

TABLE OF CONTENTS

General	1
EPS III.....	1
APS.....	1
Description	1
EPS III.....	1
APS System.....	2
Checks and Adjustments	2
General.....	2
Checks, EPS III.....	2
Dipswitches, EPS III.....	2
LED Indicators, EPS III.....	3
Check Steering System for Correct Operation, EPS III.....	3
Check Slow Travel Speed, EPS III	3
Check High Lift Traction Shutoff, EPS III	4
Checks, APS.....	4
Dipswitches, APS	4
LED Indicators, APS.....	4
Adjustments.....	4
General.....	4
Steer Motor With Steering Chain Replacement, EPS III	5
Steer Motor With Steering Gear Replacement, APS.....	5
Return-to-Center Steering System.....	5
Command Potentiometer Adjustment, EPS III.....	5
Feedback Potentiometer Adjustment (Earlier Models Only)	7
Tach Generator Steering System, EPS III.....	10
Tach Generator Adjustment, EPS III	10
Sensitivity Adjustment, EPS III	10
Feedback Potentiometer Adjustment, EPS III.....	10
Slow Travel Adjustment, EPS III.....	11
Return-to-Center and Multiturn System, APS.....	12
Encoder Replacement, APS	12
Steering Chain Adjustment, EPS III	12
Repairs.....	13
RTC Steering System, EPS III.....	13
Command Potentiometer Replacement, EPS III.....	13
TGS System, EPS III.....	14
Tach Generator Replacement, EPS III.....	14
Feedback Potentiometer Replacement, EPS III	14
ECM Replacement, EPS III	14
Steer Motor Assembly and Steering Chain Replacement, EPS III.....	14
Typical Operating Voltages, EPS III.....	15
Steering Proximity Switch and Centering Proximity Switch, APS	16
Troubleshooting.....	17
EPS III.....	17
APS.....	18

General

This section contains procedures for adjustment, repair, and troubleshooting of the Electric Power Steering (EPS III) System and Advanced Power Steering (APS) System. The systems control the steer motor used to turn the master drive unit. The lift truck steering is controlled by turning the master drive unit.

EPS III

EPS III is only applicable to the B174, E118, F118, and C174 trucks. There are three types of EPS III systems available: the standard system, called the Return-to-Center (RTC) Steering System, the optional Tach Generator Steering (TGS) System, and the optional Wire Guidance Steering System.

This section pertains to the RTC and TGS Systems only.

NOTE: This manual is NOT applicable to lift trucks with the optional Wire Guidance Steering System. See the section **Wire Guidance - Description** 2200 SRM 421 for checks and adjustments and the section **Wire Guidance - Repair** 2200 SRM 422 for repairs to the steering system of trucks equipped with the Wire Guidance Steering System.

APS

APS is only applicable to the G118 and D174 trucks. There are two steering input devices used with the APS: the standard system, called the Multiturn Steering (MTS) System and the optional Return-to-Center (RTC) System.

Description

EPS III

The EPS System is comprised of the following components:

- Steering handle (RTC System) or steering wheel (TGS System)
- Command potentiometer (RTC System) or the tach generator (TGS System)
- Feedback potentiometer
- Steer system wire harness
- Electronic Control Module (ECM)
- Lift truck battery
- Steer motor
- Steering sprocket and chain



WARNING

The Master Drive Unit (MDU) will automatically center when the key is ON. Keep hands, arms, and other appendages and tools clear.

The RTC System has a steering handle that returns to the center position when released. The handle moves 100 degrees each side of center for the full range of steering control. The TGS System has a steering wheel coupled to a belt-driven tach generator. The steering wheel does NOT automatically return to the center position.

The steering handle and command potentiometer for the RTC System are located in the operator's compartment. Similarly, the steering wheel and tach

generator for the TGS system are located in the operator's compartment. The ECM and steer motor are in the motor compartment beside the master drive unit. The feedback potentiometer is connected to the steer motor below the steer sprocket. The steering chain connects the steer sprocket at the gear motor to the sprocket of the master drive unit. The ECM is also located in the steer motor compartment.

The command potentiometer attached to the steering handle provides a signal to the ECM corresponding to the operator input. Similarly, the tach generator coupled to the steering wheel on the optional TGS system provides a signal to the ECM corresponding to the operator input. The ECM processes the signal to determine the steer angle selected by the operator.

The feedback potentiometer is connected to the steer motor. The feedback potentiometer provides a signal to the ECM that corresponds to the position of the master drive unit.

The signal from the command potentiometer (or tach generator) and the signal from the feedback potentiometer are sent simultaneously to the ECM. If the master drive unit is not at the operator-selected angle, the ECM provides electrical output to the steer motor.

The steer motor is coupled to the master drive unit with a sprocket and chain. The electrical output to the steer motor causes the motor to rotate the

sprocket and chain and turn the master drive unit. As the master drive unit approaches the selected angle, the signal from the feedback potentiometer changes to instruct the ECM to slow and then stop the rotation of the steer motor.

