# RICO Quick Troubleshooting Guide

# Sevcon Mos90 Controller

691 West Liberty Street | Medina, OH 44256 | phone 330.723.4050 | fax 330.723.4012 | www.ricoequipment.com
For more information, please contact our Customer Service department at Customerservice@ricoequipment.com

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*Notes:

1) Not all parameters listed in the “Handheld Programmer” section have the ability to be changed.
2) Any parameter change should be approved by Rico

SECTION 4

# FEATURES

4.1 Encapsulated Enclosure: For maximum environmental protection and tamper-proofing .

4.2 Triple Failsafe Mechanism: Using both hardware and software techniques to give rapid action and cross checking at each power up.

4.3 Accelerator Failure Detect: Prevents 'runaway' due to any accelerator lead becoming detached or incorrectly connected. Only available when 5K variable resistor or accelerator type 656/12013 is used (input pin 14).

4.4 Bypass Option: An additional contactor that operates with full throttle and, when the delay has run out, to bypass the MOSFETS and allow absolute maximum speed and efficiency. Bypass will also operate if the unit is in current limit for more than 1 second at full throttle.

4.5 Bypass Dropout: Releases the bypass contactor if the preset current is exceeded and returns to the pulsing mode of operation: recycle direction through neutral to re-engage bypass.

4.6 Speed Control Interfaces: Various speed control systems may be used, i.e.:-

4.6.1 Sevcon Linear Accelerator, type 656/12019 0V min. speed, 5V max speed.

4.6.2 Sevcon Linear Accelerator, type 656/12013 3.5V min. speed, 0V max. speed.

4.6.3 Variable resistor 5K ohm min. speed, 0 ohm max. speed.

4.6.4 Centre tapped potentiometer (1K + 1K) or (10K + 10K) 0V min. speed, 5V max. speed.

4.6.5 Hardellet type module (uses 10.5V feed from pin 3).

4.7 Accelerator Characteristics: Non linear relationship between accelerator position and motor voltage to give enhanced control in low speed travel (see App. IV-3).

4.8 Max. Speed: Limits the top speed of the vehicle.

4.9 Cutback Speeds: 2 speeds externally selectable and adjustable to required level.

4.10 Constant Speed Option: (Patent pending) This is available as a Control software option. The motor speed is monitored by means of software and held constant at the accelerator demand setting, independent of load. To use this option the motor characteristics are pre-set into the software.

4.11 Plugging: Constant current type, adjustable. Varied by footpedal or hand throttle position as standard. Software option - no variation with footpedal or hand throttle.

4.12 'Belly' Switch option: Used to give operator protection on 'Walkies' in line with the EEC Directive (see Appendix III).

4.13 Under-voltage Protection The controller cuts out if the battery dips below 13v, re-cycle through neutral to restart.

| | |
|---|---|
| 4.14 Reverse Battery Protection: (RBP) | Provided as standard on 24v systems, requires polarity sensitive line contactor on 24v/48v systems. |
| 4.15 Input Protection: | All customer control wiring inputs are protected against connection to B+ or B-. Calibrator adjuster socket is not protected. |
| 4.16 Contactor Suppression: | Built into logic unit for all contactors controlled by logic unit. |
| 4.17 Contactor Drives: | May operate at system voltage or via a chopping system which reduces the coil voltage for use with 24 volt contactors; stabilised against battery variations. Customer selectable. Chopping is recommended whenever 24 volt contactor coils are used. Chops at about 18 volts.<br><br>Basic controllers have direction contactor drivers only. Options units have direction and 2 other contactor drivers. These drivers may be configured as any 2 of Bypass, Field Weakening, Power Steer, by software option. |
| 4.18 Anti-Rollback: | Allows full current when drive is reselected without a direction change, even if the vehicle is rolling backwards. |
| 4.19 Start Sequence: | The unit must be in Neutral at Key ON, or drive will not be enabled. |
| 4.20 Overtemperature Rollback: | When the heatsink exceeds 80°C the current limit will linearly cut back to zero at 90°C. |
| 4.21 Field weakening option: | An additional contactor that closes at full throttle to increase top speed by means of a resistor in parallel with the motor field, or a tap on the motor field. Contactor drops out when motor current exceeds preset level. |
| 4.22 Static Return To OFF: (SRO) | Requires direction to be selected before FS1, or FS1 and direction, within 2 seconds: The direction switch must be in the neutral position before the keyswitch is turned ON. |
| 4.23 Power Steer option: | Software selectable in place of field weakening or bypass. Delay adjustable between 0 and 50 seconds in 1-second increments. Delay triggered by releasing FS1. When FS1 is not wired to the controller, the delay is triggered in neutral. |
| 4.24 Seat Switch option: | Software selectable in place of belly switch input. Delay adjustable between 0 and 5 secs in 0.1 sec increments. After opening seat switch, recycle direction, through neutral, or FS1 to restart. |
| 4.25 Diagnostic LED: | A single LED gives comprehensive diagnostic information. LED on equals controller healthy. LED off indicates a faulty controller. A flashing LED, 2-8 flashes, indicates a fault external to the controller. |
| 4.26 Adjustor & Calibrator: | Straightforward, hand-held calibrator unit for digital adjustments or traditional potentiometer adjuster unit. Calibrator also incorporates unique DVM feature and harness check facility. |
| 4.27 Hours Counter: | Hours counter records controller pulsing time up to 65,000 hours. |
| 4.28 Service Log: | Used in conjunction with calibrator unit, records maximum battery voltage and maximum and minimum temperatures controller has experienced. |
| 4.29 Electric Brake Option: | Enabled after delay in neutral, and in conjunction with 'belly' switch. |

# ADJUSTMENTS

8.1 The following procedure is relevant to both traction and pump controllers, except where otherwise marked. The controller can be adjusted in several ways to its desired parameters:-

8.1.1 The unit is pre-set at Sevcon's factory, but may be re-adjusted later by one of the methods below.

8.1.2 The unit may be adjusted by means of an 'adjuster' which contains 7 potentiometers. These are 'read' by the microprocessor and can be adjusted while the controller is in operation. The settings are 'memorised' when the unit is removed. External instrumentation (shunt, ammeter) must be used with the adjuster. Only the first 7 parameters can be adjusted with the adjuster, as illustrated below. In the case of the pump controllers, the potentiometers adjust speeds 1 to 7.

