For use in service manual
form SB4039E

SB4041E00
Sep. 2000

SERVICE MANUAL CONTENTS

NOTICE

This form lists the contents of the complete Service Manual for this product.
The items listed with form numbers are available and included in the manual.
If form numbers listed with mark(*) are, they are not available for the initial release of the manual. When items are updated, or supplements added, they will be announced in preview and should be ordered as they become available.

⚠ WARNING

SAFETY

⚠ WARNING

The proper and safe lubrication and maintenance for this machine, recommended by DAEWOO, are outlined in the OPERATION & MAINTENANCE GUIDE for this machine.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the OPERATION & MAINTENANCE GUIDE before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this machine. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the machine components, the serviceman or mechanic should check the weights noted in this Manual, Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all Warning plates and decals on the machine before operating, lubricating or repairing the product.

2. Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when pounding on any part of the machine or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.

3. Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the machine before performing any disassembly.

4. Lower the forks or other implements to the ground before performing any work on the machine. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.

⚠ WARNING

Do not operate this machine unless you have read and understand the instructions in the OPERATOR'S GUIDE. Improper machine operation is dangerous and could result in injury or death.

5. Use steps and grab handles (if applicable) when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face machine when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.

6. To avoid back injury, use a hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.

7. To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments.

8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely.

9. Be careful when removing filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot.

10. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.

11. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary. Do not mix metric fasteners with standard nuts and bolts.

12. If possible, make all repairs with the machine parked on a level, hard surface. Block machine so it does not roll while working on or under machine.

⚠ WARNING

13. Disconnect battery and discharge any capacitors (electric trucks) before starting to work on machine. Hang "Do Not Operate" tag in the Operator's Compartment.

14. Repairs, which require welding, should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.

15. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.

16. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.

17. Always support the mast and carriage to keep carriage or attachments raised when maintenance or repair work is performed, which requires the mast in the raised position.

18. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.

19. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure must be installed correctly.

20. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.

21. Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.

22. On LP equipped lift trucks, be sure to close the valve on the LP tank before service work is performed. Always close the valve on the LP tank when the lift truck is being stored. Do not check for LP leaks with an open flame.

23. Caution should be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components in **DAEWOO** products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust which contains asbestos is not generated.

If dust which may contain asbestos is present, there are several common sense guidelines that should be followed.

a. Never use compressed air for cleaning.

b. Avoid brushing or grinding of asbestos containing materials.

c. For clean up, use wet methods or a vacuum equipped with a high efficiency particulate air (HEPA) filter.

d. Use exhaust ventilation on permanent machining jobs.

e. Wear an approved respirator if there is no other way to control the dust.

f. Comply with applicable rules and regulations for the work place (for example in the U.S.A., OSHA requirements as set forth in 29 CFR 1910. 1001).

g. Follow environmental rules and regulations for disposal of asbestos.

h. Avoid areas where asbestos particles may be in the air.

SB2004E00
Dec.1998

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

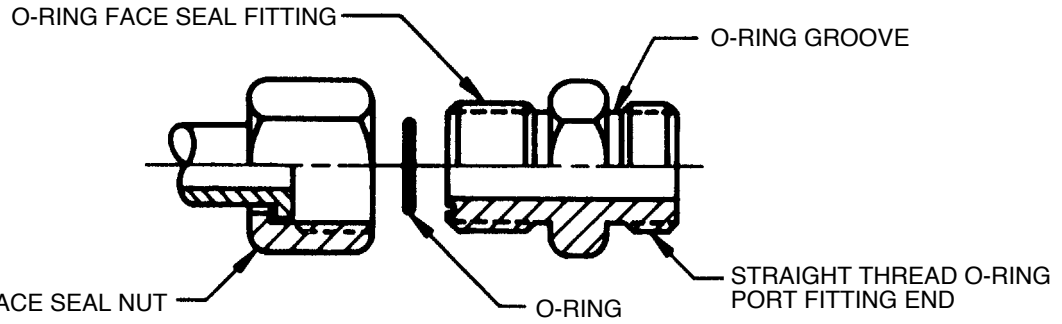
STANDARD TORQUE FOR INCH FASTENERS

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



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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.

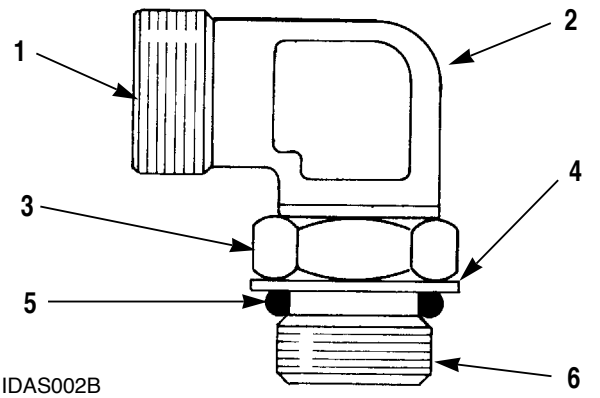
8. Look at the hose during movement of the implement. Make sure hose is not in contact with the machine or other hoses.

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.



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ELBOW BODY ASSEMBLY

(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.

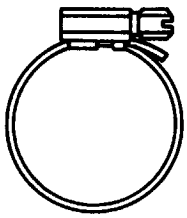
2. To put the fitting assembly in its correct position, turn the fitting body (2) out (counterclockwise) a maximum of 359°. Tighten locknut (3) to the torque shown in the correct chart for the fitting used.

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



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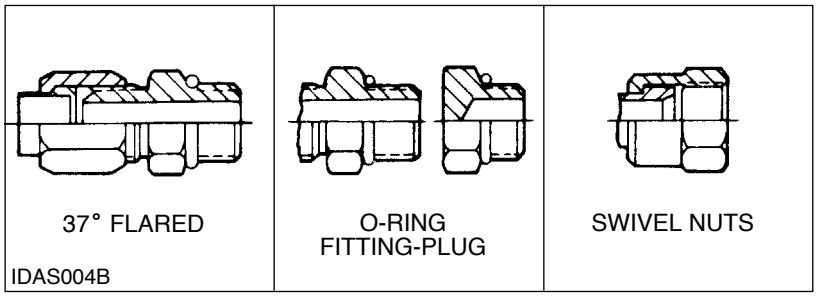
CLAMP WIDTH	TORQUE ON NEW HOSE	RETIGHTENING TORQUE
7.9 mm (.312 in)	0.9 ± 0.2 N • m 8 ± 2 lb • in	0.7 ± 0.2 N • m 6 ± 2 lb • in
13.5 mm (.531 in)	4.5 ± 0.5 N • m 40 ± 5 lb • in	3.0 ± 0.5 N • m 25 ± 5 lb • in
15.9 mm (.625 in)	7.5 ± 0.5 N • m 65 ± 5 lb • in	4.5 ± 0.5 N • m 40 ± 5 lb • in

37° FLARED AND STRAIGHT THREAD O-RING FITTINGS

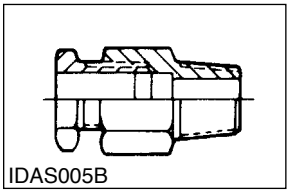


37° FLARED AND STRAIGHT THREAD O-RING FITTINGS (EXCEPT O-RING FACE SEAL FITTINGS)				
NOMINAL TUBE O.D.		THREAD SIZE inch	STANDARD TORQUE	
METRIC	INCH		(N • m)	(lb • ft)
3.18	.125	5/16	5.0 ± 1.5	4 ± 1
4.76	.188	3/8	11.0 ± 1.5	8 ± 1
6.35	.250	7/16	16 ± 2	12 ± 1
7.94	.312	1/2	20 ± 5	15 ± 4
9.52	.375	9/16	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

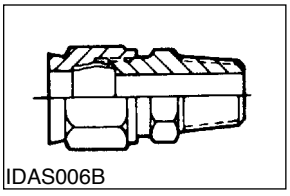
Hi Duty (Shear sleeve) Tube Fittings

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.


IDAS005B

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.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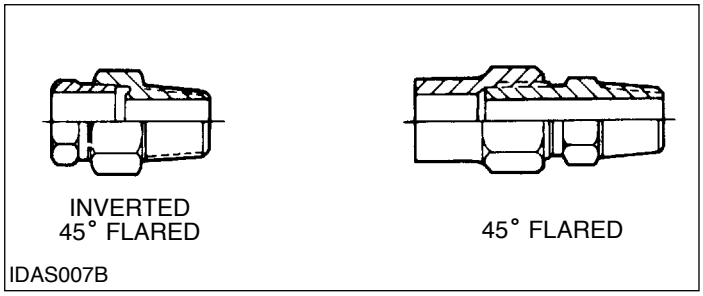
45° FLARED AND 45° INVERTED FLARE FITTINGS

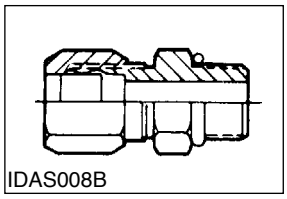


45° FLARED AND 45° INVERTED FLARE FITTINGS				
NOMINAL TUBE O.D.		THREAD SIZE inch	STANDARD TORQUE	
METRIC	INCH		(N • m)	(lb • ft)
3.18	.125	5/16	5.0 ± 1.5	4 ± 1
4.76	.188	3/8	8.0 ± 1.5	6 ± 1
6.35	.250	7/16	11 ± 2	8 ± 1
7.94	.312	1/2	17 ± 3	13 ± 2
9.52	.375	5/8	30 ± 3	22 ± 2
11.11	.438	11/16	30 ± 3	22 ± 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

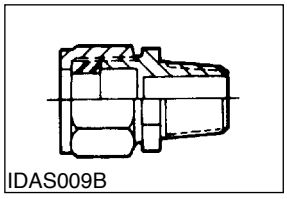
Ermeto Tube Fittings

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

IDAS010B

AIR CONDITIONING FITTINGS						
O-RING FITTING END			45° FLARE FITTING END			
THREAD SIZE inch	STANDARD TORQUE		STEEL TUBES STANDARD TORQUE		ALUMINUM TUBES 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

SB4040E00
Sep. 2000

Specifications
Systems Operation
Testing & Adjusting

MicroController Control Systems

Models : B16X, B18X, B20X

(48V P/N A244200)

for Electric Lift Trucks

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skill and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operater or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows :

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

DAEWOO cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this pulication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by DAEWOO is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. DAEWOO dealers have the most current information available.