APS SYSTEM

The APS System is comprised of the following components:

- APS controller
- Steering handle (RTC) or steering wheel (MTS) mechanisms
- Steering encoder for both systems
- Steering proximity switch (RTC only)
- MDU centering proximity switch (MTS and RTC)
- Steer motor with built-in position encoder
- Steering sprocket and chain or gear

The MTS System has a steering wheel that does NOT automatically return to the center position. It has no stops.

The RTC System has a steering handle that returns to the center position when released. The handle moves 100 degrees each side of center for the full range of steering control.

The steering wheel and encoder for the MTS System are located in the operator's compartment. The steering handle, steering proximity switch, and steering encoder for the RTC System are located in

the operator's compartment. The APS controller, steer motor, and the MDU centering proximity switch are in the motor compartment beside the master drive unit.

The steering encoder is attached to the steering wheel, which provides a signal to the Master Control Unit (MCU) corresponding to the operator input. Similarly, the steering handle on the optional RTC system provides a signal to the MCU corresponding to the operator input. The MCU processes the signal to the steer angle selected by the operator, and steering commands are sent to the APS controller via the CAN bus communication wires.

If the MDU is not at the operator-selected angle, the APS provides electrical output to the steer motor.

The steer motor is coupled to the master drive unit with a sprocket and chain or a gear. The steering chain connects the steer sprocket at the gear motor to the sprocket of the master drive unit. The electrical output to the steer motor causes the motor to rotate the sprocket and chain or pinion gear and turn the master drive unit. On lift trucks that have gear steering, the pinion gear on the steering actuator directly drives the ring gear on the master drive unit. As the master drive unit approaches the selected angle, the signal from the steering encoder changes to instruct the APS controller to slow and then stop the rotation of the steer motor.

Checks and Adjustments

GENERAL



WARNING

Do not operate a lift truck that needs adjustments or repairs. Report the need for adjustments or repairs immediately. If adjustment or repair is necessary, put a DO NOT OPERATE tag in the operator's area. Remove the key from the key switch.



WARNING

Some of the checks and adjustments are done with the battery connected. Never have any metal on your fingers, arms, or neck. During some checks or adjustments, the operator must move the lift truck. The person doing the adjustments must make the adjustments with the system energized. Make sure the operator does

not move the lift truck and cause a personal injury.

Do not make adjustments to a properly operating steer system.

CHECKS, EPS III

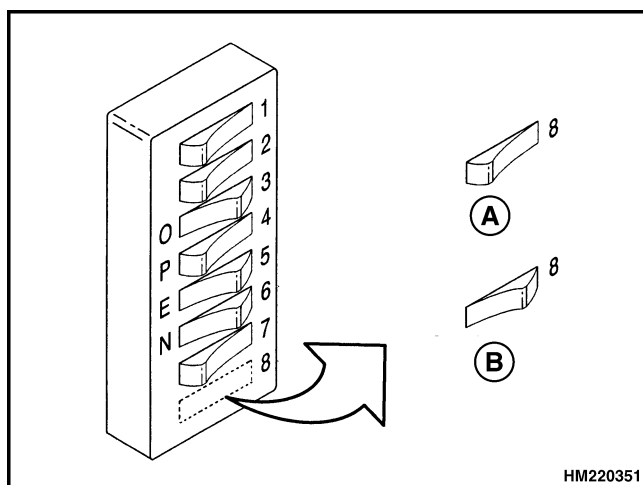
Three test points are provided for adjustment of the ECM. TP1 is the feedback potentiometer input adjusted by P2. TP2 is the command potentiometer input adjusted by P1. TP3 is the analog and logic common. Light-Emitting Diodes (LEDs) 1 through 5, located on the ECM circuit board, are used to indicate steer system faults.

Dipswitches, EPS III

NOTE: The dipswitches are factory-set and should not need to be adjusted.

If the ECM is replaced, or the settings of the dipswitches are inadvertently changed, refer to Figure 1 to set the position of the dipswitches to the factory settings.

On trucks equipped with the optional TGS System, an adjustment can be made to the settings of dipswitches 5, 6, and 7 to alter the sensitivity of the tach generator input scaling, if desired. Refer to Tach Generator Steering System, EPS III, Sensitivity Adjustment, EPS III in the Adjustments section following.



- A. SET SWITCH 8 FOR RTC STEER
B. SET SWITCH 8 FOR TACH STEER

Figure 1. Dipswitches - Factory Setting

LED Indicators, EPS III

The ECM continuously monitors the steering system. Problems detected by the ECM are indicated by 5 LEDs. Refer to Figure 2 and Table 1. The vehicles equipped with electric steering systems are designed to stop automatically when a fault occurs. The brake relay, located in the ECM, applies the brake to stop the vehicle if a fault condition is detected.

