CATERPILLAR®

99759-60100

Service Manual

MicroCommand III 36/48v & 72/80v

36/48V		72/80V	
EP16	E1EP1-62001-up	EP16	E1EP1-82001-up
EP18	E1EP1-72001-up	EP18	E1EP1-87001-up
EP20	E1EP2-62001-up	EP20	E1EP2-82001-up
EP25	E1EP2-72001-up	EP25	E1EP2-85001-up
EP30	E1EP3-62001-up	EP30	E1EP3-82001-up

AC
MC

For use with EP16, EP18, EP20, EP25, EP30 Lift Trucks

Control Panel Thermal Switch

Contacts open at . . . . . 81 to 89° C (178 to192° F)

Contacts close at. . . . . 69 to 77° C (156 to 171°F)

Contactors Tip Clearance (Gap)

Line . . . . . .no adjustment

Directional (Forward and Reverse) . . . . .3.05mm ± 7%

. . . . . .(0.120” ± 7%)

Bypass . . . . . .no adjustment

Pump . . . . . .no adjustment

Regen . . . . . .no adjustment

Fuses

Accessory/Horn . . . . . .15 A

Key . . . . . .10 A

Line . . . . . .675 A/600 A

Shunt Field Fuses . . . . . .15 A

Traction and Pump Motor Shunt Field Resistances

Model	Traction Motor Shunt Field Resistances (ohms)		Pump Motor Shunt Field Resistances (ohms)	
EP16/ 18	9” Diameter Prestolite Motor 36/48 V	72/80 V	7” Diameter Prestolite Motor 36/48 V	72/80 V
	8.55- 10.45 Ω	18.0- 22.0 Ω	6.55- 7.98Ω	16.2- 19.8Ω
EP20- 30	11” Diameter Prestolite Motor 36/48 V	72/80 V	9” Diameter Prestolite Motor 36/48 V	72/80 V
	6.3- 7.7Ω	18.0- 22.0Ω	7.29- 8.91Ω	21.6- 26.4Ω

Programmable Setup Options

Thirtyone programmable setup options are available on the EP family of electric lift trucks equipped with MicroCommand III control system. These options can be set so the truck performance matches operating conditions of the truck.

The options are divided into three groups:
Group 1: Setup options 1 - 9
Group 2: Setup options 10 - 49
Group 3: Setup options 50 - 53

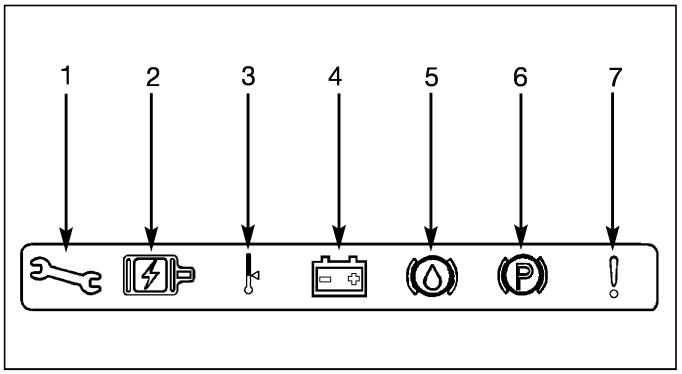
The following chart shows a list of all options in their three groups. Minimum settings, maximum settings, and the factory defaults are given in the chart.

For more information on using the Programmable Setup Options, see the following topics in this section of the manual.

- Functional Descriptions of Programmable Setup Options
- Accessing Programmable Setup Options
- Programming Setup Option 1
- Programming Setup Options (Other than Option 1)
- Activating Default Settings

Action Lights

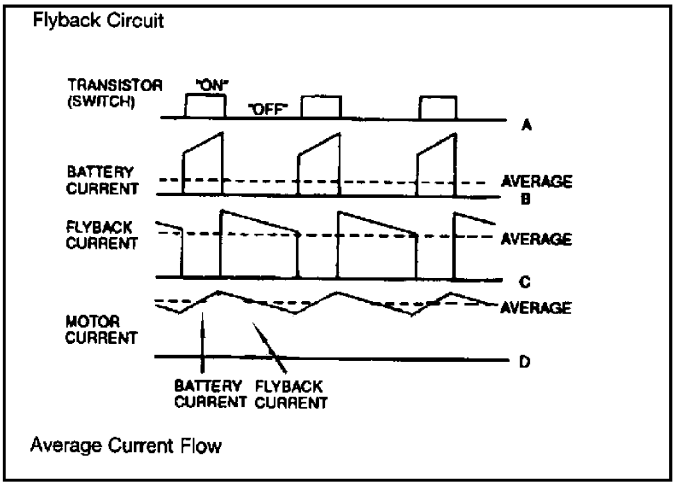
These symbols will illuminate red or yellow when specific problems are detected. The truck should be stopped and corrective action taken immediately.



