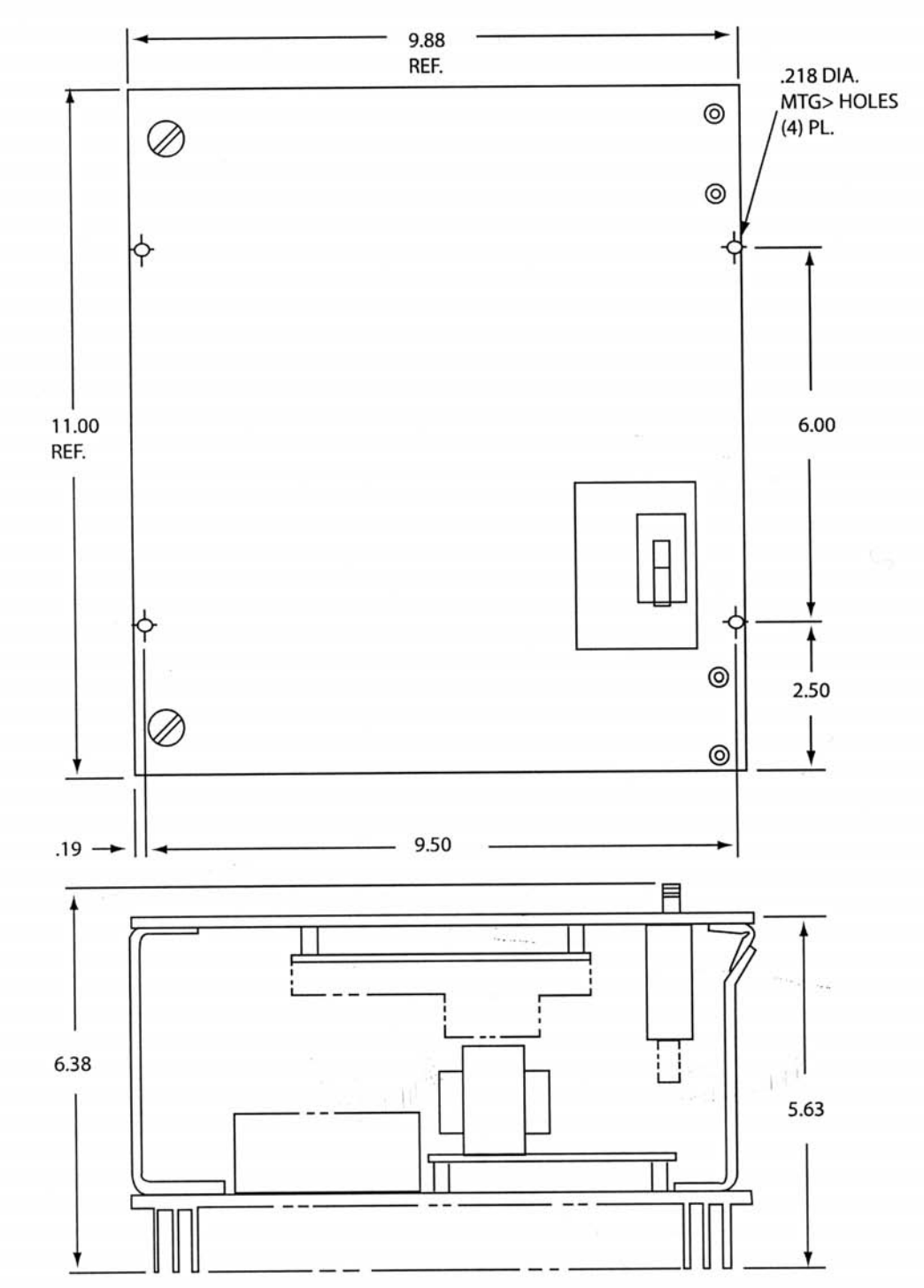
** *This option board occupies both input and feedback sections of the control board connector and, therefore, it cannot be used with any "input" options.*

