MOS90 RANGE

The new Sevcon MOS Range of D.C. Traction and Pump Controllers combines the latest state-of-the-art Mosfet and Microprocessor technologies.

The result is a highly efficient and flexible range of controllers for small to medium sized electric vehicles such as pallet, warehouse, reach and low capacity fork lift trucks plus personnel carriers.

The powerful microprocessor used in the MOS90 range offers advanced features previously unavailable in such a compact controller.

PRODUCT RANGE

VOLTAGE	24-48V
MAXIMUM CURRENT	180-600 AMPS

USER/MANUFACTURER BENEFITS:

- Quiet operation
- Increased battery shift life
- Increased motor life
- Increased contactor tip life
- Simple installation plus reduced set up time
- Reduced maintenance troubleshooting time
- Reduced peripheral hardware costs
- Waterproof
- Suitable for cold storage applications
- Designed to meet U.L. and E.E.C. Standards

The microprocessor software facilities within the MOS90 range allow a significant number of features to be built into the Controller eliminating additional hardware.
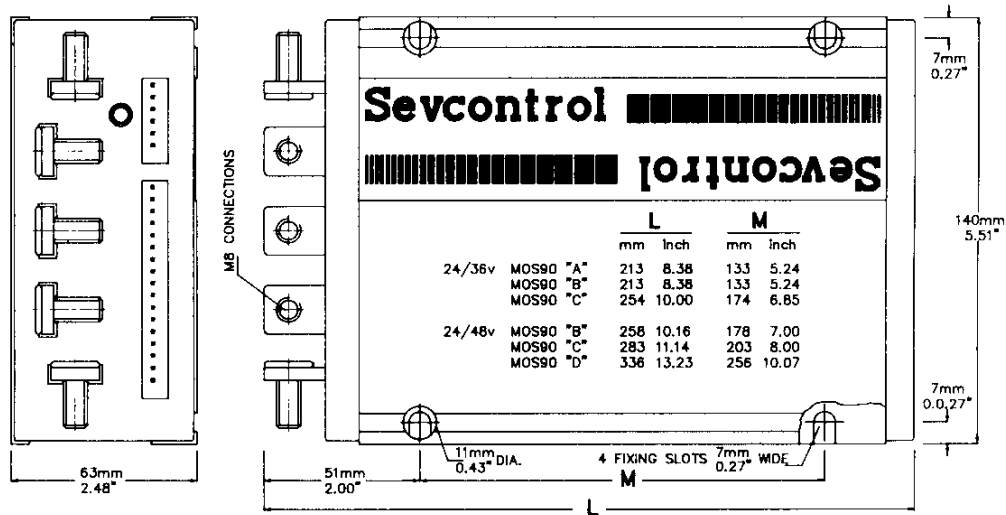
FEATURES:

- Triple failsafe
- Contactor chopping across voltage range
- Built-in diagnostic L.E.D.
- Environmental protection
- Undervoltage protection
- Ramp start
- Overtemperature cutback
- Controller input protection
- Built-in contactor suppression
- Multiple accelerator inputs
- Accelerator failure detection
- Speed cutback

OPTIONS:

- Bypass
- Field weakening
- Belly switch control
- Seat switch timer
- Reverse battery protection
- Power steer delay
- Constant speed (patent pending)
- Pump controllers (up to 9 programmable speeds)

Sevcontrol ▪▪▪▪▪▪▪▪▪|||||| Tech/Ops

The following dimensions appear in the technical drawing:

		L mm	L Inch	M mm	M Inch
24/36v	MOS90 "A"	213	8.38	133	5.24
	MOS90 "B"	213	8.38	133	5.24
	MOS90 "C"	254	10.00	174	6.85
24/48v	MOS90 "B"	258	10.16	178	7.00
	MOS90 "C"	283	11.14	203	8.00
	MOS90 "D"	336	13.23	256	10.07

M8 CONNECTIONS

140mm 5.51"
7mm 0.27"
7mm 0.0,27"
63mm 2.48"
51mm 2.00"
11mm 0.43" DIA.
4 FIXING SLOTS 7mm 0.27" WIDE

Outline Specification: MOS90 RANGE

	MOS90A	MOS90B	MOS90C	MOS90D
Voltage:	24-48V	24-48V	24-48V	24-48V
Current:	180A	275A	400A	600A
Continuous Current:	75A	125A	175A	225A
Temperature:	Operating Ambient	—30°C + 40°C		
Range:	Storage	—40°C + 90°C		

OPTIONAL EQUIPMENT:

Calibrator Unit: **Provides digital adjustment of:**
Current limit
Plugging level
Accelerator delay
Creep speed
Maximum & cutback speed
Bypass & field weakening levels
Power steer timer
Seat switch timer
Lift speeds (pump controllers)

Also acts as Digital Volt Meter measuring:
Battery volts
Motor volts
Motor current
Heatsink temperature
Vehicle diagnostics

Adjuster Module: **Provides analog adjustment of controller parameters**

Accessories: **Full range of accelerators, contactors and contactor panels etc.**

Note: This product bulletin is an outline specification only. For specific application data, the full engineering specifications available from Sevcon should be used.

Sevcon is constantly striving to improve its products and reserves the right to alter specifications without notice.

CONTENTS

This manual covers all MOS90 units produced from serial no. 0591---- onwards. For details of earlier units, please consult Sevcon.

THE SEVCON MOS90 CONTROLLER

1.1   Thank you for buying a controller from the SEVCON family of MOS90 pump and traction controllers. These controllers are designed with you the user in mind. They provide easy installation, many new features not available before on DC motor controllers, and diagnostics of drive system faults. They are designed and manufactured to the highest quality standards for long life and low failure rate. Both pump and traction controllers are available which use the most modern and efficient semiconductors available (MOSFETS), coupled with a state of the art microprocessor system that allows more features per controller than ever before.

1.2   This manual has been specially prepared to make installation of your MOS90 controller easy and trouble-free. It outlines all the major facilities available with this outstanding new controller.

1.3   If you have any questions or suggestions about this manual please contact any of the subsidiaries of Tech/Ops Sevcon where our engineering staff will be happy to provide you with all possible assistance.

SAFETY

2.1 Electric vehicles can be dangerous. All testing, fault finding and adjustment should be carried out by competent personnel. Where possible, the drive wheels should be off the floor and free to rotate during the following procedures. THE VEHICLE MANUFACTURERS MANUAL SHOULD BE CONSULTED BEFORE ANY OPERATION IS ATTEMPTED.

2.2 The MOS90 controller contains a triple failsafe system to give the highest level of safety. If the green diagnostic light emitting diode (LED) is not illuminated or flashes on and off, the safety circuit has tripped and the truck may not drive.

2.3 To ensure continued safety of the MOS90 system, the failsafe circuit should be checked whenever the truck is serviced. The maximum period between checks should not exceed 3 months.

2.4 BATTERY MUST BE DISCONNECTED BEFORE REPLACING OR ATTEMPTING ANY REPAIRS OF THE CONTROLS.

2.5 Pin 13 must be grounded if not being used as speed control input.

2.6 Note for 24/48v units without a line contactor fitted, never connect a battery to the controller with its vent caps removed, as an arc may occur due to the controller's internal capacitance when it is first connected.

2.7 Before handling controller cables on 24-48v units, disconnect battery and connect B+ and B- terminals via a 10R ohm 25 watt resistor to discharge the internal capacitor.

FAILSAFE CHECK

2.8 Ensure drive wheels are clear of the floor and free to rotate.

2.9 Switch on, release brake and select drive, wheels should rotate and green LED on controller give a steady illumination.

2.10 Switch off, disconnect battery and connect A and B- terminals with 10mm^2 or greater, cable, ensure no other fault that would allow drive.

2.11 Reconnect battery, switch on key with direction in neutral. The LED should flash 3 times. Select a direction and check that direction contactors do not close and wheels do not rotate.

2.12 Switch off at key, remove A/B- connection switch on at key. Reselect power up sequence, LED should now illuminate and truck wheels rotate.

IF THE TRUCK DRIVES IN 2.11, THE CONTROLLER IS FAULTY AND MUST BE REPLACED.

2.13 NOTES:

2.13.1 As blow out magnets are fitted to contactors, ensure that no magnetic particles can accumulate in the contact gaps and cause malfunction. Ensure that contactors are wired with the correct polarity to their power terminals (as indicated by the + sign on the top moulding).

2.13.2 The MOS90 MUST NOT be used with permanently connected on-board chargers or damage to the system may result.

TECHNICAL SPECIFICATIONS

3.1   The MOS90 series of controllers are available in 4 basic power frames of different current capacity. These 4 basic power frames then have various levels of build to give differing features, such as voltage, allocation of contactors, reverse battery protection etc. The product range sheet which follows details these variants.

The complete power frame is then 'matched' with a logic to give the required level of options.

3.1.1	Voltage:	24/36 and 24/48 volt units available.
3.1.2	Frequency:	200Hz nominal with variable mark/space ratio
3.1.3	Motors:	Suitable for 3 (split field) or 4 terminal motors. Min. motor inductances:-

24V - 0.1mH
36V - 0.15mH
48V - 0.25mH.

3.1.4	Battery Lead Length:	24/48v units, 15m max. 24/36v units, see Rating Charts, Appendix IV-2
3.1.5	Contactors:	Direction (2), forward/reverse, bypass and field weakening OR power steer, i.e. a maximum of 3 contactor functions may be mounted. Maximum coil current per input:

Contactor Coil	System Voltage	Chopping	Max. Current
24v	24v	Y	2.0A
24v	36v	Y	2.0A
24v	48v	Y	2.0A
36v	36v	N	1.5A
48v	48v	N	1.5A

A chopping facility is available so that 24 volt contactors may be used on all system voltages. It is recommended that whenever 24 volt coils are used the chopping facility is used.

An optional contactor/fuse mounting plate can be fitted onto the controller.

3.1.6   Mosfet Devices: Have a lower forward (conducting) loss and a much higher switching speed than SCR's or bipolar transistors. This improves controller efficiency and prolongs battery shift life.

3.1.7   Operating Ambient Temp: -30°C to +40°C. As the controller will limit its maximum current above 80°C (see Section 4-2, paragraph 4.20) the controller may be used in ambients above 40°C. However, if the controller is operated at higher ambient temperatures and under heavy load conditions, it may be found that the maximum current available is reduced below the Imax value as the controller may have entered thermal cutback.

3.1.8   Storage Ambient Temp: -40°C to +90°C

3.1.9   Humidity: 95% max. non-condensing

MOS90 CONTROLLERS - PRODUCT RANGE

Controller Family(8)	Frame Size	Current Rating (4)			Mechanical				Remarks
		Notes (1) 2 Min	(2) 1 Hr	(3) Bypass O/C	Power (6) Conns.	W	L	(5) H	
Basic 24v	MOS90A MOS90B MOS90C	180 270 400	75 125 175	- - -	4 (10mm²) 4 (10mm²) 4 (25mm²)	140 140 140	213 213 254	63 63 63	Direction contactor drivers only. Reverse battery protection (7).
Options 24v	MOS90A MOS90B MOS90C	180 270 400	75 125 175	360 540 800	5 (10mm²) 5 (10mm²) 5 (25mm²)	140 140 140	213 213 254	63 63 63	Direction contactors + any 2 of Bypass Field Weakening or P. Steer. Reverse battery protection (7)
Basic 24/48v	MOS90B MOS90C MOS90D	270 400 500 (600)*	125 175 225	- - -	4 (10mm²) 4 (25mm²) 4 (35mm²)	140 140 140	258 283 336	63 63 63	Direction contactor drivers only.
Options 24/48v	MOS90B MOS90C MOS90D	270 400 500 (600)*	125 175 225	540 800 1000	5 (10mm²) 5 (25mm²) 5 (35mm²)	140 140 140	258 283 336	63 63 63	Direction contactors + any 2 of Bypass Field Weakening or Power Steer.

*   1 minute current limit rating.

3.2 NOTES:

(1)   Current limit ratings are with the controller at a max. of 60% ON.

(2)   1 hour ratings are at any %ON up to maximum and assume adequate contact cooling of the controller.

(3)   This is the max. settable over current value, it is usually set at 1.5 times current limit - beware contactor and motor ratings!

(4)   These figures assume an ambient of 25°C.

(5)   The optional contactor/fuse plate increases the overall height to 125mm.