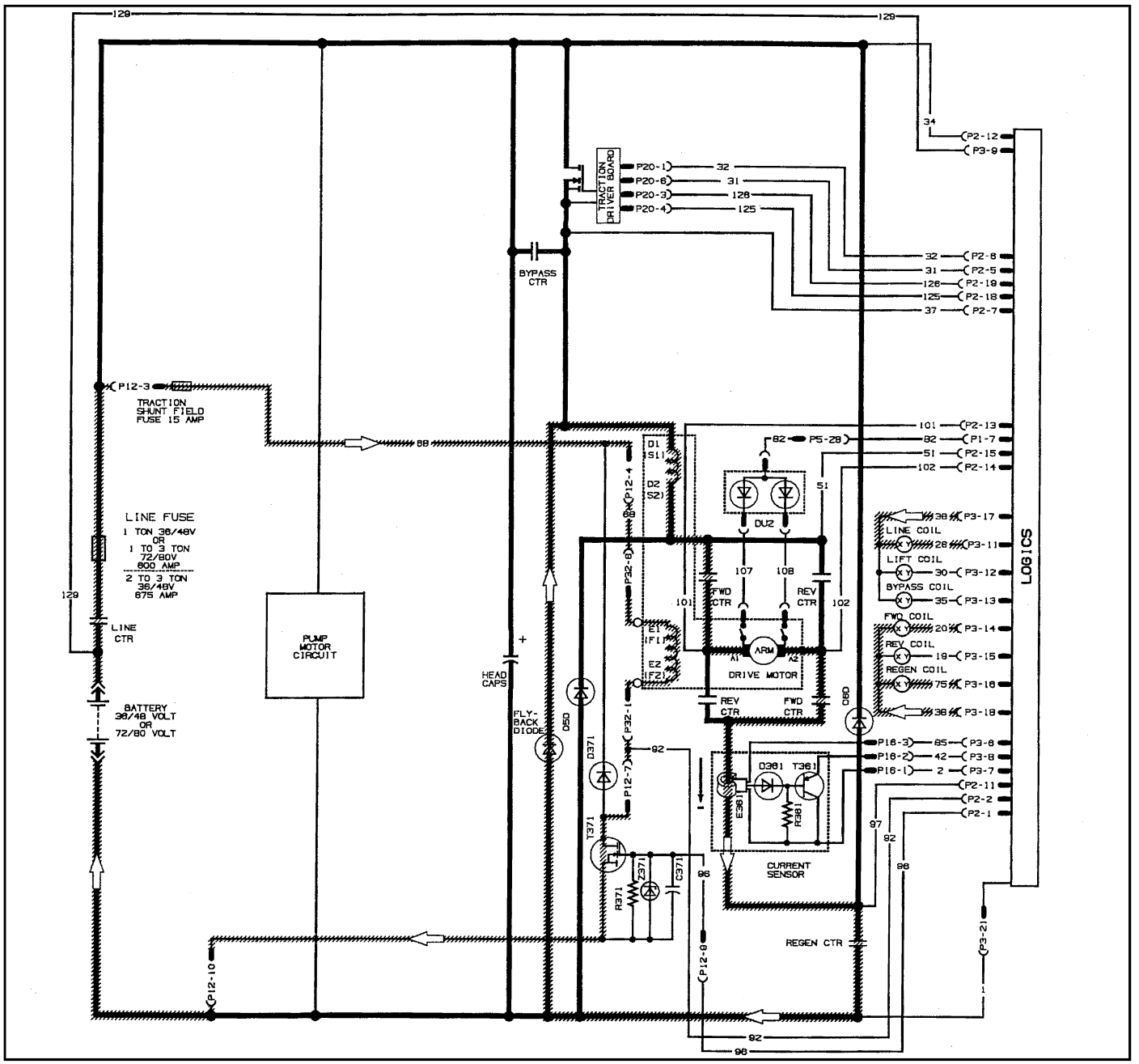
Action Lights

1. **Service Reminder** - The wrench symbol will illuminate when it is time for periodic maintenance. Maintenance intervals are programmable. See the topic, “Programmable Setup Options,” Option 9.
2. **Brush Wear Indicator** - The motor symbol will illuminate if the traction or pump motor brushes need service. Truck operation can be slowed or stopped. See the topic, “Programmable Setup Options,” Option 19.
3. **Over Temperature** - The thermometer symbol will illuminate if an over temperature condition develops in either the traction motor, pump motor, or the control panel. The control system reduces drive and/or lift performance to allow cooling.
4. **Battery Charge** - The battery symbol flashes if the battery charge reaches the 70% discharged level. At 80% discharge, the symbol will illuminate constantly (no flashing). Reduced drive and/or lift performance can be programmed. See the topic, “Programmable Setup Options,” Options 21, 22, and 23.
5. **Brake Fluid Level** - The brake fluid symbol flashes if the brake fluid reaches a predetermined low level.
6. **Park Brake** - The park brake symbol flashes when the park brake is applied.
7. **Fault Detection** - Traction and pump circuits are checked during start-up and monitored continuously during operation. If a fault is detected, the truck shuts down and cannot be operated until the cause of the fault is repaired. The fault symbol will flash and a fault code number will appear in the Speed/Fault Code Indicator.