Index

Specifications

Systems Operation

Testing And Adjusting

Specifications

Component Measurements

Component	Meter Scale	Meter Positive (+) Test Lead	Meter Negative (-) Test Lead	Desired Indication
DIODES (voltage indication)				
All	Diode	Anode	Cathode	0.3 to 0.9 volts
All	Diode	Cathode	Anode	OL
RESISTORS (resistance indication) Panels with D557003(927566) Transistor & D557065 Transistor				
DRI, DR2, PR1	200Ω			90 ohms ± 5%
R2, R5, R8	200Ω			7.5 ohms ± 5%
HEAD CAPACITOR (resistance indication)				
Head capacitor	200Ω	Positive side of capactior (+)	Negative side of capactior (-)	0 then change to above 10K ohms
CONTACTOR COILS (resistance indication)				
Direcitional	200Ω	X	Y	40 to 50 ohms
Line	200Ω	X	Y	95 to 115 ohms
Bypass	200Ω	X	Y	60 to 95 ohms

Current Measurements

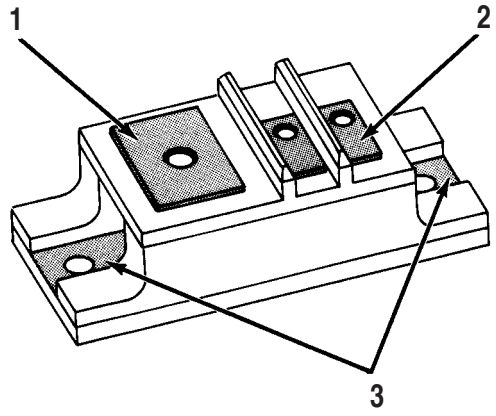
CURRENT VALUES (AMPS)		
Transistor	**Current Limit**	**Plugging Limit**
D557003 (927566)	270 ± 10A	250 ± 10A

Transistor Measurements

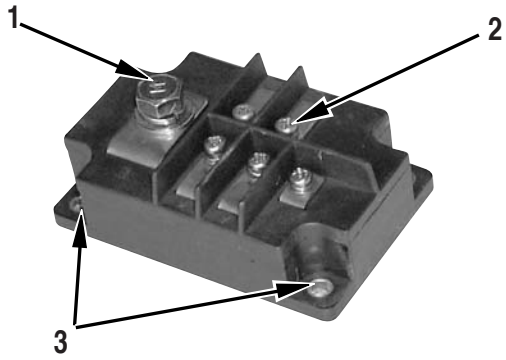
SPECIFICATIONS			
Multimeter Setting	**(+) Test Lead**	**(-) Test Lead**	**D557003 (927566) Results**
Resistance	Emitter	Base	45 to 135 ohms
Diode	Base	Collector	.3 to .9V
Diode	Collector	Base	OL
Diode	Emitter	Collector	.3 to .9V
Diode	Collector	Emitter	OL

Transistor Connections

D557003 (927566) - for Drive



D557065 - for Hydraulic

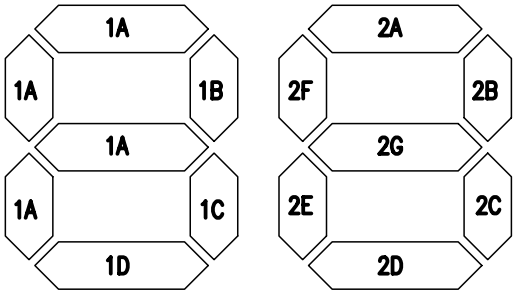


(1) Emitter connection

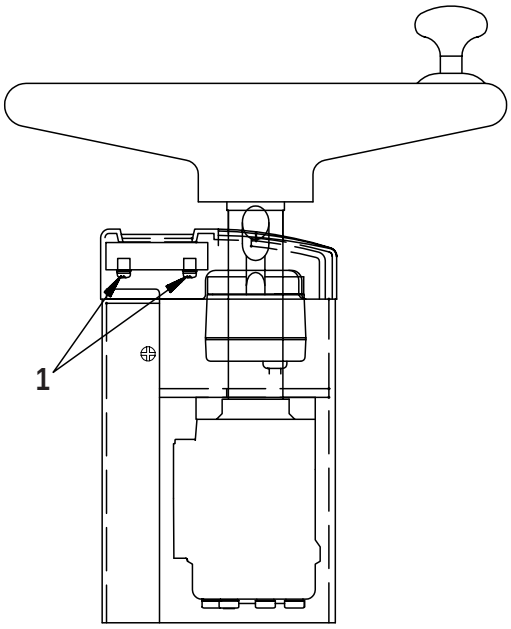
(2) Base connection

(3) Collector connection

Display Layout

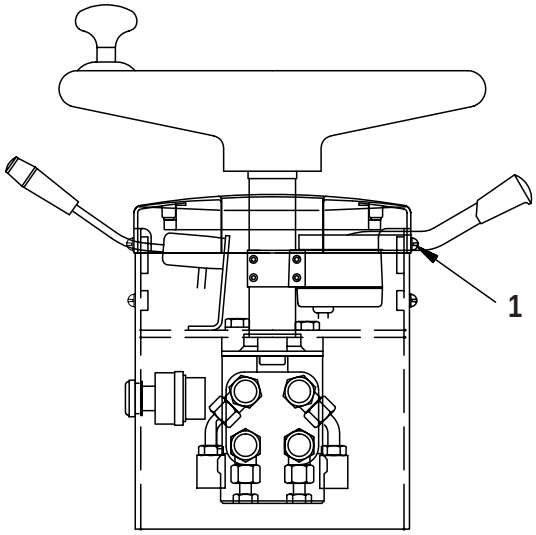


Instrument Panel



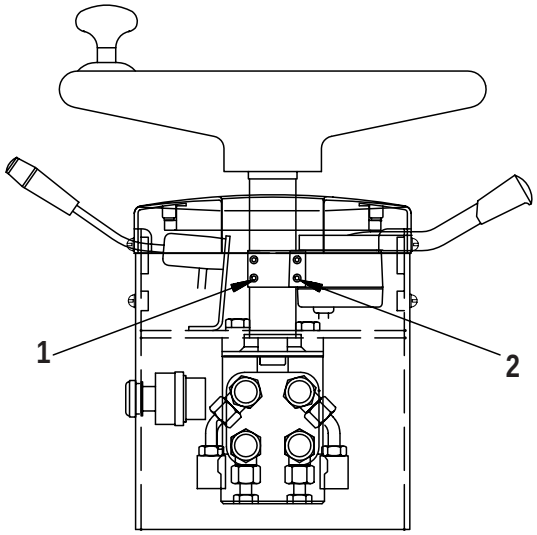
(1) Tighten screws that fasten the instrument panel to a torque of .....0.5 to 0.7 N•m (4 to 6 lb•in)

Console



(1) Tighten bolts that fasten the cover to a torque of .....1.5 to 2.5 N•m (13 to 22 lb•in)

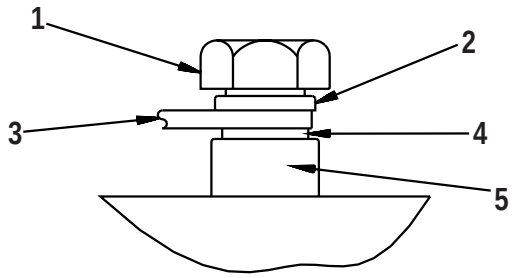
Direction Switch



(1) Torque bolts that hold bracket to steering column to .....2.8 to 3.4 N•m (25 to 31 lb•in)

(2) Torque bolts that hold bracket to switch to .....143.4 to 3.9 N•m (31 to 35 lb•in)

Head Capacitor



NOTE : Proper torque and assembly of capacitor hardware is critical. Avoid disassembly unless capacitor has to be replaced.

(1) Tighten capacitor terminal bolt to a torque of .....4.5 to 5.5 N•m (40 to 50 lb•in)

(2) Spring washer D917069.

(3) Ring terminal of wire assembly.

(4) Lockwasher D917071.

(5) Head capacitor terminal.

Thermal Switch - Control Panel

Contacts open at .....81 to 89°C (178 to 192˚F)
Contacts close at.....69 to 77°C (156 to 171˚F)

Contactors

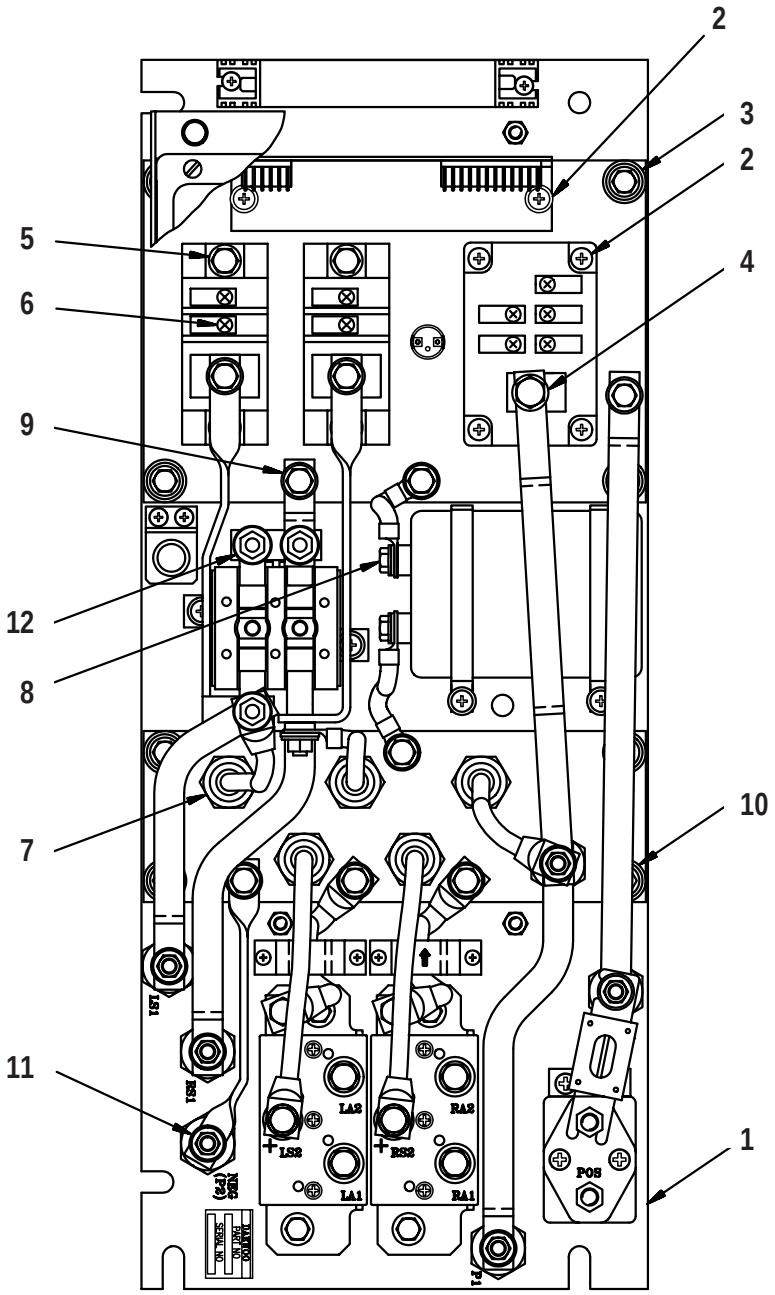
Torque for nuts that hold contactor bridge assembly .....2.2 N•m (20 lb•in)