(6)   5 power connections are required when bypass is fitted (options units only).

(7)   Reverse battery protected controllers only give this protection if used with the correct contactors - See wiring drawings and contactor section (Section 6).

(8)   24 volt controllers may be used at 36 volts with a derating (refer to App. IV-2).
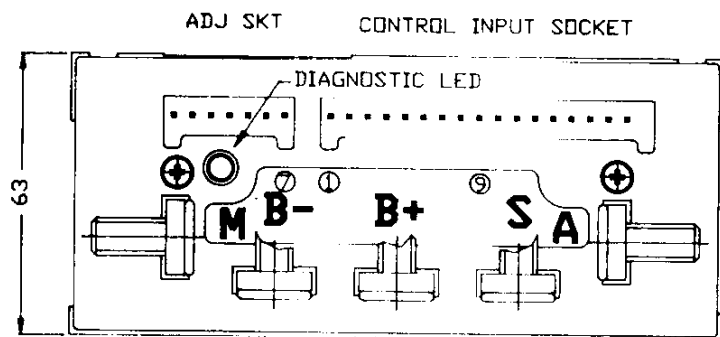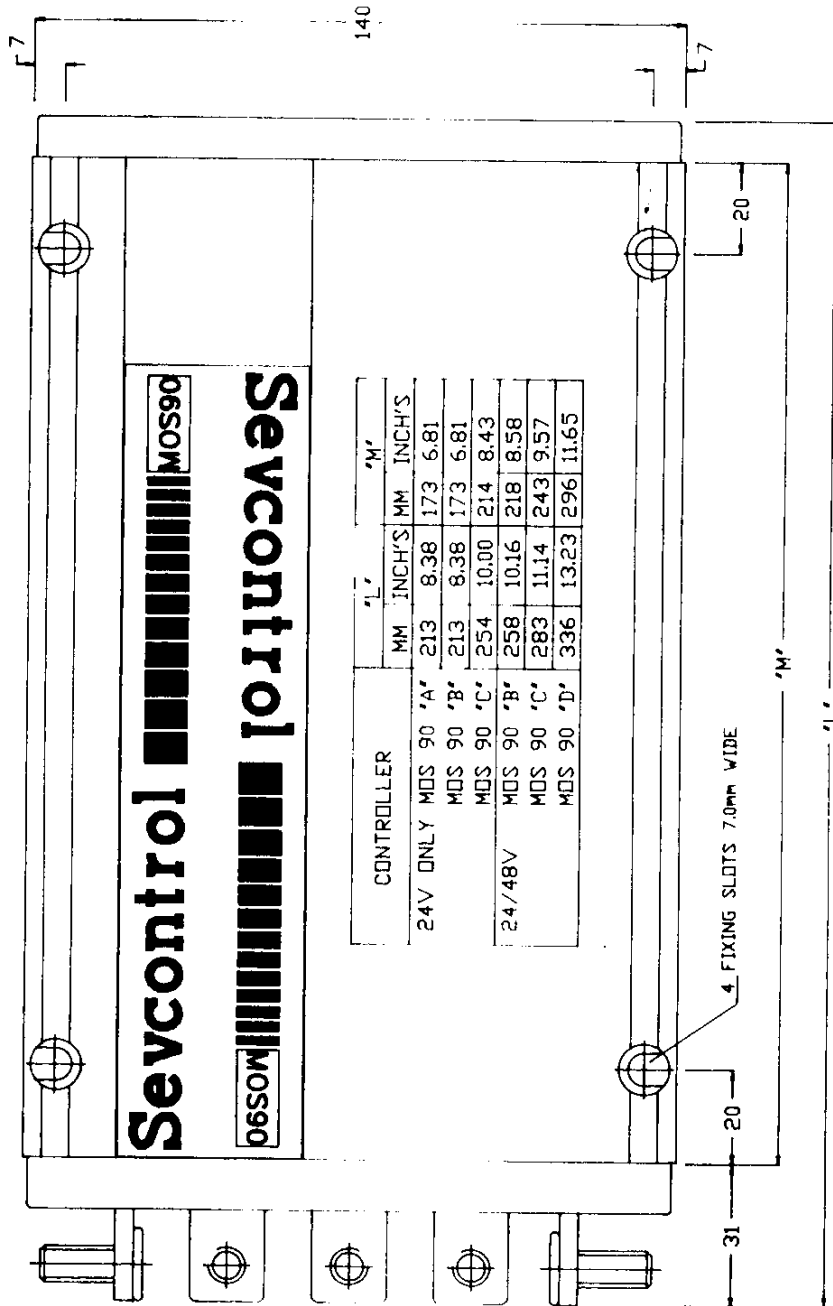
FEATURES

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.

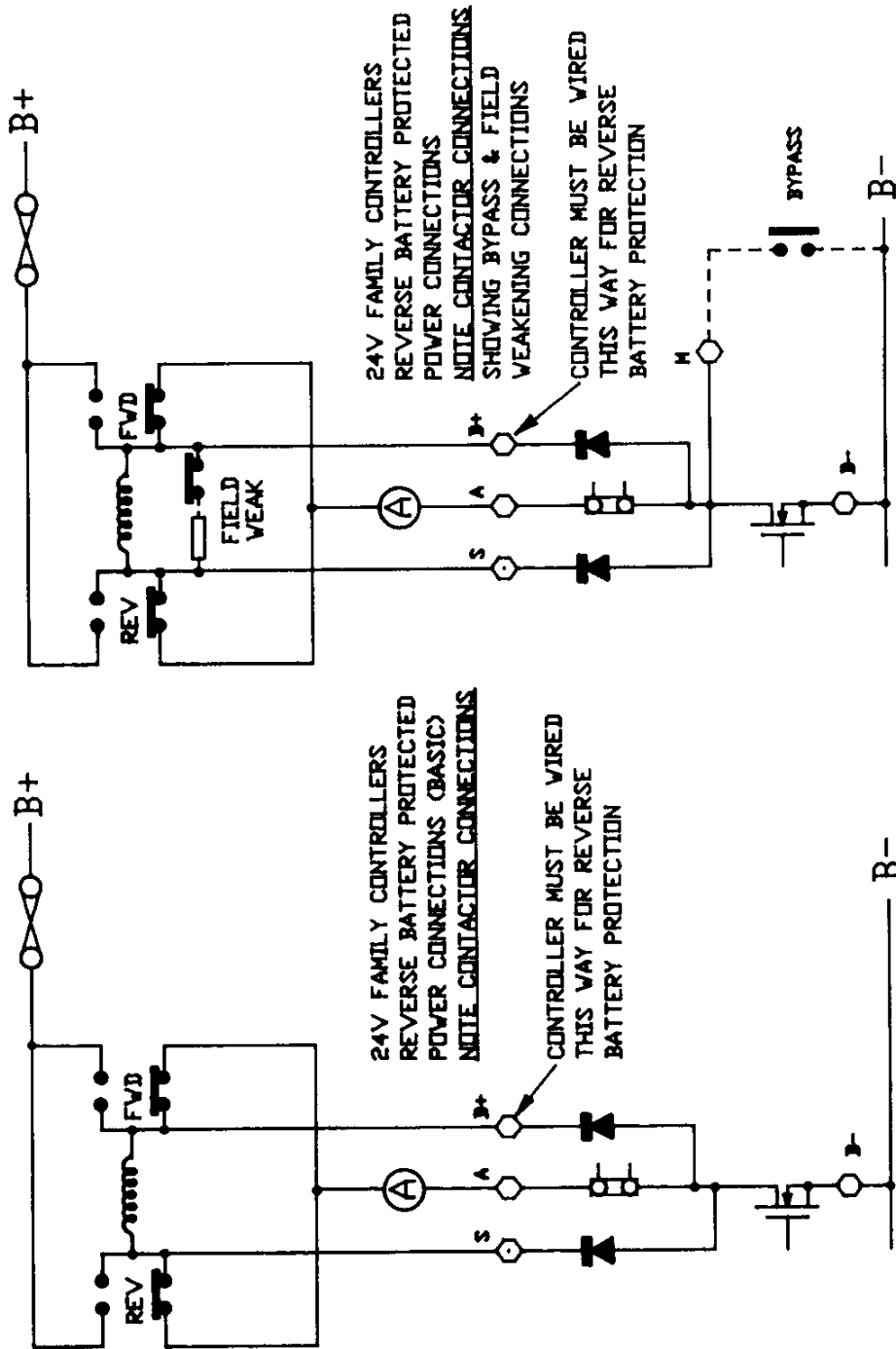| 4.14 Reverse Battery Protection: (RBP)	Provided as standard on 24v systems, requires polarity sensitive line contactor on 24v/48v systems.
4.15 Input Protection:	All customer control wiring inputs are protected against connection to B+ or B-. Calibrator adjuster socket is not protected.
4.16 Contactor 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.
	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.

INSTALLATION

5.1 The controller should be bolted down to a flat (0.2mm max. deviation) paint free surface that has been lightly coated with a thermal transfer compound, such as MS4 or Dow Corning #7, by the 4 bolt holes provided. Care should be taken not to trap any wires, etc., under the controller. The mounting surface MUST be a substantial metal section of the truck for the full controller ratings to be achieved.

5.2 Power connections should be made with flexible heat resisting cables of suitable cross-sectional area for the current to be carried. These should be terminated in soldered or crimped lugs attached to controller and the contactors. Note that nuts and washers are not supplied for the M8 connections on the controller. A battery disconnect switch should be used (EEC Directive).

5.3 Albright SW88 (MOS90 A), SW182 (MOS90 B & C) and SW202 (MOS90 D) are specified for use with the controllers when 4 terminal motors are used. The equivalent single pole N.O. contactors (SW80, 180, 200) are used for bypass and pump functions. The field weakening contactor (if used) may be of lower current rating than direction or bypass, viz:- it is possible to use an SW80 field diversion contactor with SW182 direction contactor. When alternative manufacturers contactors are used, coil currents pull in/drop out times should be investigated to ensure compatible operation.

5.4 Split field (3 terminal) motors can use single pole normally open type contactors for direction function with controllers for 24v systems, BUT, controllers for 24/48v systems require changeover contactors OR double pole normally open types (if armature field junction connection available) to utilise the Reverse Battery Protection (RBP) feature.

5.5 The contactor mounting plane can affect performance; contactors should never be mounted with their terminal studs vertically down. For further applications information on contactors, please consult SEVCON.

5.6 The controller may be supplied as a stand-alone unit, or pre-wired onto a baseplate with contactors etc. If the controller is 'stand-alone', the control wiring should be terminated at the Molex 0.15" control socket. If a 'panel' is supplied, the control wiring connector is usually an AMP 15 way MATE-N-LOK type. The harness portion of the connector can be supplied with the controller as a 'loose equipment kit'.

5.7 Control wiring connections should be made using 1.00mm^2 (AWG #) or equivalent stranded wire. The correct pressure release crimping pliers MUST be used for long term connection reliability.

5.8 The main battery cable should be fused with a suitable air-break fuse. The keyswitch line must also be fused at a level not exceeding 10 amps.

5.9 Hour meters MUST NOT have their negatives returned via the direction contactor drivers (Pins 1 & 10) as the controller will not function.

