



# Service Data

SD-25-50062

## Steering Assist System

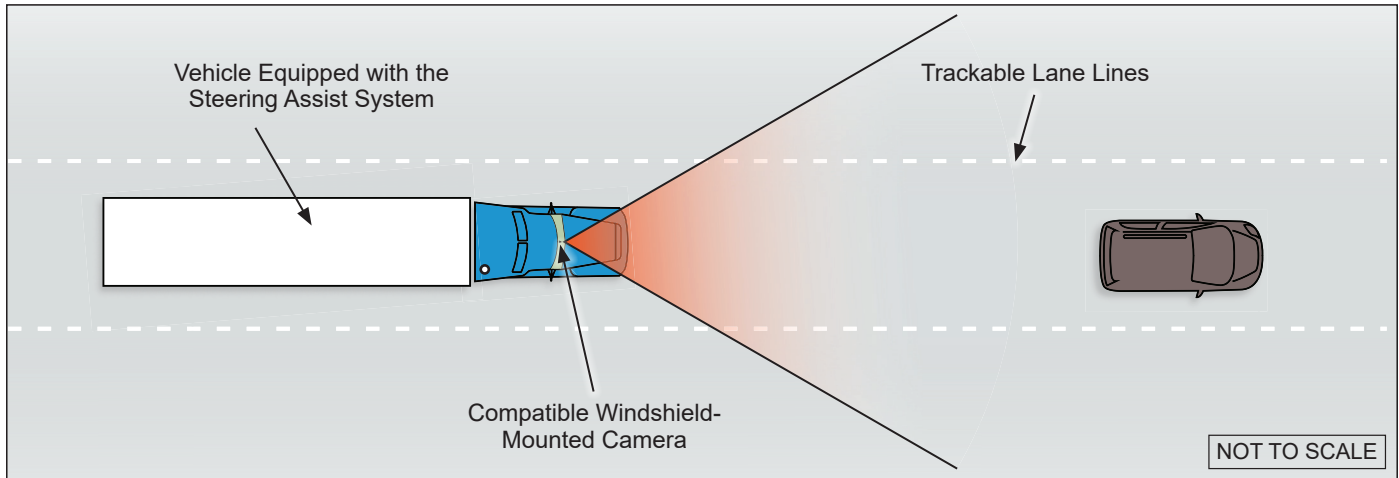


Figure 1 – The Steering Assist System Uses a Windshield-mounted Camera



**WARNING**

Bendix safety technologies complement safe driving practices. No commercial vehicle safety technology replaces a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Responsibility for the safe operation of the vehicle remains with the driver at all times.

### DESCRIPTION

The Steering Assist System is a driver assistance system that integrates with several Bendix systems including Bendix® Fusion™ Active Safety System, the vehicle itself, and select, compatible third-party components.

The Steering Assist System combines unique steering technology with a forward-facing camera for active lane identification. Steering Assist is built on the R.H. Sheppard Co. Inc. HD94™ steering gear, which offers a quick steering ratio for less hand wheel turns, ideal for large wheelbase vehicles.



Figure 2 – System Components

#### Additional Reference Information on [b2bendix.com](http://b2bendix.com)

- For installation of the camera, refer to SD-64-20124, Bendix™ AutoVue® FLC-20™.
- For vehicle operation, refer to BW8123, Steering Assist System Operator's Manual.
- Refer to [rhsheppard.com](http://rhsheppard.com) for product and diagnostic support.

## GENERAL SAFETY GUIDELINES



**WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS**

**TO AVOID PERSONAL INJURY OR DEATH:**

When working on or around a vehicle, the following guidelines should be observed **AT ALL TIMES**:

- ▲ Park the vehicle on a level surface, apply the parking brakes and always block the wheels. Always wear personal protection equipment.
- ▲ Stop the engine and remove the ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically-charged components.
- ▲ Do not attempt to install, remove, disassemble or assemble a component until you have read, and thoroughly understand, the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
- ▲ If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with a Bendix® AD-IS® air dryer system, a Bendix® DRM™ dryer reservoir module, a Bendix® AD-9si®, AD-HF®, or AD-HFi™ air dryer, be sure to drain the purge reservoir.
- ▲ Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
- ▲ Never exceed manufacturer's recommended pressures.
- ▲ Never connect or disconnect a hose or line containing pressure; it may whip and/or cause hazardous airborne dust and dirt particles. Wear eye protection. Slowly open connections with care, and verify that no pressure is present. Never remove a component or plug unless you are certain all system pressure has been depleted.
- ▲ Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, wiring, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
- ▲ Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
- ▲ Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
- ▲ For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.
- ▲ The power **MUST** be temporarily disconnected from the radar sensor whenever any tests **USING A DYNAMOMETER** are conducted on a vehicle equipped with a Bendix® Wingman® system.
- ▲ You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.



**WARNING**

Improper use of the Steering Assist System can result in a collision resulting in property damage, serious injuries, or death. Be sure to read, understand, and carefully follow the instructions in this document.



**WARNING**

Due to the inherent limitations of image recognition technology, camera-based safety technology — on rare occasions — may not be able to detect or may misinterpret lane markings. Examples may include — but are not limited to — lane marking width, lane marking color(s), lane marking location from center, and road conditions where lane markings are applied. At these times, alerts may not occur, or erroneous alerts may occur.



**WARNING**

Bendix safety technologies complement safe driving practices. No commercial vehicle safety technology replaces a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Responsibility for the safe operation of the vehicle remains with the driver at all times.



**WARNING**

This product may expose you to chemicals including nickel, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to [P65Warnings.ca.gov](http://P65Warnings.ca.gov).



**IMPORTANT**

It is the responsibility of the driver to always keep their hands on the steering wheel and to remain vigilant and change driving practices depending on traffic and road conditions.



**WARNING**

Bendix®-brand Electronic Control Units (ECUs) are not designed to store data for purposes of accident reconstruction, and Bendix® ACom® PRO™ Diagnostic Software is not intended to retrieve data for purposes of accident reconstruction. Bendix makes no representations as to the accuracy of data or video retrieved and interpreted from ECUs for purposes of accident reconstruction. Bendix does not offer accident reconstruction services or interpretation of stored data. Bendix ECUs are not protected from fire, loss of power, impact damage, or other conditions that may be sustained in a crash situation and may cause data to be unavailable or irretrievable.

## SYSTEM FEATURES

### LANE KEEP ASSIST (LKA)

*(In conjunction with a forward-facing windshield-mounted camera)*

- May detect lane markings and evaluate relative vehicle position
- May recognize when the vehicle begins to drift towards the lane markings
- May distinguish between planned lane changes and lane drifting
- May intervene before the vehicle reaches the lane markings
- May automatically apply a gentle correction torque to the steering wheel
- May smoothly release steering torque as soon as the vehicle trajectory is re-established
- LKA may become active at 37 mph (59 kph)
- The driver may use the disable switch to override or suppress LKA-applied steering wheel torque; this feature may be useful when driving on roads with inconsistent lane markings that can cause excessive false warnings. Examples would include construction zones, poorly marked lanes, or missing lane markings. The system alerts will automatically become available again after 15 minutes or if the disable switch is pressed a second time.



### STEERING ASSIST

**Speed-dependent Steering Assist** may provide variable steering assist based on vehicle speed to potentially help the driver experience easier steering response at low speeds and a firmer steering response at high speeds. The vehicle is equipped with two selectable steering profiles for driving preference (driver can select via the dash):

- Profile 1 (default): At low speeds, such as in city driving, or while yard maneuvering and parking, less steering effort is experienced to help reduce driver exertion; or,
- Profile 2: At higher speeds, such as cruising on highways, the wheel feels firmer, with a more on-center feel, to help the driver maintain a steady position.



**There is no activation on/off switch for the speed-dependent steering assist feature. The driver should always drive normally and safely.**

**Active Return** may return the steering wheel to near center position at lower speed maneuvers.



**There is no activation on/off switch for the active return feature. The driver may override this feature by applying additional steering input force. The driver should always drive normally and safely.**

**Road Disturbance Compensation** may reduce steering wheel vibration typically caused by road disturbances like potholes, road debris, and other rough road conditions.