When the traction module transistors are ON, battery current flows through the field windings of the traction motor and a magnetic field is created around the windings. When the power transistors are turned OFF, battery current through the windings stops and the created magnetic field begins to collapse. The collapsing magnetic field induces current in the flyback diode. Flyback current is used to power the traction motor while the power transistors are OFF (during pulsing). Induced current flows from the field windings through the forward contact tips, armature, forward contact tips, current sensor regen contact tips and flyback diode back to the field windings. The flyback diode is part of the Traction Module. Because of the flyback current, the average traction motor armature current will be greater than the average battery current. The traction motor shunt field remains activated during flyback.

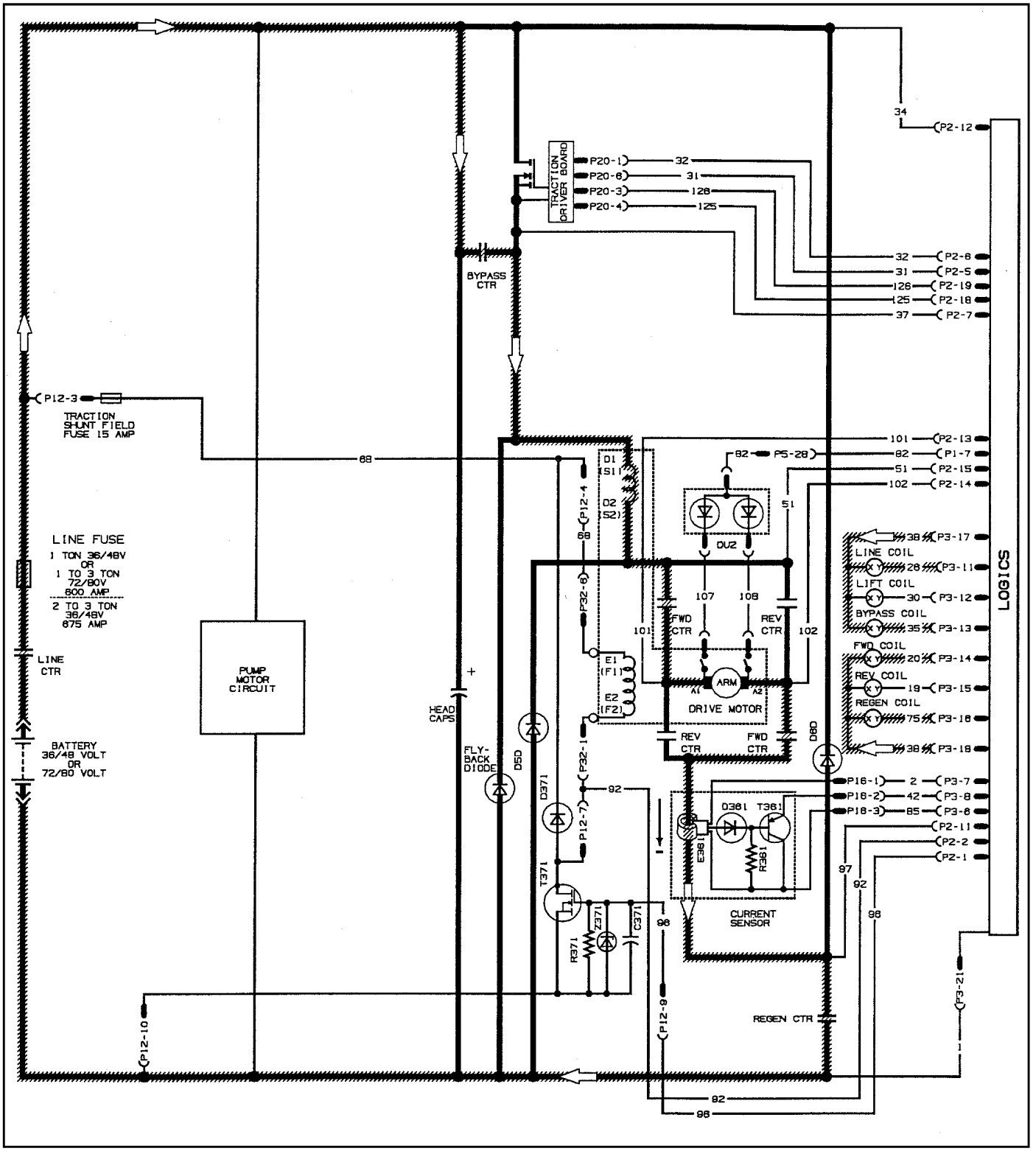


Average Current Flow



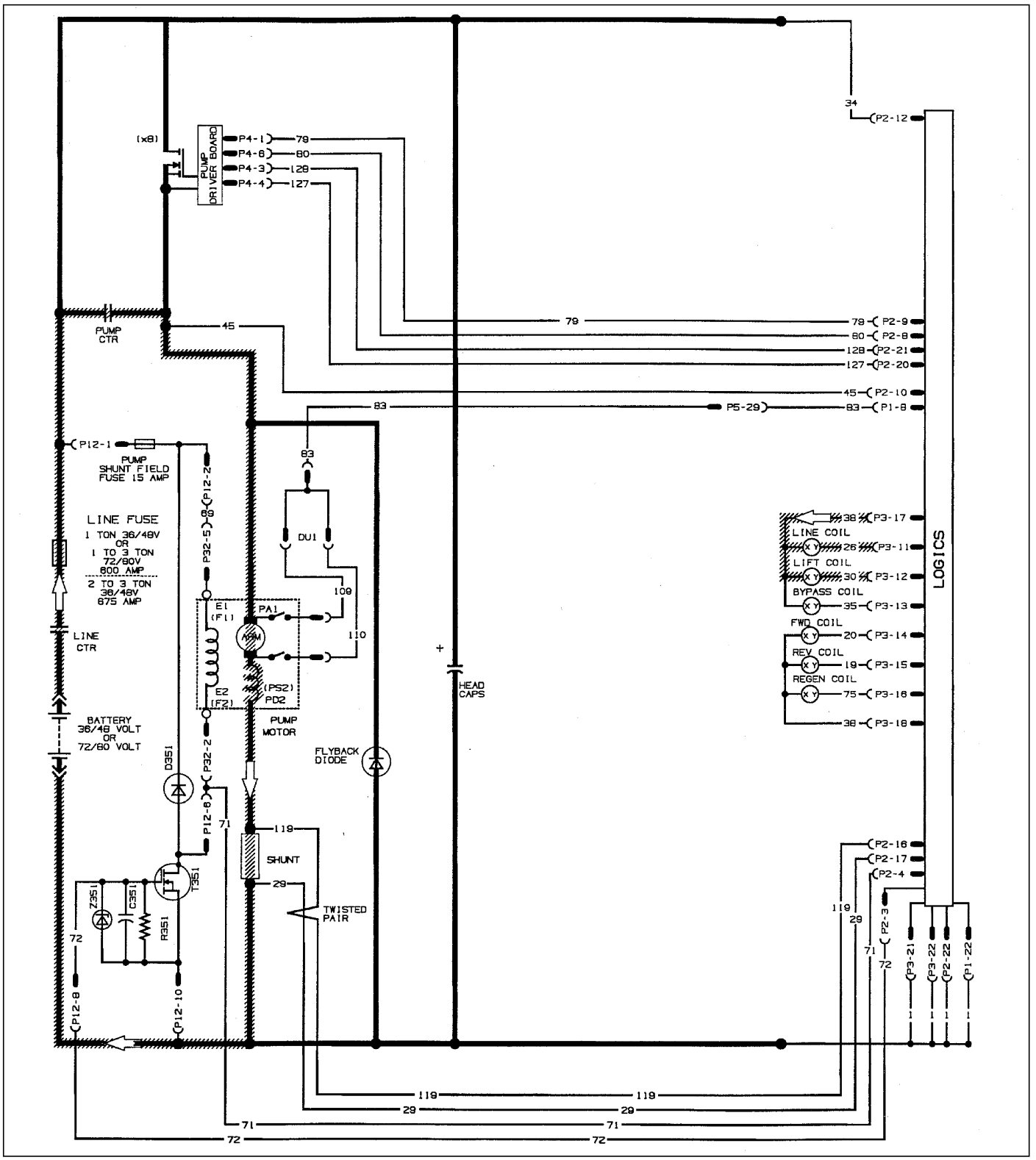
Bypass Circuit Without Shunt Field Activated

With the accelerator fully depressed and the bypass contactor closed, the logics starts to monitor drive current and truck speed. When the traction motor current decreases to a preset limit, the logics turns the shunt field OFF. With the shunt field OFF, both armature current and motor speed will increase. If the traction motor current increases above the preset limit (e.g. climbing a ramp or a hill), the logics turns the shunt field back ON. This gives maximum torque to climb ramps or steep grades.



Pump Contactor Operation

If lift speed 8, 9, or 10 is set for Option 2 (LIFT 1 Speed) or Option 3 (LIFT 2 Speed), and the lift lever has been pulled back, then the lift contactor will be used to provide 100% voltage to the pump armature/series field. The logic activates the pump contactor by allowing current to flow out of P3-17, through the pump contactor coil, through P3-12 to BAT-. While the pump contactor is pulling-in the pump module, transistors are driven at 99% to reduce tip wear when the contact tips touch. After the pump contactor has pulled-in, the logics quickly reduces transistor drive to zero. The pump armature/series field is now connected directly to the battery.