5.10 Pin 13 on control input must be connected to B-ve if not being used as speed control input.

CONTROLLER		"L"		"M"	
		MM	INCH'S	MM	INCH'S
24V ONLY	MOS 90 "A"	213	8.38	173	6.81
	MOS 90 "B"	213	8.38	173	6.81
	MOS 90 "C"	254	10.00	214	8.43
24/48V	MOS 90 "B"	258	10.16	218	8.58
	MOS 90 "C"	283	11.14	243	9.57
	MOS 90 "D"	336	13.23	296	11.65

4 FIXING SLOTS 7.0mm WIDE

Sevcontrol ▐▌▌▌▌ MOS90

ADJ SKT   CONTROL INPUT SOCKET

DIAGNOSTIC LED

M   B-   B+   S A

Rev4.11/91

MOS90 TRACTION CONTROLLER POWER WIRING DIAGRAM - 4T MOTORS

24V FAMILY CONTROLLERS REVERSE BATTERY PROTECTED POWER CONNECTIONS
NOTE CONTACTOR CONNECTIONS SHOWING BYPASS & FIELD WEAKENING CONNECTIONS

CONTROLLER MUST BE WIRED THIS WAY FOR REVERSE BATTERY PROTECTION

24V FAMILY CONTROLLERS REVERSE BATTERY PROTECTED POWER CONNECTIONS (BASIC)
NOTE CONTACTOR CONNECTIONS

CONTROLLER MUST BE WIRED THIS WAY FOR REVERSE BATTERY PROTECTION

NOTES:- 1) CONTACTOR POWER CIRCUIT CONNECTIONS ARE POLARITY SENSITIVE BECAUSE BLOW-OUT MAGNETS ARE FITTED, NOTE "+" SIGN ON CONTACTOR MOULDINGS & SEE CONTACTOR SECTION (APP.V)

Sec.6-1.1

Rev4.11/91

MOS90 TRACTION CONTROLLER POWER WIRING DIAGRAM - 4T MOTORS

THIS WIRING ARRANGEMENT WILL ALLOW THE USE OF A MOTOR WITH SOME LEAKAGE BETWEEN FIELD AND ARMATURE

THIS WIRING ARRANGEMENT WILL DETECT ANY LEAKAGE BETWEEN FIELD AND ARMATURE OF THE MOTOR AND TRIP THE FAILSAFE SYSTEM AS A RESULT. (SEE APP.II, SECTION II.4)

24/48V FAMILY CONTROLLERS
NO REVERSE BATTERY PROTECTION
NOTE CONTACTOR CONNECTIONS
SHOWING BYPASS & FIELD
WEAKENING CONNECTIONS

NOTES:- 1) CONTACTOR POWER CIRCUIT CONNECTIONS ARE POLARITY SENSITIVE BECAUSE BLOW-OUT MAGNETS ARE FITTED. NOTE '+' SIGN ON CONTACTOR MOULDINGS & SEE CONTACTOR SECTION (APP.V)

B+

B+

B−

B−

BYPASS

BYPASS

FVD

FVD

FIELD WEAK

FIELD WEAK

REV

REV

B+

A

S

M

Rev4.11/91

Sec.6-1.2

B+

24/48V FAMILY CONTROLLERS POWER WIRING WITH OPTIONS TO GIVE REVERSE BATTERY PROTECTION WHEN USED WITH D.P. N/O CONTACTOR

FWD

REV

BYPASS

B−

B+

24/48V FAMILY CONTROLLERS NOT REVERSE BATTERY PROTECTED POWER CONNECTIONS WITH BYPASS IF USED

NOTE CONTACTOR CONNECTIONS

FWD

REV

BYPASS

B−

B+

24V FAMILY CONTROLLERS REVERSE BATTERY PROTECTED POWER CONNECTIONS SHOWING BYPASS IF USED

FWD
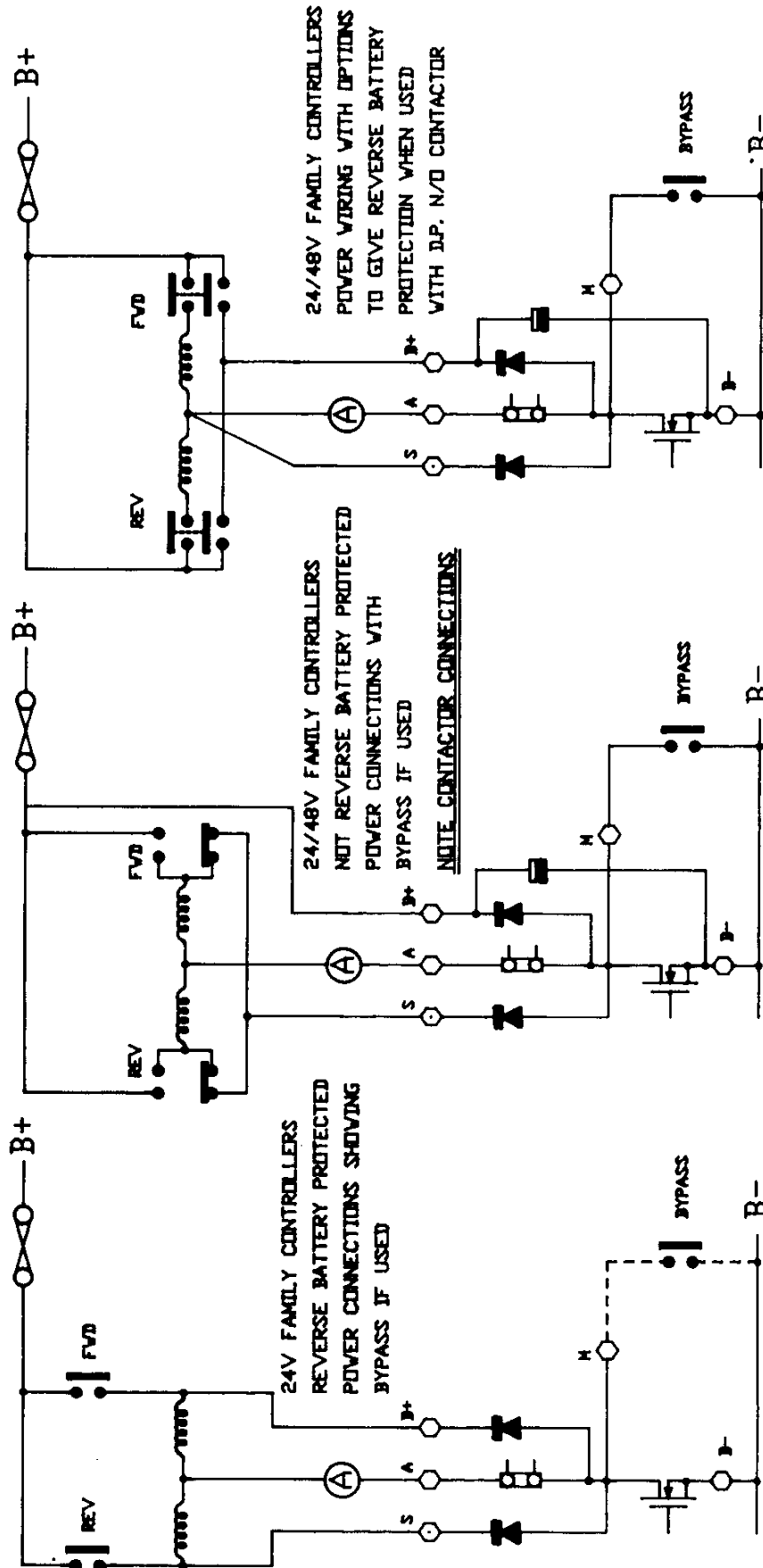
REV

BYPASS

B−

NOTES:— 1) CONTACTOR POWER CIRCUIT CONNECTIONS ARE POLARITY SENSITIVE BECAUSE BLOW-OUT MAGNETS ARE FITTED. NOTE "+" SIGN ON CONTACTOR MOULDINGS & SEE CONTACTOR SECTION (APP.V)

Rev4.11/91

BASIC CONTROL WIRING SUITABLE FOR RIDE ON TRUCK
INTERLOCK SWITCHES (FSL HANDBRAKE etc.) SHOULD
BE CONNECTED IN SERIES AT "X-X".
VALUE OF SPEED CONTROL VARIABLE RESISTOR MUST
BE 5K, MAX RESISTANCE GIVES MIN SPEED.
△ CONNECT PIN 2 TO B+ FOR 36 AND 48 VOLT
CONTACTOR COILS. LEAVE UNCONNECTED FOR 24V COILS
(COIL CHOPPING)

OPTIONS CONTROL WIRING SUITABLE FOR RIDE ON TRUCK
WITH SRO & SEAT SWITCH WIRING.
EITHER BYPASS AND/OR FIELD WEAKENING MAY BE CONNECTED
■ WIRING REMAINS THE SAME IF THE FIELD DIVERSION
CONTACTOR IS SOFTWARE ALLOCATED TO POWER STEER
△ CONNECT PIN 2 TO B+ FOR 36 AND 48 VOLT
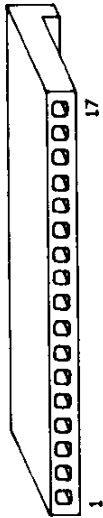CONTACTOR COILS. LEAVE UNCONNECTED FOR 24V COILS
(COIL CHOPPING)

OPTIONS CONTROL WIRING PLUS BELLY SWITCH
OR EMERGENCY SWITCH SUITABLE FOR WALKIE TRUCK
DIODE IS 3A 200V TYPE.
NOTE:- THAT SWITCHES MUST NOT BE CONNECTED
IN LINE BETWEEN THE KEY & DIRECTION SWITCHES
(eg FSL SEAT SWITCH OR THE EMERGENCY BUTTON
WILL NOT FUNCTION.
△ CONNECT PIN 2 TO B+ FOR 36 AND 48 VOLT
CONTACTOR COILS. LEAVE UNCONNECTED FOR 24V COILS
(COIL CHOPPING)

NOTES:-
1. PIN 16 MUST BE CONNECTED TO B+VE IF A SEAT SWITCH IS NOT USED.
2. DISCONNECT PINS 9 & 12 IF SRO IS NOT REQUIRED.

Pin labels (each diagram):
1 COIL IN 0000
2 CONT CHOP INPUT
3 △
5 REV INPUT
6 B+ INPUT
8 FVD INPUT
9 SPD
10 COIL IN 0000
11 FSL SV
13 ACCELERATOR
15 BYPASS 0000
16 SEAT SV / EMG SV INPUT
17 FIELD DIV 0000 (OR POWER STEER)

REV, FVD, SPEED, 5K, KEY, FUSE, B+, START SV, KEY FUSE, EMERGENCY BELLY BUTTON

Rev4.11/91
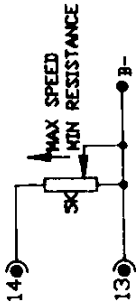
SOCKET HOUSING (VIEWED FROM HARNESS SIDE)

17

1

MOSFET CONTROLLER - CONTROL WIRING PIN OUTS

1. REVERSE CONTACTOR COIL DRIVE.

2. CONTACTOR CHOPPING OPTION - CONNECT TO B+ WHEN USING 36 AND 48 VOLT COILS. LEAVE UNCONNECTED FOR 24 VOLT COILS.

3. 10 VOLT SUPPLY (HANDSET/LCD MODULES)

4. SPEED LIMIT 1 - CONNECT TO B+ FOR NORMAL OPERATION. LEAVE UNCONNECTED FOR SPEED LIMITING

5. REVERSE INPUT FROM DIRECTION SWITCH.

6. BATTERY + FEED FROM KEYSWITCH.

7. SPEED LIMIT 2 - CONNECT TO B+ FOR NORMAL OPERATION. LEAVE UNCONNECTED FOR SPEED LIMITING

8. FORWARD INPUT FROM DIRECTION SWITCH.

9. SUPPLY FOR CENTER-TAPPED POT OR S.R.O. SUPPLY.

10. FORWARD CONTACTOR COIL DRIVE.

11. SPARE INPUT.

12. FS1 INPUT FOR S.R.O.

13. SEVCON ACCELERATOR INPUT (0V-5V MAX SPEED). (CONNECT TO B-VE IF NOT USED)

14. 5K POT ACCELERATOR INPUT (3.5V-0V MAX SPEED)

15. BYPASS/POWER STEER CONTACTOR COIL.

16. BELLY/SEAT SWITCH INPUT.
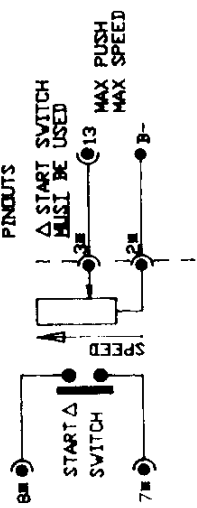
17. FIELD/DIVERSION/POWER STEER CONTACTOR COIL.

MAX SPEED
MIN RESISTANCE
5K
14
B-
13
STANDARD 5K POT OR VARIABLE RESISTOR

(LINEAR FOOTPEDAL PINOUTS

MAX PUSH
MAX SPEED
△ START SWITCH MUST BE USED
13
3■
B-
2■
SPEED
START △ SWITCH
8■
7■

LINEAR FOOTPEDAL 656/12012

9 ■
13
B-
TRACK RESISTANCE
500R MIN
10K MAX
SPEED
MAX SPEED
MAX D/P VOLTS
B-
9 ■
13
SPEED

1K+1K CT POT   POTS OTHER THAN 5K

■ IF THE SRO FUNCTION IS BEING USED THEN PIN 9 IS NOT AVAILABLE FOR USE AS AN ACCELERATOR SUPPLY. IN THIS CASE CONNECT THE POSITIVE END OF THE ACCELERATOR POT TO PIN 3 VIA A 470 OHM 1/2 WATT RESISTOR.