**There is no activation on/off switch for the road disturbance compensation feature. The driver should always drive normally and safely.**

## SYSTEM COMPONENTS

### STEERING ANGLE SENSOR (SAS)

- The Steering Angle Sensor (SAS) reports the steering wheel position through a serial communication link or CAN network. See Figure 3.



Figure 3 – Steering Assist Electronic Control Unit (ECU)

### BENDIX™ AUTOVUE® FLC-20™ CAMERA

- The forward-facing camera may track the lane markers and provide the lane characteristics for the left and right marker to the Steering Assist System over the vehicle communication network. In addition, the system also may provide information on when the lane departure warnings will be suppressed, allowing the Lane Keep Assist (LKA) feature to be suppressed at the same time. See Figure 4.
- For additional information, see the *Bendix™ AutoVue® FLC-20™ Camera Service Data Sheet, SD-64-20124*, available for download on [b2bendix.com](http://b2bendix.com).
- The AutoVue FLC-20 is compatible with later versions of Bendix® Wingman® Fusion™ systems.

### AUTOVUE FLC-20 WINDSHIELD MOUNTING BRACKET

- The properly mounted windshield bracket holds the camera secure and keeps it facing the correct direction to help to successfully determine lane width and position. See Figure 4.

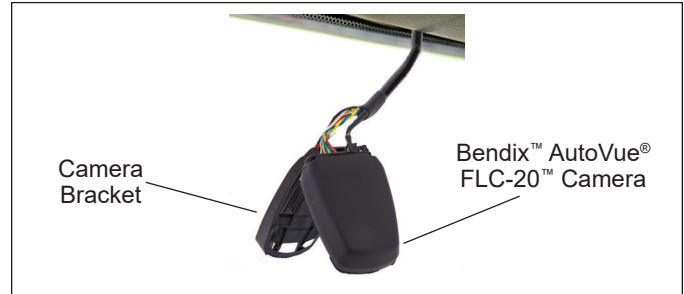


Figure 4 – Bendix™ AutoVue® FLC-20™ Camera & Bracket

### STEERING ASSIST ECU

- The Electronic Control Unit (ECU) for the Steering Assist System is a standalone unit designed to work with J1939 Vehicle CAN and applicable system components. See Figure 5.

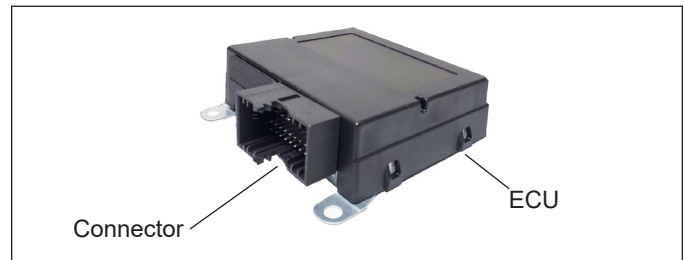


Figure 5 – Steering Assist Electronic Control Unit (ECU)

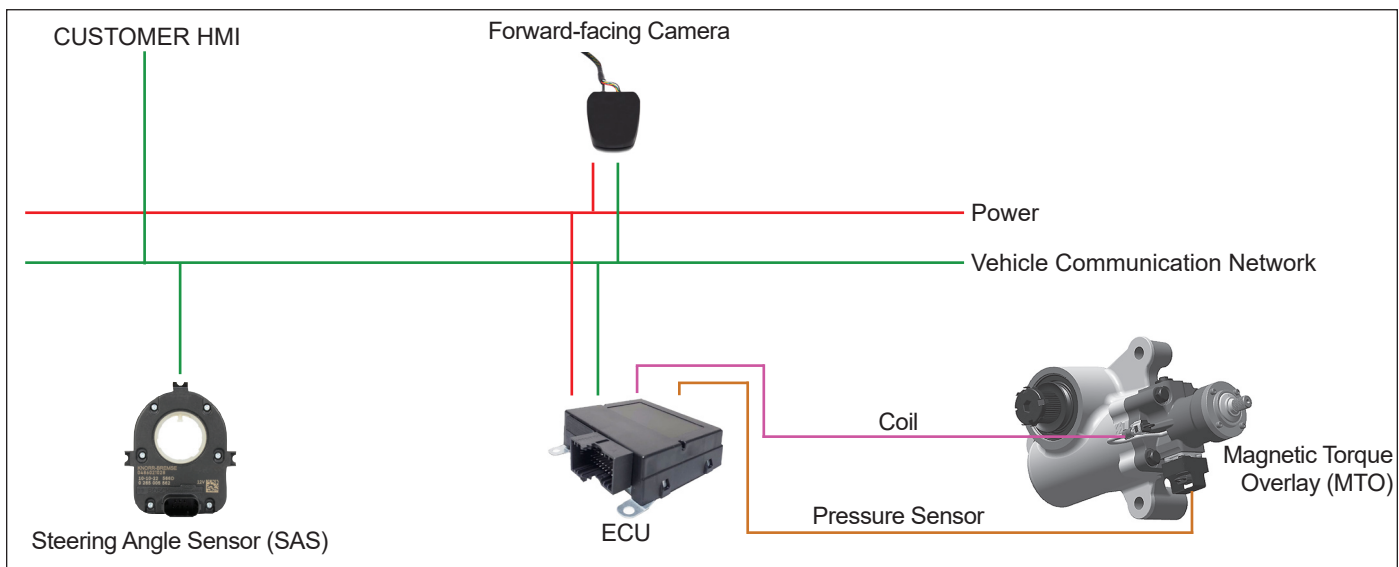


Figure 6 – Steering Assist System Schematic

## MAGNETIC TORQUE OVERLAY (MTO) POWER STEERING GEAR

- The MTO power steering gear enables hydraulic steering. For additional service and troubleshooting information, refer to the Sheppard™ D-Series Integral Power Steering Gear manual on [rhsheppard.com](http://rhsheppard.com).

## TROUBLESHOOTING

Read and follow the General Safety Guidelines shown on Page 2 of this document.



All vehicle Diagnostic Trouble Codes (DTCs) related to the engine; transmission; instrument cluster; engine cruise control; Bendix® ABS, ATC, ESP®, or Fusion® systems; or third-party components must first be resolved – with no DTCs present during the vehicle operation while in cruise control – prior to running Bendix® ACom® PRO™ Diagnostic Software to resolve Steering Assist System DTCs.



If a problem with the Steering Assist System is detected, it should be serviced as soon as possible to restore full functionality. The Lane Keep Assist (LKA) feature may be deactivated.

## BENDIX® ACOM® PRO™ DIAGNOSTIC SOFTWARE

Bendix® ACom® PRO™ Diagnostic Software is a PC-based software program available to purchase from [bendix.com](http://bendix.com). This software provides the technician with access to all the available Electronic Control Unit (ECU) diagnostic information and configuration capability. For controller-specific system diagnostics, use a current version of the ACom PRO Diagnostic Software.

## STARTING BENDIX ACOM PRO DIAGNOSTIC SOFTWARE

ACom PRO Diagnostic Software can be started from the desktop shortcut. See Figure 7.

- Select *Connect* from the main toolbar.
- Select *Heavy Duty* for the connection type to connect to the vehicle BUS using all vehicle protocols. This process could take approximately two (2) minutes.

- After the connection is complete, the roll call will show the ECU and its active and inactive DTCs. The connection depends on a compatible RP1210C adapter.

For assistance with the ACom PRO Diagnostic Software, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2, option 2).