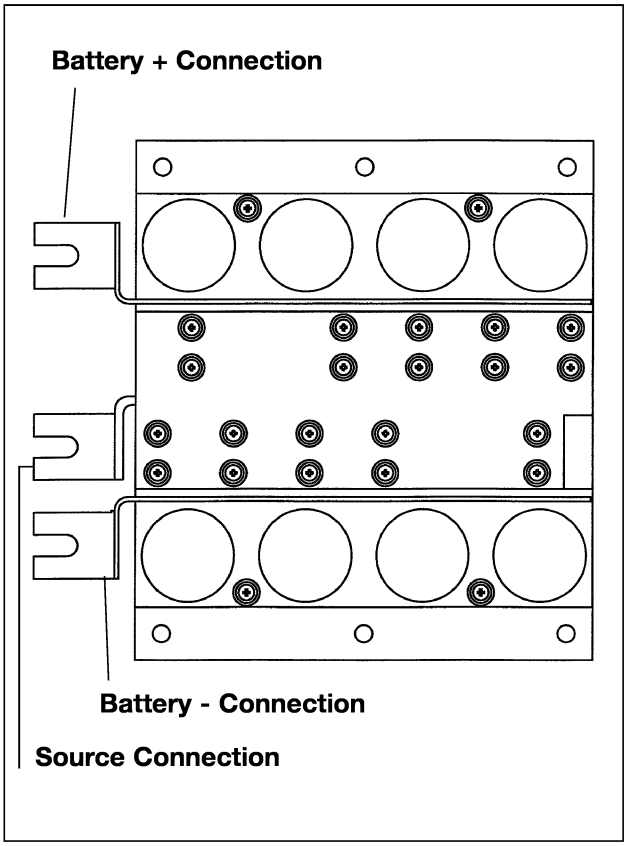
Traction Module Test Procedure

⚠ WARNING

The lift can move suddenly. Injury to personnel or damage to the lift truck is possible. Safely lift the drive wheels off the floor. Put blocks of wood under the frame so that both drive wheels are free to turn.

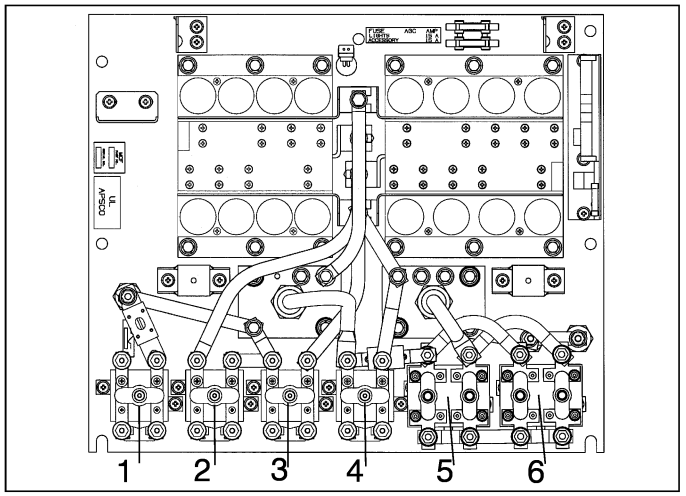
If the Traction Module fails any of the following tests, replace the module.

1. Begin this procedure with the key switch OFF and the park brake applied. Put blocks of wood under the drive wheels so that the wheels are free to turn.
2. Disconnect the battery.
3. Disconnect Logics connectors P1, P2, and P3. Remove the Logics from the truck.
4. Discharge the head capacitors.
5. Disconnect the Traction Module connector P20.
6. Set the multimeter to the Ohms test position.
7. With a multimeter, check for shorted head capacitors. Connect the positive lead to the Traction Module's +Batt connection. Connect the negative lead to the Traction Module's –Batt connection. The meter should show an increasing resistance (charging capacitors).
8. Check for shorted traction transistors. Connect the positive lead to the Traction Module's +Batt connection. Connect the negative lead to the Traction Module's source connection. The meter should not read 0.0 ohms.
9. Check for shorted Flyback diode. Connect the positive lead to the Traction Module's source connection. Connect the negative lead to the Traction Module's –Batt connection. The meter should not read 0.0 ohms.
10. Check for shorted Flyback diode. Connect the positive lead to the Traction Module's –Batt connection. Connect the negative lead to the Traction Module's source connection. The meter should not read 0.0 ohms.
11. Reconnect the Traction Module connector P20.
12. Reinstall Logics and reconnect logics connectors P1, P2, and P3.
13. Check continuity between Traction Module connector P20-1 (bottom pin) to logics connector P2-6 (wire #32).
14. Check continuity between Traction Module connector P20-6 (top pin) to logics connector P2-5 (wire #31).
15. Reconnect the battery.
16. Set the multimeter to the volts test position.
17. Measure the voltage between the positive and negative heatsinks. The voltage should be more than 50% of battery volts. If the battery has been disconnected for some time, the voltage may be rising slowly. Wait until voltage stops rising before reading voltage.
18. Turn key switch ON.
19. Measure the voltage between Traction Module connector P20-3 and P20-4. The voltage should read between 11V and 12V.



Tests “O” Through “T”

The remaining tests check contactor operation. You will toggle the DRS switch from DIAG to RUN to activate the contactor being tested, then toggle the switch back to DIAG to deactivate it. You must visually observe the contactors for proper operation during these tests.The seat switch must be closed for the contactor tests.



Contactor Locations. Panel with regen is shown. Plug-only panels will not have regen contactor (4).
(1) Line contactor (2) Pump bypass contactor
(3) Drive bypass contactor (4) Regen contactor
(5) Forward contactor (6) Reverse contactor

Test O: Line Contactor Circuit

Move the DRS switch to RUN.

Display = 12 and the line contactor (1) does not close. Circuit is defective.
See Troubleshooting Problem 50.

Display = 12 and line contactor (1) closes. Line contactor circuit OK.

