

TECHNICAL MANUAL

CUSTOM DESIGNED **Electrically Powered Lift Trucks**

PUBLICATION PREPARED FOR
SCA Tissue

SERVICING DEALER: Tri-Lift Inc.

MODEL: R-LPRH-R-120

SERIAL NUMBER: R-13804-05

ELECTRICAL RATING: "E"

CAPACITY: 12,000 LBS.

Innovative Solutions For Material Handling.

RICO EQUIPMENT - 691 WEST LIBERTY ROAD MEDINA, OH 44256

(330)723-4050 Fax (330)723-4012

TABLE OF CONTENTS

I. WARRANTY INFORMATION & VEHICLE DATA

Warranty
Warranty Claims Procedure
RMA Worksheet
Purchasing Policy
Specifying & Test Information
Sevcon PowerPak Data

II. OPERATION AND SERVICE INFORMATION

Battery Requirements
Type EE Battery
SECTION A.....

**Operation and Service
Instructions**

III. MAINTENANCE INSTRUCTIONS

SECTION B.....
SECTION C.....
SECTION D.....
SECTION E.....
SECTION F.....
-SUB SECTION F.....

**Transmission
Electric Brake
Electrical System
Hydraulic System
Vehicle Controller
Accelerator Parameters**

IV. PARTS

Adjustable Tie Bar Assembly.....
Brake Assembly, Electric.....
Chassis Assembly.....
Chassis Weldment Assembly.....
Controller.....
Contactor Assembly (F/R).....
Contactor Assembly (P/S).....
Cylinder (LIFT).....
Fan Assembly.....
Handle Switch Assembly (RIDER).....
Load Wheel Assembly.....
Oper. Compt. Door Assy.....
P/S Drive Control Assembly.....
P/S Steer Control Assembly.....


**99100063
15109926
91380401
91380402
11980208
11000131
11000132
See Chassis Weld't.
41050541
41011060
66101638-01
9138040A
99061007
99062002**



Pump & Motor Assembly (LIFT).....	33240034
-Pump Motor Breakdown (LIFT).....	05000254
Pump Motor Assembly (P/S).....	05000233
Tank Assembly (P/S).....	33101101
-Tank Lid Assembly (P/S).....	33009997
Traction Motor Assembly.....	05110390
-Traction Motor Breakdown.....	05000390
Transmission & Hub Assembly.....	25001603

V. OTHER INFORMATION

Torque Specifications.....	Other Information
Chassis Lubrication Chart.....	Lube
Wiring Diagram.....	EL13804
Hydraulic Schematic.....	HY13804
Recommended Spare Parts List	R-13804-05



WARRANTY INFORMATION & VEHICLE DATA

SUPPLY VEHICLE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS
FOR VEHICLE AND PARTS INFORMATION CONTACT CUSTOMER SERVICE BPR/RICO (330)723-4050 FAX(330)723-4012

CUSTOM DESIGNED
Electrically Powered Lift Trucks

MANUFACTURED BY
BPR/RICO MANUFACTURING INCORPORATED

DIVIDER I

RICO NEW LIFT-TRUCK WARRANTY

BPR/RICO Equipment, Inc. ("RICO") warrants its new lift trucks (electric, combustion engine, explosion proof) made by it to be free from defects in material or workmanship based on the following schedule:

- Twelve (12) month or 2000 hours parts warranty (fork to counterweight) on the entire vehicle.
- Three (3) month labor warranty.

RICO agrees only to repair or replace at its own expense, F.O.B. Medina, Ohio, any part or parts of the product found to be defective in material or workmanship, provided RICO is notified of such defect or defects within the applicable warranty period and given a reasonable time to correct the defect. In no case shall any warranty extend to defects in materials, components, or services furnished by third parties. Operating the product beyond the published rated capacity or the improper use or application of any products shall void this warranty. If any repairs or alterations are made by anyone other than an entity authorized by RICO or with parts other than authorized by RICO, customer shall pay for such repairs or parts without recourse against RICO, and RICO shall be relieved of responsibility for fulfillment of this warranty with respect to such repairs, alterations, or replacements so made. RICO's obligations under this warranty shall at all times be subject to its then current warranty procedures. Certain components such as tires, and batteries, which may be a part of the product are not manufactured or warranted by RICO. Any applicable warranty for such components is provided through the original manufacturer.

The Following Items are Not Covered by this Warranty:

1. Normal maintenance services and parts or supplies used therein including, without limitation, engine tune-up, brake and linkage adjustment, lubrication services, tightening and adjusting such as bolts, screws, hoses, fittings, etc., replacement of fuses, bulbs, filters, tune-up parts, fluids and brake and clutch linings, glass; motor brushes, contact tips; shop supplies such as rags, oil dry, hand soaps, degreasers, cleaning solutions including brake clean, etc.; and adjustments which are a part of the required or recommended pre-delivery inspection and periodic inspections .
2. Electrical and electronic components including wiring will be excluded after the first six (6) months of operation. Electronic control modules (ECM's) for the engine and transmission are not included in this exclusion and are covered under the standard warranty period.
3. Leaks due to o-ring failures and fittings after one hundred (100) hours of operation.
4. Any product on which any of the recommended periodic inspections or services have not been made.

Under no circumstances shall RICO be liable for any consequential or special damages which any person or entity may incur or claim to incur as a result of any defect in the product or in any correction or alteration thereof made or furnished by RICO or others. "Consequential" or "special damage" includes, but is not limited to costs of transportation, rental replacements, lost sales, lost orders, lost profits, lost income, increased over head, labor and material costs, and cost of manufacturing variances and operational inefficiencies. RICO's maximum liability under this warranty shall be the purchase price paid to RICO with respect to the product to which such warranty is claimed.

This warranty constitutes RICO's entire and exclusive warranty as to the product and is the sole and exclusive remedy for product defects in material and workmanship. RICO does not assume (and has not authorized any other person to assume on its behalf) any other warranty or liability in connection with any product covered by this warranty. RICO EXPRESSLY DISCLAIMS ANY AND ALL OTHER WARRANTIES OF ANY KIND WHATSOEVER AS TO THE PRODUCT FURNISHED HEREUNDER, INCLUDING BUT NOT LIMITED TO ANY EXPRESS WARRANTIES, EXCEPT FOR THE EXCLUSIVE WARRANTY PROVIDED HEREIN, OR IMPLIED WARRANTIES AS TO MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE.

RICO has no obligation to provide warranty or support services until RICO has received full payment for the product purchased. Warranty labor is based on reasonable and customary rates.

This warranty shall be void, if, upon the occurrence of any incident involving any product made by RICO and resulting in any personal injury or property damage, customer shall fail to notify RICO within 48 hours of such occurrence or permit RICO and its representatives to have immediate access to such product and all records of or within the control of customer relating to the product and occurrence.



691 WEST LIBERTY ST.
MEDINA, OH. 44256

PHONE.....(330) 723-4050

SALES FAX.....(330) 723-4012

WARRANTY / PARTS FAX..(330) 722-6980

WARRANTY CLAIMS

Warranty Return Procedure

HOURS: Warranty Claims are taken between 8:00 a.m. and 4:30 p.m. E.S.T.

CLAIMS: Before returning any parts for warranty consideration, a "WARRANTY AUTHORIZATION NUMBER" must be obtained. Your request should include:

- **Part number.
- **Quantity.
- **Description.
- **Serial Number of Unit if applicable.
- **Exact reason for warranty claim.

All parts in question should be sent to the following address:
BPR/RICO EQUIPMENT, INC.
120 North State Road
Medina, OH 44256

All validated warranty claims will be replaced ASAP via UPS GROUND. If a replacement parts must be shipped other than UPS GROUND, the additional shipping costs will be billed back.

To obtain replacement parts needed immediately, please follow the "BPR/RICO EQUIPMENT, INC. PARTS PURCHASING POLICY". All costs incurred on parts that are determined to be under warranty will be credited in full. **VALIDATION OF PARTS COVERED UNDER THIS WARRANTY IS AT THE SOLE DISCRETION OF BPR/RICO EQUIPMENT, INC.**

PLEASE NOTE: ALL PARTS BEING RETURNED FOR WARRANTY MUST BE SHIPPED DIRECTLY TO BPR/RICO EQUIPMENT, INC. IN ORIGINAL CONDITION, VIA UPS GROUND. ALL PARTS RETURNED THAT HAVE BEEN TAMPERED WITH WILL VOID THIS WARRANTY. NO EXCEPTIONS.

FREIGHT DAMAGE, MISAPPLICATION AND MISUSE OF THE PRODUCT ARE NOT COVERED BY THIS WARRANTY.

QUALITY BUILT IN AMERICA



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RMA/CUSTOMER SERVICE DEPARTMENT Warranty Evaluation Work Sheet

RMA#: _____

Serial #:	Model #:	Ship Date:	Hr. Meter Reading:		
Dealer/ID:					
Contact Name:		Parts Used/Needed			
Customer Complaint: _____ _____ _____		Qty	Part #	Description	Price Ea
Finding: _____ _____ _____ _____ _____ _____ _____ _____					
				Total	\$
Correction: _____ _____ _____ _____ _____		BPR/RICO's Findings: Valid _____ Denied _____ Partial _____ Authorized by: _____			

Notes: *Please fill out completely and fax to the RMA Department, Attn. Warranty Administrator.
 *A copy of your work order must accompany this claim.
 *All Defective parts must be returned to BPR/Rico for evaluation within 30 days.
 *Routinely maintained items, like loose nut, bolts and fittings are not covered under warranty.
 *Warranty Department hours are from 8:00 a.m. to 5:00 p.m. E.S.T.



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PARTS PURCHASING POLICY

MINIMUM ORDER: Each shipment requires a NET ORDER OF \$50.00.

PRICE & TERMS: All prices are F.O.B. Medina, OH. Terms are NET CASH 15 DAYS. Prices are subject to change without notice and without any recourse to BPR/RICO EQUIPMENT, INC.

HOURS: Parts orders are taken between 8:00 a.m. and 5:00 p.m. E.S.T.

STOCK ORDERS: All stock orders placed before 12 noon E.S.T. will be shipped same day. Any order required to ship same day after 12 noon E.S.T. will be subject to a \$15.00 handling charge.

ORDERS: All orders for parts should clearly state the part number, description and number of pieces. The truck model and serial number must accompany the order to insure receipt of correct parts. **Orders placed without referencing a serial number and model will not qualify for return credits when parts received are incorrect.** Orders are accepted by phone or facsimile.

RETURN GOODS: A return authorization number must be requested within 30 days. Your request should include the part number, quantity, description, our reference order number, your purchase order number, unit serial number and the exact reason for the return. Prepay all transportation charges. Incorrect or incorrectly shipped merchandise that was ordered with a unit serial number will be replaced or full credit issued. All other returns will be subject to a 25% handling charge plus freight. No goods will be accepted after 30 days. No returns will be accepted on non-stock or special-ordered parts in cases of customer error, **order placed without a unit serial number** or return of non-defective goods. No credit or allowance will be made for labor or charges other than the purchase price of parts.

EXPORT: Prepayment is required for export shipments and must be made in U.S. currency. Customers are requested to indicate name and address of their Custom Broker and how MA forms are to be routed.

CHANGES: BPR/RICO EQUIPMENT, INC. reserves the right to make changes or improvements in its products at any time without incurring any obligation either to modernize products previously sold or to furnish old parts which have been changed, improved or omitted in new products subsequently sold.

PARTS INQUIRES: BPR/RICO EQUIPMENT, INC. Reserves the right to quote list prices on all replacement parts.

**INCORRECTLY SHIPPED MERCHANDISE, INCLUDING QUANTITY DISCREPANCIES MUST BE REPORTED NO MORE THAN 7 WORKING DAYS FROM SHIPPING DATE.

ELECTRICAL SPECIFYING FORM

NOTE: Part numbers listed to be shown on electrical bill of material, reference other drawings as shown.

MODEL: R-LPRH-R-120

DATE: 05/26/09

SERIAL: R-13804-05

		QTY			QTY			QTY
BATT. CONNECTOR:	41050304	<input checked="" type="checkbox"/>	HOUR METER:	N/A	<input type="checkbox"/>	P/S MOTOR:	SEE MECH	<input checked="" type="checkbox"/>
BATT. CONN. REL.:	N/A	<input type="checkbox"/>	KEYLOCK:	41050398	<input checked="" type="checkbox"/>	HORN:	41050122	<input checked="" type="checkbox"/>
CONTROLLER:	11980208	<input checked="" type="checkbox"/>	TERMINAL BLOCK:	EL95	<input checked="" type="checkbox"/>	SMALL STANDOFF:	41050157	<input checked="" type="checkbox"/>
CTRL PLUG WIRED:	11980221	<input checked="" type="checkbox"/>	TOGGLE SWITCH:	N/A	<input type="checkbox"/>	LARGE STANDOFF:	N/A	<input type="checkbox"/>
HEAT SINK:	N/A	<input type="checkbox"/>	LIFT SWITCH:	SEE MECH	<input checked="" type="checkbox"/>	ELE. MTG. PLATE:	99130050	<input checked="" type="checkbox"/>
FWD/REV CONT.:	11000131	<input checked="" type="checkbox"/>	LOWER SWITCH:	SEE MECH	<input checked="" type="checkbox"/>	PENDANT:	N/A	<input type="checkbox"/>
1/AMAIN CONTACTOR:	N/A	<input type="checkbox"/>	HORN SWITCH:	SEE MECH	<input checked="" type="checkbox"/>	COIL CORD:	N/A	<input type="checkbox"/>
PUMP CONTACTOR:	SEE MECH	<input checked="" type="checkbox"/>	BRAKE SWITCH:	41050132	<input checked="" type="checkbox"/>	BUSS BAR:	11980210	<input checked="" type="checkbox"/>
P/S CONTACTOR:	11000132	<input checked="" type="checkbox"/>	HI SPEED SWITCH:	N/A	<input type="checkbox"/>	RELAY:	N/A	<input type="checkbox"/>
SECONDARY FUSE:	41050405	<input checked="" type="checkbox"/>	SAFETY SWITCH:	N/A	<input type="checkbox"/>	LIGHT:	N/A	<input type="checkbox"/>
PRIMARY DRIVE FUSE:	41050108	<input checked="" type="checkbox"/>	LIMIT SWITCH:	N/A	<input type="checkbox"/>	ALARM:	N/A	<input type="checkbox"/>
PRIMARY LIFT FUSE:	41050108	<input checked="" type="checkbox"/>	OVERRIDE SWITCH:	N/A	<input type="checkbox"/>	TIMER:	N/A	<input type="checkbox"/>
PRIMARY P/S FUSE:	41050102	<input checked="" type="checkbox"/>	EMERGENCY SWITCH:	N/A	<input type="checkbox"/>	FAN:	41050541	<input checked="" type="checkbox"/>
FUSE HOLDER:	41050414	<input checked="" type="checkbox"/>	SPD/TRAVEL SWITCH:	SEE MECH	<input checked="" type="checkbox"/>	BUSS BAR	11980220	<input checked="" type="checkbox"/>
DIODE:	41050166	<input checked="" type="checkbox"/>	REVERSING SWITCH:	N/A	<input type="checkbox"/>	PLUG KIT	11980222	<input checked="" type="checkbox"/>
RESISTOR-VARISTOR:	N/A	<input type="checkbox"/>	HDL. SWITCH ASSY:	SEE MECH	<input checked="" type="checkbox"/>	POTENTIOMETER	SEE MECH	<input checked="" type="checkbox"/>
BDI/COMBO:	11980182	<input checked="" type="checkbox"/>	DRIVE MOTOR:	SEE MECH	<input checked="" type="checkbox"/>	BRAKE STATOR	SEE MECH	<input checked="" type="checkbox"/>
BDI HARNESS:	11980219	<input checked="" type="checkbox"/>	PUMP MOTOR:	SEE MECH	<input checked="" type="checkbox"/>	ELEC. RELEASE	SEE MECH	<input checked="" type="checkbox"/>

NOTE : IF PART IS NOT ON FORM --- FIND FORM IT APPEARS AND REFERENCE THAT FORM

NOTE 1:

BLOWER FAN - 41050273 - QTY 1

NOTE 2:

NOTE 3:

MECHANICAL SPECIFYING FORM

MODEL: R-LPRH-R-120

DATE: 05/26/09

SERIAL: R-13804-05

NOTE: As a rule all assemblies are to be listed on the mechanical, referencing the assemblies on the electrical and hydraulic drawings.

Part numbers listed to be shown on the mechanical bill of material, reference other vehicles as shown.

		QTY			QTY			QTY
TRANS/HUB ASSY:	25001603	<input checked="" type="checkbox"/>	TANK, P/S:	33101101	<input checked="" type="checkbox"/>	FORKS:	N/A	<input type="checkbox"/>
CONTROLLER ASSY:	N/A	<input type="checkbox"/>	MOTOR ENCLOSURE:	N/A	<input type="checkbox"/>	BATTERY:	N/A	<input type="checkbox"/>
DRIVE MOTOR ASSY:	05110390	<input checked="" type="checkbox"/>	CONTROL ENCL.:	N/A	<input type="checkbox"/>	BATTERY CHARGER:	N/A	<input type="checkbox"/>
DRIVE TIRE:	66001654	<input checked="" type="checkbox"/>	PUMP ENCLOSURE:	N/A	<input type="checkbox"/>	BATT. CONN. MTG:	99130446	<input checked="" type="checkbox"/>
HUB/TIRE-SPECIAL:	N/A	<input type="checkbox"/>	BATT. CONN. ASSY:	N/A	<input type="checkbox"/>	BATT. ROLLERS:	N/A	<input type="checkbox"/>
BRAKE PEDAL ASSY:	SEE ELE	<input checked="" type="checkbox"/>	JUMPER-CTRL ENCL:	N/A	<input type="checkbox"/>	SIDE SHIFTER:	N/A	<input type="checkbox"/>
BRAKE ASSY:	15109926	<input checked="" type="checkbox"/>	JUMPER-MTR ENCL:	N/A	<input type="checkbox"/>	ELEC. MTG PLATE:	SEE ELEC	<input checked="" type="checkbox"/>
HANDLE ASSY:	41011060	<input checked="" type="checkbox"/>	BRG. HOUSING ASSY:	N/A	<input type="checkbox"/>	TORQUE HYD MTR:	99061007	<input checked="" type="checkbox"/>
PUMP ASSY:	33240034	<input checked="" type="checkbox"/>	EE-DR MTR SEAL KIT:	N/A	<input type="checkbox"/>	MOTOR MTG.	99130396	<input checked="" type="checkbox"/>
PUMP-MOTOR:	N/A	<input type="checkbox"/>	MI-CABLE:	N/A	<input type="checkbox"/>	BARNES MTG.	99130530	<input checked="" type="checkbox"/>
PUMP:	N/A	<input type="checkbox"/>	PULLEY ASSY:	N/A	<input type="checkbox"/>	TANK MTG.	99130725	<input checked="" type="checkbox"/>
STEERING ASSY:	99062002	<input checked="" type="checkbox"/>	EX-DISCONNECT:	N/A	<input type="checkbox"/>	FAN MTG.	99130779	<input checked="" type="checkbox"/>
P/S PUMP MOTOR:	05000233	<input checked="" type="checkbox"/>	MAST ASSY:	N/A	<input type="checkbox"/>			<input type="checkbox"/>
P/S PUMP ASSY:	N/A	<input type="checkbox"/>	CASTER:	N/A	<input type="checkbox"/>			<input type="checkbox"/>
P/S PUMP:	33002992	<input checked="" type="checkbox"/>	VALVE ASSY:	N/A	<input type="checkbox"/>			<input type="checkbox"/>
REACH ASSY:	N/A	<input type="checkbox"/>	LIFT CYLINDER:	33002201	<input checked="" type="checkbox"/>			<input type="checkbox"/>
TANK, MAIN:	N/A	<input type="checkbox"/>	CHASSIS	RICO	<input checked="" type="checkbox"/>	INFORMATION	NOTE 2	<input type="checkbox"/>

NOTE: IF PART IS NOT ON FORM --- FIND FORM IT APPEARS AND REFERENCE THAT FORM

NOTE 1:

NOTE 2:

MAKE PROVISIONS FOR (2) SQUARE DRIVE COMPARTMENT FANS

NOTE 3:

HYDRAULIC SPECIFYING FORM

MODEL: **R-LPRH-R-120**

DATE: **05/26/09**

SERIAL: **R-13804-05**

NOTE: Part numbers listed to be shown on hydraulic bill of material, reference other drawings as shown.

		<u>QTY</u>			<u>QTY</u>		<u>QTY</u>
LIFT - PUMP:	NOTE 1	<input type="checkbox"/> 1	MANUAL VALVE-3:	N/A	<input type="checkbox"/>		<input type="checkbox"/>
P/S - PUMP:	SEE MECH	<input type="checkbox"/> 1	ELECTRIC VALVE-1:	N/A	<input type="checkbox"/>	<input type="text"/>	<input type="checkbox"/>
FLOW CONTROL:	N/A	<input type="checkbox"/>	ELECTRIC VALVE-2:	N/A	<input type="checkbox"/>	<input type="text"/>	<input type="checkbox"/>
RELIEF VALVE:	NOTE 1	<input type="checkbox"/> 1	ELECTRIC VALVE-3:	N/A	<input type="checkbox"/>		<input type="checkbox"/>
SHUT OFF VALVE:	N/A	<input type="checkbox"/>	TORGUE GENERATOR:	N/A	<input type="checkbox"/>	<input type="text"/>	<input type="checkbox"/>
FLOW REGULATOR:	NOTE 1	<input type="checkbox"/> 1	CYLINDER-1:	SEE MECH	<input type="checkbox"/> 1	HYD. MOTOR	SEE MECH <input type="checkbox"/> 1
TANK - P/S:	SEE MECH	<input type="checkbox"/> 1	CYLINDER-2:	N/A	<input type="checkbox"/>	LIFT MOTOR	NOTE 1 <input type="checkbox"/> 1
TANK - MAIN:	NOTE 1	<input type="checkbox"/> 1	CYLINDER-3:	N/A	<input type="checkbox"/>	P/S MOTOR	SEE MECH <input type="checkbox"/> 1
MANUAL VALVE-1:	N/A	<input type="checkbox"/>	SELECTOR VALVE:	SEE MECH	<input type="checkbox"/> 1		
MANUAL VALVE-2:	N/A	<input type="checkbox"/>	CHECK VALVE:	N/A	<input type="checkbox"/>		

NOTE: IF PART IS NOT ON FORM --- FIND FORM IT APPEARS AND REFERENCE THAT FORM

NOTE 1:

ALL ITEMS LISTED "NOTE 1" ARE PART OF THE BARNES ASSEMBLY CALLED OFF ON THE MECHANICAL FORM

NOTE 2:

NOTE 3:

SERIAL: **R-13804-05**
 MODEL: **R-LPRH-R-120**

INSPECTION DATA

DATE INSPECTED: **10-21**
 INSPECTOR: **brian w/ joe h**

PERTINENT PARTS

CONTROLLER:	11980208	DRIVE TIRE :	66001654	PUMP-MOTOR:	N/A
CONTROLLER ASSY:	N/A	BRAKE ASSY:	15109926	STEERING ASSY:	99062002
TRANSMISSION ASSY:	25001603	PUMP ASSY:	33240034	P/S PUMP:	33002992
DRIVE MOTOR ASSY:	05110390	PUMP:	N/A	P/S PUMP MOTOR:	05000233

BATTERY INFORMATION

Model T/R:	12-125-13	Voltage:	24	Height:	30.50	Notes:	TYPE:	E
Date Information Received:	05/26/09	Amp Hour:	750	Length:	30.75			
Connector:	SB-350 GREY	Weight:	1476	Lead P:	B			
		Width:	12.85	Lead L:	20			

VEHICLE DATA

CAPACITY:	12000	OUTRIGGER OD:		O.A.L.:	186.75	VOLTAGE:	24	TYPE: (E-EE-EX)	E
LOWERED HGT:	7.5	OUTRIGGER ID:		O.A.W.:	70.75	TOWING CAPACITY:			
RAISED HGT:	13.75	TURN RADIUS:	148	O.A.H.:	50.3	DRAW BAR PULL:			
LOAD CENTER:	71	HEAD LENGTH:		V.L.C.:	50	CAPACITY W/ATACH.:			
		WHEEL BASE:	121	DEFLECT:		WEIGHT: (EMPTY)	5005		

FORKS/PLATFORM/TABLE/MECHANISM

TYPE:	COIL HANDLER	Notes:		
ATTACHMENT:				
LENGTH:	130	THICKNESS:		
HEIGHT:		ITA CLASS:		
WIDTH:		TAPPER:		

FUNCTION	DIST.	AMP	PSI	SEC	FPM	AMP	PSI	SEC	FPM	AMP _{BYPASS}	PSI _{BYPASS}
RAISE 1		104	500	6.7	0	154	1900	9.2	0	164	2200
LOWER 1				6.0	0			6.1	0		
					<Error				<Erro		
					<Error				<Erro		
					<Error>				<Erro		
					<Error				<Erro		

ENGINEERS: arron heiks
WELDERS: a harrison
ASSEMBLERS: bacil o/ rich s

Notes:

TRAVEL DATA

TRANSMISSION S/N: **see notes**

Notes:

r-13804 368 03/09
r-13805 35649 09/08

DIRECTION	DIST	AMP	SEC	MPH	AMP	SEC	MPH
FORWARD 1:	44ft	115	7.1	4.23	176	10.6	2.83
FORWARD 2:	44ft			<Error			<Erro
FORWARD 3:	44ft			<Error			<Erro
REVERSE 1:	44ft	100	7.4	4.05	162	10.7	2.8
REVERSE 2:	44ft			<Error			<Erro
REVERSE 3:	44ft			<Error			<Erro

EMPTY

LOADED

VEHICLE WEIGHT/LOADING

	TOTAL WGT.	DR 1	DR 2	L/W 1	L/W 2	TILT FWD. DRIVES	TILT LEVEL DRIVES	TILT BACK DRIVES
EMPTY	6480	4340		2140				
LOADED	18430	6100		12330		LOADED		

STEERING DATA

EMPTY

LOADED

DIRECTION	TURNS	AMP	PSI	AMP	PSI	AMP BYPASS	PSI BYPASS
RIGHT - LEFT:		55	590	63	800		
LEFT - RIGHT:							

STOPPING DISTANCE

EMPTY

LOADED

Notes:

R-13804 2009020648 R-13805 2009035634

TYPE	SEC	FEET	SEC	FEET
RELEASE		2-3		2
APPLIED				

CONTROLLER DATA

CONTROLLER: 11980208

CONTROLLER SERIAL NUMBER: see notes

CONTROLLER ASSY: N/A

CURTIS - SETTINGS

SEVCON - MOS90 SETTINGS

GE - EV100LX / 200LX SETTINGS

SEVCON - SC2145

C.1.1 MAIN C/L:	AMP	
C.1.2 LOW SPD C/LIMIT:	AMP	
C.1.3 PLUG C/LIMIT:	AMP	
C.1.4 LOW SPD P C/LIMIT:		
C.1.5 EMR REV C/LIMIT:		
C.1.6 L S E R C/LIMIT:	AMP	
C.1.7 RAMP C/LIMIT:	AMP	
C.1.8 L S R C/LIMIT:	AMP	
C.1.9 ACCEL. RATE:	SEC	
C.1.10 QUICK START:		
C.1.11 THROTTLE TYPE:		
C.1.12 RAMP SHAPE:	%	
C.1.13 CREEP SPEED:	%	
C.1.14 LOW SPEED:	%	
C.1.15 HIGH SPEED:	%	
C.1.16 EMR REV SPEED:	%	
C.1.17 SEQ. DELAY:	SEC	
C.1.18 VARIABLE PLUG:		
C.1.19 HIGH PEDAL DISABLE:		
C.1.20 STATIC RET. TO OFF:		
C.1.21 ANTI-TIEDOWN:		

S.1.1 I-MAX:	AMP	
S.1.2 PLUG:	AMP	
S.1.3 ACCEL:		
S.1.4 CREEP:		
S.1.5 BYPASS:	AMP	
S.1.6 SPEED:	%	
S.1.7 SPEED-1:	%	
S.1.8 SPEED-2:	%	
S.1.9 PS TIMER:		
S.1.10 SEAT:		

G.1.1 STATUS CODE:	
G.1.2 CREEP SPEED:	
G.1.3 CTRL ACCEL:	
G.1.4 CURRENT LIMIT:	
G.1.5 PLUG DIST:	
G.1.6 1A DROP OUT:	
G.1.7 FW WK PICK UP:	
G.1.7a PA4 INPUT:	
G.1.8 FW WK DROP OUT:	
G.1.9 REGEN BK C/L:	
G.1.10 REGEN START:	
G.1.11 SPD LIMIT SL1 TC:	
G.1.11a SPD LIMIT PA5-6 MC:	
G.1.12 SPD LIMIT SL2 TC:	
G.1.12a SPD LIMIT PA4 MC:	
G.1.13 SPD LIMIT SL3 TC:	
G.1.14 INTERNAL RES. COMP.:	
G.1.15 BATTERY VOLTS:	
G.1.16 PEDAL POSITION PLG:	
G.1.17 CARD TYPE SELECT.:	
G.1.18 P/S PUMP DELAY:	

SEVCON - POWERPAK

Settings for these controllers are generated by PC pak software. Information is saved under the vehicle Serial Number, located on the G drive in the ControlData folder.

CONTROLLER DATA

ZAPI - SETTINGS MODEL: FH8087

ACCELERATION DELAY:Sec.

INVERS BRAKING:% IMax.

RELEASE BRAKING:% IMax.

PEDAL BRAKING:% IMax.

CUTBACK SP. 1:% VBatt.

CUTBACK SP. 2:% VBatt.

CUTBACK SP. 3:%VBatt.

COMPENSATION:K (i)

BRAKING MODUL:% IMax.

I MAX (VERSION 800A):Amp.

I MAX (VERSION 1000A):Amp.

MAX. SPEED FORW-BACK: ...% VBatt.

CREEP SPEED:% VBatt.

WEAK DROPOUT:% IMax.

CURVE BRAKING:% IMax.

CURVE TIME:Sec.

AUXILIARY TIME:Sec.

BACKING TIME:Sec.

CONTROLLER DATA

CURTIS - SETTINGS MODEL: 1214-8207

EMR REV C/L: Emergency reverse current limit

THROTTLE TYPE:Throttle type*

RAMP SHAPE:Throttle map

CREEP-SPEED: Creep speed, as percent PWM duty cycle

EMR REV SPEED: ..Emerg. reverse speed. as % PWM duty cycle

SEQUENCING DLY:Sequencing delay, in seconds

VARIABLE PLUG:Throttle-variable plug braking: on or off

HIGH PEDAL DIS:High pedal disable (HPD): type**

SRO:Static return to off (SRO): type***

ANTI-TIEDOWN:Anti-Tiedown: on or off

QUICK START:Quick start throttle factor

M1 MAIN C/L:Mode 1 main current limit

M1 PLUG C/L: Mode 1 plug current limit

M1 RAMP C/L:Mode 1 ramp start current limit

M1 ACCEL RATE:Mode 1 acceleration rate, in seconds

M1 MAX SPEED:Mode 1 maximum speed, as % PWM output

M2 MAIN C/L:Mode 2 main current limit

M2 PLUG C/L:Mode 2 plug current limit

M2 RAMP C/L:Mode 2 ramp current limit

M2 ACCEL RATE:Mode 2 acceleration rate, in seconds

M2 MAX SPEED:Mode 2 maximum speed, as % PWM output

NEUT BRAKE C/L:Neutral brake current limit

NEUTRAL BRAKE:Neutral Brake: on or off



120 NORTH STATE ROAD
MEDINA, OH 44256
330-723-4050

WARNING

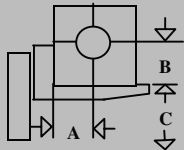
IMPROPER OPERATION OR MAINTENANCE COULD RESULT IN INJURY OR DEATH. DO NOT OPERATE OR WORK ON THIS TRUCK UNLESS YOU ARE PROPERLY TRAINED. READ AND UNDERSTAND THE OPERATION AND MAINTENANCE MANUAL. ADDITIONAL MANUALS ARE AVAILABLE FROM RICO DEALERS

MODEL	SERIAL NO.	TYPE	VOLTS
R-LPRH-R-120	R-13804-05	E	24

ALLOWABLE MACHINE WORKING CAPACITY W/ MAST VERTICAL

MACHINE CAPACITY		A	B	C
WITHOUT ATTACHMENT	5443.2 KGS.	1,803.40 MM	1,270.00 MM	349.25 MM
	12000 LBS.	71 N	50 N	13.75 N
WITH ATTACHMENT	0.00 KGS.	0.00 MM	0.00 MM	0.00 MM
	LBS.	N	N	N

ATTACHMENT



I.D. NO.	<input type="text"/>
BATT MAX A.H. CAP	750
BATTERY SIZE	30.75 LENGTH - IN 12.85 WIDTH - IN 30.50 HEIGHT - IN
BATTERY WGT MIN/MAX	669.51 KGS. 1476 LBS.
MACH WGT W/O BATT	2270.27 KGS. 5005 LBS.
MACH CONFORMS TO	<input type="text"/>

OPERATE ON LEVEL SURFACE ONLY

*Throttle types
Type 1: 5K ohm-0
Type 2: 0-5Kv, 0-10v, 3-wire pot, and electronic throttles
Type 3: 0-5K ohm

**HPD types
Type 0: no HPD
Type 1: HPD on brake input
Type 2: HPD on KSI

***SRO types
Type 0: no SRO
Type 1: SRO on brake input plus direction input
Type 2: SRO on KSI plus brake input plus direction input
Type 3: SRO on KSI plus brake input plus forward only

TOWING CAPACITY:	<input type="text"/>	LBS.
	<input type="text" value="0"/>	KGS.
DRAW BAR PULL:	<input type="text"/>	LBS.
	<input type="text" value="0"/>	KGS.

Date: 10/26/2009 9:05:22 AM

Generator :
Description :

Node : 0 Model : PowerpaK Traction
Serial number : 09020743 Access Code : 0
Software ver : V4.05B Pers CRC : 39

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1 Traction

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1.1 Personalities

Ref	Menu Item	Min	Max	Step	Value
1.1.1	Adj I. Max.	50A	650A	10A	500A
1.1.2	Adj Accel	0.1s	5.0s	0.1s	1.5s
1.1.3	Adj Decel	0.1s	0.5s	0.1s	0.1s
1.1.4	Adj Creep Speed	0%	25%	1%	10%
1.1.5	Adj Dir. Plug	50A	810A	10A	200A
1.1.6	Adj Ntrl Plug	0A	810A	10A	0A
1.1.7	Adj Foot Plug	0A	810A	10A	0A
1.1.8	Adj Dir. Regen	50A	650A	10A	50A
1.1.9	Adj Ntrl Regen	0A	650A	10A	0A
1.1.10	Adj Foot Regen	0A	650A	10A	0A
1.1.11	Adj Reg. Delay	0ms	350ms	10ms	0ms
1.1.12	Adj Max Speed	0%	100%	1%	100%
1.1.13	Adj Cut Speed 1	0%	100%	1%	100%
1.1.14	Adj Cut Accel 1	0.1s	5.0s	0.1s	0.1s
1.1.15	Adj Cut Speed 2	0%	100%	1%	40%
1.1.16	Adj Cut Accel 2	0.1s	5.0s	0.1s	0.1s
1.1.21	Adj Bypass Out	0A	970A	10A	650A
1.1.22	Adj Byp. Delay	0.5s	5.0s	0.1s	1.5s
1.1.23	Adj F.W. In	0A	480A	10A	0A
1.1.24	Adj F.W. Out	0A	480A	10A	0A
1.1.25	Adj Steer Delay	0s	60s	1s	3s
1.1.26	Adj Seat Delay	0.0s	5.0s	0.1s	0.0s
1.1.27	Adj E.Brake Del	0.0s	5.0s	0.1s	0.0s
1.1.28	Adj Accel Zero	0.00V	5.00V	0.02V	3.32V
1.1.29	Adj Accel Full	0.00V	5.00V	0.02V	0.04V
1.1.32	Adj Econ. Zero	0.00V	5.00V	0.02V	0.10V
1.1.33	Adj Econ. Full	0.00V	5.00V	0.02V	3.70V
1.1.36	Adj Speed Lmt	0KPH	60KPH	1KPH	0KPH
1.1.37	Adj Lo V Init	65.0V	75.0V	0.5V	18.0V
1.1.38	Adj Lo V Cut	65.0V	75.0V	0.5V	14.5V
1.1.39	Adj Hi V Init	14.5V	80.0V	0.5V	65.0V
1.1.40	Adj Hi V Cut	14.5V	18.0V	0.5V	70.0V
1.1.41	Adj Prot. Delay	1.2s	4.8s	0.1s	0.1s

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1.1.2 Accel

1.1.2a	Adj I Ramp Time	0.0s	2.5s	0.1s	0.0s
--------	-----------------	------	------	------	------

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1.1.5 Dir. Plug

1.1.5a	Adj Plug Turn	50A	810A	10A	100A
--------	---------------	-----	------	-----	------

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1.1.6 Ntrl Plug

1.1.6a	Adj Plug Thresh.	50	255	1	153
--------	------------------	----	-----	---	-----

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1.1.6a Plug Thresh.

1.1.6b	Adj Plug Drop	50A	810A	10A	100A
--------	---------------	-----	------	-----	------

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

1.1.8 Dir. Regen

1.1.8a	Adj Spd Brk	40A/KPH	650A/KPH	10A/KPH	40A/KPH
--------	-------------	---------	----------	---------	---------

-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----

```

1.2 Status
1.2.1 R/O Battery 24.5V
1.2.2 R/O Motor 0.0V
1.2.3 R/O Motor 0A
1.2.4 R/O Temp. 20°C
1.2.5 R/O Mosfet 7.5V
1.2.6 R/O Capacitor 25.5V
1.2.8 R/O Key 5,
4hr
1.2.9 R/O Drive 1,
3hr
1.2.10 R/O Pump 0,
0hr
Service R/O Log + to reset log

```

```
-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----
```

1.3 Test

```

1.3.1 R/O Accel 0%
1.3.2 R/O Accel 3.36V
1.3.5 R/O Economy 0%
1.3.6 R/O Economy 0.00V
1.3.9 R/O Forward Open
1.3.10 R/O Reverse Open
1.3.12 R/O Belly Open
1.3.14 R/O Tiller Open
1.3.15 R/O Cutback 1 Open
1.3.20 R/O Handbrake Open
1.3.22 R/O Trigger Open
1.3.23 R/O Pump Trigger Off
1.3.28 R/O Software V4.05B
1.3.29 R/O Ser No 902,
743

```

```
-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----
```

1.3.28 Software

```
1.3.28a R/O DL Ver DL1.08
```

```
-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----
```

1.4 BDI

```

1.4.1 R/O BDI 100% Charge Left
1.4.2 Adj Battery Volt 2V 50V 2V 24V
1.4.3 Adj Reset 1.50V/Cell11.99V/Cell10.01V/Cell12.00V/Cell
1.4.4 Adj Empty 2.00V/Cell12.50V/Cell10.01V/Cell11.73V/Cell
1.4.5 Adj Warning 0% 90% 1% 30%
1.4.6 Adj Cutout 0% 90% 1% 10%

```


```
-- Ref ----- Menu Item ---- Min ----- Max ----- Step ---- Value -----
```

1.6 Setup

```

1.6.1 Adj Chop Select Off
1.6.2 Adj Accel Linear
1.6.3 Adj BDI On
1.6.4 Adj Str Trig Brake
1.6.5 Adj Econ cuts I Off
1.6.6 Adj Byp in I Lim Off
1.6.7 Adj SRO On
1.6.8 Adj Braking Const
1.6.9 Adj Plugging Const F
1.6.10 Adj Truck walkie
1.6.11 Adj Tiller On
1.6.12 Adj Pin 6 Speed 1
1.6.13 Adj Pin 7 P. Steer
1.6.14 Adj Pin 8 Pump
1.6.15 Adj Pin 9 Handbrake
1.6.16 Adj Pin 10 Economy
1.6.17 Adj Pin 11 Accel
1.6.20 Adj Cont 3 P. Steer
1.6.21 Adj Cont 4 Bypass
1.6.22 Adj Cont 5 Pump
1.6.25 Adj Seat & Pump Off
1.6.26 Adj Fault Log On
1.6.27 Adj Service Log On
1.6.28 Adj Probe Speed High
1.6.29 Adj Full Speed 5KPH 60KPH 1KPH 20KPH
1.6.30 Adj Probe Frq 100Hz 2000Hz 10Hz 100Hz
1.6.31 Adj Mode Standalone
1.6.32 Adj Sw Lmts Spd Off

```



OPERATION AND SERVICE INFORMATION

SUPPLY VEHICLE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS
FOR VEHICLE AND PARTS INFORMATION CONTACT CUSTOMER SERVICE BPR/RICO (330)723-4050 FAX(330)723-4012

CUSTOM DESIGNED
Electrically Powered Lift Trucks

MANUFACTURED BY
BPR/RICO MANUFACTURING INCORPORATED

DIVIDER II



Battery Requirements

BATTERY REQUIREMENTS FOR ELECTRIC BATTERY POWERED INDUSTRIAL TRUCKS.....	2
I. BATTERY ENCLOSURE.....	2
II. BATTERY.....	2
III. BATTERY LEADS.....	3
IV. BATTERY PLUGS AND RECEPTACLES.....	3
BATTERY MAINTENANCE.....	4
I. BATTERY CHECKS.....	4
II. BATTERY CHARGING.....	4
III. BATTERY STORAGE.....	5
IV. BATTERY REPLACEMENT.....	5
A. Removal.....	5
B. Installation.....	5
V. BATTERY SERVICING.....	5
A. Charging.....	5
B. Cleaning.....	6



Battery Requirements

BATTERY REQUIREMENTS FOR ELECTRIC BATTERY POWERED INDUSTRIAL TRUCKS AS LISTED IN UNDERWRITERS LABORATORIES STANDARD U.L. 583 (ANSI 6B.56.3-1972)

I. BATTERY ENCLOSURE

- A. The battery shall be provided with support and protection by means of a noncombustible enclosure which, if of metal, shall be no less than 0.053 inch thick (No. 16MSG) and either shall be flanged not less than ½ an inch on all sides or shall remain closed by the force of gravity or shall be provided with a fastener.
- B. A metal cover shall have such strength and rigidity that, in conjunction with air spacing provided between it and the battery terminals, the battery terminals are not short-circuited when a 250-pound force is applied to any one square foot area of the cover. In lieu of the spacing, insulation designed to prevent short-circuiting of the battery terminals shall be secured to the inner surface of a metal battery compartment cover.

II. BATTERY

- A. A battery furnished with a noncombustible tray and cover intended to form the ultimate enclosure for the battery shall comply with the requirements in paragraphs I.A and I.B.
- B. The battery enclosure shall be provided with means for ventilation that minimizes the possibility of accumulation of explosive hydrogen-air mixtures above the battery.
- C. A battery of nominal voltage rating and representative of maximum ampere-hour capacity rating is to be supplied for the purpose of examining the truck.
- D. Cells employing metal containers (such as alkaline batteries) shall be insulated from one another and from a metal tray or metal battery compartment. Insulation of wood or other material shall be (1) treated or painted to minimize deterioration by the battery electrolyte, and (2) constructed to minimize the risk of damage to the insulation in the normal operation and maintenance of the truck.
- E. The connections shall be such that the potential between any two adjacent cells cannot be more than 24 volts(nominal).
- F. Means shall be provided as a part of the truck to restrain the battery from moving more than a total of ½ an inch in a horizontal direction.



Battery Requirements

III. BATTERY LEADS

- A. Battery leads shall be of a size and current-carrying capacity adequate for the application. They shall be neoprene insulated or insulated with an equivalent material, resistant to acids and/or alkaline, and able to withstand flexing, handling, and impact at temperatures between 54°C (130°F) and minus 29°C (minus 20°F). The average insulation thickness shall be no less than 0.060 inch for a No. 8-2 AWG wire and no less than 0.080 inch for a No. 1-4/0 AWG wire.

IV. BATTERY PLUGS AND RECEPTACLES

- A. Each electric truck shall be equipped with a battery connector located to provide physical protection as required for other electrical parts of the truck.
- B. One part of the connector shall be permanently mounted to either the truck or the battery enclosure. The length of the cable attached to the free part of the connector shall be as short as practicable, without interfering with the disconnecting operation and without placing stress on terminals.
- C. The live parts shall be recessed from the face of the connector to minimize the possibility of shorting.
- D. A battery connector shall have the proper rating for use in its particular application.
- E. The removable portion of the connector shall be provided with means for being grasped during removal.

Battery Requirements

BATTERY MAINTENANCE

I. BATTERY CHECKS

- A. Check the specific gravity of the electrolyte daily; specific gravity should be above 1.260. Check specific gravity daily at least at the center cells and weekly at all of the cells. When only the outer cells are checked, it will not necessarily indicate the true condition of the battery. After specific gravity is checked, return electrolyte to same cell from which it was taken.
- B. The value of the specific gravity of the electrolyte in a lead-acid type battery should be approximately 1.275 with battery fully charged. Never continue to discharge a battery beyond the point where specific gravity falls below approximately 1.125.
- C. To obtain "corrected specific gravity" readings when checking the electrolyte, add 1 point (0.001) of gravity for each 3°F, above 77°F (electrolyte temperature), or subtract 1 point for each 3°F below 77°F. Also subtract 15 points gravity for each 1/2" below normal level of electrolyte or add 15 points for each 1/2" above normal electrolyte level.
- D. Check the battery cables, posts, and exterior of the battery daily. Battery cables must not be frayed nor loose at the battery posts. Also inspect battery connector and make certain there is no foreign material inside the connector. Make certain filler plugs are tight and vent holes in the filler plugs are not clogged.
- E. The top of the battery should be kept clean and dry so corrosion, dust, or moisture cannot offer a conducting path to short-circuit the cells or contact a ground. A dirty battery or one where electrolyte has been spilled should be washed with a solution of baking soda and water (one pound of baking soda to one gallon of water). Disconnect battery connector and remove battery from lift truck for cleaning operation. Clean entire top of battery with the soda solution. After foaming stops, flush with clean water. Dry battery completely and install in lift truck. Apply a thin coat of petroleum jelly to battery post and cable terminals.

**CAUTION**

DO NOT FLUSH TOP OF BATTERY WHILE IT IS INSTALLED IN THE LIFT TRUCK. WATER COULD SEEP INTO ELECTRICAL COMPARTMENTS AND CAUSE SERIOUS DAMAGE.

II. BATTERY CHARGING

**CAUTION**

MAKE CERTAIN THE VENT HOLES IN THE FILLER PLUGS ARE OPEN TO ALLOW THE GAS TO ESCAPE FROM THE CELLS. WHEN BATTERY CHARGER IS CONNECTED TO THE BATTERY CONNECTOR, IT IS IMPERATIVE THAT CORRECT POLARITY BE OBSERVED. THAT IS, POSITIVE LEAD OF THE CHARGER MUST BE CONNECTED TO THE POSITIVE TERMINAL AND NEGATIVE LEAD TO THE NEGATIVE TERMINAL.

- A. The most important factor in battery service and life is proper charging. Make certain the proper method for each application is carefully followed. In general, a battery may be charged at any rate in amperes that does not cause excessive gassing or produce temperatures above 110° F (120° F for short periods only).
- B. A lead-acid battery should not require any routine overhaul or electrolyte changes during its entire life except in case of accidental loss of electrolyte. For exact information regarding charging and maintenance of individual battery, refer to the manufacturer's data.

**CAUTION**

REFRAIN FROM SMOKING IN IMMEDIATE VICINITY OF BATTERY OR FROM EXPOSING BATTERY TO AN OPEN FLAME DURING OR IMMEDIATELY AFTER CHARGING.



Battery Requirements

C. Battery specific gravity readings with electrolyte at 80°F are as follows:

Hydrometer Indication Charge Condition

1.110 - 1.135 completely discharged

1.140 - 1.200 one-fourth charged

1.205 - 1.230 one-half charged

1.235 - 1.260 three-fourths charged

1.265 - 1.290 fully charged

III. BATTERY STORAGE

- A. The battery should be stored in a clean, cool, dry location that is well-ventilated and away from a radiator or a heat duct.
- B. Before the battery is placed in storage, make certain electrolyte is a proper level in all the cells, filler plugs are tight, and battery is fully charged.
- C. Check electrolyte level and specific gravity every 30 days during storage. Whenever specific gravity is less than 1.230, the battery must be charged.

IV. BATTERY REPLACEMENT

A. Removal

1. Park truck on a firm, level floor.
2. Disconnect connector from of battery.
3. Attach chains and a suitable a hoist (see battery capacity tag) to remove battery.
4. Carefully lift battery up and away from truck. Place battery on suitable supports.

B. Installation

1. Attach chains and hoist to battery. Carefully lift battery into position on truck.
2. Connect truck cable connector to battery connector and lock in position.
3. Operate truck and check operation.

V. BATTERY SERVICING

A. Charging

1. The battery used with this vehicle must be kept charged for proper operation. Be certain there is enough solution in each cell to cover battery plates. While charging, do not allow battery temperature to exceed 110°F. Test occasionally while charging with a thermometer and reduce charging current if battery is excessively hot. Give battery ample ventilation while charging.



Battery Requirements

NOTE - Never allow battery to stand in a discharged condition.