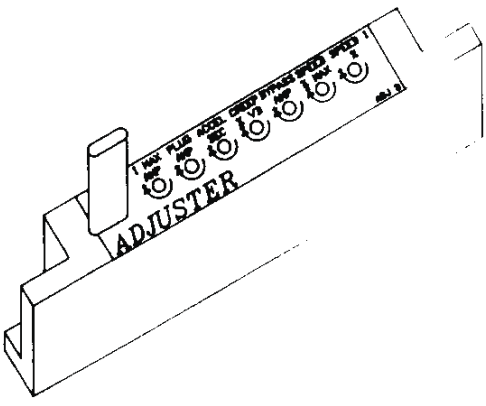
8.1.3 The adjuster as 8.1.2 may be permanently connected to the controller.

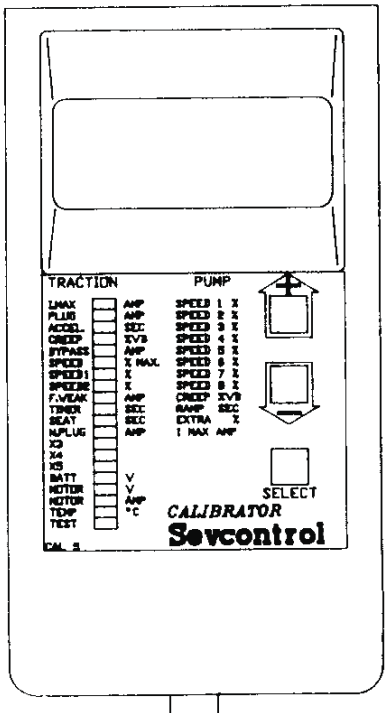
8.1.4 The adjuster as 8.1.2, once set, may be plugged into a series of controllers to set each in turn to the same parameters. This is a useful feature as it allows rapid (1 second) configuration of batches of controllers. Typically the adjuster unit(s) will have its potentiometers masked off once set up.

8.1.5 A hand-held calibrator may be plugged into the adjustment socket and used to digitally increment/decrement the parameters. The present value of these parameters will be shown on an LCD display. Additionally, the calibrator can perform certain measurements on the controller (see diagnostics section). Removal of the calibrator again causes the controller to 'memorise' the set figures. This system gives the greatest accuracy and repeatability.

The hand-held calibrator has a bar display, operated by the SELECT button, showing parameter/measurement selected and an LCD display showing values that, provided they are parameters, may be adjusted by the +/- buttons. This unit may also be used to perform certain tests on the wiring harness and accelerator.

Additional external instrumentation is not required when using the calibrator's measurement feature.

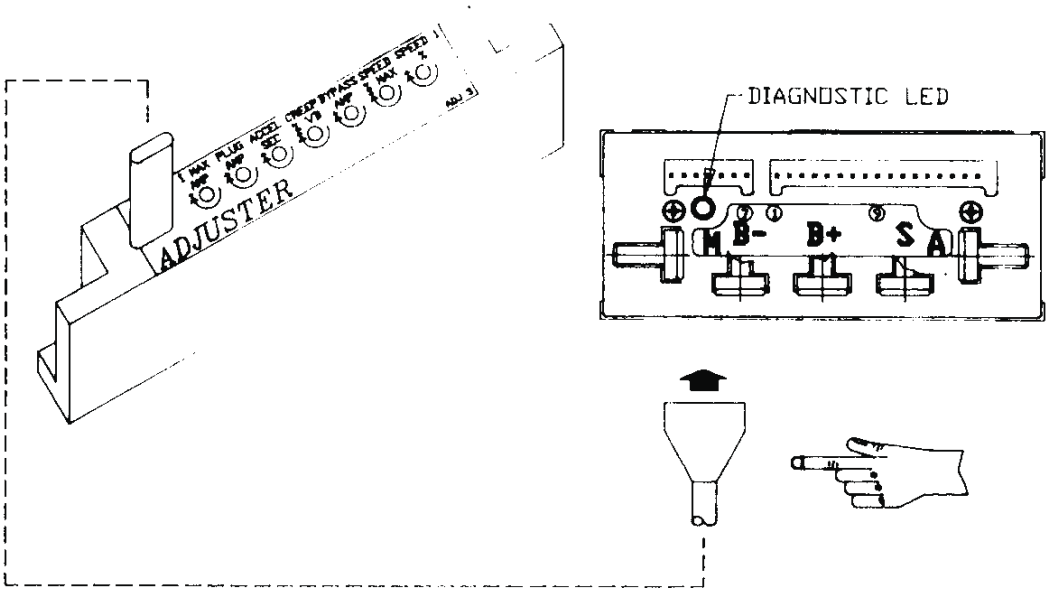



SEVCON MOS90 POTENTIOMETER MODULE (ADJUSTER) AND CALIBRATOR

# ADJUSTER

8.2 Connect the adjuster to the controller as shown below:-




The following applies to traction controllers only. For details of use with pump controllers, see Section 10-1, paragraph 10.3.

