Maintenance Instructions

Model:	**Serial No.**
EASi Orderpicker	**9000 and Up**
PDMM#	**Date:**
0032	**11/01/94**
	Revised 05/01/95

Subject **Page**

PROM Removal Tool (p/n 950-027/004)

1. Use an IC removal tool as shown in Figure 3.
2. Look at the socket for the IC in the board. Note the two holes in opposite corners of the socket. These holes are for the prongs of the removal tool.
3. Spread the jaws of the removal tool apart so that its prongs will fit into the two socket holes mentioned in the previous step. See CAUTION.

⚠CAUTION FAILURE TO USE THE INTEGRATED CIRCUIT TOOL MAY DAMAGE/DESTROY SOCKET.

4. Gently squeeze the jaws of the tool together. The tool will grasp and then withdraw the IC from its socket.
5. To install a new IC into the socket:
   a. Note that one corner of this type of IC is beveled. Also note that the corresponding corner of the socket is also beveled.
   b. Align these two beveled corners and gently press the IC into the socket.

⚠CAUTION If forced, the EPROM can be installed incorrectly (so the beveled corners do not match) This will damage the EPROM and/or socket board.

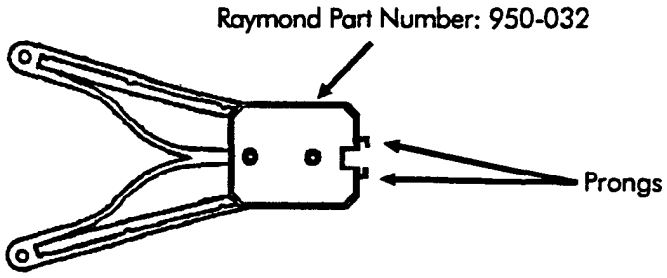


Figure 3 Integrated Circuit Tool PULLER-2.PCX

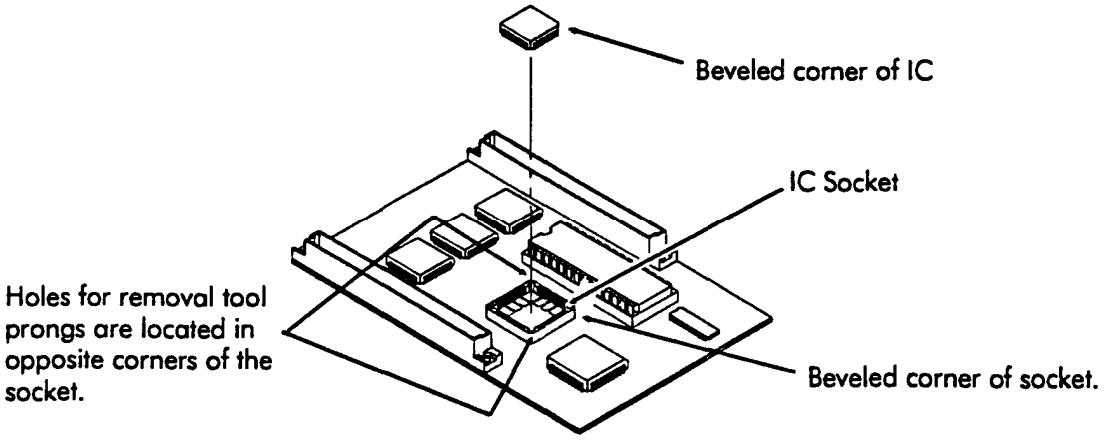


Figure 4 Installation of and Integrated Circuit (IC) EEPROM.PCX

Component
Identification
(Cont'd)

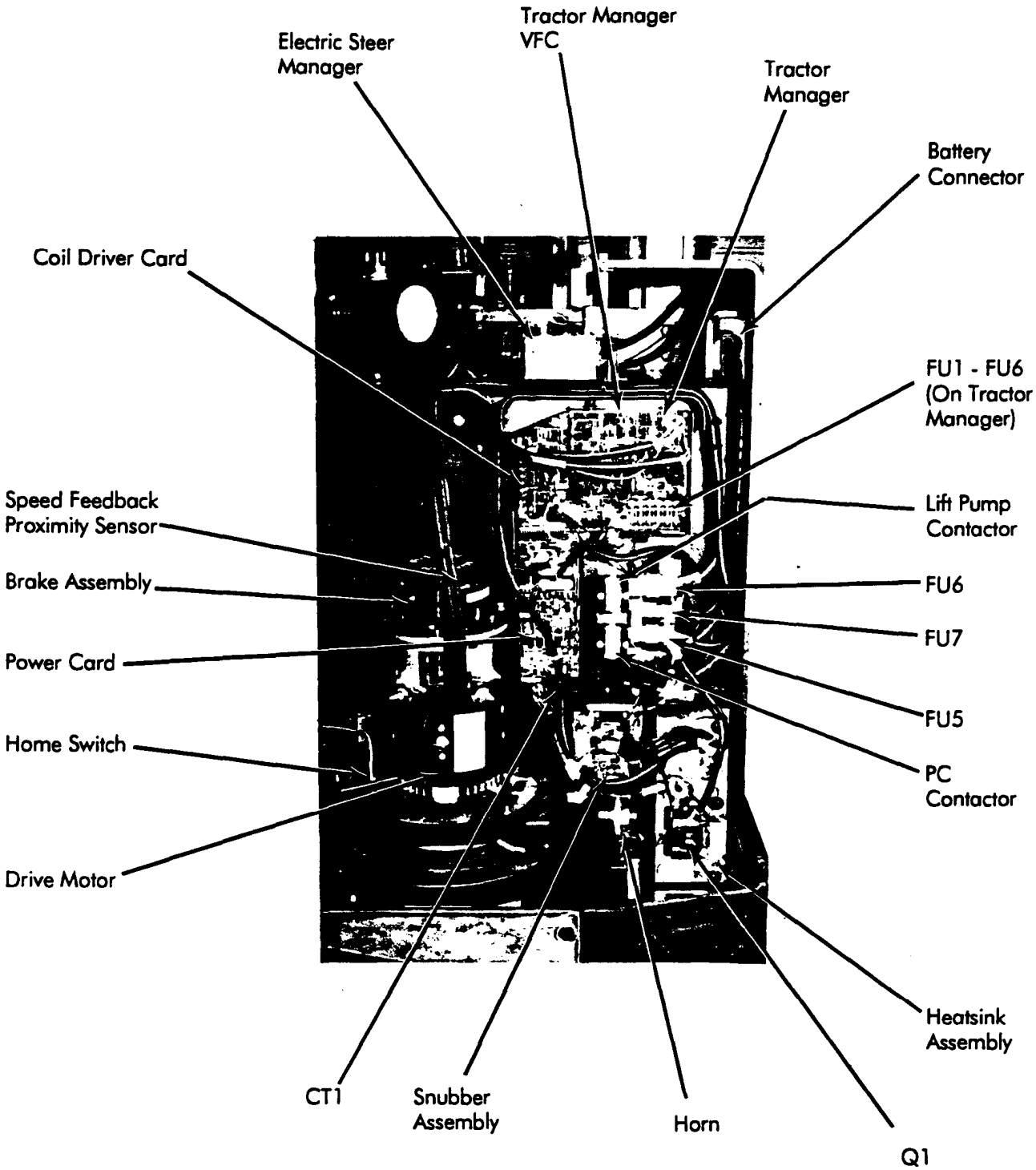


Figure 13 Electrical Compartment Components (Shown with Electric Steering)

Battery Electrical Leakage To Frame Test

1. Disconnect the battery from the truck.
2. Use a voltmeter set on the 50 volt scale.
3. Attach meter leads: negative to truck frame, positive to battery positive.
4. The voltmeter should show no voltage or at most a 2-3 volt reading.
5. Attach meter leads: negative to battery negative, positive to truck frame.
6. The voltmeter should show no voltage or at most a 2-3 volt reading.
7. If there is more than a 2 to 3 volt reading in Steps 3 and 5, clean the battery rollers. Have the battery checked for internal voltage leakage.

Battery Charging

⚠ WARNING WHEN CHARGING BATTERIES, OBSERVE THE FOLLOWING PRECAUTIONS:

- DO NOT SMOKE, USE OPEN FLAME, OR SPARK PRODUCING DEVICES NEAR THE BATTERIES.
- CHARGE IN A WELL-VENTILATED AREA TO AVOID HYDROGEN GAS CONCENTRATION.
- KEEP BATTERIES CLEAN; CORROSION CAUSES GROUNDS AND THE POSSIBILITY OF SPARKS.
- CHARGE BATTERIES AT THE INDICATED RATES.
- KEEP PLUGS, TERMINALS, CABLES, AND RECEPTACLES IN GOOD CONDITION TO AVOID SHORTS AND SPARKS.
- NEVER LAY TOOLS ON TOP OF THE BATTERIES.
- WEAR PROTECTIVE CLOTHING AND EYE PROTECTION WHEN HANDLING, CHECKING OR FILLING BATTERIES.

NOTE: Get the maximum use out of each battery by recharging the batteries only when they are effectively discharged. DO NOT routinely recharge batteries when they are only partially discharged; this will decrease battery life. At maximum recommended discharge, the specific gravity should read 1.150 or less.

Charging Process

To charge a battery, direct current is passed through the battery cells in the direction opposite to that of discharge.

1. First, become familiar with the following:
   - Charging rate, starting rate, and finish rate.
   - Time available for charge.
   - Variations in cell voltage
   - Avoiding overheating, excessive gassing or overcharging.
2. Consult your battery manual for specific charging procedures.

Short Circuit Test - Motors

A short circuited motor is one in which the insulation on the field or armature windings has broken down at two or more points. The breakdown creates a low resistance current path, allowing current to flow from one turn of the coil to another adjacent coil turn, without actually flowing through the coil wire. The result is a decrease in total resistance of the motor winding and an increase in the current flow. Location of the short determines its severity.

A shorted motor may be indicated by:

- slow or sluggish operation
- running faster than normal
- overheating
- blowing a power fuse

Short Circuit Test

1. Refer to the inspection report showing the motor current when the motor was new.
2. Duplicate the same truck conditions (loaded or unloaded) and measure the present current.
3. If the present current reading is 25% more than the original current value, check the entire truck for possible causes. Such as
   - Bad wheel bearings
   - Dragging brake
   - a short circuit within the motor.

NOTE: Excessive motor current can also be caused by abnormally high rolling resistance. Such resistance may be caused by brake dragging, defective wheel bearing(s), transmission problems. The devices driven by the motor should be inspected before replacing the motor.

Armature Shorts

A short circuit in the armature will cause heating which will probably result in burning of:

- the armature coil
- banding wires
- commutator segments

Visual inspection should show this condition.