Fuses

Line 600A
Key 10A
Horn..... 10A
Voltage Converter..... 10A
Light..... 10A
Back up 10A

Control Panel (Layout)

Control Panel - Drive



NOTE : Apply a small amount of D557047 Thermal Joint Compound on the surface of the transistor, diode or thermal switch that contacts the heatsink.

(1) Control panel plate. Apply a small amount of D557047 Thermal Joint Compound on control panel plate and mating surface prior to assembly.

(2) Apply Sealant (Loctite catalogue No. and name- No. 242, Adhesive/Sealant) on the threads of all screws that are used to fasten components on the control panel.

(3) Apply Sealant (Loctite catalogue No. and name- No. 242, Adhesive/Sealant) to the bolts used to tighten the positive heatsink to the control panel to a torque of .....10 to 14 N•m (90 to 125 lb•in)

(4) Use a backup wrench to hold nuts and tighten bolts the fasten bus bars to the power transistors to a torque of .....4 to 6 N•m (35 to 55 lb•in)

(5) Tighten screws that fasten power transistors to positive heatsink to a torque of .....4 to 6 N•m (35 to 55 lb•in)

(6) Tighten screws that fasten wires to the base of the power transistors to a torque of .....1.3 to 1.7 N•m (11.5 to 15 lb•in)

(7) Tighten diodes DD1, DD2, DD3, DD4 and PD to a torque of .....9 to 11 N•m (81 to 99 lb•in)

(8) Tighten Head Capacitor terminal bolts to a torque of .....4.5 to 5.5 N•m (40 to 50 lb•in)

(9) Tighten all bolts that fasten bus bars of cables to either heatsink to a torque of .....5.5 to 9.5 N•m (50 to 85 lb•in)

(10) Tighten bolts that hold the negative heatsink to the control panel to a torque of .....10 to 14 N•m (90 to 125 lb•in)

(11) Apply Sealant (Loctite catalogue No. and name- No. 242, Adhesive/Sealant) on portion of setscrew threads that are in the insulator and control panel plate. Tighten bolts to a torque of .....5.5 to 9.5 N•m (50 to 85 lb•in)

(12) Use a backup wrench to hold bolts and tighten the nuts that fasten the cables or bus bars to the contactors to a torque of .....4 to 6 N•m (35 to 55 lb•in)

Systems Operation

Glossary

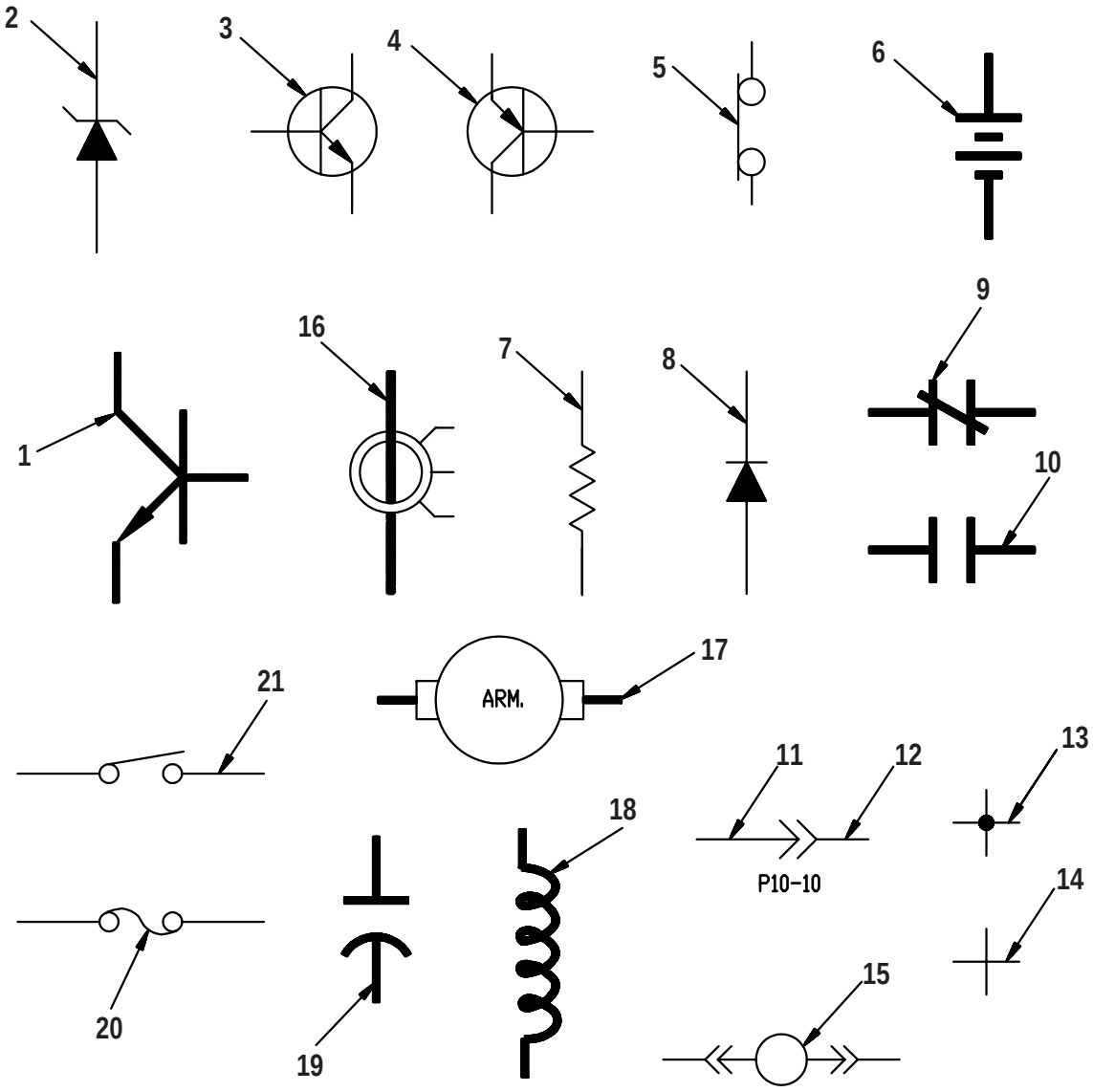
NAME	DESCRIPTION
Accelerator	A device that converts mechanical movement into a analog voltage pattern to the logics for variable drive motor speed.
Activate	Word used with a component or circuit. To change from the normal condition to the “activated” condition because of an application of force or electricity.
Ammeter	An electric meter used to measure current flow in amperes.
Ampere (or Amp)	The unit of measurement of current flow. The amount of current that one volt can push through a resistance of one ohm.
Analog to Digital Converter	A device that converts an analog voltage into a pattern of digital HIGH and LOW voltage signals.
Anode	The positive (+) side of a diode.
Armature	The rotating portion of an electric motor or generator.
Base	The terminal of a transistor through which control current flows (see Transistor).
Battery	Two or more cells connected together for a supply of electric current.
BDI	Battery Discharge Indicator - An electrically controlled display showing the operator the state of battery charge.
Brush	A conductor, normally a block of carbon, that makes sliding contact between the stationary and moving part of the motor or generator.
Bus Bar	A heavy electrical conductor to which other smaller wires are connected.
Capacitor	Device used to store electrical energy for short periods of time.
Cathode	The negative (-) side of a diode.
CVMS	Central Vehicle Monitoring System.
Circuit	A way for current to go from the positive (+) side of an electrical power source to the negative (-) side of an electrical power source. This can be through wires and electrical components.
Coil	A component made from many circles or turns of wire used to concentrate a magnetic field.
Collector	A terminal of a transistor through which main current flows (see Transistor).
Commutator	An armature component used to transfer current from the brushes to the armature windings.
Conduct	To allow the flow of current.
Conductor	A material that provides a path for current flow.
Connector	Part of a wire assembly or harness that connects with another wire assembly or harness. Used for ease of assembly and disassembly.