B. Cleaning

1. Keep battery connections and terminals clean and dry. Tighten vent plugs and clean battery with a brush dipped in an alkaline solution such as ammonia or a solution of bicarbonate of soda and water. If terminals and cable connections are corroded, disconnect and clean in same manner as the battery. When battery is excessively dirty, remove connections and steam clean if possible. After a thorough cleaning and drying, apply a thin coat of petroleum jelly or other protective grease to connections.

NOTE - Oil should not be used on leads or connections as most insulating materials are softened and disintegrate with oil, thereby permitting arcing to occur.

“EE” Batteries

Some facilities where battery powered vehicles operate are classified as “Hazardous Locations”. Typically, these are facilities where combustible gasses or vapors, explosive mixtures or other hazardous materials are used, manufactured or processed.

Electric powered lift trucks used in Hazardous Locations **MUST**, by law, be equipped with special construction to allow them to operate safely in the hazardous environment.

If the facility is defined as “EE” the truck may require an “EE” battery. As a general rule, a truck with an enclosed battery compartment (in conformance with UL 583) and having an “EE” designation on its factory nameplate does not require an “EE” battery. **Where the battery compartment is exposed, a battery with “EE” construction is MANDATORY.**

If an “EE” battery is specified, a **special** covered battery is required. It may be 0.5" higher than a normal covered battery. Its cable leads will not be interchangeable (cable position on EE batteries is always between 2.0" and 6.0" in from the tray end). EE batteries have the same base dimensions as standard batteries.

A Type EE battery is a battery assembled as a unit with a cover, and in conformance with ANSI/UL 583, that can be locked for use in type EE trucks which do not have an enclosed battery compartment.

Along with the battery type designation on the truck nameplate, a Type EE industrial truck must have the EE marker (illustrated below) applied to each side of it.
(Black outline and letters on a yellow background.)





Section A: Operation & Service Instructions

I. INTRODUCTION.....	2
II. GENERAL DESCRIPTION.....	2
A. General Operation.....	2
B. Electrical System.....	2
C. Hydraulic System.....	3
D. Brakes.....	3
E. Chassis.....	3
III. TRAVEL CONTROLS.....	3
IV. BASIC OPERATING PROCEDURES.....	4
A. Check Before Operation.....	4
B. Fwd. & Rev. Travel, Steering, Braking, & Stopping.....	4-6
C. Approaching, Lifting, Transporting, & Depositing Loads..	6-7
V. SAFETY.....	7
A. Visual Checks.....	7
B. Operational Checks.....	7
C. Safeguarding Your Unit.....	8
D. Protect Other People.....	9-10
E. Protect Yourself.....	10-11
F. Protect Other Property.....	11
VI. PERIODIC MAINTENANCE CHECKLIST.....	11-12



Section A: Operation & Service Instructions

I. INTRODUCTION

This section contains a general description of operating instructions and service instructions for 1,000 pound through 150,000 pound capacity trucks. The two basic types of trucks covered in these instructions are walkie and rider units. These designations refer to basic chassis configurations. The trucks are designed for use on smooth, relatively level surfaces such as warehouse and factory floors, loading docks, and paved areas.

II. GENERAL DESCRIPTION

A. General Operation

1. Walkie trucks are designed for operation with the operator standing and walking at the front of the truck. No provision is made for the operator to ride on any part of these trucks. Travel may be in either the forward or reverse direction.
2. Walk-ride trucks are designed for operation with the operator standing or walking at the front of the truck or riding on a platform specifically provided for this purpose. Travel may be either in the forward or reverse direction.
3. Rider trucks are designed for operation with the operator standing and riding on the front of the truck. Travel may be in either the forward or reverse direction.

NOTE - Due to the various options available, refer to the data plate attached to the truck for information regarding:

1. **Truck model.**
2. **Serial number.**
3. **Truck weight (including battery).**
4. **Truck capacity.**
5. **Battery type.**
6. **System voltage.**

B. Electrical System

1. All trucks are battery powered for both lifting of loads and travel. Tractive effort is provided through a motor-driven wheel located at the front end of the truck. A separate electric motor drives the hydraulic pump which supplies hydraulic pressure for raising the load to be transported. A hydraulic valve is used to control the lowering of the load. The travel motor may be controlled through a two-speed resistance circuit or through a SCR or Transistor control circuit. The available options as they apply to the two types of trucks are shown in the chart on the next page.



Section A: Operation & Service Instructions

TRAVEL MOTOR CONTROL OPTIONS

OPTIONS	WALKIE	RIDER
Two - Speed Resistance	YES	NO
Three - Speed Resistance	YES	YES
SCR Transistor Control	YES	YES

C. Hydraulic System

1. A hydraulic system is used to raise the load. Pressure is applied by an electric motor driven pump. A single or dual hydraulic cylinder raises through mechanical linkages. A valve controls the lowering of the load.
2. Steering is controlled by means of a control handle or steering wheel located at the front of the truck. This handle or wheel is used to swivel the drive wheel.

D. Brake

1. A band or disc brake is mounted on the drive unit.
2. On walkie trucks, the brake is controlled by the control handle. When the control handle is in the vertical position, the brake is applied, preventing truck movement. When the control handle is either in the vertical and the horizontal position, the brake is applied to prevent truck movement. (See Figure 1).
3. On rider trucks, the brake is controlled by a foot pedal which is activated by the operator while standing on the front of the truck, depressing the pedal will release the brake. Releasing the pedal engages the brake.

E. Chassis

1. The chassis comprises of two basic elements: the drive unit mount plate assembly and the load handling system (i.e. forks, platform, die table, roll cradle, etc.). On rider trucks, the chassis may be articulated as an optional feature to improve performance over uneven surfaces. The drive unit and the hydraulic pump drive motor and pump are mounted on the drive unit mount plate assembly. The load handling system is supported at the front end by the drive unit mount plate assembly. The battery compartment is integral with the load handling system.

III. TRAVEL CONTROLS

This section is to point out the location of the operating controls found on most walkie and rider units. (See Figure 1).

1. Lower Push Button
2. Lift Push Button
3. Horn

Section A: Operation & Service Instructions

IV. BASIC OPERATING PROCEDURES

A. Check Before Operation

1. Check that the battery is clean, externally dry, and charged to 1.250 specific to gravity. Check electrolyte level of all cells. Add water to cover the plates if needed.
2. With the load handling system fully lowered, check hydraulic fluid level.
3. Visually check truck for obvious discrepancies such as hydraulic fluid leaks, and loose or damaged parts.
4. Operational Check before Use:
 - a. Check operation of brake and steering.
 - b. Check operation of drive and hydraulic pump motors.
 - c. Check operation of lifting mechanism.
 - d. Check for unusual noises while traveling unloaded in both forward and reverse.

B. Forward & Reverse Travel, Steering, Braking and Stopping

1. Assume the operator's position:
 - a. **Walkie:** Standing at the front of the truck facing the steering handle end and grasping the hand guards with both hands.
 - b. **Rider:** Standing on the right side of the front riding compartment of the truck and grasping the control handle with the right hand and the steering wheel knob with the left hand.

**CAUTION**

THE FOLLOWING CONTROL FUNCTIONS FOR WALKIE TRUCKS SHOULD ONLY BE INITIATED WITH THE TILLER HANDLE PLACED IN THE UPRIGHT POSITION.

2. Raise the load handling system.
 - a. **Walkie:** Depress the push button located in the right end or center of the control handle until the load handling system is fully raised.
 - b. **Rider:** Depress the push button located in the top end of the "T" bar control handle.
 - c. **Walkie or Rider:** Manual control valve levers mounted on the operator's right. Pull lever toward operator to accomplish the raise function.

Section A: Operation & Service Instructions

3. Release the brake.
 - a. **Walkie:** With hands placed on the handle guards, gently swing the control handle downward.

**CAUTION**

ROTATING HANDLE GRIPS BEYOND SLOW SPEED BEFORE RELEASING THE BRAKE MAY CAUSE THE TRUCK TO LURCH.

- b. **Rider:** When standing and riding on the front rider platform, the brake is disengaged by depressing the pedal. Remove foot from brake pedal to engage the brake.
4. Travel and Steering.
 - a. **Walkie with Two-Speed Control:** Move hands to the control handle grips and rotate the grips in the direction you want to travel. Since the two handle grips are linked together, rotation by either hand is sufficient. For smooth operation, rotate the handle grips to the first operating (slower speed) position. If higher speed is desired, rotate the handle grips farther to the second (high speed) position after the truck is in motion. Rotating the control handle grips suddenly from the neutral position to the higher speed position will cause the truck to lurch. Steer the truck by swinging the control handle to the left or right as required. When traveling with the load in the rear use one hand and walk to one side of the truck.
 - b. **Walkie with Three-Speed Control:** Move hands to the control handle grips and rotate the grips in the direction you want to travel. Since the two handle grips are linked together, rotation of either hand is sufficient. For smooth operation, rotate the handle grips to the first (slowest speed) position. If high speed is desired, rotate the grips to the second (intermediate speed) position and third (highest speed) positions after the truck is in motion. Rotating the handle grips suddenly from the neutral position to either the second or third position will cause the truck to lurch. Steer the truck by swinging the control handle to the left or right as required. Walk with the truck as it travels; traveling with the load trailing is recommended where distance is a factor. Walk ahead and to the side of the front of the truck.
 - c. **Walkie with SCR or Transistor Control:** Move hands to the control handle grips and rotate the grips in the direction you want to travel. Since the two handle grips are linked together, rotation by either hand is sufficient. For smoother operation, rotate handle grips slowly until truck reaches desired speed. Speed is proportional to rotation of the handle grips. Steer the truck by swinging the control handle to the left or right as required. Walk with the truck as it travels; traveling with the load trailing is recommended where distance is a factor. Walk ahead and to the side of the front of the truck.
 - d. **Rider with SCR or Transistor Control:** Rotate the control handle in the direction you want to travel. Speed of travel is proportional to rotation of handle. For smooth operation, rotate the handle slowly until the truck reaches the desired speed. Steer the truck by rotating the steering wheel in the clockwise or counter-clockwise direction.



Section A: Operation & Service Instructions

5. Braking and Stopping.

- a. **Walkie:** Relax hold on the control handle grip(s), allowing them to return to the neutral position. Then depress the control handle to the nearly horizontal position or allow the control handle to return to the vertical position, thus applying the brake.

NOTE - To avoid lurching when restarting a two-speed or three-speed truck, do not rotate the handle grips beyond the first position before releasing the brake by raising or lowering the control handle.

- b. **Rider:** Relax hold on the "T" bar control handle allowing it to return to the neutral position. When operating in the riding mode, depress brake pedal to disengage brake. Remove foot from brake pedal to engage brake.

C. Approaching, Lifting, Transporting and Depositing Loads

1. Lowering the load handling system.

- a. **Walkie:** Depress the push button labeled "lower".
- b. **Rider:** Depress the push button labeled "lower".
- c. **Walkie or Rider:** Manual control valve levers mounted on the operator's right. Push lever forward to lower load handling system.

2. Approaching the Load.

- a. Approach the load squarely with load handling system fully lowered and approximately centered under the load. Move truck until the handling device is completely under the load.

3. Lifting the Load.

- a. **Walkie:** Depress the push button located in the right end or center of the control handle until the load clears the floor.
- b. **Rider:** Depress the push button located in the top of the "T" bar control handle until the load clears the floor.
- c. **Walkie or Rider:** Manual control valve levers are mounted on the operator's right. Pull lever toward the operator to raise the load.

4. Transporting the Load

- a. Operate the truck as previously described to transport the load to the desired location. Avoid sharp turns, sudden stops, and rapid acceleration when traveling with loads.



Section A: Operation & Service Instructions

5. Depositing the Load
 - a. **Walkie:** Depress the push button located in the left end or center of the control handle until the load handling system is in a fully lowered position and the load is independent of the load handling device. Slowly withdraw from underneath the load.
 - b. **Rider:** Depress the push button located in the right end of the "T" bar control handle until the load handling system is in a fully lowered position and the load is independent of the load handling device. Slowly withdraw from underneath the load.
 - c. **Walkie or Rider:** Manual control valve levers mounted on the operator's right. Push lever forward to lower until the load handling system is in a fully lowered position and the load is independent of the load handling device. Slowly withdraw from underneath the load.

NOTE - Trucks may be equipped with special controls. See label on each truck before operating.

V. SAFETY

Safety should be your primary concern when operating and maintaining the truck. Most accidents are caused by operator carelessness or misjudgment. Adhere to the following safety hints, and at all times, use good common sense.

1. Report any malfunctions to your supervisor & remove truck from service until it can be repaired.

A. VISUAL CHECKS

1. Battery is charged. Battery water level is OK. Vent caps are in place. Connector is secure.
2. Lifting chains are in place (if applicable).
3. Tires and load wheels are in good operating condition.
4. Safety shield(s) are clean (if applicable).
5. Forks are in place and properly secured.

B. OPERATIONAL CHECKS

1. Operate and re-engage the emergency power disconnect or battery connector.
2. Make sure horn is operational (toot it).
3. Raise the forks / platform.
4. Lower the forks / platform
5. Travel (slowly).
6. Apply brakes to make sure they are efficiently braking properly.



Section A: Operation & Service Instructions

7. Check the steering.
8. Test the travel through full speed range in both forward and reverse.
9. Extend and retract reach mechanism for proper operation (if applicable).
10. Tilt the mast forward and reverse or fork tips downward or upward (if applicable).
11. Pay attention to all labels and markings on truck including all attachments (if applicable).
12. YOU - are you well and alert?

C. SAFEGUARDING YOUR UNIT

1. Make safety checks and observations before use. Report any issues or concerns to your Immediate supervisor.
2. Don't let others operate your unit unless they are properly and fully authorized and trained to run that particular unit(s).
3. Use caution when changing direction with your truck. Come to a complete stop before changing direction whether it is traveling forward, reverse, left, or right.
4. Don't overload your truck (know its capacity). Overloading could upset your unit and cause hydraulic or mechanical failure endangering both you and the components on the truck.
5. Avoid sudden stops and starts with the truck.
6. Check the work area that you will be operating the truck in. Look for damaged floors. Note overhead obstructions, ramps, and docks. Make certain your unit is intended for ramp use. Check traffic areas for obstructions and pedestrian traffic.
7. When leaving your unit unattended, **Always** observe the following:
 - a. Fully lower forks.
 - b. Turn off key switch (if applicable).
 - c. Apply (set) emergency parking brake (if applicable).
 - d. Avoid parking on inclines when possible.
 - e. Block wheels of unit if you must park on an incline.
8. Maintain a distance of at least three truck lengths from the truck ahead of your unit.
9. Observe all in-plant speed limits.
10. Keep walkie units under control at **ALL** times.



Section A: Operation & Service Instructions

11. Don't pass other vehicles traveling in the same direction at intersections, blind spots or other dangerous locations.
12. Avoid running over loose objects in the aisle.
13. When attachments are used, operate the truck with a partial load to prevent tipping of truck.

D. PROTECT OTHER PEOPLE

1. Don't let others operate your unit unless they are properly authorized and trained.
2. No riders!
3. When elevating personnel:
 - a. Use a securely attached safety platform.
 - b. Make certain lifting mechanism is operating properly.
 - c. Mast is vertical (never tilt when elevated if applicable).
 - d. Make certain truck brake is set.
 - e. Lift and lower load smoothly.
 - f. Watch for overhead obstructions and other surroundings that may cause damage to you or the truck.
 - g. Never transport personnel on the platform from one location to another.
4. Watch for pedestrians when operating the truck and yield to their presence.
5. Slow down and use caution in congested areas.
6. Lower the forks when traveling. When truck is parked, lower the forks to the point where the forks are resting on the floor.
7. Always yield the right-of-way to vehicles on your right. (Except when national customs differ).
8. Don't follow too closely. Leave plenty of room for safe stopping and traveling of truck.
9. Sound your horn when approaching intersecting aisles.
10. Never drive your unit up to anyone standing in front of a fixed object.
11. Do not allow anyone to stand or pass underneath the elevated portion of the truck.
12. Operate at a speed that will permit the truck to be brought to a stop in a safe manner.



Section A: Operation & Service Instructions

13. Spread forks outward as far as the load will permit.
14. Handle only stable loads. Do not even attempt to lift an unstable load. Report any unstable loads to your immediate supervisor.
15. Use extreme care when handling long, high, or wide loads.
16. Tilting (if applicable):
 - a. Tilt forward only to deposit or pick up load.
 - b. Tilt forward only at lower elevations.
 - c. Tilt rearward only to stabilize the load.

E. PROTECT YOURSELF

17. Are you properly trained and authorized to operate this truck?
18. Watch for overhead obstructions.
19. Keep your arms, hands, and legs away from the lifting mechanism on the truck.
20. Keep your feet clear of wheels.
21. Do not drive with wet or greasy hands.
22. Check capacity and mounting of dock boards before using.
23. When using an elevator for unit transporting, please read and observe the following:
 - a. Do not drive onto elevator unless authorized and properly trained to do so.
 - b. Check capacity of elevator before entering.
 - c. Check to make certain all personnel has left the elevator.
 - d. Enter elevator load first.
 - e. Enter squarely and slowly.
 - f. Neutralize control - Shut off power - Set brakes.
24. Never pass or stand under the elevating portion of truck.
25. Maintain a safe distance from the edges of ramps, dock boards, and docks.
26. Never use your unit in an unauthorized area or explosive atmosphere **(UNLESS UNIT IS TYPE "EX" RATED)**.



Section A: Operation & Service Instructions

27. Ascend or descend grades slowly with loads always down grade.
28. Don't turn on grades, ramps, or inclines. Always travel straight up or straight down.
29. Slow down and proceed with caution when making turns.
30. Travel with load against the vertical face of the forks and with load or lifting mechanism at minimum ground clearance and tilted back.

F. PROTECT OTHER PROPERTY

1. Slow down for hazardous conditions (such as wet or slippery floors).
2. Avoid bumping into objects.
3. Be sure your load or forks are clear before lowering.
4. Be alert - Anticipate.
5. Yield to emergency vehicles.
6. Travel in the direction providing the best visibility.

For additional information pertaining to operating and maintenance procedures, we recommend the American National Standards ANSI B56.1.

VI. PERIODIC MAINTENANCE CHECKLIST

The information which follows describes in detail the maintenance requirements of all standard walkie and rider trucks including trucks equipped with standard optional equipment. Disregard references to any equipment which is not on your truck. Taking care of your truck according to the guidance given here will guarantee long satisfactory service. Your equipment dealer can arrange to have any of the procedures taken care of for you, should they be beyond the scope of your facilities.



Section A: Operation & Service Instructions

PERIODIC MAINTENANCE CHECKLIST

ITEM	DAILY	ONCE PER MONTH MINIMUM	AS REQUIRED 6 MONTH MINIMUM
A. HYDRAULIC SYSTEM			
1. Check hydraulic oil level (add oil as required).	X		
2. Check operation of lift cylinder.	X		
3. Check symptom for leaks (all components & connections).	X		
4. Check pump for noise & operation.		X	
5. Check solenoid valve operation.		X	
B. ELECTRICAL SYSTEM (INCLUDING MOTORS)			
1. Blow out drive motor.			X (500 HRS.)
2. Check motor commutators.		X	
3. Check motor brushes & brush spring tension.			X (500 HRS.)
4. Check motor mounting & electrical connectors.		X	
5. Check battery connectors.	X		
6. Check battery electrolyte level & specific gravity (add water as required).	X		
7. Check horn operation.	X		
8. Check contact fingers wear & adjustment (two-speed & three-speed only).		X	
9. Check forward & reverse switch adjustment (SCR or Transistor only).		X	
10. Check potentiometer operation (SCR or Transistor Control only).		X	
11. Check contactor tips. Clean or replace as required.		X	
12. Check wiring & terminals. (Keep clean & bright).		X	
13. Check resistor(s) (two-speed & three-speed only).		X	
14. Check brake cutout switch.		X	
15. Check pump motor contactor.		X	
C. DRIVE UNIT & BRAKE			
1. Check brake mounting, drum or disc, linings, & return spring.		X	
2. Check brake operation (adjust if required).	X		
3. Check drive belt (tension & wear).		X	
4. Check control handle spring return.		X	
5. Check drive unit, motor, transmission, & control handle mounting.		X	
6. Check for noisy operation & oil leakage.		X	
7. Check drive tire for damage & wear.		X	
D. CHASSIS & FORKS			
1. Check raising & lowering of forks.	X		
2. Check entry wheels for damage & wear.		X	
3. Check load wheels for damage & wear.	X		
4. Check paint finish & markings.		X	



MAINTENANCE INSTRUCTIONS

SUPPLY VEHICLE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS
FOR VEHICLE AND PARTS INFORMATION CONTACT CUSTOMER SERVICE BPR/RICO (330)723-4050 FAX(330)723-4012

CUSTOM DESIGNED
Electrically Powered Lift Trucks

MANUFACTURED BY
BPR/RICO MANUFACTURING INCORPORATED

DIVIDER III



SECTION B: TRANSMISSION

**CONTACT FACTORY FOR FURTHER
MAINTENANCE INSTRUCTIONS.**



Section C: Electromagnetic Brakes

I. DESCRIPTION AND OPERATION INSRUCTIONS.....	2
A. How It Works.....	2
B. How To Use It.....	2-3
II. REPAIRS AND PREVENTATIVE MAINTENANCE.....	4
A. Fitting.....	4
B. Altering The Torque Ratings.....	4-6

Section C: Electromagnetic Brakes

I. DESCRIPTION AND OPERATION INSTRUCTIONS

A. HOW IT WORKS.

1. You will see from the drawing in **FIGURE-1** that the spring-loaded brake is a failsafe brake with two friction surfaces. Its torque is produced with spring pressure which is adjustable and the brake is released electromagnetically.
2. If you look at **FIGURE-1**, you will notice that the brake is shown in its braking position, with no current flowing in the coil. The springs (**#4**) are pressing the armature plate (**#2**) against a rotor (**#7**) which in turn is pushed against a counter surface **A-B**.
3. Pass an electric current through the coil (**#1**) and the armature plate (**#2**) will be attracted to the coil body (stator). As the armature plate moves, the air gap 'a' is reduced to zero and the rotor (**#7**) is free to rotate.

B. HOW TO USE IT.

1. The components.

- a. The main components are preassembled from their constituent parts. These main components are:

STATOR/ARMATURE ASSEMBLY: (parts 1, 2, 3, 4, 5, and 8).

ROTOR AND HUB: (parts 6 and 7).

ASSEMBLY KIT: (parts 9a and 9b).

- b. The stator/armature assembly consists of a stator body with its coil (**#1**), compression springs (**#4**), tappets (**#5**), torque adjusting ring (**#3**), armature plate (**#2**) and adjustment tubes (**#8**).
- c. The rotor (**#7**) is made of a non-magnetic material which also has a very low inertia and friction material (**#6a**) is bonded to both sides. The rotor's internal splines engage the splined but to allow the rotor to move freely axially. The brake is fixed to the counter surface **A-B** by using 3 (or 6 on sizes 20 and 25) hexagon socket screw (**#9a**).

2. Electrical connections.

The brake requires D.C. voltage to operate correctly. The necessary D.C. voltage can be provided by one of our Power Units or a Bridge Rectifier type or your own supply.



Section C: Electromagnetic Brakes

3. Accessories.

- a. Should power fail, the brake can be released mechanically provided the manual release mechanism is available. Pulling the handle will release the rotor by moving the armature plate away from it. The release is a 'deadman' type. When you let go, the brake immediately returns to its failsafe function.
- b. If there is not a recommended mounting surface **A-B** ground to 5-8 m surface roughness available, mounting flange should be used. The flange can be fixed by using one of two sets of mounting hole configurations.
- c. If the environment contains oil, dirt and moisture, the friction surface should be covered by a rubber seal. Stretch the seal over the gap where the rotor is located and allow it to snap into the grooves provided in the stator and mounting flange.
- d. If the standard flange is not used, a suitable groove should be provided on the surface.

4. Maintenance.

In most applications, the brake needs practically no maintenance. However, after a long period of operation, or when the brake has done a slot of work, adjustment of the air gap '**a**' may be required. When the '**a max**' value as shown in **TABLE-1** is exceeded, adjustment is necessary, back to the nominal value '**a**'.

TABLE - 1

SIZE	06	08	10	12	14	16	18	20	25
'a' INCH	.008	.008	.008	.012	.012	.012	.016	.016	.020
'a max' INCH	.020	.024	.024	.040	.043	.055	.055	.063	.087
'u' Inch	.040	.040	.040	.040	.040	.059	.059	.059	.059

Section C: Electromagnetic Brakes

II. REPAIRS AND PREVENTATIVE MAINTENANCE.

A. FITTING.

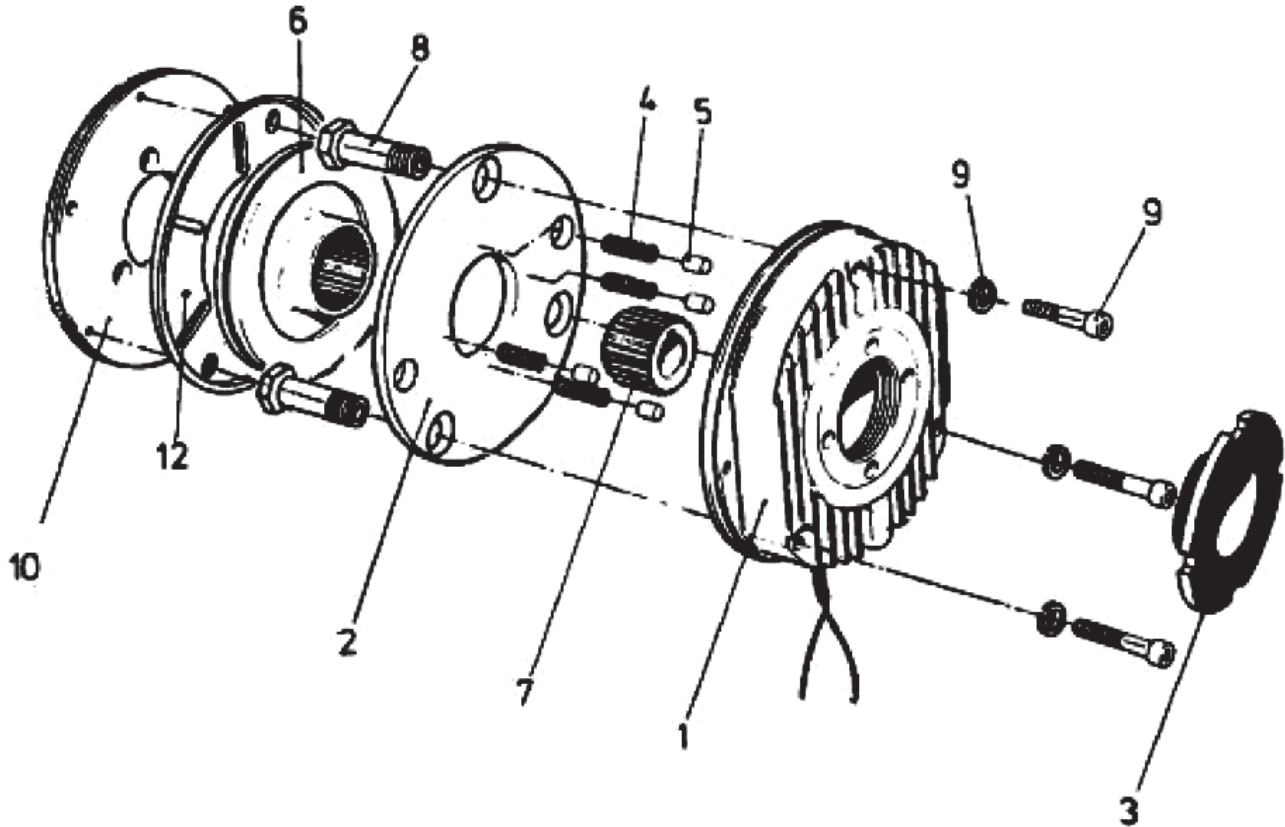
1. Where a suitable counter surface can not be provided, screw a mounting flange (#10) onto your machine.
2. Press the hub (#6) onto the shaft, please check tolerance **K6**. The hub should be secured both axially and from rotating.
3. Place the rotor (#7) onto its hub (#6).
4. Place the assembly kit screws (#9a) in the holes provided in the stator/armature assembly. Do not forget the spring washers (#9b). If you are not fitting a manual release kit, go forward to step 7.
5. The manual release lever and fork is shipped pre-assembled.
6. Remove the two fitting nuts (#12e) and associated springs. Assembly them to the stator/armature as shown in the figure below. Do not tighten the nuts (#12e) yet.
7. Screw the brake to its mounting flange or counter surface and do not forget to remove the transit clips from the adjustment tubes.
8. You can check the air gap measurement most easily by using feeler gauges in three positions.
9. If adjustment should be necessary, loosen screws (#9a) and the air gap can be set by rotating the adjustment tubes (#8). Re-tighten screws (#9a).

NOTE - The friction surface should never be allowed to come into contact with any lubricant whatsoever.

B. ALTERING THE TORQUE RATINGS.

The brake is supplied with the nominal torque settings from the factory. This torque can be reduced by unscrewing the torque adjusting ring (#3) with a 'C' spanner, as far as dimension **0_i** in **FIGURE-1**. The torque adjuster has a step or decent action and the torque variation per step is given in **TABLE-2**.

Section C: Electromagnetic Brakes



NO.	DESCRIPTION	NO.	DESCRIPTION
1	Stator (Stator/Armature Assembly)	7	Hub
2	Armature Plate	8	Adjustment Tube Kit
3	Adjuster Nut	9	Mounting Screws (9a + 9b)
4	Spring	10	Mounting Flange
5	Tappet (Spring & Tappet Kit)	11	Seal (Option)
6	Rotor	12	Wear Plate

***There are no steps for this size. The figure given relates to a rotational angle of 45° of the adjuster.

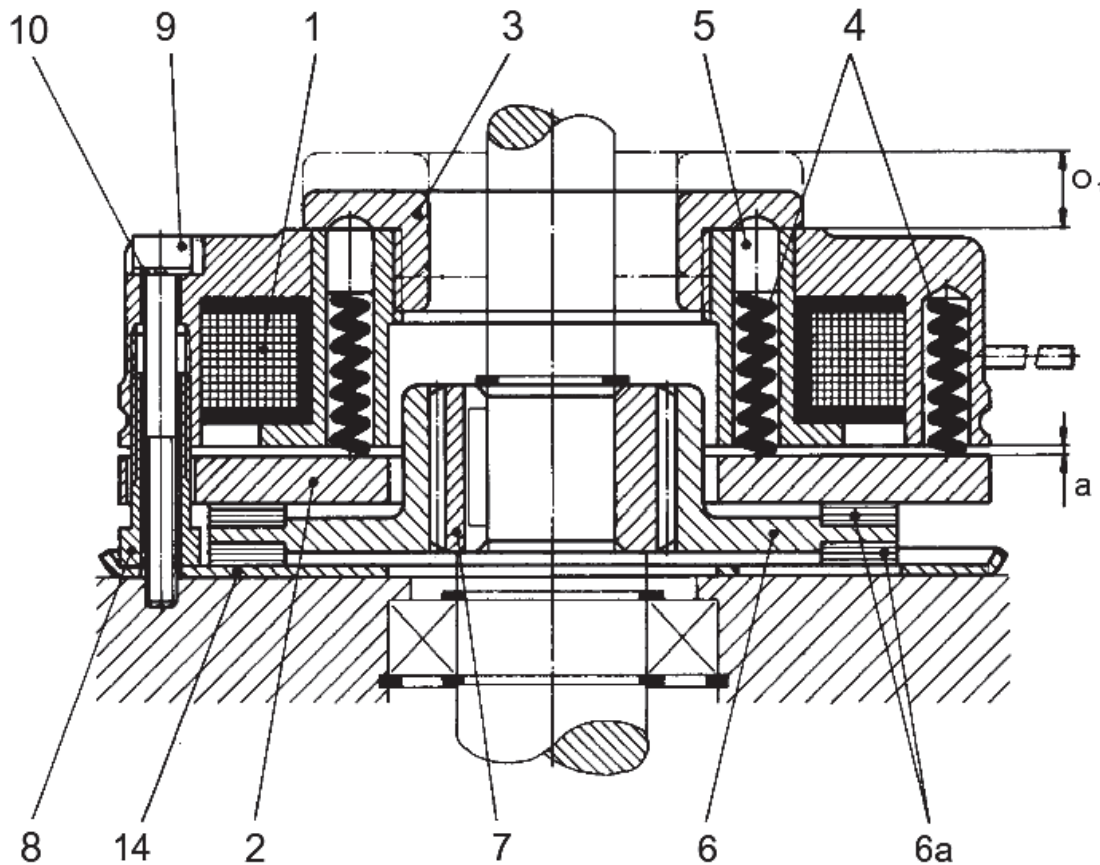
Section C: Electromagnetic Brakes

TABLE - 2

SIZE	06	08	10	12	14	16	18	20	25
Torque LBS. - FT.	3	6	12	24	44	60	110	178	25
Torque Reduction/Step LBS.- FT.	0.074	0.148	0.443	0.885	1.18	1.55	1.03	1.48	3.69
O_1 (FIG. - 1 Inch)	0.24	0.26	0.33	0.39	0.45	0.45	0.51	0.59	0.63

SOME PARTS ARE NOT AVAILABLE SEPARATELY FROM THE COMPLETE KIT, EX. #12 HAND RELEASE KIT

FIGURE - 1





Section D: Electrical System

I. GENERAL.....	2
II. CIRCUIT OPERATION.....	2
A. Battery Operation.....	2
B. Drive Motor and Drive Motor Control Circuit....	2
C. Lower Solenoid and Circuit.....	2
D. Horn Circuit.....	2
III. PREVENTATIVE MAINTENANCE.....	3
A. Battery.....	3
B. Drive Motor Control Switch.....	3
C. Contactor Panel.....	3
D. Drive Motor.....	3-5
E. Pump Motor and Pump Motor Contactor.....	5
IV. ELECTRICAL OPERATION TROUBLESHOOTING.	5-7
V. DRIVE MOTOR REPAIR AND OVERHAUL.....	7
A. General.....	7
B. Drive Motor Disassembly.....	7-9
C. Parts Cleaning.....	9-10
D. Repair and Replacement of Drive Motor Parts.	10-11
E. Assembly and Testing.....	11-14
VI. PUMP MOTOR REPAIR AND OVERHAUL.....	15
A. General.....	15
B. Pump Motor Assembly.....	15
C. Cleaning Parts.....	15
D. Parts Inspection and Replacement.....	15-16
E. Repair and Replacement of Pump Motor.....	16-17
F. Assembly and Testing.....	17
VII. PREVENTATIVE MAINTENANCE CHECKLIST.....	21



Section D: Electrical System

I. GENERAL

This section contains information on circuit operation, electrical system troubleshooting, replacement and adjustment of components, and repair instructions for repairable components.

II. CIRCUIT OPERATION

A. Battery

All electrical energy for operating the electrical system is supplied by a storage battery mounted on the truck and connected to the main terminal block through a battery cable connector. The storage battery may be either 12, 18, 24 or 36 volts.

B. Drive Motor and Drive Motor Control Circuit

The drive motor is an externally-connected four-pole or six-pole DC motor and operates as a series connected motor. Operation of the motor requires that the brake cutout switch be closed since all contactors on the contactor panel depend upon battery current through this switch. The brake cutout switch is mechanically operated by the control handle. The switch is open when the handle is in the vertical or horizontal position and is closed only when the handle is lowered to the operating position. Rotating the control handle grips to the first "forward" position closes the handle switch to complete the battery circuit to contactor. When energized, the contactor completes a circuit from positive battery to motor field terminal S1. Since the contactor remains de-energized, a series circuit is completed through the motor field, resistor RES. and the motor armature, causing the motor to rotate in the counter-clockwise direction as viewed from the output shaft end. When the control handle grips are rotated to the first "reverse" position, handle switch closes, completing the battery circuit to the contactor. The contactor completes a similar series circuit to the motor except that the current flow through the field is reversed, causing the motor to rotate in the clockwise direction. Rotating the handle grips to the second position (either forward or reverse) closes the handle switch 1A which in turn completes the circuit to contactor 1A. Energized, contactor 1A shunts resistor RES, thus allowing full battery voltage to be applied to the series connected motor for maximum forward or reverse speed. The timer provides a slight time delay to prevent lurching and to assure smooth acceleration. If the brake cutout switch opens while the drive motor is running, the circuit to the contactor forward or reverse is opened, causing the contactor to be de-energized to open the drive motor circuit.

C. Lower Solenoid Valve Circuit

Pressing in on the LOWER momentary contact push-button completes the battery circuit to the lower solenoid valve. When energized, the lower solenoid valve allows the hydraulic fluid in the raising cylinder to return to the hydraulic fluid reservoir and thus the truck forks lower. Note that the LOWER push-button switch is effective with the control handle in any position.

D. Horn Circuit

The horn is energized by means of the momentary contact horn push-button switch on the control handle. A fuse is included for protection in the horn circuit.



Section D: Electrical System

III. PREVENTATIVE MAINTENANCE

Please refer to the PREVENTATIVE MAINTENANCE TABLE found at the end of this section for general maintenance checks.

A. Battery

Follow the instructions supplied by the manufacturer of the battery for care and charging.

B. Drive Motor Control Switch

The drive motor control switch is located under the cover at the top of the control handle and is actuated by the roller grip handles. Remove the handle switch cover for access to these switches.

C. Contactor Panel

At least once a month under normal operating conditions, remove the drive unit front cover and inspect and service the contactor panel as outlined below.

1. Blow out the accumulation of dust with compressed air at approximately 40 lbs. psi.
2. Check that all electrical connections are tight. Tighten any loose connections.
3. Inspect for damage to wiring, contactor coils, timer and resistor such as scorching or burning of insulation due to electrical overloading.
4. Check that all screws and nuts are tight. Tighten loose items.
5. Check and service contactors as follows:
 - a. Darkening of contact tips does not indicate burning. The darkening of the tips is normal. Burning is judged by actual loss of contact material or by droplets of molten contact material being displaced. The contact itself may be used until the contact material has been almost completely worn away; however, it is advisable to replace tips when there is not enough tip material remaining to last until the next regular maintenance check.
 - b. Do not file contact tips for the purpose of removing discoloration or minor surface irregularities. Such action wastes good contact material and produces a contact surface which is susceptible to sticking. Occasionally a core and crater may develop on a pair of tips. To ensure continuous reliability of such contacts, remove the core only with a fine tooth file. Do not use sandpaper or emery cloth.

D. Drive Motor

1. At intervals not exceeding one month, remove the drive unit covers and inspect and service the drive motor as follows:
 - a. Remove the band cover from the commutator end of the drive motor.
 - b. Lift brush holders and compare length against new brush from stock. If any brush is less than one half the length of new brush, replace all brushes as a set.

Section D: Electrical System

- c. Check to make sure that the brushes slide freely in brush holders.
- d. Check to make sure the force of brush springs against brushes is between 1 pound 4 ounces and 1 pound 12 ounces. Replace brush springs if this requirement is not met.
- e. Check the surface of the commutator is smooth with a glossy brown color. If commutator has this appearance, no servicing is required. If commutator is pitted, the reason might be:
 - (1) Worn brushes.
 - (2) Brushes not free in brush holders.
 - (3) Weak brush springs.
 - (4) Motor has been overloaded.
 - (5) Operation with insufficiently charged battery..
 - (6) Loose electrical connections in motor circuit.
 - (7) Dirty contactor tips.
- f. If brushes have been replaced or if commutator is pitted or has other slight surface defects, proceed as follows:

**CAUTION**

WHEN PERFORMING THE FOLLOWING PROCEDURE, APPLY ONLY ½ to 2/3 OF RATED MOTOR VOLTAGE TO THE DRIVE MOTOR. OPERATION OF THE DRIVE MOTOR AT FULL RATED VOLTAGE WHILE UNLOADED WILL CAUSE THE MOTOR TO OVER SPEED, RESULTING IN SERVICE DAMAGE TO THE MOTOR.

- (1) Jack up the rear end of the truck so that the drive wheel clears the floor.
 - (2) Disconnect the cables from motor terminals. Connect the armature and field in series across a DC voltage source equal to 1/6 to 1/3 rated motor voltage.
 - (3) With motor running, stone the commutator until the surface is clean and bright and the brushes are completely seated as evidenced by little or no sparking between brushes and commutator. Do not use emery cloth to clean the commutator.
 - (4) Disconnect voltage source from motor and reconnect cables to motor terminals.
 - (5) Remove jack from rear end of truck.
2. At intervals not exceeding six months, perform the following additional services to those outlined in preceding paragraph D.1 while drive unit covers are removed:
- a. Blow out the accumulation of dust from inside the drive motor by directing compressed air nozzle (approximately 40 lbs. psi.) into openings in the ends of motor.



Section D: Electrical System

- b. Check that all mounting posts are tight and that electrical connections are secure. Tighten any loose parts.

E. Pump Motor and Pump Motor Contactor

Disassembly of the pump motor for inspection of brushes and commutator condition is recommended each time the hydraulic pump and reservoir are serviced. Refer to the disassembly and reassembly instructions in this section.

IV. ELECTRICAL OPERATION TROUBLESHOOTING.

Troubleshooting of electrical operating malfunctions is presented in table D-2.

TABLE D-2

TROUBLE	PROBABLE CAUSE	REMEDY
Truck will not drive forward.	Discharged battery Loose electrical connection between battery and terminal block. Between terminal block and -Brake cutout switch. -Contactor panel. -Drive motor. Between resistor RES and motor. Defective brake cutout switch. Defective drive motor.	Recharge or replace battery. Locate and repair electrical connection. Replace brake cutout switch. Repair or replace motor.
Truck drives in forward but will not drive in reverse.	Defective "R" switch on control handle. Defective "R" contactor on contactor panel. Loose electrical connection between "R" contactor and -Terminal block. -Motor. -Resistor RES.	Adjust or repair "R" switch. Repair or replace "R" contactor. Locate and repair loose electrical connection.



Section D: Electrical System

TROUBLE	PROBABLE CAUSE	REMEDY
Truck drives in reverse but will not drive in forward.	Defective "F" switch on control handle.	Adjust or repair "R" switch.
	Defective "F" contactor on contactor panel.	Repair or replace "F" contactor.
	Loose electrical connection between "F" contactor and -Terminal block. -Motor. -Resistor RES.	Locate and repair loose electrical connection.
Truck drives in forward and reverse at high speed but will not drive at low speed.	Defective 1A contactor.	Repair or replace 1A contactor.
	Defective resistor RES.	Replace resistor RES.
	Defective 1A switch on control handle.	Adjust or replace 1A switch.
Truck drives in forward and reverse at slow speed but will not drive at high speed.	Loose electrical connection between contactor panel 1A and -Brake cutout switch. -Control handle 1A Switch. -Resistor RES. -Timer.	Locate and repair loose electrical connection.
	Defective 1A switch on control handle.	Adjust or replace 1A switch.
	Defective timer.	Replace timer.
	Defective 1A contactor.	Repair or replace 1A contactor.
Pump motor will not operate.	Loose electrical connection between -Battery and terminal block. -Terminal block and RAISE contactor, motor, or RAISE switch. -RAISE contactor & motor.	Locate and repair loose electrical connection.
	Defective RAISE contactor.	Replace RAISE contactor.
	Defective RAISE switch.	Replace RAISE switch.
	Defective pump motor.	Repair or replace pump motor.



Section D: Electrical System

TROUBLE	PROBABLE CAUSE	REMEDY
LOWER solenoid valve does not operate.	Loose electrical connection between -Battery and terminal block. -Terminal block and LOWER contactor, motor, or LOWER switch. -Solenoid valve and LOWER switch. Defective LOWER switch. Defective LOWER solenoid valve.	Locate and repair loose electrical connection. Replace LOWER switch. Replace LOWER solenoid valve.
Horn will not sound.	Blown "F" fuse. Loose electrical connection between -Battery and terminal block. -Terminal block and "F" fuse on HORN switch. -HORN and "F" fuse on HORN switch. Defective HORN switch. Defective HORN.	Replace blown fuse. Replace HORN switch. Replace Horn.

V. DRIVE MOTOR REPAIR AND OVERHAUL.

A. General

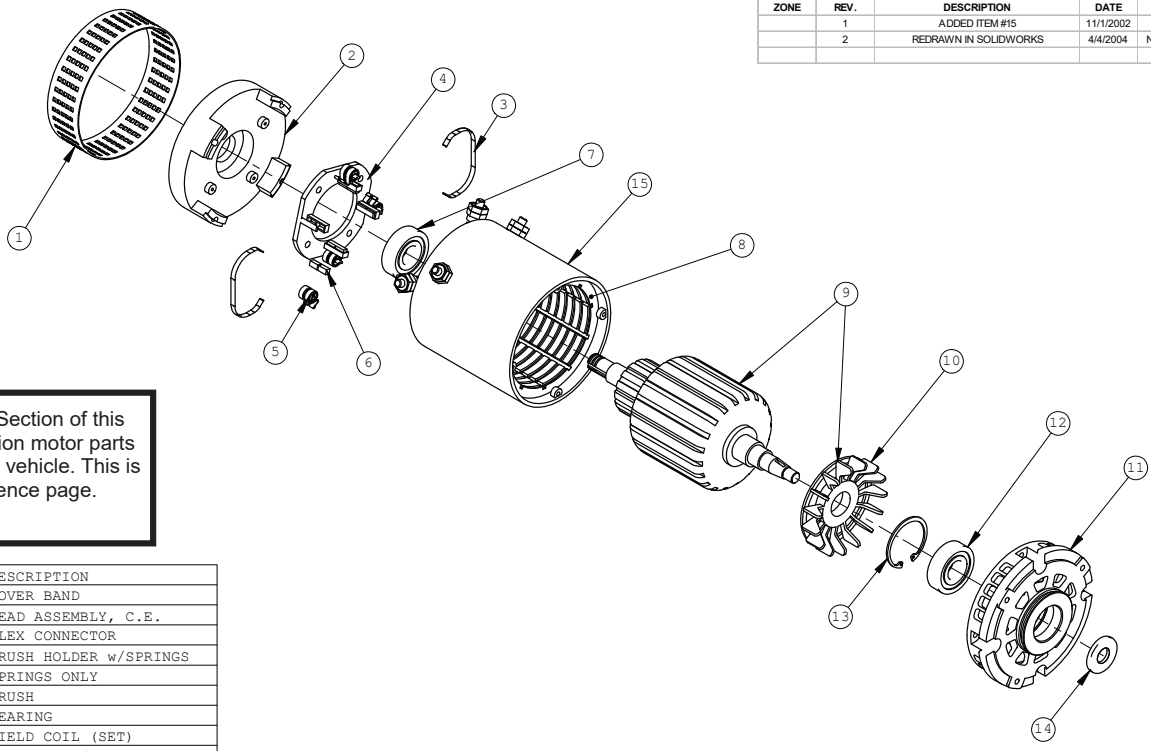
The drive motor is of the four-pole or six-pole, externally series-connected DC type. Voltage may be either 12, 18, 24 or 36 volts depending on the internal design of the motor. The output shaft is designed to mount the drive pulley and (when required) a fan. The armature shaft is ball-bearing mounted at both ends. Bearings are permanently lubricated and sealed and require no periodic lubrication.

NOTE - Disassembly of the drive motor is not recommended because of the special service facilities needed for satisfactory repair. Service exchanges for the drive motor and the drive motor armature are available from your dealer.

B. Drive Motor Disassembly

Clean the exterior of the drive motor thoroughly to remove dust, dirt, and foreign matter. Next, disassemble only as far as necessary to accomplish repair as described in the following procedure. (See figure D.4).

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
	1	ADDED ITEM #15	11/1/2002	BJM
	2	REDRAWN IN SOLIDWORKS	4/4/2004	NA/Pfeng



See the Parts Section of this manual for traction motor parts pertaining to this vehicle. This is only a reference page.

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1		COVER BAND
2	1		HEAD ASSEMBLY, C.E.
3	2		FLEX CONNECTOR
4	1		BRUSH HOLDER w/SPRINGS
5	8		SPRINGS ONLY
6	4		BRUSH
7	1		BEARING
8	1		FIELD COIL (SET)
9	1		ARMATURE w/FAN
10	1		FAN ONLY
11	1		HEAD ASSEMBLY, D.E.
12	1		BEARING
13	1		SNAP RING
14	1		SEAL
15	1		BODY SHELL
16	4		TERMINAL STUD CASE

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RICO DRIVE MOTOR	
TOLERANCES <small>(unless otherwise noted)</small> DECIMAL .X ±.1" .XX ±.05" .XXX ±.010"	DRAWN BY: _____ SCALE: 1:4.25 CHECK'D: _____ SERIAL NO.: _____ NEXT ASSEMBLY: _____
SIZE: B ANGULAR ±1°	



Section D: Electrical System

1. Loosen screw and nut then slide cover band off commutator end of motor.
2. Take out screws and lock washers. Then remove brushes from brush holders in commutator end head assembly.
3. Remove the brush springs from brush holder in commutator end head assembly.
4. Scribe match marks on drive end head, commutator end head assembly and motor frame to aid in reassembly.
5. Remove screws which secure commutator end head assembly to motor frame. Separate commutator end head assembly from motor frame by tapping lightly with a mallet if required to loosen.
6. Remove spring washer from bearing recess in commutator end head assembly.
7. Remove screws which secure drive end head to motor frame. Separate drive end head from motor frame by tapping lightly with a mallet if required to loosen parts.
8. Withdraw armature from the motor frame. Use a bearing puller to pull ball bearings from shaft of armature.
9. Remove nuts, lock washers, plain washers, shake proof washers, and insulated washers from studs of connector and stud assemblies. Then withdraw connector and stud assemblies from inside of motor frame. Remove bushings, insulating washers, and shake proof washers from studs on connector and stud assemblies.
10. Remove nuts, lock washers, plain washers, shake proof washers and insulating washers from field studs. Remove field studs from inside motor frame and remove bushings, insulating washers, and shake proof washers from field studs.
11. Remove insulator from inside motor frame.
12. Remove pole shoe screws from motor frame, and withdraw field coil package with pole shoes (not shown) from inside motor frame. Do not disconnect field coil package.