Move the DRS switch to DIAG.

Display = 13 and the line contactor (1) opens.

Test P: Pump Bypass Contactor Circuit

Move the DRS switch to RUN.

Display = 13 and the pump bypass contactor (2) does not close. Circuit is defective.
See Troubleshooting Problem 50.

Display = 13 and pump bypass contactor (2) closes. Pump bypass contactor circuit OK.

Move the DRS switch to DIAG.

Display = 14 and the pump bypass contactor (2) opens.

Test Q: Drive Bypass Contactor Circuit

Move the DRS switch to RUN.

Display = 14 and the drive bypass contactor (3) does not close. Circuit is defective.
See Troubleshooting Problem 50.

Display = 14 and drive bypass contactor (3) closes. Drive bypass contactor circuit OK.

Move the DRS switch to DIAG.

Display = 15 and the drive bypass contactor (3) opens.

Test R: Regen Contactor Circuit

Move the DRS switch to RUN.

Display = 15 and the regen contactor (4) does not close. Circuit is defective.
See Troubleshooting Problem 50.

Display = 15 and regen contactor (4) closes. Regen contactor circuit OK.

Move the DRS switch to DIAG.

Display = 16 and the regen contactor (4) opens.

Test S: Forward Contactor Circuit

Move the DRS switch to RUN.

Display = 16 and the forward contactor (5) does not close. Circuit is defective.
See Troubleshooting Problem 50.

Display = 16 and forward contactor (5) closes. Forward contactor circuit OK.

Move the DRS switch to DIAG.

Display = 17 and the forward contactor (5) opens.

Test T: Reverse Contactor Circuit

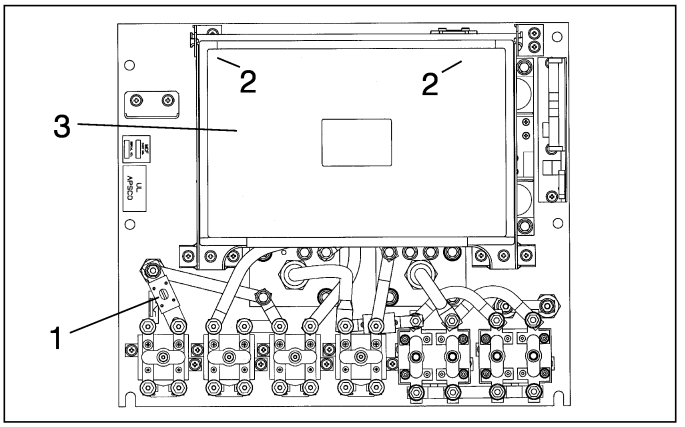
Move the DRS switch to RUN.

Display = 17 and the reverse contactor (6) does not close. Circuit is defective.
See Troubleshooting Problem 50.

Display = 17 and reverse contactor (6) closes. Reverse contactor circuit OK.

Move the DRS switch to DIAG.

Display = DONE and the reverse contactor opens.



Location of components: 1.Line Fuse 2.Screws 3.Logics Cover

This completes the self-diagnostics tests. The contactor tests may be repeated by moving the DRS switch to RUN and back to DIAG.

If you are finished with self diagnostics, do the following:

1. Turn off the truck.
2. Disconnect the battery and install the line fuse (1).
3. Move the DRS switch to the RUN position.
4. Install the logics cover (3) and tighten screws (2).

PROBLEM 8

Over temperature indicator ON. Lift speed slower than normal. Traction motor operation normal. E2 stored in fault code area.

POSSIBLE CAUSES

Pump motor overheated: pump motor thermal switch defect; open wiring; logics defect; display unit defect.

CHECKS

Allow truck to cool 15 minutes.

Over temperature Indicator Still ON

Check stored fault codes. Verify E2 is present.

E2

Measure the voltage at P3-2 (wire #77) on the logics board (silver area). Scrape coating off board if needed. Do NOT disconnect from logics.

High

Disconnect the battery. With the pump motor at close to room temperature, disconnect the thermal switch connector P8. Check continuity of thermal switch. Should have continuity below 69°C (156°F).

No Continuity

Disconnect P3 from the logics unit. Check continuity from P3-1 to battery negative (wire #1).

No Continuity

Verify problem still exists.

Continuity

Find short to battery negative in the harness. Repair or replace wire.

Continuity

Replace thermal switch.

Low

Replace logics.

No E2

Replace display unit.

Display OK

Pump motor was over-heated: resume normal operation. If condition repeats, check the following:

- Pump motor brushes
- BDI calibration
- Attachment pressures
- Heavy hydraulic application

PROBLEM 17

Display = “24”: (!) action light flashing: no lift truck operation. Line contactor opens and closes.

POSSIBLE CAUSES

Wiring defect: traction module defect: logics defect.

CHECKS

Check continuity between P2-5 and P20-6 (wire #31).

Continuity OK

Check wire #31 for burnt, crushed, or shorted areas.

Continuity Not OK

Repair or replace open wires.

Wires OK

Test traction module.

Wires Not Ok

Repair or replace wire(s).

Test OK

Replace Logics.

Test Not OK

Replace traction module.