8.2.1 Fit ammeter to motor circuit, ensure that truck drive wheels are clear of floor and free to rotate. Insulate the bypass contactor tips (if used). Switch on the controller and set the accelerator to maximum with the brakes applied so that the wheels cannot rotate. Adjust IMax. to give the desired current.

8.2.2 With the truck drive wheels still clear of the floor, remove bypass contact tip insulation. Switch on the truck and allow to run up to full speed and the bypass contactor to close. Apply the brakes to load the drive motor until the desired current is reached. Adjust the BYPASS pot counter-clockwise slowly until the bypass contactor opens.

8.2.3 Remove ammeter and set truck on ground. Drive truck and adjust ACCEL to give acceptable 'feel'.

8.2.4 Drive truck with load and plug brake, adjust PLUG to set plugging level to suit application. Note that plugging response can be affected by accelerator position on certain controller types, so that plugging must be set with the accelerator at maximum demand.

8.2.5 Creep Speed is set by adjusting CREEP so that with the drive selected, the truck is just about to move at minimum accelerator position. This level may be set differently depending upon application.

8.2.6 Drive truck unloaded on a flat surface and measure speed. Adjust SPEED to limit speed to desired level.

8.2.7 Repeat 6 above with speed limit 1 switch input at B- and adjust SPEED 1 for desired speed level.

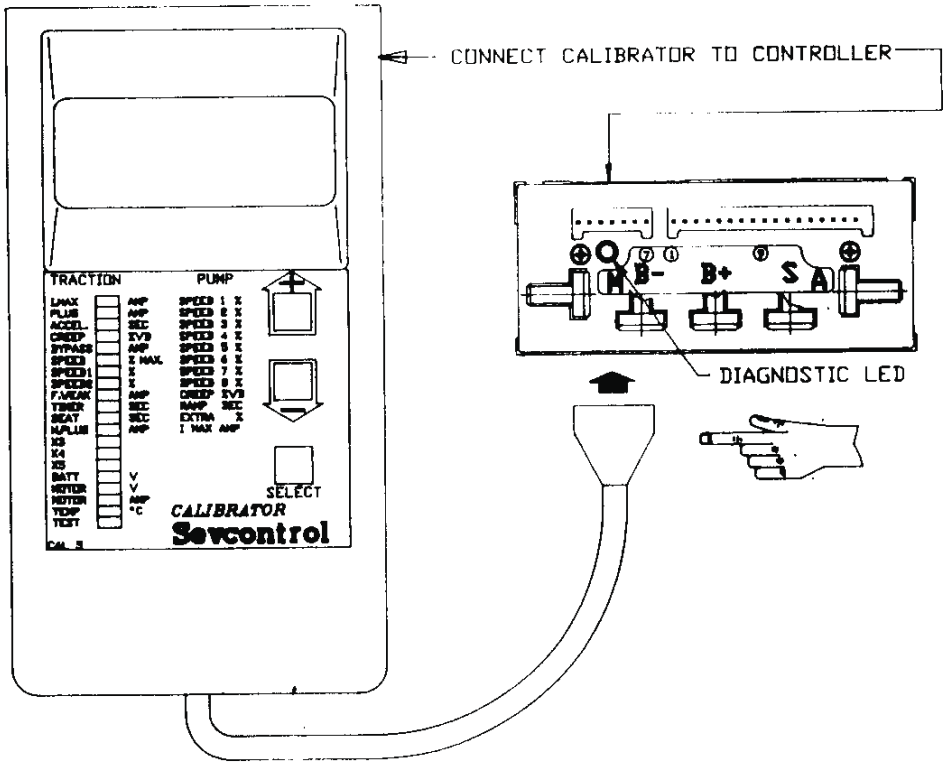
8.2.8 Note: Only the first 7 settings can be adjusted using the adjuster. The full list of settings is described on the next page.

# ADJUSTABLE CUSTOMER PARAMETERS - CALIBRATOR

TRACTION

| Parameter | Min | Max | | | | Units | Step Size |
|---|---|---|---|---|---|---|---|
| | | MOS90A | MOS90B | MOS90C | MOS90D | | |
| Current Limit (IMAX) | 50A | 180A | 270A | 400A | 600A | Amps | 10A |
| Plugging Current (PLUG) | 50A | 180A | 270A | 400A | 750A | Amps | 10A |
| Accel. Delay (ACCEL) | 0.1 | 5 secs | 5 secs | 5 secs | 5 secs | Secs | 0.1S |
| Creep Speed (CREEP) | 0% | 25% | 25% | 25% | 25% | % VB | 1% |
| Bypass Dropout (BYPASS) | 50A | 360A | 540A | 800A | 1000A | Amps | 10A |
| Maximum Speed (SPEED) | 0% | 100% | 100% | 100% | 100% | % VB | 1% |
| Cutback Speed 1 (SPEED 1) | 0% | 100% | 100% | 100% | 100% | % VB | 1% |
| Cutback Speed 2 (SPEED2) | 0% | 100% | 100% | 100% | 100% | % VB | 1% |
| Field Weakening (F.WEAK) | 50A | 180A | 270A | 400A | 600A | Amps | 10A |
| P.Steer Delay (TIMER) | 0 | 50 secs | 50 secs | 50 secs | 50 secs | Secs | 1sec |
| Seat Switch Delay (SEAT) | 0 | 5 secs | 5 secs | 5 secs | 5 secs | Secs | 0.1sec |

For details of use with pump controllers, see Section 10-1, paragraph 10.3.