Ratiotrol D.C. Systems

Figure 1
VEL/VEH-CM Series — 1/6-3 Horsepower Dimensions



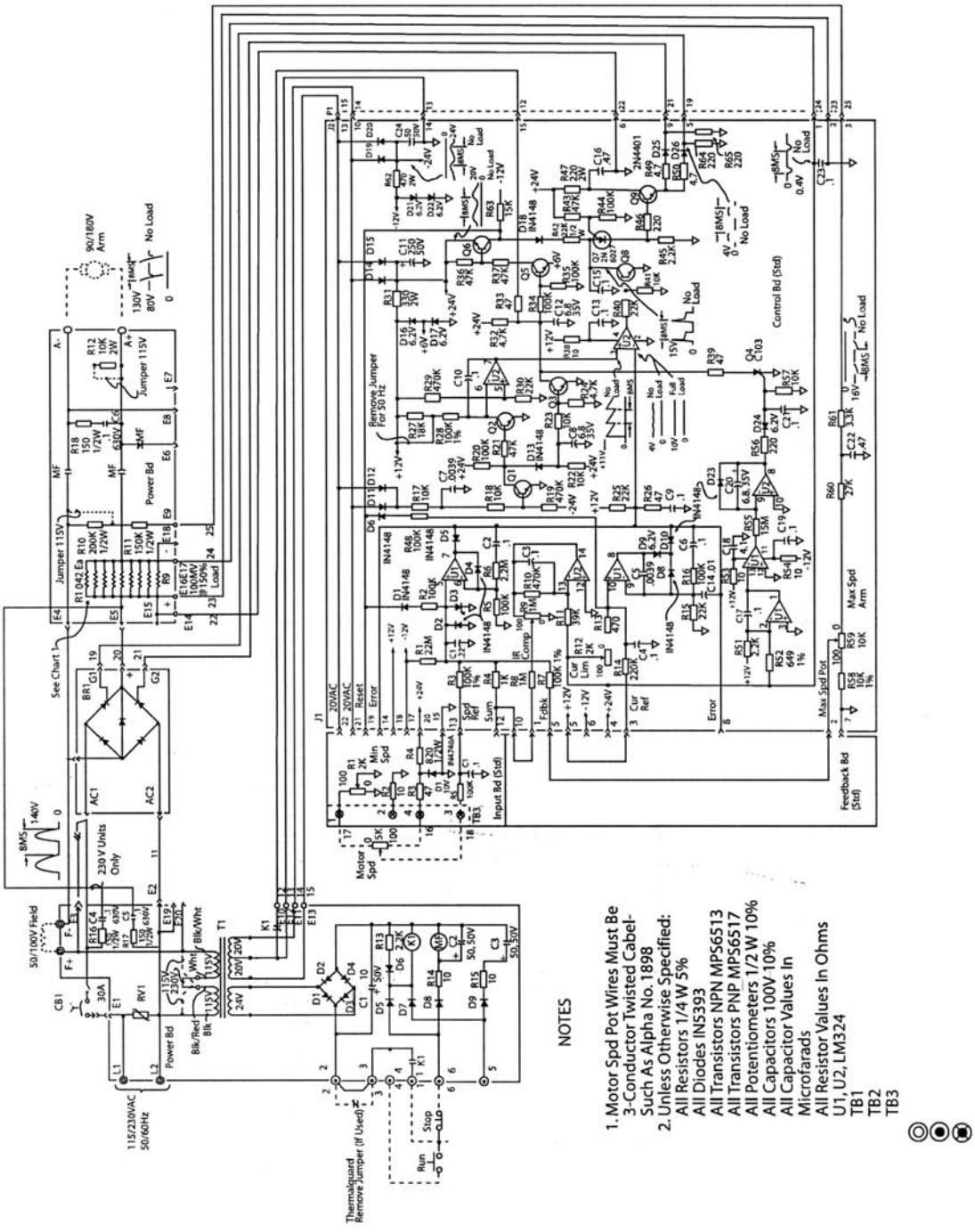
Ratiotrol D.C. Systems
Figure 2
VEH 500CM 5 Horsepower Dimensions