C. Parts Cleaning

1. Remove as much dirt and foreign matter from parts as possible with compressed air (40 lbs. psi.).
2. Wipe remaining dirt and foreign matter from parts with a cloth moistened with cleaning solvent. Do not wet armature or field windings with solvent.
3. Check field coils for continuity and for resistance when connected as shown in the following chart.

FIELD CONNECTIONS	MOTOR DESIGN VOLTAGE	RESISTANCE (OHMS)
	12	S1 TO S2: 0.0062- 0.0070
	14	S1 TO S2: 0.0076- 0.0086

Section D: Electrical System

4. Check armature on a growler for opening and shorted windings. Also check for charred or burnt insulation as evidence of damage from overheating.
5. Inspect commutator on armature for grooving, pitting, scoring, metallic slivers between segments, and for evidence of solder having been thrown from connections.
6. Inspect brush springs for distortion or loss of tension due to overheating. Check brush springs for proper tension during reassembly as described in assembly instructions.
7. Inspect brushes for excessive wear, for burnt shunts, and for security of shunts and terminals. Also check that brushes slide freely in brush holders in commutator end head assembly.
8. Inspect connector and stud assemblies for frayed insulation, security of terminal studs and for damage due to overheating.
9. Inspect brush holders in commutator end head assembly for distortion or other damage.
10. Inspect field coil assemblies for frayed wrapping and for damage to winding insulation due to overheating.
11. Inspect bearing mounting surfaces on armature and bearing bores in drive end head and commutator end head assembly for scoring, wear and other damage due to bearing failure.
12. Inspect ball bearings for corrosion. Inspect for damage to the inner and outer races which would prevent good fit-up during reassembly. Also check bearings for roughness by holding inner race lightly between fingers on one hand and slowly rotating outer race with fingers on the other hand. Check for discoloration of races as evidence of overheating.

D. Repair and Replacement of Drive Motor Parts

1. Replace all parts that are distorted or cracked or that have been damaged due to overheating.
2. Replacement of both ball bearings at each reassembly is recommended. However, bearings that have been subjected to limited service may be reused if they pass the inspection requirements stated in preceding paragraph C.12.
3. Repair minor damage to field coil wrapping by rewinding damaged or frayed areas with glass fiber tape and applying electrical insulating varnish to the repair areas. Do not attempt this repair if wire of field coils has been damaged.
4. Replace connector and stud assemblies if damaged in any way.
5. Replace brushes if worn to less than 9/16 of an inch in length or if shunts are damaged.
6. Repair minor thread damage with tap or thread chaser.
7. If required, true up commutator on armature by chucking armature in a lathe. Do not remove more metal from commutator than necessary to produce a smooth, bright, continuous surface on all segments. Commutator requirements after turning and undercutting requirements are shown in the following chart. Clean all chips from between segments.



Section D: Electrical System

MTR	MIN. DIA. (IN.)	MAX. SURFACE ROUGHNESS (MICRO INCHES)	UNDERCUTTING	
			DEPTH (IN.)	WIDTH OF SAW (IN.)
	2.750	50	1/32	0.025

E. Assembly and Testing.

1. Insert pole shoes in field coils and install in motor frame. Secure pole shoes with screws.
2. Insert insulation into motor frame.
3. Place shake proof washers on field studs and insert field studs through terminals on field coil assembly. Then apply insulating washers on field studs, and insert studs through holes in motor frame. Place an insulating bushing on each field stud, and complete installation with insulating washers, shake proof washers, plain washers and one nut. Tighten nut securely. Install one split lock washer and one nut on each terminal stud.
4. Place shake-proof washers and insulating washer on stud of each connector and stud assembly. Assemble connector and stud assemblies in motor frame. Apply insulating bushings to studs; then install insulating washer, shake proof washer, plain washer and one nut on each stud. Tighten nuts securely. Install one split lock washer and one nut on each stud.
5. Press ball bearings on shaft of armature until they bear against shoulders.
6. Place spring washer in bore of commutator end head assembly. Then assemble commutator end head assembly on commutator end of armature.
7. Work the free ends of connector and stud assemblies out through rectangular openings in motor frame, then insert armature into motor frame and align match marks on motor frame. Secure commutator end head assembly to motor frame with screws.
8. Install drive end head on other end of motor frame (with match marks aligned) and secure with screws.
9. Check that the armature rotates freely without any evidence of binding. If binding is detected, determine the cause of the binding and correct the trouble before proceeding.
10. Insert brushes into brush holders and install brush springs.
11. Attach shunts of brushes and ends of connection and stud assemblies to the brush holders with screws and washers.
12. Using a spring balance, check the force of each brush spring against the associated brush by slowly applying force to ends of brush springs that bear on brushes. At the point where the end of the spring just raises off the brush, spring balance should read 1 pound 6 ounces to 1 pound 10 ounces.

Section D: Electrical System

CAUTION

DO NOT APPLY MORE THAN 2/3 OF RATED VOLTAGE TO MOTOR UNLESS MOTOR HAS A LOAD APPLIED. MOTOR WILL OVER SPEED IF OPERATED AT RATED VOLTAGE WITHOUT A LOAD, RESULTING IN SEVERE DAMAGE.

13. With motor securely clamped to a bench, apply 2/3 of rated voltage to terminals through a reversing switch as shown in figure D.5. Check the motor rotation is clockwise as viewed from the shaft end when field terminal S2 is positive. Stop the motor and reverse the field connection with the reversing switch. Check that the rotation is now counterclockwise.
14. Lightly stone commutator if excessive sparking is noted between brushes and commutator.
15. After completing the above, disconnect leads from motor terminals.
16. Install cover band (figure D.4) on motor frame with screw and nut.

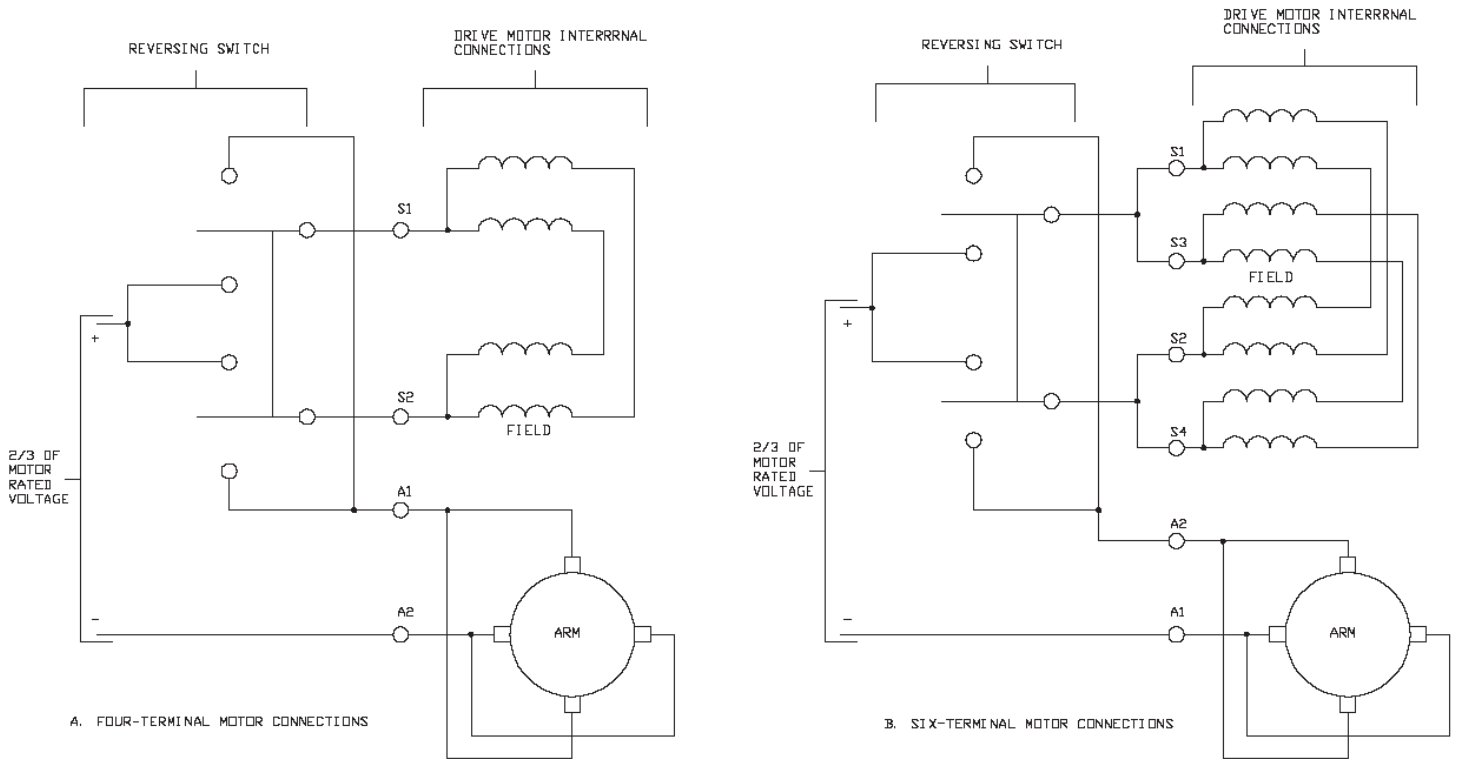
CAUTION

DURING THE FOLLOWING PROCEDURE, DO NOT ALLOW MOTOR TO OPERATE AT RATED VOLTAGE WITHOUT TORQUE LOADING. MOTOR WILL OVER SPEED AND MAY BE SEVERELY DAMAGED.

17. Install a drum on the motor shaft and clamp motor securely to bench top. Apply a torque arm to the drum (Figure D.6). The torque arm must be capable of applying increasing load to the drum. Connect motor electrically as shown in figure D.6. The motor performance characteristics must be as shown in figure D.6.
18. After completing the test above, disconnect the leads from the motor and remove drum from the motor shaft.

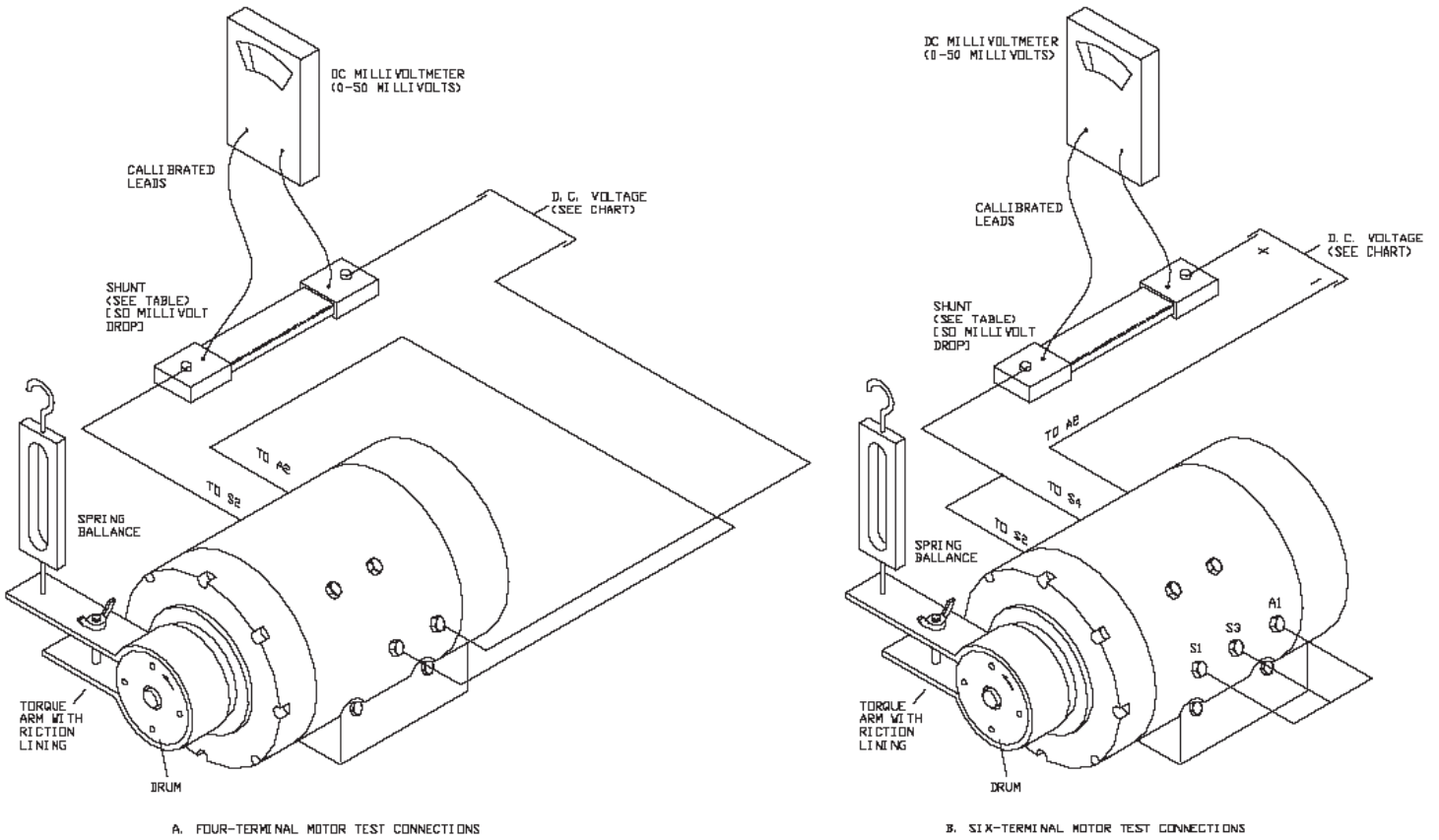
Section D: Electrical System

FIGURE D-5
Set-up for Checking Drive Motor Rotational Direction



Section D: Electrical System

FIGURE D-6 Set-up For Testing Drive Motor



MTR TYPE	TYPE OF TEST	SHUNT RATING	APPLIED VOLTAGE	CURRENT DRAW (MAX. AMPS)	RPM	TORQUE (FT. LB. MIN.)
MEA	NO LOAD	100	12	31	3,400 MIN.	0
	LOAD	100	23	69	3,400-3770	2.0
MJO	NO LOAD	100	12	30	3,300 MIN.	0
	LOAD	100	10.68	70	1,590-1,770	2.0
MKA	NO LOAD	100	24	80	4,200 MIN.	0
	LOAD	100	18.5	160	1,700-2,200	3.5



Section D: Electrical System

VI. PUMP MOTOR REPAIR AND OVERHAUL.

A. General

The pump motor is of the four-pole, internally series connected DC type. Voltage may be either 12 or 24 volts. Electrical systems rated at 18 volts are equipped with 24-volt pump motors. The pump motor output shaft is slotted to receive a coupling through which the pump motor drives the hydraulic pump. The ball bearing on the output end of the shaft is normally supported in the hydraulic pump adapter which is part of the hydraulic unit assembly. Therefore, the pump motor cannot be operated unless it is mounted on the pump adapter. The commutator end of the motor shaft is supported by a sleeve-type bearing in the head assembly. **NOTE:** - Disassembly of the pump for purposes other than inspection and replacement of brushes and bearing is not recommended because of the special facilities needed for satisfactory repair. Service exchanges for the pump motor and the pump motor armature are available from your dealer.

B. Pump Motor Disassembly

Clean the exterior of the pump motor thoroughly to remove dust, dirt, and foreign matter. Next, disassemble only as far as necessary to accomplish repair as described in the following procedures (see figure D.7). Do not attempt to disassemble beyond the point described in the following procedure.

1. Pull out thru bolts and lock washers.
2. Withdraw head assembly from motor frame.
3. Pull out pins and remove brush holders and brush springs from motor frame.
4. Remove screws securing brushes to brush holders and separate brushes from brush holders.
5. Withdraw armature from motor frame; then remove ball bearing, spacers and thrust washer from armature shaft.
6. Take out screws and lock washers. Then remove nuts, lock washers, plain washers, insulator washers, bushings, insulator washer, terminals and lead assembly from motor frame.
7. Remove screws; then withdraw field coil assembly and insulation from motor frame. Separate pole shoes (not shown) from field coil assembly. Do not disconnect field coil assembly.

C. Cleaning Parts

1. Remove as much dirt and foreign matter as possible with compressed air (approximately 40 lbs. psi.).
2. Wipe remaining dirt and foreign matter from parts with a cloth moistened with cleaning solvent. Do not wet armature or field windings.

D. Parts Inspection and Replacement

1. Inspect motor frame, bushings, insulator washers, and head assembly for cracks and distortions.
2. Inspect all threaded parts and tapped holes for stripped threads or other damage.



Section D: Electrical System

3. Check fields coils for continuity and for resistance as shown in the following chart:

MOTOR TYPE	FIELD COIL RESISTANCE (OHMS)	
	SERIES	SHUNT
MFD	.146 +/- 10%	2.240 +/- 10%
MBD	.0045 +/- 10%	-----
MDY	.003 +/- 10%	1.156 +/- 10%
ML	.0021 +/- 10%	-----

4. Check armature on a growler for openings and shorted windings. Also check for charred or burnt insulation as evidence of damage from overheating.
5. Inspect commutator on armature for grooving, pitting, scoring, metallic slivers between segments, and for solder slinging as evidence of overheating. Normal appearance of commutator is a smooth glossy brown color.
6. Inspect brush springs for distortion, or loss of tension due to overheating.
7. Inspect brushes for excessive wear.
8. Inspect head assembly for frayed insulation, security of terminals, and for damage due to overheating.
9. Inspect brush holders for distortion or other damage.
10. Inspect field coil assembly for frayed wrapping and for damage to wire insulation due to overheating.
11. Inspect plain end of shaft on armature for scoring, grooving or wear of bearing surface, and for nicks, scratches, and burrs.
12. Inspect ball bearing for corrosion of races. Inspect for damage to inner and outer races which would prevent good fit-up and alignment during reassembly. Also check bearing for roughness by holding inner race lightly with the fingers on one hand and slowly rotating the outer race with tips of fingers on other hand. Check also for discoloration of races as evidence of overheating.
13. Insert end of shaft of armature into sleeve bearing in head assembly, and check for wear. Shaft should turn freely in bearing with only perceptible clearance.

E. Repair and Replacement of Pump Motor

1. Replace all parts that are distorted, worn, cracked, or that have been damaged by overheating.
2. Replacement of ball bearing is recommended at each reassembly. However, a bearing that has been subjected to only limited service may be reused if it passes the inspection requirements state in preceding paragraph D.12.
3. Repair minor damage to field coil wrapping by rewrapping damage or frayed area with glass fiber tape and applying electrical insulating varnish to the repair. Do not attempt this repair if wire of field coils have been damaged.

Section D: Electrical System

4. Replace the lead assembly if damaged in any way.
5. Replace brushes if worn to less than a 3/8 of an inch in length.
6. Replace brush springs if distorted or heat damaged.
7. Repair minor thread damage with a tap or thread chaser.

F. Assembly and Testing.

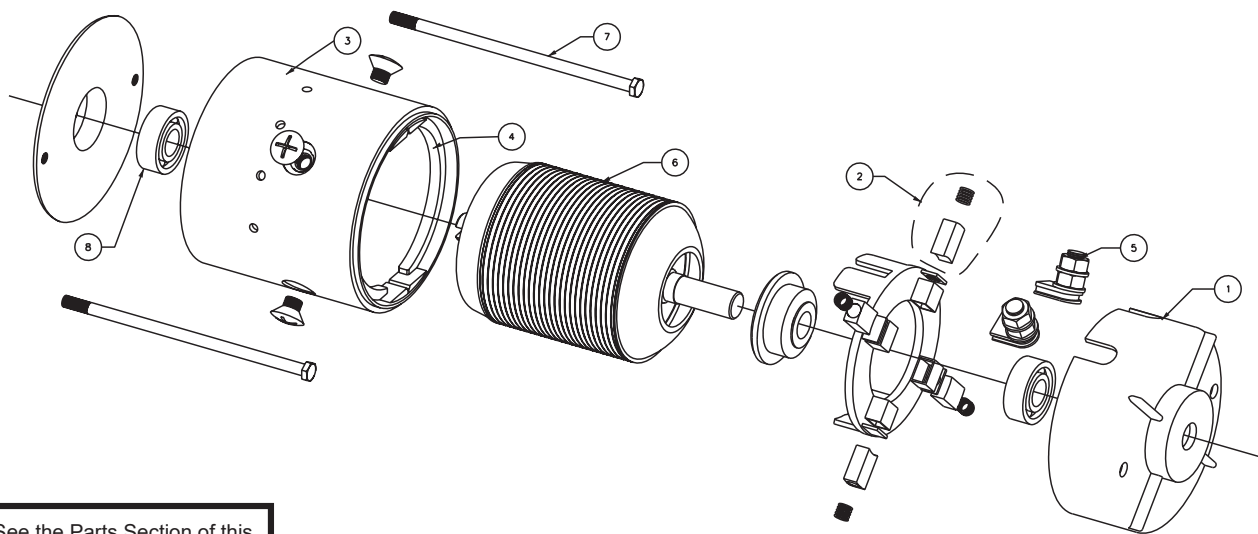
1. Insert pole shoes into field coil assembly. Install field coil assembly and insulation into motor frame and secure with screws.
2. Place lead assembly in motor frame.
3. Place insulator washer on each terminal and insert terminals through square holes in motor frame from inside. Install bushings, insulator washer, plain washers, nuts, and lock washers on terminals. Tighten nuts next to washers securely.
4. Connect terminals on the lead assembly and field coil assembly to terminals with screws and lock washers.
5. Place spacers on the shaft of armature. Then press ball bearing onto the shaft until it bears against shoulder.
6. Place thrust washer on the shaft of armature.
7. Insert the armature into the frame and field coil assembly.
8. Attach terminals of the lead assembly and the brushes to brush holders and secure brush holders and brush springs in the motor frame with pins. Check that the brushes ride squarely and evenly on commutator or armature.
9. Place head assembly motor frame and insert thru bolts with lock washers through head assembly and motor frame.
10. Align pump adapter on the output end of motor frame and secure with thru bolts.
11. Insert a thin strip of wood or plastic into slot in the end of motor armature, and check that the armature rotates freely. If binding or dragging is detected, disassemble the motor and correct the trouble before proceeding.

**CAUTION**

WHEN PERFORMING THE FOLLOWING PROCEDURES, DO NOT APPLY VOLTAGE HIGHER THAN 2/3 OF RATED MOTOR VOLTAGE. OPERATING THE PUMP MOTOR AT RATED VOLTAGE WITHOUT LOAD MAY CAUSE SEVERE DAMAGE DUE TO OVER SPEED.

12. Connect a DC source equal to 2/3 the motor rated voltage to motor terminals S (positive) and A (negative) when viewing from pump adapter end. Check that motor armature rotates in counterclockwise direction. Also check for any unusual noises such as brush noise or bearing whine. Correct any problems that are detected.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



See the Parts Section of this manual for pump motor parts pertaining to this vehicle. This is only a reference page.

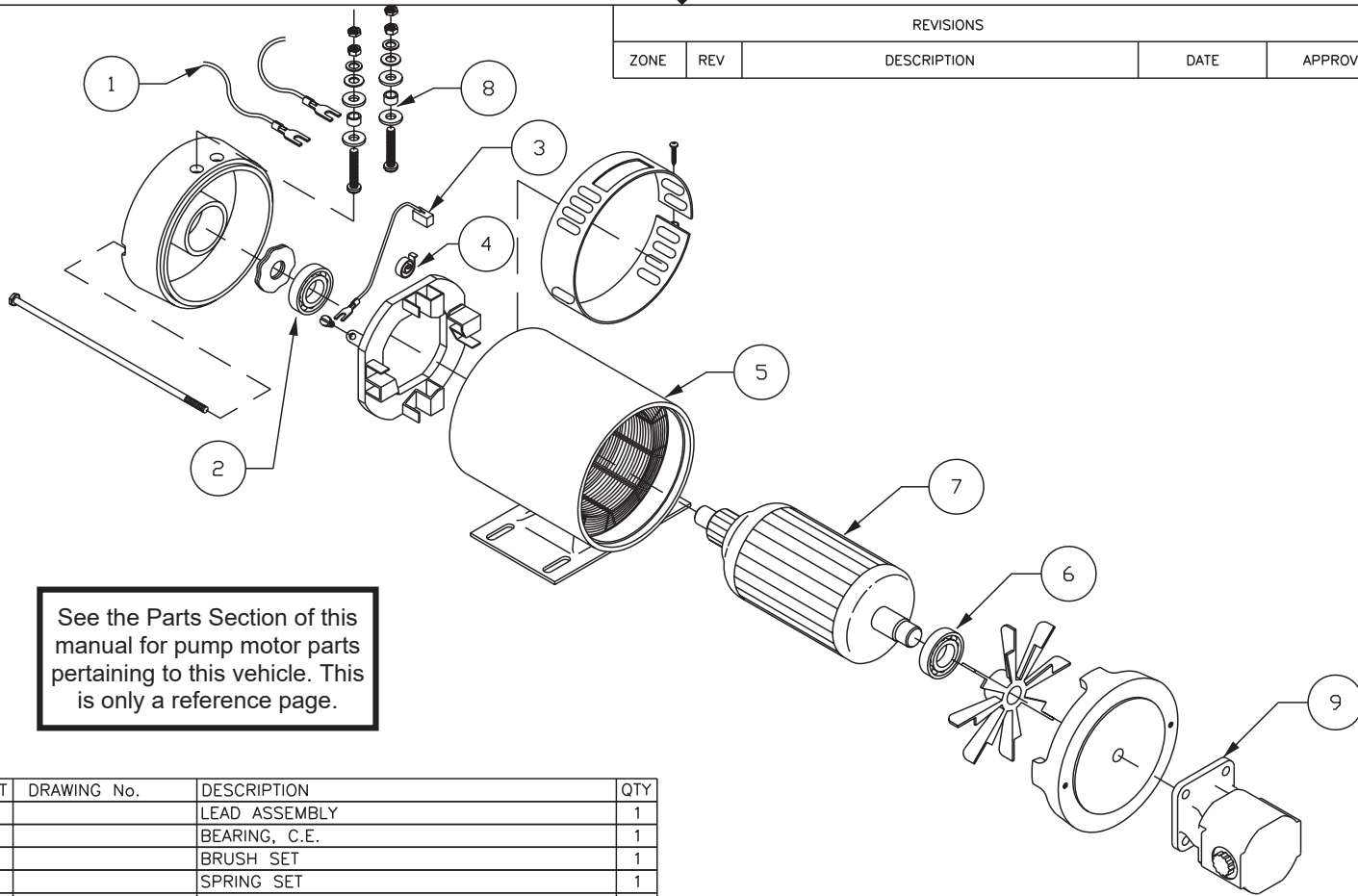
DET	DRAWING No.	DESCRIPTION	QTY
1		END COVER	1
2		BRUSH ASSEMBLY	4
3		FRAME	1
4		FIELD WINDINGS	1
5		TERMINALS	2
6		ARMATURE	1
7		BOLTS	2
8		BEARING	2

MATERIAL:

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TOLERANCES <small>(UNLESS OTHERWISE NOTED)</small> DECIMAL X ±.1" XX ±.04" XXX ±.010"			
SIZE: A ANGULAR ± 1°		MOTOR BREAKDOWN (PUMP)	
DRAWN BY CHK'D DATE	SCALE SERIAL NO.	NEXT ASSEMBLY	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



See the Parts Section of this manual for pump motor parts pertaining to this vehicle. This is only a reference page.

DET	DRAWING No.	DESCRIPTION	QTY
1		LEAD ASSEMBLY	1
2		BEARING, C.E.	1
3		BRUSH SET	1
4		SPRING SET	1
5		STATOR ASSEMBLY	1
6		BEARING, D.E.	1
7		ARMATURE	1
8		STUD ASSY	2
9		PUMP	1

MATERIAL:

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TOLERANCES (UNLESS OTHERWISE NOTED)		RICO		
DECIMAL				
X	±.1"	PUMP, MOTOR		
XX	±.04"			
XXX	±.010"			
SIZE: A		DRAWN BY	SCALE	NEXT ASSEMBLY
ANGULAR		CHK'D	SERIAL NO.	
± 1°		DATE		



Section D: Electrical System

VII. PREVENTATIVE MAINTENANCE CHECKLIST

The following checklist contains information in which preventative maintenance is recommended and can be performed. When doing your preventative maintenance, **ALWAYS** remember to initiate safety first before starting any maintenance task performed on this truck.

TROUBLE	AFTER USE	DAILY	WEEKLY	MONTHLY
Check tightness of cables and connections.			X	
Check motor brushes for wear and spring tension.				X
Check motors for mounting and connections.			X	
Observe all motors for proper response.		X		
Check motors and all components for overheating.		X		
Inspect motor commutators.				X
Inspect points of contactors for overheating or burning.			X	
Check hourmeter for operation.		X		
Check battery for damage and corrosion.			X	
Check battery cables for condition and cleanliness.			X	
Inspect battery for cracks and for leakage.			X	



Section E: Hydraulic System

I. DESCRIPTION.....	2
II. HYDRAULIC UNIT.....	2
A. General.....	2
B. Cleaning.....	2
C. Inspection and Replacement of Parts.....	2
III. HYDRAULIC CYLINDER.....	3
A. General.....	3
B. Removal of Cylinder.....	3
C. Installation of Cylinder.....	3
D. Disassembly of Cylinder.....	3
E. Cleaning.....	3
F. Inspection and Replacement of Parts.....	3-4
IV. HYDRAULIC SYSTEM TROUBLESHOOTING CHART.....	4
V. HYDRAULIC SYSTEM PREVENTATIVE MAINTENANCE.....	4
A. Daily Checks and Services.....	4
B. Weekly Checks and Services.....	5
C. Monthly Checks and Services.....	5
D. Semi-annual Checks and Services.....	5
E. Preventative Maintenance Checklist.....	6



Section E: Hydraulic System

I. DESCRIPTION

The hydraulic system includes a motor driven pump, a single-acting hydraulic cylinder, interconnecting hoses (pressure and return), a solenoid valve, and a hydraulic oil reservoir. The motor starts and drives the pump when the "raise" contact in the electrical control circuit is activated. Pressure developed by the pump is applied to the lower end of the cylinder through a check valve. The cylinder extends, causing the truck forks/platform to raise. The relief valve within the pump prevents excessive pressure buildup and motor overloading after the cylinder reaches maximum stroke. The check valve prevents return flow to the reservoir when the pump stops, thus preventing the forks/platform from lowering. The solenoid valve mounted on the pump is energized to allow oil to return to the reservoir when the "lower" contact in the electrical circuit is activated.

II. HYDRAULIC UNIT

A. General

The hydraulic unit comprises a drive motor directly coupled to a hydraulic pump assembly, a pump adapter, and a hydraulic oil reservoir. The unit contains a check valve to prevent return flow and an adjustable relief valve. A solenoid switch (relay) is mounted on the drive motor for control of pump operation.

B. Cleaning

1. Wash metallic parts in cleaning solvent and dry with compressed air at approximately 40 lbs. psi.
2. Give particular attention to ensure that the oil passages in the adapter strainers and in the pump assembly are free of obstruction.
3. Be sure all solvent is removed from the pump assembly to prevent possible dilution of hydraulic oil at startup.

C. Inspection and Replacement of Parts

1. Inspect adapter for cracks, deformation, or other damage. Replace if damaged.
2. Inspect all tapped holes and externally threaded parts for stripped threads or other thread defects. Repair minor thread damage with thread chaser or tap; otherwise replace part.
3. Inspect reservoir for dents or other damage. Replace if damaged.
4. Inspect return tubes for dents and deformations. Replace if defective.
5. Check pump assembly by rotating input shaft by hand. Rotation should be smooth with no evidence of binding or scraping of internal parts. Replace if internal wear or tear is suspected.
6. Replace all gaskets and o-rings with new parts.

Section E: Hydraulic System

III. HYDRAULIC CYLINDER

A. General

The hoses which connect the cylinder to the hydraulic pump unit are also considered part of the cylinder.

B. Removal of Cylinder

1. Be sure the cylinder is fully lowered and pump is not operating. For safety, disconnect electrical leads from pump motor.
2. Disconnect hoses from the hydraulic pump unit and allow hydraulic oil to drain from hoses. Plug ends of hoses to prevent entrance of foreign matter. Dispose of drained hydraulic oil.

C. Installation of Cylinder

1. Reverse the removal procedure outlined in B above.
2. Replenish hydraulic oil level in hydraulic oil reservoir.
3. Test for smooth operation.

D. Disassembly of Cylinder.

**CAUTION**

DISASSEMBLE AND ASSEMBLE HYDRAULIC CYLINDER ONLY UNDER CLEAN WORKING CONDITIONS.

1. Disconnect hoses from fittings. Plug ends of hoses to prevent entrance of foreign matter.

**CAUTION**

HANDLE PISTON ROD ASSEMBLY WITH CARE TO PREVENT SCRATCHING, NICKING OR BURRING THE POLISHED SURFACE.

E. Cleaning

1. Clean all metallic parts in cleaning solvent and dry with compressed air at approximately 40 lbs. psi.

F. Inspection and Replacement

1. Inspect all metallic parts for cracks, distortion, corrosion, or other damage. Replace all defective metallic parts.
2. Inspect bore in tube assembly and surface of piston rod assembly for nicks, scratches, burrs, corrosion or other damage. If polishing with a crocus cloth does not remove the defects, replace defective parts.
3. Inspect hoses for cuts, abrasion and deterioration. Replace if any defects are visually observed.



Section E: Hydraulic System

4. Replace seals and wipers with new parts.

NOTE - Wet cylinder internal parts with clean hydraulic fluid to facilitate assembly of the cylinder.

IV. HYDRAULIC SYSTEM TROUBLE SHOOTING CHART

<i>FORKS DO NOT RAISE OR RAISE AT LOW RATE (NO LOAD OR NORMAL LOAD)</i>	
PROBABLE CAUSE	REMEDY
1. Pump motor does not run or lacks power.	1. Refer to ELECTRICAL SYSTEM TROUBLESHOOTING
2. Low hydraulic oil level.	2. Add hydraulic oil.
3. Defective or improperly adjusted relief valve.	3. Replace or adjust relief valve.
4. Defective pump.	4. Replace pump.
5. Excessive leakage in cylinder.	5. Repair or replace cylinder.
6. Blockage in system (strainer, ports, hoses).	6. Disassemble system and remove blockage.
7. Excessive internal leakage in pump unit.	7. Repair or replace pump unit.
<i>FORKS DRIFT DOWNWARD UNDER LOAD</i>	
PROBABLE CAUSE	REMEDY
1. Defective check valve.	1. Repair or replace check valve.
2. Excessive leakage in cylinder.	2. Repair or replace cylinder.
3. Leakage in cylinder.	3. Replace leaking seals or hoses or tighten connections.
<i>FORKS WILL NOT LOWER OR LOWER AT SLOW RATE</i>	
PROBABLE CAUSE	REMEDY
1. Defective Solenoid valve.	1. Replace solenoid valve.
2. Blockage in pump adapter, hoses, or return tube.	2. Disassemble system and remove blockage.
3. Bent or deformed cylinder rod or dented cylinder housing.	3. Repair or replace cylinder.

V. HYDRAULIC SYSTEM PREVENTIVE MAINTENANCE

A. Daily Checks and Services

1. Check operation of lift cylinders by raising and lowering forks/platform several times. Operation should be smooth without unusual noises. If operation is otherwise, locate and correct cause of trouble before using the truck.
2. Check system for leaks at pump, cylinder, hoses, and hose connections. Correct any system leaks before using the truck.



Section E: Hydraulic System

B. Weekly Check and Service

1. Check level of oil in hydraulic oil reservoir by removing fill plug from inside of reservoir. Add oil if level is below hole. Investigate cause of frequent adding of oil, if frequent adding of oil is required. Replace fill plug.

C. Monthly Checks and Service

1. Check operation of pump by raising and lowering forks/platform several times with load. Operation should be smooth without unusual noises. If operation is otherwise, locate and correct cause of trouble before using the truck.
2. Check operation of solenoid valve while forks/platform are lowering under load. Lowering should be smooth. If operation is otherwise, locate and correct trouble before using the truck.

D. Semi-annual Checks and Service

1. At six-month intervals (approximately 1000 hours of operation or more often if operated under extremely dusty conditions) remove, clean and drain the hydraulic reservoir, and refill with new hydraulic oil. Follow the procedures outlined in this section for removal and disassembly.

E. Preventative Maintenance Checklist

The following checklist contains information in which preventative maintenance is recommended and can be preformed. When doing your preventative maintenance, **ALWAYS** remember to initiate safety first before starting any maintenance task preformed on this truck.



Section E: Hydraulic System

PREVENTATIVE MAINTENANCE - HYDRAULIC SYSTEM

TROUBLE	AFTER USE	DAILY	WEEKLY	MONTHLY	3 MONTHS	SPRING AND FALL
Check lift mast assembly & components for cleanliness and lubricate (if applicable).			X			
Inspect, clean and lubricate chains (if applicable)			X			
Inspect and clean rollers (if applicable).			X			
Check hoses and fittings for secure attachment.			X			
Check system for leakage.		X				
Inspect all hydraulic cylinders for mounting, leakage and operation.			X			
Inspect hydraulic pump for leakage and operation.		X				
Add hydraulic fluid to reservoir as necessary.			X			
Change hydraulic fluid and clean reservoir completely.						X
Inspect and lubricate pivot points.			X			
Lubricate cylinder ends.			X			



SERIES

This user manual details the features of the following PowerpaK Series controllers and variants.

- | | | | |
|----|-----------------|------------------------|------------------|
| 1. | Traction Series | 24-48V, 300A,450A,650A | Low I/O Logic |
| 2. | “ | 72-80V, 450A,600A | Low I/O Logic |
| 3. | “ | 24-48V, 300A,450A,650A | Medium I/O Logic |
| 4. | “ | 72-80V, 450A,600A | Medium I/O Logic |
| 5. | “ | 24-48V, 300A,450A,650A | High I/O Logic |
| 6. | “ | 72-80V, 450A,600A | High I/O Logic |
| 7. | Pump Series | 24-48V, 300A,450A,650A | Pump I/O Logic |
| 8. | “ | 72-80V, 450A,600A | Pump I/O Logic |

Modification History

Revision	Issue Date	Author	Changes
Rev D	19 January 1999	P.R.G.	Menu & Feature changes, corrections
Rev E	9 April 1999	P.R.G.	High I/O Changes / New Variants

CONTENTS

MODIFICATION HISTORY.....	1
1 INTRODUCTION.....	4
2 POWERPAK CONTROLLER VARIANTS.....	5
3 CONTROLLER FEATURES WITH THE DIFFERENT LOGIC VARIANTS.....	7
4 SAFETY	8
5 TECHNICAL SPECIFICATIONS	8
6 CONTROLLER WIRING AND CONNECTIONS	10
7 CALIBRATOR AND ADJUSTMENTS	14
8 DIAGNOSTICS.....	22
9 SERVICE AND FAULT LOGS (ALL LOGICS).....	23
10 CONTROLLER OPERATION AND FEATURE DESCRIPTIONS.....	24
11 DASHBOARD DISPLAYS - OPERATION AND FEATURE DESCRIPTIONS.....	33
12 POWER CIRCUIT DESCRIPTIONS	41
13 INSTALLATION.....	42
14 EMC GUIDELINES	43
FIGURE 1 LIGHT WIRING - LOW I/O LOGIC. (PUMP FUNCTIONS IN BRACKETS.).....	48
FIGURE 2 LIGHT WIRING - MEDIUM I/O LOGIC.....	49
FIGURE 3 LIGHT WIRING - HIGH I/O LOGIC.....	50
FIGURE 4 SERIES TRACTION REGEN.....	51
FIGURE 5 SERIES TRACTION PLUGGING.....	52
FIGURE 6 SERIES PUMP.....	53
FIGURE 7 MECHANICAL DETAILS	54

1 INTRODUCTION

1.1 The PowerpaK range of Controllers uses a new concept in power switching technology to provide a full range of power frames 24V-80V, 300A-650A in one small, highly efficient package. This is achieved using a new power switching scheme and radical new construction techniques, both the subject of patent applications, which enable large powers to be incorporated into very small packages.

The PowerpaK range of controllers are available in standalone Traction and Pump formats, with the Traction offering either Regen and plug braking or plug braking only. To improve flexibility and serviceability the logic is plugged into the power frame and can be removed easily without disturbing the power connections or having to remove the power frame cover.

To further increase flexibility and tailor the controller to specific applications, there are 3 core versions of logic which vary in complexity and the amount of I/O, input and output functions, to help ensure the most cost effective controller package is offered for a particular application. The Low I/O logic is a minimum feature logic aimed at walkies and basic forklift truck applications. The Medium logic is more suitable for more sophisticated vehicles including Forklift and Reach truck types, whilst the High I/O logic is targeted at the Aerial lift market where increased I/O is required. All logics have CAN communications.

All PowerpaK controllers are microprocessor based with flexible software and setup options, and use high frequency MOSFET power switching technology. Controllers have been designed to satisfy the requirements of the relevant UL and EC standards.

PowerpaK controllers have been optimised for use with D.C. series wound motors. There is a separate range of PowerpaK SEM controllers.



2 PowerpaK CONTROLLER VARIANTS

PP xxx	Model number description	
<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; width: 10px; height: 100px; margin-right: 5px;"></div> <div style="margin-left: 5px;">1st digit</div> </div>	Controller Type	1 = ----- 2 = Traction 3 = Pump 4 = ----- 5 = ----- 6 = ----- 7 = -- Reserved -- (SEM)
<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; width: 10px; height: 100px; margin-right: 5px;"></div> <div style="margin-left: 5px;">2nd digit</div> </div>	Voltage Range	2 = --Reserved-- (24-36V) 4 = 24V - 48V 8 = 72V - 80V
<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; border-right: 1px solid black; width: 10px; height: 100px; margin-right: 5px;"></div> <div style="margin-left: 5px;">3rd digit</div> </div>	Current Limit	3 = 300A 4 = 450A 6 = 650A* (* Note 600A at 80V)
	Suffix	L = Low I/O, Traction M = Medium I/O, Traction H = High I/O, Traction P = Low I/O, Pump

MODEL	POWER	CONFIGURATION	LOGIC	NO. off Power Terminals	UNIT SIZE
PP243L	24-48V 300A	Traction Regen/Plug	Low I/O	6	142 x 142 x 140mm
PP244L	24-48V 450A	Traction Regen/Plug	Low I/O	6	142 x 142 x 140mm
PP246L	24-48V 650A	Traction Regen/Plug	Low I/O	6	142 x 142 x 140mm
PP284L	72-80V 450A	Traction Regen/Plug	Low I/O	6	142 x 142 x 140mm
PP286L	72-80V 600A	Traction Regen/Plug	Low I/O	6	142 x 142 x 140mm
PP243M	24-48V 300A	Traction Regen/Plug	Med. I/O	6	142 x 142 x 140mm
PP244M	24-48V 450A	Traction Regen/Plug	Med. I/O	6	142 x 142 x 140mm
PP246M	24-48V 650A	Traction Regen/Plug	Med. I/O	6	142 x 142 x 140mm
PP284M	72-80V 450A	Traction Regen/Plug	Med. I/O	6	142 x 142 x 140mm
PP286M	72-80V 600A	Traction Regen/Plug	Med. I/O	6	142 x 142 x 140mm
PP343P	24-48V 300A	Pump	Pump I/O	4	142 x 142 x 140mm
PP344P	24-48V 450A	Pump	Pump I/O	4	142 x 142 x 140mm
PP346P	24-48V 650A	Pump	Pump I/O	4	142 x 142 x 140mm
PP384P	72-80V 450A	Pump	Pump I/O	4	142 x 142 x 140mm
PP386P	72-80V 600A	Pump	Pump I/O	4	142 x 142 x 140mm
PP243H	24-48V 300A	Traction Regen/Plug	High I/O	6	142 x 142 x 140mm
PP244H	24-48V 450A	Traction Regen/Plug	High I/O	6	142 x 142 x 140mm
PP246H	24-48V 650A	Traction Regen/Plug	High I/O	6	142 x 142 x 140mm

PP284H	72-80V 450A	Traction Regen/Plug	High I/O	6	142 x 142 x 140mm
PP286H	72-80V 600A	Traction Regen/Plug	High I/O	6	142 x 142 x 140mm

3 CONTROLLER FEATURES WITH THE DIFFERENT LOGIC VARIANTS

Logic Feature	Pump Low I/O Logic	Traction Low I/O Logic	Traction Med. I/O Logic	Traction High. I/O Logic
Number of Connectors	2	2	3	3
Number of Digital switch inputs.	6	6	8	10
Number of Analogue inputs	2	2	2	2
Number of Contactor drive outputs (2 Amps)	0	3	5	10
24V - 80V Operation	yes	yes	yes	yes
Can cater for Current Limit range of 300A to 650A	yes	yes	yes	yes
Logic Case enclosed to IP65, Power Case to IP55	yes	yes	yes	yes
Microprocessor control	yes	yes	yes	yes
High frequency (Silent Operation)	yes	yes	yes	yes
Internal watchdog monitoring microprocessor operation	yes	yes	yes	yes
Arcless contactor switching and built in coil suppression	n/a	yes	yes	yes
Use of 24V contactors at all voltages possible	n/a	yes	yes	yes
Low impedance, active low inputs switched to B-ve	yes	yes	yes	yes
Thermally compensated current limit	yes	yes	yes	yes
Selectable accelerator characteristics	yes	yes	yes	yes
Adjustable creep speed	yes	yes	yes	yes
Bypass with over current dropout + Field Weakening	n/a	no	yes	yes
Seat switch timer	yes	yes	yes	yes
Belly switch operation	n/a	yes	no	no
Power steer contactor driver and timer	n/a	yes	yes	yes
Regenerative or plug brake only	n/a	yes	yes	yes
Braking proportional to accelerator position	n/a	yes	yes	yes
Braking in neutral	n/a	yes	yes	yes
Braking with brake pedal	n/a	yes	yes	yes
Under and Over-voltage protection	yes	yes	yes	yes
Accelerator wire off detect	n/a	yes	yes	yes
Inching and timed burst inching facilities	n/a	yes	yes	yes
Economy pot input	n/a	yes	yes	yes
Short circuit and open circuit contactor detect	n/a	yes	yes	yes
3 traction cutback speeds with independent accel delays	n/a	yes	yes	yes
6 Pump speeds with Additive, Priority & Compensation	yes	n/a	n/a	n/a
Input to disable pump operation	yes	n/a	n/a	n/a
Independent Power steer speed and compensation settings	yes	n/a	n/a	n/a
Hardware and Software fail-safe systems	n/a	yes	yes	yes
+ 12V output pin	yes	no	yes	yes
Diagnostics with LED indication	yes	yes	yes	yes
Adjustments made via a calibrator	yes	yes	yes	yes
Serial communications (external module gives RS232)	yes	yes	yes	yes
Can be setup with a PC (via above external module)	yes	yes	yes	yes
CAN serial communications	yes	yes	yes	yes
Hours count displaying Key & Pulsing hours on calibrator	yes	yes	yes	yes
BDI on Calibrator	yes	yes	yes	yes
Dual Motor Non Proportional variant with switches or pot	n/a	no	no	no
Dual Motor steer angles can be adjusted	n/a	no	no	no
Dual Motor independently ramp up/down delay adjustable	n/a	no	no	no
Speed limit facility optionally available with speed sensor	n/a	no	yes	yes
Resettable Service and Fault logs	yes	yes	yes	yes
Foreign languages selectable on calibrator	yes	yes	yes	yes
Standard + Full Feature Dashboard Display compatible	yes	yes	yes	yes
Setup menu on calibrator to enable various options	yes	yes	yes	yes

4 SAFETY

- 4.1 Electric vehicles can be dangerous. All testing, fault-finding and adjustment should be carried out by competent personnel. The drive wheels should be off the floor and free to rotate during the following procedures. THE VEHICLE MANUFACTURER'S MANUAL SHOULD BE CONSULTED BEFORE ANY OPERATION IS ATTEMPTED.
- 4.2 The PowerpaK controller contains a triple fail-safe system to give a high level of safety. If the diagnostic LED is not illuminated or flashes, the safety circuit may have tripped and the truck may not drive.
- 4.3 To ensure continued safety of the PowerpaK system, the fail-safe circuit should be checked whenever the truck is serviced . The period between checks should not exceed 3 months.
- 4.4 THE BATTERY MUST BE DISCONNECTED BEFORE REPLACING OR ATTEMPTING ANY REPAIRS OF THE CONTROLS.
- 4.5 Before working on the controls disconnect the battery and connect the B+ and B- controller terminals via a 10 ohm 25 watt resistor to discharge the internal capacitors.
- 4.6 Never connect the controller to a battery with its vent caps removed as an arc may occur due to the controller's internal capacitance when it is first connected.
- 4.7 FAIL-SAFE CHECK:
- 4.7.1 Ensure the drive wheels are CLEAR OF THE FLOOR AND FREE TO ROTATE.
- 4.7.2 Switch on, select seat switch, release brake, select direction and FS1, the wheels should rotate and the diagnostic LED should give a steady illumination.
- 4.7.3 Switch off, disconnect battery and connect the A and B- terminals together with, at least, 10mm² cable. Ensure that no other fault that would allow drive is present.
- 4.7.4 Reconnect battery, switch on key with direction in neutral. The LED should stay off. Select a direction and check that the direction contactors do not close and the wheels do not rotate.
- 4.7.5 Switch off at key and remove the A/B- connection. Switch on at key, reselect the power-up sequence and check that the LED illuminates and the truck wheels rotate.
- IF THE TRUCK DRIVES IN 4.7.4 THE CONTROLLER IS FAULTY AND MUST BE REPLACED.
- 4.8 As blow-out magnets are fitted to contactors (except 24V) 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.
- 4.8 The PowerpaK controller must NOT be used with permanently-connected on-board chargers or damage to the system may result.