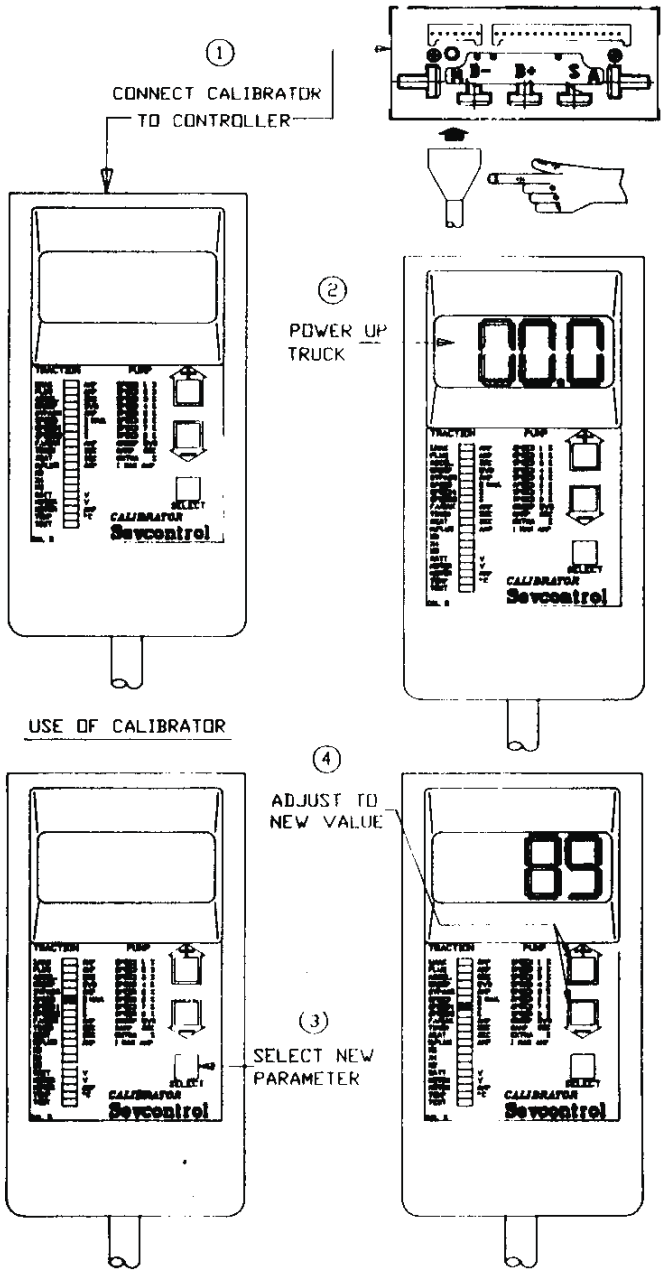
8.3 Connect the calibrator as shown below and power up the vehicle.

8.3.1. No LED segment will be lit and the minutes/seconds count is displayed. The hours count is displayed by pressing the '-' button and the 1,000s of hours count by pressing the '+' button as described in Appendix I-1. Pressing the select button reverts the calibrator to its normal operation, i.e. the IMax segment will be lit.

8.3.2 When the desired parameter has been selected, it may be increased or decreased by means of the + and - buttons on the right of the calibrator. The range of adjustments are given on a previous page.

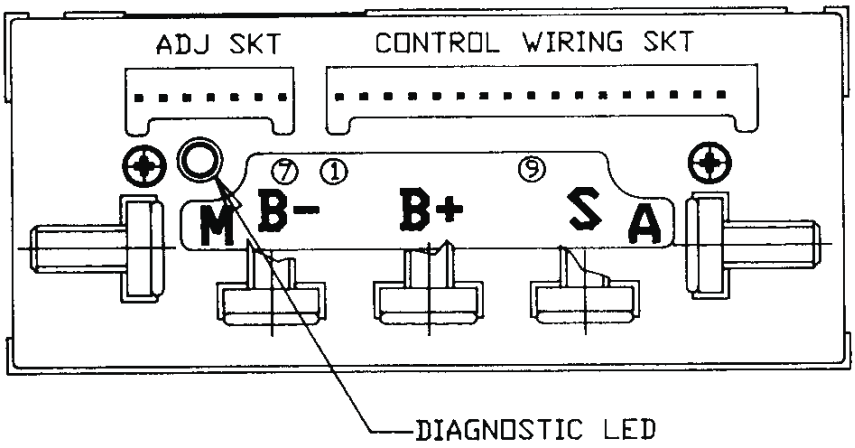
8.3.3 Note that parameters 6, 7 and 8 (SPEED, SPEED1 and SPEED 2) may reduce current limit and ramp climbing ability.

8.3.4 For details of the measurement and test functions, please refer to the DIAGNOSTICS section.



# DIAGNOSTICS

9.1 The controller is equipped with a diagnostic system using a green LED located on the connection plate near the adjuster socket.




9.2 On power up the LED will be illuminated if the system is functioning correctly.

9.3 The LED is extinguished if the controller is faulty, the fuses are blown, the failsafe is not operational, the contactor driver protection has tripped, or the Mosfets fail to turn on during drive. If the contactor driver transistors are short circuit, the contactors may close but the vehicle will not drive under single fault conditions.