Table 1. LED Indicators

LED 1 on (green) (with motor clicking sound)	Controller active
LED 2 on (red)	Left limit reached
LED 3 on (red)	Right limit reached
LED 4 on, LED 5 off	Error in sensor circuit

Table 1. LED Indicators (Continued)

LED 4 off, LED 5 on	Error in controller or motor circuit
LED 4 on, LED 5 on	Error in controller
LED 4 off, LED 5 off, and LED 1 on (with no sound from motor)	Supply contactor fault or voltage on emergency brake coil (the controller must remain off for a minimum of 2 seconds before a new startup to avoid an error condition)

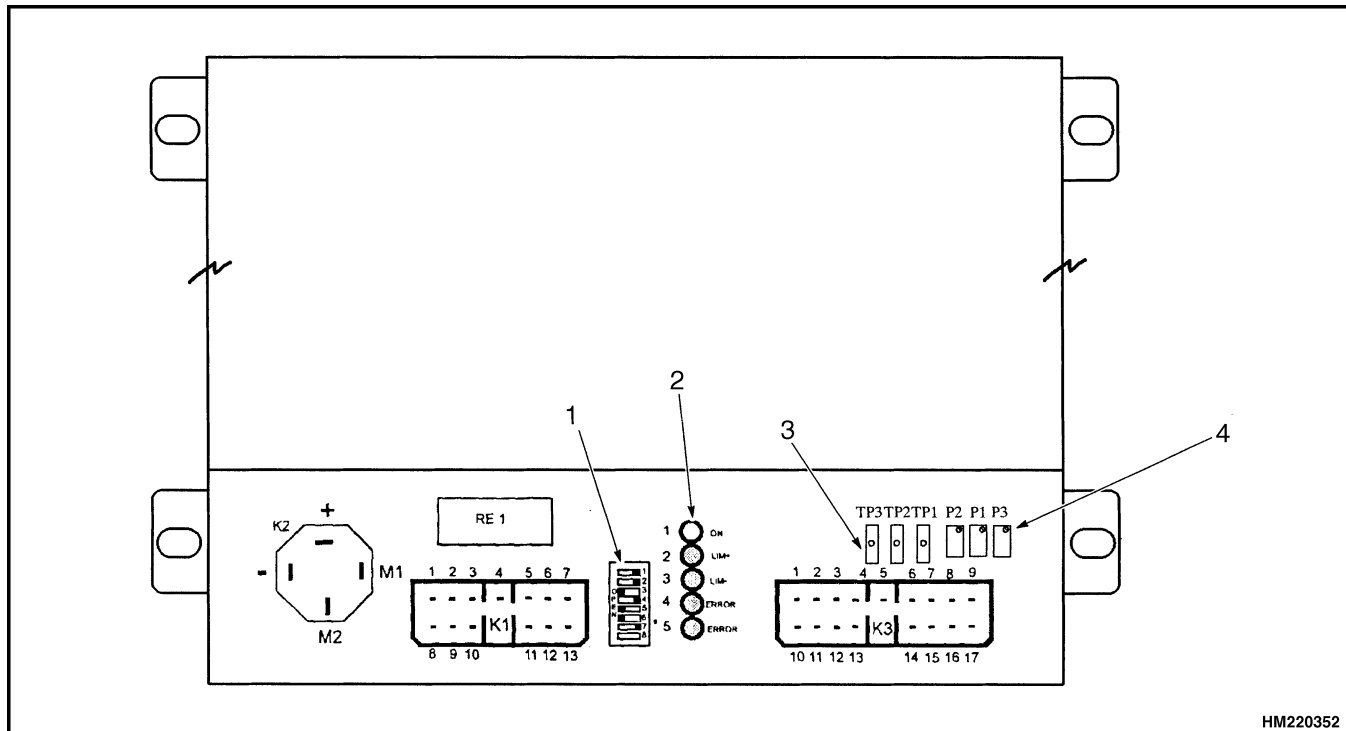
Check Steering System for Correct Operation, EPS III

The ECM check includes checks for the command potentiometer and the feedback potentiometer.

1. Open the motor compartment door. Move the key switch to the **ON** position and push the foot switch. Make sure the battery has a corrected specific gravity of at least 1.250.
2. Check the system for correct operation, move the steering handle or steering wheel from a full left turn position to a full right turn position. The master drive unit should move 85 to 95 degrees in each direction from straight travel.
3. If the master drive unit moves less than 90 degrees (± 5 degrees) in either direction, the steering is incorrectly adjusted or may have a mechanical problem. Refer to Adjustments.
4. Check that the master drive unit moves through the full range of rotation in 5 seconds or less. The lift truck must be on smooth concrete with a fully charged battery and no load.
5. If the master drive unit requires greater than 5 seconds to move through the full range of rotation, check for a mechanical problem or defective ECM.

Check Slow Travel Speed, EPS III

NOTE: The slow travel speed is checked during the adjustment procedure. Refer to Adjustments.