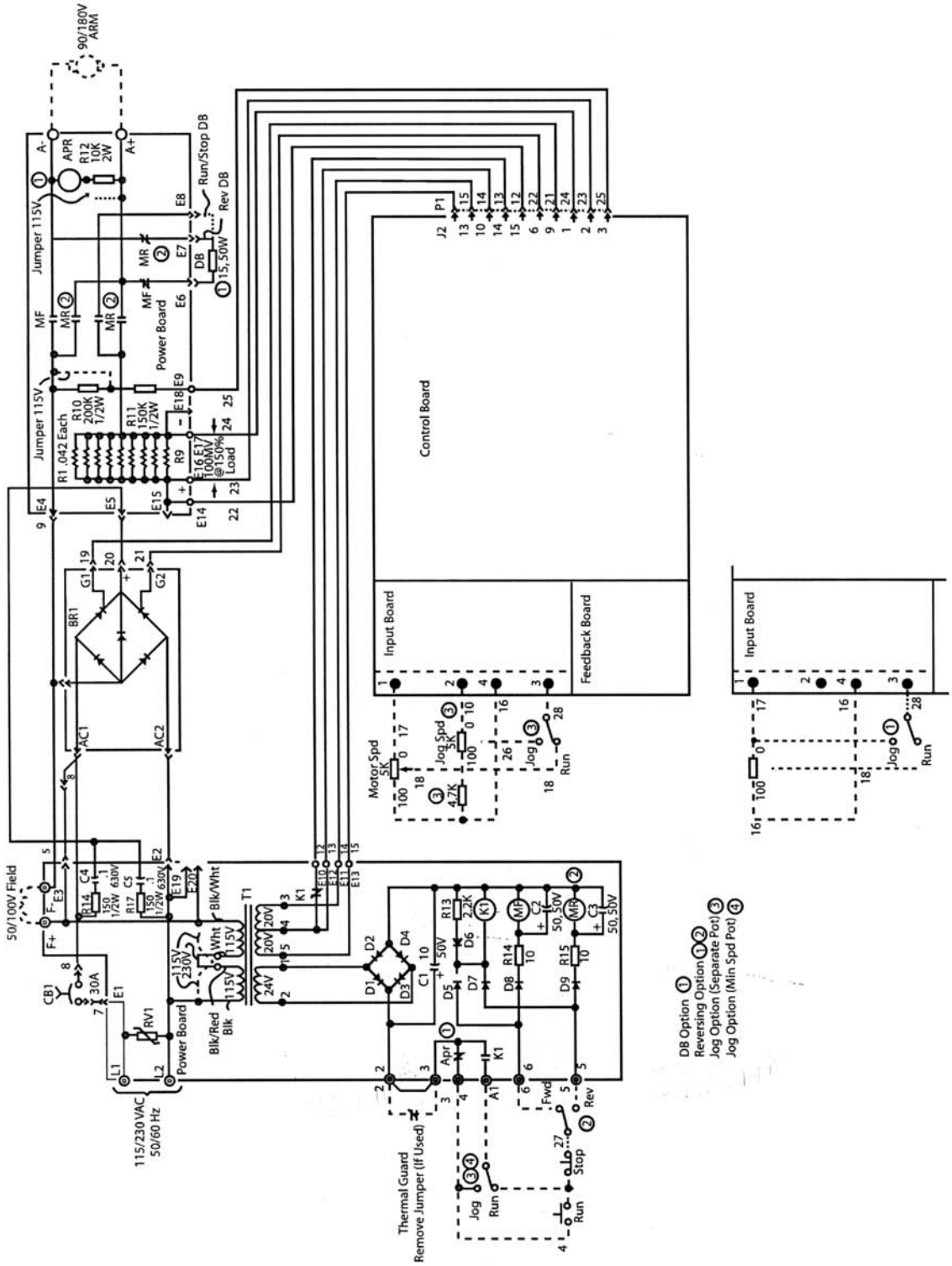
Ratiotrol D.C. Systems
Figure 3
Schematic, Run-Stop VEL/H CM CM