5 TECHNICAL SPECIFICATIONS

5.1 Electrical

5.1.1 Voltage specifications:

Model	Voltage	Nominal Battery	Absolute Maximum Operating voltage
PP x4x	48V Units	24-48V	14.5 - 75V
PP x8x	80V Units	72-80V	43.0 - 97.5V

5.1.2

Current specifications:

Model	Power	Current limit (1 min)	Safe operating Area (SOA)	Continuous Current 1 Hour rating. Unit mo on an aluminium base-plate 780x380x10m 20°C ambient.
PP x43	48V 300A	300A	30 - 60%	90A
PP x44	48V 450A	450A	30 - 60%	135A
PP x46	48V 650A	650A	30 - 60%	200A
PP x84	80V 450A	450A	25 - 45%	125A
PP x86	80V 600A	600A	25 - 45%	150A

- 5.1.3 Switching Frequency: 16 KHz Traction/Regen/Pump Drive and 6KHz Plug Braking.
 5.1.4 Electrical Isolation: Enclosure to any live part = 1KV. Controller internal insulation specified at > 10MΩ @500V DC. Dielectric strength 1000V @ 50Hz for 1 Minute.
 5.1.5 Battery Polarity: A Line Contactor driven from the keyswitch, with a 2A diode in series with the coil, will prevent Line Contactor closure if the battery positive and negative connections are reversed.

5.2 Environmental

- 5.2.1.1 Protection - Logic The enclosure is protected to IP66.
 1st digit (6) = Protection against dust ingress
 2nd digit (6) = Protection against high pressure jets of water in any direction.
 5.2.1.2 Protection - Power frame The enclosure is protected to IP55.
 1st digit (5) = Limited dust ingress permitted
 2nd digit (5) = Protection against low pressure jets of water in any direction. Limited ingress permitted.
 5.2.2 Vibration: 6G, 40-200Hz for 1 hour, in x, y and z planes.
 5.2.3 Operating Temperature: -30°C to +40°C ambient around controller.
 5.2.4 Storage Temperature: -40°C to +70°C.
 5.2.5 Humidity: 95% maximum, non-condensing.
 5.2.6 Humidity Resistance: No functional defects after controller is left at 60°C and 100% humidity for one hour after freezer use (-30°C minimum).
 5.2.7 HALT: PowerpaK has been Highly Accelerated Life Tested.

5.3 Mechanical

- 5.3.1 Unit size(all units): Length 142mm, Width 142mm, Height 140mm with logic fitted. (Height is 86mm with logic unplugged)
 5.3.2 Enclosure: Aluminium die cast base-plate with ABS plastic injection moulded power frame and logic covers.
 5.3.3 Power connections: Aluminium vertical power bushes for M8 connection.
 5.3.4 Fixings: 4 x M6 clearance holes.
 5.3.5 Weight: 1.8Kg

5.4 Logic I/O Specifications

- 5.4.1 **Switch/Digital Inputs:**
 Operation: Active-low (The input becomes active when connected to battery negative, otherwise inactive).
 Voltage Range: Low (Closed) -1.0 to +1.8 V
 High (Open) +4.5 to +150 V (or open-circuit).
 Input Impedance: Max. resistance to ground for a 'low' = 500 Ω.
 Min. resistance to ground for a 'high' = 2.7 kΩ
 Note : negative switch returns must be connected to controller B- terminal and not at battery negative.
 5.4.2 **Analogue Inputs:** 0-5V inputs available and 5K potentiometer/3V5-0V inputs available. Fully protected i/ps and threshold settable.
 5.4.3 **Supply output:** An unregulated +12V, 5mA power supply is available for supplying Accelerators, speed sensors etc.
 5.4.4 **Contactor Drives:** Maximum Current: 2A.
 Protection: Drives are protected against direct connection to B+ and B-.
 Suppression: Coil suppression built-in.

+ve coil supply Logic variant dependant, see wiring diagrams figs 1-3

6 CONTROLLER WIRING AND CONNECTIONS

6.1.1 Power Connections

See power wiring diagrams for specific connections.

6.1.2 Power wiring

Minimum cable sizes:- Current limits up to 500A 35mm²
650A 50mm²

6.1.3 Fuse ratings

Maximum fuse ratings:- Current limits up to 300A 325A (air break)
450A 500A (air break)
650A 700A (air break)

6.1.4 Contactor Types

The recommended contactors for controllers with current limits up to 300A are:

Line	(Optional)	Albright SW80	Continuous Rating
Direction		Albright DC88	Intermittent Rating
Regen	(Optional)	Albright DC84	Continuous Rating
Traction Bypass	(Optional)	Albright SW80	Intermittent Rating
Field Weakening	(Optional)	Albright SW80	Intermittent Rating
Power Steer	(Optional)	Albright SW80	Continuous Rating

The recommended contactors for controllers with current limits up to 450A are:

Line	(Optional)	Albright SW180	Continuous Rating
Direction		Albright DC182	Intermittent Rating
Regen	(Optional)	Albright SW181	Continuous Rating
Traction Bypass	(Optional)	Albright SW180	Intermittent Rating
Field Weakening	(Optional)	Albright SW80	Intermittent Rating
Power Steer	(Optional)	Albright SW80	Continuous Rating

The recommended contactors for controllers with current limits up to 650A are:

Line	(Optional)	Albright SW200	Continuous	Rating
Direction		Albright SW202	Intermittent	Rating
Regen	(Optional)	Albright SW201	Continuous	Rating
Traction Bypass	(Optional)	Albright SW200	Intermittent	Rating
Field Weakening	(Optional)	Albright SW80	Intermittent	Rating
Power Steer	(Optional)	Albright SW80	Continuous	Rating

It is recommended that 24 V contactors are used together with the chopping feature.

6.1.5 Regen Diode - available from SEVCON (840/44245) and connected as follows:

Cathode	Lead connected to Regen Contactor common terminal.
Anode	Stud screwed into Regen Contactor B-.

6.2 Light Wiring Connections (Fig. 1)

The following section details the connectors on the Minimum, Medium and High logics. The Minimum logic has 2 connectors, 1 for the vehicle/contactors connections and 1 for serial communications. The Medium I/O logic has 3 connectors, 1 for the vehicle connections, 1 for the contactor connections and 1 for serial communications. The High I/O logic also has 3 connectors in total, 1 for the vehicle connections, 1 for the contactor connections, and 1 for serial communications.

CUSTOMER CONNECTOR & CONTROLLER INTERCONNECT PIN OUT'S

Pin No.	Vehicle & Panel Connector Socket B Pump low I/O Logic. 12 way Molex Connector. 6 Digital i/ps 2 Analog i/ps No Cont. Drives	Vehicle & Panel Connector Socket B Traction Low I/O Logic. 12 way Molex Connector. 6 Digital i/ps 2 Analog i/ps 3 Cont. Drives	Vehicle Connector Socket B Traction Med. I/O Logic. 12 way Molex Connector. 8 Digital i/ps 2 Analog i/ps 1 +12V o/p	Vehicle Connector Socket B Traction High I/O Logic. 16 way Molex Connector. 10 Digital i/ps 2 Analog i/ps 1 +12V o/p
1.	Key sw	Key sw	Key sw	Key sw
2.	Pump sw 3	Fwd sw	Fwd sw	Fwd sw
3.	Pump sw 4	Rev sw	Rev sw	Rev sw
4.	Pump sw 5	FS1/Belly sw	FS1/Belly sw	FS1 sw
5.	See note 3	Seat/Tiller sw	Seat/Tiller sw	Seat sw
6.	See note 3	See note 1	See note 1	See note 1
7.	See note 3	See note 1	See note 1	See note 1
8.	-	Fwd Cont	See note 1	See note 1
9.	-	Rev Cont	See note 2	See note 2
10.	Accel 0V-5V (Pump sw2 / Econ)	Accel/F.Brake/Economy pot /Over Temp 0V-5V	Accel/F.Brake/Economy pot /Over Temp 0V-5V	Accel/F.Brake/Economy pot /Over Temp 0V-5V
11.	Accel 3V5-0V (Pump sw1)	F.Brake/Accel/Economy pot /Over Temp 3V5-0V	Accel/F.Brake/Economy pot /Over Temp 3V5-0V	Accel/F.Brake/Economy pot /Over Temp 3V5-0V
12.	+12V o/p	Regen/Psteer Cont.	+12V o/p	+12V o/p
13.				See note 1
14.				See note 1
15.				-
16.				-

Note 1. The user can configure these inputs to be any of the following:- Speed1, Speed2, Speed3, Inch Fwd (Pins 6,8,13), Inch Rev (Pins 7,14), Pump, Power Steer Trigger, Handbrake, Footbrake, Sideload, Brushes Worn.

Note 2. The user can configure this input to be any of the following:- Speed1, Speed2, Speed3, Inch Rev, Pump, Power Steer Trigger, Handbrake, Footbrake, Sideload, Brushes Worn, Speed Encoder.

Note 3. The user can configure these inputs to be any of the following:- Pump Switch 6, Pump Switch 7, Power Steer Trigger, Pump Inhibit, Motor Temperature, Pump Brushes Worn, Low Oil Pressure.

Pin No.	Panel Connector Socket C Traction Med. I/O Logic. 10 way Molex Connector. 5 Cont. Drives	Panel Connector Socket C Traction High I/O Logic. 12 way Molex Connector. 10 Cont. Drives	Communications Connector Socket A All Logics. 6 way Molex Connector RS232 & CAN
1.	Cont. o/p	Cont. o/p	+ 10V5
2.	Fwd Cont	Fwd Cont	0V
3.	Rev Cont	Rev Cont	N/C
4.	Regen/P.Steer Cont	Regen	+ 10V5
5.	Bypass/F.Weak Cont	P.Steer	CAN High
6.	P.Steer/F.Weak/Pump/Remote LED	Bypass	CAN Low
7.	-	F.Weak	
8.	-	Pump Cont	
9.	-	Remote LED	
10.	-	Any of 2-9	
11.	-	Any of 2-9	

6.2.3 **CAN (Controller Area Network) Overview**

CAN is an acronym for Controller Area Network. It is a bus system, meaning that it is a collection of intelligent “nodes” which are connected to the same physical piece of wire. If one node transmits something on the wire, all nodes will receive it (including the one doing the transmitting).

CANbus was developed (in 1984) by Bosch, the German electronics manufacturer, for use in road vehicles. The aim of CANbus is to reduce vehicle wiring, as all electrical functions (such as lights, electric windows, ignition) share the same physical wire. Its emphasis on reliable data transmission has made it popular with manufacturers of industrial equipment and materials handling vehicles.

The main applications for CAN communications are automotive and industrial electronics where high speed, noise immune serial communications are required to work reliably in high vibration and high temperature environments.

SEVCON'S CAN system is defined as CAN 2.0A (Basic CAN, error active) and is implemented using a Philips Semiconductor chip-set with an 80C250 transceiver chip. The PowerpaK CAN protocol sets the baud rate to be 100K bits per second.

CAN is extremely flexible and versatile, allowing multi-master operation in a serial communication network with an almost unlimited number of nodes. Data rates of up to 1 Mbit/s are possible transmitting over distances of up to 40 meters, with a very low probability of undetected errors. CAN is basically a 2-wire twisted-pair differential system with 10V5 and 0v supply rails. Connections are made via a 6way Molex connector.

Presently the CAN bus is used to communicate with the calibrator. It can be used to communicate with a dashboard display and for remote control from a host PC. Long term, communications with auxiliary controllers and equipment will be possible.

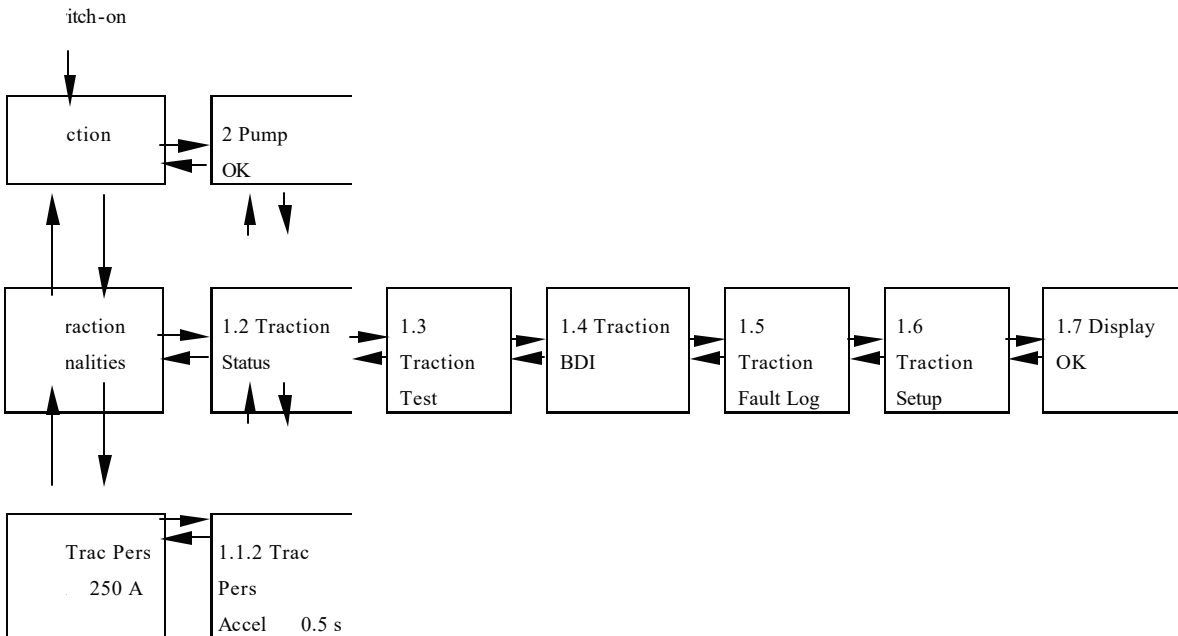
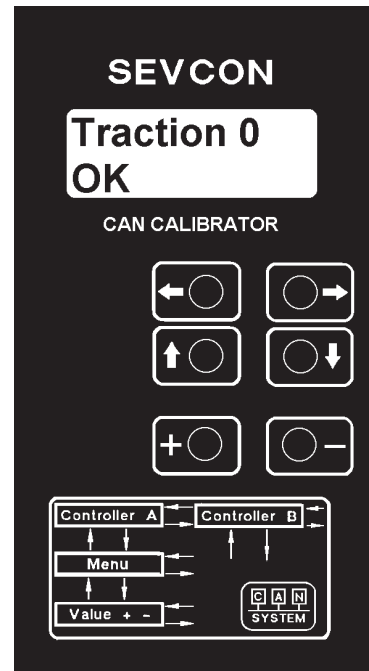
E.g. Battery Chargers, Standalone Power Steer Controllers, Controller I/O expanders ...etc. At present it is possible to connect up to 8 pieces of equipment onto the CAN bus.

7 CALIBRATOR AND ADJUSTMENTS

A sophisticated, yet easy to use hand held adjustment unit, called the Calibrator is used to make adjustments to the controller and select configurations. The Calibrator is also used as a diagnostic tool displaying the status of all voltages, currents and temperatures within the controller together with the condition of all the controller's switch and analogue inputs.

The diagram below describes how the Calibrator is used. The left and right arrows move between screens on the same level. The up and down arrows move between levels and the + and - buttons increment or decrement the parameters by the amount indicated in the STEP column of the following tables.

The calibrator can be specified to have various levels of access to certain adjustments.



7.1.1 Traction Controller Personalities (Controller Adjustments)

Cal. Ref	Parameter Adjusted (* Note at 80V max current is 600A)	Logic: Low i/o Med i/o Hi i/o	Min adjust (all units)	Max. adjust 300A unit	Max. adjust 450A unit	Max. adjust 650A* unit	Step size all units	Typical Default
1.1.1	Current limit	L,M,H	50 A	300 A	450 A	650 A	10 A	100% A
1.1.2	Acceleration delay	L,M,H	0.1 S	5.0 S	5.0 S	5.0 S	0.1 S	1.5 S
1.1.2a	Current Ramp delay	L,M,H	0.0	2.5 S	2.5 S	2.5 S	0.1 S	0.0 S
1.1.3	Deceleration delay	L,M,H	0.1 S	0.5 S	0.5 S	0.5 S	0.1 S	0.3 S
1.1.4	Creep speed	L,M,H	0 %	25 %	25 %	25 %	1.0 %	5.0 %
1.1.5	Direction Plug Current	L,M,H	50 A	370 A	560 A	810 A	10 A	75 % A
1.1.5a	Plug Turn	L,M,H	50 A	370 A	560 A	810 A	10 A	100 A
1.1.6	Neutral Plug Current	L,M,H	10A (0 disables)	370 A	560 A	810 A	10 A	25 % A
1.1.6a	Plugging Threshold	L,M,H	50	255	255	255	1	153/180
1.1.6b	Plug Drop	L,M,H	50 A	370 A	560 A	810 A	10 A	100 A
1.1.7	Footbrake Plug Current	L,M,H	10A (0 disables)	370 A	560 A	810 A	10 A	50 % A
1.1.8	Direction Regen Current	L,M,H	50 A	300 A	450 A	650 A	10 A	200 A
1.1.8a	Speed Limit Braking	M,H	40 A/KPH	300 A	450 A	650 A	10 A	40 A/KPH
1.1.9	Neutral Regen Current	L,M,H	10A (0 disables)	300 A	450 A	650 A	10 A	100 A
1.1.10	Footbrake Regen Current	L,M,H	10A (0 disables)	300 A	450 A	650 A	10 A	150 A
1.1.11	Regen Delay	L,M,H	0ms(0 plug only)	350 ms	350 ms	350 ms	10 ms	160 mS
1.1.12	Maximum speed	L,M,H	0 %	100 %	100 %	100 %	1.0 %	100 %
1.1.13	Cutback speed 1	L,M,H	0 %	100 %	100 %	100 %	1.0 %	75 %
1.1.14	Acceleration delay 1	L,M,H	0.1 S	5.0 S	5.0 S	5.0 S	0.1S	1.5 S
1.1.15	Cutback speed 2	L,M,H	0 %	100 %	100 %	100 %	1.0 %	50 %
1.1.16	Acceleration delay 2	L,M,H	0.1 S	5.0 S	5.0 S	5.0 S	0.1 S	2.0 S
1.1.17	Cutback speed 3	L,M,H	0 %	100 %	100 %	100 %	1.0 %	25 %
1.1.18	Acceleration delay 3	L,M,H	0.1 S	5.0 S	5.0 S	5.0 S	0.1 S	2.5 S
1.1.19	Inch Speed	L,M,H	0 %	25 %	25 %	25 %	1 %	10 %
1.1.20	Burst Inch Delay	L,M,H	0.1 S	5.0 S	5.0 S	5.0 S	0.1 S	2.0 S
1.1.21	Bypass Over Current	M,H	10 A (0 disables)	450 A	680 A	970 A	10 A	100% A
1.1.22	Bypass Delay	M,H	0.5 S	5.0 S	5.0 S	5.0 S	0.1 S	1.5 S
1.1.23	Field Weak Pull In	M,H	50 A	300 A	450 A	650 A	10 A	100 A
1.1.24	Field Weak Drop Out	M,H	50 A	300 A	450 A	650 A	10 A	200 A
1.1.25	Power Steer Delay	L,M,H	0 S	60 S	60 S	60 S	1.0 S	5.0 S
1.1.26	Seat Switch Delay	L,M,H	0 S	5.0 S	5.0 S	5.0 S	0.1 S	2.0 S
1.1.27	Electric Brake Delay	L,M,H	0S	5.0 S	5.0 S	5.0 S	0.1 S	0S
1.1.28	Accelerator Zero Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.29	Accelerator Full Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.30	Footbrake Pot ZeroLevel	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.31	Footbrake Pot Full Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.32	Economy Pot Zero Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.33	Economy Pot Full Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.34	O. Temp Pot Zero Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.35	O. Temp Pot Full Level	L,M,H	0 V	5.0 V	5.0 V	5.0 V	0.02 V	
1.1.36	Speed Limit	M,H	0KPH(0 disables)	60KPH	60KPH	60KPH	1 KPH	0KPH
1.1.37	Low Voltage Init	L,M,H	14.5 V	48/80 V	48/80 V	48/80 V	0.5V	14.5/43V
1.1.38	Low Voltage Cutback	L,M,H	14.5 V	48/80 V	48/80 V	48/80 V	0.5V	14.5/43V
1.1.39	High Voltage Init	L,M,H	14.5 V	75/100	75/100	75/100	0.5V	70/95.0V
1.1.40	High Voltage Cutback	L,M,H	14.5 V	75/100	75/100	75/100	0.5V	72.5/97.5
1.1.41	Battery Protection	L,M,H	14.5 V	48/80 V	48/80 V	48/80 V	0.5V	14.5/43V
1.1.42	Protection Delay	L,M,H	0.1 S	2.5 S	2.5 S	2.5 S	0.1 S	0.1 S

Note 1 : Depending on controller type and configuration some of the above may not be displayed.

Note 2 : pressing the calibrator “down arrow” key from 1.1.2 allows access to 1.1.2a, likewise for 1.1.5a, 1.1.6a and 6b.

Note 3 : pressing the calibrator “down arrow” key from the potentiometer zero and full personalities (1.1.27 to 1.1.32, and 2.1.24 to 2.1.27) jumps directly to the associated voltage measurement in the test menu. Pressing this key from the test menu jumps back to the associated zero level personality.

7.1.2 Traction Controller Status Information

Cal. Ref.	Parameter Displayed	Logic Type	Min.Display	Max.Display	Step size	Log Info.
1.2.1	Battery Voltage	L,M,H	0 V	127 V	0.1 V	+
1.2.2	Traction Motor Voltage	L,M,H	0 V	127 V	0.5 V	
1.2.3	Traction Motor Current	L,M,H	0 A	1200 A	6 A	+
1.2.4	Traction Controller Temp.	L,M,H	-30 °C	+225 °C	1 °C	+ -
1.2.5	Traction MOSFET Voltage	L,M,H	0 V	127 V	0.5 V	
1.2.6	Capacitor Voltage	L,M,H	0 V	127 V	0.5 V	
1.2.7	Speed Sensor Indication	L,M,H	0 KPH	60 KPH	1.0 KPH	
1.2.8	Key Switch Hours Count	L,M,H	0 Hrs	65279.9 Hrs	0.1 Hrs	
1.2.9	Traction Pulsing Hours Count	L,M,H	0 Hrs	65279.9 Hrs	0.1 Hrs	
1.2.10	Pump Pulsing Hours Count	L,M,H	0 Hrs	65279.9 Hrs	0.1 Hrs	
-	Service Log Reset	L,M,H	press + followed by - to reset service log			

Notel : Log Info shows where the + and - keys can be used to access the service max and min data.

7.1.3 Traction Controller Test Information

Cal. Ref.	Input Displayed	Logic Type	Min. Display	Max.Display	Step Size
1.3.1	Accelerator % Range	L,M,H	0%	100 %	1 %
1.3.2	Accelerator Voltage Range	L,M,H	0.0 V	5.0 V	0.02 V
1.3.3	Footbrake Pot. % Range	L,M,H	0%	100 %	1 %
1.3.4	Footbrake Pot. Voltage Range	L,M,H	0.0 V	5.0 V	0.02 V
1.3.5	Economy Pot. % Range	L,M,H	0%	100 %	1 %
1.3.6	Economy Pot. Voltage Range	L,M,H	0.0 V	5.0 V	0.02 V
1.3.7	O. Temp Pot. % Range	L,M,H	0%	100 %	1 %
1.3.8	O. Temp Pot. Voltage Range	L,M,H	0.0 V	5.0 V	0.02 V
1.3.9	Forward	Switch	Open	Closed	-
1.3.10	Reverse	Switch	Open	Closed	-
1.3.11	FS1	Switch	Open	Closed	-
1.3.12	Belly	Switch	Open	Closed	-
1.3.13	Seat	Switch	Open	Closed	-
1.3.14	Tiller	Switch	Open	Closed	-
1.3.15	Speed Cutback 1	Switch	Open	Closed	-
1.3.16	Speed Cutback 2	Switch	Open	Closed	-
1.3.17	Speed Cutback 3	Switch	Open	Closed	-
1.3.18	Inch Forward	Switch	Open	Closed	-
1.3.19	Inch Reverse	Switch	Open	Closed	-
1.3.20	Handbrake	Switch	Open	Closed	-
1.3.21	Footbrake	Switch	Open	Closed	-
1.3.22	Power Steer Trigger Input	Switch	Open	Closed	-
1.3.23	Pump Contactor Trigger	Switch	Open	Closed	-
1.3.24	Speed Limit	Switch	Open	Closed	-
1.3.25	Sideload	Switch	Open	Closed	-
1.3.26	Speed Encoder	Switch	Open	Closed	-
1.3.27	Brushes Worn	Switch	Open	Closed	-
1.3.28	Software Version/Revision	L,M,H	000.00	999.99	-
1.3.29	Controller Serial Number	L,M,H	00000000	99999999	-

Note: As with the personalities, only relevant switch tests will be shown determined by configuration.

7.1.4 BDI Adjustments (if enabled in setup menu)

Cal. Ref.	Parameter Adjusted/Displayed	Logic Type	Min Setting	Max. Setting	Step Size.	Default
1.4.1	Xxx % Charge remaining	L,M,H,P				
1.4.2	Battery Volt xx V	L,M,H,P	24 V	96 V	2 V	Nominal V
1.4.3	Reset x.xx V/Cell	L,M,H,P	2.00 V/Cell	2.50 V/Cell	0.01 V/Cell	2.09V
1.4.4	Empty x.xx V/Cell	L,M,H,P	1.50 V/Cell	1.99 V/Cell	0.01 V/Cell	1.73V
1.4.5	Warning xx %	L,M,H,P	0 %	90%	1.0 %	30%

1.4.6	Cutout xx %	L,M,H,P	0 %	90%	1.0 %	0%
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-7.1.5 Fault Log

Can be disabled via setup menu. See section 9 for more details.

7.1.6 Traction Controller Setup Menu (Enables/Disables features)

Cal.Ref	Feature	Logic Type	Options
1.6.1	Contacting Chopping	L,M,H	24 V / On / Off
1.6.2	Accelerator Type	L,M,H	Linear / Curved / 2* Slope/ Crawl
1.6.3	BDI	L,M,H	On / Off
1.6.4	Power Steer Trigger	L,M,H	None to ES1 +Dir+ Brake +Seat
1.6.5	Economy Cuts Traction Current	L,M,H	On / Off
1.6.6	Bypass in Current Limit	M,H	On / Off
1.6.7	SRO	L,M,H	On / Off
1.6.8	Braking	L,M,H	Proportional / Constant
1.6.9	Plugging Style	L,M,H	Constant Current / Fixed Percentage
1.6.10	Ride-on / Walkie truck	L,M,H	Ride-On / Walkie
1.6.11	Tiller switch	L,M,H	On / Off
1.6.12	Digital i/p 5 config (Skt B pin 6)	L,M,H	Inch Fwd (only Pins 6 & 8) / Inch Rev (only Pins 7 & 9) / Pump / PstTrig / Handbrake / Footbrake / Speed cutback 1 / Speed cutback 2 / Speed cutback 3 / Speed Limit / Sideload / Brushes Worn / Speed Probe(only Pin 9)
1.6.13	Digital i/p 6 config (Skt B pin 7)	L,M,H	
1.6.14	Digital i/p 7 config (Skt B pin 8)	M,H	
1.6.15	Digital i/p 8 config (Skt B pin 9)	M,H	
1.6.16	Analog i/p 1 config (Skt B pin 10)	L,M,H	Accelerator / Footbrake / Economy / O. Temp
1.6.17	Analog i/p 2 config (Skt B pin 11)	L,M,H	Accelerator / Footbrake / Economy / O. Temp
1.6.18	Digital i/p 9 config (Skt B pin 13)	H	Inch Fwd (only Pin 13) / Inch Rev (only Pin 14) / Pump / Pst Trig / Handbrake / Speed cutbacks 1,2,3
1.6.19	Digital i/p 10 config (Skt B pin 14)	H	
1.6.20	Contacting 3 (Skt B pin 12 Low I/O) config . (Skt C pin 4 Med/Hi I/O)	L,M	Low I/O Logic - P.Steer /Regen/Electric Brake Med I/O Logic - Regen /P.Steer High I/O Logic - Regen only
1.6.21	Contacting 4 config (Skt C pin 5)	M	Bypass / F.Weak
1.6.22	Contacting 5 config (Skt C pin 6)	M	F.Weak / P.Str / Pump / Remote LED / BDI Cut / E. Brake
1.6.23	Contacting 9 config (Skt C pin 10)	H	Forward / Reverse / Regen / P.Str / Bypass / F.Weak / Pump / Remote LED / BDI Cut / E. Brake
1.6.24	Contacting 10 config (Skt C pin 11)	H	Forward / Reverse / Regen / P.Str / Bypass / F.Weak / Pump / Remote LED / BDI Cut / E. Brake
1.6.25	Seat Switch Cuts Pump	M,H	On / Off
1.6.26	Fault Log	L,M,H	On / Off
1.6.27	Service Log	L,M,H	On / Off
1.6.28	Full Speed	M,H	5 to 60 KPH in 1 KPH steps default 20
1.6.29	Probe Frequency	M,H	100 to 2000 Hz in 10 Hz steps default 1000
1.6.30	Canbus Mode	L,M,H	Standalone / CAN Master
1.6.31	Switch Limits Speed	L,M,H	On/Off

Note 1: Changes only take effect after a key-switch recycle

7.2.1 Pump Controller Personalities (Controller Adjustments)

Cal. Ref	Parameter Adjusted	Logic Type	Min adjust (all units)	Max.adjust 450 A unit	Max.adjust 650 A unit	Step size (all units)	Typical Default
2.1.1	Current Limit	P	50 A	450 A	650 A	10 A	100% A
2.1.2	Ramp Up Delay	P	0.1 S	5.0 S	5.0 S	0.1 S	0.5 S
2.1.3	Ramp Down Delay	P	0.1 S	0.5 S	0.5 S	0.1 S	0.3 S
2.1.4	Creep Speed	P	0 %	25 %	25 %	1.0%	5.0 %
2.1.5	Pump Speed 1	P	0 % (0=inhibit)	100%	100%	1.0%	100%
2.1.6	Pump Compensation 1	P	1 % (0 disables)	200%	200%	1.0%	0 %
2.1.7	Pump Speed 2	P	0 % (0=inhibit)	100%	100%	1.0%	80 %
2.1.8	Pump Compensation 2	P	1 % (0 disables)	200%	200%	1.0%	0%

2.1.9	Pump Speed 3	P	0 %	100 %	100%	1.0 %	60 %
2.1.10	Pump Compensation 3	P	1 % (0 disables)	200 %	200%	1.0 %	0 %
2.1.11	Pump Speed 4	P	0 %	100 %	100%	1.0 %	50 %
2.1.12	Pump Compensation 4	P	1 % (0 disables)	200 %	200%	1.0 %	0 %
2.1.13	Pump Speed 5	P	0 %	100 %	100%	1.0 %	40 %
2.1.14	Speed 5 (Priority/Additive)	P	priority	additive	additive	-	priority
2.1.15	Pump Speed 6	P	0 %	100 %	100%	1.0 %	30 %
2.1.16	Speed 6 (Priority/Additive)	P	priority	additive	additive	-	priority
2.1.17	Pump Speed 7	P	0 %	100 %	100%	1.0 %	25 %
2.1.18	Speed 7 (Priority/Additive)	P	priority	additive	additive	-	priority
2.1.19	Power Steer Speed	P	0 %	100 %	100%	1.0 %	15 %
2.1.20	Power Steer Compensation	P	1 % (0 disables)	200 %	200%	1.0 %	0 %
2.1.21	Power Steer Ramp Up Delay	P	0.1 S	5.0 S	5.0 S	0.1 S	0.3 S
2.1.22	Power Steer Ramp Down Delay	P	0.1 S	0.5 S	0.5 S	0.1 S	0.3 S
2.1.23	Power Steer Delay	P	0 S	60 S	60 S	1 S	2 S
2.1.24	Seat Switch Delay	P	0 S	5 S	5 S	0.1 S	2 S
2.1.25	Accelerator Zero Level	P	0.0 V	5.0 V	5.0 V	0.02 V	
2.1.26	Accelerator Full Level	P	0.0 V	5.0 V	5.0 V	0.02 V	
2.1.27	Accelerator 2 Zero Level	P	0.0 V	5.0 V	5.0 V	0.02 V	
2.1.28	Accelerator 2 Full Level	P	0.0 V	5.0 V	5.0 V	0.02 V	
2.1.29	Low Voltage Init	P	14.5 V	48V for 24-48Vunits, 80V for 72-80V			14.5/43V
2.1.30	Low Voltage Cutback	P	14.5 V	48V for 24-48Vunits, 80V for 72-80V			14.5/43V
2.1.31	High Voltage Init	P	14.5 V	75V for 24-48Vunits, 100V for 72-80V			70/97.5V
2.1.32	High Voltage Cutback	P	14.5 V	75V for 24-48Vunits, 100V for 72-80V			72.5/97.5
2.1.33	Battery Protection	P	14.5 V	48V for 24-48Vunits, 80V for 72-80V			14.5/43V
2.1.34	Protection Delay	P	0.1 S	2.5 S	2.5 S	0.1 S	0.1 S

7.2.2 Pump Controller Status Information

Cal. Ref	Parameter Displayed	Logic Type	Min. Display (all units)	Max. Display (all units)	Step size (all units)	Log Info.	
2.2.1	Battery Voltage	P	0 V	127 V	0.5 V	+	
2.2.2	Pump Motor Voltage	P	0 V	127 V	1 V		
2.2.3	Pump Motor Current	P	0 A	1200 A	6 A	+	
2.2.4	Pump MOSFET Voltage	P	0 V	127 V	0.5 V		
2.2.5	Pump Controller Temp.	P	-30 °C	+225 °C	1 °C	+ -	
2.2.6	Key Switch Hours Count	P	0 Hrs	65279.9 Hrs	0.1 Hrs		
2.2.7	Pump Pulsing Hours Count	P	0 Hrs	65279.9 Hrs	0.1 Hrs		
-	Service Log Reset	P	press + followed by - to reset service log				

Note : Log Info shows where the + and - keys can be used to access the service max and min data.

7.2.3 Pump Controller Test Information

Cal .Ref.	Input Displayed	Logic Type	Min.Display (all units)	Max.Display (all units)	Step size (all units)
2.3.1	Accelerator 1 % Range	P	0 %	100 %	1 %
2.3.2	Accelerator 1 Voltage Range	P	0.0 V	5.0 V	0.1 V
2.3.3	Accelerator 2 % Range	P	0 %	100 %	1 %
2.3.4	Accelerator 2 Voltage Range	P	0.0 V	5.0 V	0.1 V
2.3.5	Pump Switch 3	P	Open	Closed	-
2.3.6	Pump Switch 4	P	Open	Closed	-
2.3.7	Pump Switch 5	P	Open	Closed	-
2.3.8	Pump Switch 6	P	Open	Closed	-
2.3.9	Pump Switch 7	P	Open	Closed	-
2.3.10	Power Steer Trig ger	P	Open	Closed	-
2.3.11	Inhibit	P	Open	Closed	-
2.3.12	Motor Temperature	P	Open	Closed	-
2.3.13	Brushes Worn	P	Open	Closed	-
2.3.14	Low Oil	P	Open	Closed	-
2.3.15	Software Version/Revision	P	000.00	999.99	-

2.3.16	Controller Serial Number	P	00000000	99999999	-
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Note : pressing the calibrator “down arrow” key from 2.3.11 allows access to 2.3.11a.

7.2.4 Pump BDI (as Traction 7.1.4)

7.2.5 Pump Fault Log (as Traction 7.1.5)

7.2.6 Pump Setup Menu Enables/Disables features

Cal Ref.	Feature	Logic Type	Options
2.6.1	CANbus Mode	P	Standalone / CAN Slave
2.6.2	Accelerator Type	P	Linear / Curved / 2 *Slope / Crawl
2.6.3	Accelerator 2	P	Lift / Economy / O. Temp
2.6.4	BDI	P	On / Off
2.6.5	Fault Log	P	On / Off
2.6.6	Service Log	P	On / Off
2.6.7	Seat and Pump	P	On / Off
2.6.8	Digital i/p 4 config (Skt B pin 5)	P	P.Switch 6 / P.Switch 7 / P. Steer / Inhibit / Motor Temp / Brush Worn / Low Oil
2.6.9	Digital i/p 5 config (Skt B pin 6)		
2.6.10	Digital i/p 6 config (Skt B pin 7)	P	
2.6.11	Power Steer Active Sense	P	Open / Closed

Note: changes only take effect after a key-switch recycle.

7.3.1 Traction and Pump adjustment descriptions

Adjustment	Logic type	Description (T=Affects traction, P=Affects Pump)
Current Limit	L,M,H,P	Maximum allowable motor current.
Acceleration Delay	L,M,H,P	Time taken to ramp up from 0 to 100% on.
Current Ramp Delay	L,M,H	Time taken to ramp up current in plugging and drive.
Deceleration Delay	L,M,H,P	Time taken to ramp down from 100% to 0% on.
Creep Speed	L,M,H,P	Minimum applied % on when drive first selected. Only PS1 on pump
Dir.Brake Current (Plug)	L,M,H	Maximum Plug braking current during direction switch change.
Plug Turn Current (Plug)	L,M,H	Current at which braking ends and drive starts. (Fixed percentage only)
Neut.Brake Current (Plug)	L,M,H	Maximum Plug braking current in neutral.
Plugging Threshold (Plug)	L,M,H	Plug to Drive threshold. Higher numbers mean earlier plug exit
Plug Drop Current (Plug)	L,M,H	Current at which neutral braking ends. (Fixed percentage only)
Footbrake Current (Plug)	L,M,H	Maximum Plug braking current in neutral when F.brake switch active.
Dir.Brake Current (Reg)	L,M,H	Maximum Regen braking current during direction switch change.
Neut.Brake Current (Reg)	L,M,H	Maximum Regen braking current in neutral.
Footbrake Current (Reg)	L,M,H	Maximum Regen braking current in neutral when F.brake switch active.
Speed Brake Current	M,H	Maximum Braking current when speed limit braking.
Regen Delay (Reg)	L,M,H	Used to minimise delays for unsuccessful Regen attempts at low speeds. Higher numbers give Regen at lower speeds. 0 forces plugging only.
Maximum Speed	L,M,H	Maximum allowable % on.
Cutback Speeds 1, 2 & 3	L,M,H	Maximum allowable % on when cutback switches active.
Accel. Delay 1, 2 & 3	L,M,H	Independently adjustable acceleration delays during speed cutbacks.
Inch Speed	L,M,H	Maximum allowable % on during inching operation.
Burst Inch Delay	L,M,H	Timer to allow inching for a set period only.
Bypass Over Current	M,H	Maximum allowable current in Bypass before contactor opens.
Bypass Delay	M,H	Time for Bypass contactor to close after 100% on reached
F.W. Pull In Current	M,H	F.Weak. contactor allowed to pull in at currents < pull in level.

F.W Drop out Current	M,H	F.Weak. contactor will drop out at currents > drop out level.
Power Steer Delay	L,M,H	Delay after power steer trigger removed until contactor opens.
Seat Switch Delay	L,M,H,P	Delay after seat switch opens until pulsing is inhibited.
Zero Levels	L,M,H,P	Used to select minimum voltage input level for function. E.g. an Accel Zero level=0.5V means pulsing begins at 0.5V I/P
Full Levels	L,M,H,P	Used to select maximum voltage input level for function, E.g. an Accel Full Level of 4.0v means 100% pulsing is reached at 4V I/P
Speed Limit	M,H	Used with external speed sensor to provide speed limit feature.
Low Voltage Init	L,M,H,P	Voltage at which controllers starts reducing the max available current limit to help reduce voltage drops
Low Voltage Cutback	L,M,H,P	Voltage at which current limit is reduced to 0
High Voltage Init	L,M,H,P	Voltage at which controller changes from Regen braking to Plug braking to help prevent high generated voltages damaging the battery or controller.
High Voltage Cutback	L,M,H,P	Voltage at which contactors will open, to prevent high voltage damage.
Battery Protection	L,M,H,P	Voltages below this level cause a battery low 7 flash fault
Protection Delay	L,M,H,P	Length of time the voltage can fall below the Battery Protection level for, before a fault is indicated. This helps prevent spikes tripping a low batt fault
Pump Speeds 1-7	P	Maximum allowable % on's when respective switch active
Power Steer Speed	P	As above, but for Power Steer speed.
Pump Comp. 1-4	P	Set-up compensation by adjusting the relevant pump speed to give the required minimum no load speed, then set the associated compensation adjustment to give the same speed under full load conditions
Power Steer Comp.	P	As above but for Power Steer speed compensation.
Power Steer Ramp up	P	Independent acceleration delay for power steer function.
P. Steer Ramp down	P	As above but deceleration delay.
Speed 5, 6 & 7 Priority/Additive	P	Lower numbers have priority over higher numbers. Additive is where the speed 5, 6 or 7 is added to lower numbered switches.
Electric Brake Delay	L,M,H	Used to specify a variable time delay between the power steer trigger becoming inactive and the electric brake contactor opening (brake on).

7.3.2 Setup Menu Descriptions

Setup menu Option	Logic Type	Description
Contactors Chopping	L,M,H	24V/On/Off - Set to 24V to obtain 24V across coils when a lamp is also being driven, On when just contactor coils are being driven and Off when battery voltage contactor coils are used.
Accelerator type	L,M,H,P	Linear/Curved/2*slope/Crawl - Set to Linear for a straight line accelerator characteristic, Curved for more low speed manoeuvrability, 2*Slope for a balance between Linear and Curved, and Crawl for a very shallow low speed manoeuvrability curve. See graph 2 appendix.
BDI	L,M,H,P	On/Off - On enables the BDI (Battery Discharge Indicator) and any warning/cut-out settings, Off disables the BDI feature and removes the BDI setup menu display.
Power Steer Trigger	L,M,H	None/FS1/Dir/F+D/Brake/F+B/D+B/F+D+B/Seat/F+S/D+S/F+D+S/B+S/F+B+S/D+B+S/F+D+B+S – These are the various triggers for power steer activation, FS1 or F = FS1 switch, Dir or D = Direction switch, Brake or B = Foot brake and Seat or S = Seat switch . e.g. setting to FS1 will trigger the power steer delay only when FS1 is close., whilst setting to F+D+B will trigger the delay when either FS1 or Direction or the Brake switches are closed.
Economy cuts traction current	L,M,H	On/Off - set to On for current limit to be reduced during economy or Off for just the standard acceleration delay increase.
Accelerator 2 Type	P	Lift is pump accel 2 or Economy for use as economy input (current limit reduced) or O.Temp for use as overtemperature sensor input (current limit reduced)
Bypass in current limit	M,H	On/Off - On =Bypass at max %on and current limit, Off = just Bypass at max %on.
SRO	L,M,H	On/Off - On = SRO enabled, Off = SRO disabled
Braking	L,M,H	Prop/Const - Prop = Direction braking level is proportional to accelerator position, Const = Direction braking is constant level.
Plugging Style	L,M,H	Constant Current = fixed current level plugging, Fixed Percentage plugging

Ride-on / Walkie truck	L,M	Ride-on / Walkie – Ride-on = Skt B pin 4 is FS1 input, pin 5 is Seat sw i/p Walkie = Skt B pin 4 is Belly sw input, pin 5 is tiller sw i/pt
Tiller switch	L,M	On/Off - On =Tiller switch must be wired in, Off = leave Skt B pin 5 un connected
Digital Input Configuring	L,M,H	Inch Fwd/Inch Rev/Pump/Speed 1 cutback/Speed 2 cutback/Speed 3 cutback /Handbrake/Footbrake/Pst. Trig/ Speed Limit/Sideload/Brushes Worn/ Speed Encoder
Digital Input Configuring	P	P.Switch 6 / P.Switch 7 / P. Steer / Inhibit / Motor Temp / Brush Worn / Low Oil
Analog Input Configuring	L,M,H	None/Accel/Footbrake Pot/Economy pot/Over Temp pot Skt B pins 10 & 11 analog inputs can be configured to perform the above input functions.
Contactour Output 3-6 configuring.	L,M,H	Forward/Reverse/P.Steer/Regen/Bypass/F.Weak/Pump/Remote LED / BDI Cut / E. Brake Skt B pin 12 (Low I/O logics only) and Skt C pins 4,5,6 (Med & High I/O Logics) and Skt C pins 9 & 10 (High I/O logic only) can be configured to perform some of the above Contactour output functions.
Seat switch cuts pump	M,H	On/Off - On = Seat switch cuts Traction and Pump, Off = just Trac.
Seat switch cuts pump	P	On/Off - On = Seat switch cuts just Pump, Off = disabled
Fault Log	L,M,H,P	On/Off - On = Fault Log enabled, Off = Disabled and no display.
Service Log	L,M,H,P	On/Off - On = Service Log enabled, Off = Disabled and no display.
Canbus Mode	L,M,H,P	Standalone – standalone operation, CAN Master – Canbus master for controlling display (L,M,H only), CAN Slave – Canbus slave (P only)
Switch Limits Speed	L,M,H	On/Off - On = speed limit applied if speed limit switch input is active, if speed limit switch is inactive no speed limit is applied, Off = speed limit applied regardless of switch.
Power Steer Active Sense	P	Open/Close - power steer is on when the digital input configured as P.Steer matches this setup state, otherwise the power steer is off (unless internally triggered)

7.3.3 BDI adjustment descriptions

BDI Adjustment	Logic Type	Description
Charge remaining	L,M,H	Displays remaining battery charge. Display only, no adjustments can be made.
Battery Voltage	L,M,H	Adjustment used to enter the nominal battery voltage
Reset Volts/Cell	L,M,H	Sets the voltage at which the BDI resets to 100% at power up. E.g. the BDI will reset to 100% on a 48V system, with the reset adjustment set to 2.20 Volts per cell, if the battery voltage is above 52.8V. $(48V/2)*2.20V$
Empty Volts/Cell	L,M,H	Sets the voltage at which the BDI indicates the battery is fully discharged E.g. the BDI will eventually show 0% on a 48V system, with the empty adjustment set to 1.60 Volts per cell, if the battery voltage is below 38.4V. $(48V/2)*1.60V$
Warning Level %	L,M,H	Sets the discharged level at which the warning threshold is reached, at which point the remaining lit segments flash.
Cutout Level %	L,M,H	Sets the discharged level at which the cut-out threshold is reached, at which point all the segments flash together and the cut-out action, Pump cut-out and Traction speed 2 limit initiated.