9.4 This applies only to traction controllers. See Section 10-1, paragraph 10.4 for pump controllers. The LED will flash a number of times on power up, or during running, to indicate a fault external to the controller.

| | | |
|---|---|---|
| 9.4.1 | 2 flashes | Incorrect start procedure fault.<br>Both forward and reverse selected. |
| 9.4.2 | 3 flashes | Bypass contactor welded - recycle through neutral to clear.<br>Contactor coil short circuit - recycle the keyswitch to clear. |
| 9.4.3 | 4 flashes | Direction contactor welded. |
| 9.4.4 | 5 flashes | Direction contactor did not close, or open-circuit motor. |
| 9.4.5 | 6 flashes. | Faulty accelerator input. |
| 9.4.6 | 7 flashes | Low battery voltage. |
| 9.4.7 | 8 flashes | Thermal cutback. |

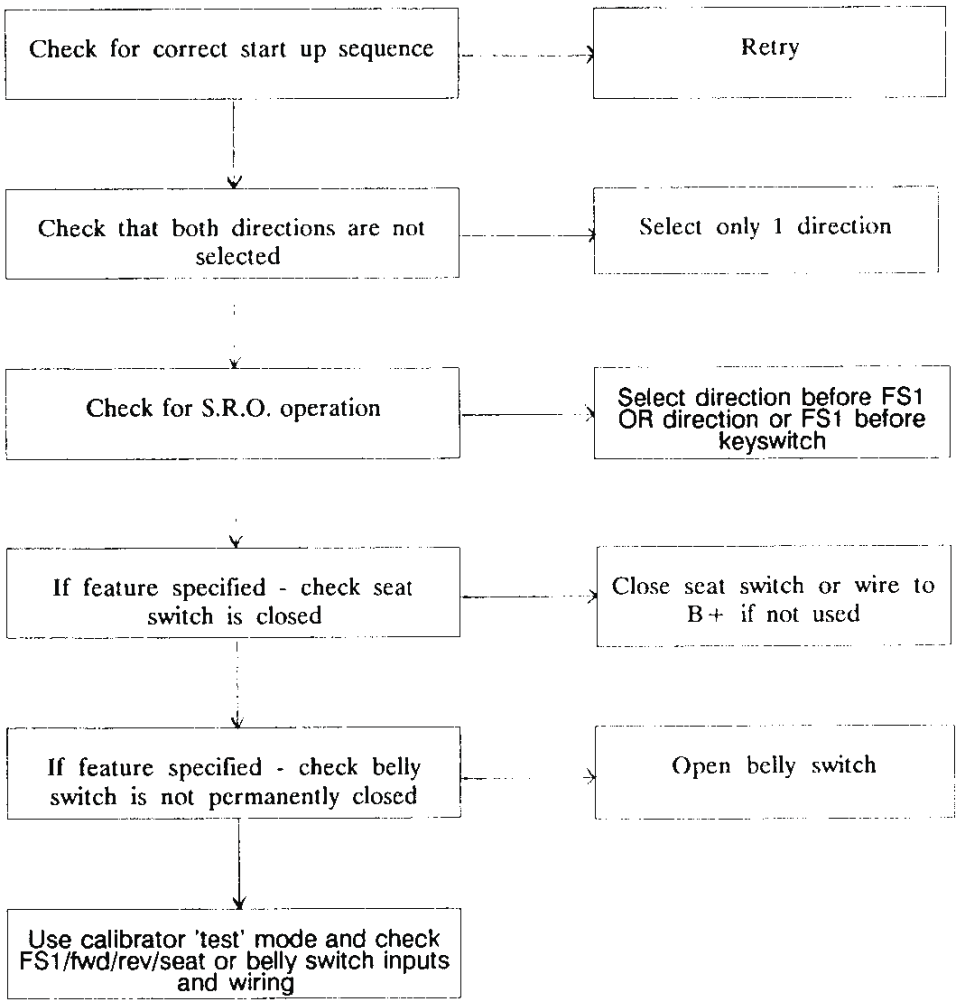
See Appendix II for detailed fault-finding flowcharts.

# APPENDIX II

## FAULT FINDING FLOW CHARTS

II.1 At battery connection, the LED should not illuminate. At key ON, the LED should illuminate steadily. If the LED illuminates and remains steady, but no drive can be selected, the calibrator can be used to test the wiring harness.

II.2 2 FLASHES (TRACTION ONLY)
- Procedure Fault
- Illegal start up sequence, 2 directions selected, no seat switch closed, static return to off, (SRO) in operation.
- Drive inhibited.
- Flashes until fault is cleared

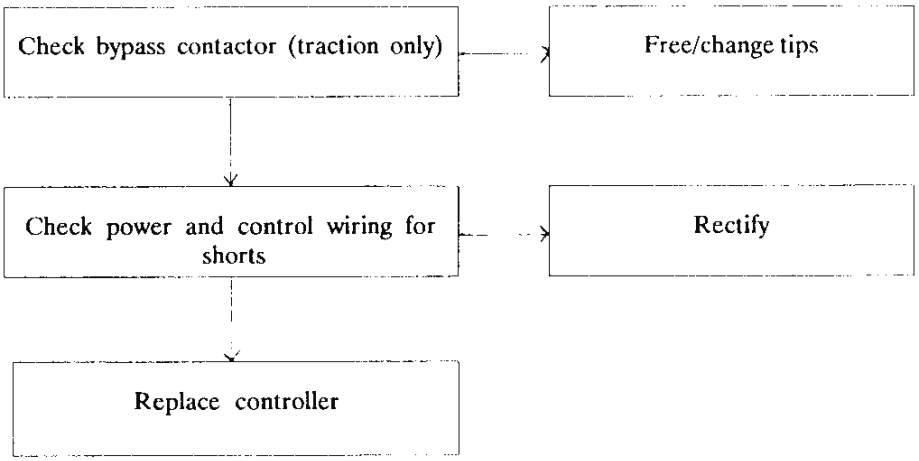



2 FLASHES - (PUMP ONLY) Check pump inhibit input (Pin 1) for high input (BDI, etc)

II.3 3 FLASHES (TRACTION & PUMP)