Chart 1

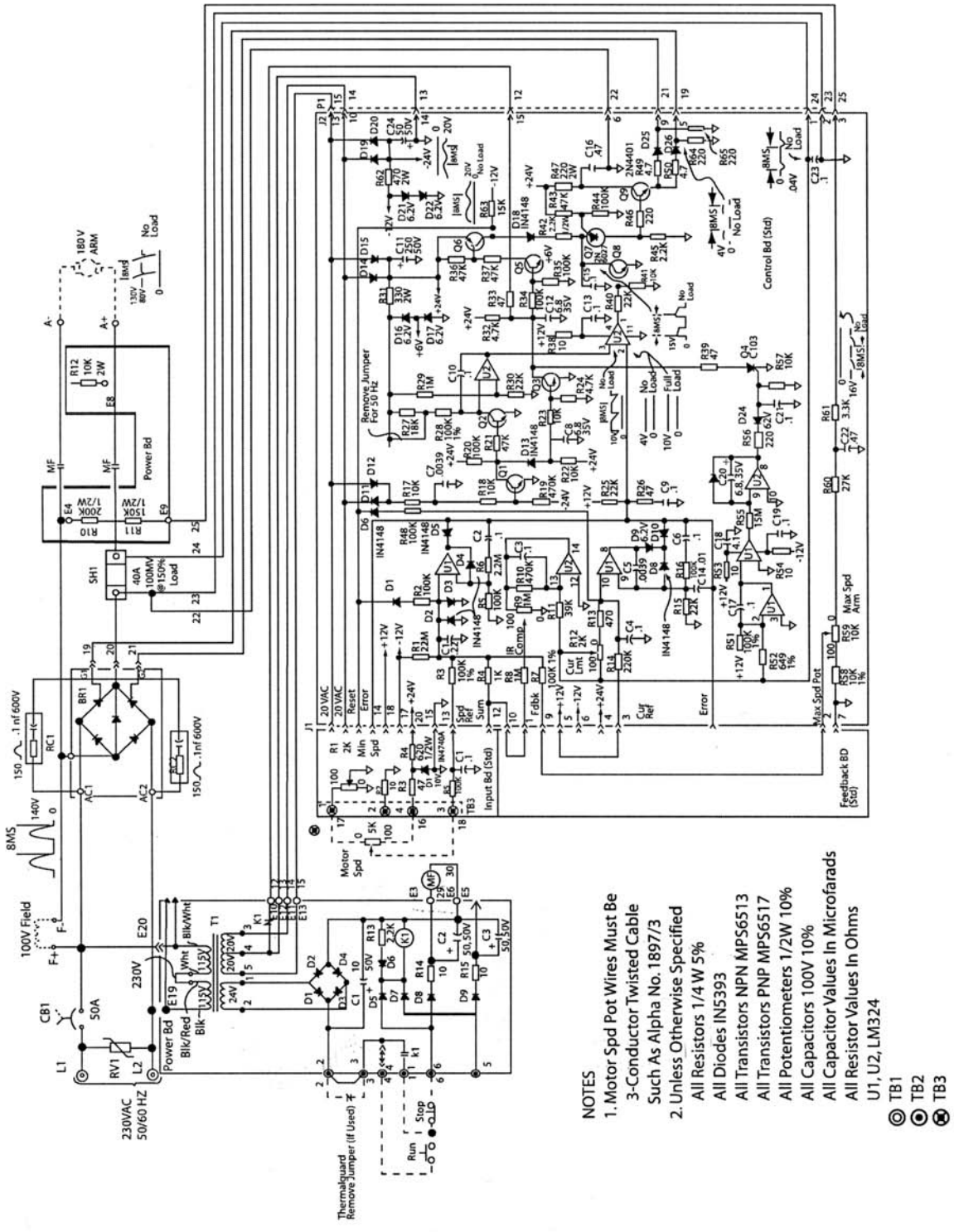
HP Rating		Resistance Wire
115V	230V	Remove
1/6	---	R2 Thru R9
1/4	1/2	R3 Thru R9
1/3	3/4	R3 Thru R9
1/2	1	R4 Thru R9
3/4	1 1/2	R6 Thru R9
1	2	R8, R9
---	3	None