1. DIPSWITCHES
2. LEDS

3. TEST POINTS
4. POTENTIOMETERS

Figure 2. Electronic Control Module (ECM) - EPS III

Check High Lift Traction Shutoff, EPS III

1. Instruct the operator to raise the platform above 3810 mm (150 in.).
2. The traction system should **NOT** operate with the operator platform above 3810 mm (150 in.) unless the truck is equipped with the high lift travel-enable option. Note that the standard travel cut-out for the E/F118 is 5384.8 mm (212 in.). If the unit is so equipped, check that the traction system operates normally **EXCEPT** when the steering is set for 10 degrees or more from center and the operator platform is above 3810 mm (150 in.). If the steering is set for more than 10 degrees and the operator platform is above 3810 mm (150 in.), the traction system should **NOT** operate.

CHECKS, APS

There are no adjustments for the 1243 Controller Module for APS System.

Dipswitches, APS

There are no dipswitches on the APS System.

LED Indicators, APS

There are no LED indicators on the APS System.

ADJUSTMENTS

General

NOTE: This manual is **NOT** applicable to lift trucks with the optional Wire Guidance Steering System. See **Wire Guidance - Description EPS III** 2200 SRM 421 or **Wire Guidance - Description APS** 2200 SRM 957 for checks and adjustments to the Wire Guidance Steering System.

NOTE: Do not make adjustments to a properly operating steering system. The following adjustments must be done in the order specified. Do not move the steering wheel or handle after it has been accurately centered unless instructed to move it in the following procedures.

NOTE: The steer motor has no internal serviceable parts. Do not disassemble the steer motor.

NOTE: The steer motor gearbox does not have any serviceable parts, nor does the gearbox oil need to be checked, refilled, or replaced.

Make sure the battery has a corrected specific gravity of at least 1.250. Move the lift truck to an open area where it can be driven in a straight line for a distance of at least 9 m (30 ft).

Steer Motor With Steering Chain Replacement, EPS III

Refer to Figure 5 and Figure 6 for the following instructions.

1. Turn key switch **OFF**, disconnect battery, and open the motor compartment door.
2. Hold the steer motor assembly and remove the capscrews, nuts, and washers that fasten the motor assembly to the frame.
3. Carefully tip the top of the assembly away from the panel to remove the motor from the truck. Remove the steering chain from the sprocket.
4. Remove the steering chain from the master drive unit sprocket as required by pulling the chain anchor pins out of the holes in the sprocket. Clean and lubricate the chain using multipurpose grease.
5. Make sure the master drive unit is aligned for straight travel. Install the steering chain on the master drive unit sprocket. Install the pin of the chain anchor in the first hole before the axle centerline.
6. Install the new motor and sprocket assembly. Tighten the capscrews and nuts to 31 N•m (23 lbf ft).

Steer Motor With Steering Gear Replacement, APS

Refer to Figure 7 for the following instructions.

1. Turn key switch **OFF**, disconnect battery, and open the motor compartment door.
2. Remove the three bolts holding the steer motor assembly to the frame and lift out the steer motor and pinion gear.

3. Install steer motor onto the frame by aligning the teeth of the pinion gear with the teeth of the steering gear and installing the three bolts.

NOTE: There are no adjustments between the steering gear motor and the steering gear.

4. Torque the three bolts holding the steer motor assembly to the frame to 23 N•m (17 lbf ft). Lubricate the pinion gear and ring gears using multi-purpose grease.

Return-to-Center Steering System

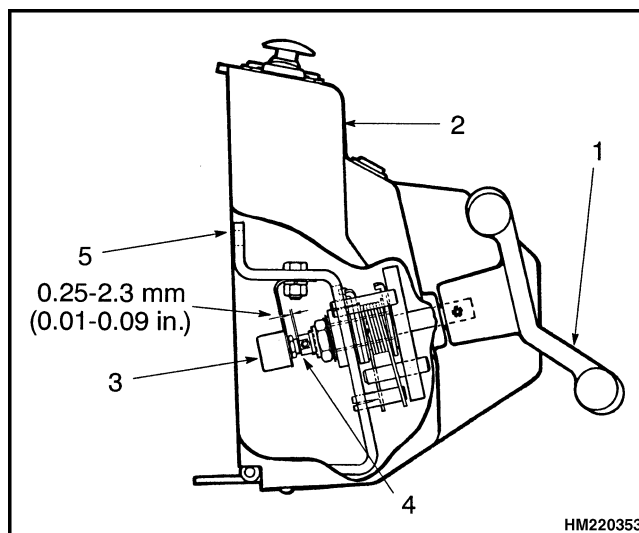
Command Potentiometer Adjustment, EPS III