8 DIAGNOSTICS

Traction and Pump Fault Messages and LED status/number of flashes

	Calibrator Message	Standard Display	Full Feature Display	Led	Description and how to clear	Check...
0	OK (lowest priority)			on	Traction operational and OK.	No action required.
1	Testing...	Run Tests		on	Only displayed briefly at power up.	No action required.
2	Trac Brush	Trac Brush	TRAC BRUSHES	on	Traction brushes worn.	Check brushes.
2	Pump Brush	Pump Brush	PUMP BRUSHES	on	Pump brushes worn.	Check brushes.
3	Pump Overtemp	Pump Hot	PUMP HOT	on	Pump over temperature.	Allow controller to cool.
4	Oil Fault	Oil Fault	OIL LOW	on	Oil pressure low.	Check oil.
5	BDI Cutout	BDI Cut	BDI CUT OUT	7F	BDI enabled and cut-out action initiated.	Battery charged.
6	Thermal Cutback	Over Temp.	TRAC HOT	8F	Traction heatsink above 75°C. Allow controller to cool.	Heatsinking, Mounting, Surfaces clean, fan req.
6	Thermal Cutback	Over Temp.	PUMP HOT	8F	Pump heatsink above 75°C. Allow controller to cool.	Heatsinking, Mounting, Surfaces clean, fan req.
7	Speed Probe	Speed Probe	SPEED PROBE	6F	Speed limit feature enabled & wire off.	Probe connections.
8	Accel. Fault	Accel Fault	ACCEL FAULT	6F	Accel. pedal pressed at power up, or wire off. Recycle FS1 and Direction.	Accel wiring. Accel Zero & Full Personalities.
9	Contacto r o/c	Cont o/c	CONTACT FAULT	4F	Contacto r has bad contact or didn't close, motor o/c. Recycle FS1 & Dir.	Coil wiring, power wiring, motor o/c.
10	Contacto r s/c	Cont s/c	CONTACT FAULT	4F	Contacto r didn't open or is welded. Recycle FS1 and Direction switch.	Welded tips, particles in tips, wiring.
11	Sequence Fault	Seq. Fault	SEQ FAULT	2F	Direction or FS1 switch at power up. Recycle Direction FS1 or both.	Dir and FS1 in neutral and Dir/FS1 wiring.
12	2 Dir. Fault	2 Dir Fault	2 DIR FAULT	2F	Two directions selected together. Recycle both Directions and FS1.	Direction switch wiring.
13	SRO Fault	SRO Fault	SRO FAULT	2F	Dir. switch selected > 2 seconds after FS1. Recycle FS1 and Dir.	Dir first then FS1, FS1 and Dir. switch wiring.
14	Seat Fault	Seat Fault	SEAT FAULT	2F	Drive selected and no seat sw. Recycle Dir and FS1 switch	Seat switch, closed, seat wiring.
15	Inch Fault	Inch Fault	INCH FAULT	2F	Inch switch at power up , both inch switches selected or inching attempted with seat switch or Dir/FS1 selected. Recycle inch switches.	Inch switch in neutral at power up ,only 1 selected, Seat/Dir/FS1 switches open.
16	Battery High	Bat. High	BATTERY HIGH	7F	Battery > High battery personality. Recycle FS1 or Direction switch	Correct battery voltage. Loose or missing B+ to controller.
17	Battery Low	Bat. Low	BATTERY LOW	7F	Battery < Low battery personality. Recycle FS1 or Direction switch	Correct battery voltage, Discharged battery.
18	Pers Error	Pers Error	PERS ERROR	1F	Personalities out of range at power up.	Reset personalities out of range (shown as ----.).
19	CRC error	CRC Error	CRC ERROR	1F	One or more personalities have been corrupted.	Check all personalities then recycle keyswitch.
20	Coil s/c	Coil s/c	COIL FAIL	9F	A contacto r coil s/c or miswired. Recycle Keyswitch	coil s/c, Drive connected directly to B+ve, wiring.
21	Mosfet s/c	FET s/c	MOSFET FAIL	3F	Bypass contacto r s/c or MOSFET s/c Recycle FS1 or Direction	A / P /B- power wiring, MOSFETs s/c.
22	Canbus Fault	Canbus Fault	CAN FAULT	off	Can connection between controllers has been disconnected	Can connection between controllers.

23	Various internal controller power up messages (highest priority)	FAIL	FAIL	off	If any of these message are displayed then the controller has failed one of its internal power up checks.	Contact Sevcon.
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9 SERVICE AND FAULT LOGS (All Logics)

The Service and Fault Logs have been incorporated to allow end users and service personnel to inspect and note the controller’s performance and fault history. Utilising the controller’s existing Status measurements and Diagnostics capabilities, information (such as the maximum temperature the controller has operated at or the number and type of faults that have been detected) can be stored in non-volatile memory and presented at a later date. Both the Service and Fault logs can be selected/deselected via the setup menu on the calibrator, and when selected can be cleared at any time to start recording new data.

9.1 Service Log

Service information is available in the Traction and Pump Status menus, where holding down the ‘+’ key shows the maximum value of the current item, and holding down the ‘-’ key shows the minimum value. The following items are logged:

- Maximum Battery Voltage
- Maximum Motor Current
- Maximum Controller Temperature and Minimum Controller Temperature.

To clear the log, access the “Service Log + to reset log” message at the end of the Status menu, and follow the prompts. The service log can be enabled and disabled in the Setup menu.

9.2 Fault Log

The Fault log is available at location 1.5 on the calibrator. Faults are grouped together by “LED flash fault”; the types of flash fault and whether each is logged is shown below. Generally faults that can occur during normal operation e.g. a 2 flash driver procedure error or an 8 flash thermal cutback indication, are not logged.

- | | | |
|------------------|------------|--|
| - LED off faults | Logged | (Internal controller power up check faults) |
| - 1 flash faults | Logged | (Personality/CRC faults) |
| - 2 flash faults | Not Logged | (Driver procedure/sequence/wiring type faults) |
| - 3 flash faults | Logged | (MOSFET/Bypass wiring type faults) |
| - 4 flash faults | Logged | (Contactor o/c or s/c or wiring type faults) |
| - 5 flash faults | Not Logged | (Not used) |
| - 6 flash faults | Not Logged | (Potentiometer wire off type faults) |
| - 7 flash faults | Logged | (Battery low or high faults) |
| - 8 flash faults | Not Logged | (Thermal cutback faults) |
| - 9 flash faults | Logged | (Contactor coil s/c type faults) |

Each of the above logged categories contains - The total number of faults of this type, the Key hours count of the most recent fault and a text description of the fault. An example of how the Fault Log information is presented is shown below:

12*04F 12345.6hr Contactor o/c

This display shows that 12 4-Flash faults have occurred and been logged, the most recent at 12345.6 Key hours and it was a Contactor o/c fault.

Once into the fault log menu, the left and right arrows are used to view any faults stored and at the end of the list a “Fault Log + to reset log” message is shown, where the Fault Log can be reset in a similar way to the service log. The Fault Log can be enabled and disabled in the setup menu.

10 CONTROLLER OPERATION AND FEATURE DESCRIPTIONS

10.1 TRACTION OPERATION - Applicable to all Traction logics unless otherwise specified

- 10.1.1 **Start Up Sequence** - At keyswitch on, the Direction and FS1 switches must be in the neutral condition simultaneously at least once before drive can be selected. This is a safety feature to help prevent unexpected movement immediately after power up.
- 10.1.2 **SRO** (Static return to off)- This feature is optional in the setup menu and when specified, forces the following sequences of switch inputs to be followed before drive is allowed: Keyswitch-Direction-FS1 or Keyswitch-FS1-Direction (within 2 seconds of FS1) . Any other sequence will not allow drive. Drive will be inhibited if FS1 is active for more than 2 seconds with no direction selected. In this case the FS1 will need to be recycled.
- 10.1.3 **Seat Switch** - If the seat switch is opened and the seat switch timer has timed out during drive the controller will stop pulsing and a seat fault will be indicated. Before drive can be restarted the seat switch must be closed, and FS1 and the direction switch must be recycled through neutral. Note the start sequence for drive requires that the seat switch is closed and both the direction and FS1 switches are in the neutral position simultaneously before drive can be initiated. The time period is programmed by means of the Calibrator (Seat Switch Delay). As a setup menu option the seat switch can also inhibit pump operation if required. There are also additional seat switch start up sequences available as options, although the above described SEVCON standard is recommended.
- 10.1.4 **Belly Switch** - (Not available on High I/O logic) - A Belly Switch function is available when the controller is used on a walkie type truck. The feature can be enabled in the setup menu. See this section and wiring diagrams for additional information. Basic operation is as follows:-
- Truck moving in Reverse and activating the Belly Switch, accelerator in reverse position:-
- a) The contactors change direction to forward drive (this initiates plug braking). b)150% maximum plugging is applied for a maximum of 1.5 seconds, when it will then revert to maximum plugging. c)The vehicle will accelerate at full speed along the 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 the Belly switch is pressed again however, action as at c) above.
- Accelerator in Neutral:- As above
- Accelerator in Forward position :- Start at c) above
- Truck moving in Forward and activating the Belly Switch, accelerator in forward position:-
- Accelerator in Forward position :- No effect
- Accelerator in Reverse position :- Belly switch closed, truck drives as per start of c) above.
- 10.1.4 **Handbrake Switch** (Not available on Low I/O logic) - An input is provided for the connection of a handbrake switch, which if operated will disable traction pulsing but leave the drive related contactors in position to effect a minimum roll back hill start when drive is selected and the handbrake is released.
- 10.1.6 **Deceleration Delay** - This is an adjustable delay to ramp down the pulsing from 100% on to 0% on, and can be used to limit the inherent truck lurch when acceleration is interrupted. When neutral is selected, contactors are only opened when the % on has ramped down to 0.
- 10.1.7 **Creep** - The Creep speed is adjustable and is used to select a minimum pulsing level as soon as drive is requested, to minimise delays and dead-bands. The motor voltage is rapidly ramped to the creep level (equivalent to a 100mS acceleration delay).
- 10.1.8 **Cutback speeds** - Each one has an associated personality to adjust the maximum % on when the switch is active. In addition each cutback has an independently adjustable acceleration delay associated with it to further enhance low speed manoeuvrability. When both switches are active together, the lower speed is selected together with the slowest acceleration delay. The cutback speed inputs are usually normally closed so that a wire off type fault or bad connection initiates a lower speed.

If the speed limit feature is turned on when a cutback speed limit switch is closed, the cutback percentage will be applied to the maximum speed setting.

When the BDI feature is enabled and the cut-out level is reached the speed 2 cutback is automatically initiated.

A maximum speed adjustment is also available to limit the maximum applied %on. (If the setting is less than 95% then Bypass and Field Weakening are disabled).

- 10.1.9 **Bypass** - (Not available on Low I/O logic) The Bypass contactor is used to short out the main MOSFET switching device to increase speed and efficiency at high speeds and to allow higher motor currents than the controller's maximum current limit, to climb ramps laden or to escape from ruts or pot holes.

Bypass can be initiated in 2 ways:

Current-limit Bypass: the accelerator is fully depressed and the controller has been in current limit for longer than 2 seconds. In order to prevent a sudden lurch of the truck the contactor will not be energised if the motor voltage during current limit is less than 20% of battery voltage. This mode of operation can be disabled via the setup menu.

High-speed Bypass: If the accelerator is fully depressed and the controller has been pulsing at maximum % on for 1.5 seconds and the Bypass Delay personality has timed out. The Bypass delay timer is a feature that can be used to allow the truck to obtain full speed, before contactor closure.

The bypass contactor will be de-energised if the accelerator demand is reduced below 86%, or if the motor current exceeds the Bypass over-current dropout level, adjustable by the calibrator. To allow for initial overshoots the over-current test is disabled for the first 2 seconds of Bypass. Although the software attempts to minimise arcing when the contactor opens, some arcing is inevitable under certain load conditions. After an over-current drop out, the Bypass function will be inhibited until neutral is recycled to prevent repeated opening and closing of the tips under heavy current conditions.

Bypass can be disabled by setting the over-current drop out to 0 A. Also Bypass will be disabled if either of the 2 speed cutback switches are enabled and the settings are adjusted below 95% or the maximum speed setting is less than 95%. Applying the footbrake switch or economy > 0% will also prevent Bypass closure.

- 10.1.10 **Field Weakening** - (Not available on Low I/O logic) This is carried out by connecting a low value/high wattage resistor connected in series with a contactor across the traction motor field to weaken the field and hence increase speed whilst reducing torque. As a guide line the value of the resistor should be the same as the motor field resistance and it should be rated to carry field current.

At full accelerator depression and maximum %on, and after bypass contactor closure (if fitted) the field weakening contactor is energised providing the current is below the Pull-In level. If the motor current increases above the Drop-out level or the accelerator demand is less than 86% or the bypass contactor is de-energised, the Field Weakening contactor will be opened. Both the Field Weakening Drop-Out and Pull-In current levels are adjusted with the calibrator.

- 10.1.11 **Power Steer, Traction Controller** - A contactor drive is available to control a separate Power Steer motor. An adjustable delay allows the motor to operate for a set time, after the power steer trigger or power steer demand has been removed. SEVCON's standard trigger, i.e. when the contactor is closed, is when either FS1 or the Footbrake switch is closed, or the Traction unit is pulsing. It is an either-or situation, so any one of these 3 inputs is sufficient to trigger the Power Steer.

This standard trigger is designed to give power steer when ever the truck is moving, but not to have a situation where the Power steer could be on continuously, i.e. on a direction switch where the truck could be left with a direction selected and the Keyswitch left on. If FS1 or the Footbrake is applied then the vehicle is either about to move or is moving, and the Traction pulsing is used if the truck was neutral braking (pulsing) down a long ramp, when it is conceivable that neither of the 2 switches would be closed. On a tow-tractor, power steer is disabled during inching.

An independent input pin (see figures 2 & 3) also exists to trigger Power Steer operation. This is normally used in conjunction with a steer on demand system where an output is generated when the steering wheel is turned. This gives Power steer on demand and is more efficient since typically no steering delay, or only a short delay is needed.

The independent trigger only, or other trigger combinations can be configured if necessary in the setup menu.

Some vehicles derive the power steering assistance from the main Pump Hydraulic motor, instead of having a separate Steer motor. In this situation the trigger is fed to the Pump controller and runs the pump at the speed set by the P. S. Speed personality.

Independent ramp up and ramp down delays are provided when Power steer assistance is derived from the main Pump controller, to help tune steering responsiveness without affecting the main pump operation.

10.1.12 **Regen Braking** - Regen provides vehicle braking by controlling the motor as a generator and returning the generated energy back to the battery. Regen braking reduces motor heat dissipation compared with plug braking. Regenerative braking can be initiated in 3 ways, each with an independently adjustable braking level, as follows:

i) A direction switch change will initiate Regen braking at a level set by the Direction Brake Current level. Braking effort is proportional to the accelerator position, with a minimum accelerator pedal position giving 50% of the set brake level increasing to 100% for a fully depressed pedal. The proportionality range allows the driver to modify the braking effort without allowing freewheeling. The proportionality feature is optional and can be configured in the setup menu to give fixed braking at the set personality level.

ii) Closure of the foot-brake switch in neutral, will initiate Regen braking at the Footbrake personality level. An input is provided to allow braking effort to be proportional to the Footbrake position if a potentiometer is fitted. Setting a 0 into the personality disables braking on the Footbrake switch.

iii) When neutral is selected, Regen is initiated at the Neutral Brake Current level. Setting a 0 into the personality disables neutral braking and allows freewheeling. Neutral braking will only be attempted if the % on in the previous direction exceeded 20% above the set creep level. This helps minimise unnecessary delays and contactor operations.

Regen braking is not possible at low speeds depending on the motor characteristics. To help minimise delays attempting to Regen, a Regen Time adjustment is offered which can be set so that Regen is only attempted for a short period of time, which is sufficient to initiate Regen at medium to high speeds but not to cause unnecessarily long delays at very slow speeds where Regen is not possible. If the Regen Time setting is increased then Regen can be initiated at lower speeds. Setting the Regen Time to 0 disables Regen and forces plug braking only.

If Regen is not possible due to low vehicle speed, the following action will be taken:

- 1) For direction braking, plugging will be used to slow, then reverse the vehicle.
- 2) For neutral or footbrake braking, the vehicle will freewheel.

The switching frequency in Regen is high frequency and silent.

10.1.13 **Plug Braking** - Plug braking is achieved by controlling the rotating motor armature as a generator and dissipating most of the energy in the motor and the plug diode.

For plugging-only controllers, the conditions for initiating braking are identical to those for Regen controllers: on a direction change, footbrake switch and in neutral Plugging also operates on Regen controllers if the truck has been travelling to slowly to initiate Regen direction braking.

The switching frequency in the Plug braking mode is 6KHz.

10.1.14 **Inching** - This facility is normally used on Tow Tractors to manoeuvre the Tractor towards the load from the rear of the vehicle, using 2 inching buttons, one for forward and one for reverse. The inch speed is adjustable via the calibrator.

Inching will only operate if the main direction control and FS1 switches are in the neutral position and the seat switch is open, and handbrake off. These safety interlocks prevent anyone from sitting in the driver's cab whilst an operator is using the inching switches at the rear.

A burst inching feature is also available which uses inching in conjunction with an adjustable timer to provide inching for a limited period. This is typically used in conjunction with an electromechanical brake to provide inching on gradients and to help prevent against unlimited travel if an inching button became jammed in the closed position or failed short circuit.

- 10.1.15 **Anti-Rollback** - This is a standard SEVCON feature and is used to help prevent roll back conditions on ramps. If the driver reselects the previous direction after a neutral condition, braking is not attempted, and full drive power is available to restart on a hill.
- 10.1.16 **Analogue Inputs** - The accelerator/analogue inputs are flexible in the range of signal sources they can accommodate and can be adjusted to minimise dead-bands and mechanical tolerances. Each analogue inputs has 2 adjustments associated with it, that allow the input voltage range to be determined.
- For the Traction Accelerator, for example, the 2 adjustments are called the “Accelerator Zero Level” and the “Accelerator Full Level”. If these were set to 0.20V and 4.80V then 0% pulsing would start at 0.20V at the input, increasing to 100% pulsing at 4.80V. For accelerators with decreasing voltage outputs, the Zero adjustment might be set to 3.5V and the Full adjustment to 0.0V. The Calibrator test menu shows the instantaneous voltage reading, and the equivalent % “push” for each input, and to allow easy set-up, pressing the “down” key on the calibrator from either of these test displays, allows a direct jump to the Zero voltage and Full voltage personality settings. Note that a 6 flash fault will occur if the full and zero levels are set within 0.50V of each other.
- For wiring details see Figures 1 to 3.
- 10.1.17 **Traction Accelerator** - When Drive is selected and the accelerator is first pressed, pulsing will commence at the Creep Speed setting increasing towards the maximum %on.
- If the accelerator is depressed at power up, pulsing will be inhibited and a 6 flash fault will be indicated, until the pedal is released. In case of a wire off type fault, pulsing will be limited to the creep setting and a 6 flash fault will also be given.
- Various accelerator characteristics i.e. relationship between accelerator push and the applied motor voltage, can be selected via the setup menu. There are 4 options: Linear, Curved, 2*slope and Crawl. Set to Linear for a straight line accelerator characteristic, Curved for more low speed manoeuvrability, 2*Slope for a balance between Linear and Curved, and Crawl for a very shallow low speed manoeuvrability curve. See graph 2 for actual characteristics.
- 10.1.18 **Footbrake Potentiometer** - This input is available to allow a potentiometer to be fitted to the Footbrake pedal for proportional braking. It can be connected and set-up as per the accelerator input. Note that footbrake operation drops out both Bypass and Field weakening.
- 10.1.19 **Footbrake Switch** - This input is available to allow a switch to be fitted to the Footbrake pedal for constant braking. Note that footbrake operation drops out both Bypass and Field weakening.
- 10.1.20 **Economy Potentiometer** - This potentiometer, normally available to the driver of the truck, varies the acceleration ramp delay from its set value to its maximum value. It can be adjusted as per the accelerator input. As a setup menu option the economy function can reduce the traction current limit, instead of increasing the acceleration delay. Note that the economy function drops out both Bypass and Field Weakening.
- 10.1.21 **Over-Temperature Sensor** - This input is available for overtemperature sensors which are attached to the traction or pump motors. The input will reduce the traction or pump current limit from maximum to 1/3 current limit, similar to the economy cuts current limit function. If a Full Feature Display is fitted, the over temperature symbol (thermometer) and the traction or pump identifier will be displayed.
- 10.1.22 **Digital Switch Inputs** - The digital inputs on the controller can be configured as Active Low inputs, where the switches are wired to B-ve. Active High inputs, connecting to B+ve, are not available. The SEVCON standard is Active Low, and is recommended for its low impedance input stage and immunity to moisture related problems.
- A further configuration allows each input to be specified as normally open or normally closed. Most switches are normally open, with the exception of the 3 speed cutback switch inputs which are normally closed, so that a wire off type fault, or bad connection initiates the cutback speed, rather than a higher speed. On compensated Pump systems the Power Steer input can be conveniently configured as normally closed.
- 10.1.23 **Contactors** - The Pump logic has no contactor drives. The Low I/O logic has 3 outputs for driving contactors, the medium I/O has 5 outputs and the High I/O has 10. On Medium and High I/O logics it is also possible to reconfigure an output, as an external LED or Lamp driver to allow dashboard indication of the controller’s integral LED.

The controller can diagnose open circuit (o/c) and short circuit (s/c) problems with certain contactors, as described in the diagnostic section. Generally, following a request to open a contactor, the controller will report a 4 flash fault and a calibrator message if a successful operation was not detected after approximately 500ms. To help prevent against minor tip contaminants causing spurious diagnostic trips when closing a contactor, if a closure is not detected after 500ms, pulsing up to a maximum of 25% is allowed. This is designed to pass a controlled amount of current to try and break through any contaminant present to allow uninterrupted drive. If a closure isn't detected on reaching 25%, then the contactor drive is removed and a 4 flash fault is indicated.

An optional Line Contactor, not controlled from the controller, can be connected between the B+ terminal of the controller and battery positive. A diode should be fitted in series with the line contactor coil to prevent large currents flowing through the battery connectors and into the internal capacitors when the controller is first connected to the battery. After the keyswitch has been switched, and once the capacitors have charged up (via internal resistance) the line contactor will be energised. An internal diode fitted in the keyswitch line will prevent any contactor energising if the polarity of the battery voltage is reversed. On Pump controllers the Line Contactor also gives a mechanical break.

Under normal operating conditions contactors will operate without arcing. However, under certain fault conditions, contactors may arc when opening. The Bypass contactor may also arc during Bypass over-current drop out conditions.

- 10.1.24 **Contactor chopping** - This feature allows 24 V contactors to be used at all battery voltages 24V - 80V, by continuously monitoring the battery voltage and chopping the contactor output pins accordingly, to present an average voltage suitable for 24V coils. Chopping is selectable by the calibrator. All the contactor drives will be either chopped or not chopped. It is not possible to select individual drives to chop. Care must be taken to ensure that chopping is always selected if 24V contactors are being used on battery voltages higher than 24V. In applications > 24 volts contactors must be fitted with blow out magnets.

Chopping can reduce the overall dissipation in the coils and allows only one set of contactors to be stocked for all battery voltages.

Chopping Frequency approx. = 650Hz (Slightly audible at higher battery voltages)
Typical contactor coil voltage during chopping = 16 volts.
Typical contactor coil voltage during energisation = 24 volts for 1 second.

There are 3 contactor chopping options available via the setup menu: Off, On and 24V. The off setting is used for nominal battery voltage coils, and the On setting is for 24V coils on higher voltage vehicles. Setting to 24V provides chopping for 24V coils and lamps without the drop to 16V after 1s.

- 10.1.25 **Fail-safe** - The controller's safety system includes a microprocessor watchdog which can detect software failure, and a hardware fail-safe system which can prevent dangerous runaway conditions in the event of certain hardware failures.

Every time the controller is powered-up, the software checks that the fail-safe circuit is able to switch off the MOSFETs and open the contactors.

- 10.1.26 **Speed Limit** - (Not available on Low I/O logic) A traction speed limit in KPH can be set via personality T.1.36 (0 KPH disables the feature). As the speed of the vehicle approaches the limit, the maximum motor voltage is reduced. If the speed limit is exceeded by more than 2 KPH (when the vehicle is travelling down-hill for example) electrical braking will be used until the speed of the vehicle falls to below the limit. Speed limit braking may operate in normal drive (as described above), to increase existing braking torque if the vehicle over-speeds, or if the vehicle is rolling in neutral.

The actual limit speed of the vehicle is typically ± 2 KPH of the personality setting, depending on motor loading. When the feature is enabled, a probe "wire-off" feature will limit the motor voltage if the probe is disconnected.

Calibration of the feature is made via the set menu items "Full Speed" (1.6.23) and "Probe Frequency" (1.6.24). Full Speed should be set to the maximum speed of the vehicle, unloaded on level ground. The Probe Frequency setting should be the output frequency of the sensor at that speed.

The recommended sensor is an active low (i.e. NPN) inductive proximity switch. The output is connected to the customer connector, pin 9. A +12V supply on the customer connector pin 12 can be used for most types of sensor. The negative supply of the sensor should be connected to the controller's B- terminal. Contact SEVCON for further recommendations if required.

If the speed limit feature is turned on when a cutback speed limit switch is closed, the cutback percentage will be applied to the maximum speed setting.

- 10.1.27 **Sideloader** - (Only available on High I/O logic when contactors 9 & 10 are configured to Forward and Reverse). If the sideloader switch is active, this will reverse contactors 9 & 10 when compared to contactors 1 & 2 e.g. if the forward direction is selected and the sideloader switch is active, contactor 1 (FORWARD) = CLOSED, 2(REVERSE) = OPEN, 9(FORWARD) = OPEN and 10(REVERSE) = CLOSED. The sideloader switch is only acted upon when the controller is in a neutral state (no driving or braking). The application must ensure that the vehicle is at a standstill before the switch input is changed.

10.2 **PUMP OPERATION**

- 10.2.1 **Pump Operation** - There is no start-up sequence, so pulsing will be initiated after a small delay at power-up if one or more of the pump switches is selected. There are adjustable ramp up and ramp down delays. A Pump contactor can be specified as an option. There are facilities for prioritising pump speeds, for having different pump speeds added together and for having speed compensation for different load conditions.

- 10.2.2 **Pump Speeds and Priorities** - Each of the 5 pump switch inputs has its own speed setting. The pump speeds are prioritised in numerical order so that Speed 1 has priority over all other speeds and Speed 2 has priority over Speeds 3 to 5, etc. Example:- If Speed 1 is set to 10%, Speed 2 to 20% and Speed 3 to 30% then selecting Speeds 1 and 3 will give 10% and selecting Speeds 2 and 3 will give 20%.

- 10.2.3 **Additive speeds** - Pump switches 5 and 6 can be adjusted to have an "Additive" speed. In this mode, the switch is excluded from the priority system described in 10.2.2; instead its speed is added to the prioritised pump speed to give increased power required to handle simultaneous pump operations.

Example:- If speed 2 is set to 40%, speed 5 is set to 25% and speed 6 is set to 10%, then selecting all three switches will give a demand of 75%, and selection 2 and 6 alone will give a demand of 50%.

- 10.2.4 **Pump accelerator inputs** - The pump accelerator demands are associated with Speeds 1 & 2. The pump will operate at the Creep Speed setting when the accelerator is at minimum demand and change linearly to Speed 1 or 2 as the accelerator is increased to the maximum demand. The pump pot accelerator input can be connected and adjusted as per the previously described traction accelerator input.

- 10.2.5 **Economy Potentiometer** - This potentiometer if configured varies the pump current limit. 0% economy gives maximum current and 100% economy gives 1/3 of maximum current.

- 10.2.6 **Power Steer speed** - On compensated pump systems this setting can be used to control the power steer speed from the main pump motor. This speed is selected from the power steer trigger input as previously described and can be compensated for as described in the section below. The power steer also has independent ramp up and ramp down delays. See the section 10.1.11 on Power Steer for more information.

- 10.2.7 **Pump Speed Compensation** - Some trucks utilise the main hydraulic pump motor to provide power steering assistance, instead of a separate power steer motor. This feature provides speed compensation so that the pump motor always provides steering assistance, whilst allowing the motor to slow down when assistance isn't required to minimise noise and improve efficiency. Pump speeds 1 - 4 and the Power Steer speed can be compensated if required.

The compensation is a straight line characteristic set up using 2 personalities. The set up procedure may require some repetition to give optimum performance of low load (low noise) and full compensated load. The low load speed is normally set up to run the pump motor at its lowest permissible lubrication speed to keep audible noise to an absolute minimum.

The calibrator's base speed sets up the low load speed and the compensation factor sets the amount of boost when the controller detects a current increase due to the pump motor load increasing. The controller monitors the motor current and changes the motor voltage to ensure that the motor remains on this compensated speed line.

Set up Procedure - Set both the base speed and the compensation factor to 0. Activate the pump switch associated with the speed to be compensated. Ensure that the motor has its minimum load. Increase the Base speed until the correct operating speed at minimum load is achieved. Increase the load associated with this pump speed to its maximum. Increase the compensated speed until varying the load has little or no effect on the speed.

Example - Power steer compensation where the main pump motor provides the hydraulic steering assistance. Set the Power Steer personality base speed and compensation factor to 0. Activate the Power Steer Trigger input and increase the Power Steer base speed until the pump motor is running at its desired low speed. Operate the steering. Very little assistance will be given if the pump is going slow. Increase the Power Steer compensation setting until the required amount of assistance is given when the steering is operated. The set-up is an iterative process so it may be necessary to change the base speed again and repeat the procedure to obtain optimum results.

10.3 GENERAL OPERATION

10.3.1 **Operating Frequency** - The drive frequency of both the Traction and Pump power frames is 16KHz, for silent operation. For Traction Regen-braking the frequency is also 16KHz, whilst Plug braking is 6KHz.

10.3.2 **Temperature Monitoring** - If the temperature of either power frame exceeds 75°C its maximum available current will be reduced. Note, however, that if the set current limit is less than the maximum available current limit actual cutback will occur at progressively higher temperatures than 75°C. The thermal cutback ensures that the maximum heatsink temperature is limited to 95°C (See Graph 1). When cutback occurs the diagnostic LED will flash 8 times.

10.3.3 **Safe Operating Area (SOA)** - The controller's current may be limited at high and/or low duty cycles depending on its current and voltage specification. This is to reduce the thermal stress on the power components in order to increase long term reliability. See Graph 2.

The "Safe Operating Area" is a characteristic of the MOSFETs and Freewheel Diodes which make up the power-frame. The MOSFET SOA restricts current at high duty cycles on all configurations, and the Diode SOA tends to restrict the current at lower duty cycles on lower voltage applications.

For most applications SOA will have little or no effect on the operation of the controller. Its effect is more significant in protecting the controller against adverse loads such as damaged motors and static test rigs.

10.3.4 **Under-voltage and over-voltage protection** - In order to prevent a sudden loss in power, the controller will begin to linearly ramp down the current limit, once the average battery voltage falls below a pre-set under-voltage start level. The current will be ramped down to 0 and a 7 flash fault indicated if the averaged battery voltage falls below the under-voltage cutout level.

To protect the controller from over-voltage caused by prolonged regen braking, regen braking will be terminated and plug braking initiated when the average battery voltage reaches the over-voltage start level. If the voltage exceeds the over-voltage cutout level in braking then all contactors will open and freewheeling will occur, requiring the vehicle's mechanical brakes to be used.

Under any other circumstances if the battery voltage exceeds the over-voltage cutout level, all pulsing is stopped and a 7-flash fault is indicated. This protects against incorrect battery connection.

Nominal Battery Voltage	Under-voltage Cutout	Under-Voltage Start	Over-voltage Start	Over-voltage Cutout
24 V	14.5 V	18.0 V	40.0 V	45.0 V
48 V	29 V	36.0 V	65.0 V	70.0 V
80 V	43.0 V	60.0 V	95.0 V	97.5 V

10.3.5 **Diagnostic LED** - This is mounted between the connectors on the front of the controller. It serves as a simple diagnostic tool as explained below:

Constant illumination	- No fault, normal condition
LED extinguished	- Internal controller fault
1 flash	- Personality out of range
2 flashes	- Illegal start condition
3 flashes	- MOSFET Short Circuit
4 flashes	- Contactor fault or Motor Open-Circuit
5 flashes	- Not used
6 flashes	- Accelerator or Speed Probe wire off fault
7 flashes	- Low or High battery voltage or BDI cut-out operating
8 flashes	- Over temperature
9 flashes	- Contactor coil s/c

Further explanation of the LED flashes are displayed on the calibrator fault message section.

10.3.6 **Fault Clearance** - Any fault indication will be cleared by re-initiating the start sequence after the cause of the fault has been removed.

10.3.7 **Software Version and Revision indication** - For identification purposes and to assist in queries, the Software version and revision, and the controller serial number are indicated in the calibrator Test Menu.

10.3.8 **Dashboard Displays** - SEVCON's existing CAN based standard and full feature displays are compatible with PowerpaK controllers.

10.3.9 **Setup Menu** - A setup menu has been added to the Calibrator that allows various features to be enabled and disabled. See section 7 for more information.

Note. Once a change has been made to the setup menu, the Key switch must be recycled for the change to be operational.

10.3.12 **Multi Languages** - Non-English languages can be specified for displaying on the Calibrator. Languages can be presently specified as either English, German, Spanish, Italian or French. NOT AVAILABLE AT PRESENT.

11 DASHBOARD DISPLAYS - OPERATION AND FEATURE DESCRIPTIONS

SEVCON offers 2 dashboard mounted CAN (Controller Area Network) Displays for any SEVCON controller equipped with serial CAN communications, including the PowerpaK range. A standard display offers a compact design compatible with 2" dashboard hole mounting, and a full-feature display offers a higher specification LCD. Both are back-lit for use in low ambient light conditions.

Both displays have BDI Indication, and 4 hours-counters. The hours counters are retained in the display in the event of the controller or the controller's logic being replaced in the field.

11.1 STANDARD DISPLAY

The unit consists of a 2x16 alphanumeric LCD display housed in a standard 50mm circular plastic case, with a rectangular front facia. The display incorporates a 10 segment BDI (Battery Discharge Indicator), a 6 digit hours counter and a 10 character area for diagnostic and status messages. When there are no diagnostic messages the area can be used to indicate a variety of system status readings.

11.1.1 STANDARD DISPLAY FEATURES.

- * One unit for 24V-96V.
- * Standard 50mm circular case with rectangular front facia, enclosed to IP65
- * Alphanumeric display 2x16 characters.
- * Readily understandable display format consisting of numbers, text and segments.
- * 10 segment BDI indication, with low charge warning and cut-out warnings.
- * 10 character text based diagnostic/status display.
- * 6 digit hours counter with 0.1 hour indication, and flashing "egg timer" counting symbol.
- * Capable of counting up to 99999.9 hours. Equates to 34 years @ 8 hour shift per day
- * Keyswitch, Traction and Pump hours count can be shown, identified as K, T, P.
- * Hours count retained in display in the event of a controller or logic replacement.
- * Display connected via single cable, no external power connections necessary.

Display example showing diagnostic message



11.1.2 STANDARD DISPLAY TECHNICAL SPECIFICATIONS

11.1.2.1 Environmental

Protection (front face):	IP65
Protection (rear):	IP34
Vibration:	6G, 0-150Hz for 1 hour
Operating Temperature:	-5°C to +50°C
Storage Temperature:	-40°C to +85°C
Humidity:	95% maximum, non-condensing
Humidity Resistance:	No functional defects after display is left at 60°C and 100% humidity for one hour after freezer use (-30°C minimum).

11.1.2.2 Mechanical

Mounting Hole:	2" Nominal. (See mechanical drawing)
Unit weight:	0.12 Kg (including mounting bracket)
Enclosure:	Injection moulded plastic case, with transparent front facia.
Connections:	One 6 way AT socket.
Fixings method:	Mounting bracket supplied

11.1.3 Electrical

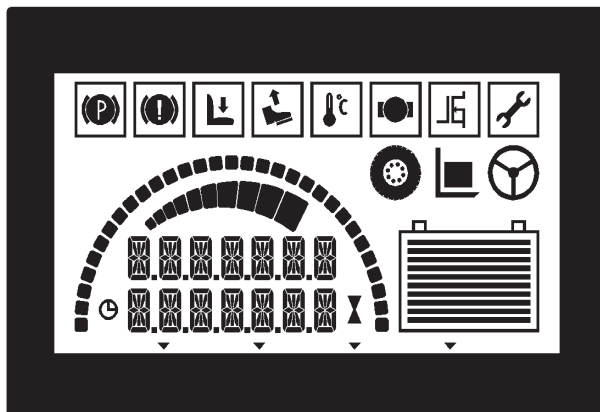
Power Supply:	Derived from CANbus
Supply Current	60mA (typical)

11.2 FULL-FEATURE DISPLAY

The unit consists of a custom graphic LCD display housed in a SEVCON designed rectangular plastic case. The display incorporates a 10 segment BDI (Battery Discharge Indicator), a 6 digit hours counter and a 14 character area for diagnostic and status messages. The display has 11 warning symbols which can be lit by the controller (via the CANbus) or by 8 active low switch inputs. When there are no diagnostic messages the top line of the message area can be used to indicate one of a number of status readings (see “display related adjustments” below). In addition there are two multipurpose indicators, that can be reprogrammed using the calibrator to show one of a selection of system status readings.

11.2.1 FULL-FEATURE DISPLAY FEATURES

- * One unit for 24V-96V.
- * SEVCON-designed full-custom LCD with LED backlight.
- * Readily understandable display format consisting of numbers, text and segments.
- * 10 segment BDI indication, with low charge warning and cut-out warnings.
- * 14 character text based diagnostic/status display.
- * 6 digit hours counter with 0.1 hour indication, and flashing “egg timer” counting symbol.
- * Capable of counting upto 99999.9 hours. Equates to 34 years @ 8 hour shift per day
- * Keyswitch, Traction and Pump hours count can be shown, identified as K, T, P.
- * Hours count retained in display in the event of a controller or logic replacement.
- * Speed indication (indicator #2), can be reprogrammed via calibrator.
- * Text status area can show one of a selection of system status readings.



Full Feature Display with all segments lit.

11.2.2 FULL-FEATURE DISPLAY TECHNICAL SPECIFICATIONS

11.2.2.1 Environmental

Protection:	The enclosure is protected to IP65
Vibration:	6G, 40-200Hz for 1 hour
Operating Temperature:	-20°C to +70°C
Storage Temperature:	-40°C to +85°C
Humidity:	100% maximum, with condensing

11.2.2.2 Mechanical

Mouting hole:	128mm x 87mm (see mechanical drawing)
Unit weight:	0.35 Kg.
Enclosure:	Injection moulded plastic case, with transparent front facia.
Connections:	One 6 way AT socket, One 12-way.
Fixings method:	Mounting bracket supplied

11.2.2.3 Electrical

Power supply:	Derived from CANbus
Supply current:	60mA (typical)
Backlight supply	14.5V to 150.0V
Backlight supply current	50mA (typical)

11.2.2.4 12-Way Connections

Pin	Type	Description
1	Digital i/p	Traction Motor Temperature Warning
2	Digital i/p	Pump Motor Temperature Warning
3	Digital i/p	Power Steer Motor Temperature Warning
4	Digital i/p	Traction Motor Brush Wear
5	Digital i/p	Pump Motor Brush Wear
6	Digital i/p	Power Steer Motor Brush Wear
7	Digital i/p	Oil Warning
8	Digital i/p	Diagnostic/Service Warning
9	0V	Return for swtich inputs, pins 1-8
10	PSU i/p	Battery negative (backlight supply)
11	spare	
12	PSU i/p	Battery positive (backlight supply)

11.3 DISPLAY RELATED ADJUSTMENTS

11.3.1 Hours counter, Display status and Contrast adjustments (On pump only systems located in Pump sub menu 2.8)

Cal. Ref.	DISPLAY Parameter Adjusted	Minimum or default setting.	Maximum or other settings.	Step size.
1.8.1	Main Hours	Trac	Pump, Key, Work	n/a
1.8.2	Status	Off	Ver #	n/a
1.8.3	Contrast (standard only)	0	127	1
1.8.4	Indicator 1 (FFD Only)	Off	Ver #	n/a
1.8.5	Indicator 2 (FFD Only)	Off	Ver #	n/a
1.8.6	Fault Messages	On	Off	n/a

1.8.1 The main hours adjustment is used to select which of the hours counters: Keyswitch (“K”), Traction (“T”) or Pump (“P”) hours, remains on the display after power-up sequencing. Normally this is Key (“K”).

1.8.2,4,5 Selects a system status reading for display (or indication on the full-feature display) from: Off, Traction motor current, Traction motor voltage, Pump motor current, Pump motor voltage, vehicle speed in KPH, vehicle speed in MPH, Accelerator pushes and display software version number (not available on indicator 1 or 2).

1.8.3 Sets the contrast of the standard display.

11.3.2 BDI adjustments (Located at the end of the first Traction sub menu 1.4, or in Pump sub menu 2.4)

Cal. Ref.	BDI Parameter Adjusted or displayed	Minimum setting or displayed value	Maximum or other settings	Step size
1.4.1	xxx % Charge remaining	n/a	n/a	n/a
1.4.2	Battery Volt xx V	24V	96V	2V
1.4.3	Reset x.xx V/Cell	2.00	2.50	V/Cell
1.4.4	Empty x.xx V/Cell	1.50	1.99	V/Cell
1.4.5	Warning xx %	0%	90%	1.0 %
1.4.6	Cutout xx %	0%	90%	1.0 %

WARNING: The BDI Empty level must be set in accordance with the specification of the battery fitted to the vehicle. Setting the Empty level lower than the battery manufacture’s specified discharged level can result in permanent damage to the battery.

1.4.1 Displays the remaining battery charge. No adjustments can be made.

1.4.2 Adjustment used to enter the nominal battery voltage.

1.4.3 Sets the voltage at which the BDI resets to 100% at power up. E.g. the BDI will reset to 100% on a 48V system, with the reset adjustment set to 2.20 Volts per cell, if the battery voltage is above $52.8V = (48V/2)*2.20V$.

1.4.4 Sets the voltage at which the BDI indicates the battery is fully discharged E.g. the BDI will eventually show 0% on a 48V system, with the empty adjustment set to 1.60 Volts per cell, if the battery voltage is below $38.4V = (48V/2)*1.60V$.

1.4.5 Sets the discharged level at which the warning threshold is reached, and the unlit segments flash.

1.4.6 - Sets the discharged level at which the cut-out threshold is reached. All BDI segments flash, pump operation is cut, and cutback 2 is applied to traction.

11.4 BDI OPERATION

The state of battery charge is indicated by 10 segments on the display. When the battery is deemed fully charged, all 10 segments will be lit. When the battery is deemed fully discharged all segments will be extinguished, with each 10% drop in capacity extinguishing 1 segment. There are 5 adjustments associated with the BDI as described on the previous page, adjustable by the hand held calibrator.

When the battery charge drops below an adjustable warning level, typically set to 30%, the remaining lit segments will flash to warn the driver of this. When the charge drops further to below an adjustable cut-out level, typically 20%, all 10 segments will flash. At the cut-out level, Pump operation will be inhibited at the end of its present operating cycle, and cutback 2 personalities will be applied to the Traction.

The state of battery charge is retained even when power is removed, and is stored in the controller's non-volatile EEPROM memory. At power up the display will always indicate the previous state of charge for approximately 1 second, whereupon it will either continue to display this, or revert to a fully charged indication if the battery is deemed to have been charged in the meantime. The BDI system uses an averaged, accurate battery voltage to deduce the state of charge. Pin 10 on connector 2 is the Battery voltage measurement input for the BDI and to maintain accuracy should be connected as close as possible to the actual battery terminals, without overriding safety disconnects.




11.5 HOURS COUNTER (INDEPENDENT FROM CONTROLLER HOURS COUNT)




















A 6 digit hours counter is provided to indicate Traction pulsing, Pump pulsing and Key switch hours. The last digit displays tenth's of hours, i.e 6 minute intervals, with the counter capable of displaying up to 99999.9 hours in total. As a guideline, this is equivalent to approximately 34 years operation if the truck was used for an 8 hour shift every day.










At power up the hours count display initially indicates Key switch hours for approximately 3 seconds, followed by Pump pulsing hours for 3 seconds(if applicable), followed by Traction pulsing hours which remains permanently displayed. This order can be changed using the calibrator as described on the previous page. When the hours are being counted, a flashing egg timer symbol is displayed to indicate this. Hours counting accuracy is approx. +/- 2%. The display has its own integral non-volatile memory to retain all the hours counts in the event of the controller or controller logic being replaced.

11.6 DIAGNOSTIC/STATUS TEXT MESSAGES

The controller can transmit text messages for diagnostic and status indication. On the standard display these appear over the status area, and on the full-feature display, they also overwrite the hours counter until the fault condition has cleared. This feature can be disabled via personality 1.8.6 as described on the previous page. Some messages may be displayed with one or more symbols. The following table shows the fault message and symbols displayed for each fault condition.

	Message	Symbols Displayed	Fault Description
0			Traction operational and OK.
1			Only displayed briefly at power up.
2	TRAC BRUSHES		Traction brushes worn.
2	PUMP BRUSHES		Pump brushes worn.
3	PUMP HOT		Pump over temperature.

4	OIL FAULT		Oil pressure low.
5	BDI CUT OUT		BDI enabled and cut-out action initiated.
6	TRAC HOT	 & 	Traction heatsink above 75°C. Allow controller to cool.
6	PUMP HOT	 & 	Pump heatsink above 75°C. Allow controller to cool.
7	SPEED PROBE		Speed limit feature enabled & wire off.
8	ACCEL FAULT		Accelerator wire off. Recycle FS1 and Direction.
9	ACCEL FAULT		Accelerator pedal pressed at power up, or wire off. Recycle FS1 and Direction.
10	CONTACT FAULT		Contact has bad contact or didn't close, motor o/c. Recycle FS1 & Dir.
11	CONTACT FAULT		Contact didn't open or is welded. Recycle FS1 and Direction switch.
12	SEQ FAULT		Direction or FS1 switch at power up. Recycle Direction FS1 or both.
13	2 DIR FAULT		Two directions selected together. Recycle both Directions and FS1.
14	SRO FAULT		Dir. switch selected > 2 seconds after FS1. Recycle FS1 and Dir.
15	SEAT FAULT		Drive selected and no seat sw. Recycle Dir and FS1 switch
16	INCH FAULT		Inch switch at power up, both inch switches selected or inching attempted with seat switch or Dir/FS1 selected. Recycle inch switches.
17	BATTERY LOW		Battery < Low battery personality. Re cycle FS1 or Direction switch
18	BATTERY HIGH		Battery > High battery personality. Recycle FS1 or Direction switch
19	PERS ERROR	 & 	Personalities out of range at power up.
20	CRC ERROR	 & 	One or more personalities have been corrupted.

21	COIL FAIL		A contactor coil s/c or miswired. Recycle Keyswitch
22	MOSFET FAIL	 & 	Bypass contactor s/c or MOSFET s/c Recycle FS1 or Direction
23		 & 	Traction motor too hot.
24		 & 	Pump motor too hot.
25	FAIL	 & 	If any of these message are displayed then the controller has failed one of its internal power up checks.

12 POWER CIRCUIT DESCRIPTIONS

The main switching element of the PowerpaK consists of a bank of power MOSFET transistors connected in parallel. These are switched at high frequency (16KHz) to give silent operation. Switching speeds have been optimised to minimise switching losses.

Fast-recovery Freewheel diodes, also connected in parallel but arranged to share current, are used to maintain circulating current around the motor when the main MOSFETs are turned off.

Both the MOSFETs and Freewheel diodes have their temperatures monitored. The software will cutback motor current to prevent either thermal stress, or operation outside their safe operating areas.

Electrolytic capacitors are fitted internally between B+ve and B-ve to maintain constant current in the battery leads and to keep a constant battery voltage across the controller.

In traction power frames a Plug Diode is internally connected across the motor armature to limit the generated voltage during plugging so that controlled braking can be achieved. This diode is not necessary for Pump motor controllers.

On traction controllers, Regen is achieved by adding an extra single pole change over contactor and an optional regen diode which connects the top of the motor armature to B-ve during braking, to allow circulating generated current to flow round the motor loop after the direction contactors have been reversed and the motor excited. The generated armature voltage charges the motor field with current when the MOSFETs are on. When they are off, this current flows through the freewheel diodes back into the battery. This has the effect of returning a small amount of energy back to the battery and minimising heat dissipation in the motor during braking.

A current shunt is connected in series with the motor armature to monitor motor currents, during all operations including drive, regen and plug braking modes.

On traction controllers the direction contactors should be used to switch the armature. A line contactor can be used to offer reverse battery connection protection, minimise any battery connector arcing when powering up, and to give a mechanical break in pump controller systems. The line contactor is optional, and is not operated by the Controller.

Bypass operation is possible on traction systems to short out the main MOSFET devices for maximum efficiency and high speed or high current operation. Field Weakening operation is also possible on traction controllers by controlling a contactor to switch in resistor in parallel with the motor field. An output for controlling a power steer contactor is also provided.

13 INSTALLATION

- 13.1 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 GE G641 or Dow Corning heatsink compound, by the 6 fixing 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.
- 13.2 Power connections should be made with flexible heat resisting cables of suitable cross-sectional area for the current to be carried (See section 6.1.2). These should be terminated in soldered or crimped lugs attached to controller and the contactors. Note that nuts and washers are supplied for the M8 connections on the controller. A battery-disconnect switch should be used (EC Directive).
- 13.3 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.
- 13.4 The controller may be supplied as a stand-alone unit or pre-wired onto a base-plate with contactors etc. If the controller is 'stand-alone', both Connectors 1 and 2 will be used. If a 'panel' is supplied, only Connector 1 will be used as Connector 2 will contain the contactor wiring. The mating halves of the connectors can be supplied with the controller as a 'loose equipment kit'.
- 13.5 Control wiring connections should be made using 1.00mm² (AWG#18) or equivalent stranded wire. The correct pressure release crimping tools **MUST** be used for long term connection reliability.
- 13.6 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 A when using the specified Albright contactors.
- 13.7 The return wiring for the accelerators should be connected to the B- terminal on the controller to prevent large currents altering accelerator signals.
- 13.8 Fixing torque for power connectors
M8 terminals 11NM

14 EMC GUIDELINES

The following guidelines are intended to help vehicle manufacturers to meet the requirements of the EC directive 89/336/EEC for Electromagnetic Compatibility.

Any high speed switch is capable of generating harmonics at frequencies that are many multiples of its basic operating frequency. It is the objective of a good installation to contain or absorb the resultant emissions.

All wiring is capable of acting as a receiving or transmitting antenna. Wiring should be arranged to take maximum advantage of the structural metal work inherent in most vehicles. Vehicle metalwork should be electrically linked with conductive braids.