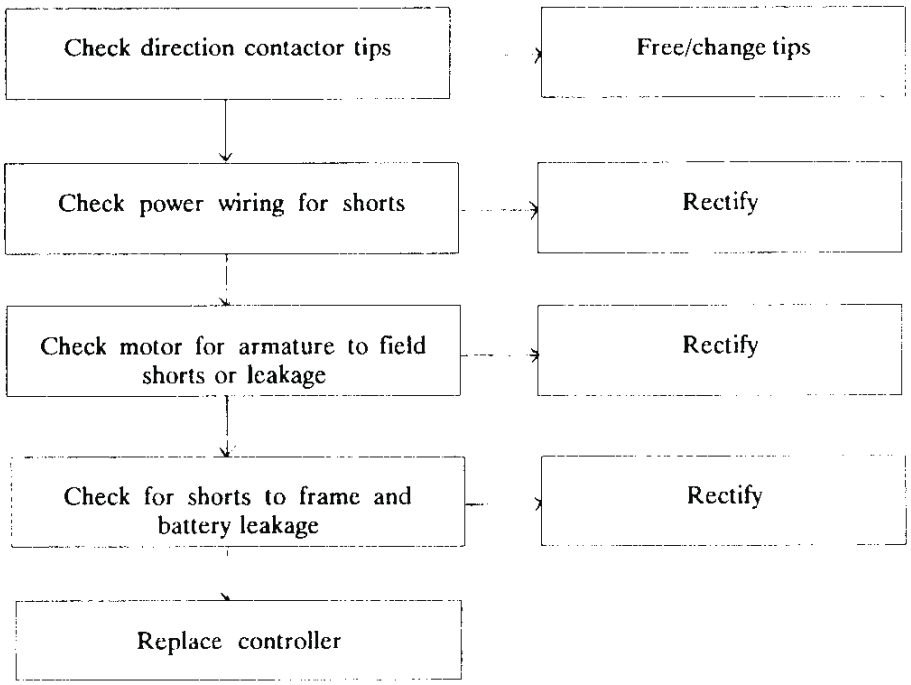
- Bypass contactor welded/hardware failsafe trip.
- Point 'A' < 7v in neutral, or < 7v for 15mS in drive, or contactor coil short circuit.
- Drive inhibited.
- Recycle to neutral to clear.

NOTE: if recycling to neutral does not clear the fault, then the failsafe is due to an S/C contactor coil and the keyswitch must be recycled (and coil replaced).




II.4 4 FLASHES (TRACTION ONLY)

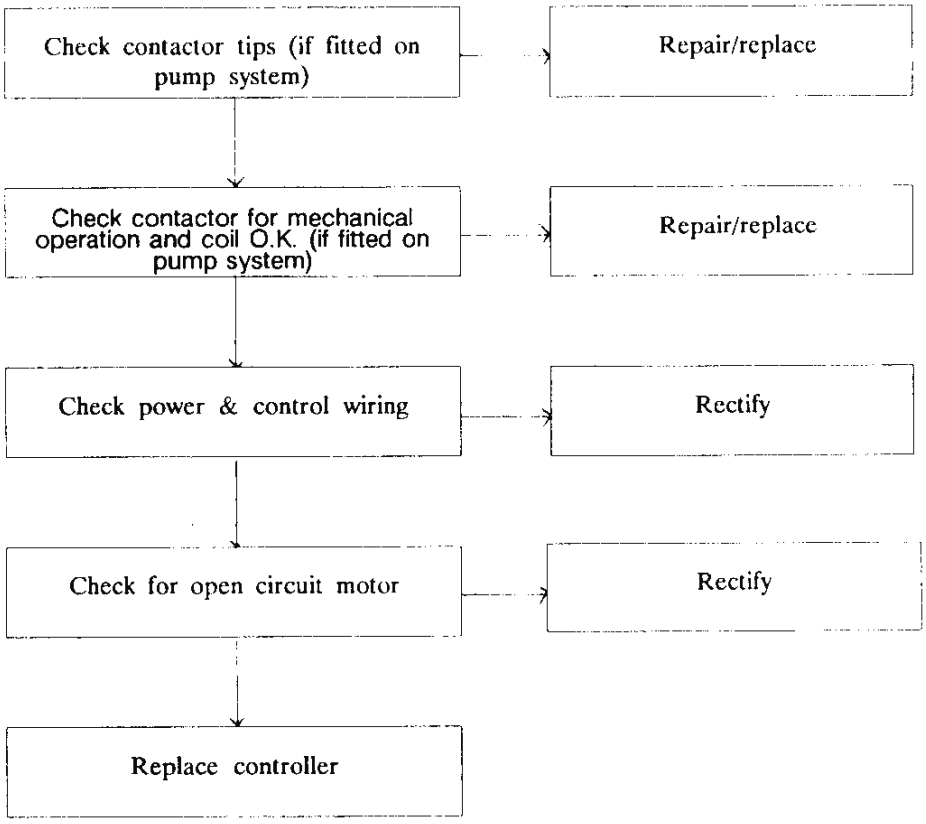
- Direction contactor welded. (Point 'A' within 6V of B + ve in neutral).
- Leakage between motor armature and field.
- Drive inhibited.
- Flashes in neutral until fault is cleared.



II.5 5 FLASHES (TRACTION & PUMP)

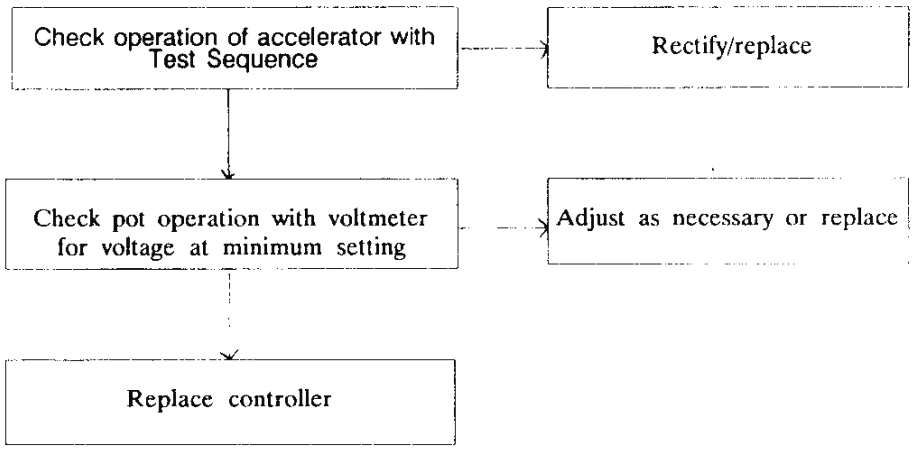
- Direction contactors (or line contactor) did not close.
- Motor armature or field open circuit.
- Point 'A' not within 6V of B + ve within 1 second of selecting direction.
- Drive inhibited.