START SW   FUSE
B+
KEY
R
DIR/ (FSD)
F
NORM CLOSED
NORM CLOSED
FWD
SPEED
5K
B-

REV
COIL IN
CONT CHOP INPUT
△
SPEED LIMIT 1 INPUT
REV INPUT
B+ INPUT
SPEED LIMIT 2 INPUT
FWD INPUT
COIL IN
ACCELERATOR

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

BASIC CONTROL WIRING WITH SPEED LIMIT SUITABLE FOR WALKIE OR RIDE-ON TRUCKS. BYPASS & FIELD WEAKENING (IF FITTED) ARE INHIBITED WHEN IN SPEED LIMIT.

NOTE:- THAT FS1 OR SIMILAR SWITCHES MUST NOT BE USED WHEN A BELLY SWITCH IS FITTED

△ CONNECT PIN (2) TO B+ FOR 36 AND 48 VOLT CONTACTOR COILS. LEAVE UNCONNECTED FOR 24V COILS (COIL CHOPPING)
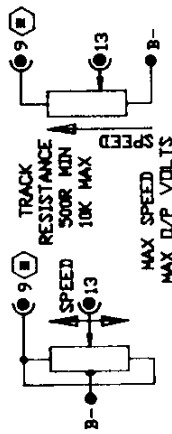
ADJUSTMENTS

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.

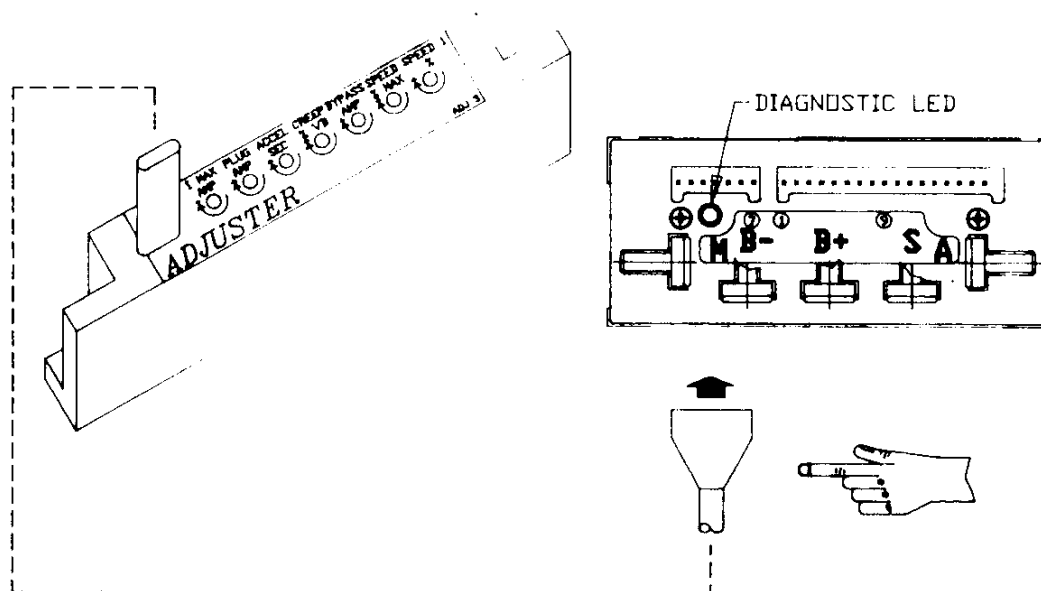Additional external instrumentation is not required when using the calibrator's measurement feature.
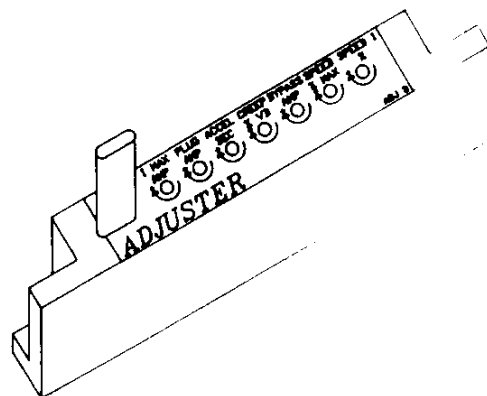
SEVCON MOS90 POTENTIOMETER
MODULE (ADJUSTER) AND CALIBRATOR
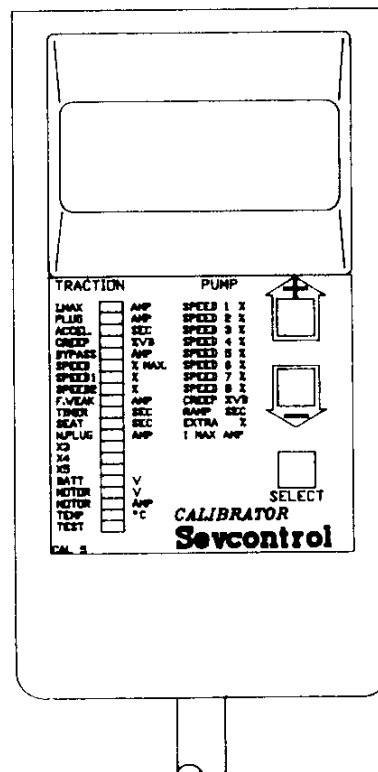
Rev4.11/91

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.

Sec.8-2

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.
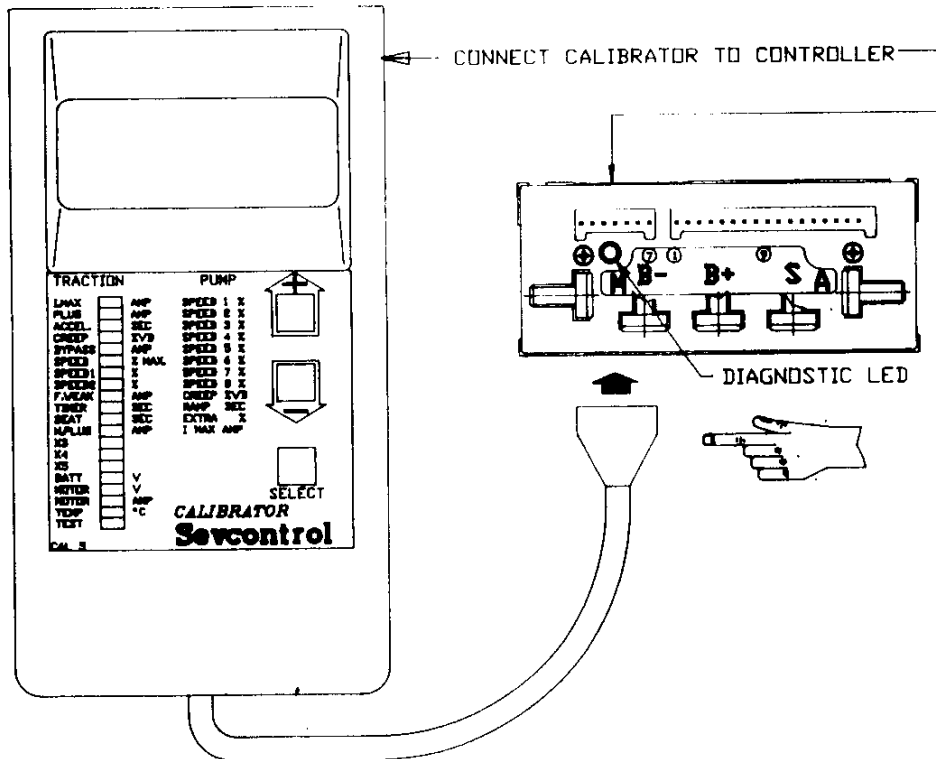
CONNECTION OF CALIBRATOR TO CONTROLLER

Rev4.11/91

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.

① CONNECT CALIBRATOR TO CONTROLLER

② POWER UP TRUCK

USE OF CALIBRATOR

④ ADJUST TO NEW VALUE

③ SELECT NEW PARAMETER

Rev4.11/91
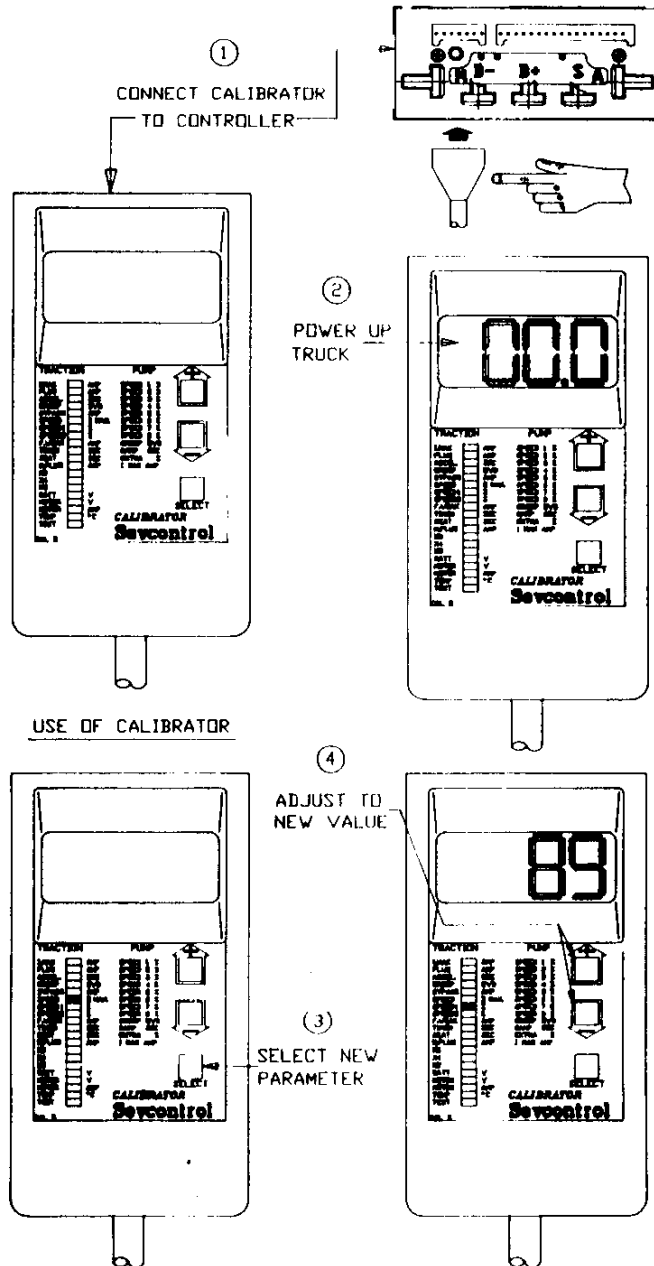
SETTING PARAMETERS WITH CALIBRATOR