NAME	DESCRIPTION
Contactor Assembly	An electrical component consisting of an electromagnetic coil and a set of heavy contact tips. Control current passes through the coil, building a magnetic field which closes or opens the contact tips.
Contactor Coil	An electromagnet used to close or open contact tips in a contactor assembly.
Contact Tips or Contacts	The portion of a switch, relay or contactor where the circuit can be opened or closed.
Continuity	Having the ability to allow current flow.
Control Circuits	The wires and components carrying low current used to signal the logic unit, turn on main components, or support auxiliary circuits (indicated by narrow lines on a schmatic).
Counter Electromotive Force (CEMF)	An opposing voltage set up by a collapsing or increasing magnetic field within a coil.
Current	The movement or flow of electricity through a conductor. A circuit must be complete for current to flow.
Current Limit	The maximum allowable armature current of a stalled drive motor during pulsing.
Current Sensor	A hall-effect sensor in the drive motor circuit that produces an increasing voltage output as the drive motor current increases.
Deactivate	To change from the activated condition back to the normal (deactivated) condition. It can be caused by the application of force, the removal of force,or the removal of electricity.
Digital Signal	A signal in which the elements may be either of two distinct values. For example high voltage, low voltage.
Diode	A semiconductor device that allows current to flow in one direction, from the anode to the cathode.
Display	An electrical device that converts voltage inputs to a visual output.
Electrical Braking	Electrically trying to rotate the drive motor opposite to the direction of truck movement.
Electromagnet	A coil of wire, most often wound on an iron core, which produces a strong magnetic field when current is sent through the coil.
Electromotive Force (EMF)	The force that causes an electric current to flow in a circuit. This force is measured in volts.
Emitter	A terminal of a transistor through which low control current and main current flow (see Transistor).
Field Windings	The stationary coils that produce a magnetic field in motors and generators.
Filter	An electrical device or component for restriction or suppression of undesired voltage spikes.
Fuse	A component in an electrical circuit that will open the circuit if too much current goes through it.
Harness	An assembly made of two or more wires that are held together.
Heatsink	A mounting frame used for semiconductor cooling.

NAME	DESCRIPTION
Hour Meter	An electrically activated device used to record the amount of usage a truck receives.
Indicator	LCD that gives an indication of some vehicle condition when it turns on or flashes.
Input	A voltage change at the incoming connection of a component.
Insulator	A material that has a very large resistance so that it will not let current flow through it.
LCD	Liquid Crystal Display.
Logics or Logic Unit	The main printed circuit board containing a microprocessor and circuits to condition the voltage signals that go into or come out of the logics. It electronically monitors and controls the truck's functions.
Magnetic Field	The area around a magnet where magnetic forces can be detected.
Microprocessor	A small computer chip preprogrammed to control the various electrical functions on a lift truck.
Normal Condition	Words used with a switch or relay. Their normal condition is their condition when they are not controlled by the application of force, temperature, pressure, or electricity.
Normally Close (N.C.)	A switch or relay whose contacts are closed in the normal condition.
Normally Open (N.O.)	A switch or relay whose contacts are opened in the normal condition.
OFF-Time	The amount of time current does not flow through a transistor.
Ohm	The unit of measurement of resistance. The amount of resistance that will let one volt push only one ampere of current through it.
ON-Time	The amount of time current flows through a transistor.
Open Circuit	Wiring or components of a circuit that have no continuity.
Output	The current flow from a component which initiated from a voltage change at the component's input.
Overload	The presence of voltage or current which is greater than an electrical circuit or component is designed to handle.
Pin	The male contact of a connector that fits into a female contact (socket) of another connector.
Plugging	A portion of electrical braking where the generated current is directed back through the armature.
Plugging Current Limit	The maximum allowable current at the drive motor armature during the plugging portion of electrical braking.
Potentiometer	An adjustable resistor to preset electronic controls for proper specifications.
Power Circuits	The main current carrying components and conductors (indicated by the heavy lines on a schematic).
Power Transistor	A component in the power circuit which allows main motor current to pass through when turned on.
Pulsing	Current flow in a circuit being turned on and off.

NAME	DESCRIPTION
Relay	An electrical component consisting of an electromagnetic coil and a set of small contact tips. Control current passes through the coil, building a magnetic field which closes or opens the contact tips. When the contact tips are closed, low current can flow in a separate isolated circuit.
Resistor	A component made of a material that has a specific resistance to the flow of current.
Schematic	A line drawing of an electrical or electronic assembly which uses symbols to show individual components. It shows how the components, wires and connectors function electrically.
Semiconductor	Components such as, transistors, diodes, thyristors, etc. Having electrical characteristics between a conductor and an insulator.
Series Wound Motor	A motor in which the armature is connected in series with the field windings.
Short Circuit	An electrical connection between two or more components that is not desired.
Socket	The female contact of a connector that slips over a male contact (pin) of another connector.
Solid State	Reference to semiconductor components or circuits that use semiconductor components that have no moving parts, such as diodes and transistors.
Switch	A component used to control an electric circuit . It can close or open a circuit.
Systems	The electrical components, circuits, and connections that deliver power to perform specific tasks.
Terminal	An electrical connection point on an electrical component.
Thermal Switch	A switch that activates at a set temperature.
Transistor	A semiconductor component used in electric lift trucks as an electronic switch. A transistor most often has three terminals, a base (B), a collector (C) and an emitter (E). The main current flow is between the collector and emitter. This main current flow is controlled by a much smaller current flow between the base and emitter.
Turn ON	When an electrical component conducts current.
Varistor	A component terminated across the horn connections to eliminate voltage spikes when the horn is activated.
Volt	The unit of measurement of electromotive force. One volt is the force needed to make one ampere of current flow through one ohm of resistance in a circuit.
Watt	The unit of measurement of power. The amount of power used when one volt pushes one ampere of current through a resistance of one ohm. The result of amperes (current) multiplied by volts (voltage) is watts (power).
Wire	A conductor used to provide a path for current to flow to and from electrical components.
Wiring Diagram	A drawing using visual representation of components the way they actually look. It is used to show the locations of components and the connections between them.
Zener Diode	A special diode used to regulate voltage or as an overvoltage (too high a voltage) protector.

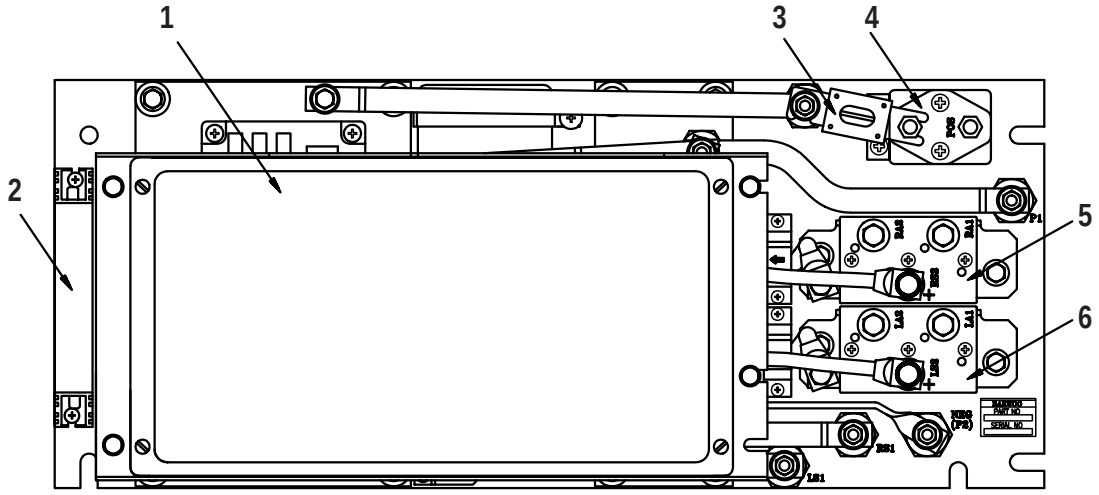
Symbol Library



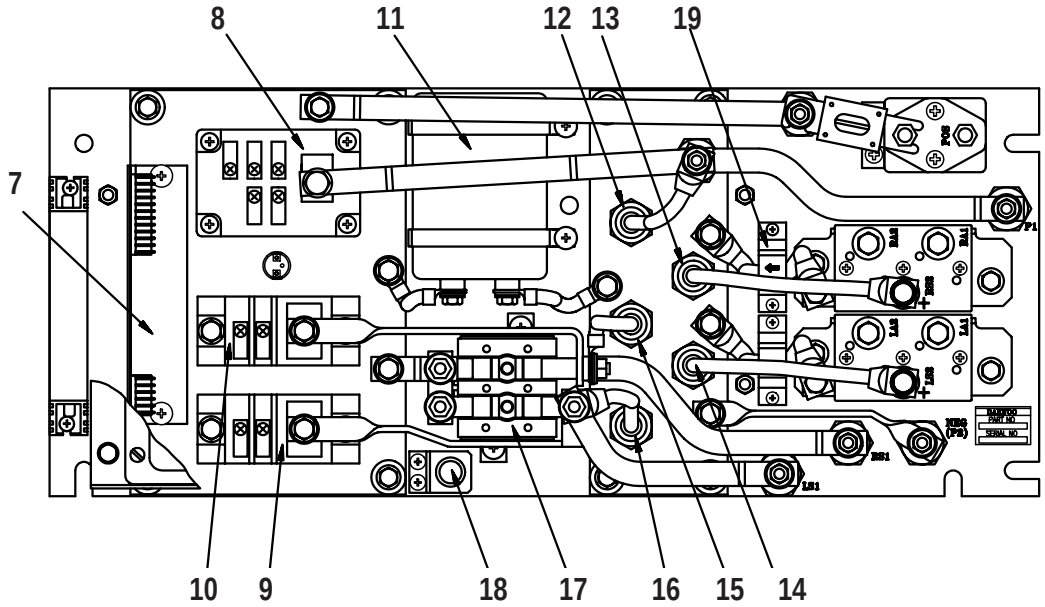
Schematic Symbols
(1) Power Transistor. (2) Zener Diode. (3) NPN Transistor. (4) PNP Transistor. (5) Thermal Switch. (6) Battery. (7) Resistor.
(8) Diode. (9) Normally Close Contacts. (10) Normally Open Contacts. (11) Male Terminal of Connector (pin).
(12) Female Terminal of Connector (socket). (13) Wire Connection. (14) No Wire Connection. (15) Contactor Coil.
(16) Current Sensor. (17) Armature. (18) Field Windings. (19) Capacitor. (20) Fuse. (21) Switch.