14.1 Power Cables

All cables should be routed within the vehicle framework and kept as low in the structure as is practical - a cable run within a main chassis member is better screened from the environment than one routed through or adjacent to an overhead guard.

Power cables should be kept short to minimise emitting and receiving surfaces

Shielding by the structure may not always be sufficient - cables run through metal shrouds may be required to contain emissions.

Parallel runs of cables in common circuits can serve to cancel emissions - the battery positive and negative cables following similar paths is an example.

Tie all cables into a fixed layout and do not deviate from the approved layout in production vehicles. A re-routed battery cable could negate any approvals obtained.

14.2 Signal Cables

All wiring harnesses should be kept short.

Wiring should be routed close to vehicle metalwork.

All signal wires should be kept clear of power cables or made from screened cable

Control wiring should be kept clear of power cables when it carries analogue information - for example, accelerator wiring.

Tie all wiring securely and ensure wiring always follows the same layout.

14.3 Controller

Thermal and EMC (emissive) requirements tend to be in opposition.

Additional insulation between the controller assembly and the vehicle frame work reduce capacitive coupling and hence emissions but tend to reduce thermal ratings. A working balance needs to be established by experiment.

The complete installation should be documented, in detail, and faithfully reproduced on all production vehicles. When making changes, consider their effect on compliance ahead of any consideration of cost reduction or other "improvement".

STANDARD SEVCON POWER UP, SEAT SWITCH AND SRO SEQUENCING DESCRIPTION

KEY SWITCH POWER UP TRUTH TABLE (NO SRO ENABLED)						
	Key Sw.	Seat Sw.	Direction Sw.	FSI Sw.	Drive	Fault Indicated
1-8	0	x	x	x	No	None
9	1	0	0	0	No	None
10	1	0	0	1	No	None
11	1	0	1	0	No	None
12	1	0	1	1	No	Seat Fault
13	1	1	0	0	No	None
14	1	1	0	1	No	None
15	1	1	1	0	No	None
16	1	1	1	1	Yes	None

KEY SWITCH POWER UP SEQUENCE TABLE (NO SRO ENABLED)						
	Key	Seat	Direction	FSI	Drive	Fault Indicated
1	Key	Seat	Direction	FSI	Yes	None
2	Key	Seat	FSI	Direction	Yes	None
3	Key	Direction	Seat	FSI	No	Seat Fault
4	Key	Direction	FSI	Seat	No	Seat Fault
5	Key	FSI	Seat	Direction	No	Seat Fault
6	Key	FSI	Direction	Seat	No	Seat Fault
7	Seat	Key	Direction	FSI	Yes	None
8	Seat	Key	FSI	Direction	Yes	None
9	Seat	Direction	Key	FSI	No	Power Up Fault
10	Seat	Direction	FSI	Key	No	Power Up Fault
11	Seat	FSI	Key	Direction	No	Power Up Fault
12	Seat	FSI	Direction	Key	No	Power Up Fault
13	Direction	Key	Seat	FSI	No	Power Up Fault
14	Direction	Key	FSI	Seat	No	Power Up Fault
15	Direction	Seat	Key	FSI	No	Power Up Fault
16	Direction	Seat	FSI	Key	No	Power Up Fault
17	Direction	FSI	Key	Seat	No	Power Up Fault
18	Direction	FSI	Seat	Key	No	Power Up Fault
19	FSI	Key	Seat	Direction	No	Power Up Fault
20	FSI	Key	Direction	Seat	No	Power Up Fault
21	FSI	Seat	Key	Direction	No	Power Up Fault
22	FSI	Seat	Direction	Key	No	Power Up Fault
23	FSI	Direction	Key	Seat	No	Power Up Fault
24	FSI	Direction	Seat	Key	No	Power Up Fault

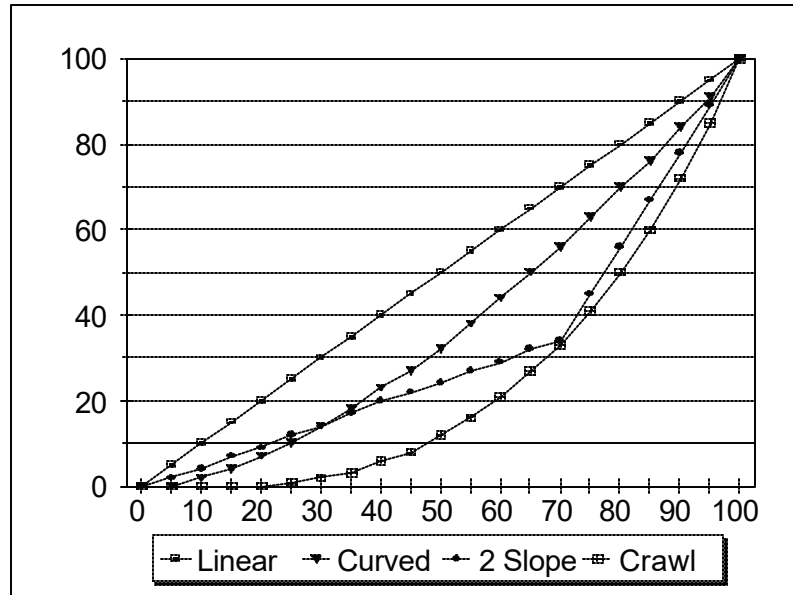
SEAT SWITCH TRUTH TABLE (NO SRO ENABLED)						
	Seat Sw.	Seat Timer	Direction Sw.	FSI Sw.	Drive	Fault Indicated
1	0	0	0	0	No	No
2	0	0	0	1	No	No
3	0	0	1	0	No	Seat Fault
4	0	0	1	1	No	Seat Fault
5	0	1	0	0	No	No
6	0	1	0	1	No	No
7	0	1	1	0	No	No
8	0	1	1	1	Yes	No
9	1	x	0	0	No	No
10	1	x	0	1	No	No
11	1	x	1	0	No	No
12	1	x	1	1	Yes	No
13	1	x	0	0	No	No
14	1	x	0	1	No	No
15	1	x	1	0	No	No
16	1	x	1	1	Yes	No

SEAT SWITCH SEQUENCE TABLE (NO SRO ENABLED)						
	Seat	Direction	FSI	Drive	Fault Indicated	
1	Seat	Direction	FSI	Yes	No	
2	Seat	FSI	Direction	Yes	No	
3	Direction	Seat	FSI	No	Seat Fault	
4	Direction	FSI	Seat	No	Seat Fault	
5	FSI	Seat	Direction	No	Seat Fault	
6	FSI	Direction	Seat	No	Seat Fault	

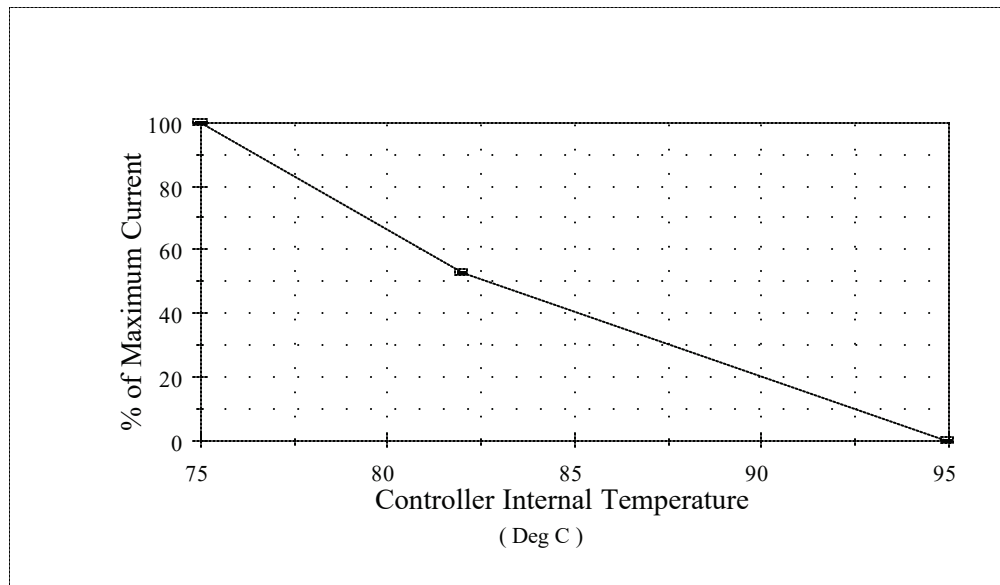
SRO (Static Return to Off) TRUTH TABLE				
	Direction Sw.	FSI Sw.	Drive	Fault Indicated
1	0	0	No	None
2	0	1	No	None
3	1	0	No	None
4	1	1	Yes	None

SRO (Static Return to Off) SEQUENCE TABLE				
	Direction	FSI	Drive	Fault Indicated
1	Direction	FSI	Yes	None
2	FSI	Direction within 2	Yes	None

Accelerator Characteristics



Thermal Cutback Characteristic



Safe Operating Area Graphs

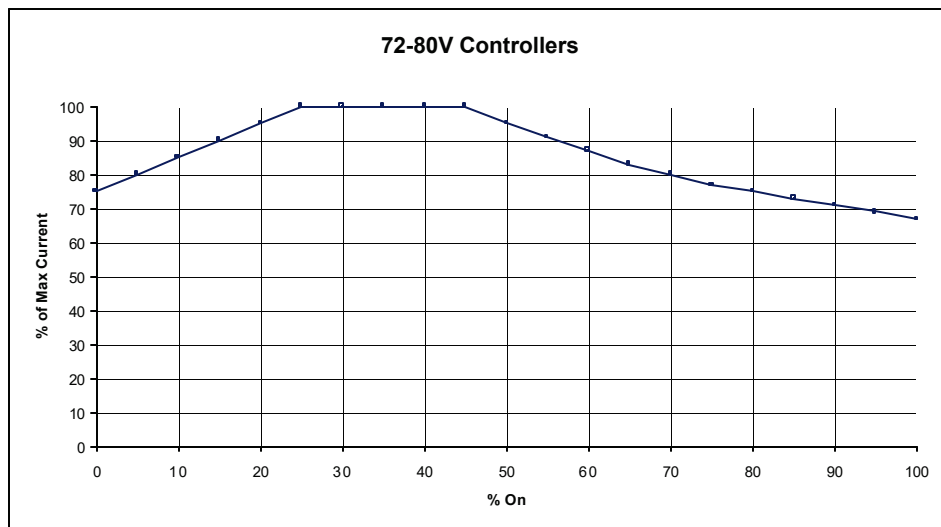
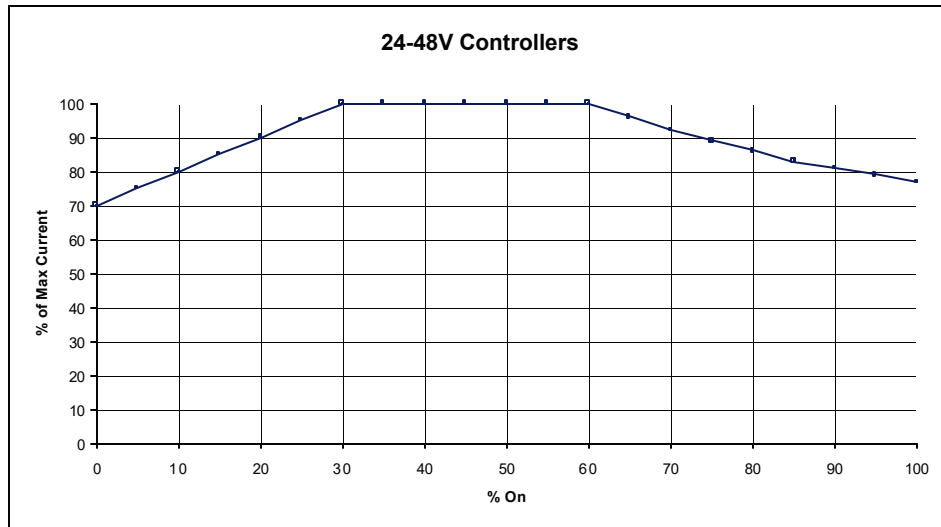


Figure 1 Light Wiring - Low I/O Logic. (Pump Functions in brackets.)

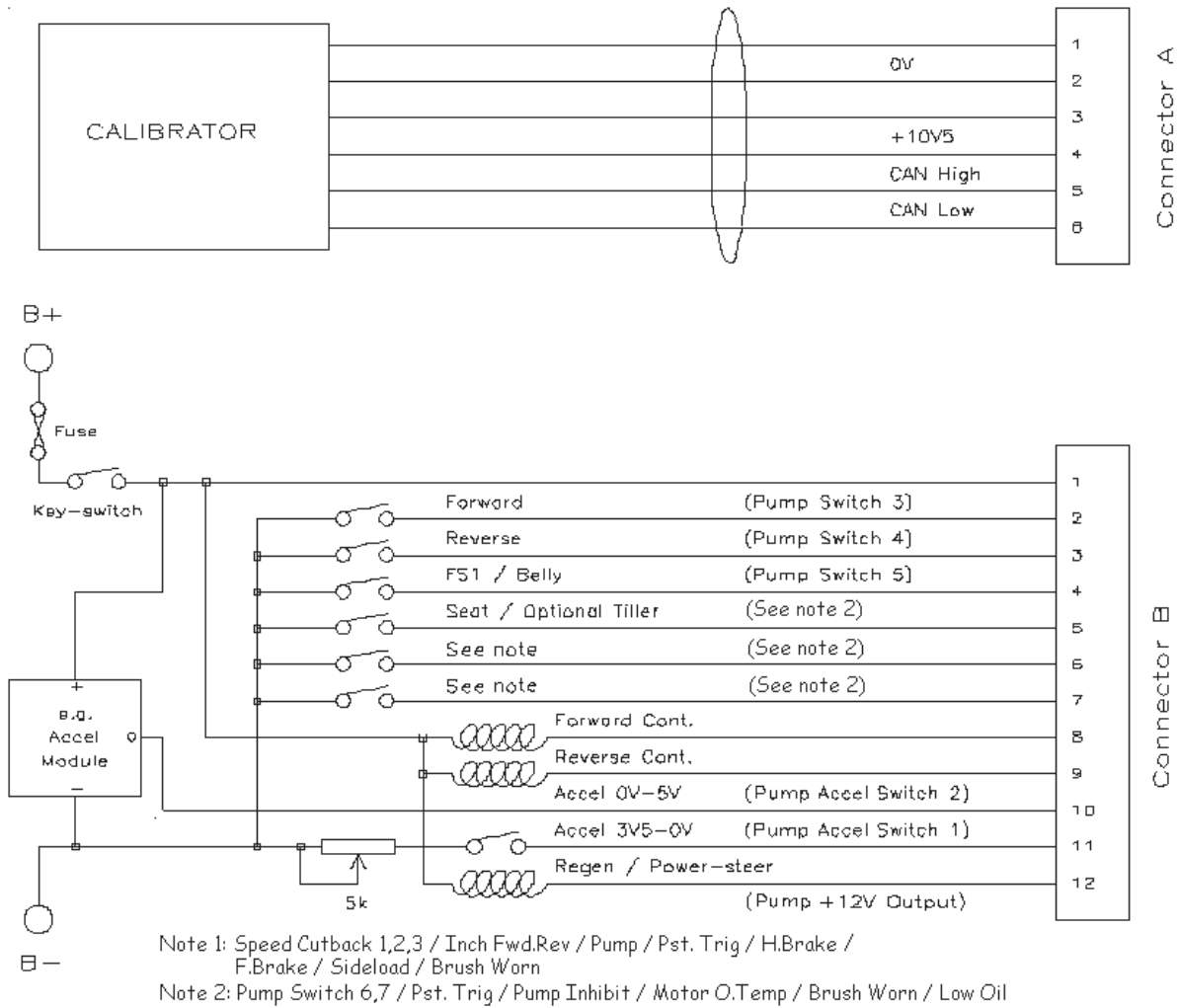


Figure 2 Light Wiring - Medium I/O Logic

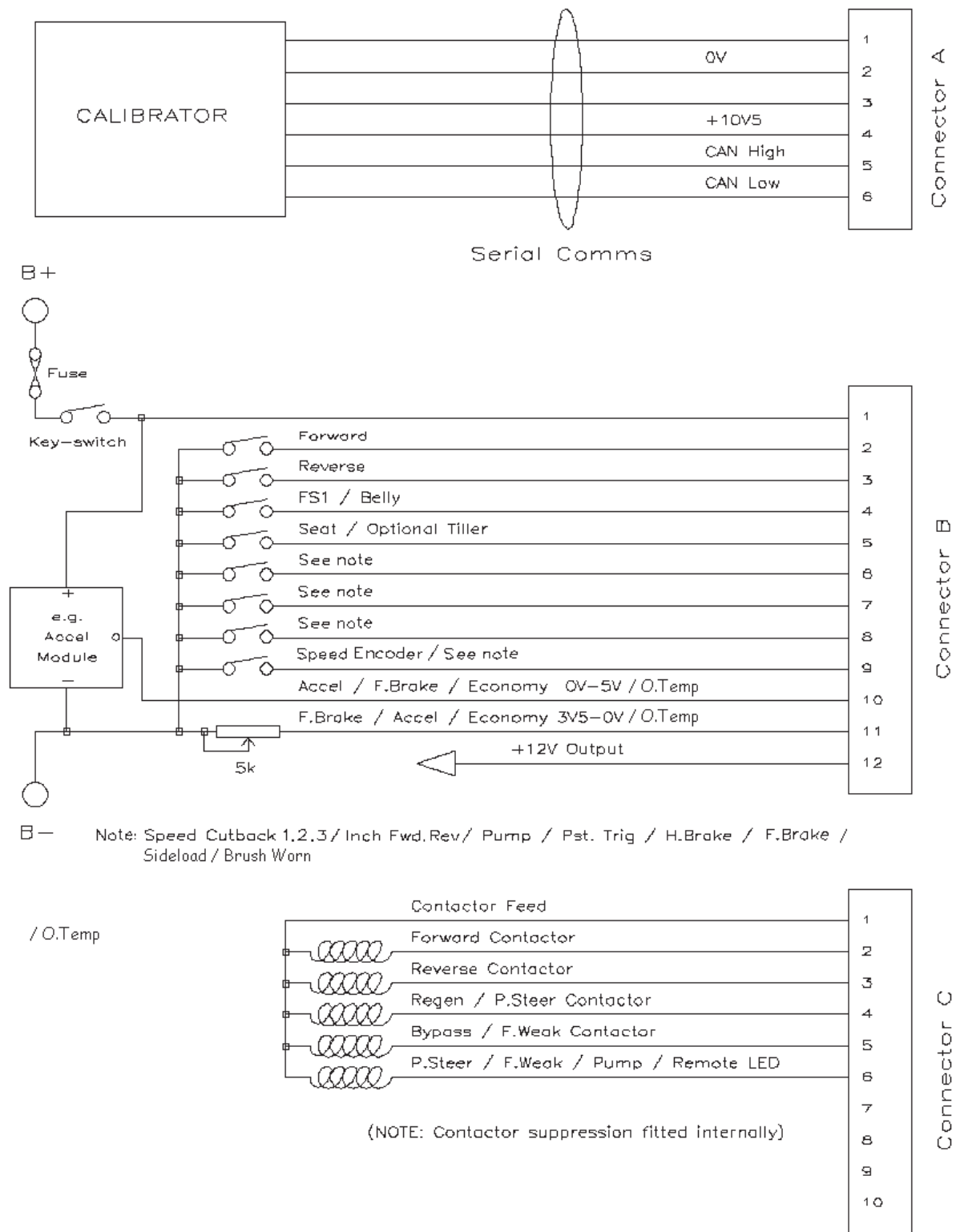


Figure 3 Light Wiring - High I/O Logic

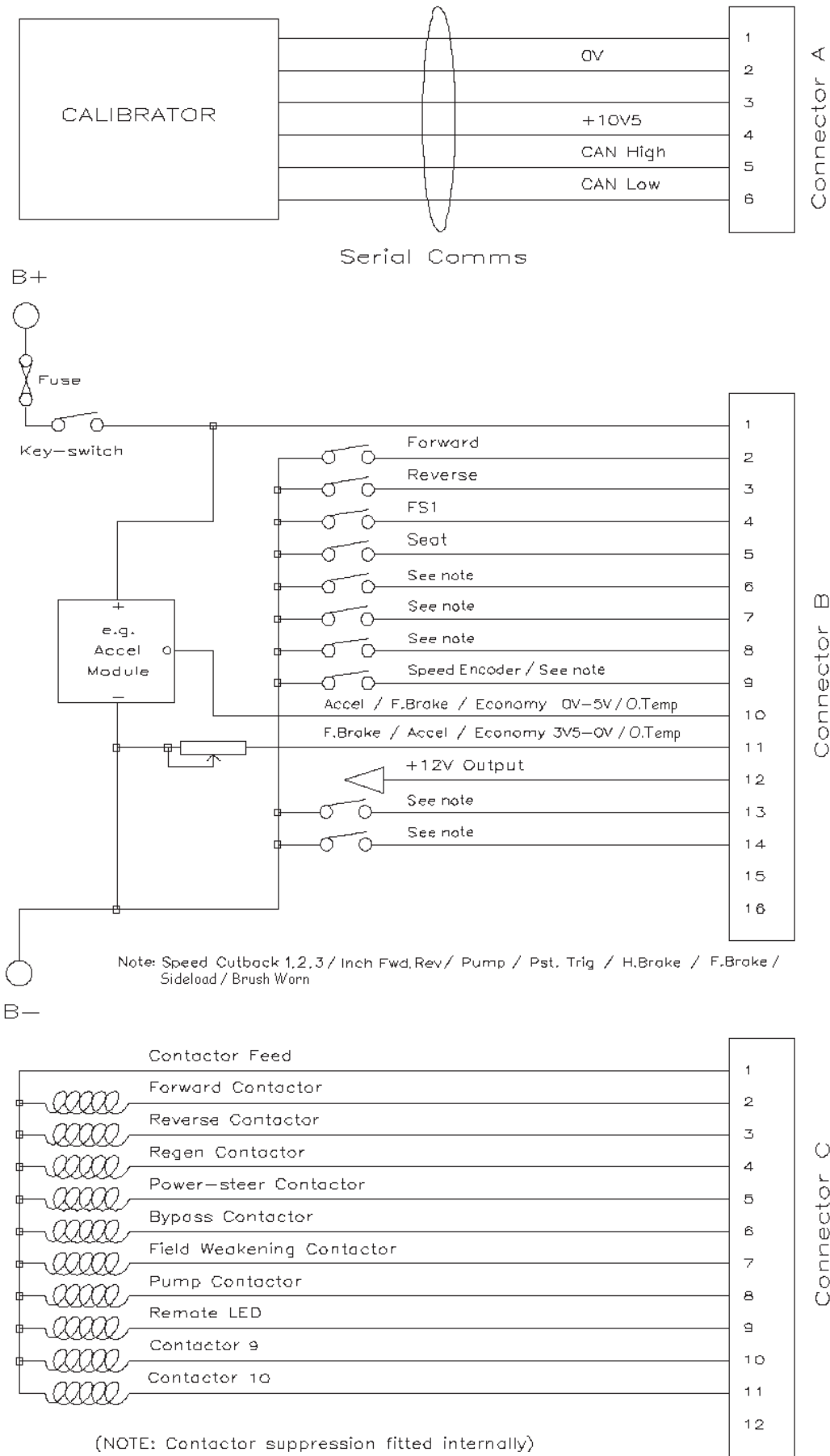
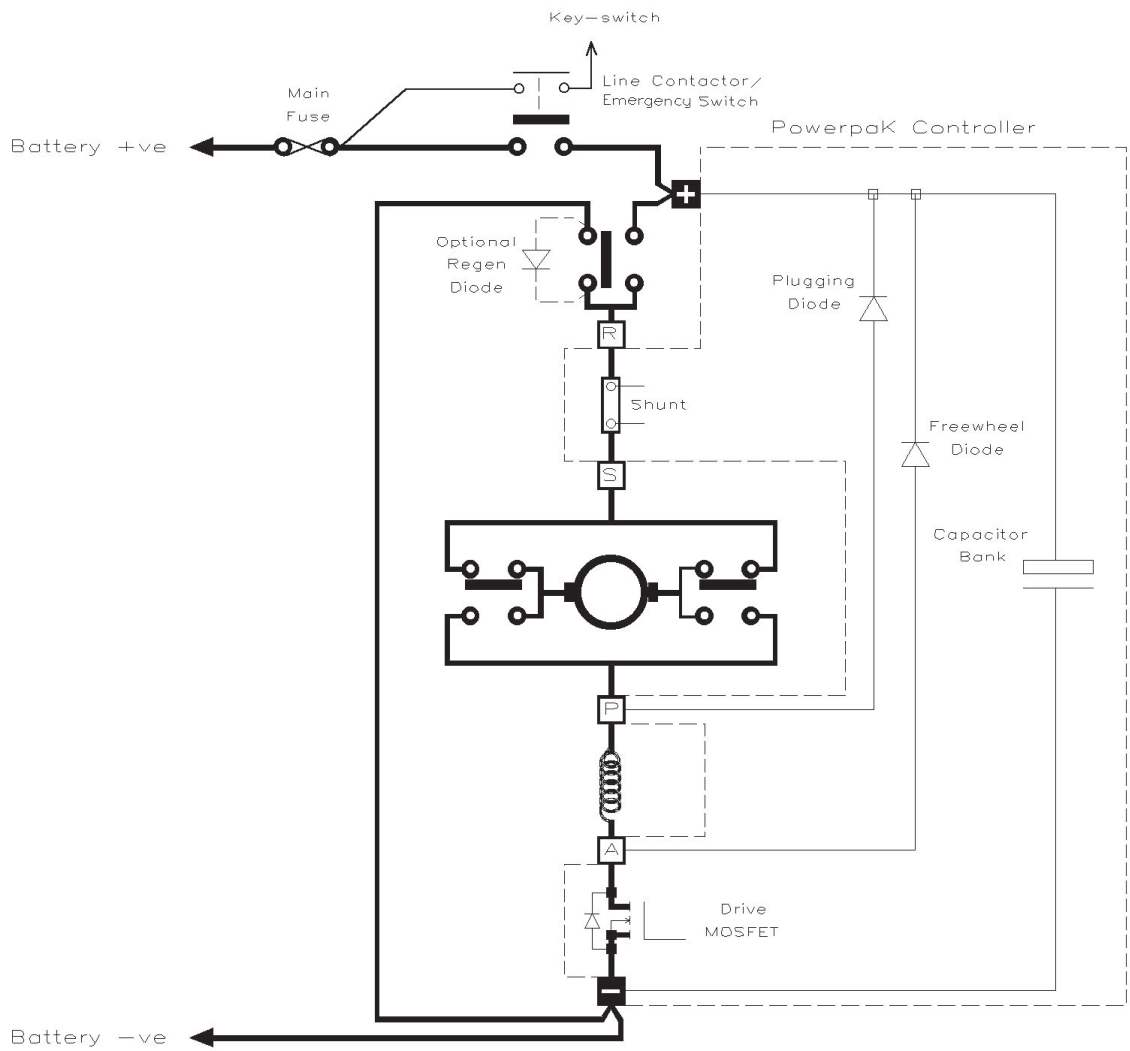


Figure 4 Series Traction Regen



Note: When an emergency battery disconnect switch is fitted, the key switch must be fed through an auxiliary switch to prevent overvoltage damage due to disconnect during regen.

Figure 5 Series Traction Plugging

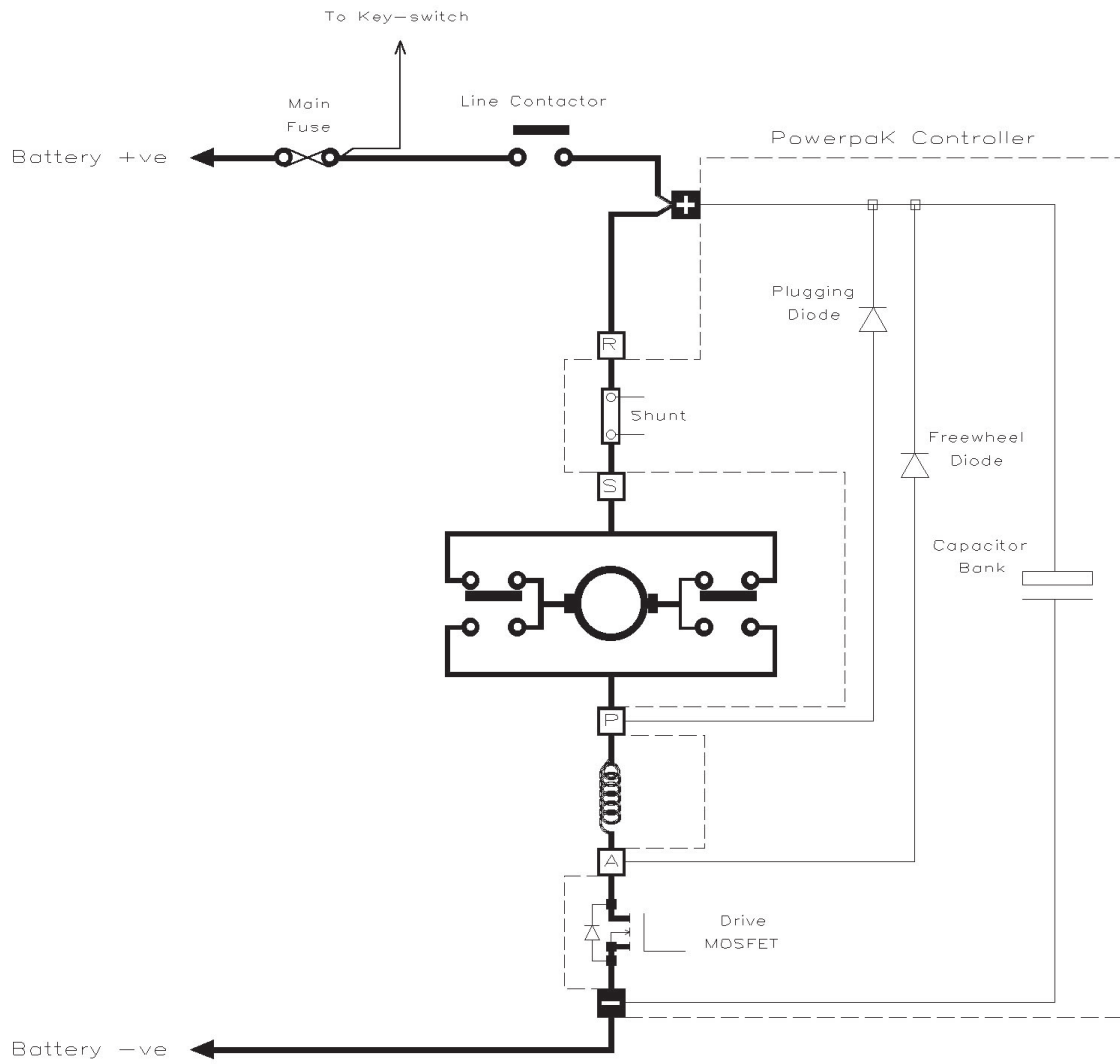


Figure 6 Series Pump

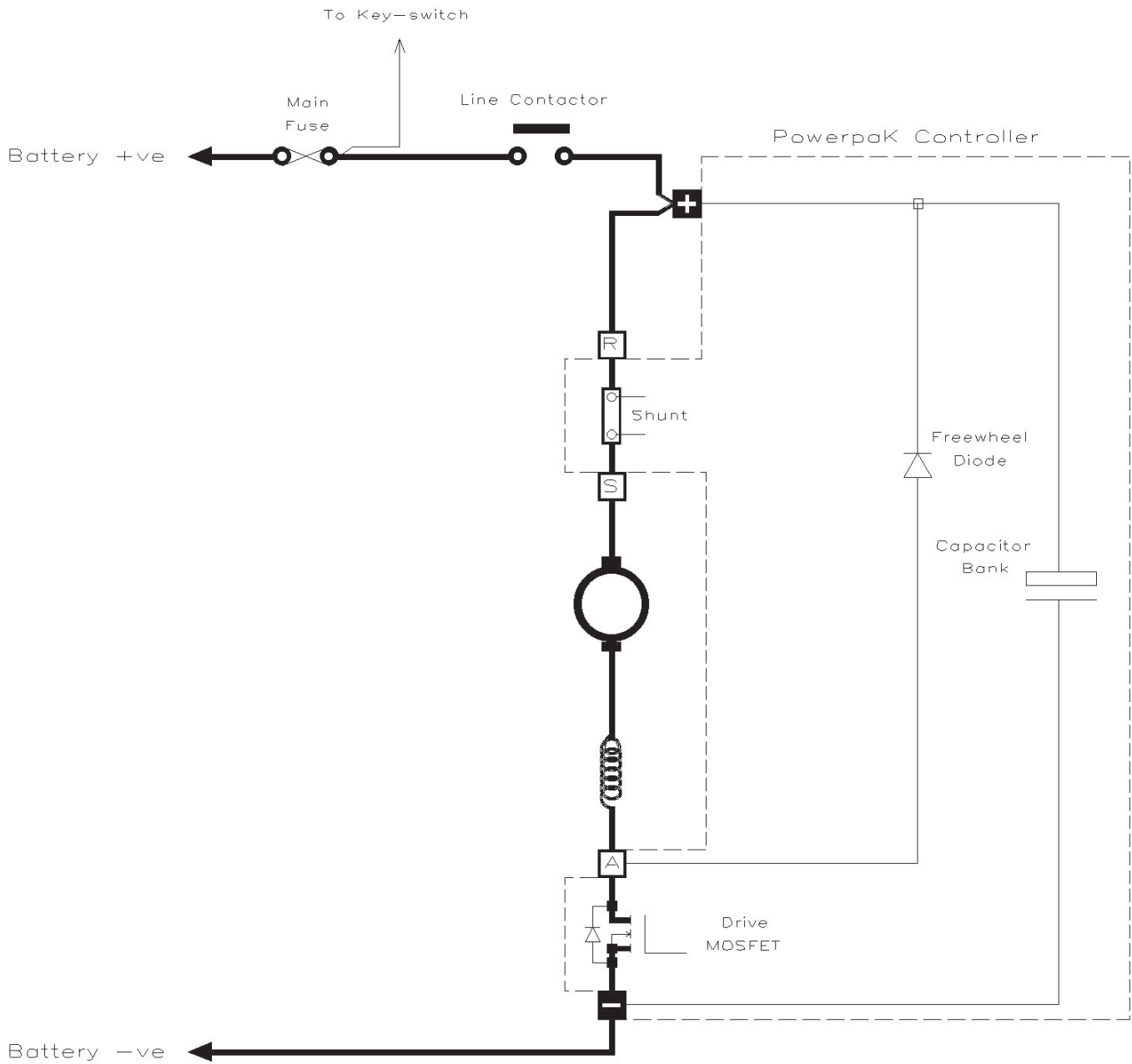


Figure 7 Mechanical Details

NB: Diagram shows controller with Medium I/O Logic fitted
Mounting holes are for M6 bolts.



Section F: Controller (Accelerator Parameters)

The following is a step by step set of instructions for setting the accelerator parameters for the Sevcon PowerPak.

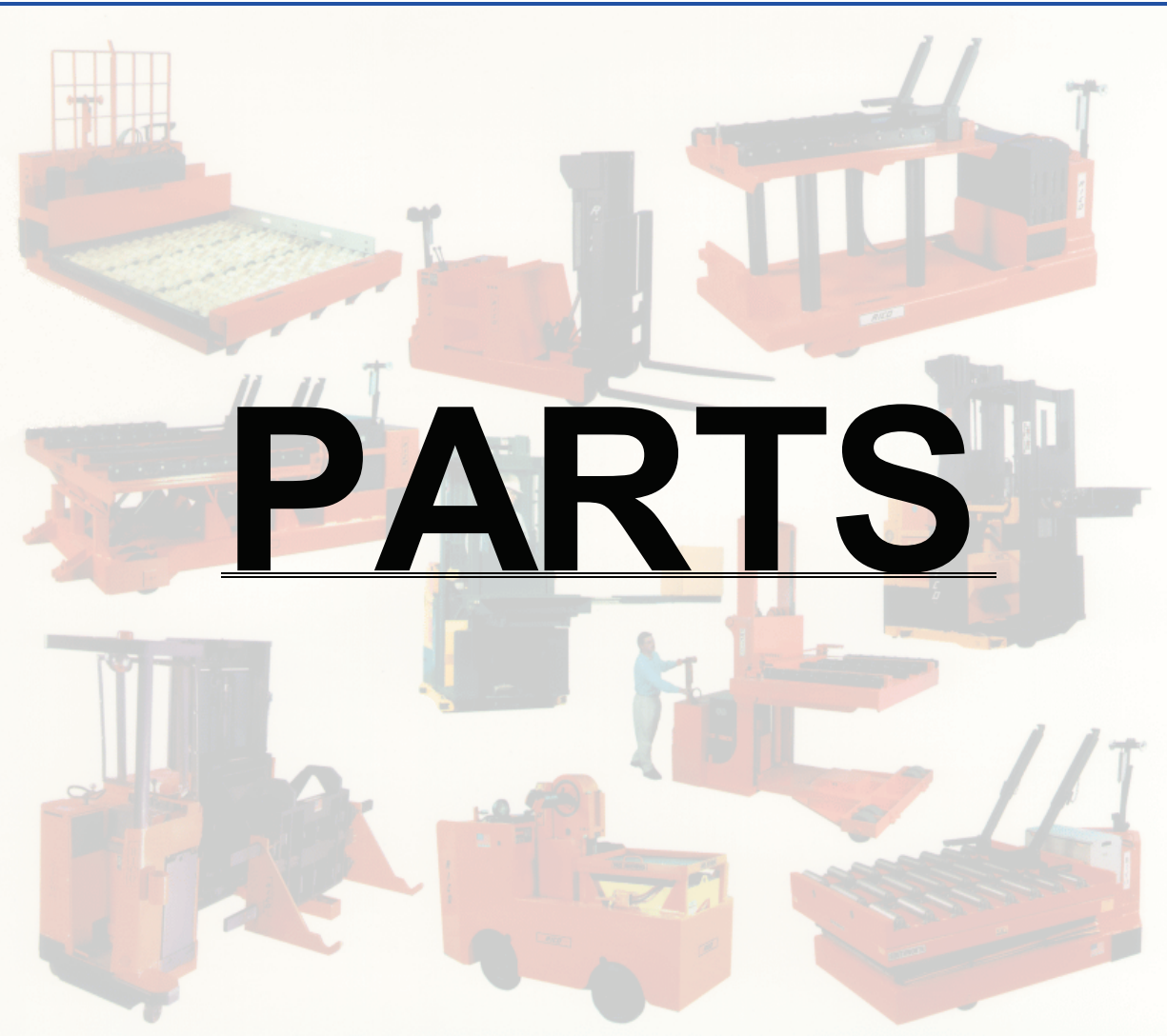
Note: Before setting any parameters, the potentiometer needs to be centered.

1. Using the calibrator, go into the Traction Test Section. (Section 1.3)
2. Scroll over to 1.3.2. (This reading is the Accelerator voltage that the controller is currently reading from the handle accelerator with the handle switch in the neutral position)
3. Write this Voltage down. (This is the Accelerator Zero Voltage)
4. Rotate the handle grips completely forward or reverse. (The voltage should go down)
5. Write this voltage down. (This is the Accelerator Full Voltage)
6. After recording these two voltages, use the **DOWN** arrow and you will be toggled over to the Traction Personalities Accelerator Zero Level. 1.2.28
7. Using the Accelerator Full Voltage you wrote down earlier, set the voltage on 1.1.28 to .04 volts below that number.

Example: If the voltage read on 1.3.2 was 3.26 volts than the voltage setting on 1.1.28 would be 3.22 volts. Scroll over to 1.1.29 Accelerator Full Level and set the voltage .04 volts above the voltage that was recorded earlier.

Example: If the voltage went down to 0, you would set the voltage to .04 volts.

Note: After completing these steps, push the down arrow and you will be toggled back to 1.3.2. Scroll over to 1.3.1 Accelerator % and check the operation of the accelerator. When in the neutral position it should read 0%. When the grips are rotated this number should climb up to 100%.



PARTS

CUSTOM DESIGNED

SUPPLY VEHICLE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS

FOR VEHICLE AND PARTS INFORMATION CONTACT CUSTOMER SERVICE BPR/RICO (330)723-4050 FAX(330)723-4012

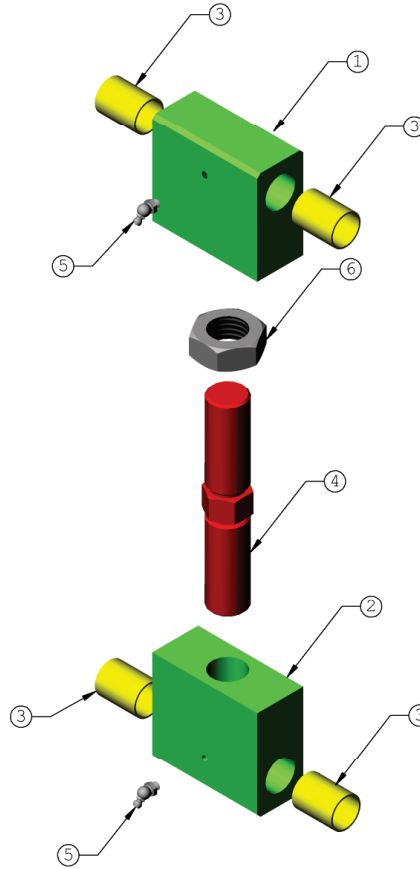
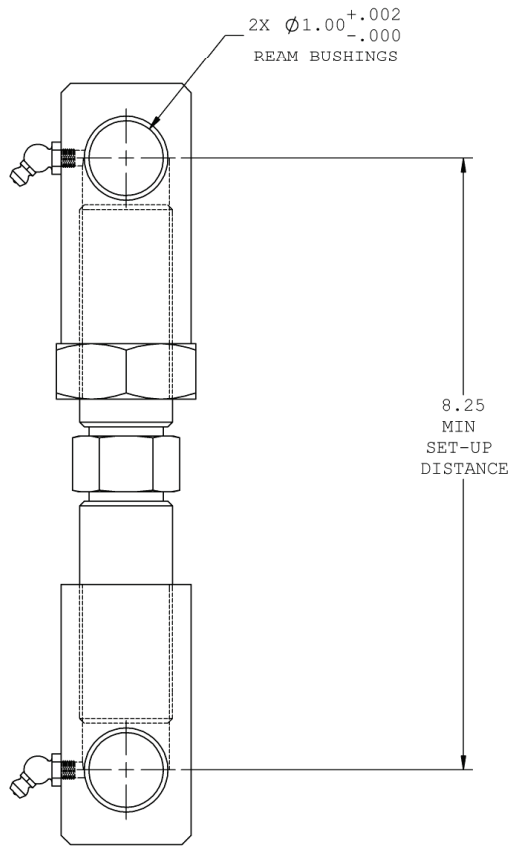
Electrically Powered Lift Trucks

**MANUFACTURED BY
BPR/RICO MANUFACTURING INCORPORATED**

DIVIDER IV

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	99101321	ADJ TIE BAR BLOCK (RH)
2	1	99101320	ADJ TIE BAR BLOCK (LH)
3	4	90170110	BUSHING 1" X 1 1/8" X 1 1/2"
4	1	99101319	ADJ TIE BAR SCREW
5	2	H134	GREASE FITTING (1/4-28 45 DEG)
6	1	H1081	JAM NUT 1-1/4-12

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
	1	REDRAWN IN SOLIDWORKS ADDED ITEMS 3,5 & 6	3/12/03	BJM

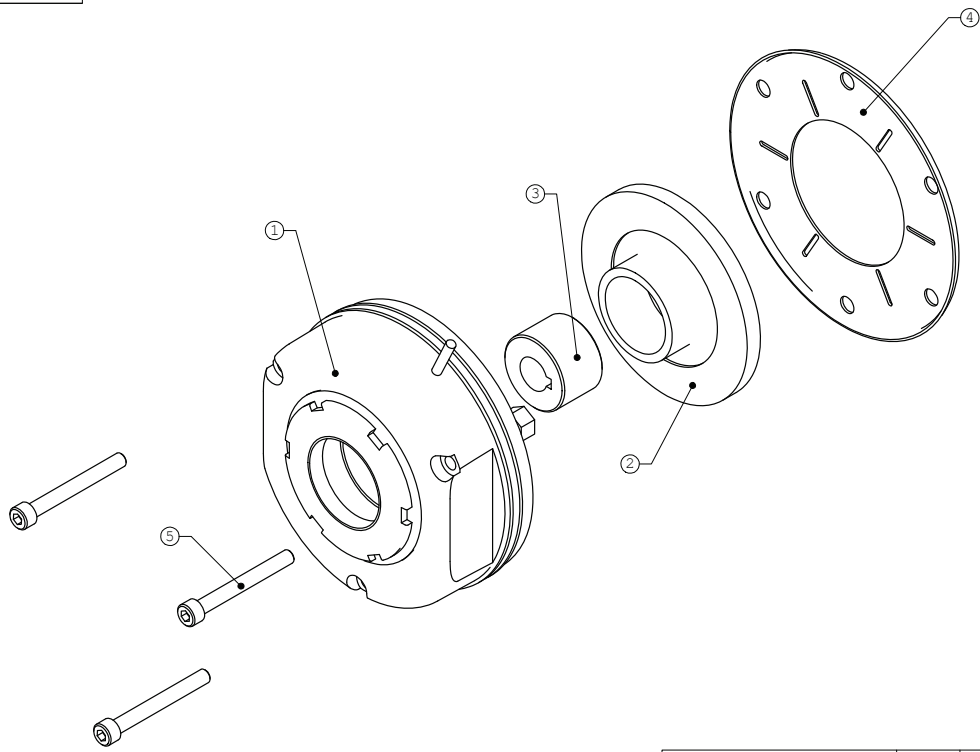


NOTE (UNLESS OTHERWISE SPECIFIED):
BREAK ALL SHARP EDGES AND DEBUR

This drawing contains proprietary information. This drawing or any part of it shall not be reproduced in any manner except as authorized in writing.	DRAUGHTSMAN J. L. ...	RICO	
	TITLE ADJ TIE BAR BLOCK ASSY	DATE DCA	SCALE 1:1
	SHEET 1 OF 1	APPROVAL 1/7/98	DRAWING NO.