WARNING

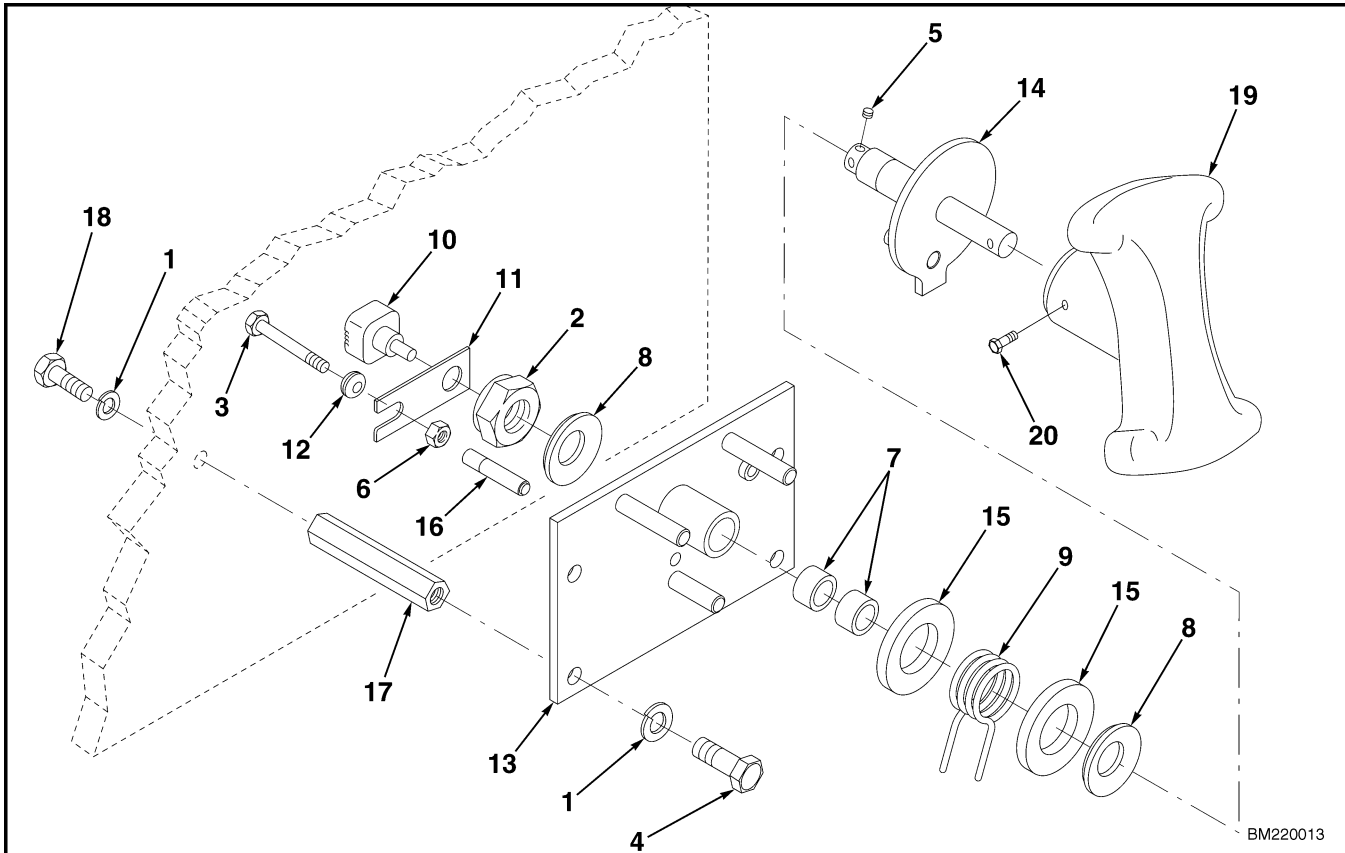
The MDU will automatically center when key is ON. Keep hands, arms, and other appendages and tools clear.

The Return-to-Center (RTC) command potentiometer is located at the steering mechanism in the instrument panel. Refer to Figure 3 and Figure 4. Remove the screws at the top of the instrument panel. Tilt the panel to the open (down) position for access to the potentiometer.



1. RTC STEERING HANDLE
2. INSTRUMENT PANEL
3. COMMAND POTENTIOMETER
4. RETAINING NUT
5. COWL CAPSCREWS

Figure 3. Return-to-Center (RTC) Steering, EPS III



- | | | |
|---------------|-----------------------|----------------------|
| 1. LOCKWASHER | 8. BELLEVILLE WASHER | 15. WASHER |
| 2. NUT | 9. SPRING - TORSION | 16. PROXIMITY SWITCH |
| 3. CAPSCREW | 10. ENCODER | 17. STANDOFF |
| 4. CAPSCREW | 11. BRACKET - ENCODER | 18. CAPSCREW |
| 5. SETSCREW | 12. GROMMET - RUBBER | 19. HANDLE |
| 6. NUT | 13. PLATE WELDMENT | 20. SCREW |
| 7. BUSHING | 14. SHAFT | |