PROBLEM 27

Display = “40”: (!) action light flashing: no lift truck operation. Line contactor closes then opens.

POSSIBLE CAUSES

Excessive pump current: pump shunt defect: wiring defect: pump/pump motor defect: failed logics.

CHECKS

Check continuity between P2-16 and pump shunt. (Wire #119, side closest to negative heatsink.)
Check continuity between P2-17 and pump shunt. (Wire #29, side attached to standoff.)

Continuity OK

Check wire #29 for burnt, smashed, cut or shorted areas.

Continuity Not OK

Repair or replace open wires.

Wires OK

Check pump shunt connections to make sure they are tight and there is no corrosion between the terminals for wire #29 or #119 and the shunt.

Wires Not OK

Repair or replace defective wires.

Tight

Attach clamp-on ammeter to PS2 cable. Power up truck and check current. In steer idle, current should be less than 50A.

Not Tight

Tighten bolts.

Current OK

Replace logics.

Current High

Correct pump/motor pump problem. Pump could be binding. Cables running to pump motor could be connected incorrectly. Pump motor could be defective.

PROBLEM 37

Seat switch or circuit defect.

POSSIBLE CAUSES

Seat switch defect: wiring to seat defect: logics defect.

CHECKS

Measure the voltage at logics P1-13 (wire #7, silver area) with weight on and off seat. Scrape coating off card pins if needed.
Voltage measured should be:
High with weight off the seat.
Low with weight on the seat.

Voltage OK

Disconnect seat switch and check the continuity with weight on and off the seat. Resistance should be:

Less than 50 ohms with weight on the seat.
OL (infinite) with weight off the seat.

OK

Check continuity from P1-13 to seat switch (wire #7).
Check continuity from seat switch to battery negative (wire #1).

OK

Check for short to battery negative (wire #1) in wire #7. Correct short. If there is no short replace logics.

Not OK

Correct any open wires.

Not OK

Replace seat switch.

Voltage Not OK

Verify problem still exists. If it does, replace logics.

PROBLEM 47

Aux 2 switch circuit defect.

POSSIBLE CAUSES

Aux 2 switch not properly adjusted or defective: wiring defect: logics defect.

CHECKS

Check mechanical linkage for proper operation. Switch should “click” when depressed.

Adjustment OK

Measure the voltage on logics card (silver area) at P1-5. Scrape coating off card pins if needed. Use the following chart to determine proper voltages:

Logics Pin	Aux 2 Fully FWD	Aux 2 Lever Fully BACK	Aux 2 Lever NEUTRAL
P1-5	Low	Low	High

Adjustment Not OK

Adjust lever to make proper engagement with switch.

Voltage Not OK

Disconnect switches and check continuity with lever fully forward, in neutral position and pulled fully back. Resistance should be:

Fully FWD—<50 ohms
Neutral—OL (infinite)
Fully Back—<50 ohms

Voltages OK

Verify problem still exists. If it does, replace logics.

Check OK

Check continuity between P13-4 to P1-5 (wire #87).

Check continuity between P13-4 to battery negative (wire #1).

Not OK

Replace park brake switch.

Checks OK

Check for short to battery negative (wire #1) in wire #87.

Repair short.

Checks Not OK

Repair or replace open wire.

PROBLEM 55B

Voltage Below 11 Volts (See problem 55).

CHECKS

Measure the (POS INPUT) or (+IN) terminal to the (NEG INPUT) or (- IN) terminal of the DC/DC converter.

35 Volts or Above

Remove all connections at the (12V POS) and the (12V NEG) or the (+OUT) and the (-OUT) terminals of the DC/DC converter. Measure the voltage from the (12V POS) to (12V NEG) or (+OUT) to (-OUT).

11 to 13 Volts

Check for a short or low resistance in the auxiliary circuits and loads. NOTE: Excessive loading places the converter into current limit. (12A maximum)

Below 11 Volts

DC/DC converter faulty. Replace converter.

Below 35 Volts

Perform “Battery Load Tests”.

Battery Low

Charge or replace battery.

Battery Good

Check all DC/DC converter input connections from the battery, fuse, and key switch or relay.

All Connections Good

Replace plug-in relay at the relay printed circuit board (if equipped with a relay).

Poor Connections

Repair or replace faulty wiring or connections.