Another method of checking for armature shorts is to:

1. Remove all the brushes.
2. Touch one lead from a ohmmeter to a bar on the commutator.
3. Work your way around the commutator, touching each bar, checking the resistance.
4. There should be only one commutator bar that shorts to the bar that has ohmmeter attached to it.
5. The remainder of the commutator bars should have high resistance.

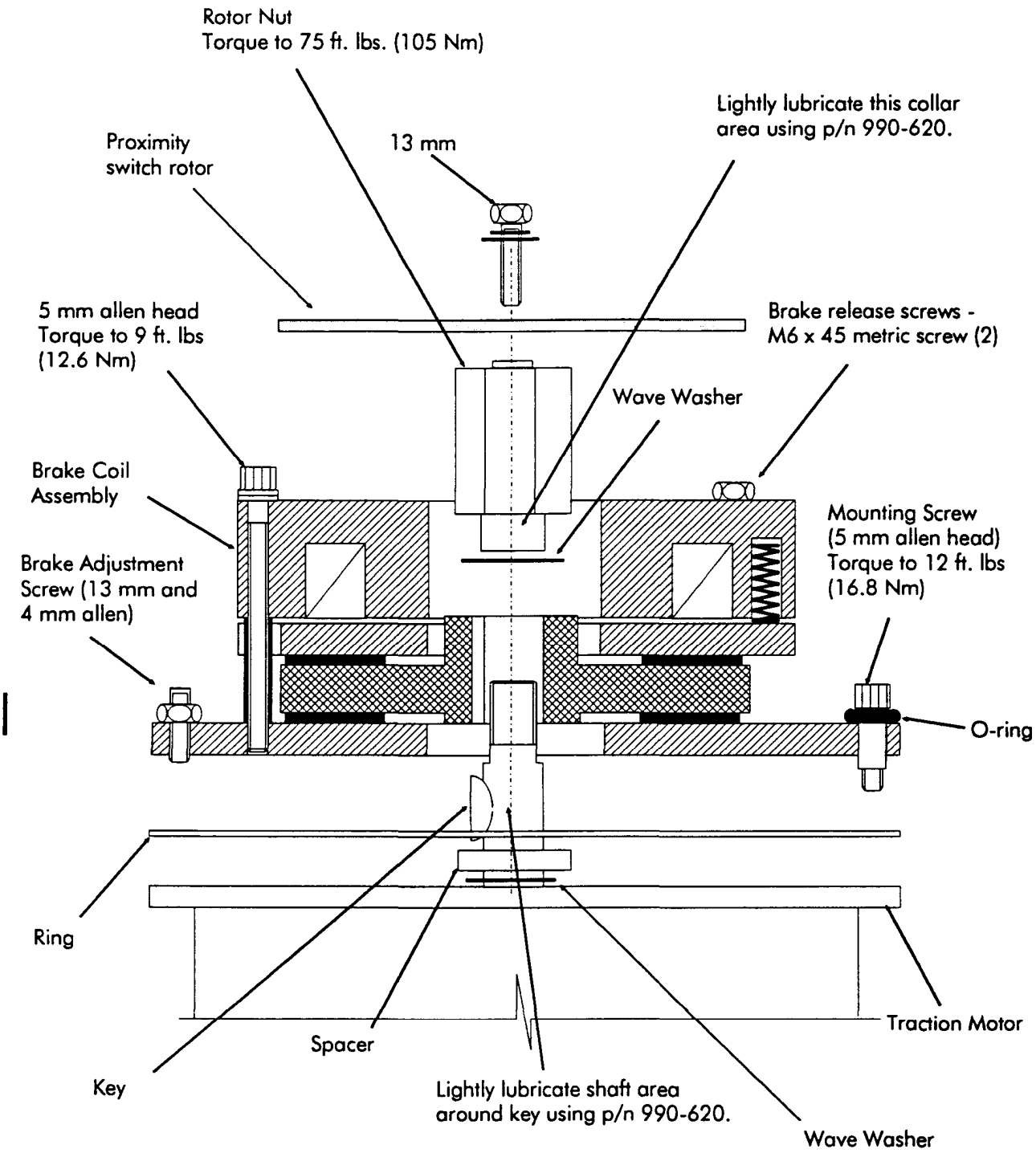


Figure 25 Brake Assembly - Section View

Advanced intellispeed Manager (Optional)

The Advanced intellispeed is associated with the lift system and monitors the height of the operator's carriage. Height input to Advanced intellispeed is done through the flow sensor located in the hydraulic system. Advanced intellispeed also monitors hydraulic pressure of the lift system to determine the load weight. Height and weight information is sent to the Carriage Control Card where it is used to determine the maximum allowable travel speed.

1. Advanced intellispeed monitors:
   a. Flow sensor inputs used to determine lift/lower speed and direction.
   b. Main pressure via PRESS A
   c. Monitors temperature of the hydraulic oil

Advanced intellispeed transmits the above information over BUS+/BUS- to the Tractor Manager and Carriage Control Card. This information is then used by the Tractor Manager and Carriage Control Card to determine travel speed, and to display load height and weight on the OD.

Operator's Display (OD)

1. The OD is a write-only type device. It receives and displays data only from the Carriage Control Card. Data which can be displayed includes:
   - Time or calendar
   - Battery voltage or optional BSOC
   - Hour meters (hours on deadman [HD], hours spent lifting [HL], total miles [TM])
   - Status/Fault messages
   - Weight of load (option)
   - Fork Height (option)
   - Maintenance required indicator
   - Over-temperature indicator
   - Lift limit indicator (optional)
   - Steering direction indicator
   - Guidance indicator (optional)

2. The Operator's Display is not required for operation or to pass the SelfTest.

BSOC

BSOC (Battery State-of-Charge) is an option that monitors and remembers the charge level of the battery connected to the truck and prevents excessive discharging of that battery. Operating a truck using a discharged battery can damage both the battery and the electrical components that make up the truck's electrical system.

At power-up, BSOC tests the battery to determine if it is the same battery that was installed at power-down. If it is the same battery, it continues to monitor the battery for discharge and updates the Operator's Display as required.

If a different battery is detected, BSOC tests to determine the state-of-charge of the new battery. These tests are as follows:

- BSOC computes the charge of the battery that was connected to the truck with the new battery's charge. A charge difference of a least 50% between the two batteries resets BSOC to show the state-of-charge of the new battery, i.e. the displayed state of charge of the new battery minus the displayed state of charge of the old battery must equal or exceed 50. This reset can be higher or lower than the old battery. Example - A battery in the truck is at 10% charge; the new battery is at 95%. With more than a 50% difference in the charge levels, BSOC will reset the Operator's Display to show the new battery's charge.
- BSOC looks at the configured reset point. BSOC reset is programmable from 55% to 100% of total battery charge and can be changed by entering Configure Mode using the Superwrd. The new battery must be equal to or greater than the configured percent of charge before the BSOC will change. Example - BSOC configured at 95%. Plugging in a battery at anything below 95% charge will not change the Operator's Display. Older batteries may require a lower configured value for BSOC since older batteries may be unable to reach higher percent charge. Therefore, older batteries may require BSOC configure to 85% before the Operator's Display will reset to show the charge of the new battery.

The following example describes installing a new battery but the Operator's Display does not reset. Assume the following:

- BSOC configured at 95%, the battery connected is at 45% charge, and the new battery is at 92% charge.

Since the new battery charge has not changed by at least 50% and the state-of charge of the new battery is not greater than the BSOC reset configured value, the Operator's Display will continue to show the old battery's charge of 45% (even though the new battery is at 92%). What will occur is that the Operator's Display will remain at 45% until the charge of the new battery declines to 45%. Then the display will resume its normal descent.

One final example. Assume the following:

- BSOC configured at 95%, the battery connected is at 65% charge, and the new battery is at 20% charge.

Again, the change in charge is not at least 50% and the new battery is not above the configured BSOC level. The Operator's Display will continue to show 65%, but then descends rapidly as the truck operates until the Operator's Display shows the original charge of 20%. Once the display shows 20% it resumes a normal descent.

Manual Steering Wire Rope Adjustment

Adjustments should only be done with the carriage fully lowered.

1. Fully lower the operator's carriage.
2. Adjust each cable to get the proper cable tension on both sides. Refer to the figure below.

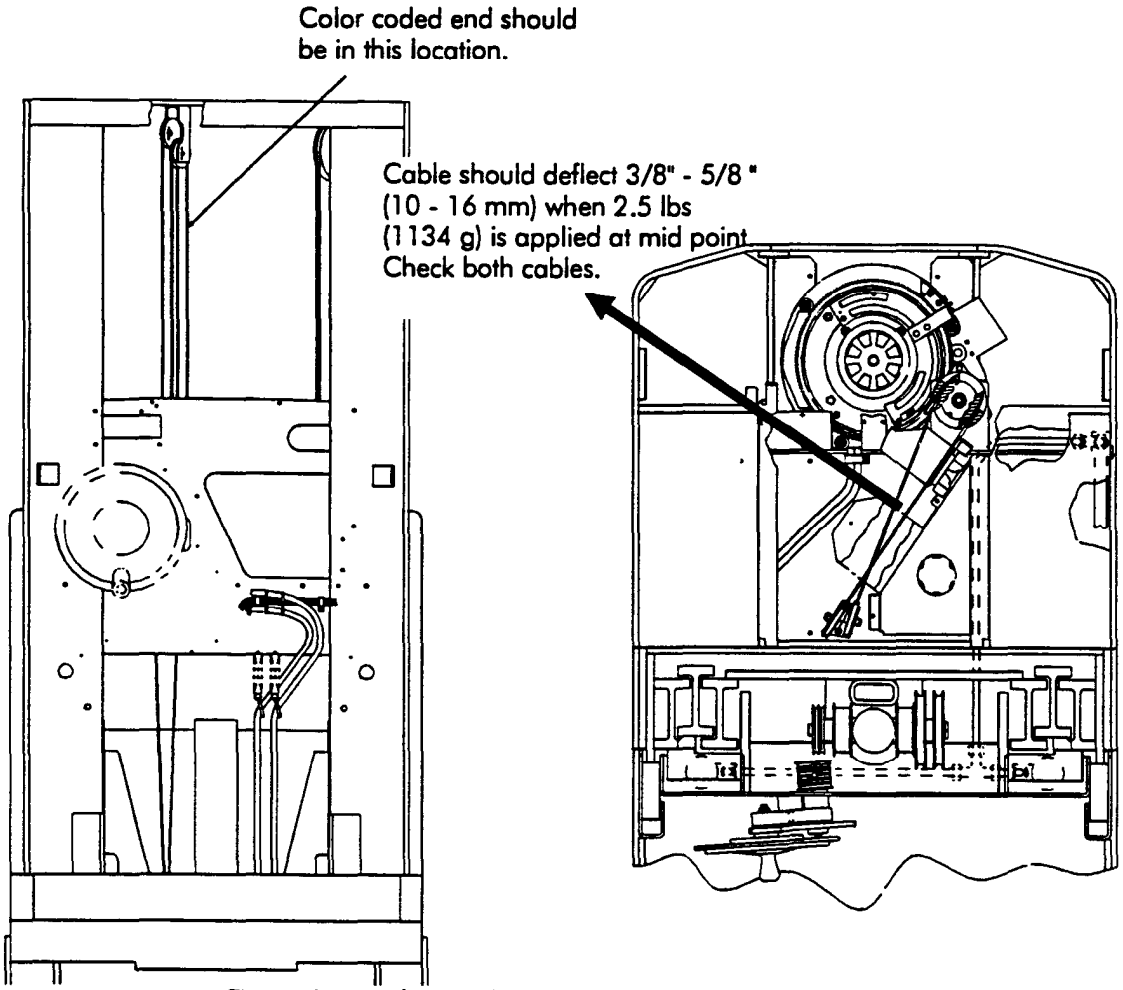


Figure 41 Adjusting Steering Cables

Performance Limiting Messages

Initialize To Allow Full Speed

Code Title	Initialize To Allow Full Speed
Reason	After SelfTest, the operator's carriage needs to to cross the lower reference switch. Basically, this allows the intellidrive system to figure out where the operator's carriage is located.
System Response	1. Alarm sounds: No 2. Operator's Display: Lift system not initialized 3. Speed Limit: 1 mph (1.6 kph)
How to Clear	Cross the lower mast reference switch to clear this speed limit condition.