DIAGNOSTICS

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

```
                ADJ SKT        CONTROL WIRING SKT

           ⊕  ◯  ⑦ ①              ⑨
           M  B-      B+        S  A

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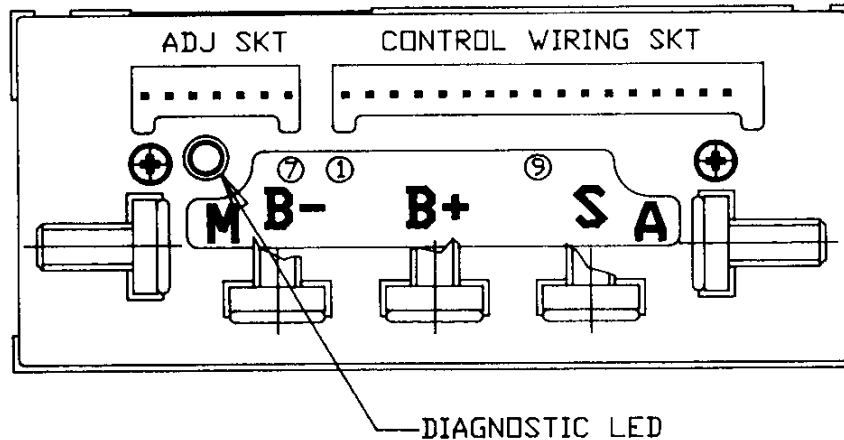
9.2 On power up the LED will be illuminated if the system is functioning correctly.

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. Both forward and reverse selected.
9.4.2	3 flashes	Bypass contactor welded - recycle through neutral to clear. 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.

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.

LINK SIZE 16 X 4mm
(ALL LINKS)

4 FIXING SLOTS 7.5mm WIDE

13mm
10mm

CONTROL INPUT SOCKET

DIAGNOSTIC LED

ADJ SKT

S
A
B+
B-
M

63mm

31mm

140

50

50

31

CONTROLLER						
		MM	INCH'S	MM	INCH'S	
24/48V	MOS 90 'A'	852	283	1016	818	852
	MOS 90 'C'	283	1114	243	9.57	
	MOS 90 'D'	336	1323	968	1143	

Sevcontrol MOS90

B+

PUMP CONTACTOR
(IF FITTED)

S

A

B-

B-

Sec.10-2

SOCKET HOUSING (VIEWED FROM HARNESS SIDE)

1   17

1 — PUMP INHIBIT — 10A MAX CONTROL FUSE — KEY SWITCH — B+

2 — NORMALLY CLOSED — SV8

3 — 10V SUPPLY

4 — SV4

5 — SV2

6 — BATT+(VIA KEY SW)

7 — SV5

8 — SV1

9 — ACCELERATOR SUPPLY

10 — NC

11 — SV7

12 — SV3

13 — CONNECT TO B- IF NOT USED FOR ACCELERATOR

14

15 — NC

16 — SV6

17 — NC

0-5V OPTION LINEAR ACCELERATOR

PUMP CONTACTOR COIL (IF FITTED)

(MUST BE RATED FOR CONTINUOUS OPERATION)

REVERSE BATTERY PROTECTION DIODE (IF USED)

(3A/200V WHEN USING ALBRIGHT CONTACTORS)

5K

(IF FITTED, OPERATED WITH SV1) — B-

Rev4.11/91

APPENDIX I

CALIBRATOR MEASUREMENT DISPLAY

I.1   Selection of the last five segments on the display gives the following results:-

    I.1.1   BATT   This displays the battery voltage.

    I.1.2   MOTOR V.   This displays motor voltage and can be used to set speed limit.

    I.1.3   MOTOR AMP.   This displays motor current as the truck is being driven.

    I.1.4   TEMP   This displays the temperature of the MOSFET heatsink in °C.

    I.1.5   TEST   This invokes the diagnostic test routines to check truck switches, accelerator, harnesses etc.

I.2   The BATTERY VOLTAGE test allows the state of battery voltage to be continuously monitored during drive. This test assists in the diagnosis of battery faults. Max voltage is recorded by service log.

I.3   If MOTOR VOLTAGE is monitored during driving at a particular speed and loading, it can be related to a percentage of battery voltage and used to set speed cutback.

I.4   Use of the MOTOR AMP test will reveal if the motor is running at max. current up gradients etc. This test will aid setting current limit to optimise battery life.

I.5   The TEMP test can be used during prolonged running of the truck to check that no high temperature conditions exist, due to poor heatsinking or under-specification. Min/max temperatures are recorded by the service log.

I.6   TEST displays are explained on page I-2.

HOURS COUNT AND SERVICE LOG

PARAMETER LOGGING

The following data will be logged:-

1.   Max battery voltage.

2.   Max heatsink temperature.

3.   Min heatsink temperature.

This data is displayed by selecting the measurement section on the calibrator (either BATT or TEMP) and then using the ' + ' and '-' buttons to display the maximum and minimum excursions.

E.g., select battery voltage on the calibrator and press the ' + ' button to display the maximum battery voltage the controller has ever measured.

HOURS COUNTER

The counter records pulsing hours, and displays the count when the calibrator is first plugged in (with no LED segment lit). Once the select button is pressed, the calibrator reverts to its normal operation, i.e. stepping on to displaying the present current limit setting.

Initially a minute/second count is displayed. By pressing the '-' button, hours are displayed and by pressing the ' + ' button 1,000s of hours are displayed.

E.g., a count of 11,436 hours 27 minutes and 20 seconds would be:-

1.   Initial display would be 27.2 indicating 27 mins, 20 secs.

2.   Hold down '-' button to display hours, i.e. 436.

3.   Hold down ' + ' button to display 1,000 hours, i.e. 11.

Releasing the buttons reverts back to the minute and 10's of second display. The decimal point 'blinks' every second during drive. The counter will record up to 65,500 hours before rolling over to 0.

CALIBRATOR   DIAGNOSTICS

I.7 With the calibrator connected to the controller and the truck powered up, use the SELECT button to select the TEST LED. If the SELECT button is pressed at any time during the tests, they will be terminated and the minutes/seconds count will be displayed.

*** SAFETY! ***

WHEN TEST IS SELECTED, THE TRUCK CAN STILL OPERATE!

I.8 The first test selected is the accelerator test. This displays acceleration output as 0-100% as the accelerator is moved from min. to max.

I.9 The + and - buttons step through the tests as shown on the following page.

I.10 After test 10, the sequence will loop back to the accelerator test, then test 1.

Sequence No	Traction	Test Pump	Display	Customer Connector Pin
-	Accelerator	Speed Pot.	0-100%	13 or 14
1	Fwd. Switch	SW1	CL/OP	8
2	Rev. Switch	SW2	CL/OP	5
3	FS1 Switch	SW3	CL/OP	12
4	Speed 1 Switch	SW4	CL/OP	4
5	Speed 2 Switch	SW5	CL/OP	7
6	Belly/Seat Switch	SW6	CL/OP	16
7	Spare I/P, pin 11	SW7	CL/OP	11
8	Chop. Select	SW8	CL/OP	2
9	-	-	CL/OP	
10	-	Inhibit	CL/OP	1

NOTE:

CL = Switch input at B + ve
OP = Switch input at B-ve or disconnected

ACCELERATOR TEST	FORWARD SWITCH	FOOTSWITCH 1
AT 85% PUSH	(1) - CLOSED	(3) - OPEN
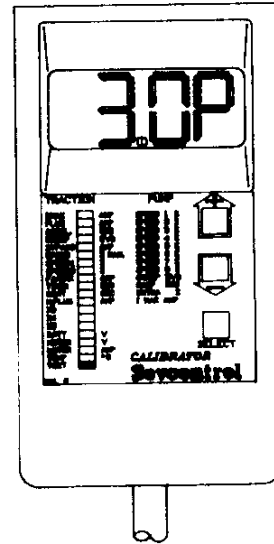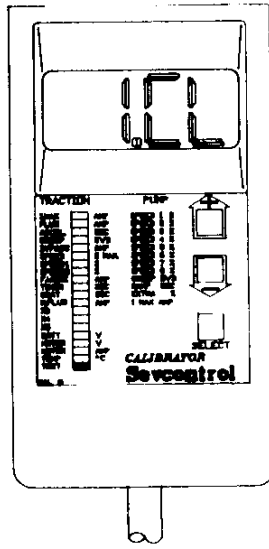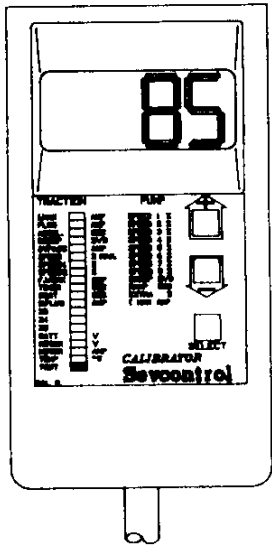
APPENDIX II

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

| Check for correct start up sequence | ┄┄┄→ | Retry |

↓

| Check that both directions are not selected | ┄┄┄→ | Select only 1 direction |

↓

| Check for S.R.O. operation | ┄┄┄→ | Select direction before FS1 OR direction or FS1 before keyswitch |

↓

| If feature specified - check seat switch is closed | ┄┄┄→ | Close seat switch or wire to B+ if not used |

↓

| If feature specified - check belly switch is not permanently closed | ┄┄┄→ | Open belly switch |

↓

| Use calibrator 'test' mode and check FS1/fwd/rev/seat or belly switch inputs and wiring |

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

II.3   3 FLASHES   -   Bypass contactor welded/hardware failsafe trip.
      (TRACTION   -   Point 'A' <7v in neutral, or <7v for 15mS in drive, or contactor coil short circuit.
      & PUMP)   -   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).

| Check bypass contactor (traction only) | ----> | Free/change tips |

↓

| Check power and control wiring for shorts | ----> | Rectify |

↓

| Replace controller |
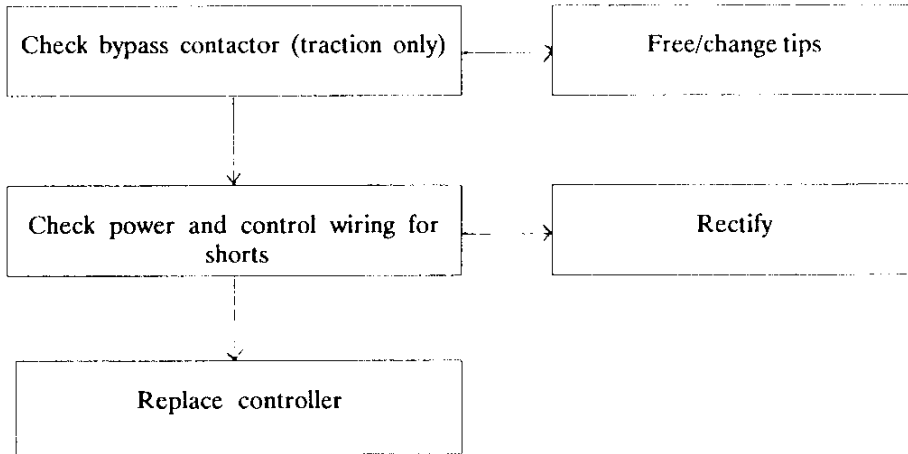
II.4   4 FLASHES   -   Direction contactor welded. (Point 'A' within 6V of B + ve in neutral).
      (TRACTION   -   Leakage between motor armature and field.
      ONLY)   -   Drive inhibited.
                -   Flashes in neutral until fault is cleared.

| Check direction contactor tips | ----> | Free/change tips |

↓

| Check power wiring for shorts | ----> | Rectify |

↓

| Check motor for armature to field shorts or leakage | ----> | Rectify |

↓

| Check for shorts to frame and battery leakage | ----> | Rectify |

↓

| Replace controller |
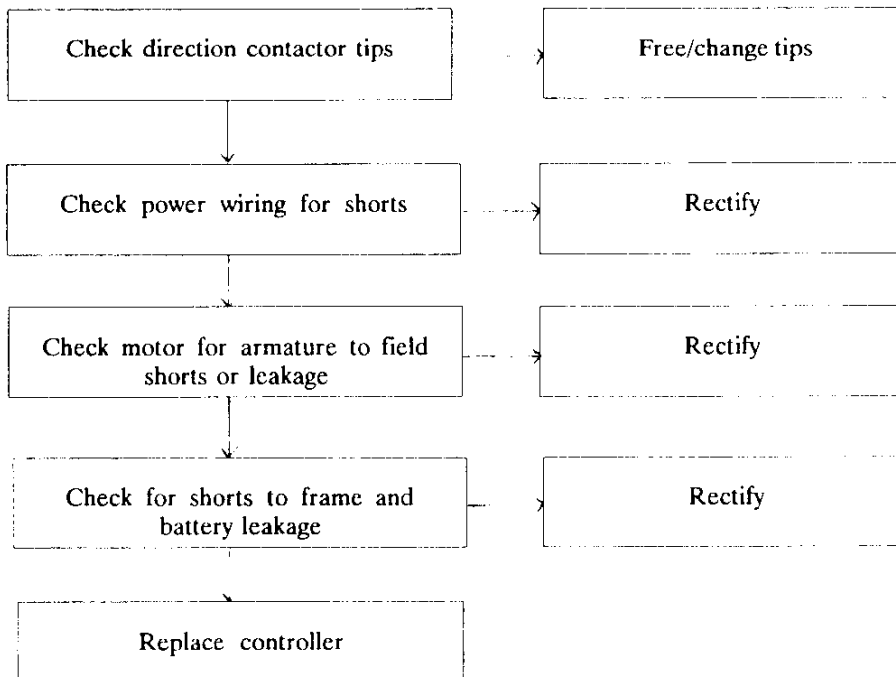
II.5   5 FLASHES   -   Direction contactors (or line contactor) did not close.
        (TRACTION   -   Motor armature or field open circuit.
        & PUMP)   -   Point 'A' not within 6V of B + ve within 1 second of selecting direction.
                     -    Drive inhibited.
                          Flashes until fault is cleared, when contactor closes.