Logic Terminal	Wire No.	Function	*Normal Voltage	Activated Voltage	Test Procedure.
P2-13	101	A1			
P2-14	102	A2			
P2-15	51	Plug			
P2-16	119	Pump Shunt sense +			
P2-17	29	Pump Shunt sense -	0	0	
P2-18	125	Traction Driver Board (supply+)	10.9 to 13.8	10.9 to 13.8	Measure with volt meter neg. on P2-19
P2-19	126	Traction Driver Board (supply -)	-10.9 to -13.8	-10.9 to -13.8	Measure with volt meter neg. on P2-18
P2-20	127	Pump Driver Board (supply+)	10.9 to 13.8	10.9 to 13.8	Measure with volt meter neg. on P2-21
P2-21	128	Pump Driver Board (supply -)	-10.9 to -13.8	-10.9 to -13.8	Measure with volt meter neg. on P2-20
P2-22	1	Battery Negative (-B)	0	0	
P3-1	76	Drive Thermal	Low	High	Activated by hot traction motor.
P3-2	77	Pump Thermal	Low	High	Activated by hot pump motor.
P3-3	46	Control Thermal	Low	High	Activated by hot control panel.
P3-4	12	Display (+)	10.9 to 13.75	10.9 to 13.75	Test with truck in normal state.
P3-5	16	Display (-)	0 to 2.75	0 to 2.75	Test with truck in normal state.
P3-6	85	Current Sensor (supply+)	7.15 to 7.5	7.15 to 7.5	Test with truck in normal state.
P3-7	2	Current Sensor (supply -)	0	0	Test with truck in normal state.
P3-8	42	Current Sensor Sense	3.6 to 4.0	Increasing Output	Activated by current flow in traction motor armature.
P3-9	129	+B (for BDI)	+B	+B	
P3-10		Polarizing Key			
P3-11	26	Line Contactor	B+	See Note 3.	B+ = coil open. Pulsed voltage = coil closed.
P3-12	30	Pump Bypass Contactor	B+	See Note 3.	B+ = coil open. Pulsed voltage = coil closed.
P3-13	35	Drive Bypass Contactor	B+	See Note 3.	B+ = coil open. Pulsed voltage = coil closed.
P3-14	20	Forward Contactor	B+	See Note 3.	B+ = coil open. Pulsed voltage = coil closed.
P3-15	19	Reverse Contactor	B+	See Note 3.	B+ = coil open. Pulsed voltage = coil closed.
P3-16	75	Regen Contactor	B+	See Note 3.	B+ = coil open. Pulsed voltage = coil closed.
P3-17	38	Contactor Supply	B+	B+	
P3-18	38	Contactor Supply	B+	B+	
P3-19	4	Switch Positive	B+	B+	
P3-20	4	Switched Positive	B+	B+	
P3-21	1	Battery negative (-B)	0	0	
P3-22	1	Battery negative (-B)	0	0	

NOTES:

***** “Normal” = Battery connected, key switch, seat switch, park brake switch and line contactor closed.

High voltage should be 14 to 16 volts. *Hi voltage is 14V without line contactor and 22V with line contactor in.

Low voltage should be 0 to 1 volt.

1. Depending upon Option 13, voltages could be reversed.
2. Check voltage between P1-18 and P1-19.
3. Battery voltage minus the voltage drop across the contactor (18 to 28 volts).

Rapid Tune-Up Procedure

The rapid tune-up procedure establishes a starting point for logic card adjustments. The following procedure allows the truck to be operated for test purposes without damage to the truck or its components.

Always verify that the jumper on the logic board is in its proper position for the voltage of the lift truck being tuned.

J1 = 36V	J2 = 48V	J3 = 72V	J4 = 80V

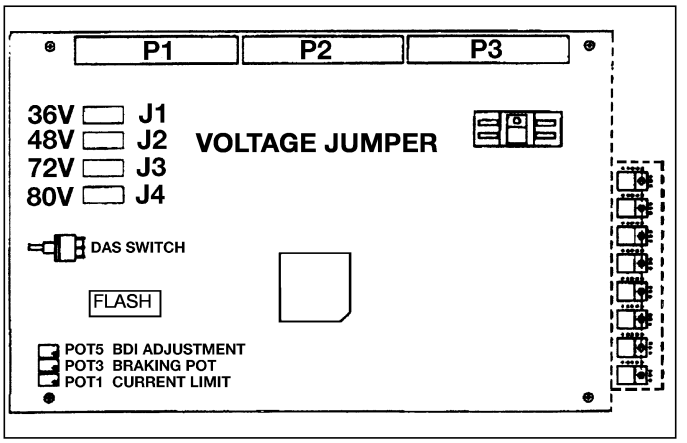
Service exchange logic boards do not need a rapid tune-up procedure. These boards are preadjusted from the factory and their programmable features are set to the default values. However, Option #52 must be programmed to the correct truck type and size. The current limit, electrical braking, and BDI should be checked and adjusted by certified technicians.

⚠ WARNING

The lift truck can move suddenly. Injury to personnel or damage to the lift truck is possible. Safely lift the drive wheels off the floor. Put blocks of wood under the frame so that both drive wheels are free to turn.

NOTE: *All programmable features should be set to their default values before making any adjustments. See the topic "Activating Default Settings" in the Systems Operation section of this manual.*

1. Turn current limit potentiometer P1 fully counterclockwise, then eight turns clockwise.
2. Turn electrical braking potentiometer P3 fully counterclockwise, then eight turns clockwise.
3. Make the final adjustments, as specified in each of the Testing and Adjusting Procedures, before putting the truck back into service. Perform these procedures in the following order.
   1. Current Limit-P1
   2. Electrical Braking-P3
   3. Battery Discharge Indicator (BDI)-P5



Logics Board

MITSUBISHI CATERPILLAR FORKLIFT AMERICA INC.

SCHEMATIC(S) INSERTION

Schematic(s) name/number

Schematic 97C64-06211