Corrective Actions and Checks

1. Elevate the carriage to cross the lower mast reference switches.
2. The lower reference switch may be bad. Use Active Maintenance Mode and run test:
   - 100 - Display Lower Reference Switch. Refer to page 232.

   Other possible causes:
   1. The Carriage Control Card may be defective. Refer to page 10 for proper procedures.

Remember to run Learn when replacing either the Carriage Control Card or Tractor Manager VFC.

Code 23

Code Title	Open Detected In Main Transistor Circuit
Reason	During SelfTest, proper current levels were not sensed by CT1 (on the Power Card) from the Power Transistor (Q1)
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE 23. Inform Service 3. PC contactor: De-energized 4. Speed Limit: 0.0 mph
How to Clear	If cycling the key switch Off/On does not clear this code then follow the procedure below.

Corrective Actions and Checks

If the problem is intermittent, the cause may be noise spikes. Check the following:

- Make sure that there is an insulator between the horn bracket and the tractor frame
- The horn may be shorted or the varistor on the horn may be bad. Try a different horn assembly
- Check the snubber circuit for Q1 (REC3, C1, R2)
- Check the snubber circuit for Q2 (REC4, C2, R3)

Run Tests:

- A01 - Armature Current Sense Voltage. Refer to page 199.
- O14 - Ramp PWM to Chopper. Refer to page 288.

Possible causes:

1. FU5 may be blown.
2. There may be an open circuit in the drive motor. Check the:
   - connections to the drive motor terminals.
   - drive motor brushes.
   - drive motor armature resistance
3. Check for voltage to frame per page 391.
4. Check cable from Q1 to Power Card JPC1.
5. Test power transistor Q1 per page 334.
6. REC1 may be shorted. Test per page 338.

Code 2F

Code Title	Failure detected in REGEN circuit
Reason	The signal from the REGEN Card is not correct.
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE 2F. Inform Service 3. PC contactor: Energized 4. Speed Limit: Top speed minus 2 mph (3.2 Km/hr) and plugging only
How to Clear	If cycling the key switch Off/On does not clear this code then follow the procedure below.

Corrective Actions and Checks

The REGEN circuit may not be functioning correctly.

If you think there is a problem with the REGEN circuit, perform the following check:

1. Turn the truck OFF and then back ON. This will reset the system.
2. In an area where there are no obstructions (such as a clear aisle) drive the truck at top speed (or at least greater than 5 mph[8.0 km/hr]).
3. Once the truck is above 5 mph (8.0 km/hr), move the control handle to the full opposite direction (maximum braking).
4. If there is a problem with the REGEN circuit, a Code 2F will appear.

Possible causes:

1. PC2 could be disconnected.
2. Wiring in the REGEN circuitry may be disconnected or damaged.
3. The screw mounting the Regen card to Q2 may be loose.
4. The REGEN Card may be bad.
5. Q2 may be bad. **Refer to page 335.**
6. C2 may be shorted/open.
7. R3 may be open.

Code 51

Code Title	No Carriage Control Card communications received by Tractor Manager
Reason	The Tractor Manager did not receive a message from the Carriage Control Card for over 100 ms.
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE 51 Inform Service 3. PC contactor: De-energized
How to Clear	If cycling the key switch Off/On does not clear this code then follow the procedure below.

Possible Causes and Checks

1. This code could be the result of static electricity or shorts to frame. Check and clean all static straps. Check for shorts to frame.
2. Check the connections of BUS+/BUS- on the Tractor Manager.
3. If truck is equipped with optional travel alarms, check the suppressors for those circuits.
4. Check that the jumpers listed in the table below are in their proper position on the Tractor Manager (TM).

TM Jumper	Electric Steer
IN position	No
OUT position	Yes

5. Check the LED on the Tractor Manager VFC. You are looking for a LED heartbeat rate of approximately 46 per minute. If the blinking rate is not correct, turn the truck off then back on. See if the blinking rate of the LED on the Tractor Manager is now OK. If not, proceed with the rest of the checks. If there is a problem, the LED will be off or stay on continually.

Continued next page.

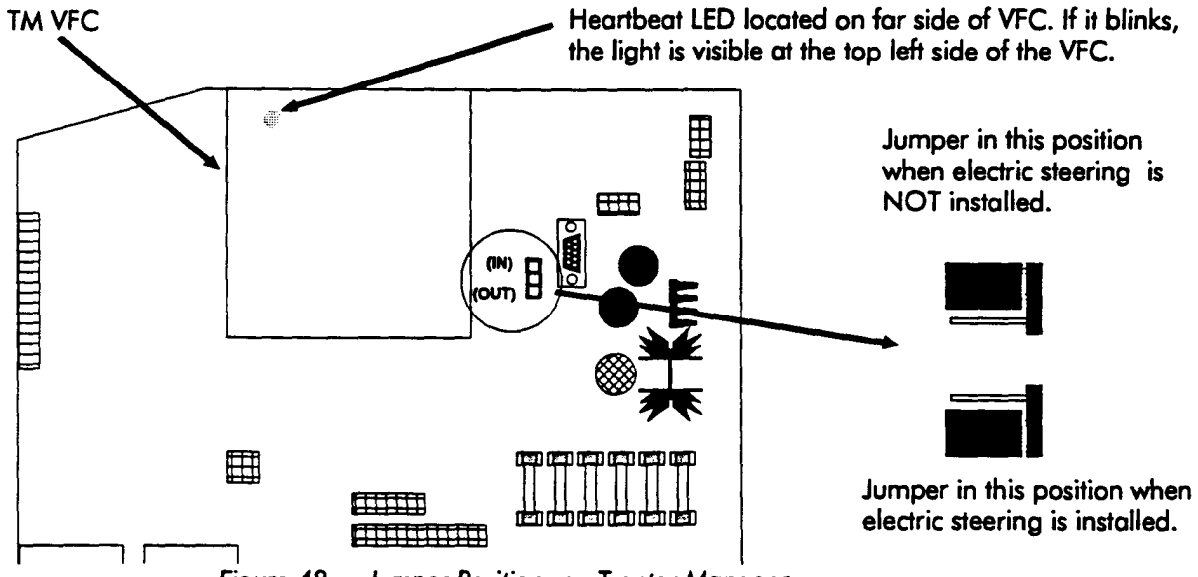


Figure 48 Jumper Positions on Tractor Manager

Code 63

Code Title	Upper and lower reference switches don't agree.
Reason	During operation, the Carraige Control Card sensed that the position of the upper and lower switches were incorrect.
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE 63. Inform Service 3. PC contactor: Energized 4. Speed Limit: 1 mph (1.6 km/hr)
How to Clear	If cycling the key switch Off/On does not clear this code then follow the procedure below.

Possible Causes and Checks

1. Run tests:
   - I00 -Display lower reference switch. Refer to page 232.
   - I01 - Display upper reference switch. Refer to page 234.
2. Check switch S10 (upper reference switch) connection to the Tractor Manager.
3. Check switch S11 (lower reference switch) connection to the Carriage Control Card.
4. Check rail adjustment with switches.

Code 6N

Code Title	Flow sensor temperature out-of-range
Reason	The value sensed by the Electric Steer Manager exceeded the allowable limit.
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE 6N. Inform Service 3. PC contactor: Energized 4. Speed Limit: Non - intellispeed Limit
How to Clear	If cycling the key switch Off/On does not clear this code then follow the procedure below.

Possible Causes and Checks

1. Run test A25 - Flow Sensor Temperature Voltage. Refer to page 225.

Code 93

Code Title	Not near wire - tractor coil pair
Reason	The guide wire is not being sensed by the tractor coil pair.
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE 93. Wire lost, step off/on deadman 3. PC contactor: Energized 4. Speed Limit: Hard plug until <1 mph (1.6 km/hr) then dump brake
How to Clear	Step Off/On deadman pedal.

Possible Causes and Checks

1. There may be a problem in the warehouse floor. Drive the truck on the wire in other aisles to determine if a pattern for the problem can be established.
2. The output of the line driver may be incorrect. Refer to page 341 if it is a Raymond line driver or to the manufacturers specifications if it is not.
3. Learn steering.
4. Learn the wire guidance offsets.
5. Inspect/clean the 4 static straps under the truck.
6. Check for shorts to frame.
7. Run test A20 - If the output of the wire is less than approximately 0.5 volt while over the wire, the truck will never sense the guide wire. Refer to page 220.
8. The cable(s) to the Filter Card (JPW1) may be disconnected.
9. The cables at the antenna(s) (JP1T) may be disconnected.
10. The cables between the antennas and the Filter Card may be bad.
11. Run tests:
    - A16 - Left Tractor Guidance Coil Voltage. Refer to page 216.
    - A17 - Right Tractor Guidance Coil Voltage. Refer to page 217.
    - A20 - Tractor Near Wire Voltage. Refer to page 220.

If the cables are connected and check good, swap cables JPW1 and JPW2. If the values reverse then the antenna is bad. If the values do not reverse then either the Filter Card or Electric Steer Manager is bad.

Code A0

Code Title	Incorrect software for proper vehicle operation.
Reason	The model number stored in the Carrage Control Card PROM is not the proper model number for the vehicle type.
System Response	1. Alarm sounds: Yes 2. Operator's Display: CODE A0 Inform Service 3. PC Contactor: De-energized
How to Clear	The key must be cycled OFF/ON to clear this fault.