Location of Control Panel Components

Control Panel



Behind Logic Unit



MicroController Control Panel
(1) Logic Unit (Logics). (2) DR1, DR2, PR1. (3) Line Fuse. (4) Line Contactor. (5) Right Dir. Contactor. (6) Left Dir. Contactor.
(7) Driver Board. (8) PTR1 (Pump Transistor 1). (9) DTR1 (Drive Transistor 1). (10) DTR2 (Drive Transistor 2). (11) Head Capacitor.
(12) PD (Pump Flyback Diode). (13) DD4 (Drive Plugging Diode 4). (14) DD2 (Drive Plugging Diode 2).
(15) DD3 (Drive Flyback Diode 3). (16) DD1 (Drive Flyback Diode 1). (17) Bypass Contactor. (18) Key Fuse. (19) Current Sensors.

General Information

The MicroControl Panel is the control center and the Logic Unit (logics) is the decision making part of the MicroController System. The logics provide a self contained Battery Discharge Indicator (BDI) with lift interrupt and built-in diagnostic capabilities. The battery charge state and built-in diagnostic are monitored by the logics and displayed by the Central Vehicle Monitoring System (CVMS) located on the steer console.

NOTICE

Damage to all motors and control panels will result. The motors and control panels are 48 volt unit and must be operated at their designed voltage. The voltage can not be changed without changing motors and control panel.

The steering system is activated when the truck is powered up and the line contactor closes. The truck uses a combined power steering/hydraulic system where the hydraulic fluid for steering is provided by a DC series hydraulic motor, pump, and priority valve.

The drive motor and the hydraulic pump motor are controlled by pulsing transistors ON and OFF and controlling contactor operation.

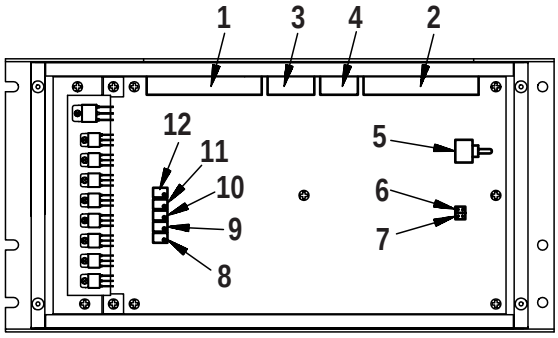
The speed and direction of the drive motor are controlled by voltage inputs to and outputs from the logics. Inputs to the logics are generated by the accelerator control and direction switch. Outputs from the logics control contactor coils and drive transistor pulsing.

The drive circuit pulses transistors to provide travel speed control up to 90% of full speed, after which the bypass contactor closes to provide full speed. The drive circuit includes a failure protection circuit which detects malfunctions of the drive power circuit, a plugging circuit to provide electrical braking and a current limit circuit to prevent excessively high currents during transistor pulsing.

The speed of the hydraulic pump motor is controlled by switch inputs to and outputs from the logics. Outputs pulses the hydraulic pump power transistor. The power transistor pulse to control the speed of the hydraulic pump motor. To provide full speed the logics turns the power transistor ON 100%. The hydraulic pump system includes a failure protection circuit to protect against malfunctions of the power circuit.

Thermal protection circuits are used on the hydraulic pump motor, the drive motor and the control panel to prevent permanent damage caused by over heating.

Logic Unit

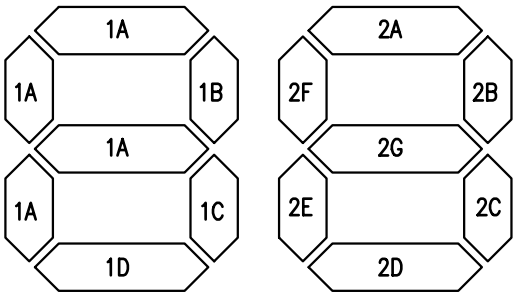


Components on Logic Unit
(1) Connector P1
(2) Connector P2
(3) Connector P9
(4) Connector P8
(5) DIAG/RUN/SETUP
(6) Jumper JP1 - 36 V
(7) Jumper JP2 - 48 V
(8) VR1 potentiometer - Drive current limit adjustment
(9) VR2 potentiometer - Plugging current limit adjustment
(10) VR5 potentiometer - BDI adjustment
(11) VR6 potentiometer - Bypass dropout adjustment
(12) VR8 potentiometer - ELEC. Brake (EAB) adjustment

Operational Circuit Elements

Central Vehicle Monitoring System

The Central Vehicle Monitoring System (CVMS) is located on the steering console.
It is a self contained, solidstate instrument panel with two seven segment liquid crystal displays, warning and system condition segments.
The LCD consists of seven segments which are turned on or off to form numbers and letters.



Seven Segment Display Layout

The Central Vehicle Monitoring System interacts with the logics and failure detection circuits.
It functions as a battery discharge indicator (BDI) and provides on-board diagnostic data on the operational condition of the truck.
During normal operation it provides “Run Time” diagnostics, and during troubleshooting it provides “Self” diagnostics.

On Board “Run Time” Diagnostics (Fault Detection)

“Run Time” diagnostics use letters and numbers on the seven segment LCD portion of the CVMS, International Pictorial Symbols and LCD to signal both improper operating sequences and truck circuit defects.

Display = “EE” Static Return to Off (SRO)

The logics has a Static Return to Off (SRO) circuit which assures that the direction switch has been returned to neutral and the accelerator returned to the full up position after the key and seat switch are closed. This safeguards against an accidental actuation of direction and speed when an operator resumes operation of an idle truck.
If SRO occurs, the direction lever can be moved to neutral and the accelerator pedal released.
The direction can now be reselected and the accelerator pedal depressed to start normal lift truck drive operation.

Display = “EE” (Flashing) Seat Circuit Problem

Anytime the battery is connected, the key is turned to ON and no one is in the seat longer than 6 seconds the letter “EE” will flash on and off.
The truck will not operate until the seat switch is closed.

Display = “E1” Drive Motor Brush Problem

The logics monitor the length of the brushes in the drive motors. As the brushes wear, a wire built into the brushes moves down and makes contact with the commutator. A wire from each motor brush set is connected to the logics. If any brushes wear down to a preset limit, an “E1” will display on the LCD.

Display = “E2” Pump Motor Brush Problem

The logics monitor the length of the brushes in the pump motor. As the brushes wear, a wire built into the brushes moves down and makes contact with the commutator. A wire from each motor brush set is connected to the logics. If any brushes wear down to a preset limit, an “E2” will display on the LCD.

Display = "EL" Battery Lock-out

When the battery is discharged, the CVMS displays "EL" and pump motor will not operate. If key switch turn off and then on, pump will operate for only 3 seconds. Drive motor speed will not exceed 70% of the max. regardless of an accelerator's output voltage.

Display = "F2" Drive System Problem (Left)

The logics at P9-5 uses wire #L64 from the emitter of the left drive transistor to detect if the left drive transistor, bypass contactor tips or the driver board are shorted. In normal operation P9-5 has battery voltage only when the logics is pulsing the left drive transistor or the bypass contactor is activated. When a failure occurs the line contactor will be deactivated and an "F2" will display on the LCD.

Display = "F2" (Flashing) Drive System Problem (Right)

The logics at P9-6 uses wire #R64 from the emitter of the right drive transistor to detect if the right drive transistor, bypass contactor tips or the driver board are shorted. In normal operation P9-6 has battery voltage only when the logics is pulsing the right drive transistor or the bypass contactor is activated. When a failure occurs the line contactor will be deactivated and an "F2" will flash on the LCD.

Display = "F3" Pump System Problem

The logics at P9-7 uses wire #74 from the emitter of the pump transistor to detect if the pump transistor or the driver board are shorted.
In normal operation P9-7 has battery voltage only when the logics is pulsing the pump transistor is activated. When a failure occurs the line contactor will be deactivated and an "F3" will display on the LCD.

Display = "F4" Drive and Pump System Problem

The logics will release the line contactor and display "F4" on the LCD when BOTH wires #64 and #74 detect battery voltage when it should not be present. See "F2", "F2" (Flashing) and "F3".

Display = "F5" Drive System Problem (Left)

The logics at P9-5 uses wire #L64 from the emitter of the left drive transistor to detect battery negative. The logics sends a test pulse out to the left drive transistor when power up. This test pulse is detected at P9-5 also. If battery negative is present or the test pulse is not detected, the line contactor will be deactivated and an "F5" will display on the LCD.

Display = "F5" (Flashing) Drive System Problem (Right)

The logics at P9-6 uses wire #R64 from the emitter of the right drive transistor to detect battery negative. The logics sends a test pulse out to the right drive transistor when power up. This test pulse is detected at P9-6 also. If battery negative is present or the test pulse is not detected, the line contactor will be deactivated and an "F5" will flash on the LCD.

Display = "F6" Pump System Problem

The logics at P9-7 uses wire #74 from the emitter of the pump transistor to detect battery negative.
The logics sends a test pulse out to the pump transistor when power up. This test pulse is detected at P9-7 also. If battery negative is present or the test pulse is not detected the line contactor will be deactivated and an "F6" will display on the LCD.

Display = "F7" Drive and Pump System Problem

The logics will release the line contactor and display "F7" on the LCD when BOTH wires #64 and #74 detect battery negative or do not detect the proper pulsing.
See "F5", "F5" (Flashing) and "F6".

Display = "FA" Angle Circuit Problem

Steer angle commands are monitored by the logics. If steer angle switch has defects or each wires #50, 51, 52 and 53 is shorted/opened, the line contactor will be deactivated and an "FA" will display on the LCD.

Display = “Fb” Battery Mismatch

The motors and control panels are 48 volt units and must be operated at 48 volt. If battery condition is abnormal, an “Fb” will display on the LCD.

Display = “Fd” Pressure Switch Problem

The logics at P 2-1 uses wire ££41 from the pressure switch to detect if the pressure switch is opened for more than 10 seconds after the key switch ON. The “Fd” will be displayed and the truck will be operated normally.

Central Vehicle Monitoring System (CVMS) International Pictorial Symbols

Park Brake Symbol

Park Brake Symbol

If the park brake is applied, the park brake symbol will turn on to warn the operator that the brake is applied, and drive operation will be prevented.

Overtemperature Symbol

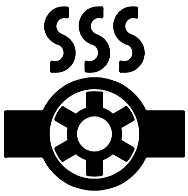
Normally closed thermal switches are constantly monitored by the logics and the CVMS. All these thermal switches are normally closed, so must open for the LCD to turn on. Truck performance will automatically be cut back by the logics, and the CVMS will light the LCD until the component cools.