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	15100568	BRAKE STATOR
2	1	15100113	BRAKE ROTOR
3	1	15100126	BRAKE HUB
4	1	15100133	FRICTION PLATE
5	3	H269	SHCS M8 X 70MM

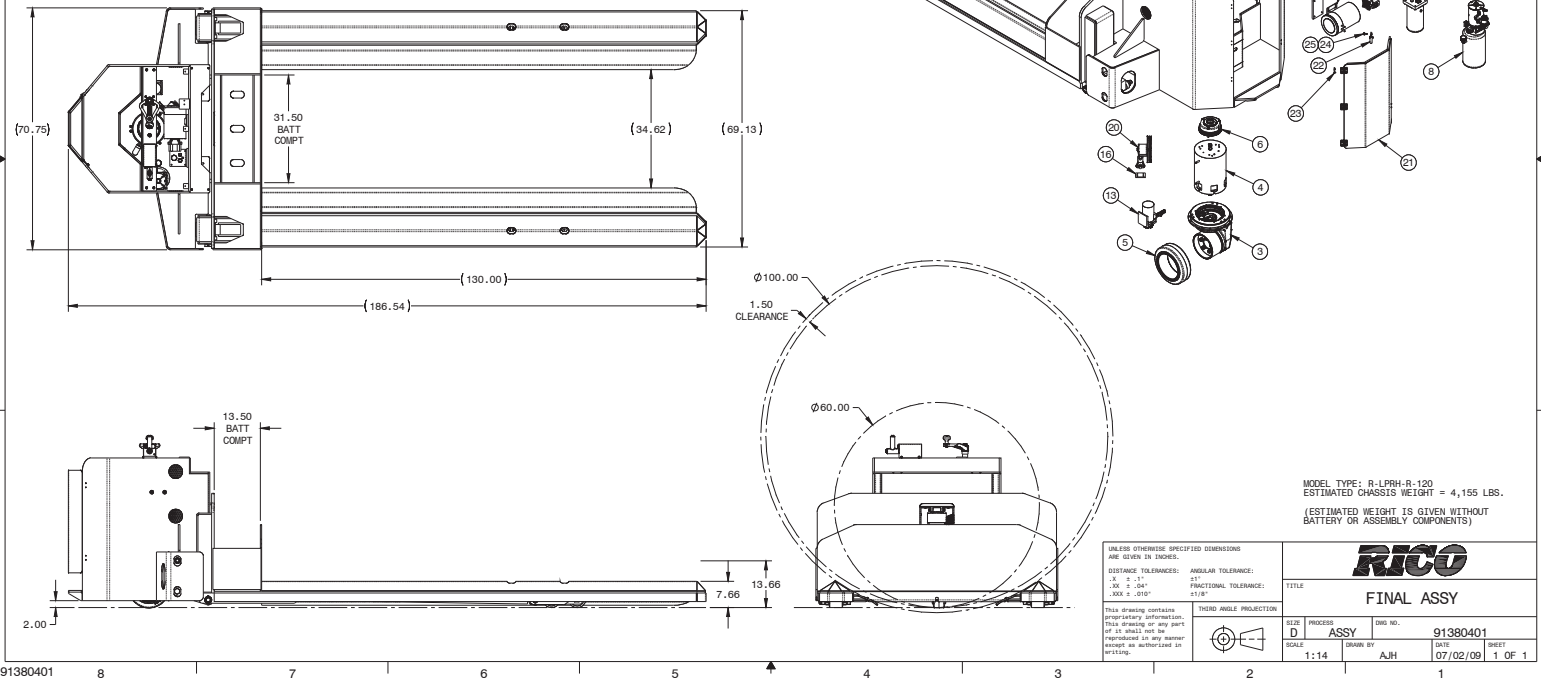
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
	1	BRAKE HUB WAS PART NO. 15100116	5/6/03	JFK



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	SIZE: B		DATE 2/27/2002	SERIAL NO.	
	ANGULAR ±.1°				

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	91380402	CHASSIS ASSY
2	1	91380411	COVER, MAST
3	1	25001603	300BF TRANSMISSION ASSY
4	1	05110390	DRIVE MOTOR ASSEMBLY
5	1	66001654	TIRE, SFP XL, 12 X 4 X 8
6	1	15109925	BRAKE ASSY 14-20V/20MM HUB
7	1	41011060	RIDER HANDLE SWITCH ASSY
8	1	33240034	BARNES PUMP ASSEMBLY
9	1	99062002	PWR STG STEER CONTROL
10	1	05000233	MOTOR, PUMP
11	1	33002992	PUMP ASSY
12	1	33101101	HYDRAULIC TANK ASSY
13	1	99061007	PWR STG DRIVE CONTROL
14	1	99130396	MOUNT, PUMP MOTOR
15	1	99130725	HYD TANK MTG PLATE
16	1	99130779	MTG PL, FAN
17	2	50000102	COVER, 4 INCH ROLLER (FORM)
18	1	EL13804	ELECTRICAL SCHEMATIC
19	1	HY13804	HYDRAULIC DIAGRAM
20	1		FAN, COOLING (SEE ELC)
21	1	9138040A	OPER COMPT DOOR ASSY
22	2	9138044A	LATCH RECEIVER
23	6	H195	FL HD SHCS 10-32 X 3/4
24	4	H451	HHCS 1/4-20 X 3/4 GD-5
25	4	H307	LOCK WASHER 1/4

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
A		ADDED 9138040A, 9138044A, H195, H451, H307	8/8/2017	ELL

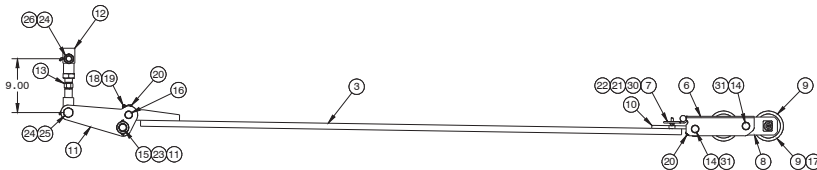
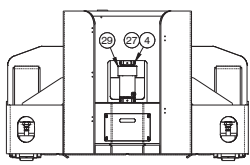
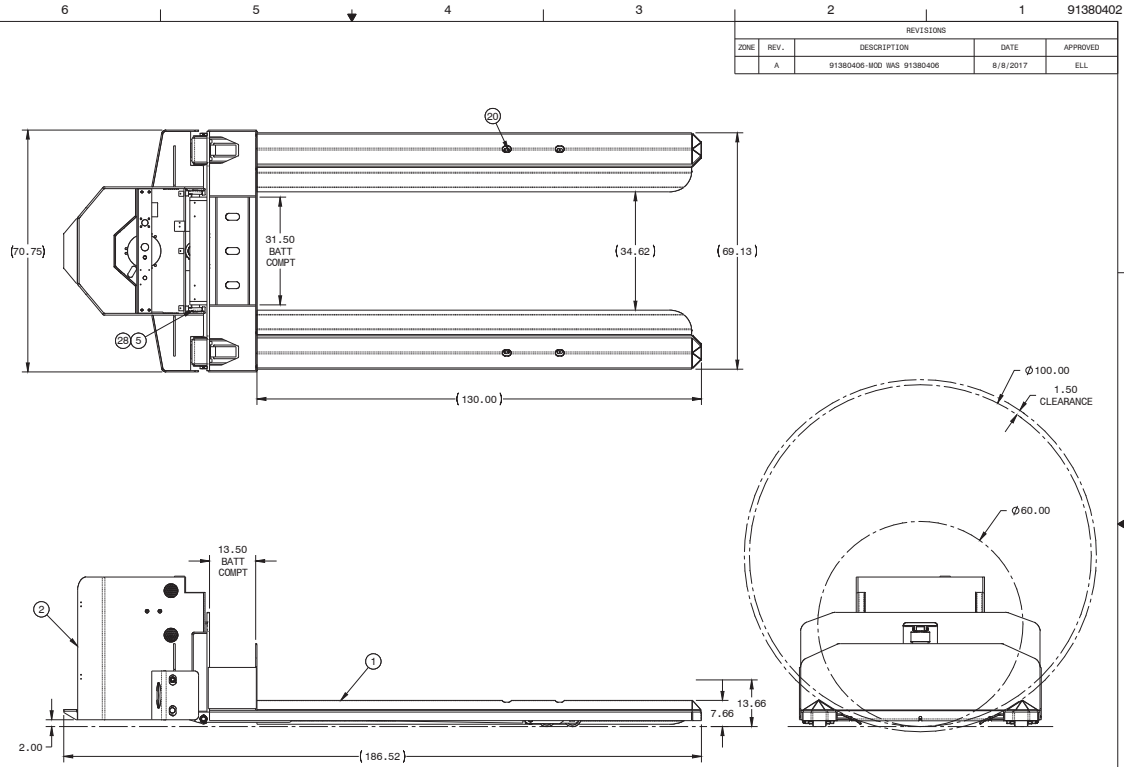


MODEL TYPE: R-LPRH-R-120
 ESTIMATED CHASSIS WEIGHT = 4,155 LBS.
 (ESTIMATED WEIGHT IS GIVEN WITHOUT BATTERY OR ASSEMBLY COMPONENTS)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE GIVEN IN INCHES.		ANGULAR TOLERANCE: ±1°		TITLE: FINAL ASSY	
DISTANCE TOLERANCES: .X ±.1		FRACTIONAL TOLERANCE: ±1/8"		RICO	
.XX ±.04"				SIZE: D	
.XXX ±.010"				PROCESS: ASSY	
		THIS DRAWING CONTAINS PROPRIETARY INFORMATION. THE DESIGN OF ANY PART OF IT SHALL NOT BE REPRODUCED IN ANY MANNER EXCEPT AS AUTHORIZED IN WRITING.		DRAWN BY: AJH	
		THEIR ANGLE PROJECTION		DATE: 07/02/09	
		SCALE: 1:14		SHEET: 1 OF 1	
				DIB NO.: 91380401	

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	91380405	CARRIAGE WELDT
2	1	91380406-MOD	DRIVE END MODIFICATION
3	2	91380420	TIE BAR WELDT
4	2	91380421	CYLINDER PIN
5	4	26031041	ROLLER, MAST
6	2	99100203	SHACKLE WELDMENT
7	2	99100059	CLAMP, SHACKLE
8	2	99100060	ARTICULATOR ASSY
9	4	66101638-01	WHEEL ASSY, 5 X 4 X 30MM, XL
10	2	99100058	WING PLATE ASSEMBLY
11	2	99100202	TOGGLE ASSY
12	4	94000016	CYLINDER MNT
13	2	99100063	ADJ TIE BAR BLOCK ASSY
14	4	72061C001	PIN
15	2	72061C003	PIN
16	2	72061C002	PIN
17	4	70060197	AXLE ASSY, 30MM X 5.625
18	2	H435	KEP NUT 1/4-20
19	2	H157	CUP POINT SET SCREW 1/4-20 X 1
20	6	H135	GREASE FITTING 1/4-28 90 DEG
21	4	H309	LOCK WASHER 3/8
22	4	H293	FLAT WASHER SAE 3/8
23	2	H1087	SPRING PIN 3/8 X 2-1/2
24	4	H434	NYLOCK FULL NUT 1-8
25	2	H1187	HHCS 1-8 X 8
26	2	H1112	HHCS 1-8 X 7 GD-8
27	4	H115	COLTER PIN 3/16" X 1"
28	16	50100079	SHIM
29	1	33002201	CYLINDER
30	4	H461A	HHCS 3/8-16 X 1 GD 8
31	4	H163	CUP POINT SET SCREW 5/16-18 X 1

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
A		91380406-MOD WAS 91380406	8/8/2017	ELL



MODEL TYPE: R-LPRH-R-120
 ESTIMATED CHASSIS WEIGHT = 4,155 LBS.
 (ESTIMATED WEIGHT IS GIVEN WITHOUT BATTERY OR ASSEMBLY COMPONENTS)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE GIVEN IN INCHES. DISTANCE TOLERANCES: .015" .X .015" .XX .024" .XXX .010"		ANGULAR TOLERANCE: .5° FRACTIONAL TOLERANCE: .5/16"		RICO CHASSIS ASSY	
THIS DRAWING CONTAINS PROPRIETARY INFORMATION. IT IS THE PROPERTY OF RICO AND IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF RICO.		THIRD ANGLE PROJECTION		TITLE: CHASSIS ASSY SIZE: D SCALE: 1:14 PROCESS: ASSY DRAWN BY: AJH DATE: 07/02/09 SHEET: 1 OF 1	

POWER PACK

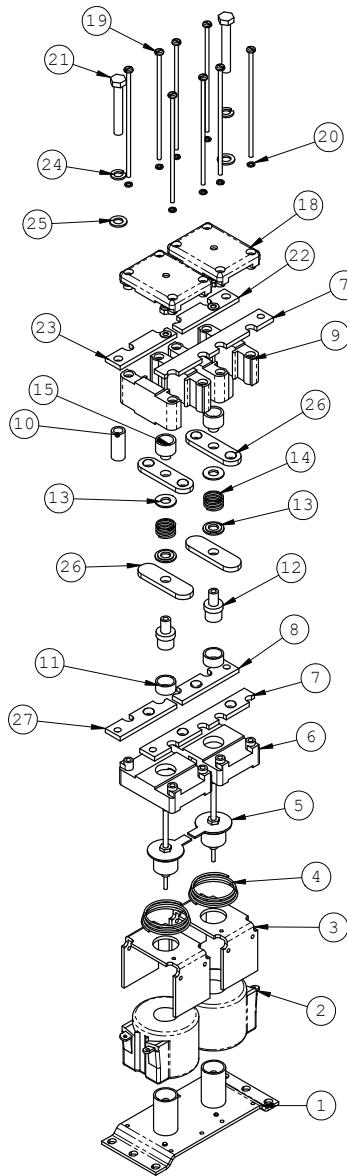
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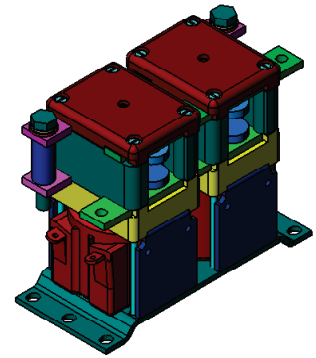


ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	11001292	MAGNET BASE ASSEMBLY
2	2	11001012	COIL
3	2	11001287	MAGNET FRAME
4	2	11000714	RETURN SPRING
5	2	11001293	ARMATURE ASSEMBLY
6	2	11001285	BUS BASE
7	2	11000531	BUS ASSEMBLY
8	1	11000535	BUS ASSEMBLY
9	4	11001294	BUS CLAMP
10	2	11001296	CLAMP
11	2	11001281	PLUNGER BUSHING
12	2	11001284	MOVABLE TIP CARRIER
13	4	11001282	SPRING SEAL
14	2	11000712	SPRING, MOVABLE
15	2	11001297	UPPER BUS INSULATION
16	2	11001288	FLAT WASHER
17	2	11001290	LOCK NUT
18	2	11001295	COVER
19	8	11001298	SCREW
20	8	11001289	LOCK WASHER
21	2	11001299	HEX CAP SCREW
22	1	11000532	BUS ASSEMBLY
23	1	11000533	BUS ASSEMBLY
24	2	11001300	LOCK WASHER
25	2	11001301	FLAST WASHER
26	4	11000544	MOVABLE TIP ASSEMBLY
27	1	11000534	BUS ASSEMBLY
28	1	11000209	TIP KIT

(ITEMS 4,7,8,11,13,15,23 PART OF TIP KIT - ITEM NO. 28)



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
	1	REDRAWN IN SOLIDWORKS, ADDED FM BLOCKS	04/12/07	DFC
	2	ADDED BOM AND EXPLODED VIEW	04/12/07	AKS



CONTACTOR ASSEMBLY (FIR)

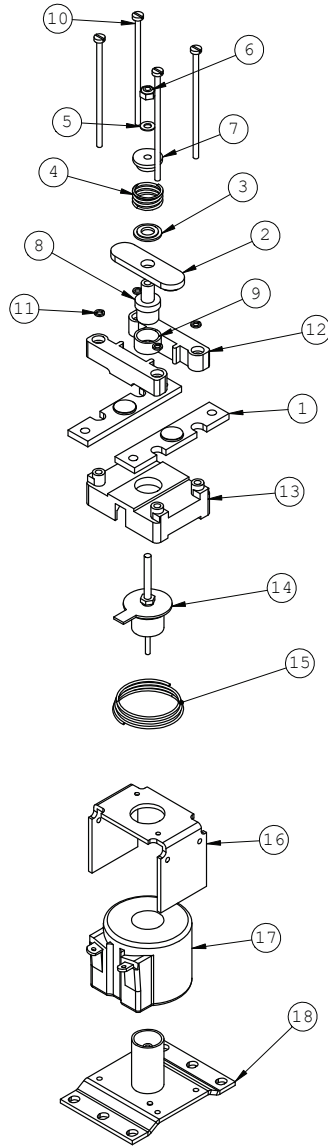
NO CHANGES TO THIS INFORMATION IS PERMITTED WITHOUT PRIOR WRITTEN CONSENT OF FM APPROVALS. REQUEST FOR CHANGES MUST BE SUBMITTED TO FM APPROVALS ON FORM 797

11000131

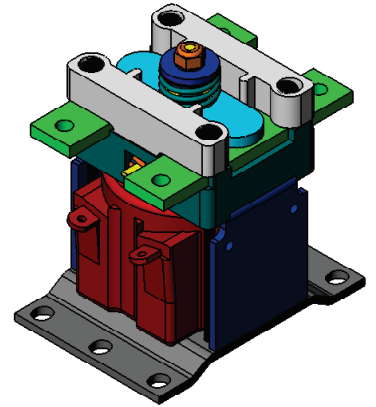
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	DATE: 04/12/07		SCALE: 3:8
SHEET 1 OF 1	SIZE: C	DATE: 04/12/2007	PART NO. 11000131

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	2	11000537	BUS ASSEMBLY
2	1	11000530	MOVABLE TIP ASSEMBLY
3	1	11001282	SPRING SEAL
4	1	11000717	SPRING, MOVABLE
5	1	11001288	FLAT WASHER
6	1	11001290	LOCK NUT
7	1	11001283	TIP SPRING RETAINER
8	1	11001284	MOVABLE TIP CARRIER
9	1	11001281	PLUNGER BUSHING
10	4	11001291	SCREW
11	4	11001289	LOCK WASHER
12	2	11001286	BUS CLAMP (SHORT)
13	1	11001285	BUS BASE
14	1	11001280	ARMATURE ASSEMBLY
15	1	11000713	RETURN SPRING
16	1	11001287	MAGNET FRAME
17	1	11001012	COIL
18	1	11001279	MAGNET BASE ASSEMBLY
19	1	11000211	TIP KIT

(ITEM 1,2,4,8,AND 15 PART OF TIP KIT - ITEM NO. 19)



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
	1	REDRAWN IN SOLIDWORKS, ADDED FM BLOCK	04/12/07	DFC



CONTACTOR ASSEMBLY (LIFT)

NO CHANGES TO THIS INFORMATION IS PERMITTED WITHOUT PRIOR WRITTEN CONSENT OF FM APPROVALS. REQUEST FOR CHANGES MUST BE SUBMITTED TO FM APPROVALS ON FORM 797

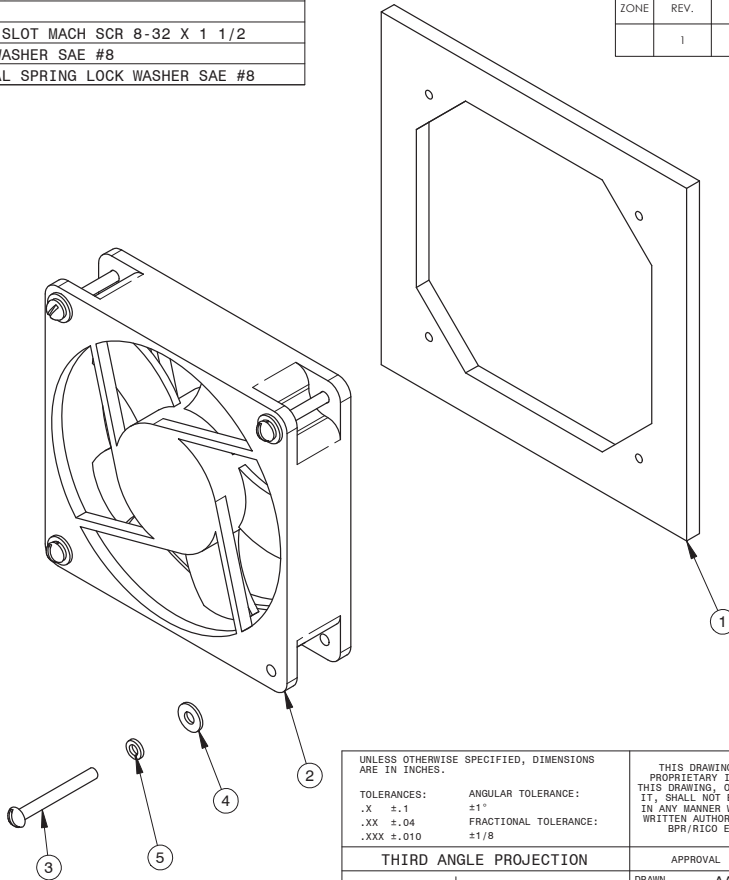
11000132

This drawing contains proprietary information. This drawing or any parts of it shall not be reproduced in any manner except as authorized in writing.			
SHEET 1 OF 1		CONTACTOR ASSEMBLY	
		SIZE: C SCALE: 1:2 DATE: 04/09/07 PART NO.: 11000132	

DWG NO 41050541 SH 1 REV 1

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	99130601	MTG PL, FAN
2	1	41050252	FAN
3	4	H14	RD HD SLOT MACH SCR 8-32 X 1 1/2
4	4	H29	FLAT WASHER SAE #8
5	4	H33	HELICAL SPRING LOCK WASHER SAE #8

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1	REPLACES WITH CHANGE 41050538	10/23/09	AAS



UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

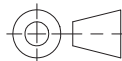
TOLERANCES: ANGULAR TOLERANCE:
 .X ±.1 ±1°
 .XX ±.04 FRACTIONAL TOLERANCE:
 .XXX ±.010 ±1/8

THIS DRAWING CONTAINS PROPRIETARY INFORMATION. THIS DRAWING, OR ANY PART OF IT, SHALL NOT BE REPRODUCED IN ANY MANNER WITHOUT PRIOR WRITTEN AUTHORIZATION FROM BPR/RICO EQUIPMENT.

RICO

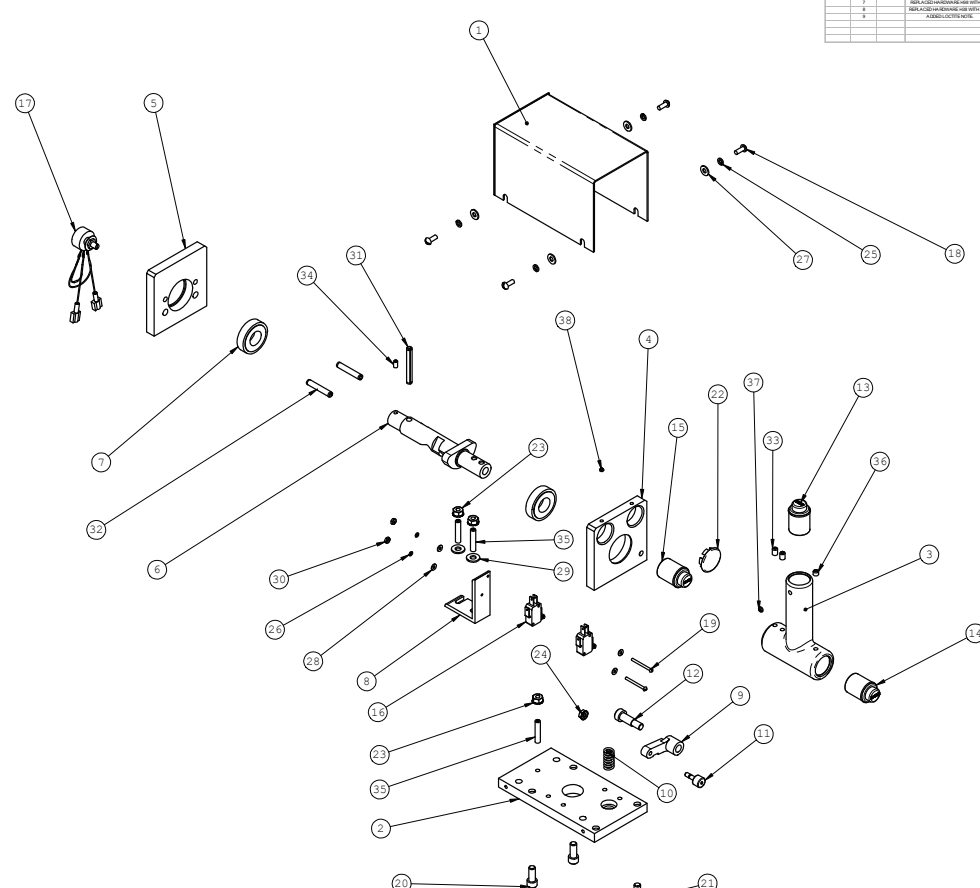
TITLE			
FAN ASSEMBLY			
APPROVAL	DATE	SIZE	PROCESS
DRAWN AAS	10/23/09	B	ASSY
CHECKED		DWG NO	41050541
ENGR AAS	10/23/09	SCALE	3:4
		WEIGHT	
		SHEET	1 OF 1
		REV	1

THIRD ANGLE PROJECTION



REV	REV	DATE	DESCRIPTION	BY	APPV
1		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
2		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
3		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
4		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
5		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
6		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
7		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
8		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00
9		11/08/00	ISSUED FOR PRODUCTION	11/08/00	11/08/00

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	41011011	COVER WELDMENT
2	1	41011002	BASE PL, HANDLE SWITCH
3	1	41011076	RIDER HANDLE "T"
4	1	41011003	MTG. PL, RIDER HANDLE
5	1	41011004	REAR PLATE
6	1	41011005	ACTIVATING SHAFT
7	2	26030003	BEARING
8	1	41011008	MTG BRACKET
9	1	41011030	CAM LEVER
10	1	90220227	DIE SPRING
11	1	26031008	CAMPFOLLOWER-1/2" DIA
12	1	H1480	SHOULDER BOLT 3/8" X 3/4" X 5/16-18 X 1/2"
13	1	41010001	PUSH BUTTON, LIFT
14	1	41010002	PUSH BUTTON, LOWER
15	1	41010003	PUSH BUTTON, HORN
16	2	41010005	SWITCH, SMALL ROLLER MICRO
17	1	41050238	POTENTIOMETER ASSY
18	4	H17	RD HD SLOT MACH SCR 10-32 X 1/2
19	2	H4	RD HD SLOT MACH SCR 4-40 X 1 1/4
20	3	H180	SHCS 5/16-18 X 3/4
21	1	H179	SHCS 5/16-18 X 1/2
22	1	H1479	1" NYLON HOLE PLUG
23	3	H435	KEP NUT 1/4-20
24	1	H525	KEP NUT #10-32
25	4	H34	HELICAL SPRING LOCK WASHER SAE #10
26	2	H31	HELICAL SPRING LOCK WASHER SAE #4
27	4	H30	FLAT WASHER SAE #10
28	4	H27	FLAT WASHER SAE #4
29	2	H291	FLAT WASHER SAE 1/4
30	2	H35	FULL NUT 4-40
31	1	H98	SPRING PIN 1/4 X 2
32	2	H97	SPRING PIN 1/4 X 1-1/2
33	2	H154	CUP POINT SET SCREW 1/4-20 X 3/8
34	1	H1141	CUP POINT SET SCREW 10-32 X 3/8
35	3	H1140	CUP POINT SET SCREW 1/4-20 X 1 1/4
36	1	H153	CUP POINT SET SCREW 1/4-20 X 1/4
37	1	H151	CUP POINT SET SCREW 1/4-20 X 1/8
38	1	H149A	CUP POINT SET SCREW 10-32X1/8



NOTE:
USE REMOVABLE LOCTITE
ON SCREW THREADS.

NOTE:
USE REMOVABLE LOCTITE
ON SCREW THREADS.

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RICO
RICO MOTOR SYSTEMS ASSY

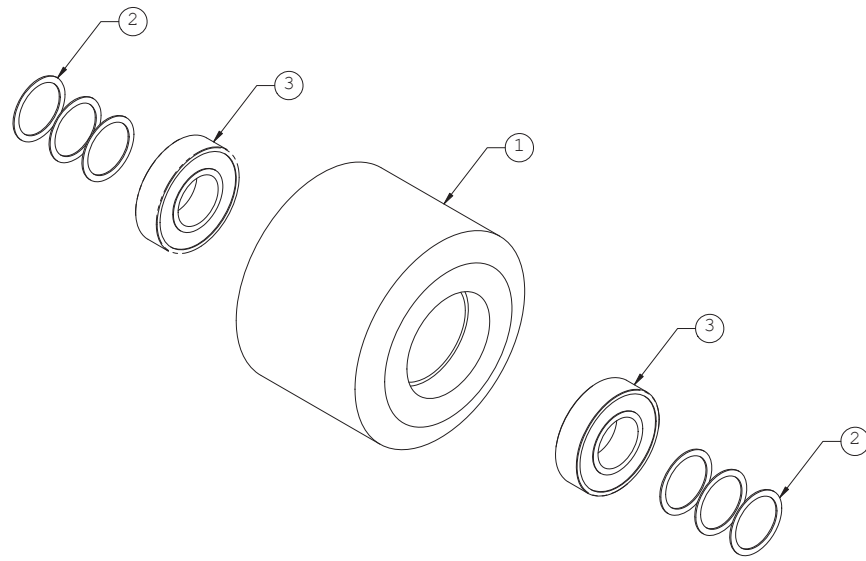
DATE: 11/08/00
BY: 11/08/00
APPV: 11/08/00

SHEET 1 OF 1

41011060

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	66001638	LOAD WHEEL
2	6	99021011	30 MM SHIM X 1/32" THK
3	2	26030010	BEARING (30mm ID)

REVISIONS					
ZONE	REV.	SERIAL / D#	DESCRIPTION	DATE	APPV



PART NO. 66101638-01

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	LOAD WHEEL ASSY, 5X4 POLY XL	
	SIZE: B	SCALE: 1:2
	SHEET 1 OF 1	PART NO. 66101638-01

9138040A

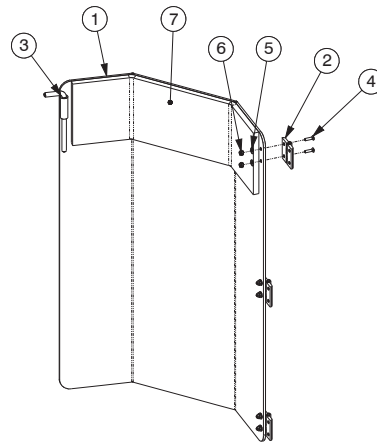
B

A

4 3 2 1

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	913804A1	OPER COMPT DOOR WELDT
2	3	90100135	HINGE, SURFACE MOUNT
3	1	70060418	BATTERY HINGE PIN
4	6	H195	FL HD SHCS 10-32 X 3/4
5	6	H30	FLAT WASHER SAE #10
6	6	H144	NYLOCK FULL NUT 10-32
7	1	913804A5	DOOR HIP CUSHION

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



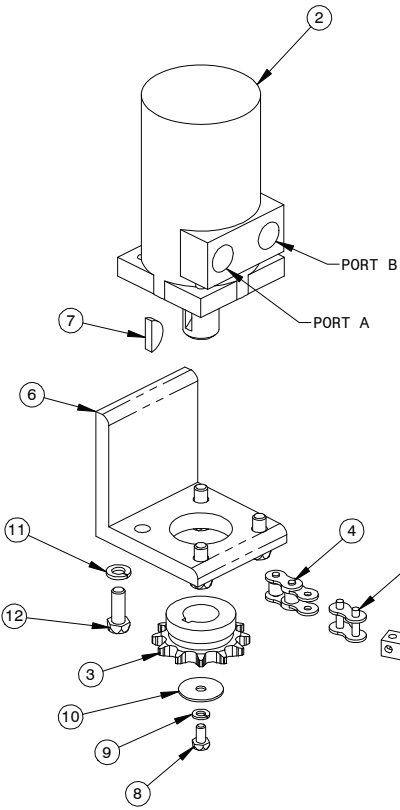
B

A

- NOTES:
1. THE ADDITION, OMISSION, OR SUBSTITUTION OF FASTENERS OR THREAD-LOCKING ADHESIVES IS PROHIBITED WITHOUT PRIOR APPROVAL BY ENGINEERING.
 2. UOS, FASTENER TORQUE SPECIFICATIONS ARE GIVEN IN THE DRY (UNLUBRICATED) CONDITION. IF THREAD LUBRICANTS ARE APPLIED, REDUCE ADVISED TORQUE BY 25% OR CONSULT ENGINEERING.

UOS, DIM ARE IN INCHES. .X ± .3 .XX ± .13 .XXX ± .063 ANGULAR ± 1° INTERPRET DIM AND TOL PER ASME Y14.5-2009.	THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND NEITHER IT NOR THE INFORMATION CONTAINED THEREIN SHALL BE DISCLOSED OR DUPLICATED WITHOUT THE EXPRESS WRITTEN CONSENT OF BPR/RICO MFG INC.		MFG PROCESS ASSY		
	THIRD ANGLE PROJECTION 	DRAWN BY ELL	ENGINEER ELL		
	8/8/2017	8/8/2017	SIZE B	DRAWING NUMBER 9138040A	REV LEVEL
	SCALE 1:8	WEIGHT 39.5 LB	SHEET 10F1		

4 3 2 1



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1	ADDED H1606 AND H48	5/22/09	AAS

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	15001611	CHAIN TENSIONER ASSY
2	1	33002073	MOTOR, HYDRAULIC
3	1	75010014	SPROCKET 50B12 X 1
4	3	99071017	CHAIN, ROLLER #50
5	2	99071015	MASTER LINK, #50 ROLLER CHAIN
6	1	99050017	MTG. ANGLE, POWER STEERING
7	1	H77	WOODRUFF KEY #808
8	1	H443	HHCS 1/4-20 X 1/2 GD-5
9	1	H307	LOCK WASHER 1/4
10	1	H299	FENDER WASHER 1/4
11	4	H309	LOCK WASHER 3/8
12	4	H461	HHCS 3/8-16 X 1 GD-5
13	1	H1606	SHCS 5/16-18 X 1
14	1	H48	LOCK WASHER HI-COLLAR 5/16

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE GIVEN IN INCHES.

DISTANCE TOLERANCES:
 .X ± .1"
 .XX ± .04"
 .XXX ± .010"
 ANGULAR TOLERANCE:
 ±1°
 FRACTIONAL TOLERANCE:
 ±1/8"

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THIRD ANGLE PROJECTION

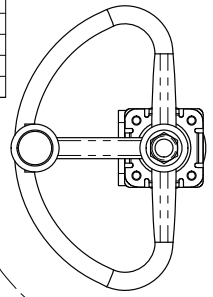


TITLE
PWR STG DRIVE CONTROL

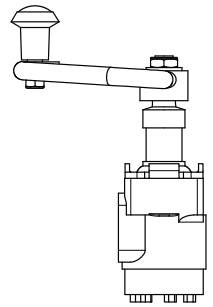
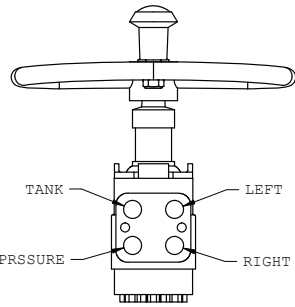
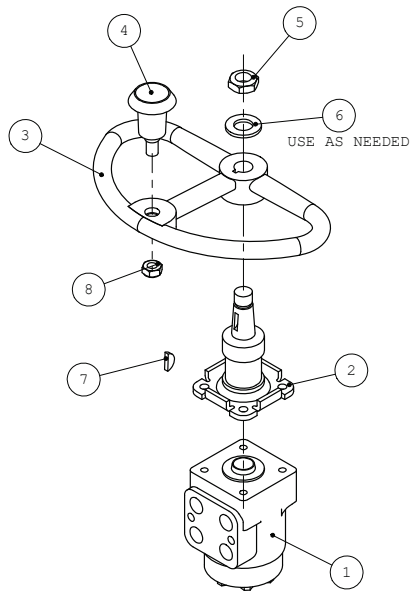
SIZE B	PROCESS ASSY	DWG NO. 99061007
SCALE 3:8	DRAWN BY AAS	DATE 5/22/2008
		SHEET 1 OF 1

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	33002771	STEERING SELECTOR
2	1	33002906	STEERING COLUMN
3	1	99070903	STEERING WHEEL
4	1	99070907	KNOB, STEERING
5	1	H336	NYLOCK JAM NUT 3/4-16
6	1	H296	FLAT WASHER SAE 3/4
7	1	H76	WOODRUFF KEY #607
8	1	H422	NYLOCK JAM NUT 1/2-13

REVISIONS					
ZONE	REV.	SERIAL / DW	DESCRIPTION	DATE	APPV
	1		H422 WAS H406 H296 "AS NEEDED"	9/28/2004	A.J.H.M.W.B.



R8.5 MIN. KNUCKLE CLEARANCE

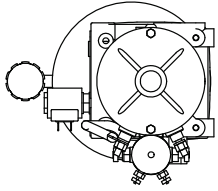


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TOLERANCES <small>(unless otherwise specified)</small> DECIMAL .0001" ±.0001" .001" ±.001" .005" ±.005" .010" ±.010" .015" ±.015" .030" ±.030" .060" ±.060" .125" ±.125" .250" ±.250" .500" ±.500" 1.000" ±.005" 1.500" ±.010" 2.000" ±.015" 3.000" ±.020" 4.000" ±.025" 5.000" ±.030" 6.000" ±.035" 7.000" ±.040" 8.000" ±.045" 9.000" ±.050" 10.000" ±.055" 11.000" ±.060" 12.000" ±.065" 13.000" ±.070" 14.000" ±.075" 15.000" ±.080" 16.000" ±.085" 17.000" ±.090" 18.000" ±.095" 19.000" ±.100" 20.000" ±.105" 21.000" ±.110" 22.000" ±.115" 23.000" ±.120" 24.000" ±.125" 25.000" ±.130" 26.000" ±.135" 27.000" ±.140" 28.000" ±.145" 29.000" ±.150" 30.000" ±.155" 31.000" ±.160" 32.000" ±.165" 33.000" ±.170" 34.000" ±.175" 35.000" ±.180" 36.000" ±.185" 37.000" ±.190" 38.000" ±.195" 39.000" ±.200" 40.000" ±.205" 41.000" ±.210" 42.000" ±.215" 43.000" ±.220" 44.000" ±.225" 45.000" ±.230" 46.000" ±.235" 47.000" ±.240" 48.000" ±.245" 49.000" ±.250" 50.000" ±.255" 51.000" ±.260" 52.000" ±.265" 53.000" ±.270" 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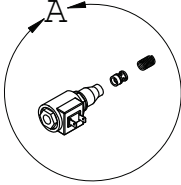
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	33003011	PUMP KIT
2	1	33003001	ADAPTER KIT
3	1	41010008	SOLENOID 24V
4	1	33003142	FLOW CONTROL SPRING
5	1	33003043	FLOW CONTROL SPOOL (.128 DRILL)
6	1	33003017	REL VALVE INCL COIL 41051018
7	1	33003197	HYDRAULIC TANK
8	1	05000254	MOTOR, PUMP
9	1	33003003	VALVE, RELIEF

REVISIONS					
ZONE	REV.	SERIAL / D#	DESCRIPTION	DATE	APPV
	1		UPDATED PUMP	1/15/2001	MB/CP
ALL	2		REDRAWN IN SOLIDWORKS	3/5/2002	MJT
	3		ADDED 33003003 VALVE, RELIEF	12/4/2003	MWB / ASM

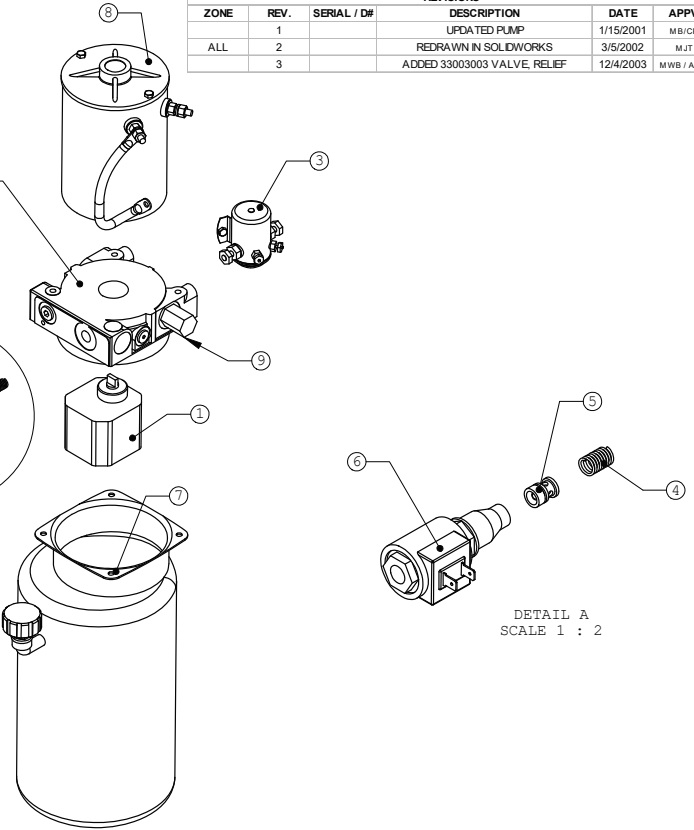
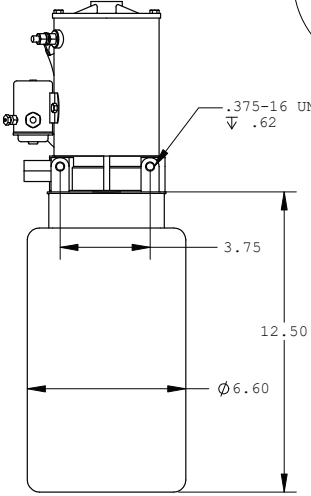
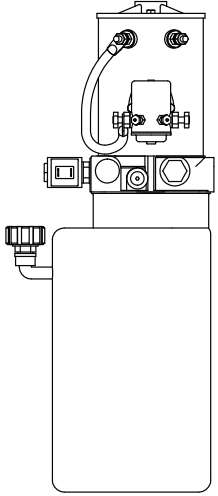
HYDRAULIC OIL TANK W/1.28 USABLE GALLONS
(24 VOLT D.C. MOTOR)



A
B
C
D



DETAIL A
SCALE 1 : 2



PART NO. 33240034

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RICO BARNES PUMP ASSEMBLY	
SIZE: B ANGULAR ±**	SCALE: 1:4 DATE: 8/2/1999 PART NO. 33240034

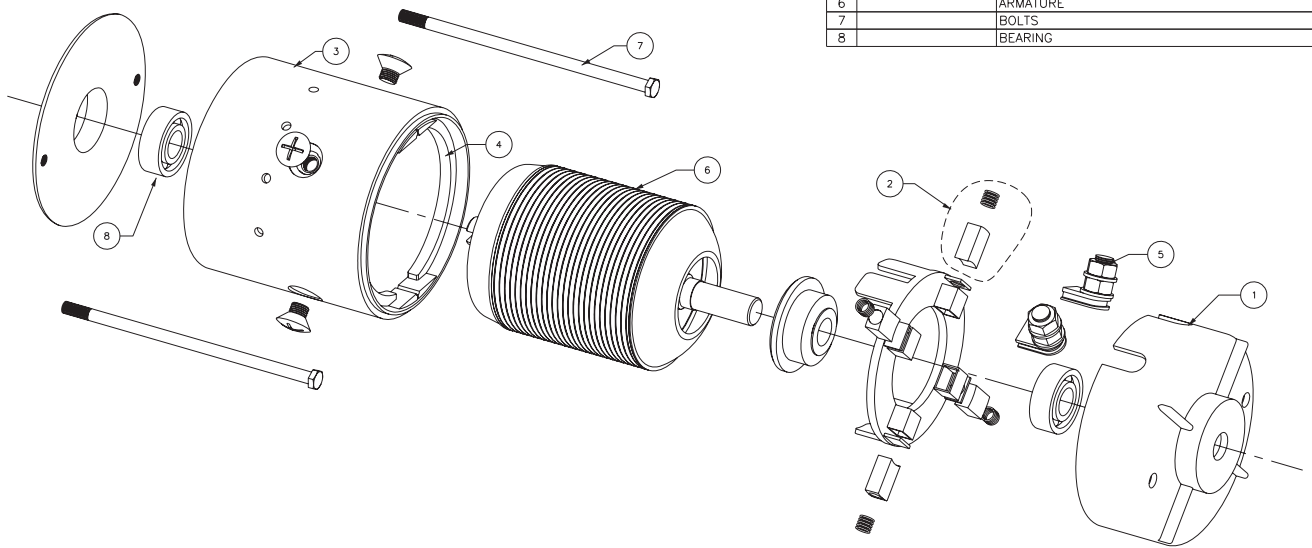
SHEET 1 OF 1



05000254

REVISIONS		DATE	APPROVED
1	CHANGED ITCX 42 FROM 05000153	08/14/00	JMK
2	REVISED FROM ITCX ONLY	9/2/04	MUS/PURCH

DET	DRAWING No.	DESCRIPTION	QTY
1		END COVER	1
2	05002154	BRUSH ASSEMBLY	4
3		FRAME	1
4		FIELD WINDINGS	1
5		TERMINALS	2
6		ARMATURE	1
7		BOLTS	2
8		BEARING	2



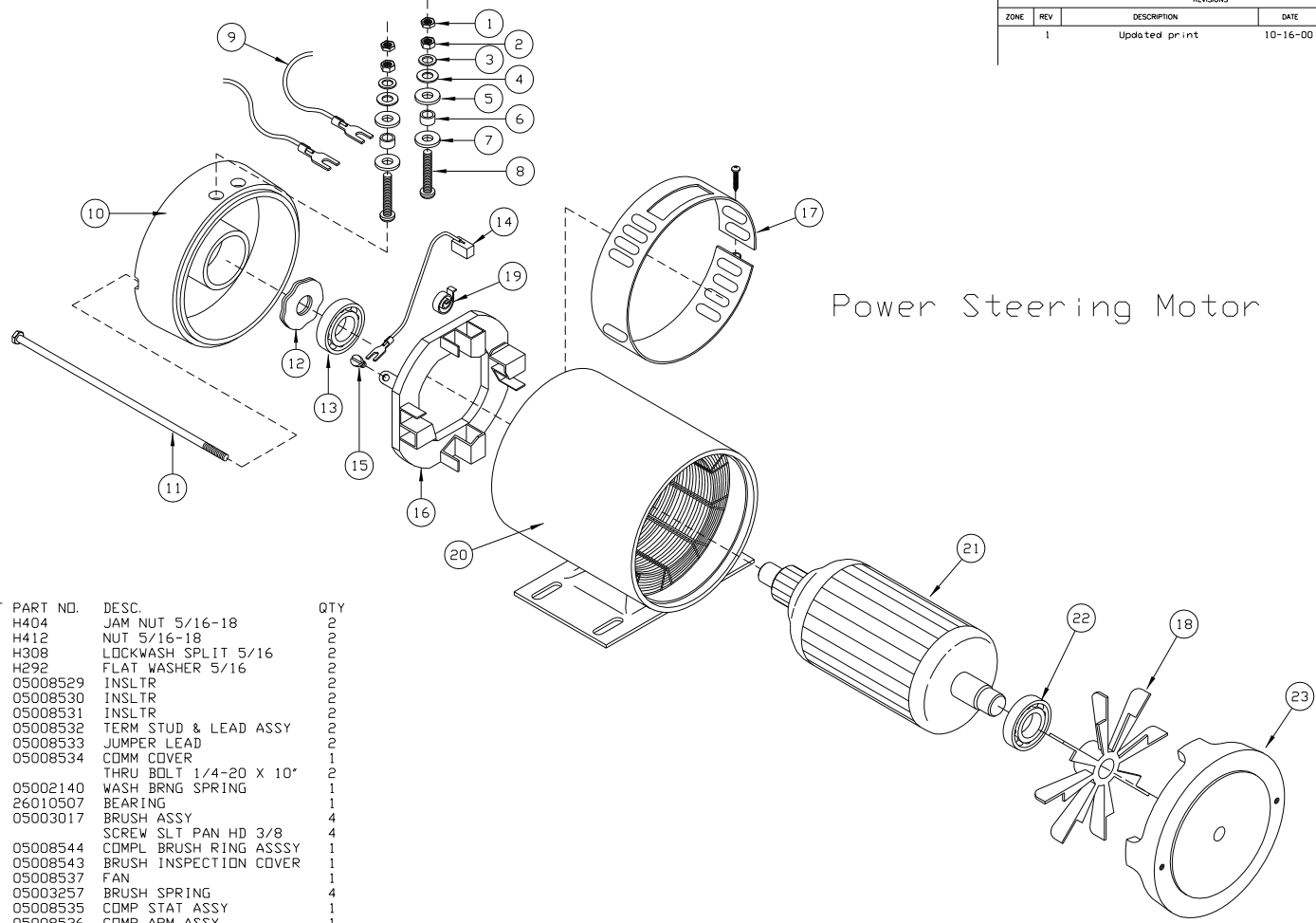
MATERIAL:			
This drawing contains proprietary information. This drawing or any part of it shall not be reproduced in any manner except as authorized in writing.		MODEL: MOTOR, PUMP SIZE: 1 REV: 1	DATE: 08/14/00 DRAWN BY: JMK CHECKED BY: MUS/PURCH

05000254

1 05000233

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	1	Updated print	10-16-00	MB-DJ

Power Steering Motor



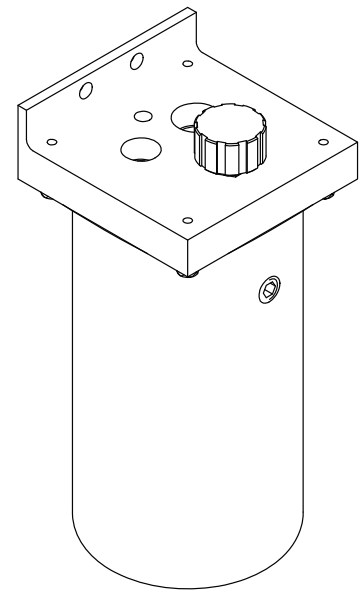
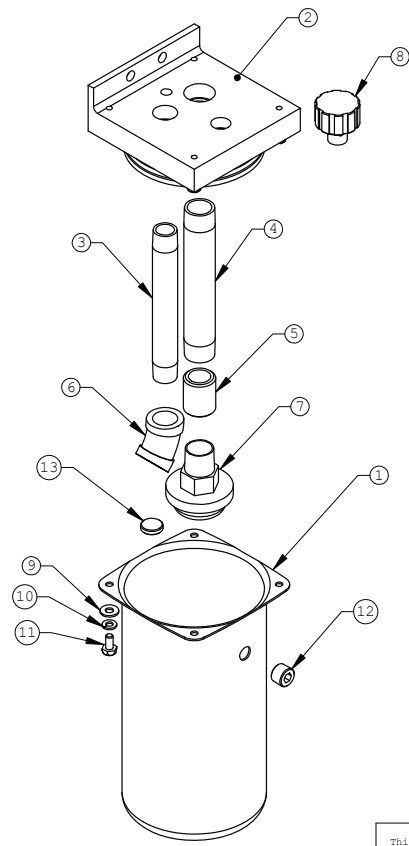
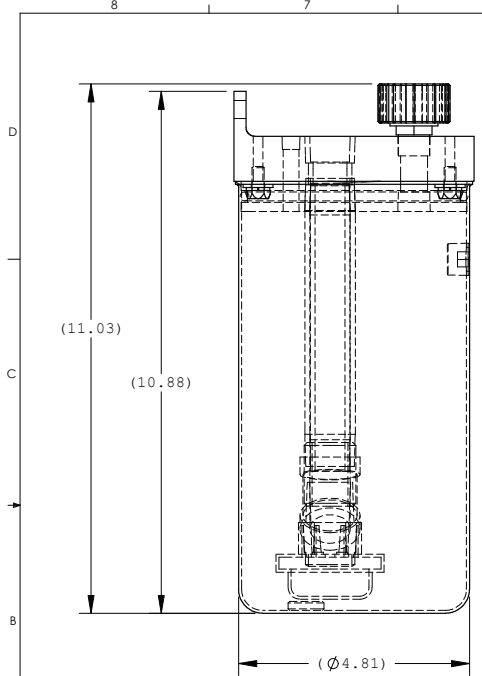
DET	PART NO.	DESC.	QTY
	1	H404 JAM NUT 5/16-18	2
	2	H412 NUT 5/16-18	2
	3	H308 LOCKWASH SPLIT 5/16	2
	4	H292 FLAT WASHER 5/16	2
	5	05008529 INSLTR	2
	6	05008530 INSLTR	2
	7	05008531 INSLTR	2
	8	05008532 TERM STUD & LEAD ASSY	2
	9	05008533 JUMPER LEAD	2
	10	05008534 COMM COVER	1
	11	THRU BOLT 1/4-20 X 10"	2
	12	05002140 WASH BRNG SPRING	1
	13	26010507 BEARING	1
	14	05003017 BRUSH ASSY	4
	15	SCREW SLT PAN HD 3/8	4
	16	05008544 COMPL BRUSH RING ASSY	1
	17	05008543 BRUSH INSPECTION COVER	1
	18	05008537 FAN	1
	19	05003257 BRUSH SPRING	4
	20	05008535 COMP STAT ASSY	1
	21	05008536 COMP ARM ASSY	1
	22	26030149 BEARING	1
	23	05008545 PULLEY COVER	1

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TOLERANCES UNLESS SHOWN OTHERWISE	RICO/ETS	
DECIMAL	PUMP MOTOR	
X ±.1"	DRAWN BY	SCALE
.XX ±.04"	JASON	
.XXX ±.010"	CHECKED	SERIAL NO.
SIZE C	DATE	6/4/97
ANGULAR		
±.1°		

1 05000233

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
	1	ADDED STORAGE NOTE	4/25/01	JRK
	2	SUCTION SCREEN WAS PN#33002017	5/18/01	JRK/RM
	3	F95 WAS 33101501.A ADDED F353	10/30/01	BJM
	4	ADDED 33003135	1/22/02	BJM
	5	UPDATE TO SW	5/8/02	PH



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	33003005	HYDRAULIC TANK
2	1	33009997	TANK LID ASSEMBLY
3	1	F95	1/2" X 6" NIPPLE
4	1	F101	3/4" X 6" NIPPLE
5	1	F47	STEEL COUPLER
6	1	F353	45 DEGREE ELBOW 1/2"
7	1	33003539	SCREEN, SUCTION
8	1	33003084	BREATHER, PLASTIC
9	4	H291	FLAT WASHER SAE 1/4
10	4	H307	LOCK WASHER 1/4
11	4	H443	HHCS 1/4-20 X 1/2 GD-5
12	1	01HP-6	MALE PIPE HOLLOW HEX PLUG
13	1	33003134	MAGNET

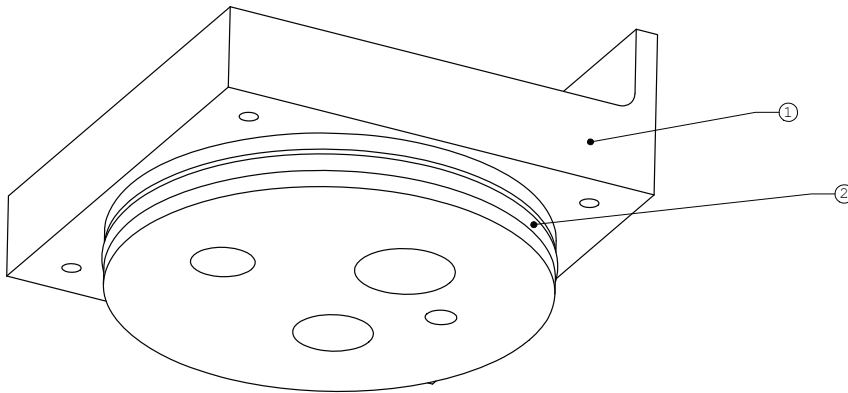
NOTE: HYDRAULIC TANK CAPACITY (USABLE)=0.46 GAL

This drawing contains proprietary information. This drawing or any part of it shall not be reproduced in any manner except as authorized in writing.	TOLERANCES UNLESS OTHERWISE SPECIFIED		RICO	
	DECIMAL	±.015"		HYDRAULIC TANK ASSY
	ANGULAR	±.5°		DATE: 03/08/00
SHEET 1 OF 1	DESIGNED BY: JAR	SCALE: 1:2	DRAWN BY: JAR	

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	33009998	TANK LID (MACHINED)
2	1	33050002	O-RING



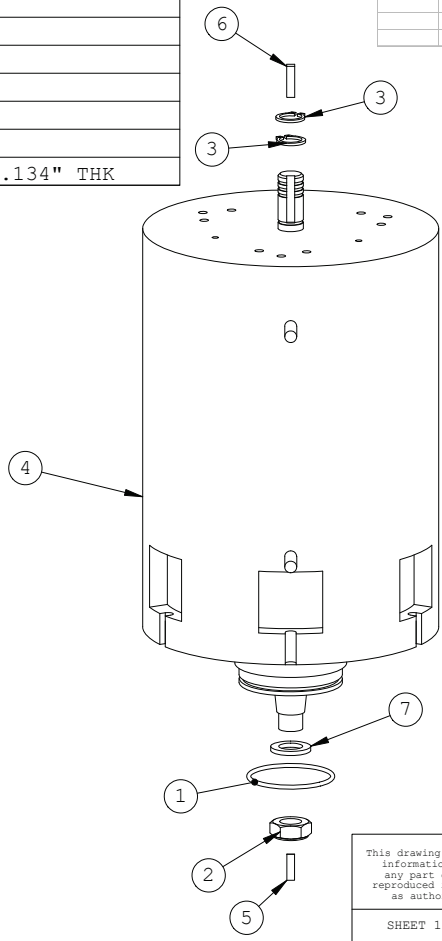
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPV
ALL	1	REDESIGNED AS ONE PIECE SOLIDWORKS	8/30/01	MJT/JU
D6	2	ORING WAS 90180123	3/27/02	MJT/PC



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	DECIMAL			
	±.01"		TANK LID ASSEMBLY	REPT ASSEMBLY
	±.001"		DATE: 8/30/01	SERIAL NO.
SIZE: B	ANGULAR	±.1°	DATE: 8/30/01	SERIAL NO.