Corrective Actions and Checks

1. Cycle the key switch Off/On several times to see if the code clears.
   - This problem could be a result of static electricity or shorts to frame. Check and clean all static straps for proper operation. Inspect for shorts to frame.
2. If cycling the key switch does not clear this code then replace the Carriage Control Card PROM.
3. Replace the microprocessor on the Carriage Control card. Refer to page 10 for proper procedures when replacing the Carriage Control Card and/or Carriage Control Card microprocessor.

After replacing a PROM or card, be sure to run Learn Mode.

NOTE: None of the Program modes (Maintenance, Learn, or Config) can be entered until this code is cleared.

Code F8

Code Title	Tractor Manager VFC COP not enabled
Reason	This code indicates that the start-up procedure detected either an PROM failure or a Tractor Manager VFC malfunction. This check is run before the contactor test is started. This code should never be detected in normal operation.
System Response	1. Alarm Sounds: Yes 2. Operator's Display: CODE F8. Inform Service 3. PC Contactor: De-energized
How to Clear	The key must be cycled OFF/ON to clear this fault.

Corrective Actions and Checks

1. Cycle the key switch Off/On several times to see if the code clears.
   - This problem could be a result of static electricity or shorts to frame. Clean and check all static straps for proper operation. Inspect for shorts to frame.
2. If truck is equipped with optional travel alarms, check the suppressors for those circuits.
3. If the above does not correct the problem replace the Tractor Manager VFC PROM.
4. Install a replacement Tractor Manager VFC. See page 7 for proper VFC/PROM replacement procedures.

After replacing boards, be sure to run Learn Mode.

Code G1

Code Title	Electronic steering power supply out-of-range
Reason	+ 12 volts is not being sensed at the Electric Steer Manager.
System Response	1. Alarm sounds: Yes 2. Operator's Display: Code G1. Check Battery 3. PC Contactor: De-energized 4. Speed Limit: 0.0 mph
How to Clear	The key must be cycled OFF/ON to clear this fault.

Corrective Actions and Checks

1. Check the battery condition.
2. The power supplied to the Electric Steer Manager (JPA2-4/JPA2-9) from the Tractor Manager may be less than 11.0 volts or greater than 13.0 volts.
3. Run the following tests us active maintenance:
   - A23 - Steer Controller Power Supply Voltage. Refer to page 223.
   - A00 - Tractor Manager +12 Volt Power Supply. Refer to page 197.
   - A11 - Battery Voltage. Refer to page 211.

Code J4

Code Title	Aisle sensor not present
Reason	One of the aisle sensors is disconnected.
System Response	1. Alarm sounds: Yes 2. Speed Limit: 2.5 mph (4 kph)
How to Clear	Install or replace sensor.

Corrective Actions and Checks

1. Verify that all cables between the sensors and the Tractor Manager are connected. If the cables are connected, verify the continuity of the cables.
2. Run tests:
   - I25 - End of Aisle Sense, Sensor #2
   - I27 - End of Aisle Sense, Sensor #1

Added 11/01/94

Details Pertaining to Learn (Cont'd)

Learning Wire Frequency

NOTE: Learning the guide wire frequency is only required if the wire frequency is configured to "***other***".

Align the vehicle centered over the guide wire (1 to 10 kHz).

When the operator chooses"WireFreq" from the Learn menu, the following message appears:

"Center over wire, then press enter"

After the operator presses "Enter" the following message is displayed:

"Learning guide wire, to ABORT press enter"

Be patient, this process takes several seconds. If a valid frequency is not found the following message will be displayed:

"Unable to learn...ENTER to continue"

If this message appears:

- Check that the line driver output is between 1kHz to 10kHz.
- Run tests A16 through A21

When the frequency and amplitude of the guide wire has been learned, the vehicle will display the following message:

"Done learning guide wire"

Maintenance
Mode (Cont'd)

⚠ WARNING **BY ENTERING STATIC MAINTENANCE MODE, YOU HAVE DISABLED THE SAFETY CIRCUITS ASSOCIATED WITH THE INTELLIDERIVE SYSTEM. THEREFORE, YOU MUST TAKE EXTRA PRECAUTIONS WHILE IN STATIC MAINTENANCE MODE. FOLLOW ALL INSTRUCTIONS CONTAINED IN THIS MANUAL FOR EACH TEST. IF YOU ARE UNSURE HOW TO CONDUCT A TEST WHILE IN MAINTENANCE MODE, STOP - DO NOT PROCEED WITH THE TEST. CONTACT A CERTIFIED RAYMOND TECHNICIAN.**

Please review the following comments and suggestions before doing any tests.

1. If you go into and out of "Maint" several times to resolve a problem, it may save time if the SUPERWRD is temporarily changed to a single digit code. That way, when Program Mode is started, a long password does not have to be entered. Remember to re-enter the correct SUPERWRD when you are done.

⚠CAUTION **DISCONNECTING WIRES OR CONNECTORS TO INTEGRATED CIRCUITS WITH POWER ON CAN RESULT IN PREMATURE FAILURE OF THOSE OR OTHER COMPONENTS. ALWAYS DISCONNECT THE BATTERY BEFORE MAKING OR BREAKING ANY CONNECTIONS.**

WHEN REMOVING A CONNECTOR, DO NOT PULL ON THE WIRES TO SEPARATE THE CONNECTION!

⚠ WARNING **WHILE IN STATIC MAINTENANCE MODE, THE DRIVE TIRE MUST BE ELEVATED OFF THE FLOOR AND THE EMERGENCY LOWERING VALVE MUST BE OPENED.**

Test A04 - Lift/Lower Pot Voltage

This test displays the voltage that the Carriage Control Card reads from the lift/lower pot (VR2).

Related Codes and Tests

Code 81 - Lift/Lower controller reading out of range. Refer to page 130.

NOTE: Run this test if the voltage output by the lift/lower pot exhibits problems.

NOTE: Learn mode should be run whenever the lift/lower pot is replaced or repaired.

Procedure

1. For information on using maintenance mode, refer to page 194. This test can also be run from active maintenance.
2. The Operator's Display will display the voltage which the Carriage Control Card reads from the lift/lower pot.
3. The test is a success if the voltage displayed is within these limits:

Lift/Lower Control Position	Voltage Displayed
Full lift position	0.4 - 1.5 v
Neutral position	2.0 - 3.0 v
Full lower position	3.5 - 4.6 v

Expected Results

If the voltage reading is outside of these limits, then the test is a failure.

The voltage reading should increase when the lift/lower control is moved from the lift to the lower position. If this is not observed, then the test is a failure.

Possible causes of test failure:

1. The lift/lower pot or wiring between the pot and the Carriage Control Card may be defective. Using an ohmmeter, measure the controller harness between JPC9-5 and JPC9-6, then between JPC9-7 and JPC9-6. The resistance should go in the opposite direction as the control handle is moved.
2. The lift/lower pot may be out of adjustment. With the control handle in neutral, the voltage of the pot should be between 2.0 - 3.0 volts. You can use static maintenance mode to observe the voltage.
3. The mechanical portion of the controller may be defective. Check for loose hardware. If parts are replaced, be sure to run Learn before returning truck to service.
4. The Carriage Control Card may not be functioning properly. Replace with a known good board and re-run the test.

Refer to page 10 for proper procedures when replacing the Carriage Control Card.

Test A15 - Traction Motor Temperature Voltage (Cont'd)

Possible causes of test failure:

1. The drive motor temperature sensor may be defective, or the wiring between the sensor (DT) and the Tractor Manager (JPS19-6 & JPS19-7) may be bad. The sensor can be checked as follows:
   a. Unplug DT connector (located near the drive motor).
   b. Using a digital meter, measure the resistance between the leads from DT-1 and DT-2, (polarity does not matter). The resistance should be approximately 2000 ohms at 68°F (18° C).
   c. The sensor can be further checked by removing it from the heat sink. While watching the digital meter, cup your hands around the sensor and breathe directly on it with a steady, hot breath. The resistance should increase by about 20 ohms.
   d. Check that the temperature sensor is isolated from the truck by checking the resistance from one lead of the sensor to the outside case of the sensor. If high impedance is not found, replace the temperature sensor.

⚠ CAUTION DO NOT USE A HEAT GUN, LIGHTER, OR OTHER SOURCE OF STRONG HEAT FOR THIS TEST, AS THIS MAY DAMAGE THE SENSOR.

2. The cable between the Tractor Manager and the drive motor may be defective.
   a. Check for continuity between JPS19-6 and DT-1, and between JPS19-7 and DT-2.

3. The Tractor Manager VFC may not be functioning properly. Replace with a known good VFC. See page 6 for proper VFC replacement procedures.

4. The Tractor Manager may not be functioning correctly. Replace with a known good unit, and re-run the test.

After replacing boards, be sure to run Learn Mode BEFORE re-running the test.

Test A25 - Flow Sensor Temperature Voltage

This test displays the flow sensor temperature voltage as sensed by the Electric Steer Manager at JPA1-4.

Related Codes and Tests

Code 6N - Flow Sensor Temperature Sensor Out-of-Range. Refer to page 128.

For information on using maintenance mode, refer to page 194. This test can also be run from active maintenance.

Expected Results

1. The Operator's Display will display the flow sensor temperature voltage which the Electric Steer Manager senses from JPA1-4.
2. The test is a success if the current displayed is within these limits:

Test Setup None required.	**Voltage Displayed**
Allowable range.	0.2 - 4.86
Sensor at room temperature.	3.15 - 3.20 (@ 86°F/30°C)

The voltage increases as the temperature increases. A successful test proves that the Electric Steer Manager is properly reading the flow sensor temperature voltage.

If the reading is outside these limits, then the test is a failure.

Possible causes of test failure:

1. Check for 12 volts at JPY1-5. If not found, check for +12 volts at:
   - JPA1-5 - if found here, cable between the Electric Steer Manager and the Flow Module is bad
   - JPA2-9 - if found here, replace the Electric Steer Manager. If not, run test A00. Refer to page 197.
2. The connection at the temperature sensor may be bad.
3. The temperature sensor may be defective.
4. Check for continuity of the negative side of the circuit at: (all wrt TP6 on the Tractor Manager)
   - JPY1-3
   - JPA1-3
   - JPA2-5

Test I01 - Upper Mast Reference Switch (Cont'd)

Possible causes of test failure:

1. The switch actuator may not be properly adjusted.
2. The cable from the switch may not be properly plugged into the Tractor Manager at JPS8. Inspect and verify the connection.
3. The Tractor Manager may not be functioning properly.
   - Disconnect JPS8 from the Tractor Manager. The Display should read Abov.
   - Measure the voltage at JPS8-2 WRT (With Respect To) TP6 (DGND) on the Tractor Manager. The voltage should be 6 to 12 volts.
   - If the voltage is OK, connect a jumper between JPS8-3 and JPS8-1. The Display should change to Belw. If this is not observed, replace the Tractor Manager.
4. The switch may not be operating correctly.
   - Disconnect S10. Remove socket S10 from the connector. Reconnect the connector if using active maintenance. Leave the connector off if using static maintenance.
   - With the test running, jumper the center socket removed to TP6 (DGND) on the Tractor Manager. With S10 jumpered to TP6 on the Tractor Manager, the display should show "Belw". With the jumper removed, the display should show "Abov".