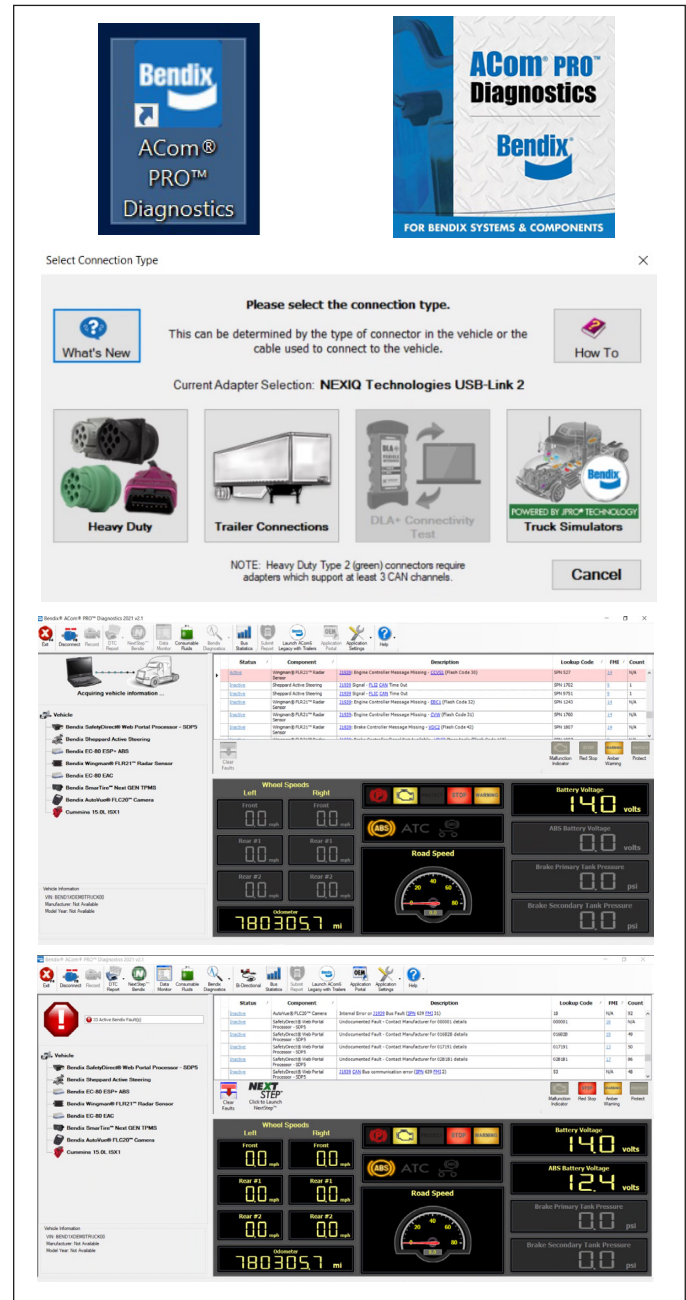
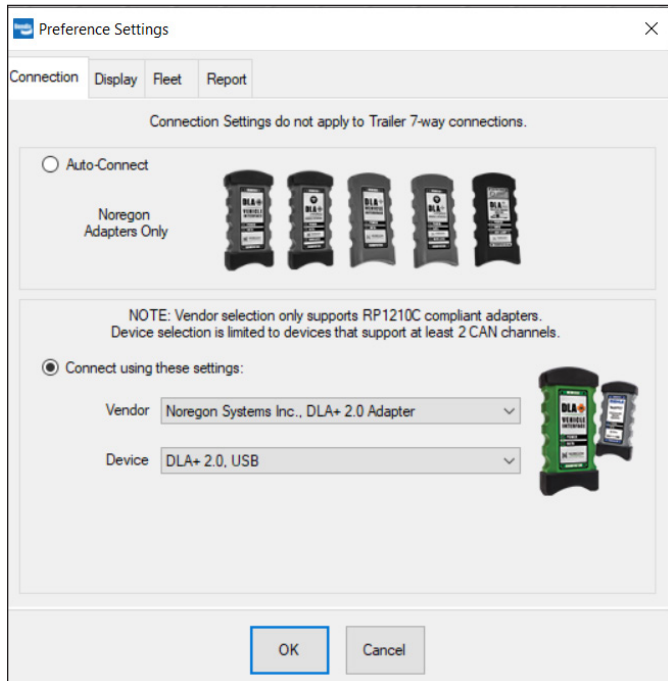


Figure 7 – Starting ACom PRO Diagnostic Software

**NOTE:** When using the Bendix® ACom® PRO™ Diagnostic Software for the first time, the service technician will need to check the communication adapter for the Steering Assist

System controller. During the initial setup, the technician will need to indicate which adapter to use by accessing *Application Settings, Preferences, then Connection*.



**Figure 8 – Bendix® ACom® PRO™ Diagnostic Software – Hardware Interface Screen**

## READING AND CLEARING DIAGNOSTIC TROUBLE CODES (DTCs)



All vehicle Diagnostic Trouble Codes (DTCs) related to the engine; transmission; instrument cluster; engine cruise control; Bendix® ABS, ATC, ESP®, or Fusion® systems; or third-party components must first be resolved – with no DTCs present during the vehicle operation while in cruise control – prior to running Bendix® ACom® PRO™ Diagnostic Software to resolve Steering Assist System DTCs.

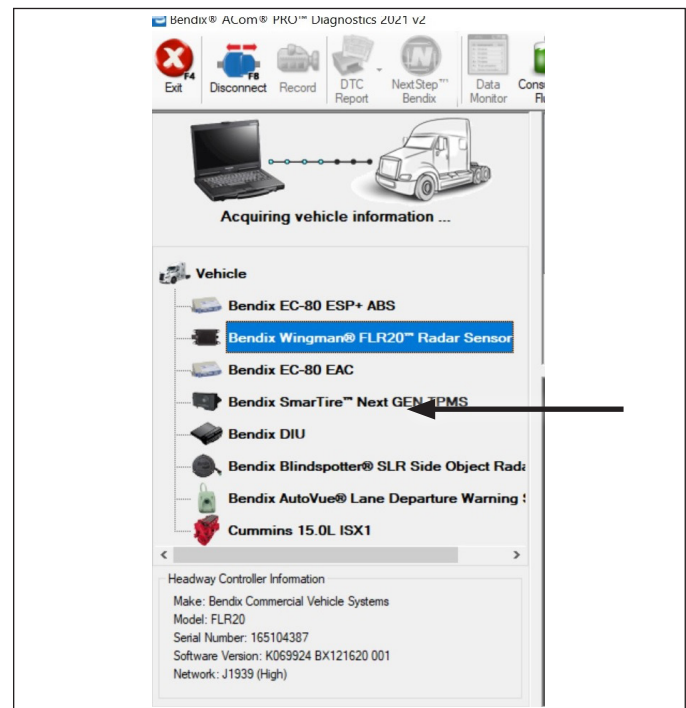
1. Connect a current version of the ACom PRO Diagnostic Software to the vehicle.
2. Once the roll call is complete, you can view active and inactive Diagnostic Trouble Codes (DTCs) and clear DTCs from all vehicle components or solely from a selected Bendix controller.
3. To read and clear DTCs from all vehicle components at the same time, select the vehicle on the roll call and clear the DTCs by selecting *Clear Faults*.

4. To read and clear DTCs from a specific Bendix Electronic Control Unit (ECU), select the Bendix ECU on the roll call and select *Clear Faults*.

For assistance with ACom PRO Diagnostic Software, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2, option 2).

## READING THE SYSTEM SOFTWARE VERSION

1. Connect a current version of ACom PRO Diagnostic Software to the vehicle.
2. View the software version by selecting the appropriate vehicle.