```
┌─────────────────────────────┐            ┌─────────────────────────────┐
│  Check contactor tips (if fitted on │ ──── ┐   │       Repair/replace        │
│         pump system)        │         └─> │                             │
└─────────────────────────────┘            └─────────────────────────────┘
                │
                ↓
┌─────────────────────────────┐            ┌─────────────────────────────┐
│  Check contactor for mechanical │            │       Repair/replace        │
│  operation and coil O.K. (if fitted on │ ── ──> │                             │
│         pump system)        │            │                             │
└─────────────────────────────┘            └─────────────────────────────┘
                │
                ↓
┌─────────────────────────────┐            ┌─────────────────────────────┐
│   Check power & control wiring │ ──── ──> │           Rectify           │
└─────────────────────────────┘            └─────────────────────────────┘
                │
                ↓
┌─────────────────────────────┐            ┌─────────────────────────────┐
│   Check for open circuit motor │ ── ──> │           Rectify           │
└─────────────────────────────┘            └─────────────────────────────┘
                │
                ↓
┌─────────────────────────────┐
│      Replace controller     │
└─────────────────────────────┘
```
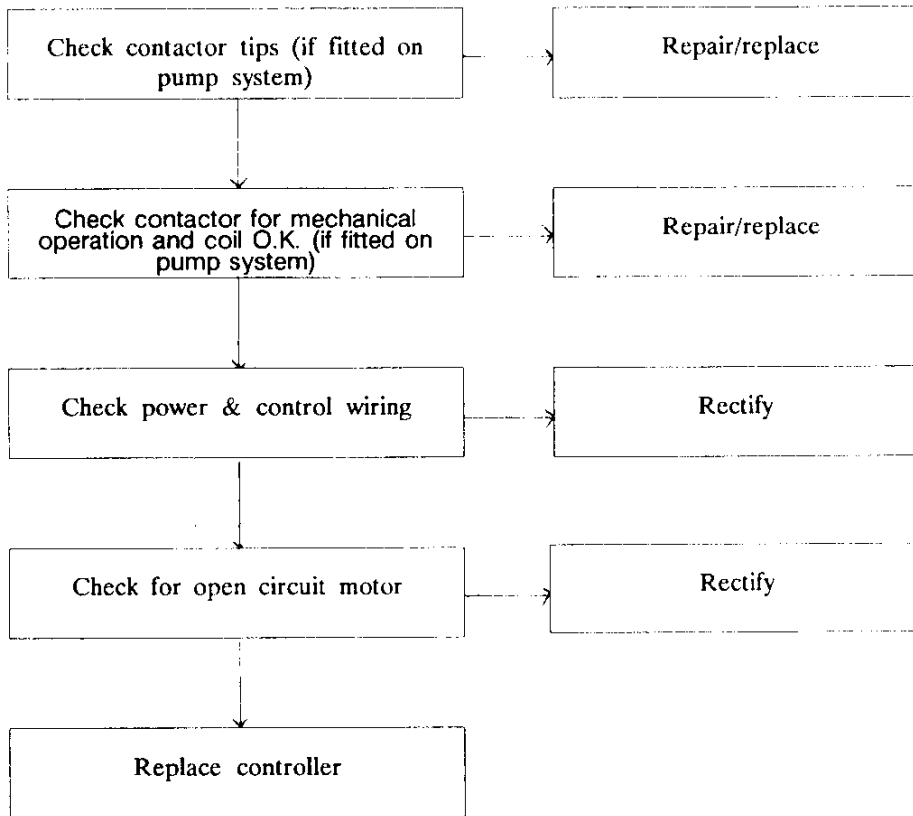
II.6   6 FLASHES   -   Accelerator faults.
         (TRACTION   -   3V5-0V input:-   Voltage < 2V5 on power up
         ONLY)   Voltage > 4V5 in drive
                      -    0-5V input:-   Voltage > 1V on power up
                      -    Controller pulses at creep setting.
                      -    Flashes until fault cleared.

```
┌─────────────────────────────┐        ┌─────────────────────────────┐
│ Check operation of accelerator with │ - - - -> │      Rectify/replace        │
│        Test Sequence        │        │                             │
└─────────────────────────────┘        └─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐        ┌─────────────────────────────┐
│ Check pot operation with voltmeter │ - - -> │ Adjust as necessary or replace │
│  for voltage at minimum setting │        │                             │
└─────────────────────────────┘        └─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│     Replace controller      │
│                             │
└─────────────────────────────┘
```
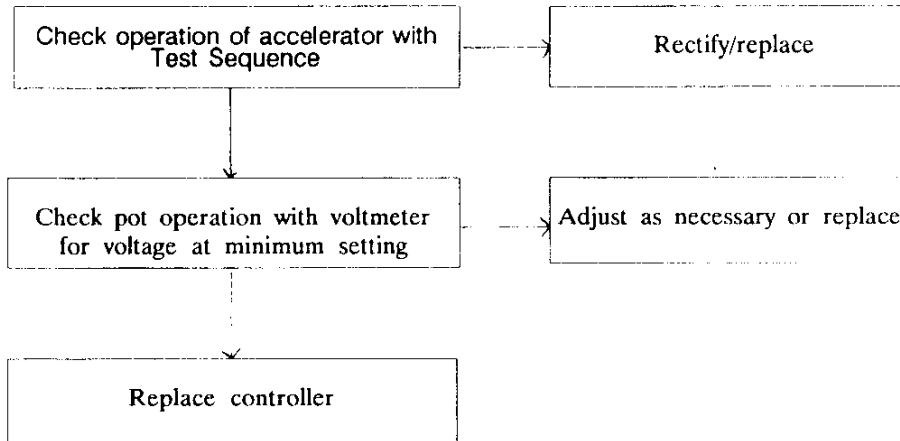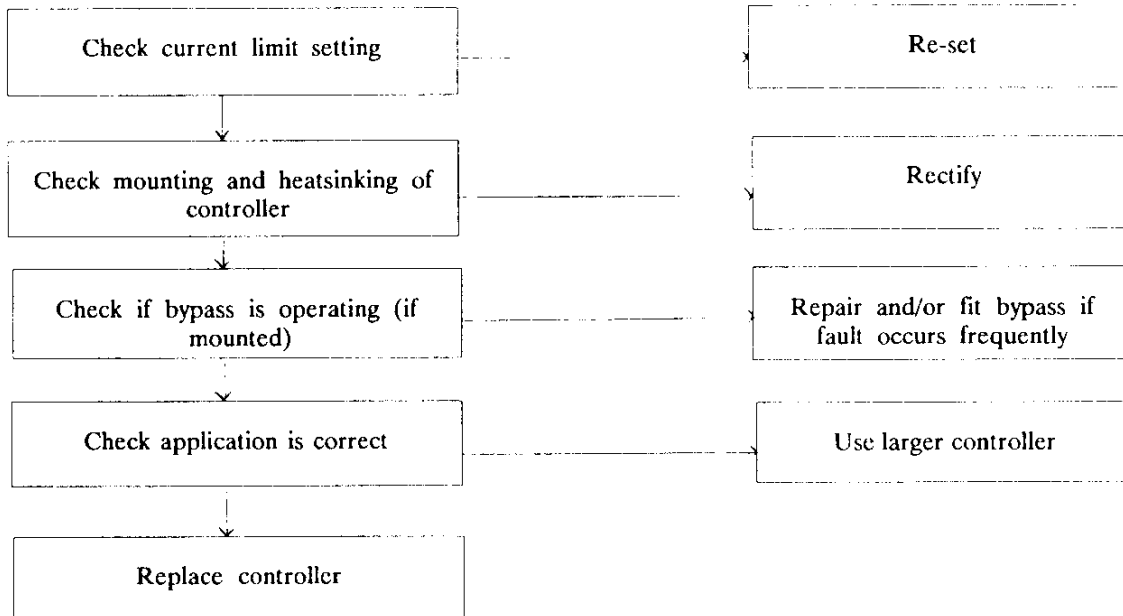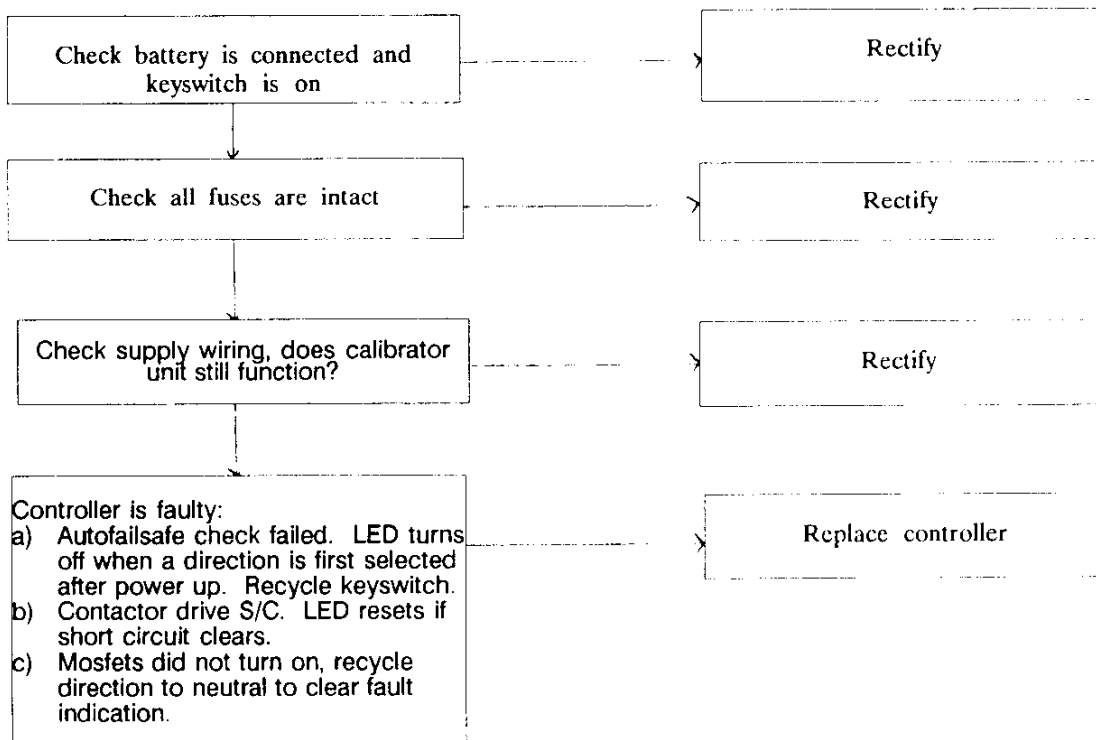
II.7   7 FLASHES   -   Battery voltage < 13V
         (PUMP &   -   Drive inhibited
         TRACTION)   -   Recycle to neutral to clear flash