If this is not observed, the cable may be defective. Check the continuity of the cable between the Tractor Manager and the upper mast reference switch. If it checks OK then replace the switch.

If this is observed, replace switch S10.

5. If the truck is displaying a Code 6L and the cable is good, run Test I37. If it fails, replace the Tractor Manager. See NOTE.

NOTE: If the intellispeed option is turned on, Code 6L may not appear. If truck doesn't lift above 150" (381 cm), be sure that jumper is installed at JPS8 on the Tractor Manager.

Test 114 - Side Gate Switches

Using this test, the state of the side gate switches (S60, S61) can be tested. This test will show what the Carriage Control Card is reading from the switch. This test will only work on vehicles equipped with the side gate switch option.

Related Codes and Tests

Lower Side Gates. Refer to page 82.

Procedure

1. For information on using maintenance mode, refer to page 194. This test can also be run from active maintenance.
2. The display will show the state of the side gate switch. Since the switches are in series in software, both side gates must be down for the display to change states.

Side Gates	Operator's Display
One side gate up	Up
Both side gates up	Up
Both side gates down	Down

If this is not observed, then the test is a failure.

Possible causes of test failure

1. The cable from S60/S61 (JPC14/JPC13) may not be properly plugged into the Carriage Control Card. Inspect and verify the connection.
2. The switch(es) may not be properly adjusted.
3. The cable between the switches and the Carriage Control Card may be disconnected or defective.
   a. Disconnect JP13. On the Carriage Control Card, jumper JP13-1 to TP3. The display should show "Down" when the connection is made and "Up" when the jumper is removed. If not, then S60 (JP14) is the problem or the Carriage Control Card is bad.
   b. Repeat step "3a" for JP14.
   c. Both sides must test good for the system to work properly. If both sides check OK, troubleshoot the cables/switches.
   d. Check for +12 volts at the following: (if not OK, replace the Carriage Control Card)
      - JP13-2 wrt JP13-3
      - JP14-2 wrt JP14-3

Refer to page 10 for proper procedures when replacing the Carriage Control Card.

Test I24 - Home Position Switch

This test is only for vehicles with electric steering.

This test displays what the Electric Steer Manager sees from the home position proximity sensor.

Related Codes and Tests

Code G2 - No Steer Position Reference Input. Refer to page 168.
Code G4 - Open Detected in Steer Control Circuit. Refer to page 170.

Procedure

1. For information on using maintenance mode, refer to page 194. This test can also be run from active maintenance.
2. When the test is run, the results will be as follows:

Home Proximity Sensor	Operator's Display
Over metal	On
Away from metal	Off

If this is not observed then the test is a failure.

Possible causes of test failure

1. The gap between the home proximity sensor and metal is very important. If the gap is to great, the voltage generated will not be great enough for the Electric Steer Manager to sense. The gap measured between metal and the sensor must be between 0.060" - 0.100" (1.52 - 2.54 mm).
2. The home sensor proximity switch may not be plugged in properly at JPA7 on the Electric Steer Manager. Inspect and verify connection.
3. Check for +12 volts at JPA7-3 wrt TP1 on the Electric Steer Manager. If not there, replace the Electric Steer Manager. Inspect and verify the connection.
4. Check that ground is available at JPA7-2 wrt JPA2-9. The meter should indicate -10 to -12 volts. If not there replace the Electric Steer Manager.
5. Test the output of the home sensor proximity switch. Connect a DVM to JPA7-1 wrt TP1 on the Electric Steer Manager. When the sensor is over metal there should be zero volts. When the switch is away from metal, the reading should be approximately 10 - 12 volts. If the output is not as described, replace the sensor and test again.

Test 134 - Display Channel B of Steer Encoder

This test applies only to vehicles with electric steering. This test displays what the system senses from channel B of the manual steering signal. This signal is generated by the steering encoder(SE). This encoder is mounted behind the steering wheel.

Related Codes and Tests

No steering, no code displayed, lift and travel OK.
Code G0 - Manual Steering Error (This code can only appear when the truck is **not** guiding on the wire). If there is no request to travel, this code will not appear.
Refer to page 166.

Procedure

1. For information on using maintenance mode, refer to page 194. This test can also be run from active maintenance.
2. The display will show on/off pulses from channel B as the steering wheel is turned. If this is not observed this test is a failure.

Possible causes of test failure

1. Check the continuity of the cable between the Carriage Control Card and the steering encoder.
2. Check for +5.3 volts at JPC1-1 and JC1-7 wrt JPC1-2 (or TP3). If +5.3 volts is not found, replace the Carriage Control Card.

Refer to page 10 for proper procedures when replacing the Carriage Control Card and/or Carriage Control Card microprocessor.

3. The mechanical connection between the steering wheel and the steering encoder may be loose.
4. When using static maintenance mode, disconnect JPP1 at the steering encoder. If the Voltage checks OK from step 2, jumper between JPP1-3 to JPP1-2 (or TP3 on the Carriage Control Card).
    - When the connection is made, the display should show On. When the jumper is removed, the display should show Off.
    - If the display changes from On to Off, replace the steering encoder card.
    - If the display did not change from On to Off, replace the Carriage Control Card.

Test O04 - Reverse Enable Test

Using this test, proper operation of the Tractor Manager's reverse enable signal can be verified.

A successful test proves that the wiring and related circuitry in the Tractor Manager and the Tractor Manager VFC are all functioning properly.

Related Codes and Tests

Code 25 - Short detected in field current. Refer to page 90
Code 26 - Open detected in field current. Refer to page 91.
Test O13 - PWM Test - field. Refer to page 286.

NOTE: This test will toggle the Tractor Manager reverse enable signal on and off. The enable signal "enables" the Power Card to pulse the Power Transistors (TM1, TM2). If the Power Card is not enabled, it can't pass pulses from the Tractor Manager on to the transistors (TM1, TM2).

During normal operation, the enable signal is activated whenever the Tractor Manager is pulsing the Power Transistors (TM1, TM2).

This test only checks that the reverse enable signal from the Tractor Manager is actually arriving at the input to the Power Card. *Test O13 - PWM Ramp* must be run to verify that the Power Card is correctly enabling its output.

For information on how to use maintenance mode, refer to page 194.

Procedure

Connect the positive (+) lead of a voltmeter to JPS5-9 (+12VF). Connect the negative (-) lead of the voltmeter to JPS5-6.

The voltmeter should display the following:

Display	Voltage Reading
OFF	>10.5 volt
ON	< 1.0 volts

If this is not observed, then the test is a failure.

Possible causes of failure:

1. The connection between the Power Card and the Tractor Manager may be bad.
2. The Tractor Manager VFC may not be functioning properly. Replace with a known good Tractor Manager VFC. See page 6 for proper Tractor Manager VFC replacement procedures.
3. The Tractor Manager may not be functioning properly. Replace with a known good Tractor Manager and re-run the test.
4. The Power Card may be bad.

After replacing boards, be sure to run Learn Mode BEFORE re-running the test.

Test O11 -
Chopper Enable
Signal (Cont'd)

Possible causes of failure:

1. The connection between the Power Card and the Tractor Manager may be bad.
2. The Tractor Manager VFC may not be functioning properly. Replace with a known good Tractor Manager VFC. See page 6 for proper Tractor Manager VFC replacement procedures.
3. The Tractor Manager may not be functioning properly. Replace with a known good Tractor Manager, and re-run the test.
4. The Power Card may be bad.

After replacing boards, be sure to run Learn Mode BEFORE re-running the test.

Power Transistor Description

The Power Transistor is a solid-state semiconductor device. Its operation is like that of an electronic switch with no moving parts or contact points. The switching ON and OFF of the transistor is electronically controlled and can be done at a much faster rate than with mechanical switches. In addition, the transistor has a much longer service life, since it contains no moving or mechanical parts. Figure 60 shows the physical characteristics of a Power Transistor while Figure 59 shows the electrical symbol. Switching the transistor on and off is done with electrical potential applied to its base lead. This changes the characteristic of the core material from non conductive to conductive. Once the potential is removed from the base lead, the transistor returns to a non conductive state.

To demonstrate Power Transistor operation, a transistor is connected to the circuit shown in Figure 61. The following processes occur:

- Switch S1 is closed.
- Battery potential is applied to the collector through a load resistor. At this point, the transistor acts like an open switch allowing no current flow.
- When the Power Card applies potential to the base lead of the power transistor, the power transistor turns "ON", allowing a current flow from the collector to the emitter. As long as power is applied to the base lead of the Power Transistor, it will continue to conduct current.
- Removing current from the base lead will return the Power Transistor to a non conductive state, stopping current flow.

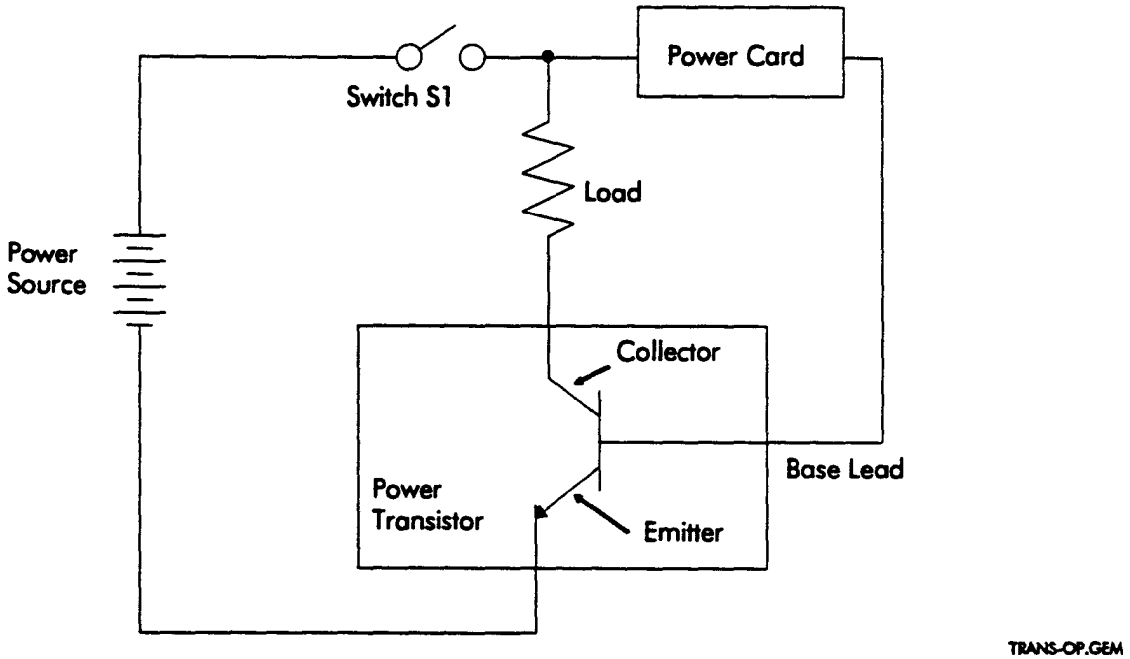


Figure 61 Power Transistor Operation

Turning Key Switch (S1) ON (Cont'd)