**Figure 9 – Bendix ACom PRO Diagnostic Software Starter Screen Showing Software Version**

## HOW TO GENERATE A DIAGNOSTIC TROUBLE CODE (DTC) REPORT

1. Connect a current version of the Bendix® ACom® PRO™ Diagnostic Software with the vehicle. **NOTE:** The current version will show at the bottom of the ACom PRO startup screen.
2. Once the roll call is complete, select the *DTC Report* icon in the top menu.
3. The Diagnostic Trouble Code (DTC) report drop-down gives the following options:
  - Print DTC Report
  - Print Preview of the DTC Report
  - Submit DTC Report

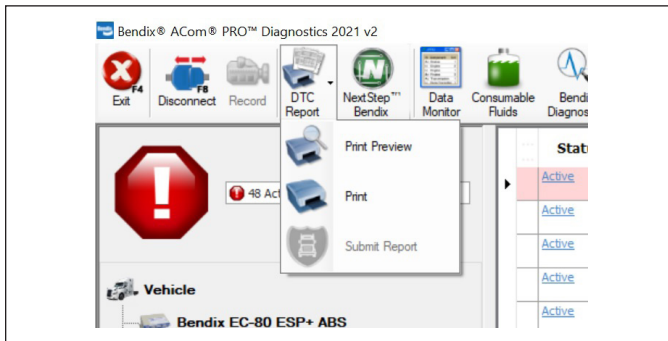


Figure 10 – DTC Report Options

4. Select *Print Preview* to generate and save the DTC report.

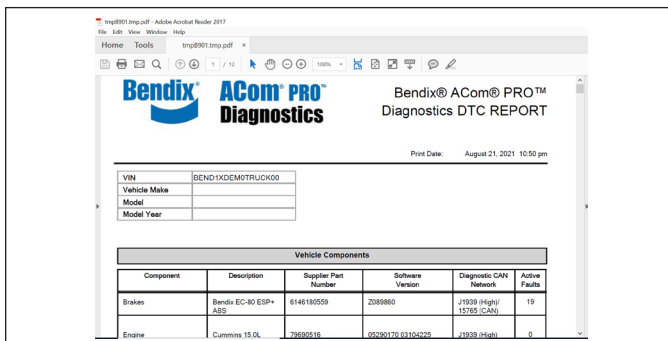


Figure 11 – Generate and Save the DTC Report

## STEERING ANGLE SENSOR (SAS) AND LANE KEEP ASSIST (LKA) DIAGNOSTIC TESTING

1. Determine if there are any active driver alerts on the driver display. Specifically check if the *Check Steering Electronic Control Unit (ECU)* alert is active. See Figure 12.

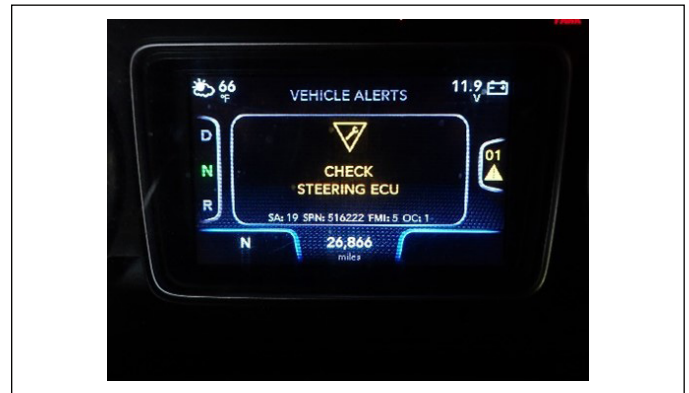


Figure 12 – Check Steering ECU Alert

2. Connect a laptop to the tractor's diagnostic port and use Bendix ACom PRO Diagnostic Software to generate a DTC report. After generating the DTC report, perform the following:

- A. Check the calibration of the Bendix® EC-80™ ESP® Steering Angle Sensor (SAS) using ACom PRO Diagnostic Software as follows:

- i. With the engine running, ensure the steer tires are positioned at 12 o'clock for straight-line motion of the vehicle. It may be necessary to drive the vehicle forward in a straight line before proceeding to the next step.
- ii. In ACom PRO Diagnostic Software, select *Bi-Directional Test* in the header.
- iii. Select the *Bendix® EC-80™ ESP ABS* in the pop-up window.
- iv. Select the *Steering Angle Test and Calibration* option.
- v. Select *Start*.
- vi. The pop-up window will display three tabs. Select the first tab, *Steering Angle Test*, then select *Next*. Follow the procedure as listed and note whether the calibration is accurate by observing that the measured steering angles are within the GREEN box during each step of the test.
- vii. If the calibration is not accurate, the SAS needs recalibrated by selecting the *Calibration* tab and following the listed calibration procedure.
- viii. Before performing the recalibration, document the amount by which the SAS is out of calibration.

3. Verify through Bendix® ACom® PRO™ Diagnostic Software that there are no active Diagnostic Trouble Codes (DTCs). Using safe driving practices, drive the vehicle under normal conditions to confirm the vehicle operation is consistent with the applicable operator's manual.

## TROUBLESHOOTING DIAGNOSTIC TROUBLE CODES (DTCs)

- **Ignition Voltage Too Low:** Measure the ignition voltage under load. Ensure that the ignition voltage is greater than 9 VDC (Volts DC). Check the vehicle battery and associated components. Inspect for damaged wiring, damaged or corroded connectors, and loose connections. Check the condition of the fuse.
- **Ignition Voltage Too High:** Measure the ignition voltage. Ensure that ignition voltage is not greater than 16 VDC. Check the vehicle battery and associated components. Inspect for damaged wiring, damaged or corroded connectors, and loose connections.

## POWER SUPPLY TESTS

1. Take all measurements at the Electronic Control Unit's (ECU's) harness connector.
2. Place a load (i.e., 1157 bulb) across the supply voltage and ground connection. Measure the voltage with the load. The supply voltage on Pin 1 to ground should measure between 10 to 16 Volts DC (VDC).
3. Check for damaged wiring, damaged or corroded connectors, and loose connections.
4. Check the condition of the vehicle battery and associated components. Ensure the connection to ground is secure and tight.
5. Using the procedures described by the vehicle manufacturer, check the alternator output for excessive noise.

## SERIAL DATA TROUBLESHOOTING PROCEDURE

1. Take all measurements at the harness connector unless otherwise indicated.



**Do not insert any probe into the pin on the mating connector of the sensor that is greater than the width of a terminal. Damaged connector pins will require the replacement of the harness.**

2. Unplug the Steering Assist ECU harness. With the ignition switch off, measure the resistance (ohms) using a multimeter between harness pins 10 and 11. The reading should be approximately 120 ohms. If it is not, the vehicle wiring should be investigated.
3. Check if the Private Communications wiring is reversed or damaged. If the Private Communications HIGH, or Private Communications LOW, wiring circuits are damaged, such as shorting together, the entire Private Communications link will be lost. The problem may be intermittent, enabling the Private Communications link to operate normally sometimes. In this event, multiple diagnostic trouble codes may be logged in the camera and radar. If the Private Communications HIGH, and Private Communications LOW, wiring circuits are reversed, communication over the entire Private Communications link will be lost. Devices that use the affected network will not be able to transmit or receive messages on that network.
4. Check for corroded or damaged wiring connector problems such as opens or shorts to voltage or ground. If the connector terminals are corroded, this may be an indication of water intrusion into the wiring system. Replacement of the entire harness is recommended. If the terminals of the Steering Assist ECU, coil, or pressure are corroded, replacement of the sensor/ECU is recommended.
5. Check for other Private Communications devices which may be inhibiting communication. The service technician should consult the procedures for Private Communications troubleshooting. The device's power should be removed, and measurements made at the ECU pins for shorts to ground and power pins and resistance between the Private Communications HIGH or Private Communications LOW input circuits.





If replacing the steering gear, a new Electronic Control Unit (ECU) will also need to be installed. ECUs are VIN and serial number specific.

After installing a new ECU on the Steering Assist System, two procedures must be completed in the Bendix® ACom® PRO™ Diagnostic Software:

- Pressure Trimming Test
- Coil Polarity Check

Reference *TCH-025-002, Bendix® ACom® PRO™ Diagnostic Software Procedures for New Electronic Control Unit (ECU) Installation*, on [b2bendix.com](http://b2bendix.com) for additional information.