Flashes until fault is cleared, when contactor closes.



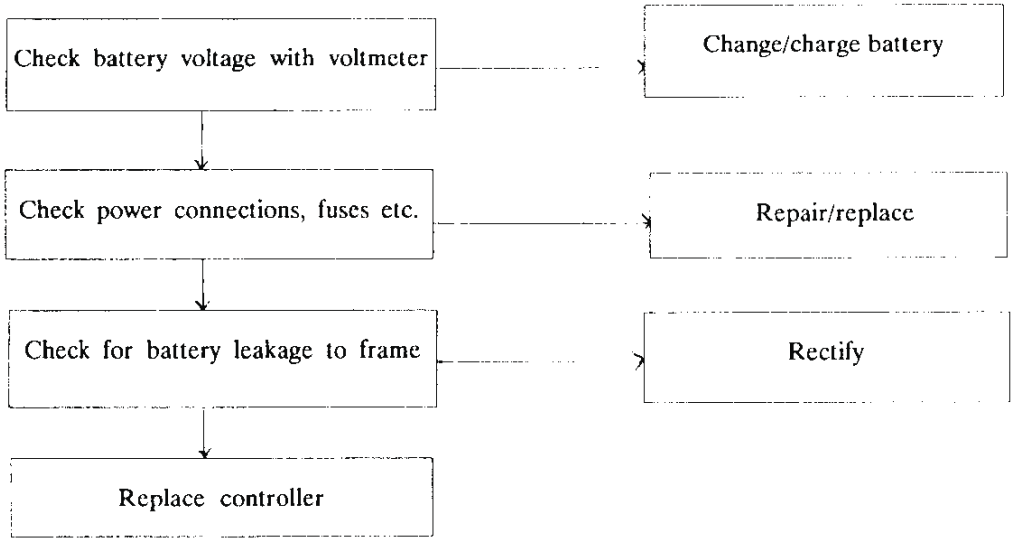
II.6 6 FLASHES (TRACTION ONLY)

- Accelerator faults.
- 3V5-0V input:- Voltage < 2V5 on power up
  Voltage > 4V5 in drive
- 0-5V input:- Voltage > 1V on power up
- Controller pulses at creep setting.
- Flashes until fault cleared.

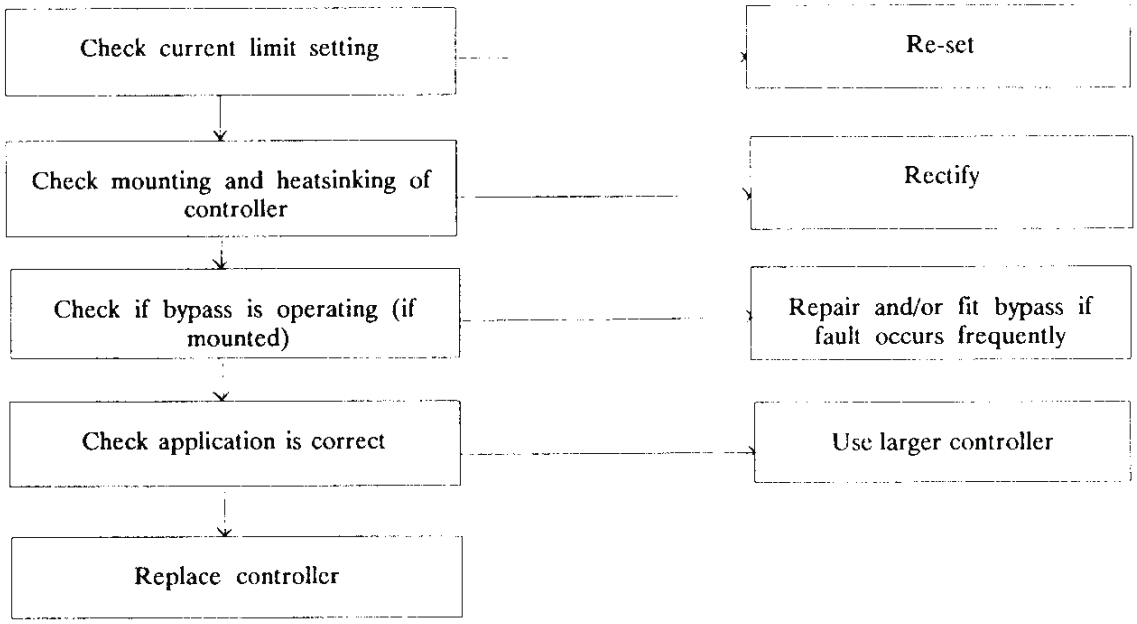



II.7 7 FLASHES (PUMP & TRACTION)