Control Panel Overtemperature Symbol

Control Panel Overtemperature Symbol

Two thermal switches (HYD and MAIN control panels) are connected in series to the logics. If any of the control panels overheat, the thermal switch in the center of the positive heatsink will open. The logics will slow lifting speeds and reduce drive speed. Truck acceleration will decrease.
The overtemperature symbol and “Ec” will display on until the controller cools. “Ec” will be saved as stored error code.

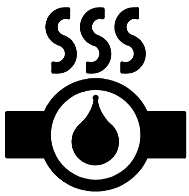
Drive Motor Overtemperature Symbol



Drive Motor Overtemperature Symbol

The drive motor thermal switch, held against the drive motor field, will open if the motor gets too hot. The logics will reduce drive pulsing and prevent the bypass contactor from pulling in. The truck speed and acceleration will be reduced.
The overtemperature symbol and “Ed” will display on until the motor cools. “Ed” will be saved as stored error code.

Pump Motor Overtemperature Symbol



Pump Motor Overtemperature Symbol

The pump motor thermal switch, similar to the drive motor thermal switch, will open if the motor gets too hot. The logics will reduce pump motor speeds.
The overtemperature symbol and “EP” will display on until the pump motor cools. “EP” will be saved as stored error code.

Wait Mode

If the seat switch is closed, key turned to ON and the direction lever is left in neutral with no other operator requests, the line contactor will deactivate after approximately six seconds. The LCD will display “PP”. The lift truck will remain in this condition until the operator activates the direction switch, accelerator pedal or a control valve lever. The line contactor then reactivates and the truck is ready for normal operatation.

Current Sensor

The left current sensor mounts around the cable that carries left drive motor current. The logics supplies a constant voltage to one lead of the current sensor at P1-16 wire #25 (12V). A second lead of the current sensor is connected to battery negative at the negative heatsink. When current passes through the cable, the third current sensor lead wire #L22 causes the voltage to change at logic P1-12. As the current passing through the cable increases, the voltage at logic P1-12 increases. The logics uses the voltage at P1-12 to determine the amount of current flowing through the left drive motor.

The right current sensor, similar to the left current sensor, mounts around the cable that carries right drive motor current. A third lead of the right current sensor is connected to logics at P1-13 #R22. The logics uses the voltage at P1-13 to determine the amount of current flowing through the right drive motor.

Contactors

The control panel is equipped with intermittent duty contactors. The logics controls the voltage supplied to the coils. When a contactor is first activated, full battery voltage is supplied to the coil. After the contactor tips have closed, the logics will pulse the coil to reduce the voltage across the coil to between 18 and 36 volts.

Battery Discharge Indicator (BDI)

The logics monitors the battery voltage during truck operation and shows the level of battery charge on the LCD. If the battery voltage is below 40.0V or above 60.0V, this is a battery mismatch or misconnection. If these voltages are monitored, the display will show “Fb” on the LCD and no lift truck operate.

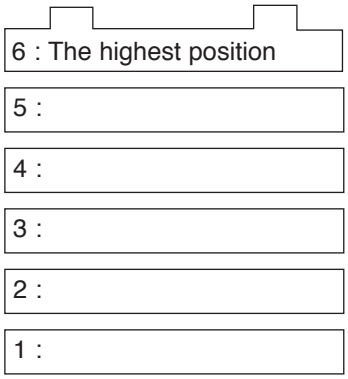
Full 6 bars on the LCD indicates a fully charged battery. As the battery discharges, the bars decreases to 5, 4 etc, down to 1st bottom bar.

When the battery nears the 80% discharge level, the 1st bar continuously flashes. This is a warning that lift interrupt is near. The operator should complete the current lift operation and travel to the battery replacement or charge area. If the truck is kept in operation, the display go to a “EL”. The lift, tilt and auxiliary functions will be vastly reduced in speed, operating only with steering flows and the vehicle travel speed will be cut in harf. At this point the battery is greater than 80**%** discharged. The logics will now remember that the battery has been discharged to lift interrupt and require a fully charged battery to reset the remembered interrupt. See Programmable Option Features “3”.

Due to different voltage characteristic of battery technologies, it may be necessary to use the battery voltage chart as shown below. You can choose a type in Programmable Option Features “10”.

Descriptions of BDI symbol on the LCD

Bar Symbols



BAR SYMBOLS DISPLAY	BATTERY TERMINAL VOLTAGE TYPE 1 (OPT) : Closed Voltage	
	36V	48V
6	above 37.2	above 49.1
5	36.8 to 37.2	48.6 to 49.1
4	36.4 to 36.7	48.0 to 48.5
3	36.0 to 36.3	47.5 to 47.9
2	35.6 to 35.9	47.0 to 47.4
1	35.2 to 35.5	46.5 to 46.9
1*	25.8 to 35.1	33.8 to 46.4
O/EL	below 25.8	below 33.8

1* = Display is flashing

BAR SYMBOLS DISPLAY	BATTERY TERMINAL VOLTAGE TYPE 2 (STD) : Closed Voltage	
	36V	48V
6	above 37.2	above 49.1
5	36.8 to 37.2	48.4 to 49.1
4	36.3 to 36.7	47.7 to 48.3
3	35.9 to 36.2	47.1 to 47.6
2	35.4 to 35.8	46.4 to 47.0
1	35.0 to 35.3	45.9 to 46.3
1*	34.5 to 34.9	45.0 to 45.8
O/EL	below 34.5	below 45.0

1* = Display is flashing

BAR SYMBOLS DISPLAY	BATTERY TERMINAL VOLTAGE TYPE 3 (OPT) : Closed Voltage	
	36V	48V
6	above 37.2	above 49.1
5	36.9 to 37.2	48.3 to 49.1
4	36.6 to 36.8	47.4 to 48.2
3	36.3 to 36.5	46.6 to 47.3
2	35.9 to 36.2	45.7 to 46.5
1	35.6 to 35.8	44.9 to 45.6
1*	35.3 to 35.5	44.0 to 44.8
O/EL	below 35.3	below 44.0

1* = Display is flashing

Accelerator Control

Accelerator Table

OUTPUT VOLTAGE	REMARKS
OVER 11.00	ACCELERATOR CIRCUIT DEFECT
9.60	BYPASS OPERATION DRIVE SPEED (100%)
	DRIVE SPEED STEP 14
9.02	DRIVE SPEED STEP 13
8.44	**DEAD ZONE I**
7.86	DRIVE SPEED STEP 12
7.28	DRIVE SPEED STEP 11
6.70	DRIVE SPEED STEP 10
6.12	DRIVE SPEED STEP 9
5.54	DRIVE SPEED STEP 8
4.96	DRIVE SPEED STEP 7
4.38	DRIVE SPEED STEP 6
3.80	DRIVE SPEED STEP 5
3.22	DRIVE SPEED STEP 4
2.64	DRIVE SPEED STEP 3
2.06	DRIVE SPEED STEP 2
1.48	DRIVE SPEED STEP 1
0.90	DRIVE SPEED STEP 0
0.00	**DEAD ZONE II**

i) DEAD ZONE I
In order to eliminate the bypass contactor chattering, the bypass contactor will be engaged if the accelerator output voltage is over than 9.6V. But the bypass contactor should be disengaged if the accelerator output is less than 9.02V.

ii) DEAD ZONE II
In order to eliminate the direction contactors chattering, the direction contactors will be engaged if the accelerator output voltage is over than 1.48V.
But the direction contactors should be disengaged if the accelerator output is less than 0.9V.

Steer Angle Control

Two drive motors are controlled independently according to steer wheel position. A direction of drive motors is determined with wheel angle as shown in the chart.

WHEEL ANGLE	P2-17	P2-18	P2-19	P2-20	ON - TIME(%)	
					LEFT	RIGHT
↑ -36°	LOW	HIGH	HIGH	LOW	0	75
-36° ~ 36°	LOW	LOW	LOW	LOW	100	100
+36° ↓	HIGH	HIGH	LOW	LOW	75	0

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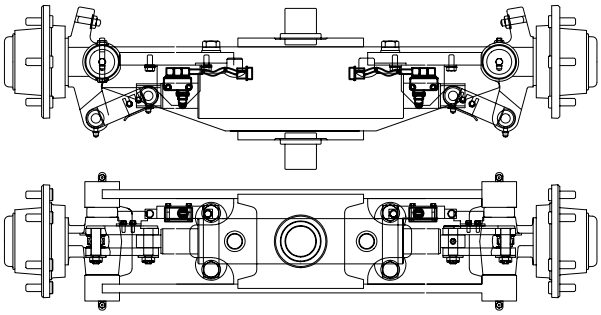


Steer Angle Switches

Accessory Circuits

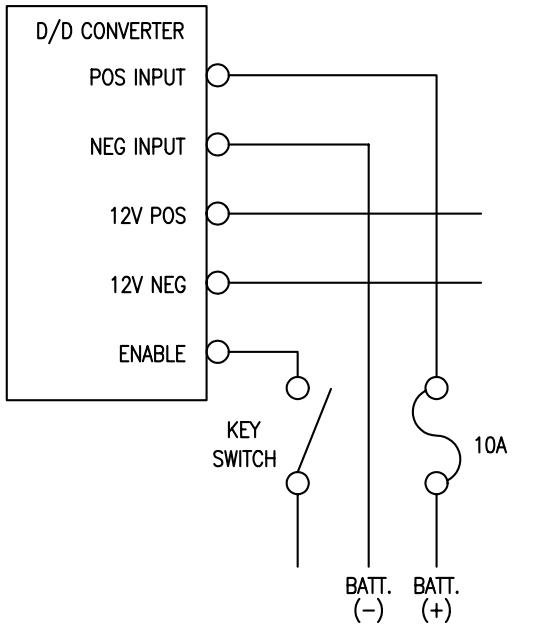
Horn Circuit

The horn will operate when the battery is connected and the horn button is pushed. Current flows from battery positive through horn fuse, horn switch and horn, back to battery negative.

Hour Meter Circuit

The hour meter, dependent on marketplace, can be wired a number of different ways. Battery voltage is always supplied from the key switch to the positive terminal of the hourmeter. The negative terminal of the hourmeter can go to seat switch to record seat switch hours, or can be wired into the drive motor armature through a diode assembly to record drive motor hours.