## DIAGNOSTIC TROUBLE CODE (DTC) TABLE

SPN	FMI	Diagnostic Trouble Code (DTC)		Go to the Service Action Code List in Table 2
		Name	Description	
70	9	J1939 Signal - CCVS1 CAN Time Out		F
70	19	J1939 Signal - Error in CCVS1 - Parking Brake Switch		G
190	9	J1939 Signal - EEC1 CAN Time Out	Engine Speed	F
190	19	J1939 Signal - Error in EEC1 - Engine Speed	Engine Speed	G
904	9	J1939 Signal - EBC2 CAN Time Out	Average Speed of the Two (2) Front Wheels	F
904	19	J1939 Signal - Error in EBC2 - Front Axle Speed	Average Speed of the Two (2) Front Wheels	G
1702	9	J1939 Signal - FLI2 CAN Time Out	Lane Departure Indication Enable Status	F
1710	19	J1939 Signal - Error in FLI2 - Lane Tracking Status Left Side	Lane Tracking Status - Left Side	G
1711	19	J1939 Signal - Error in FLI2 - Lane Tracking Status Right Side	Lane Tracking Status - Right Side	G
1807	9	J1939 Signal - VDC2 CAN Time Out	Steering Wheel Angle	F
1807	19	J1939 Signal - Error in VDC2 - Steering Wheel Angle	Steering Wheel Angle	G
1808	19	CAN_OR_VDC2_YAW_RATE		G
1809	19	J1939 Signal - Error in VDC2 - Lateral Acceleration	Lateral Acceleration	G
1814	9	J1939 Signal - VDC1 CAN Time Out	VDC Fully Operational	F
1816	19	J1939 Signal - Error in VDC1 - ROP Engine Control Active	ROP Engine Control Active	G
1817	19	J1939 Signal - Error in VDC1 - YC Engine Control Active	YC Engine Control Active	G
1818	19	J1939 Signal - Error in VDC1 - ROP Brake Control Active	ROP Brake Control Active	G
1819	19	J1939 Signal - Error in VDC1 - YC Brake Control Active	YC Brake Control Active	G
2876	19	J1939 Signal - Error in OEL - Turn Signal Switch	Turn Signal Switch	G
5676	9	J1939 Signal - AEBS CAN Time Out	Forward Collision Autonomous Emergency Braking System (AEBS) State	F
5676	19	J1939 Signal - Error in AEBS - Forward Collision Advanced Emergency Braking System State	Forward Collision Autonomous Emergency Braking System (AEBS) State	G
5876	9	J1939 Signal - OEL CAN Time Out	Transmission's Gear Ratio in Low Forward Range - Intended to Identify Conditions Related to Gear Ratio Checks when Low Forward Range is Expected	F
9751	9	J1939 Signal - FLIC CAN Time Out	Lane Keep Assist Enable Command	F

**Table 1 – Diagnostic Trouble Codes (DTCs)**

SPN	FMI	Diagnostic Trouble Code (DTC)		Go to the Service Action Code List in Table 2
		Name	Description	
9751	19	J1939 Signal - Error in FLIC - Lane Keep Assist Enable Command	Lane Keep Assist Enable Command	G
9760	19	J1939 Signal - Error in FLIC - Requested Steering Assist Driver Preference Mode	Requested Steering Assist Driver Preference Mode	G
516222	2	ECU H Bridge - Not OK	Manufacturer Assignable SPN	C
516222	3	ECU H Bridge - Short to Battery	Manufacturer Assignable SPN	D
516222	4	ECU H Bridge - Short to Ground	Manufacturer Assignable SPN	D
516222	5	ECU H Bridge - Open Load	Manufacturer Assignable SPN	D
516700	0	High Temperature of ECU	Manufacturer Assignable SPN	A
516701	3	Battery Voltage Above Threshold	Manufacturer Assignable SPN	B
516701	4	Battery Voltage Below Threshold	Manufacturer Assignable SPN	B
516702	5	Pressure Sensor - Open Circuit	Manufacturer Assignable SPN	H
516702	3	Pressure Sensor - Short Circuit	Manufacturer Assignable SPN	J
516707	13	EOL Calibration Not Performed	Manufacturer Assignable SPN	E
516707	12	ECU Fault - Internal Error	Manufacturer Assignable SPN	K
516708	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	CAN Time Out	F
516708	13	EOL Gear Parameters Not Programmed Properly	NVM Read/Write Error	M
516708	12	NVM Failed to Read or Write	NVM Read/Write Error	N
516709	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	CAN Time Out	F
516710	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	CAN Time Out	F
516711	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	CAN Time Out	F
516712	9	J1939 Signal - Camera Supplier Proprietary CAN Timeout	CAN Time Out	F
517554	2	Coil Implausible Data	Manufacturer Assignable SPN	D
517554	10	Coil Current - Out of Tolerance	Manufacturer Assignable SPN	D
517554	3	Short in Coil Connection	Short in Coil Connection	D
520196	2	Lane Direction Mismatch in Camera	Manufacturer Assignable SPN	P
524032	5	J1939 Bus - Open or Short	CAN Fault	F

**Table 1 – Diagnostic Trouble Codes (DTCs)**

## SERVICE ACTION CODE TABLE

NO DTC	The Steering Assist System is equipped with a dual integrated pressure sensor that reads pressure from the left and the right turn side of the hydraulic chamber of the steering gear. The Steering Assist Electronic Control Unit (ECU) uses the pressure signal from the pressure sensor to apply torque. If the pressures sensor wires are not in the correct pin locations, greater turning resistance may be felt in the steering wheel. <u>There will not be any Diagnostic Trouble Codes (DTCs) that set for this scenario.</u> To check for the proper wire orientation, verify that Pin 1 of the ECU is connected to Pin 4 of the pressure sensor, and Pin 2 of the ECU is connected to Pin 3 of the pressure sensor.
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Service Action Code	Recommended Service
A	<p><b>This DTC <i>may not</i> be an indicator of a malfunctioning ECU.</b></p> <p><b>Possible causes:</b> Some error conditions may occur at extreme high or low temperatures. These DTCs must be diagnosed with the ambient temperature above 32°F (0°C) and below 100°F (38°C).</p> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Ensure ambient temperature is within operating range.</li> <li>• Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> <li>• If the DTC is set to inactive and can be cleared by the above step, the ECU is functioning properly and the system can be returned into operation.</li> <li>• If the DTC stays active and is unable to be cleared, the ECU will need to be replaced.</li> </ul>
B	<p><b>This DTC <i>may not</i> be an indicator of a malfunctioning ECU.</b></p> <p><b>Possible causes:</b> These DTCs result from incorrect battery supply voltage or wiring harness issues as measured at the Steering Assist ECU.</p> <p><b>Review the following sections:</b></p> <ul style="list-style-type: none"> <li>• Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests.</li> <li>• Troubleshooting Wiring Harnesses.</li> </ul> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Verify the battery supply voltage to the Steering Assist ECU is between 9 to 18 Volts DC (VDC).</li> <li>• Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear).</li> <li>• Visually check for damaged wiring (at the ECU and the steering gear).</li> <li>• Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> <li>• If the voltage at the ECU is within normal range and the DTC is still active, the ECU will need to be replaced.</li> </ul>

### Table 2 – Service Action Codes

If any error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m., and Friday 8:00 a.m. to 5:00 p.m. ET. The Bendix Tech Team can also be reached at [techteam@bendix.com](mailto:techteam@bendix.com).

Service Action Code	Recommended Service
C	<p><b>If this Diagnostic Trouble Code (DTC) is continuously active and is unable to be cleared, this is an indicator of an internal malfunction in the Electronic Control Unit (ECU). The ECU must be replaced. If this DTC is intermittent and/or inactive, this is an indication of a battery supply issue.</b></p> <p><b>Possible causes:</b> If the supply voltage drops below 9 Volts DC (VDC) during startup, an internal fault may display.</p> <p><b>Review the following sections:</b></p> <ul style="list-style-type: none"> <li>• Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests.</li> <li>• Troubleshooting Wiring Harnesses.</li> </ul> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Verify the battery supply voltage to the Steering Assist ECU is between 9 to 18 VDC.</li> <li>• Cycle the ignition on/off/on and recheck the DTCs.</li> <li>• If the voltage remained above 9 VDC and the DTC is now inactive, verify there is no physical damage to the coil connector.</li> <li>• If there is no damage to the coil connector, check the Steering Assist wiring harness. <ul style="list-style-type: none"> <li>• Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear).</li> <li>• Visually check for damaged wiring (at the ECU and the steering gear).</li> </ul> </li> <li>• Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> </ul>
D	<p><b>This DTC may not be an indicator of a malfunctioning ECU.</b></p> <p><b>Possible causes:</b> These DTCs result from wiring harness issues as measured at the Steering Assist ECU from the steering gear.</p> <p><b>Review the following sections:</b></p> <ul style="list-style-type: none"> <li>• Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests.</li> <li>• Troubleshooting Wiring Harnesses.</li> </ul> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Check the coil in the steering gear. The resistance measured at the coil connector on the steering gear should be 1 - 5 Ohms. If the resistance is not within the normal range, replace the steering gear.</li> <li>• Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear).</li> <li>• Visually check for damaged wiring (at the ECU and the steering gear).</li> <li>• Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> <li>• If the coil measurement is within specification and all of the wiring is trouble-free, the ECU will need to be replaced.</li> </ul>
E	<p><b>This DTC may not be an indicator of a malfunctioning ECU.</b></p> <p><b>Possible Causes:</b> The Steering Assist ECU is indicating that parameters in the ECU are missing or incorrect. Whenever an ECU is replaced, this DTC will be active until the pressure trimming and coil polarity tests are conducted through Bendix® ACom® PRO™ Diagnostic Software.</p> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Open the ACom PRO utility and run the pressure trimming and coil polarity tests (details on how to perform this procedure are available in ACom PRO).</li> <li>• If the pressure trimming and coil polarity tests complete successfully and the issue is still not corrected, the ECU will need to be replaced.</li> </ul>
<p><b>Table 2 – Service Action Codes</b>  If any error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m., and Friday 8:00 a.m. to 5:00 p.m. ET. The Bendix Tech Team can also be reached at <a href="mailto:techteam@bendix.com">techteam@bendix.com</a>.</p>	