Figure 4. Return-to-Center (RTC) Steering, APS (Exploded View)

1. Set the key switch in the **OFF** position.
2. Unplug the connector from the command potentiometer. Refer to Figure 3.
3. Use an ohmmeter to measure the resistance between wires 19 (black) and 20 (green). Measure the resistance between wires 20 (green) and 21 (white).
4. Adjust the command potentiometer until the resistance values measured in Step 3 are equal (+50 ohms). Adjust the potentiometer by loosening the retaining nut and moving the potentiometer body to attain the desired resistance readings. Tighten the retaining nut without moving the potentiometer body.
5. Attach the plug removed in Step 2 to the command potentiometer.
6. Set the key switch to the **ON** position.
7. Measure the voltage across TP3 and TP2 on the ECM circuit board by inserting the negative probe into TP3 and the positive probe in TP2. Refer to Figure 2. Adjust potentiometer P1 on the ECM circuit board to a value of 0 VDC (+ 0.05 VDC).

Feedback Potentiometer Adjustment (Earlier Models Only)



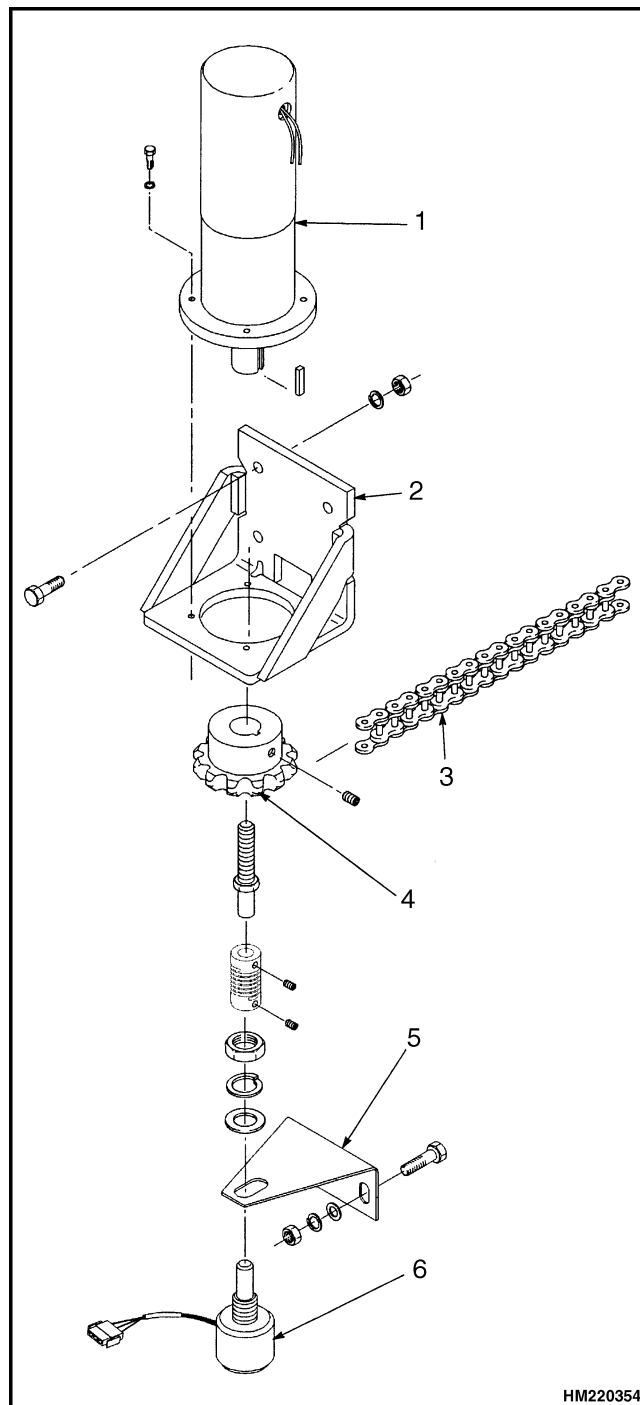
CAUTION

Make sure the RTC command potentiometer is properly adjusted before adjusting the feedback potentiometer.

1. Center the drive tire and steer handle for straight travel. After the drive tire and handle are centered, do not adjust the steer handle again until specifically instructed to do so in this procedure.
2. Refer to Figure 5 and Figure 6 to identify the feedback potentiometer. Unplug the connector from the feedback potentiometer.
3. Measure the resistance between wires 16 and 17. Measure the resistance between wires 17 and 18.
4. Adjust the feedback potentiometer until the resistance values measured in Step 3 are equal (+50 ohms). Adjust the potentiometer by loosening the retaining nut and moving the potentiometer body to attain the desired resistance readings. Tighten the retaining nut without moving the potentiometer body.
5. Attach the plug removed in Step 2 to the feedback potentiometer.
6. Set the key switch to the ON position.