9. + 12 VF is now found at the following points on the Carriage Control Card:
   - JPC10-9 (Optional *SMARTi* Port)
   - JPC9-5 (VR2, Lift/Lower Control Pot)
   - JPC9-8 (VR1, Travel Control Pot)
   - JPC3-2 (S28, 60" Limit Switch)
   - JPC7-5 (S23, Carriage Deadman Switch)
   - JPC7-2 (S2, Brake Deadman Switch)
   - JPC8-2 (S11, 24" Limit Switch)
   - JPC4-2 (S25, Optional Lower Inhibit Limit Switch)
   - JPC13-2 (S61, Optional Side Gate Switch)
   - JPC14-2 (S60, Optional Side Gate Switch)

10. The Carriage Control Card receives the +12 VF and generates +5.3 Volts.

11. +5.3 Volts is now found at the following locations on the Carriage Control Card:
    - JPC15-16 (Carriage Control Light Display Card)
    - JPC1-1 (Steering Encoder, if equipped with electronic steering)
    - JPC1-7 (Steering Encoder, if equipped with electronic steering)
    - Used internally by the Carriage Control Card

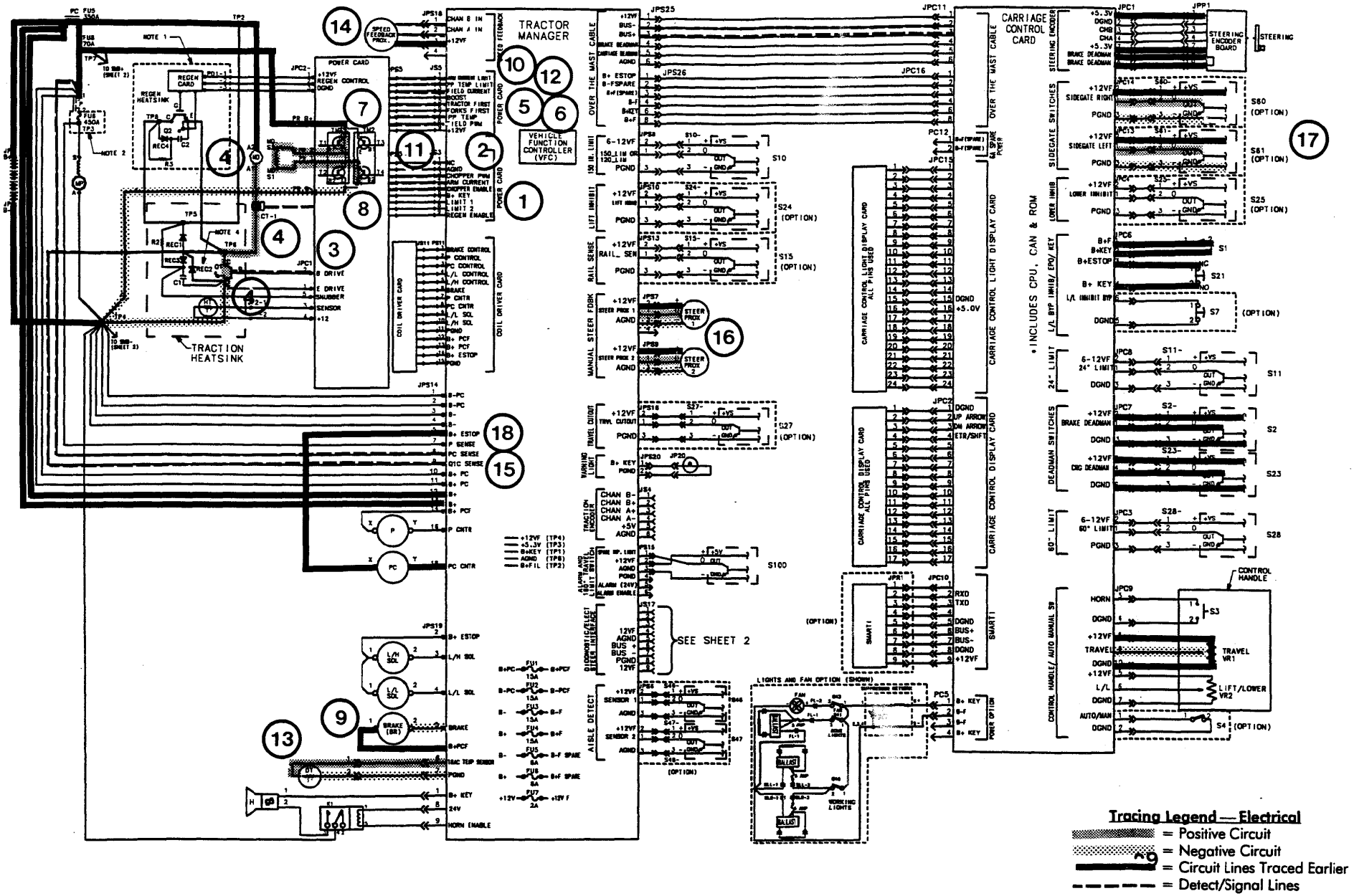


Figure 70 Schematic - Moving Directional/Speed Control to Forward

NOTE:
This schematic is for Theory of Operation only. Refer to the electrical schematic at the back of this manual when troubleshooting or performing maintenance.

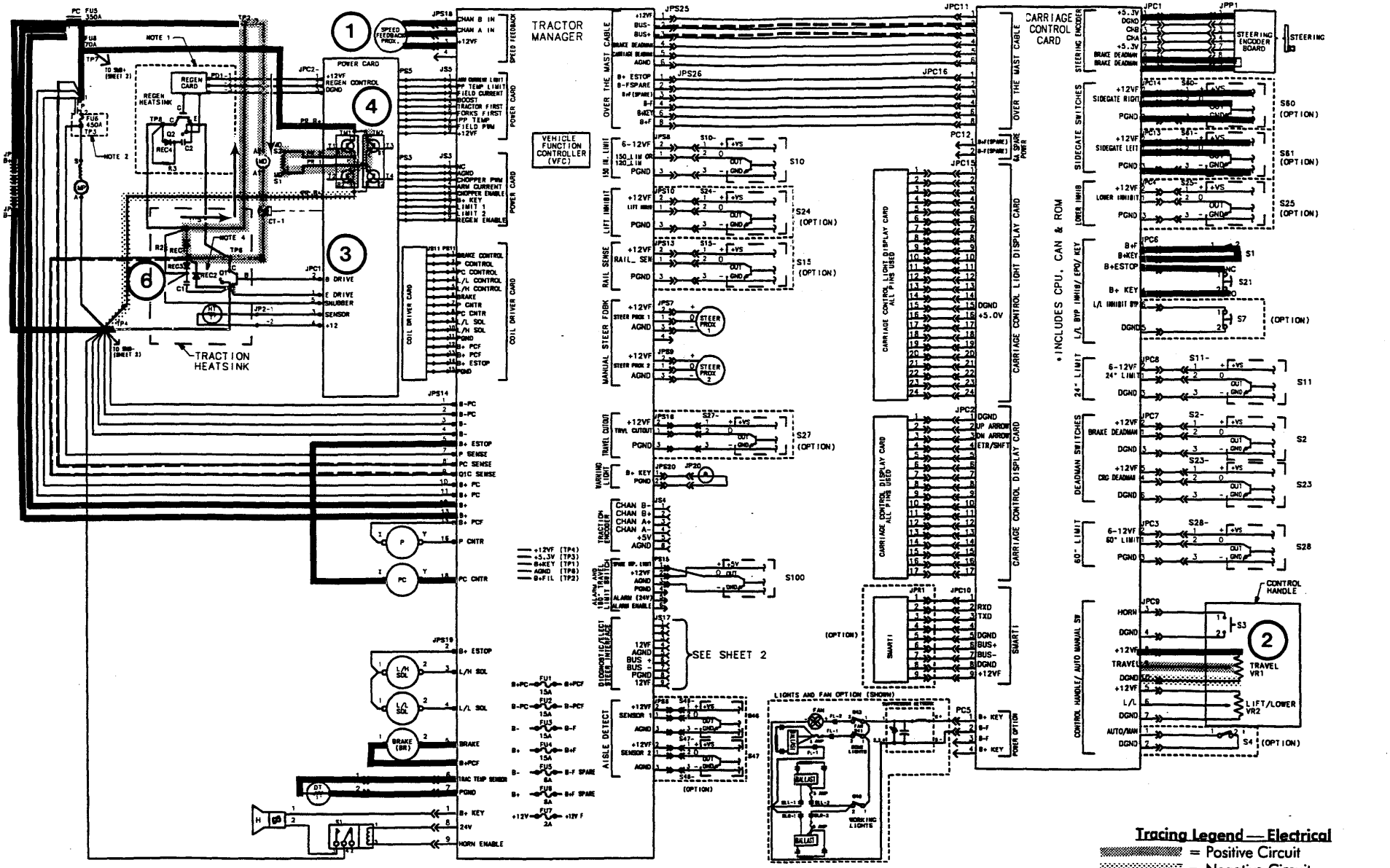


Figure 77 Schematic - Proportional Plugging

NOTE:
This schematic is for Theory of Operation only. Refer to the electrical schematic at the back of this manual when troubleshooting or performing maintenance.

Regenerative Braking Operation

The following steps (1 and 2) assume that the operator has accelerated the vehicle and then has moved the throttle to a position opposite that of travel.

1. ***If REGEN is working properly:***
   a. The truck will go back into DRIVE mode at speeds less than approximately 1 mph (1.6 kph). No error code will be displayed.
   b. At speeds above approximately 1 mph (1.6 kph), the truck will go in the REGEN mode and stay there until the truck is below approximately 0.5 mph (0.8 kph). Then the truck will go back into DRIVE mode.