Service Action Code	Recommended Service
F	<p><b>This Diagnostic Trouble Code (DTC) may not be an indicator of a malfunctioning Electronic Control Unit (ECU).</b></p> <p><b>Possible Causes:</b> The Steering Assist System has not received the J1939 signal(s) it is expecting from one or more sources. This could be accompanied by other active DTCs from the same source. Some examples of components, cameras, or switches that produce J1939 signals are brake pressure switches; Steering Angle Sensors (SAS); lighting indicators (high/low beam lights, turn signals); windshield wiper status; various engine torque signals; Bendix® Wingman® Fusion™ Active Safety System components; and Wheel Speed Sensors (WSS).</p> <p><b>Review the following sections:</b></p> <ul style="list-style-type: none"> <li>Serial Data (J1939) Troubleshooting Procedure.</li> </ul> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>Check the engine, cab/body controller, or Antilock Braking System (ABS) for DTCs using the manufacturer's diagnostic procedures. The controller that broadcasts the error signal must be investigated first; however, the origin of the signal could potentially be another source. <i>Refer to Table 3 for more information.</i></li> <li>After investigating the possible causes, clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> </ul>
G	<p><b>This DTC may not be an indicator of a malfunctioning ECU.</b></p> <p><b>Possible Causes:</b> The Steering Assist System has received J1939 signal(s) it is expecting; however, the values indicated that there is a malfunctioning component. Some examples of components, cameras, or switches that produce J1939 signals are brake pressure switches; SAS; lighting indicators (high/low beam lights, turn signals); windshield wiper status; various engine torque signals; Wingman Fusion Active Safety System components; and WSS.</p> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>Check the engine, cab/body controller, or ABS for DTCs using the manufacturer's diagnostic procedures. The controller that broadcasts the error signal must be investigated first; however, the origin of the signal could potentially be another source. <i>Refer to Table 3 for more information.</i></li> <li>After investigating the possible causes, clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> </ul>
<p><b>Table 2 – Service Action Codes</b></p> <p><i>If any error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m., and Friday 8:00 a.m. to 5:00 p.m. ET. The Bendix Tech Team can also be reached at <a href="mailto:techteam@bendix.com">techteam@bendix.com</a>.</i></p>	

Service Action Code	Recommended Service
H	<p><b>This Diagnostic Trouble Code (DTC) may not be an indicator of a malfunctioning Electronic Control Unit (ECU).</b></p> <p><b>Possible Causes:</b> These DTCs may result from wiring harness issues as measured at the Steering Assist ECU from the steering gear, issues with the pressure sensor on the steering gear, or issues with the ECU.</p> <p><b>Review the following sections:</b></p> <ul style="list-style-type: none"> <li>• Troubleshooting DTCs: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests.</li> <li>• Troubleshooting Wiring Harnesses.</li> </ul> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Check the voltage at the pressure sensor connector. <ul style="list-style-type: none"> <li>• Unplug the connector for the pressure sensor at the steering gear.</li> <li>• Measure the voltage on the pressure sensor harness from Pin 3 to Pin 5. The voltage should be between 0.5 - 4.5 Volts DC (VDC).</li> <li>• Measure the voltage on the pressure sensor harness from Pin 4 to Pin 5. The voltage should be between 0.5 - 4.5 VDC.</li> </ul> </li> <li>• If the voltage is within the normal range, replace the pressure sensor on the steering gear (replacement kit part number 0992564K).</li> <li>• If the voltage is not within the normal range, plug the pressure sensor back in and check the voltage at the ECU. <ul style="list-style-type: none"> <li>• With the ECU connected, measure the voltage from Pin 1 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned.</li> <li>• With the ECU connected, measure the voltage from Pin 2 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned.</li> </ul> </li> <li>• If the voltage is within the normal range, the ECU will need to be replaced.</li> <li>• If the voltage is not within the normal range, check the wiring harness.</li> <li>• Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear).</li> <li>• Visually check for damaged wiring (at the ECU and the steering gear).</li> <li>• If the wiring is trouble-free, the ECU will need to be replaced.</li> </ul>

**Table 2 – Service Action Codes**

*If any error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m., and Friday 8:00 a.m. to 5:00 p.m. ET. The Bendix Tech Team can also be reached at [techteam@bendix.com](mailto:techteam@bendix.com).*

Service Action Code	Recommended Service
J	<p><b>This Diagnostic Trouble Code (DTC) may not be an indicator of a malfunctioning Electronic Control Unit (ECU).</b></p> <p><b>Possible Causes:</b> These DTCs may result from wiring harness issues as measured at the Steering Assist ECU from the steering gear, issues with the wiring harness as measured at the Steering Assist ECU from the steering gear, or pressure sensor failure.</p> <p><b>Review the following Sections:</b></p> <ul style="list-style-type: none"> <li>• Relief Plunger Adjustment video on rhsheppard.com (<i>select the Customer Service tab and Sheppard Service and Instructional Videos</i>).</li> <li>• Troubleshooting Diagnostic Trouble Codes: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests.</li> <li>• Troubleshooting Wiring Harnesses.</li> </ul> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Reset the relief plungers following the procedure in the Relief Plunger Adjustment video on rhsheppard.com.</li> <li>• Check the voltage at the pressure sensor connector. <ul style="list-style-type: none"> <li>• Unplug the connector for the pressure sensor at the steering gear.</li> <li>• Measure the voltage on the pressure sensor harness from Pin 3 to Pin 5. The voltage should be between 0.5 - 4.5 Volts DC (VDC).</li> <li>• Measure the voltage on the pressure sensor harness from Pin 4 to Pin 5. The voltage should be between 0.5 - 4.5 VDC.</li> </ul> </li> <li>• If the voltage is within the normal range, replace the pressure sensor on the steering gear (replacement kit part number 0992564K).</li> <li>• If the voltage is not within the normal range, plug the pressure sensor back in and check the voltage at the ECU. <ul style="list-style-type: none"> <li>• With the ECU connected, measure the voltage from Pin 1 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned.</li> <li>• With the ECU connected, measure the voltage from Pin 2 to Pin 3. The voltage should fluctuate between 0.5 - 4.5 VDC as the steering wheel is turned.</li> </ul> </li> <li>• If the voltage is within the normal range, the ECU will need to be replaced.</li> <li>• If the voltage is not within the normal range, check the wiring harness.</li> <li>• Visually check for damaged or poorly crimped connectors (at the ECU and the steering gear).</li> <li>• Visually check for damaged wiring (at the ECU and the steering gear).</li> <li>• If the wiring is trouble-free, the ECU will need to be replaced.</li> </ul>
K	<b>This DTC is an indicator of an internal malfunction in the ECU. The ECU must be replaced.</b>
M	<b>This DTC is an indicator that the parameters specific to the steering gear have not be programmed properly or that the parameters have been erased due to an error. The ECU must be replaced.</b>
<p><b>Table 2 – Service Action Codes</b>  If any error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m., and Friday 8:00 a.m. to 5:00 p.m. ET. The Bendix Tech Team can also be reached at <a href="mailto:techteam@bendix.com">techteam@bendix.com</a>.</p>	