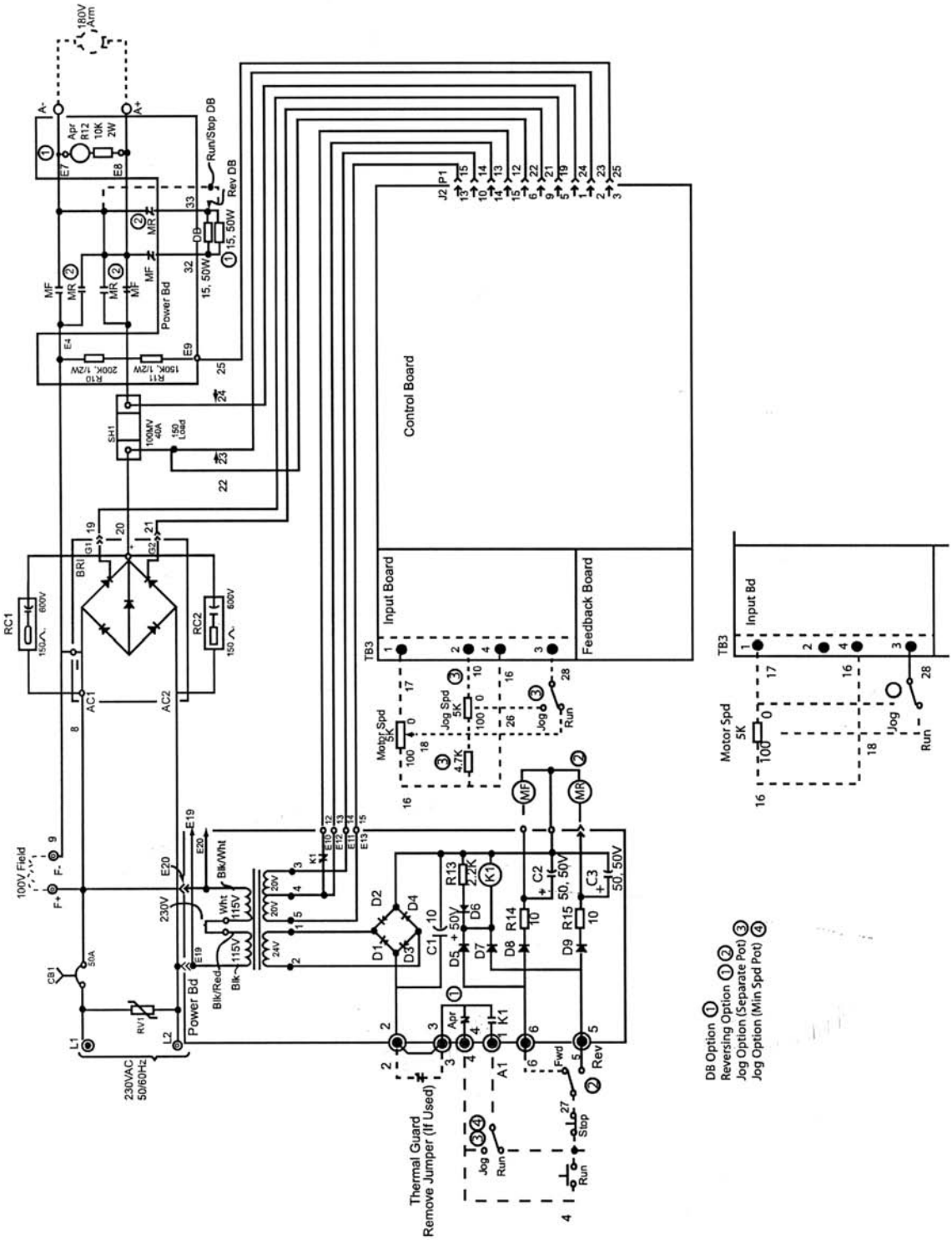
Ratiotrol D.C. Systems
Figure 4
Schematic, DB, Reverse, Jog - VEL/H CM



Ratiotrol D.C. Systems
Figure 5
Schematic, Run-Stop - VEH500CM



Ratiotrol D.C. Systems
Figure 6
Schematic, DB, Reverse, Jog - VEH500CM



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Boston Gear

Boston Gear, Inc
14 Hayward Street • Quincy, MA 02171
617-328-3300 • Fax: 617-479-6238
www.bostongear.com
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