2. ***If REGEN has failed:***
   a. The truck will go back into DRIVE mode at speeds less than approximately 1 mph (1.6 kph). No error code will be displayed.
   b. At speeds between approximately 1 and 1.5 mph (1.6 and 2.4 kph), the truck will coast. No error code will be displayed.
   c. At speeds faster than approximately 1.5 mph (2.4 kph) with the throttle at more than 50% in the opposite direction of travel:
      - The truck will plug. Braking effort will be controllable by the travel control handle.
      - Error code 2F will be displayed. Maximum speed will be limited to 2 mph (3.2 kph) below the configured speed. To clear the error, turn the key switch to OFF and back to ON. The truck can now reach its maximum travel speed. However, the next time the operator reverses the control handle as described in this step (step 2), one of the situations as described in step 2 will occur.

   d. At speeds faster than 1.5 mph (2.4 kph) with the throttle moved less than 50% in the opposite direction, the truck will coast.

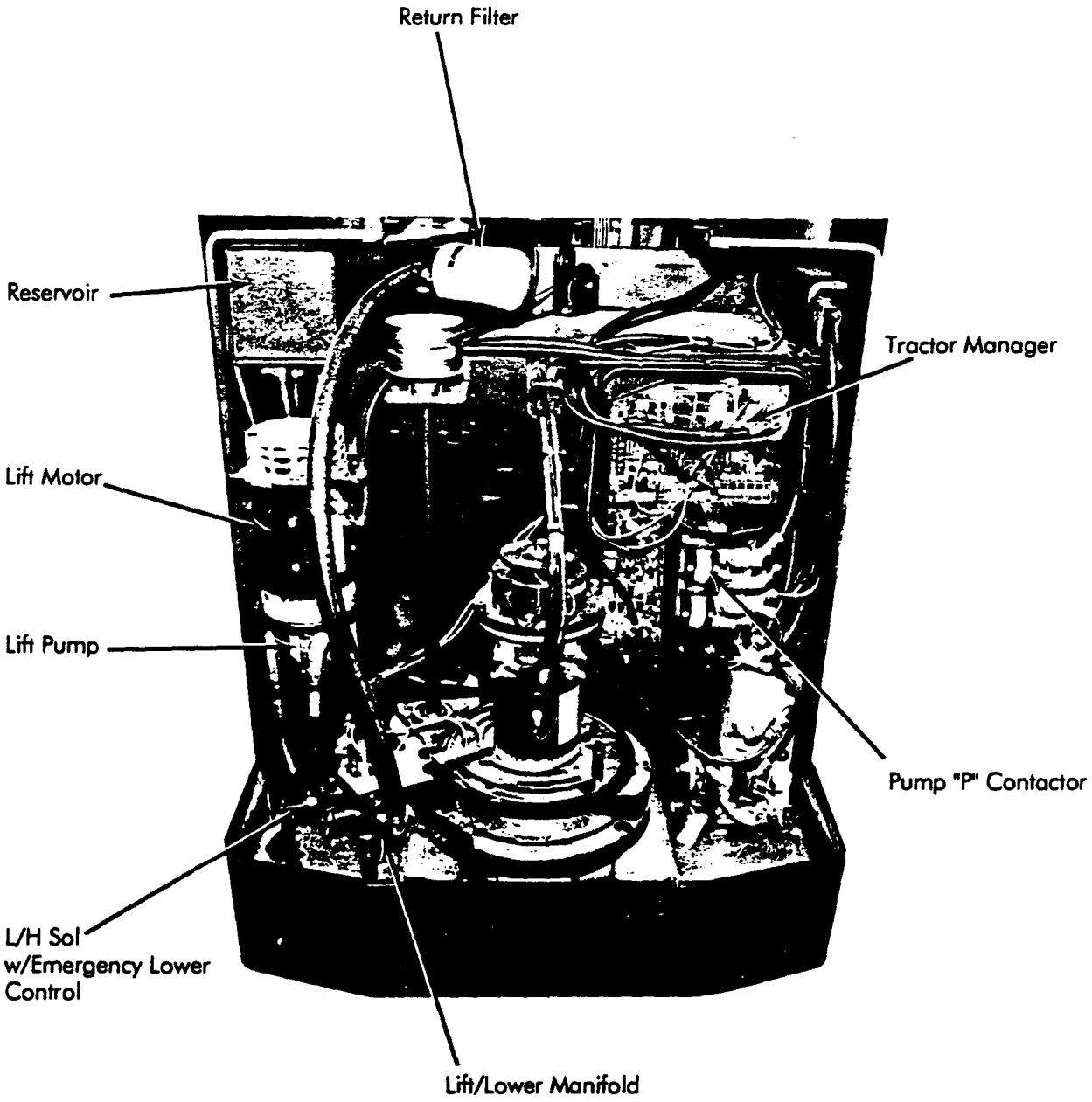


Figure 93 Single Speed Lift/Lower Components

Added 09/15/94

Variable Lift (Cont'd.)

Proportional flow control (L/L Sol) is electrically positioned by the following process:

- Voltage generated by potentiometer VR2 is sent to and processed by the Carriage Control Card. The Carriage Control Card sends lift/lower commands to the Tractor Manager over Bus+/Bus-.

- The Tractor Manager controls the L/L Sol via JPS11-4 (L/L Control). This signal drives the L/L Solenoid coil driver. The frequency is held constant while the pulse width will vary depending on the position of the lift control. The output signals for fast and slow lift rates are shown in Figure 102 and Figure 101 respectively.

Continued next page.

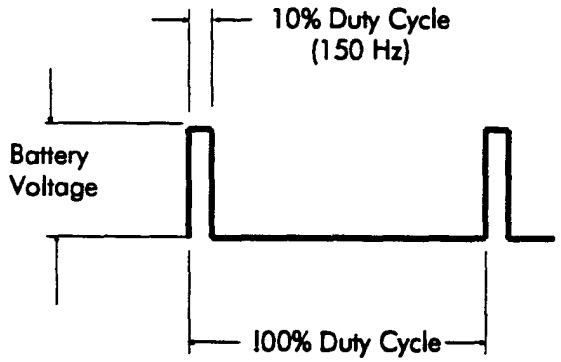
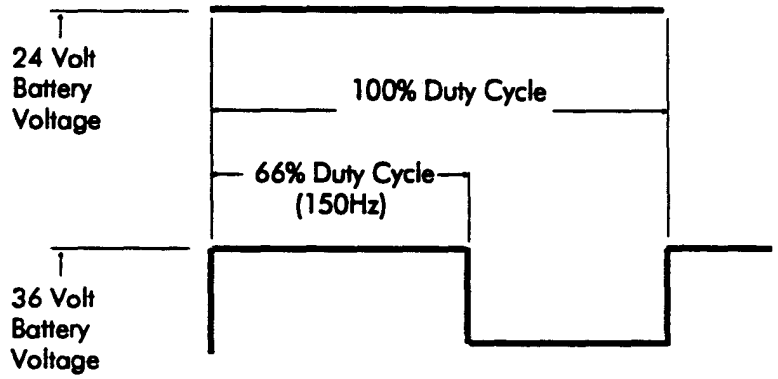


Figure 102 Pulse Width Modulation for Fast Lifting Rate at SOL1



24 volt battery - 100% Duty Cycle
36 volt battery - 66% Duty Cycle (36 volts X 66% = 24 volts)

Figure 101 Pulse Width Modulation for Slow Lifting Rate at SOL1

2-Stage Lift Cylinder Service

1. Remove snap ring (1) from housing.
2. Remove wiper ring (2) from housing.
3. Remove snap ring (9) from housing.
4. Pull piston out until piston stop forces piston seal (3), back-up ring (4), O-ring (5), double gland seal (6), U cup seal (7), and back-up ring (8) out of housing.
5. Pull piston out of housing. Place piston on cushioned stand using care not to damage the piston surface.

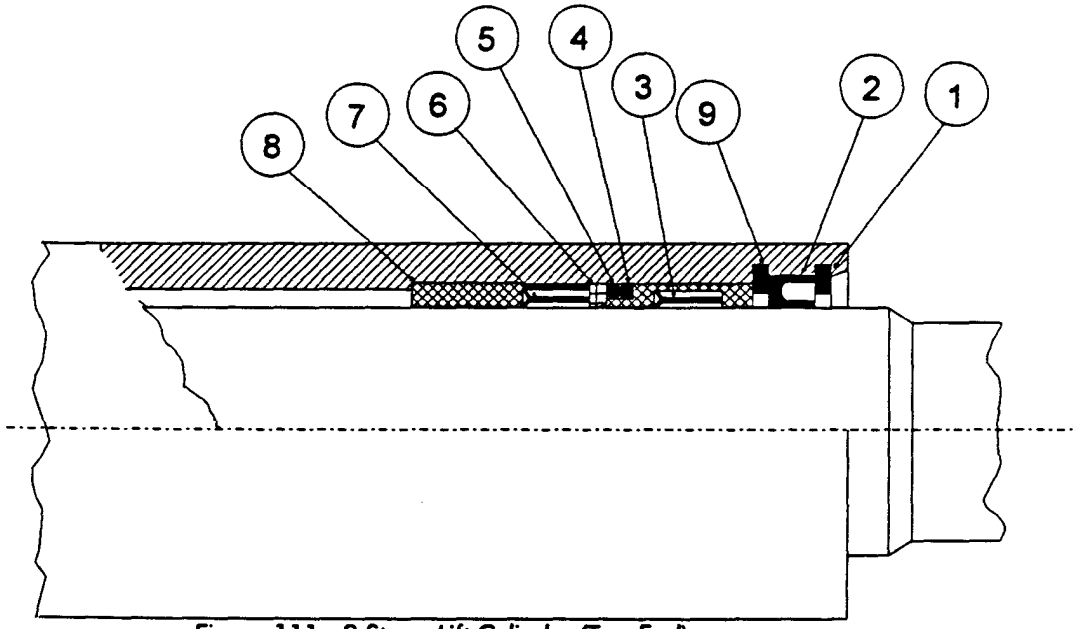


Figure 111 2 Stage Lift Cylinder (Top End)

6. Push plunger (10) in slightly at base of piston (Figure 112).
7. Remove snap ring (11) and retaining ring (12).
8. Release pressure on plunger (10) and remove.
9. Remove spring (13).
10. Remove seal (14) from plunger.
11. Do not separate piston (16) and piston plug (15) unless absolutely necessary. If disassembly is required, use a strap wrench only. Do not mar piston surface.

NOTE: When repacking the cylinder, replace all packings. Refer to the parts section for packing kit part numbers.

Lift/Lower Hydraulic Troubleshooting

The following table is designed to refer service personnel to diagnostics and/or procedures which should aid in pinpointing and eliminating problems in the lift/lower hydraulic system.

Numbered Procedures

The procedures referred to by number (1 - 5) will be found below. When they are indicated, follow them in the order suggested.