NOTE: If there are no steering changes within a 10-second period, the ECM removes power to the steer motor. To restore power to the steer motor, step on the foot switch.

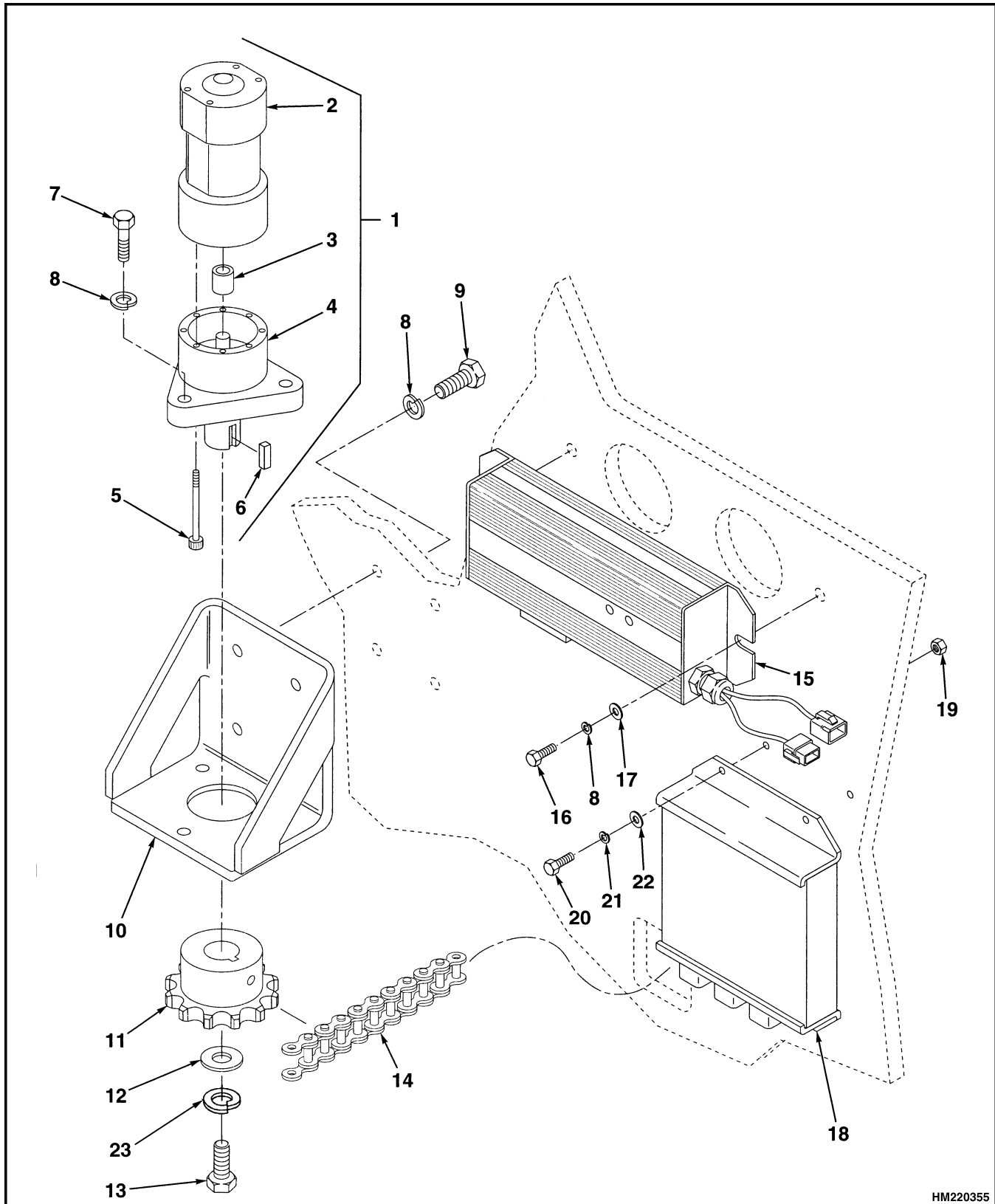
7. Measure the voltage across TP3 and TP1 on the ECM circuit board by inserting the negative probe into TP3 and the positive probe into TP1. Refer to Figure 2. Ensure that the ECM has not removed power to the steer motor. Adjust potentiometer P2 on the ECM circuit board to a value of 0 VDC (+ 0.05 VDC).