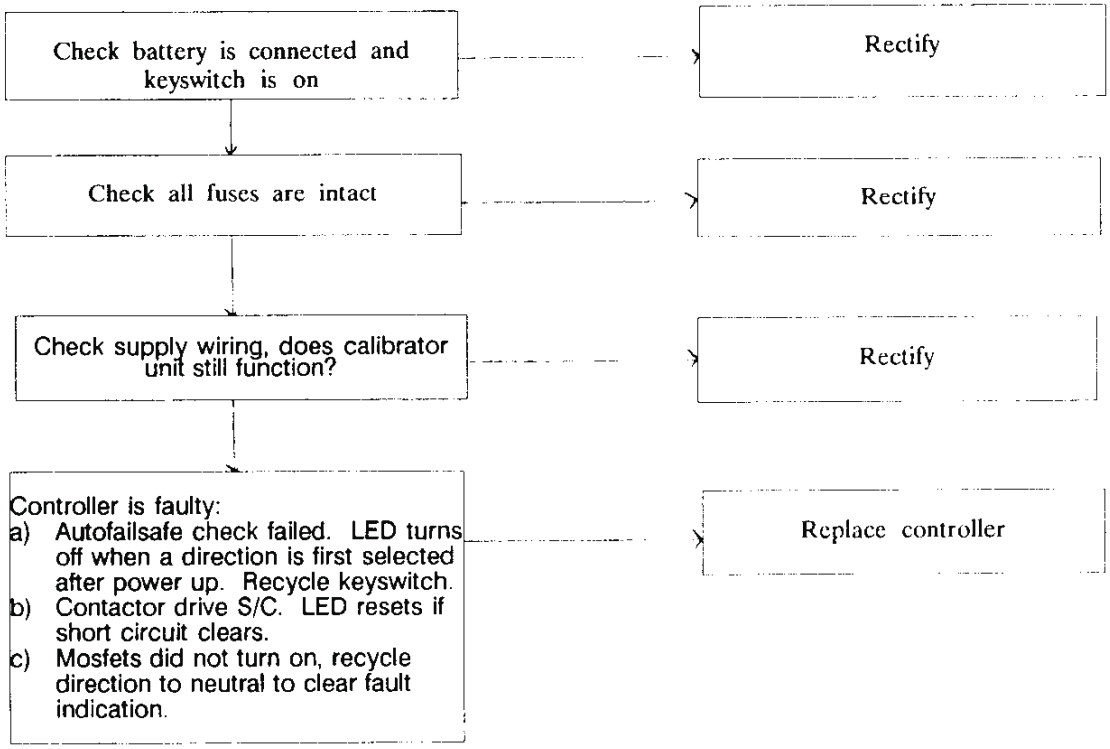
- Battery voltage < 13V
- Drive inhibited
- Recycle to neutral to clear flash



II.8 8 FLASHES (TRACTION & PUMP)
- Thermal cutback
- Heatsink temperature > 80°C (Current limit will be zero at 90°C)
- Allow unit to cool down, to clear flashing




II.9 LED off - Unit not powered up or controller faulty, or LED faulty.



# PUMP CONTROLLER

10.1 The MOS90 pump controller is a derivative of the range of traction controllers which has been optimised for the control of hydraulic pump motors in electric vehicles. The same powerful single chip microprocessor, calibrator and diagnostic system are used.

10.2 Features

10.2.1 Three power frame sizes are available with current ratings of 275, 400 and 600A. These units are physically the same size as the MOS90B, C and D units, but with only 3 connection busbars.

10.2.2 Voltage range 24-48v.

10.2.3 Reverse battery protected with polarity sensitive line contactor; capable of operation without a line contactor.

10.2.4 Up to 8 programmable speeds, with the priority of SPEED 1 highest, SPEED 8 lowest.

10.2.5 SPEEDS 1-7 are active high and these inputs must be connected to B+ to enable the speeds. SPEED 8 is active low to allow its use as a power steer speed. The input must be connected to B+ to disable this speed and either disconnected or connected to B- to enable it.

10.2.6 Lift speed (SPEED 1) may be infinitely variable with the use of an external 5K variable resistor, or a 0-5v input from a linear accelerator unit.

10.2.7 Creep speed adjustable (but overridden by lower selected speed).

10.2.8 Soft start (ramp-up) delay is adjustable.

10.2.9 Current limit adjustable.

10.2.10 Additive speed feature increases % ON when speed switch 8 (normally power steer) is selected together with any other pump function. The speed increase depends upon the 'EXTRA' speed setting and gives a measure of speed compensation.

10.2.11 An inhibit input is provided which can be used in conjunction with a B.D.I. low battery signal to prevent SPEEDS 1-7 operating. SPEED 8 is still allowed to operate.

10.3 Adjustment

The pump controller may be adjusted in exactly the same manner as the traction unit. Using the calibrator, all 8 speeds, the ramp delay, creep, current limit and the 'extra' speed may be set and reset with their values being displayed:-

10.3.1 Speeds displayed as 0-100% representing 0-100% of battery voltage.

10.3.2 Ramp up delay displayed as 0.10 to 1.00 representing seconds in increments of 20mS (0.02 secs).

10.3.3 Creep adjustable between 0 and 25% of battery voltage.

10.3.4 Current limit adjustable between 50A and maximum controller rating.

10.3.5 Using the adjuster, the first 7 speeds may be set.

10.4 Diagnostics

The diagnostic system is generally as described for the traction system. The number of flashes is defined below:-

| | | |
|---|---|---|
| 10.4.1 | LED off | Mosfets did not turn on. |
| 10.4.2 | 2 flashes | Pump inhibit input operating. |
| 10.4.3 | 3 flashes | Short circuit across Mosfets, or motor open circuit. |
| 10.4.4 | 7 flashes | Battery voltage less than 13v. |
| 10.4.5 | 8 flashes | Thermal cutback operating. |

The test sequencer function of the calibrator is generally as described for the traction controller in Appendix I, with the pump pot. (if fitted) being tested first, followed by switches 1-8, then the inhibit input.