DC-DC Converter



DC-DC Converter Circuit System

The DC-DC converter changes the lift truck battery voltage to 12 volts. This 12 volts is used to power accessories such as floodlights, brakes/side lights and backup alarms.

The positive of the 12 volt output is common to the positive of the battery voltage. The negative of the 12 volt output is pulsed to maintain a steady 12 volt supply.

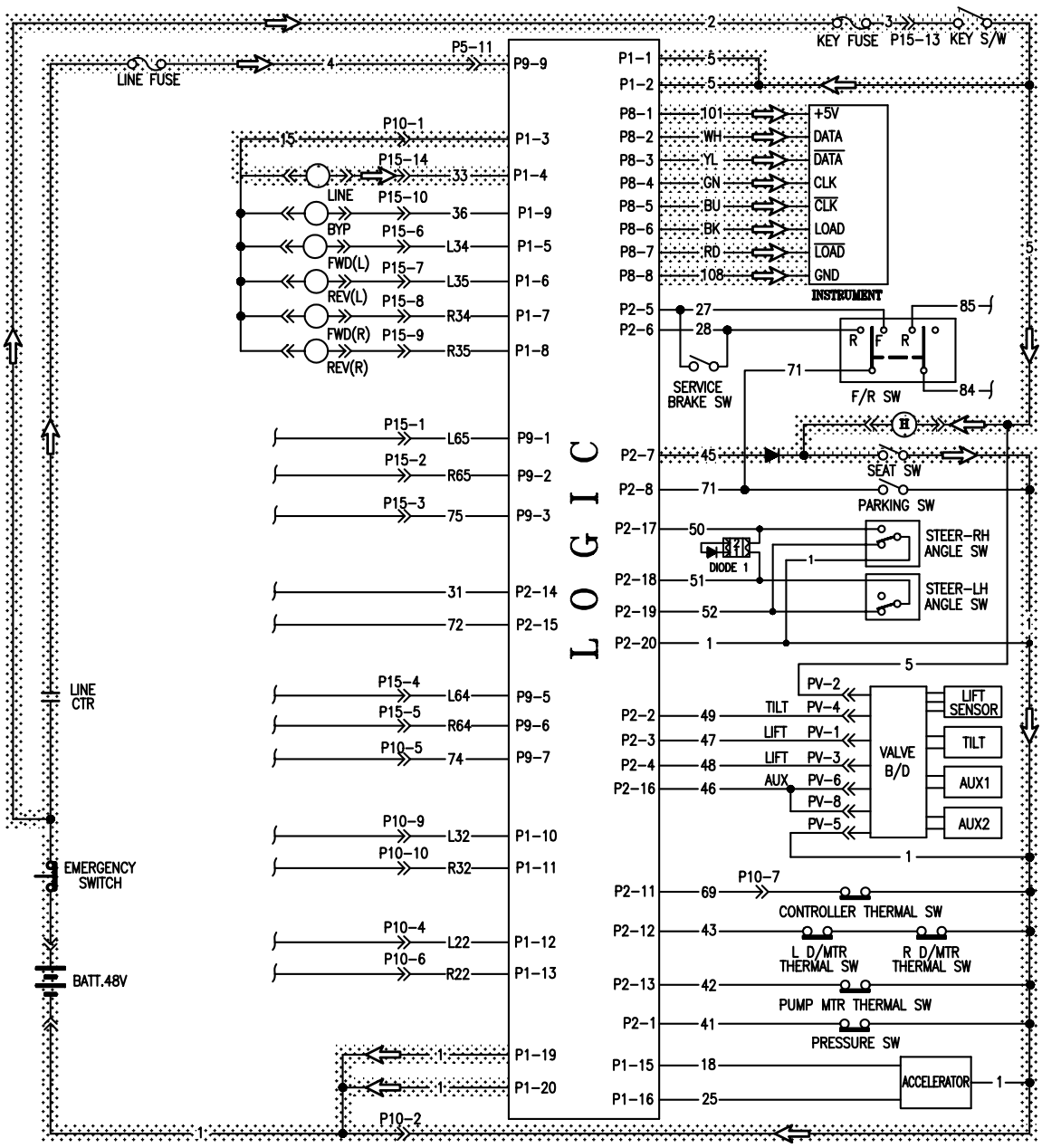
The 12 volt output of the converter is protected against short circuits and overloading by an internal 15 amp current limit circuit. A fuse on the converter protects it from reverse connection of the battery voltage.

Refer to Problem 31 in Troubleshooting section.

NOTICE

Do not connect the 12volt negative output of the DC-DC converter to battery negative. Damage to system components could occur.

Actuation Circuit



Actuation Circuit

NOTE: The circuit diagrams have shaded lines for illustration of current flow in each circuit. Other circuits can be activated at the same time, but each one is shown separately to illustrate current flow in each individual circuit.

This circuit supplies power to the MicroController Control System and the Central Vehicle Monitoring System (CVMS). It must be activated before power steering, hydraulics or drive will operate.

When the battery is connected and the key switch is closed, current flows from battery positive through the key fuse, key switch, wire #5 to the logic connector P1-1 and P1-2.

The logic connection to battery negative is at P1-19 and P1-20. The logic circuits are powered up to accept voltage inputs and create voltage outputs whenever the battery is connected and the key is turned to ON.

The Central Vehicle Monitoring System (CVMS) is also powered at this time. The CVMS first does a “LCD test” which will light all the warning lights through 6 shield wires, wire #101(5V) and wire #108 (B-) for approximately five seconds.

The logics will start to perform a set of “Run Time” diagnostic checks. The letter “EE” will flash on the CVMS display indicating the key is ON with no operator in the seat.

When the seat switch is closed, current will flow from the logic P2-7 through the seat switch to battery negative. The logics then activates the line contactor by allowing current to flow from P1-3 through the line contactor coil and P1-4 back to battery negative.

With the line contactor tips closed the logics continues its checks for any “Run Time” faults. If no faults are detected the display will indicate the battery charge level, the power steering (IDLE) system operates, the pump and drive power circuits receive battery voltage and the logics receives battery voltage on wire #4 at P9-9.

Hydraulic Pump Motor Circuit

Only one hydraulic pump motor (series winding) is used for all power steering, lift, tilt and auxiliary hydraulic functions. To activate the pump circuit, the seat switch, key switch and line contactor must be closed first as explained in the topic, Actuation Circuit.

Power Steering Circuit

The power steering (PS) circuit has two speeds (PS idle and PS boost-up) independent of the lifting speeds.

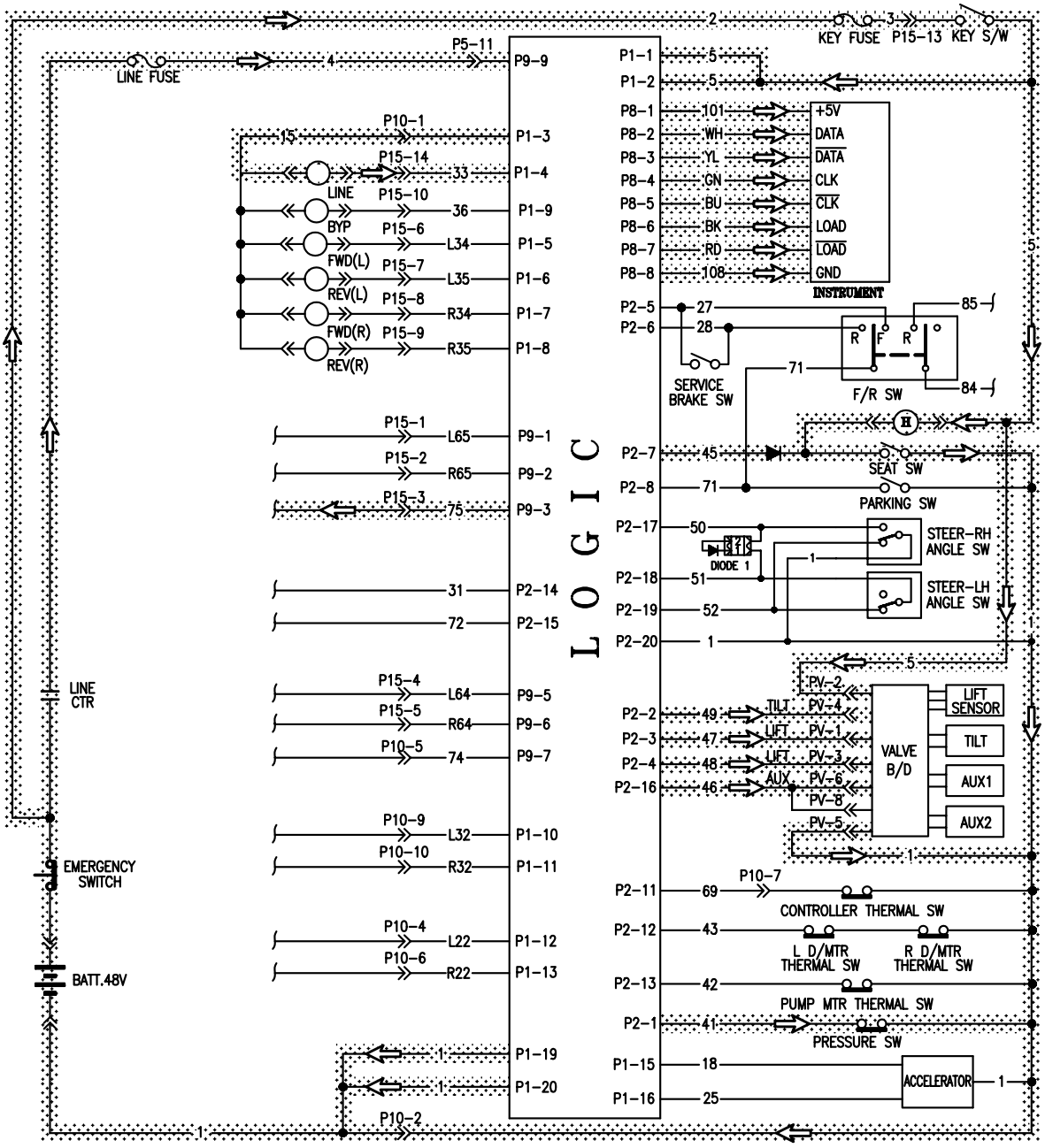
Followings are standard PTR1 pulsing rates of the signal at the logics.