HM220354

1. MOTOR
2. MOTOR MOUNTING BRACKET
3. CHAIN
4. SPROCKET
5. POTENTIOMETER MOUNTING BRACKET
6. FEEDBACK POTENTIOMETER

Figure 5. Motor Mounting Assembly (EPS III)

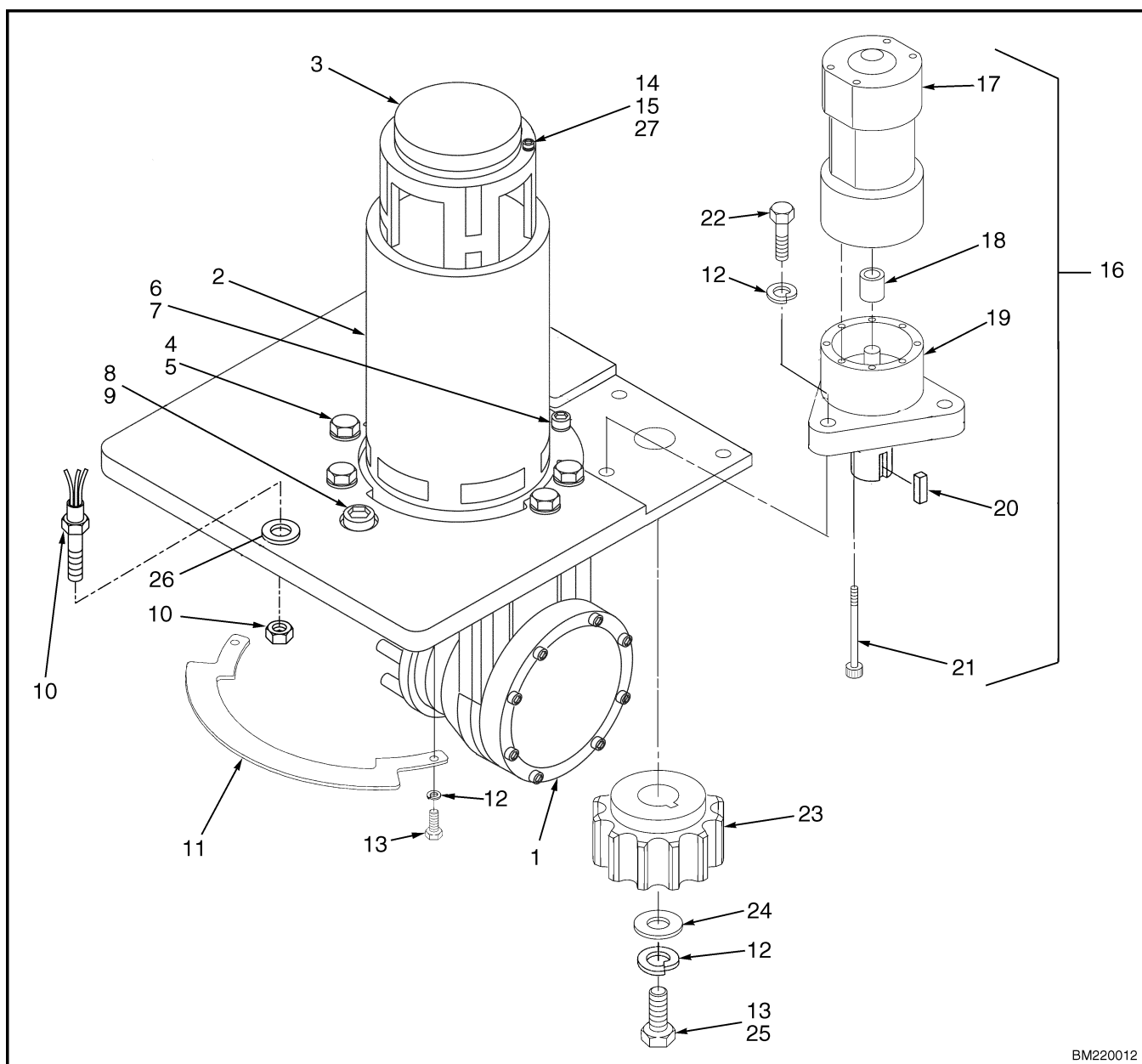


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Figure 6. Motor Mounting Assembly (D174 and G118 Only) - APS

Legend for Figure 6

- | | | |
|----------------------------|-------------------------------|--|
| 1. STEERING ACTUATOR | 9. CAPSCREW | 17. FLAT WASHER |
| 2. MOTOR | 10. BRACKET - STEER MOTOR | 18. STEERING CONTROLLER, WIRE GUIDANCE |
| 3. COUPLING, MOTOR/GEARBOX | 11. SPROCKET | 19. NUT |
| 4. GEARBOX | 12. FLAT WASHER | 20. CAPSCREW |
| 5. CAPSCREW | 13. CAPSCREW | 21. LOCKWASHER |
| 6. OUTPUT SHAFT KEY | 14. CHAIN - ROLLER | 22. FLAT WASHER |
| 7. CAPSCREW | 15. STEERING CONTROLLER (APS) | |
| 8. LOCKWASHER | 16. CAPSCREW | |

**Figure 7. Motor Mounting - Gear Steering**

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(More Content includes: Brake system, Capacities, and specifications, Frame, Hydraulic, System, Industrial battery, Main control, Valve, Mast repair, Fasteners, Schematics diagrams, Steering axle, Steering system, Wire harness repair And more)

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