Table

If...	Then...
The load drifts excessively (more than 3 inches in 10 minutes with a 3000# load).	• Lift relief valve may be faulty or maladjusted. (#'s 4, 1, 2, 3,5) • Load holding check valve may be faulty. (#'s 1, 2, 3, 5) • Emergency lowering valve may be faulty or maladjusted. (#'s 4, 1, 2, 3, 5) • L/L Sol may be faulty. (#'s 1, 2, 3, 5)
The forks begin to drop while LIFT is actuated.	• Lift relief valve may be faulty. (#'s 4, 1, 2, 3, 5)

Suggested Procedures - Hydraulic Troubleshooting For Lift/Lower

These checks and procedures are designed to aid in locating the cause of trouble in lift/lower system.

1. Check the operation of the indicated component:
   - solenoids: remove, energize, watch for spool or poppet motion, listen for click of plunger.
   - relief valves: check poppet for sticking; back-off adjustment (counterclockwise) if necessary.

2. Check the indicated component for contamination:
   - visually inspect for metal chips, grit, teflon tape bits.
   - remove foreign material
   - inspect sealing surfaces for damage.

3. Check O-rings and backup rings; replace seals if:
   - nicked
   - extruded
   - deformed
   - if doubt exists.

4. Re-adjust relief valves to factory specification.

5. Replace the indicated component. If any doubt exists about the operation or condition of a component, we recommend replacement.

Flow Sensor Disassembly (Cont'd)

5. With the longer section of the turbine assembly pointed up, compress the turbine shaft and spin the turbine using your fingers. The turbine should spin freely for several seconds without chattering. If the turbine does not spin freely, the entire flow sensor assembly must be replaced.

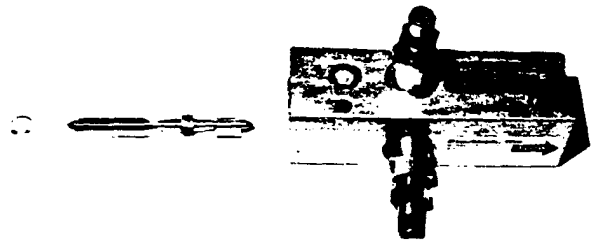
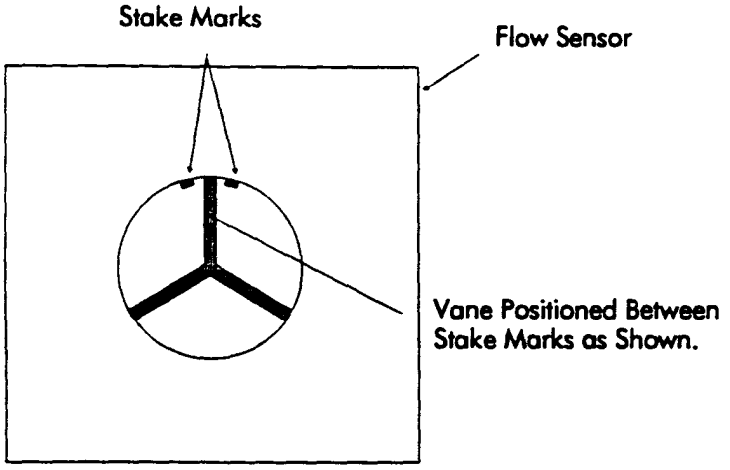


Figure 125 Turbine Assembly Removed from Flow Sensor

6. Reinstall the turbine assembly in the body of the sensor so that one of the vanes of the straightening section, is between two stake marks located in the turbine bore.



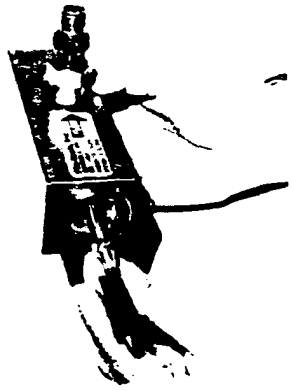


Figure 126 Reinstalling Turbine Assembly in Flow Sensor

7. Using the pencil eraser, depress the turbine assembly and reinstall the inlet snap ring.
8. For reassembly back in the truck, reverse to the hydraulic flow sensor removal procedure.

Troubleshooting

In troubleshooting truck problems it is important to:

- use a logical, common sense approach
- begin with the simplest solution and work towards the most complex.

The following procedure can aid in developing a logical and systematic troubleshooting procedure:

Troubleshooting Procedure

1. Verify problems by:
   - obtaining as much information as you can about the problem.
   - determining, if possible, what the truck's performance was before the problem began.
   - seeing any records which might have been kept about the truck's performance.
   - operating the truck yourself to verify the problem.

2. Locate the truck problem area by:
   - opening the various truck compartment doors and visually inspecting the systems, then consult the hydraulic, electrical and mechanical maintenance sections for general information which may save you time.
   - determining if the problem is in the control circuit or the power circuit if there is no obvious physical problem.

3. Establish a logical testing sequence by:
   - use the electrical schematic. Begin at the battery and establish a sequence of testing points to locate the problem. Use the schematic in conjunction with the appropriate Flow Diagram.
   - establishing test points which indicate that all components between any new test point and the battery are good.
   - avoiding haphazard checking which provides inconclusive results.

4. Use the Troubleshooting Flow Diagrams by:
   - consulting the List of Truck Problems.
   - If a Flow Diagram is applicable, then follow the particular diagram from the beginning to where the probable cause is isolated.

5. Identify the cause of the problem by:
   - checking for improper truck usage.
   - bringing the problem to the service manager's attention to avoid repetition of the cause.

6. Correct the problem by:
   - repairing or replacing defective components following instructions in the maintenance section of this manual.
   - complying with appropriate safety procedures.

Continued next page.

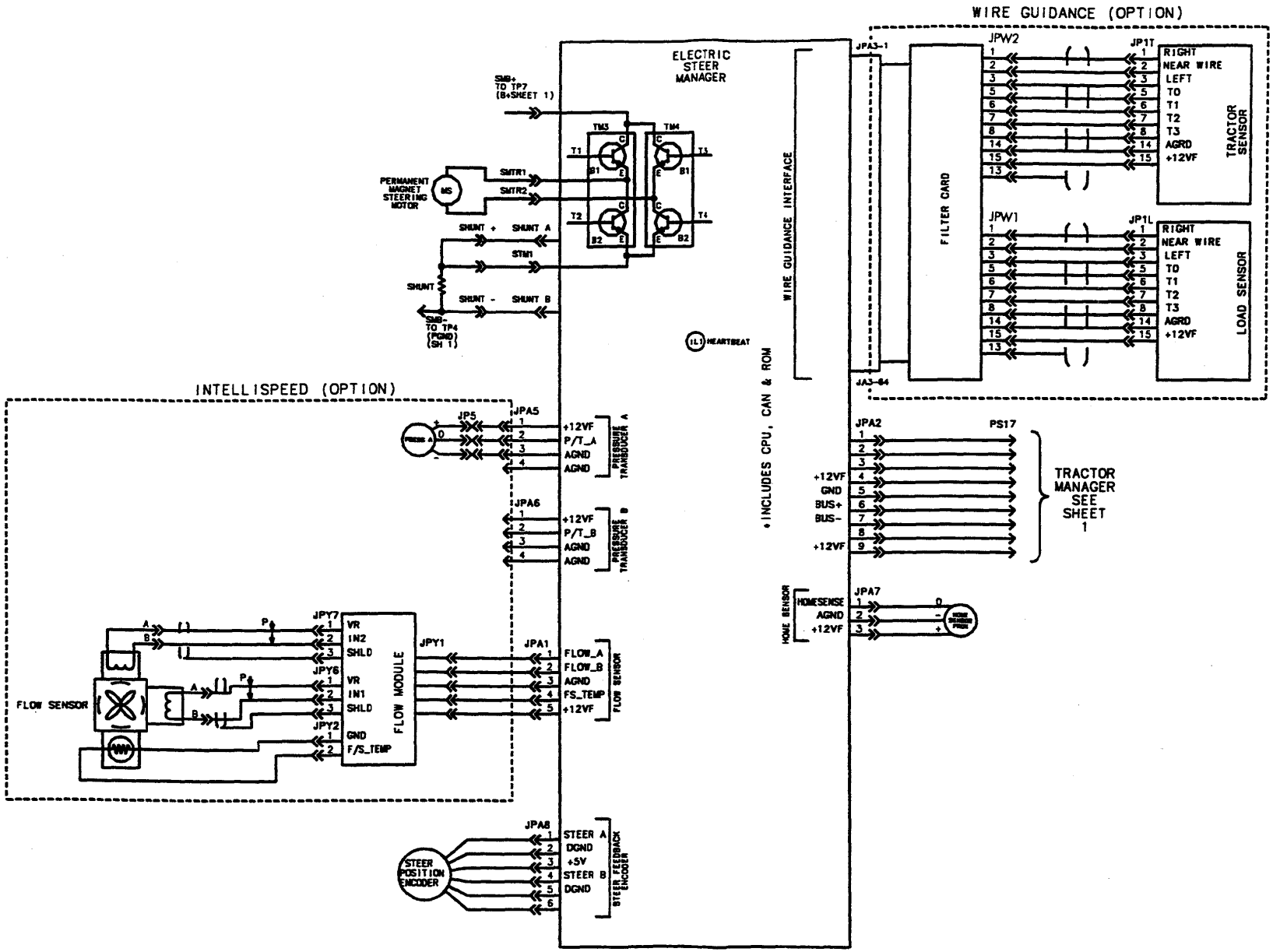


Figure 135 *Schematic, Electrical (Sheet 2 of 3)*
With Carriage Control Card p/n 154-012-377 Rev D or Lower

PROCEDURES (Cont'd.)

1. Disassemble the handle.
2. Temporarily label each wire at the horn switch and lift pot to avoid confusion when re-assembling the handle.
3. Unsolder all wires at the horn switch and lift pot and pull them through the opening of the handle housing.
4. Remove and discard the horn switch, metal pin, compression spring, and plastic spring button.
5. Assemble the new switch to the new handle cover using the lock washer and nut that comes with the switch.
6. Route the horn switch and lift pot wires through the opening in the new handle housing.
7. Solder the wires to the horn switch and lift pot and cover each terminal with 1/2 in. of shrink tubing.
8. Remove the temporary wire labels and assemble the handle.

PARTS AVAILABILITY: The following new handles are available with the solid-state horn switch.

114-120-264/004	Raymond Standard
114-120-264/005	Raymond Cold Storage 24V
114-120-264/006	Raymond Cold Storage 36V

All are now available through the Parts Distribution Center.

Note: Any horn switch under warranty requires a handle replacement.

FILING INSTRUCTIONS: File a copy of this notice in the following Maintenance Manuals and page locations:

PDMM-0032 after page 372

PDMM-0029 after page 443

PDMM-0101 after page 7-28

FOTP-0005/mlc/01-01-03/C