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	15005642	O-RING
2	1	H336	NYLOCK JAM NUT 3/4-16
3	2	90180103	SNAP RING, .750 EXTERNAL
4	1	05000390	MOTOR, DRIVE
5	1	H84	WOODRUFF KEY M6 X 9
6	1	KEY CXCX1	KEY 1/4 SQ X 1"
7	1	H549	SHIM .75"ID X 1.25"OD X .134" THK

REVISIONS					
ZONE	REV.	SERIAL / D#	DESCRIPTION	DATE	APPV

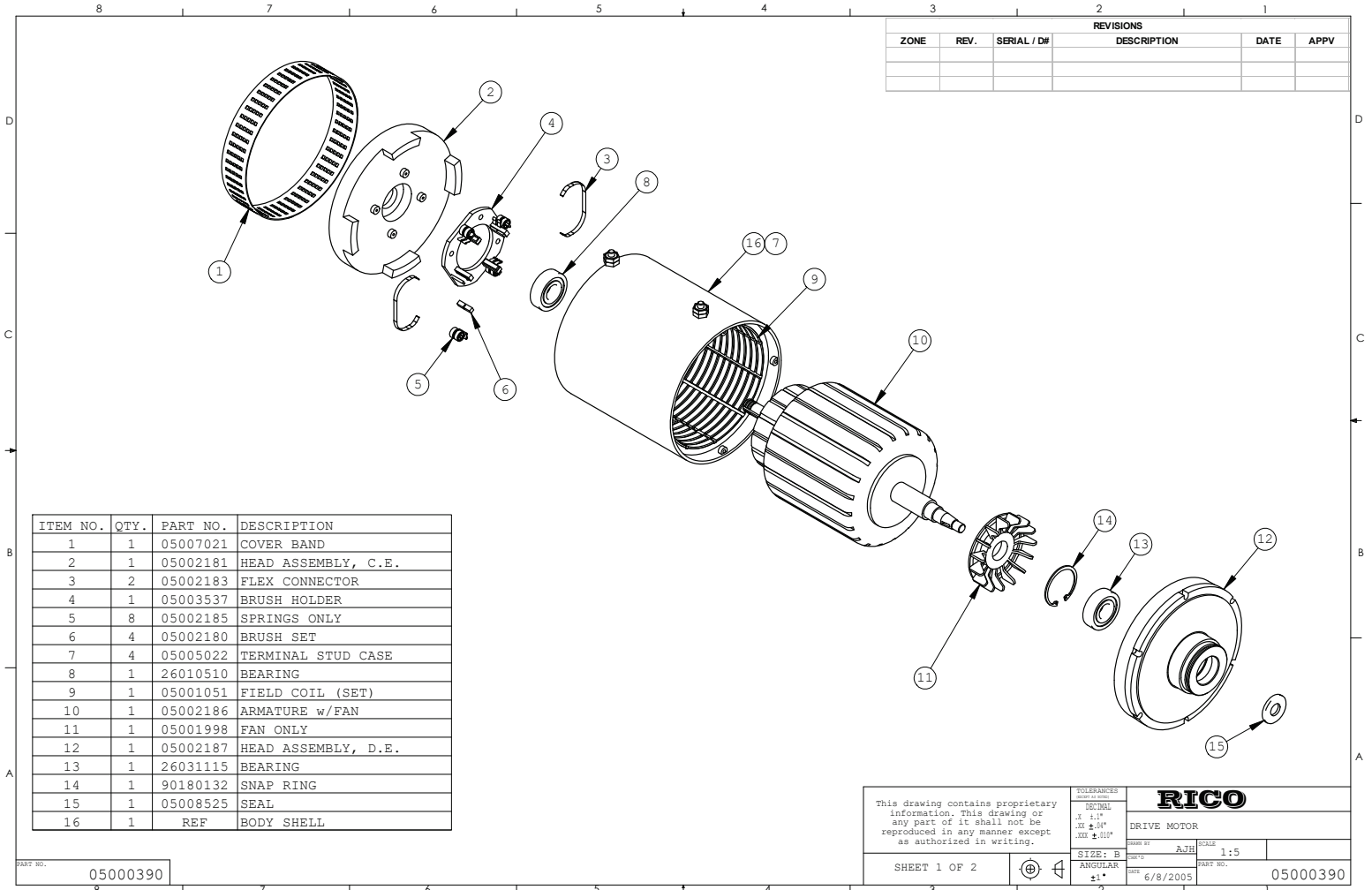


PART NO. 05110390

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SHEET 1 OF 1

TOLERANCES UNLESS OTHERWISE SPECIFIED		RICO	
INCHES	DECIMALS	DRIVE MOTOR ASSEMBLY	
.125" - .1250"	±.001"	DATE BY	AAS
.1250" - .1250"	±.001"	SCALE	1:3
SIZE: B	ANGULAR	DATE	5/5/2008
±.1°	±.1°	PART NO.	05110390



REVISIONS					
ZONE	REV.	SERIAL / D#	DESCRIPTION	DATE	APPV

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	05007021	COVER BAND
2	1	05002181	HEAD ASSEMBLY, C.E.
3	2	05002183	FLEX CONNECTOR
4	1	05003537	BRUSH HOLDER
5	8	05002185	SPRINGS ONLY
6	4	05002180	BRUSH SET
7	4	05005022	TERMINAL STUD CASE
8	1	26010510	BEARING
9	1	05001051	FIELD COIL (SET)
10	1	05002186	ARMATURE w/FAN
11	1	05001998	FAN ONLY
12	1	05002187	HEAD ASSEMBLY, D.E.
13	1	26031115	BEARING
14	1	90180132	SNAP RING
15	1	05008525	SEAL
16	1	REF	BODY SHELL

PART NO. 05000390

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TOLERANCES
 UNLESS OTHERWISE SPECIFIED:
 .0001" ±.0001"
 .0002" ±.0002"
 .0005" ±.0005"
 .001" ±.001"

RICO
 DRIVE MOTOR

SIZE: B
 ANGULAR ±.1°

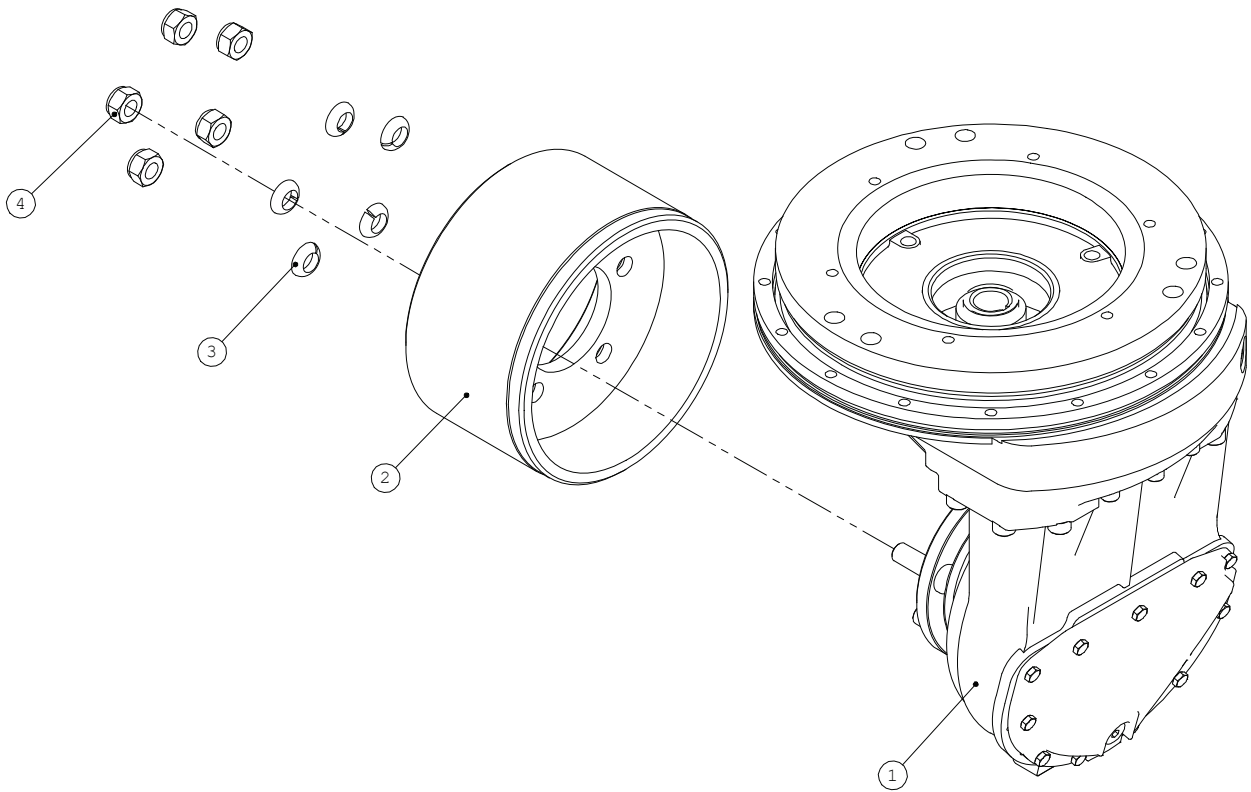
DATE: 6/8/2005

SCALE: 1:5

SHEET 1 OF 2

PART NO. 05000390

REVISIONS					
ZONE	REV.	SERIAL / DR	DESCRIPTION	DATE	APPV



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	15001603	TRANSMISSION (300BF-25MM)
2	1	66001202	HFK 300 HUB ASSEMBLY (MACHINE)
3	5	15P01402	LOCK WASHER, LUG
4	5	15P01401	LUG NUT

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RICO
 TRANSMISSION ASSY (300BF-25MM)
 SHEET 1 OF 1
 SIZE: C
 DATE: 12/01/07
 PART NO.: 25001603

25001603



OTHER INFORMATION

SUPPLY VEHICLE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS
FOR VEHICLE AND PARTS INFORMATION CONTACT CUSTOMER SERVICE BPR/RICO (330)723-4050 FAX(330)723-4012

CUSTOM DESIGNED
Electrically Powered Lift Trucks

MANUFACTURED BY
BPR/RICO MANUFACTURING INCORPORATED

DIVIDER V

Specifications

TORQUE SPECIFICATIONS

STANDARD TORQUE FOR METRIC FASTENERS

NOTE : Take care to avoid mixing metric and inch dimensioned fasteners. Mismatched or incorrect fasteners can result in vehicle damage or malfunction, or possible injury. Exceptions to these torques are given in the Service Manual where needed.

NOTE : Prior to installation of any hardware, be sure components are in near new condition. Bolt and nut threads must not be worn or damaged. Hardware must be free of rust and corrosion. Clean hardware with a non-corrosive cleaner and apply engine oil to threads and bearing face. If thread lock or other compounds are to be applied, do not apply engine oil.

METRIC NUTS AND BOLTS		
THREAD SIZE (mm)	STANDARD TORQUE	
	(N • m)	(lb • ft)
M6	12 ± 3	9 ± 2
M8	28 ± 7	20 ± 5
M10	55 ± 10	40 ± 7
M12	100 ± 20	75 ± 15
M14	160 ± 30	120 ± 22
M16	240 ± 40	175 ± 30
M20	460 ± 60	340 ± 44
M24	800 ± 100	600 ± 75
M30	1600 ± 200	1200 ± 150
M36	2700 ± 300	2000 ± 225

METRIC TAPERLOCK STUDS		
THREAD SIZE (mm)	STANDARD TORQUE	
	(N • m)	(lb • ft)
M6	8 ± 3	6 ± 2
M8	17 ± 5	13 ± 4
M10	35 ± 5	26 ± 4
M12	65 ± 10	48 ± 7
M16	110 ± 20	80 ± 15
M20	170 ± 30	125 ± 22
M24	400 ± 60	300 ± 45
M30	650 ± 80	480 ± 60
M36	870 ± 100	640 ± 75

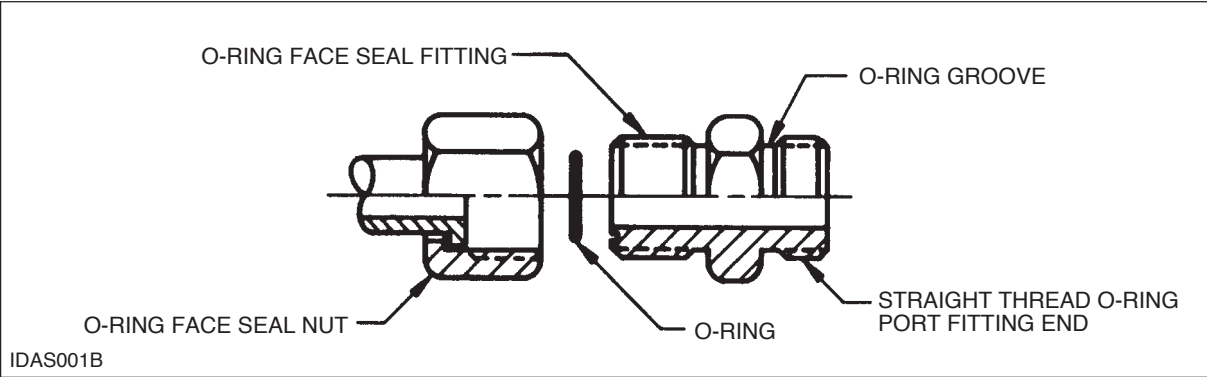
STANDARD TORQUE FOR INCH FASTENERS

Exceptions to these torques are given in the Service Manual where needed.

INCH NUTS AND BOLTS		
THREAD SIZE inch	STANDARD TORQUE	
	(N • m)	(lb • ft)
1/4	12 ± 3	9 ± 2
5/16	25 ± 6	18.0 ± 4.5
3/8	47 ± 9	35 ± 7
7/16	70 ± 15	50 ± 11
1/2	105 ± 20	75 ± 15
9/16	160 ± 30	120 ± 20
5/8	215 ± 40	160 ± 30
3/4	370 ± 50	275 ± 35
7/8	620 ± 80	460 ± 60
1	900 ± 100	660 ± 75
1-1/8	1300 ± 150	950 ± 100
1-1/4	1800 ± 200	1325 ± 150
1-3/8	2400 ± 300	1800 ± 225
1-1/2	3100 ± 350	2300 ± 250

INCH TAPERLOCK STUDS		
THREAD SIZE inch	STANDARD TORQUE	
	(N • m)	(lb • ft)
1/4	8 ± 3	6 ± 2
5/16	17 ± 5	13 ± 4
3/8	35 ± 5	26 ± 4
7/16	45 ± 10	33 ± 7
1/2	65 ± 10	48 ± 7
5/8	110 ± 20	80 ± 15
3/4	170 ± 30	125 ± 22
7/8	260 ± 40	190 ± 30
1	400 ± 60	300 ± 45
1-1/8	500 ± 70	370 ± 50
1-1/4	650 ± 80	480 ± 60
1-3/8	750 ± 90	550 ± 65
1-1/2	870 ± 100	640 ± 75

O-RING FACE SEAL FITTINGS



STRAIGHT THREAD O-RING FITTING (FOR O-RING FACE SEAL FITTING ONLY)		
THREAD SIZE inch	STANDARD TORQUE	
	(N • m)	(lb • ft)
5/16-24	5.0 ± 1.5	45±15 lb•in
3/8-24	12 ± 2	110±20 lb•in
7/16-20	20 ± 4	15 ± 3
1/2-20	30 ± 5	22 ± 4
9/16-18	40 ± 5	30 ± 4
3/4-16	100 ± 15	75 ± 10
7/8-14	135 ± 15	100 ± 10
1 1/16-12	200 ± 25	150 ± 20
1 3/16-12	250 ± 25	185 ± 20
1 5/16-12	300 ± 40	225 ± 30
1 5/8-12	300 ± 40	225 ± 30
1 7/8-12	300 ± 40	225 ± 30
2 1/2-12	300 ± 40	225 ± 30

O-RING FACE SEAL FITTING NUT		
THREAD SIZE inch	STANDARD TORQUE	
	(N • m)	(lb • ft)
9/16-18	16 ± 3	12 ± 2
11/16-16	30 ± 4	22 ± 3
13/16-16	50 ± 7	37 ± 5
1-14	90 ± 10	65 ± 7
1 3/16-12	120 ± 15	90 ± 10
1 7/16-12	160 ± 20	120 ± 15
1 11/16-12	190 ± 20	140 ± 15
2-12	215 ± 25	160 ± 20

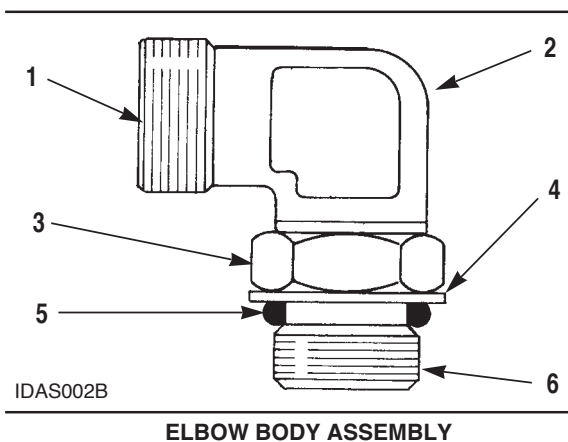
FITTING INSTALLATION

HYDRAULIC LINE INSTALLATION

1. For a metal tube to hose installation, install the tube and tighten all bolts finger tight.
2. Tighten the bolts at the rigid end.
3. Install the hose and tighten all bolts finger tight.
4. Put the hose in a position so that it does not make contact with the machine or another hose.
5. Tighten the bolts on both connections.
6. Start the engine.
7. Move the implement control levers to all positions.
8. Look at the hose during movement of the implement. Make sure hose is not in contact with the machine or other hoses.
9. Shut off the engine.
10. If necessary, put the hose in a new position where it will not make contact when the implement is moved.

ASSEMBLY OF FITTINGS WITH STRAIGHT THREADS AND O-RING SEALS

This type of fitting is used in many applications. The tube end of the fitting will be different in design so that it can be used in many different applications. However, the installation procedure of the fitting is the same. If the tube end of the fitting body is the same as in the illustration (either an elbow or a straight body) it will be necessary to assemble the sleeve on the tube before connecting the tube to the end.



- (1) End of fitting body (connects to tube). (2) Fitting body.
 (3) Lock-nut. (4) Backup washer. (5) O-ring seal. (6) End of fitting that goes into other part.

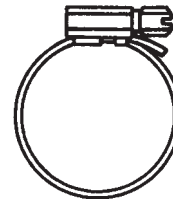
1. Put locknut (3), backup washer (4) and O-ring seal (5) as far back on fitting body (2) as possible. Hold these components in this position. Turn the fitting into the part it is used on until backup washer (4) just makes contact with the face of the part it is used on.
2. To put the fitting assembly in its correct position, turn the fitting body (2) out (counterclockwise) a maximum of 359°. Tighten locknut (3) to the torque shown in the correct chart for the fitting used.

NOTE: If the fitting is a connector (straight fitting), the hex on the body takes the place of the locknut. To install this type fitting, tighten the hex against the face of the part it goes into.

TORQUES FOR FLARED AND O-RING FITTINGS

The torques shown in the charts that follow are to be used on the nut part of 37° Flared, 45° Flared and Inverted Flared fittings (when used with steel tubing), O-ring plugs, O-ring fittings and swivel nuts when used in applications to 3000 psi (20 700 kPa).

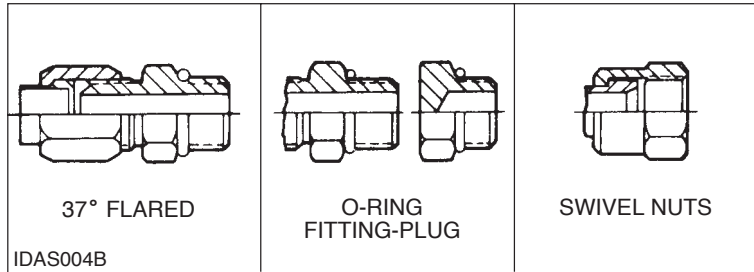
HOSE CLAMP-BAND TYPE



IDAS003B

CLAMP WIDTH	TORQUE ON NEW HOSE	RETIGHTENING TORQUE
7.9 mm (.312 in)	0.9 ± 0.2 N • m 8 ± 2 lb • in	0.7 ± 0.2 N • m 6 ± 2 lb • in
13.5 mm (.531 in)	4.5 ± 0.5 N • m 40 ± 5 lb • in	3.0 ± 0.5 N • m 25 ± 5 lb • in
15.9 mm (.625 in)	7.5 ± 0.5 N • m 65 ± 5 lb • in	4.5 ± 0.5 N • m 40 ± 5 lb • in

37° FLARED AND STRAIGHT THREAD O-RING FITTINGS

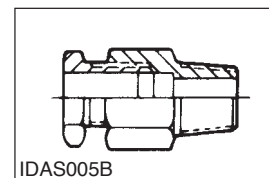


37° FLARED AND STRAIGHT THREAD O-RING FITTINGS (EXCEPT O-RING FACE SEAL FITTINGS)				
NOMINAL TUBE O.D.		THREAD SIZE inch	STANDARD TORQUE	
METRIC	INCH		(N • m)	(lb • ft)
3.18	.125	5/16	5.0 ± 1.5	4 ± 1
4.76	.188	3/8	11.0 ± 1.5	8 ± 1
6.35	.250	7/16	16 ± 2	12 ± 1
7.94	.312	1/2	20 ± 5	15 ± 4
9.52	.375	9/16	25 ± 5	18 ± 4
9.52	.375	5/8	35 ± 5	26 ± 4
12.70	.500	3/4	50 ± 7	37 ± 5
15.88	.625	7/8	65 ± 7	48 ± 5
19.05	.750	1-1/16	100 ± 10	75 ± 7
22.22	.875	1-3/16	120 ± 10	90 ± 7
25.40	1.000	1-5/16	135 ± 15	100 ± 11
31.75	1.250	1-5/8	180 ± 15	135 ± 11
38.10	1.500	1-7/8	225 ± 15	165 ± 11
50.80	2.000	2-1/2	320 ± 30	240 ± 22

TIGHTENING OTHER FITTINGS

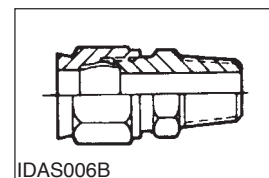
Hi Duty (Shear sleeve) Tube Fittings

After tube has been put through the nut and makes contact against the tube shoulder in the fitting body, turn the nut with a wrench until a small decrease in torque is felt. This is an indication that the sleeve has been broken off the nut. Hold the tube to prevent turning and tighten the nut 1-1/2 turns.

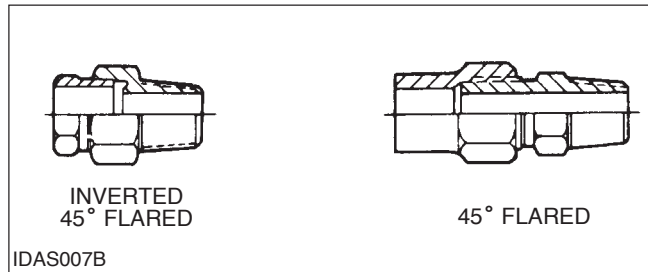


Hi Seal Fittings

Put nut and sleeve over the tubing with the short heavy end of the sleeve facing the end of tubing. Put the tube end against the counterbore in the body of the fitting and tighten until nut is over the last thread on the body. The remainder of space is used whenever the fitting is removed and installed again.



45° FLARED AND 45° INVERTED FLARE FITTINGS

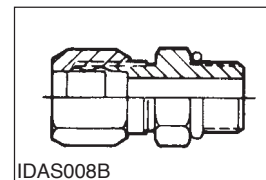


45° FLARED AND 45° INVERTED FLARE FITTINGS				
NOMINAL TUBE O.D.		THREAD SIZE inch	STANDARD TORQUE	
METRIC	INCH		(N • m)	(lb • ft)
3.18	.125	5/16	5.0 ± 1.5	4 ± 1
4.76	.188	3/8	8.0 ± 1.5	6 ± 1
6.35	.250	7/16	11 ± 2	8 ± 1
7.94	.312	1/2	17 ± 3	13 ± 2
9.52	.375	5/8	30 ± 3	22 ± 2
11.11	.438	11/16	30 ± 3	22 ± 2
12.70	.500	3/4	38 ± 4	28 ± 3
15.88	.625	7/8	50 ± 5	37 ± 4
19.05	.750	1-1/16	90 ± 8	65 ± 6
22.22	.875	1-1/4	100 ± 10	75 ± 7

TIGHTENING OTHER FITTINGS

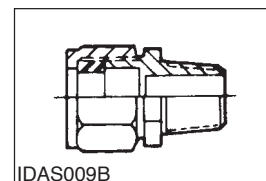
Ermeto Tube Fittings

Put nut and sleeve over the tube with head or shoulder end of sleeve next to nut. Push tube into counterbore of fitting body as far as possible. Turn nut clockwise until sleeve holds tube and prevents movement. Tighten the nut 1-1/4 turns more to seat sleeve and give a locking action. When necessary to assemble again, put sleeve over tube and tighten nut until a sudden increase in torque is felt. Then tighten 1/6 to 1/3 turn more to seat the sleeve.

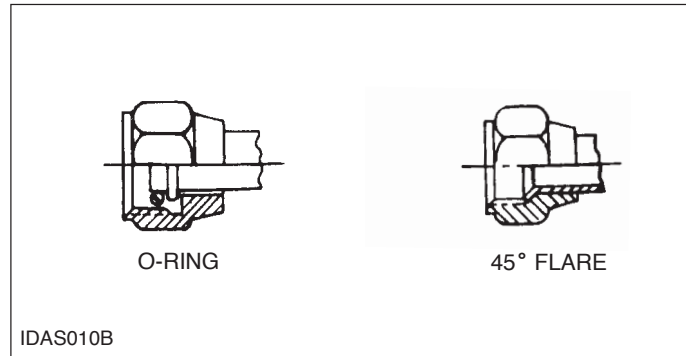


Flex Fittings

Put nut and sleeve over the tubing and push tube in to counterbore of fitting body as far as possible. Tighten the nut until it is against the hex part of the fitting body.



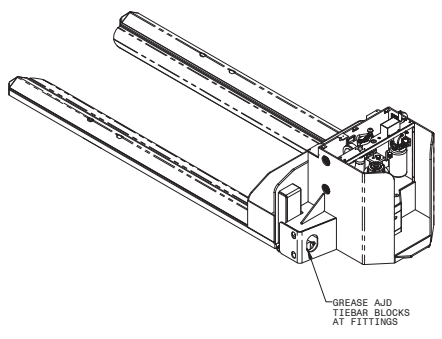
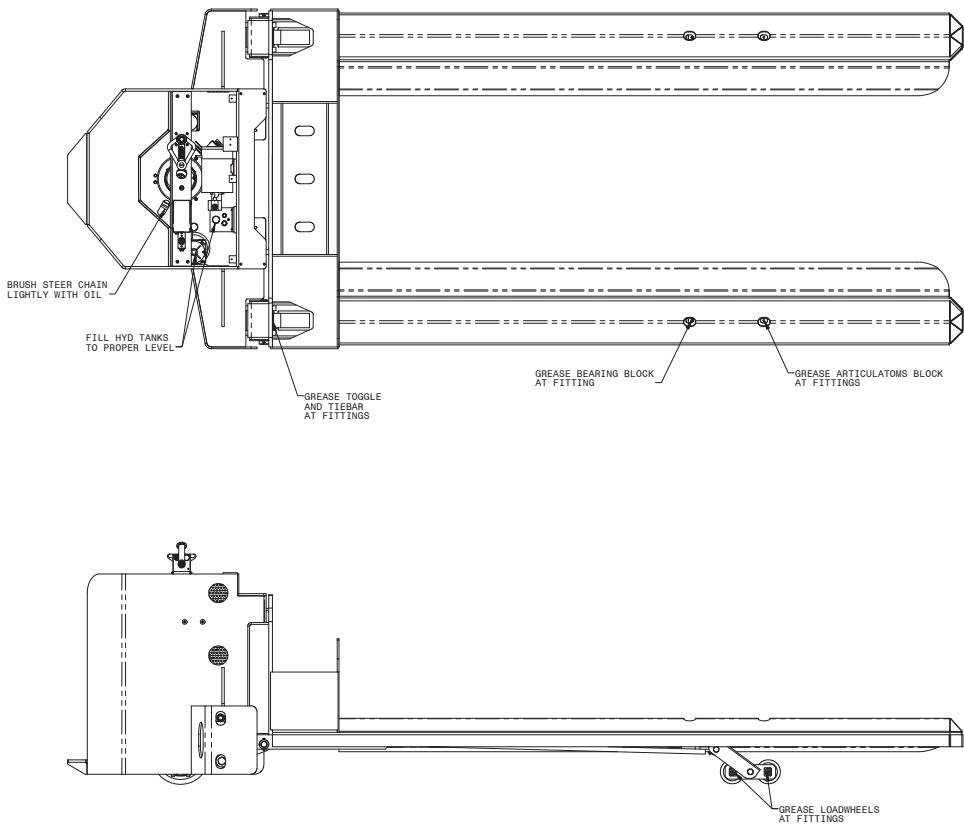
AIR CONDITIONING AND TAPERED PIPE THREAD FITTINGS



AIR CONDITIONING FITTINGS						
O-RING FITTING END			45° FLARE FITTING END			
THREAD SIZE inch	STANDARD TORQUE		STEEL TUBES		ALUMINUM TUBES	
			STANDARD TORQUE		STANDARD TORQUE	
	N • m	(lb • ft)	N • m	(lb • ft)	N • m	(lb • ft)
5/8-18	18 ± 4	13 ± 3	30 ± 3	22 ± 2	23 ± 3	17 ± 2
3/4-16	37 ± 4	27 ± 3	52 ± 5	38 ± 4	33 ± 4	24 ± 3
7/8-14	40 ± 4	30 ± 3	60 ± 7	44 ± 5	38 ± 4	28 ± 3
1 1/16-14	45 ± 5	33 ± 4	75 ± 8	55 ± 6	50 ± 5	37 ± 4

TAPERED PIPE THREAD FITTINGS				
PIPE THREAD SIZE inch	STANDARD TORQUE			
	THREADS WITH 1E2200E SEALANT		THREADS WITHOUT SEALANT	
	N • m	(lb • ft)	N • m	(lb • ft)
1/16-27	15	11	20	15
1/8-27	20	15	25	18
1/4-18	25	18	35	26
3/8-18	35	26	45	33
1/2-14	45	33	60	45
3/4-14	60	45	75	55
1-11 1/2	75	55	90	65
1 1/4-11 1/2	95	70	110	80
1 1/2-11 1/2	110	80	130	95
2-11 1/2	130	95	160	120

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED



NOTE:
 1. GEAR LUBE 90 IN TRANSMISSION.
 2. GREASE TRANSMISSION BEARING & FITTING(S).
 3. FILL HYDRAULIC TANK TO PROPER LEVEL WITH HYDRAULIC FLUID.
 4. BRUSH MAST CHANNEL LIGHTLY WITH OIL.
 CHECK FLUID LEVELS DAILY.
 COMPLETE TRUCK SERVICE WEEKLY.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE GIVEN IN INCHES.			
DISTANCE TOLERANCES: .X X .11" .XX X .24" .XXX X .010"		ANGULAR TOLERANCE: 15" FRACTIONAL TOLERANCE: 1/16"	
THIS DRAWING CONTAINS PROPRIETARY INFORMATION. THIS DRAWING OR ANY PART OF IT SHALL NOT BE REPRODUCED OR ANY MANNER WITHOUT BE AUTHORIZED IN WRITING.		THIRD ANGLE PROJECTION 	
TITLE LUBE DRAWING		SIZE D	PROCEDURE MANUAL
DRAWN BY AJH		DATE 07/02/09	SHEET 1 OF 1
SCALE 1:10		Dwg No. 913804LB	913804LB

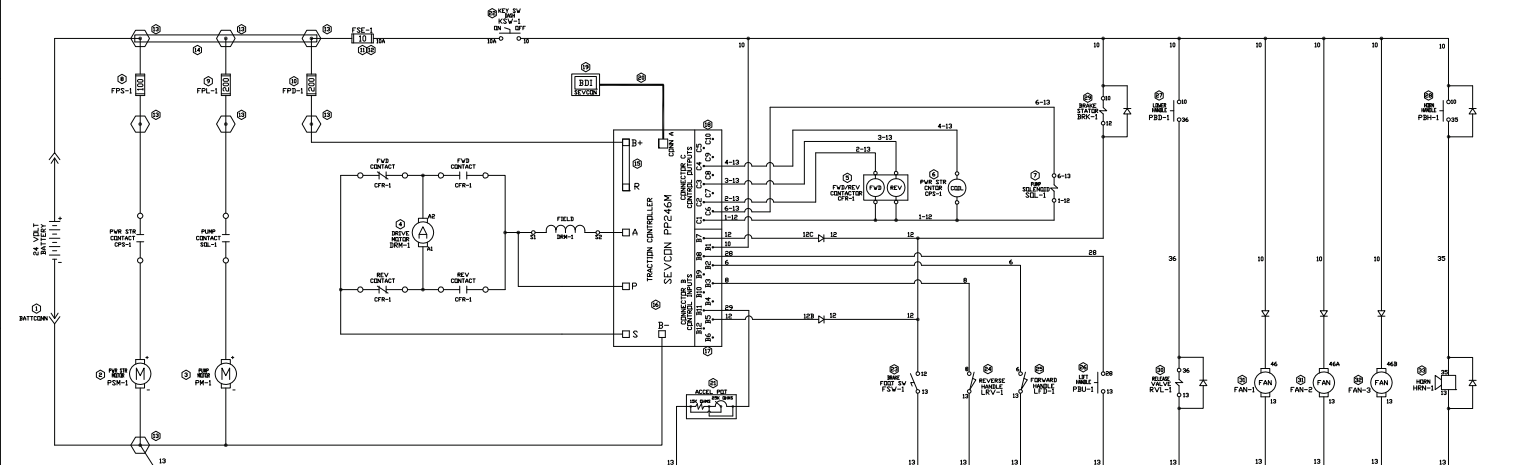
8 7 6 5 4 3 2 1

WIRE GAGE SIZE (MINIMUM)
FOR R-13804

PRIMARY SIDE
BATT CONN TO STANDOFF 1/8 AWG
POWER STEERING 2 AWG
LIFT CIRCUIT 1 AWG
DRIVE CIRCUIT 1 AWG

SECONDARY SIDE
SECONDARY FUSE TO KEYSWITCH 18 AWG
KEYSWITCH TO TERMINAL BLOCK 18 AWG
GROUND TO TERMINAL BLOCK 18 AWG
TERMINAL BLOCK TO COMPONENTS 20 AWG

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1	41050541 WAS 41050538 (OBSOLETE)	10/23/2009	PSS



THERMAL SAFETY,
POSITION BLOWER FAN
TOWARD DRIVE MOTOR

BILL OF MATERIAL			
ITEM NO	QTY	PART NO	DESCRIPTION
1	1	41050304	CONNECTOR, BATTERY (33-350 GREY)
2	1	41050102	MOTOR, PWR STR (05000254)
3	1	41050108	MOTOR, PWR STR (05000254)
4	1	11000131	CONTACTOR, FWD/REV (300A - 24V)
5	1	11000132	CONTACTOR, PWR STR (300A - 24V)
6	1	41050102	FUSE, PRIMARY P/S (100A)
7	1	41050108	FUSE, PRIMARY LIFT (200A)
8	1	41050108	FUSE, PRIMARY DRIVE (200A)
9	1	41050405	FUSE, SECONDARY (10A)
10	1	41050414	FUSE HOLDER
11	7	41050157	STANDOFF, SMALL
12	1	11980210	BUSS BAR (3 HOLE)
13	1	11980220	BUSS BAR (FOR SEVCN 11980208)
14	1	11980208	CONTROLLER, SEVCN (PP246M)
15	1	11980221	HARNES, CTRL INPUT (SEVCN PP)

18	1	11980222	HARNES, CTRL OUTPUT (SEVCN PP)
19	1	11980182	BDI/HOURMETER (SEVCN)
20	1	11980219	HARNES, BDI (SEVCN PP246M)
21	1	41050398	ACCELERATOR, PGT W/RES (41050238)
22	1	41050132	KEYSWITCH
23	1	41050132	FOOT SWITCH, BRAKE
24	1	41050132	LIMIT SWITCH, REVERSE (41010005)
25	1	41050132	LIMIT SWITCH, FORWARD (41010005)
26	1	41050132	PUSHBUTTON, LIFT (41010001)
27	1	41050132	PUSHBUTTON, LOWER (41010002)
28	1	41050132	PUSHBUTTON, HORN (41010003)
29	1	41050132	STATOR, BRAKE (15109926)
30	1	41050132	VALVE, RELEASE (33003017)
31	2	41050541	FAN ASSY (24V)
32	1	41050273	FAN (24V)
33	1	41050122	HORN (24 VOLT)
34	1	EL95	TERMINAL BLOCK (15 POSITIONS)
35	1	99130050	MOUNTING PL., ELECTRICAL
36	9	41050166	DIODE

MODEL: R-L-PRH-R-120 BASE DWG: ELBASE108-01

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE GIVEN IN INCHES

DISTANCE TOLERANCES: .015" ANGULAR TOLERANCE: .1°

FRACTIONAL TOLERANCE: 1/16"

THIRD ANGLE PROJECTION

THIS DRAWING CONTAINS PROPRIETARY INFORMATION. THIS INFORMATION IS TO BE KEPT CONFIDENTIAL AND NOT REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

ELI

TITLE: ELECTRICAL SCHEMATIC

SIZE: D PROCESS: ASSY DWG NO: EL13804

SCALE: NTS DRAWN BY: PSS DATE: 07/06/09 SHEET: 1 OF 1

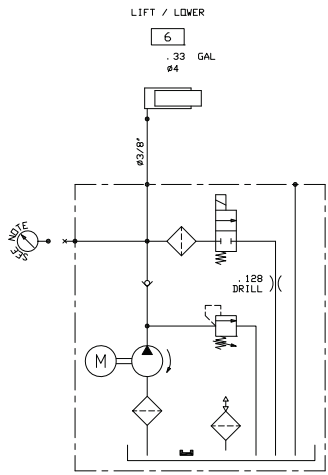
8 7 6 5 4 3 2 1

TRUCK MODEL: R-LPRH-R-120
 EST. LIFT PRESSURE: 1,719 PSI
 EST. LIFT SPEED: 3.8 FPM
 EST. TIME TO LIFT: 8 SEC.
 EST. LIFT MOTOR AMPS: 133 AMPS

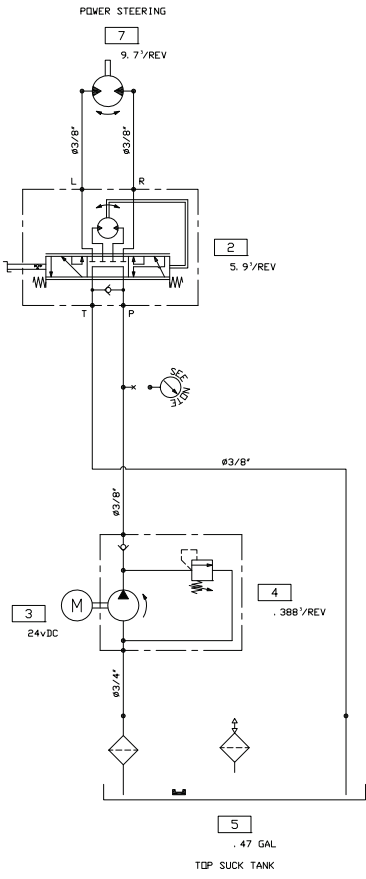
NOTE: ALL HYDRAULIC LINE SIZES SHOWN ARE TO BE CONSIDERED MINIMUM. ENGINEERING MUST BE CONTACTED PRIOR TO USING LINE SIZES SMALLER THAN THOSE SPECIFIED.
 THE GRAPHIC SYMBOLS CONTAINED IN THIS DOCUMENT ARE THE APPROXIMATE EQUIVALENT TO THOSE ESTABLISHED BY ISO 1219.

8 7 6 5 4 3 2 1

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED



1
 MOTOR=24VDC
 TANK =1.2 GAL
 PUMP = 129/REV



4
 .388/REV
 5
 .47 GAL
 TOP SUCK TANK

PORT PROVIDED FOR USE OF PRESSURE GAUGE (PRESSURE GAUGE NOT SUPPLIED)

BILL OF MATERIAL			
ITEM NO	QTY	PART NO	DESCRIPTION
1	1		PUMP & MOTOR ASSY (33240034)
2	1		STEERING SELECTOR (33002771)
3	1		MOTOR, ELC (05000233)
4	1		PUMP (33002992)
5	1		TANK (33101101)
6	1		RAM (33002201)
7	1		MOTOR, HYDR (33002073)

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE GIVEN IN INCHES.

DISTANCE TOLERANCES: .5 .1
 .XX .5 .04"
 .100 ± .010"

ANGULAR TOLERANCE: .1°
 FRACTIONAL TOLERANCE: 1/16"

THIRD ANGLE PROJECTION

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RUD

TITLE: HYDR DIAGRAM

SIZE: D
 PROCESS: ASSY
 SCALE: NTS

DWG NO: HY13804
 DRAWN BY: A-JH
 DATE: 7/9/09
 SHEET: 1 of 1

8 7 6 5 4 3 2 1

BASE DWG: HYBASE103-00



Recommended Spare Parts List

MODEL: R-LPRH-R-120

SERIAL NUMBER: R-13804-05

PART NUMBER	DESCRIPTION	QTY
66001654	Drive Tire	1
66001638	Load Wheel	4
26030010	Bearing, Load Wheel	8
05002180	Brush Set, Traction Motor	1
05002185	Springs, Traction Motor	8
05003017	Brush Set, (P/S)	1
05003257	Spring Set, (P/S)	1
05002154	Brush Set, Lift Pump Motor	1
41010001	Push Button, Lift	1
41010002	Push Button, Lower	1
41010003	Push Button, Horn	1
41010005	Switch, Small Micro	1
15100113	Brake Rotor	1
41050132	Brake Switch	1
41050238	Potentiometer	1
41050102	Fuse, P/S	1
41050108	Fuse, Lift	1
41050108	Fuse, Drive	1
41050405	Fuse, Secondary	1
41050414	Fuse, Holder	1
11980208	Controller	1
11980203	Calibrator	1
11000209	Contactactor Tip Kit (F/R)	1
11000211	Contactactor Tip Kit (P/S)	1
99100202	Toggle	2

91380420	Tie Bar	2
99100063	Adjustable Tie Bar Block Assy	2
99100058	Wing Plate	2
99100203	Shackle	2
33000884	Seal Kit, Lift Cylinder	1
41050398	Keyswitch	1
41010008	Solenoid, 24v	1
99100060	Articulator	2
41050273	Fan	2
15100568	Brake Stator	1
41050298	Fan	2