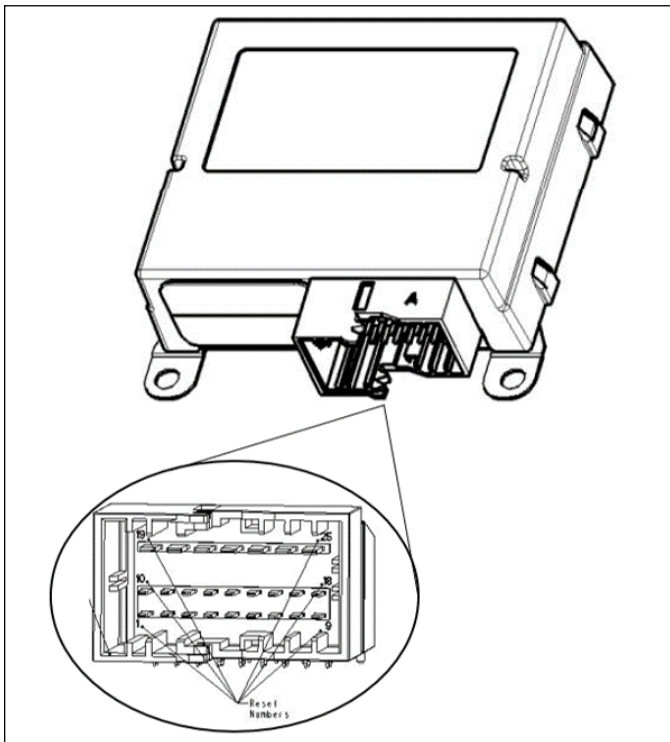
Service Action Code	Recommended Service
N	<p><b>This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning Electronic Control Unit (ECU).</b></p> <p><b>Possible Causes:</b> The ECU may have lost battery power during the shutdown sequence.</p> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Cycle the ignition on/off/on.</li> <li>• Clear the Steering Assist ECU DTCs using the procedure in the section titled <i>Clearing Diagnostic Trouble Codes</i>.</li> <li>• If the DTC is set to inactive and can be cleared by the above step, the ECU is functioning properly and the system can be returned into operation.</li> <li>• If the DTC stays active and is unable to be cleared, the ECU will need to be replaced.</li> </ul>
P	<p><b>This DTC is not an indicator of a malfunctioning ECU.</b></p> <p><b>Possible Causes:</b> Information from the camera may not be correct.</p> <p><b>Perform the following:</b></p> <ul style="list-style-type: none"> <li>• Refer to the camera manufacturer's diagnostics to troubleshoot for proper lane detection.</li> <li>• Recalibrate the camera.</li> </ul>

**Table 2 – Service Action Codes**

If any error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m., and Friday 8:00 a.m. to 5:00 p.m. ET. The Bendix Tech Team can also be reached at [techteam@bendix.com](mailto:techteam@bendix.com).

**PIN IDENTIFICATION**

See Figure 13 and refer to Table 3 for the connector pins for the Steering Assist Electronic Control Unit (ECU).

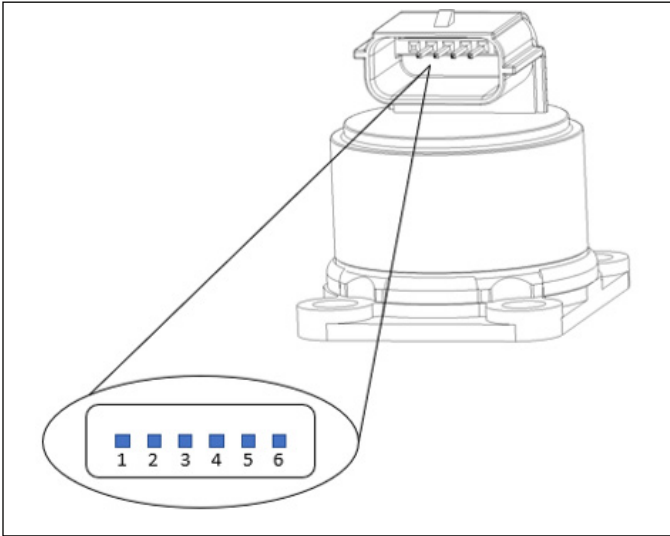


**Figure 13 – Steering Assist ECU Connector Pins**

Pin Number	Description
1	Left Pressure Signal
2	Right Pressure Signal
3	Pressure Sensor Ground
4	Pressure Sensor Supply
5	—
6	—
7	—
8	—
9	—
10	J1939 Low
11	J1939 High
12	Private Communication Low
13	Private Communication High
14	—
15	—
16	Coil Supply A
17	Coil Supply B
18	—
19	—
20	Ignition
21	—
22	Module Power 12V
23	—
24	—
25	Ground GND (-)

**Table 3 – Steering Assist ECU Connector Pins**

See Figure 14 and refer to Table 4 for the connector pins for the pressure sensor.

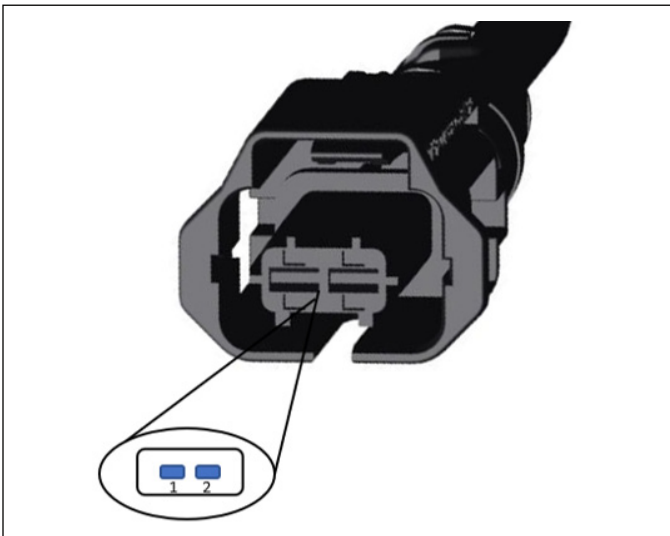


**Figure 14 – Pressure Sensor Connector Pins**

Pin Number	Description
1	—
2	Pressure Sensor Supply
3	Pressure Sensor Right
4	Pressure Sensor Left
5	Pressure Sensor Ground
6	—

**Table 4 – Pressure Sensor Connector Pins**

See Figure 15 and refer to Table 5 for the connector pins for the coil.



**Figure 15 – Coil Connector Pins**

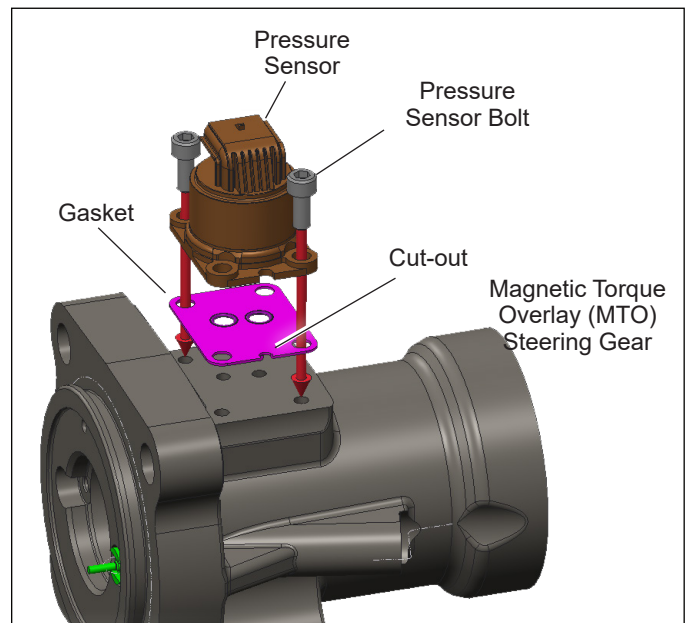
Pin Number	Description
1	Coil Supply A
2	Coil Supply B

**Table 5 – Coil Connector Pins**

## PRESSURE SENSOR, COVER, AND GASKET REPLACEMENT

If a pressure sensor has been identified as faulty or damaged, it must be replaced. Once the faulty or damaged pressure sensor is removed, follow the steps below for the installation of the new sensor.