```
┌─────────────────────────────┐        ┌─────────────────────────────┐
│ Check battery voltage with voltmeter │ - - - -> │   Change/charge battery     │
└─────────────────────────────┘        └─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐        ┌─────────────────────────────┐
│ Check power connections, fuses etc. │ - - -> │      Repair/replace         │
└─────────────────────────────┘        └─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐        ┌─────────────────────────────┐
│ Check for battery leakage to frame │ - - -> │         Rectify             │
└─────────────────────────────┘        └─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│     Replace controller      │
└─────────────────────────────┘
```
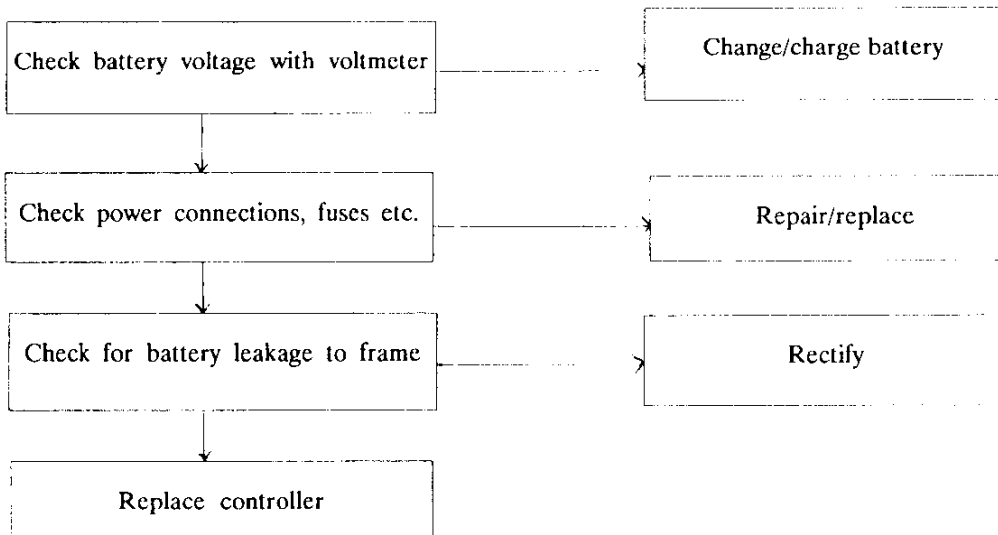
II.8   8 FLASHES   -   Thermal cutback
           (TRACTION   -   Heatsink temperature > 80°C (Current limit will be zero at 90°C)
           & PUMP)   -   Allow unit to cool down, to clear flashing

Check current limit setting	Re-set
Check mounting and heatsinking of controller	Rectify
Check if bypass is operating (if mounted)	Repair and/or fit bypass if fault occurs frequently
Check application is correct	Use larger controller
Replace controller	

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

Check battery is connected and keyswitch is on	Rectify
Check all fuses are intact	Rectify
Check supply wiring, does calibrator unit still function?	Rectify
Controller is faulty: a) Autofailsafe check failed. LED turns off when a direction is first selected after power up. Recycle keyswitch. b) Contactor drive S/C. LED resets if short circuit clears. c) Mosfets did not turn on, recycle direction to neutral to clear fault indication.	Replace controller

APPENDIX III

SAFETY BUTTON (BELLY SWITCH) - METHOD OF OPERATION

TRUCK MOVING IN REVERSE AND ACTIVATING THE BELLY SWITCH

III.1 Condition | Result

III.1.1 The accelerator in reverse position

a) The contactors change direction to forward drive (this initiates plug braking).

b) 150% maximum plugging is applied maximum of 1.5 seconds; it will then revert back to maximum plugging.

c) The vehicle will accelerate at full speed along the standard accelerator curve.

d) All drive will cease 1.5 seconds from the start of (c) above.

e) The controller will wait for neutral to be selected before drive will operate. If belly switch pressed again however, action as at (c) above.

III.1.2 In neutral   Same as above.

III.1.3 Accelerator in forward position

Already in plugging cycle.
Action as at start of (c) above.

TRUCK MOVING FORWARD AND ACTIVATING THE BELLY SWITCH

III.2 Condition | Result

III.2.1 Accelerator in forward position   No effect.

III.2.2 Accelerator in reverse position   When belly switch closed, truck drives forward as at start of (c) above.
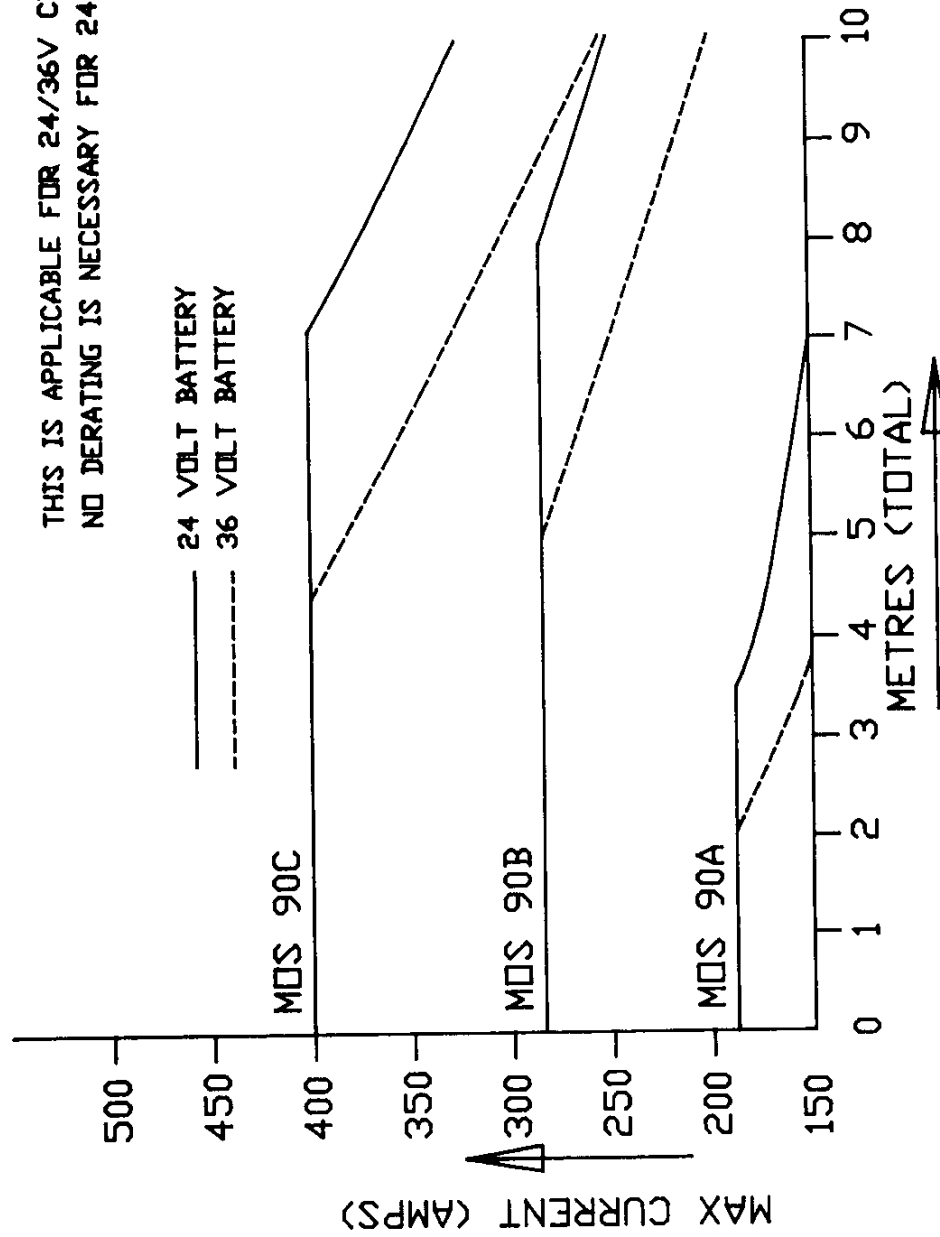
APPENDIX IV
MOS90 RANGE APPLICATIONS

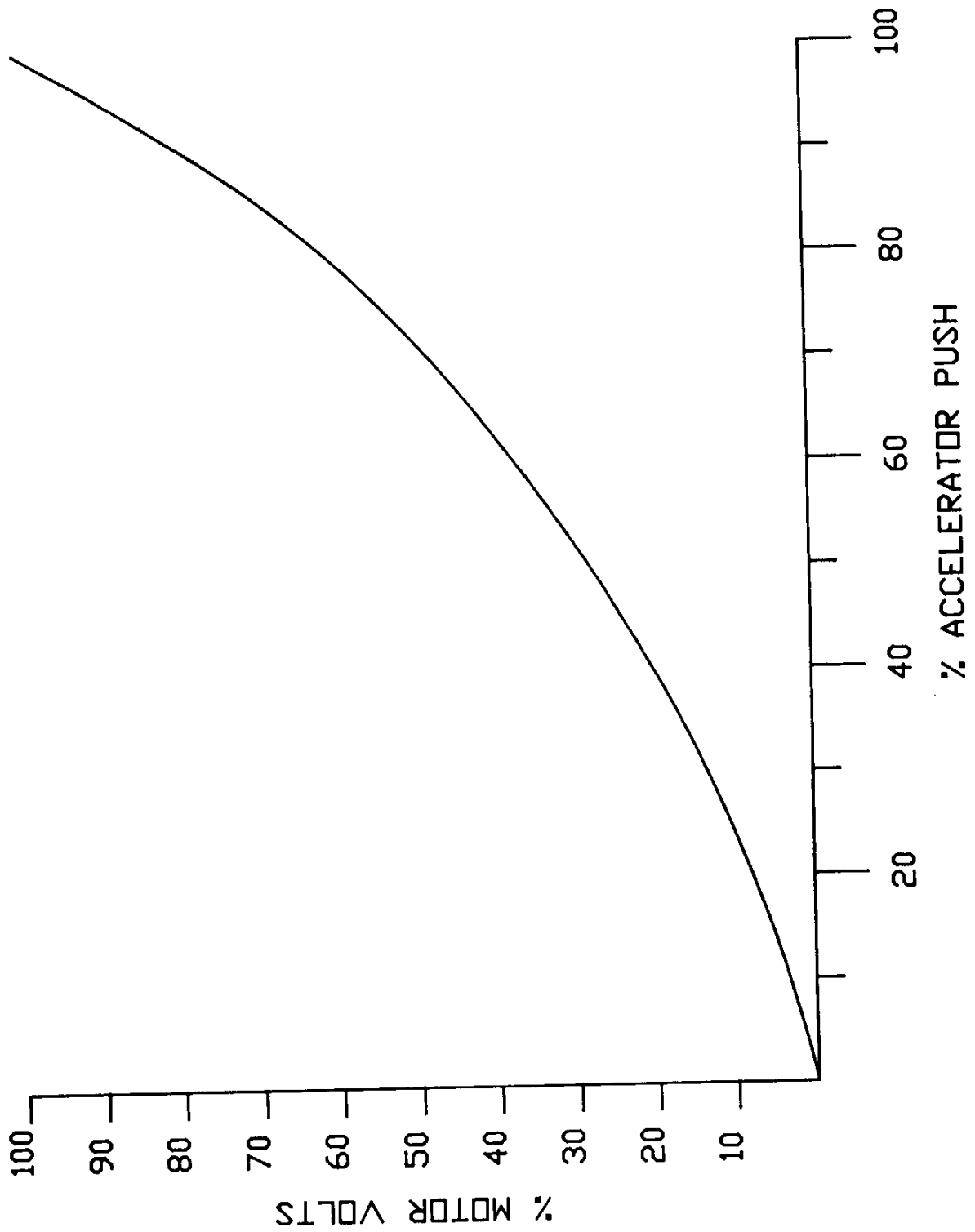## HOW TO CHOOSE THE CORRECT CONTROLLER
FOR YOUR APPLICATION

THIS GRAPH ASSUMES
MOTOR EFFICIENCY OF 85%
AND ADEQUATE COOLING TO
VECHICLE CHASSIS.

✳ ONLY AVAILABLE IN 24/48V VERSIONS

▲ ONLY AVAILABLE IN 24/36V VERSIONS

MOTOR POWER KW

	12	24	36	48
				D (8)
			D (6)	C (6)
			C (4.5)	
		D ✳ (4)	B (3)	B (2.7)
		C (3)		
		B (2.2)		
			A ▲ (1)	
		A (1)		

BATTERY VOLTAGE →
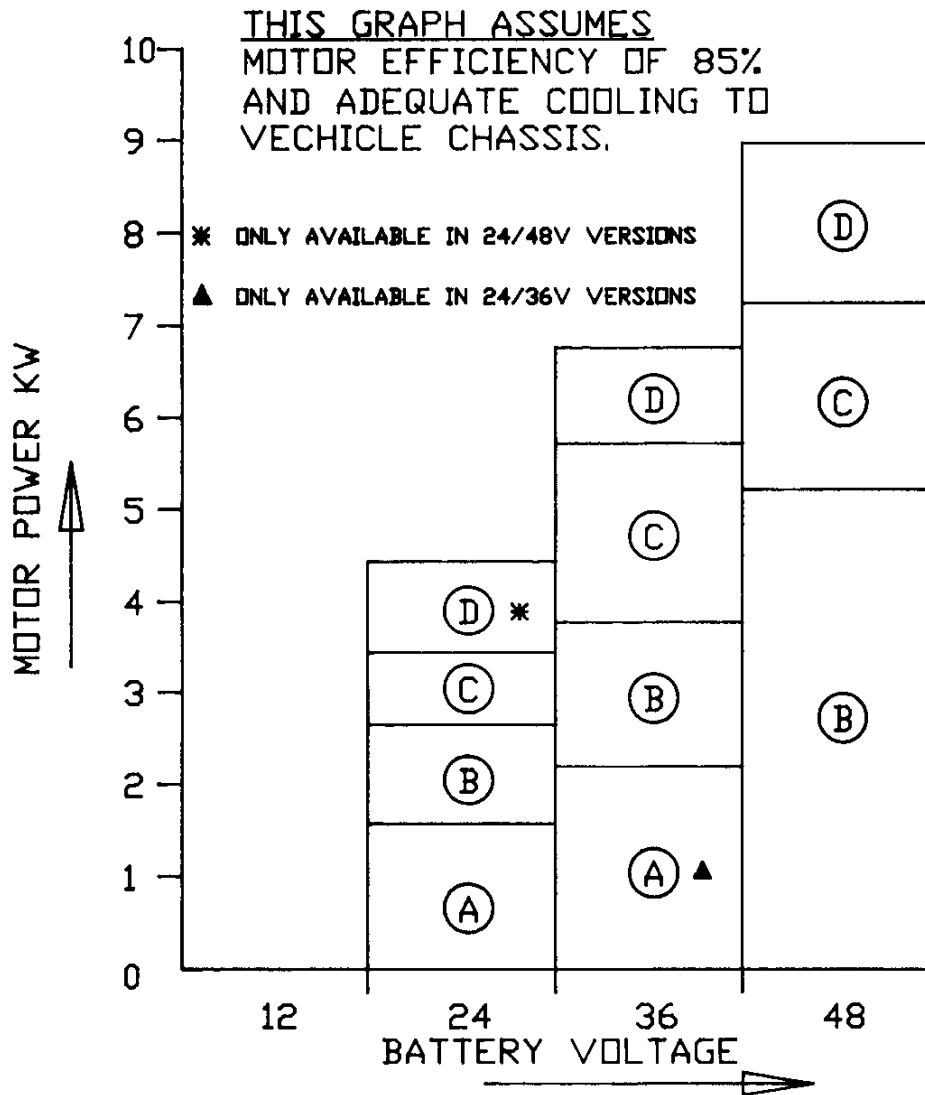
MOS90 RATINGS - BATTERY LEAD LENGTHS

THIS IS APPLICABLE FOR 24/36V CONTROLLERS
NO DERATING IS NECESSARY FOR 24/48V CONTROLLERS.

24 VOLT BATTERY
36 VOLT BATTERY

MOS 90C

MOS 90B

MOS 90A

MAX CURRENT (AMPS)

500 450 400 350 300 250 200 150

METRES (TOTAL)

0 1 2 3 4 5 6 7 8 9 10

MOS90   ACCELERATOR   RESPONSE

X-axis: % ACCELERATOR PUSH (20, 40, 60, 80, 100)

Y-axis: % MOTOR VOLTS (10, 20, 30, 40, 50, 60, 70, 80, 90, 100)

App.IV-3

APPENDIX V

CONTACTORS AND FUSES

V.1   The MOS 90 series of controllers are designed to cover virtually the full spectrum of electric vehicles. The contactors used with these controllers can have various different ratings. Sevcon recommend and fit Albright contactors, the optional fuse/contactor plate available with the MOS 90 being drilled to accept Albright contactor fixing centers.

V.2   The table on the following page details the recommended types of contactor that are used on the MOS units, depending upon amperage and type of motor.

V.3   Exploded views of contactors are given on the following page to aid repair. Note that contacts are normally only available in sets and MUST NEVER be filed.

V.4   The contact stud securing nuts must not be overtightened.

V.6   Contactors whose coils are driven from the controller, should not be fitted with suppression diodes. All other contactors and electromagnetic devices must be suppressed.