Motor Speed	PTR1 Pulsing Rate	Logic Pin#
IDLE	11%	–
POWER STEERING	17%	P2-1
TILT	50%	P2-2
LIFT1	35%	P2-3 & P2-4
LIFT2	50%	
LIFT3	95%	
AUX.	45%	P2-16

The above pulsing rate can be adjustable in “Programmable Option Features”.

NOTE: The circuit diagrams have shaded lines for illustration of current flow in each circuit. Other circuits can be activated at the same time, but each one is shown separately to illustrate current flow in each individual circuit.

Lift Circuit



Lift Circuit

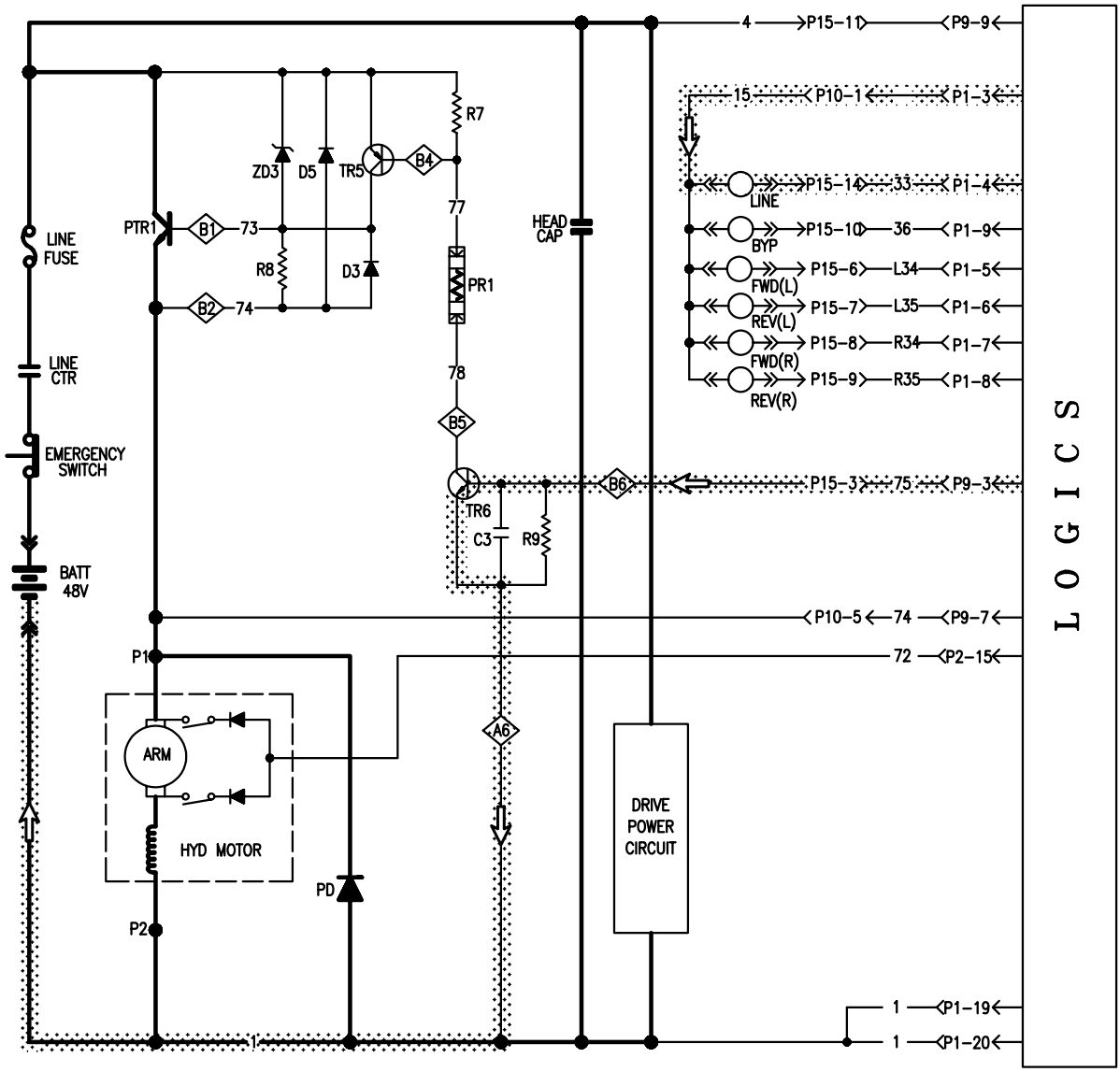
If the streeing wheel is turned, hydraulic pressure increases and a pressure switch (PRESSURE SW) located in the steering gear load sensing hose, will open. This causes the voltage at logic connector P2-1 to change from a LOW (less than one volt) to a HIGH (12 volts). When a HIGH is present the logics knows that more hydraulic flow is required and will supply a pulse from P9-3 to PTR1 at rate of 17% “on-time” for 48 volt trucks. The pump motor speed will increase.

When the lift lever is pulled to lift speed 1 the logics will pulse the pump transistors PTR1.

As shown in the chart under Lift Control Circuit, if the lift lever is pulled to lift speeds 2 through 3 the pump transistors are pulsed with a higher percent “on-time”. The pump motor armature will turn faster.

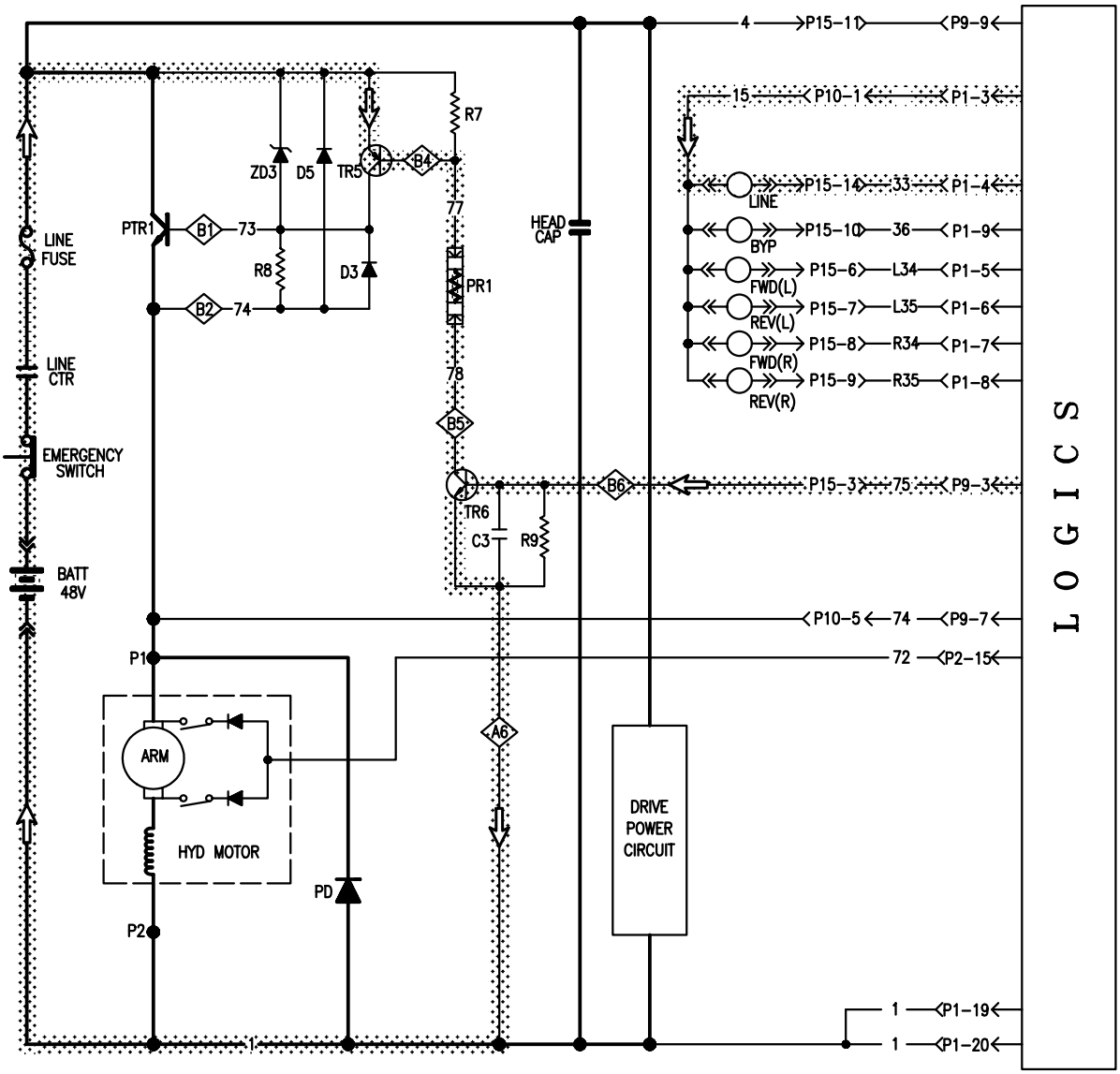
Power Steering Idle

Transistor PTR1 Pulsing



TR6 Base Input Signal

After the line contactor is closed the logics generates a positive pulsing signal (approximately 0.7 volts) on P9-3 to the base of transistor TR6. This is a rapidly changing signal that can only be viewed on an oscilloscope. Because TR6 is a NPN type transistor, the positive signal into the base causes current flow through the base/emitter junction. When current flows through the base/emitter junction the transistor turns ON and main current will flow through the collector/emitter junction. If the base signal from the logics is ON at TR6, TR6 will be ON.
When the base signal is OFF, TR6 will be OFF.



TR5 Base Input Signal, TR6 ON

When TR6 is ON, current flows through the emitter/base junction of transistor TR5, through PR1 and TR6 to battery negative. Because TR5 is a PNP type transistor, the current flow to battery negative through the emitter/base junction causes TR5 to turn ON. When TR6 is OFF, TR5 is OFF.