1. Align the gasket and pressure sensor with the half circle cut-out in each part. See Figure 13.
2. Align the pressure sensor and gasket on the bearing cap. See Figure 13.
3. Hand start and torque the front right and back left pressure sensor bolts to 13-16 ft-lb (17.6-21.7 N•m) with the 5-mm hex (Allen®) bit. See Figure 13.
4. Remove the alignment fixture (if used) and install the pressure sensor cover by aligning the bottom tabs with the open bolt holes. See Figure 14.
5. Hand start and torque the front left and back right bolts to 13-16 ft-lb (17.6-21.7 N•m) through the tabs of the pressure sensor cover with the 5-mm hex (Allen) bit. See Figure 16.



**Figure 16 – Pressure Sensor and Gasket**

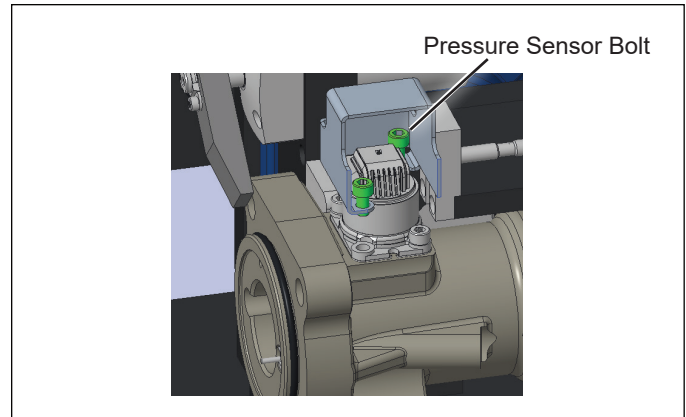
## MAGNETIC TORQUE OVERLAY (MTO) STEERING GEAR AND ELECTRONIC CONTROL UNIT (ECU) REPLACEMENT

See *Figure 17*. To replace the steering gear or the Electronic Control Unit (ECU), please contact the Bendix Tech Team or Sheppard™ Technical Support.

**NOTE:** When replacing the steering gear, the ECU must be matched to the gear at the factory. If ordering the ECU only, please provide the gear serial number and vehicle VIN so the ECU can be flashed at the factory to match. When purchasing a new steering gear, you must order a new steering gear *and* ECU set. The existing ECU and steering gear must be returned to Bendix to receive core charge credit.



**The Magnetic Torque Overlay (MTO) steering actuator is not a "bolt-on" device to the Sheppard™ HD94™ steering gear. The valve inside the HD94-based MTO steering gear is different than the valve in a standard HD94 Recirculating Ball Gear (RCB) set. You cannot unbolt the MTO actuator and bolt it onto an off-the-shelf HD94 base gear. The MTO steering set is a gear-actuator combo that is shipped as an integrated unit and has a single part number for the integrated assembly.**



**Figure 17 – Bolt Installation**

## TORQUE OVERLAY POWER STEERING GEAR

Perform a visual inspection to ensure proper installation and functionality. The power steering gear with torque overlay should be clean and free of fluid. All connectors around the gear should be connected and secured. See *Figure 1*. For additional service and troubleshooting information, refer to the *Sheppard™ D-Series Integral Power Steering Gear manual on rhsheppard.com*.

## TECHNICAL SUPPORT

For the latest information and to download the Bendix® ACom® PRO™ Diagnostic Software, visit [b2bendix.com](http://b2bendix.com). Contact technical support by email at [techteam@bendix.com](mailto:techteam@bendix.com) or by phone at 1-800-AIR-BRAKE (1-800-247-2725), option 2. Follow the instructions in the recorded message. Representatives are available Monday through Thursday, 8 a.m. to 6 p.m. ET, and Friday, 8 a.m. to 5 p.m. ET.

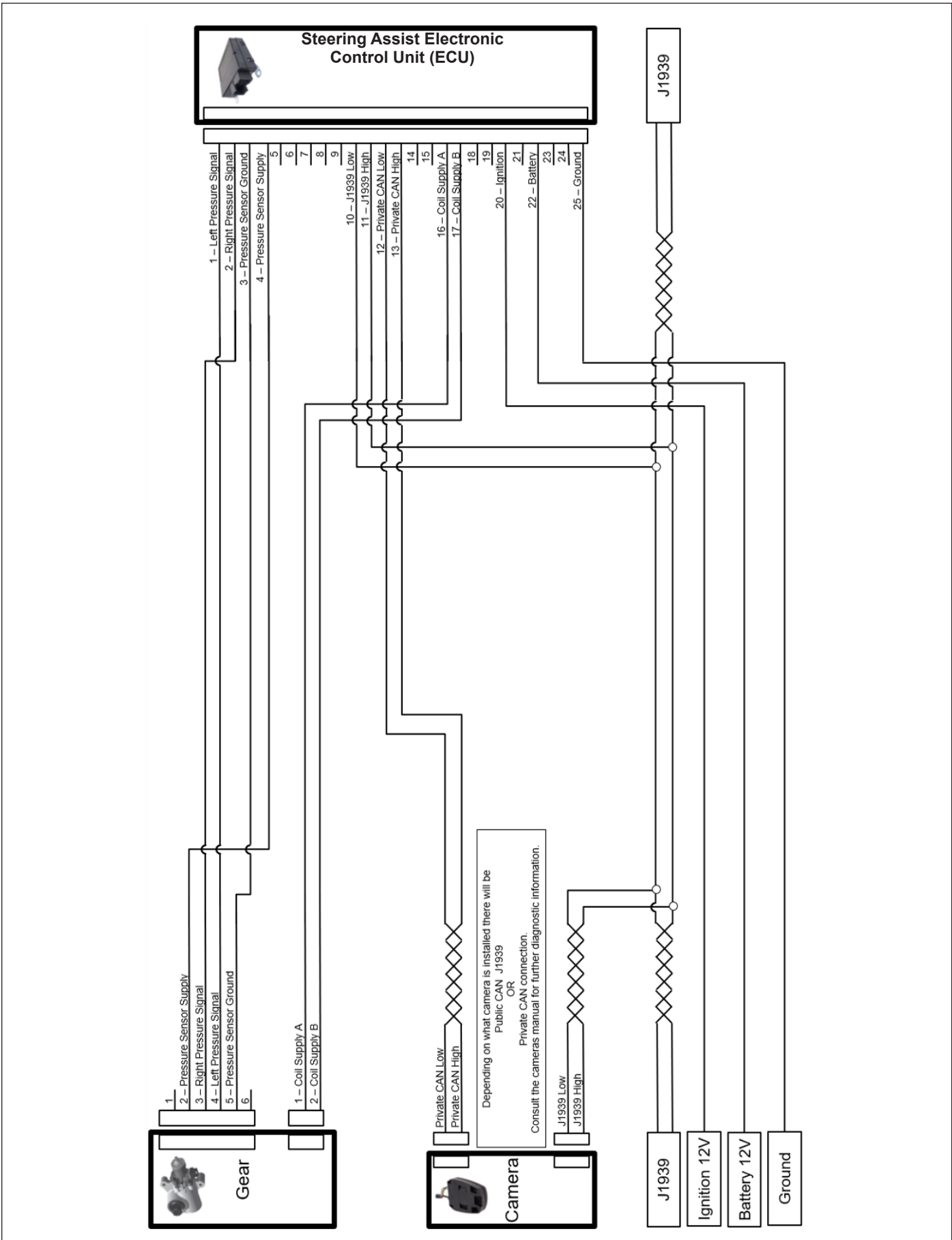


Figure 18 – System Schematic







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