V.7   Three basic types of contactor are used with the MOS 90 system.

   V.7.1   Single Pole Normally Open contactors.

             These contactors are normally used for Bypass, Field Weakening, Pump or Power Steer functions. They are also used in pairs for direction contactors on 3 terminal motor applications. (SW80, 180 and 200 types).

   V.7.2   Double Pole Normally Open contactors.

             These contactors are only used for direction function on split field motors where the armature/field function is available as a power terminal and where reverse battery protection is required on 24/48v family controllers. (SW822, 192 types).

   V.7.3   Double Pole Changeover Pair contactors.

             These contactors are available as reversing pairs and are used for direction functions with 4 terminal motors as well as 24/48v family controllers with split field motors where reverse battery protection is not required.

             Note that these contactors may be wired either normally open to battery positive or normally closed to battery positive depending upon the motor type (SW88, 182, 202 types).

V.8   Coil Voltage

With the MOS 90 system, 24 volt contactor coils may be used irrespective of the system voltage, provided contactor coil chopping is used.

V.9   Polarity

All contactors are fitted with blow-out magnets, so the '+' terminal must be connected to the most positive voltage. This ensures that, under a fault condition, any arc produced during contactor opening is blown away from the contactor..

V.10 Coil Ratings

Various different types of contactor coil are available to match different contactor duty cycles. It is important that the correct replacement types are used. If in doubt - consult SEVCON.

Controller	Contactors	Fuse	Notes
MOS90A	SW80/88	150	Recommended type
MOS90B	SW80/88	150	Recommended type.
	SW180/182	275	May be used if the panel is being used at its full rating to give longer life.
MOS90C	SW180/182	325	Recommended type
MOS90D	SW182/180*	425	Can be used at lower currents but life will be shortened.
	SW200/202	425	Recommended type

*   An increase in contactor tip life can be obtained by using L (large) area contactor tips in these SW180/182 applications. Especially for pump use.

The above are recommended air-break fuse sizes that are mounted on panels supplied by SEVCON. Similar sizes are normally mounted for pump and traction applications. Control fuse rating should not exceed 10 amps.

APPENDIX VI

SPARE PART NUMBERS

VI.1 All genuine SEVCON spare parts have an 8 digit part number and a serial number incorporating a date code, viz: 0590xxxx, May 1990 manufacture. ALWAYS use the correct spare parts and refer to Sevcon in cases of doubt.

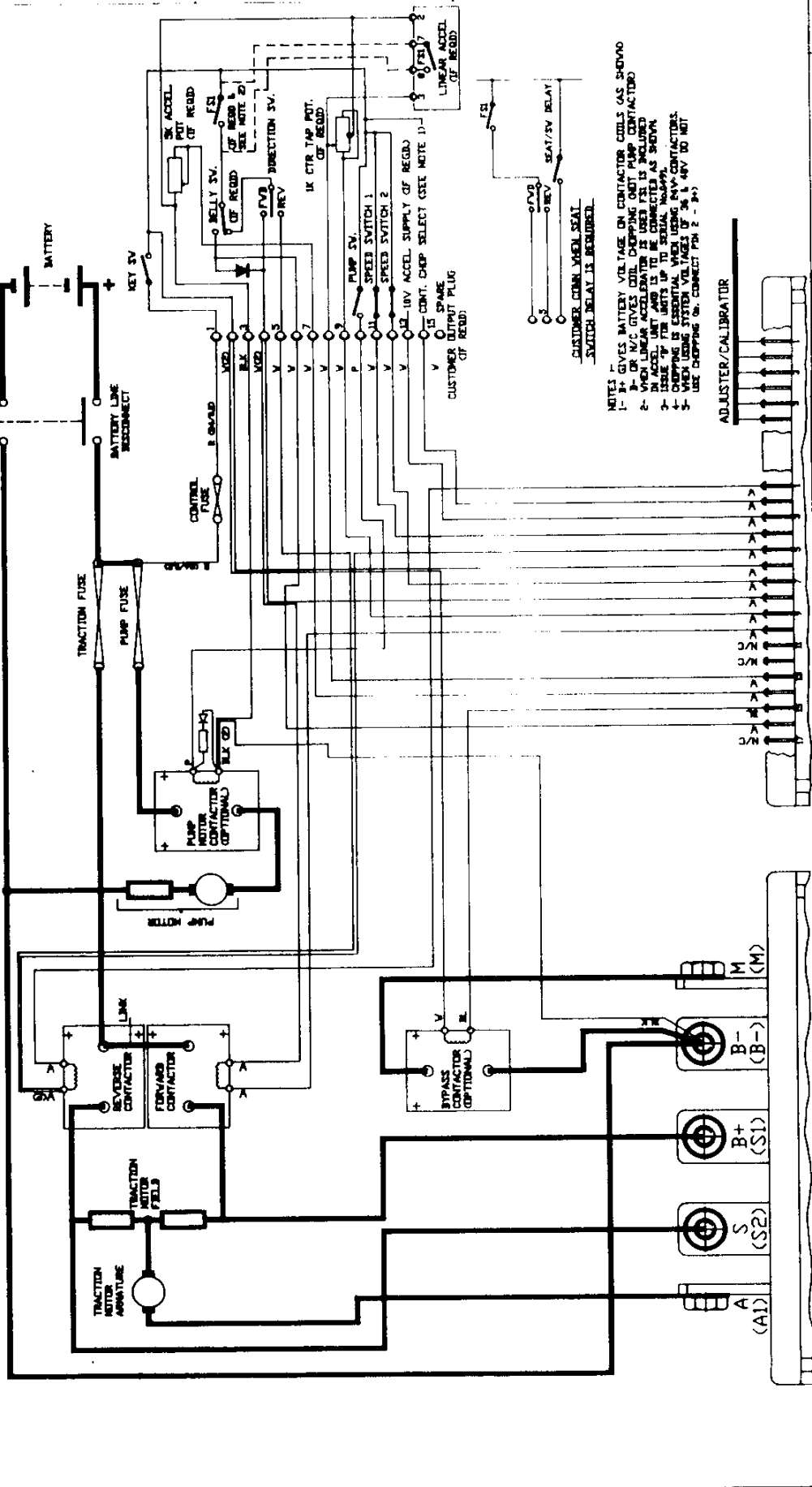| Part no.	Description
631/40001-10	MOS90C controller (options) 24/36v system
631/40011-20	MOS90B controller (options) 24/36v system
631/40021-30	MOS90A controller (options) 24/36v system
631/40031-40	MOS90D controller (options) 24/36v system
631/40041-50	MOS90C controller (pump) 24/48v system
631/40051-60	MOS90B controller (pump) 24/48v system
631/40061-70	MOS90B controller (options) 24/48v system
631/40071-80	MOS90D controller (options) 24/48v system
631/40081-90	MOS90A controller (basic) 24v system
631/40091-100	MOS90B controller (basic) 24/48v system
631/40101-10	MOS90C controller (basic) 24/48v system
631/43001-15	MOS90A & B panels 3T motors 24/36v
631/43016-30	MOS90A & B panels 3T motors 24/48v
631/43031-45	MOS90C panels 3T motors 24/48v
631/44001-15	MOS90C panels 4T motors 24v
631/44016-30	MOS90A & B panels 4T motors 24/36v
631/44031-45	MOS90A & B panels 4T motors 24/48v
631/44046-60	MOS90C panels 4T motors 24/48v
631/44061-75	MOS90D panels 4T motors 24/48v
130/15114	MOS90A & B contactor plate
130/15115	MOS90C contactor plate
130/15116	MOS90D contactor plate
858/27001	Air brake fuse 150A
858/81991	Air brake fuse 275A
858/82331	Air brake fuse 325A
858/81990	Air brake fuse 425A
858/80038	1.25 x 0.25 control fuse 7A
681/11011	In-line fuse-holder
151/82954	Fuse mounting blocks without hardware
661/27059	Loose equipment kit
967/28023	Crimping pliers for loose equipment kit
662/14001	Calibrator
662/13091	Adjuster
656/12013	Linear footpedal unit (3.5v to 0v)
656/12019	Linear footpedal unit (0v to 5v)
932/92007	5K ohm 30° potentiometer
927/11042	10K ohm 330° centre tapped pot
927/11043	10K ohm 330° standard pot
661/27035	Plug kit linear accelerator (019)
661/27060	Plug kit linear accelerator (013)

APPENDIX VII - SAMPLE PUMP CONTROLLER WIRING

CONTACTOR EXPLODED VIEWS

SW192
SW822

SW80
SW180
SW200

SW88
SW182
SW202