Volvo Chassis - Equipped With Bendix Wingman Fusion - Volvo Active Driver Assist (VADA) And Lane Departure Warning System (LDWS) Fault Code And Troubleshooting Information

On Volvo Trucks equipped with Volvo Active Driver Assist (VADA), and with or without Lane Departure Warning System (LDWS) troubleshooting / diagnostics of this system cannot be done with Premium Tech Tool (PTT).This system could include up to 4 separate modules in the truck:

1. ABS ECU
2. Front Antenna, FLR20 – Mounted on the front of the vehicle
3. Camera, FLC20 – Mounted to the windshield
4. Safety Direct Processor, SDP – Mounted in the overhead console above the driver

The use of ACOM and the documents listed below containing fault codes for each individual ECU will need to be used.

Tech Tool	Bendix / ACOM ECU	Document	Notes
136 - Brake System Controller (SA11)	EC-80	PDF	ABS ECU
209 - Safety Direct Processor (SA209)	SDP	PDF	Safety Direct Processor, Only With Land Departure Warning System
219 - VORAD, Adaptive Cruise Control	Wingman	PDF	FLR20 Front Antenna
232 - Lane Departure Warning System (SA232)	FLC20	PDF	Windshield Mounted Camera, On All Trucks With Collision Avoidance

NOTE: If ACOM version 6.14 is used, the Driver Information Display (DID) may display a " Check Engine Fault " message and a Check Engine Light in the cluster, and log an inactive count of DTC U0001-88. PTT should be clear U0001-88 when work with ACOM is completed. **Updating to ACOM version 6.15 or newer will resolve this issue.**

If further assistance is needed, start a new Service Request in eService. Attach a DTC Readout from PTT as well as the ACOM report for the ECU in question.

Tags k05175215 volvo

Related links and attachments

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Service Data

SD-13-4983

Bendix® EC-80™ ABS / ATC Controllers

FIGURE 1 - *BENDIX® EC-80™ ABS AND ATC CONTROLLERS*

See SD-13-21021 for the Bendix® eTrac™ Automated Air Suspension Transfer System

Bendix® EC-80™ ESP(+) Controllers will be featured in SD-13-4986.

INTRODUCTION

Bendix® EC-80™ ABS and ATC controllers are members of a family of electronic **Antilock Braking System (ABS)** devices designed to help improve the braking characteristics of air braked vehicles - including heavy- and medium-duty buses, trucks, and tractors. ABS controllers are also known as **Electronic Control Units (ECUs)**.

Bendix® ABS uses wheel speed sensors, ABS modulator valves, and an ECU to control either four or six wheels of a vehicle. By monitoring individual wheel turning motion during braking, and adjusting or pulsing the brake pressure at each wheel, the Bendix EC-80 controller is able to optimize slip between the tire and the road surface. When excessive wheel slip, or wheel lock-up is detected, the Bendix EC-80 controller will activate the Pressure Modulator Valves to simulate a driver pumping the brakes. However, the Bendix EC-80 controller is able to pump the brakes on individual wheels (or pairs of wheels) independently, and with greater speed and accuracy than a driver.

In addition to the ABS function, the ATC version of the Bendix EC-80 controller provides an **Automatic Traction Control (ATC)** feature. Bendix® ATC can improve vehicle traction during acceleration, plus lateral stability while driving through curves. ATC utilizes **Engine Torque Limiting (ETL)** where the ECU communicates with the engine's controller and/or **Differential Braking (DB)** where individual wheel brake applications are used to improve vehicle traction.

Bendix EC-80 ATC controllers also have the capability to provide a **Hill Start Assist (HSA)** feature. HSA interfaces

⚠ WARNING

The driver is always responsible for the control and safe operation of the vehicle at all times. The Bendix® ABS system does not replace the need for a skilled, alert professional driver, reacting appropriately and in a timely manner, and using safe driving practices.

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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, or a Bendix® **AD-9si®** 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.

between the transmission and braking system to help the driver prevent the vehicle from rolling backwards when moving forward from a stationary position on steep inclines.

Bendix® EC-80™ ATC controllers have a drag torque control feature which reduces driven-axle wheel slip (due to driveline inertia) by communicating with the engine's controller and increasing the engine torque.

COMPONENTS/ECU MOUNTING

The Bendix EC-80 controller's ABS function uses:

- Bendix® WS-24™ wheel speed sensors (4 or 6, depending on ECU and configuration). Each sensor is installed with a Bendix® Sensor Clamping Sleeve
- Bendix® M-32™ / M-32QR™ / M-40X™ Pressure Modulator Valves (4, 5, or 6 depending on ECU and configuration)
- Dash-mounted tractor ABS indicator lamp
- Service brake relay valve
- Dash-mounted trailer ABS indicator lamp (used on all towing vehicles manufactured after March 1, 2001)
- Optional blink code activation switch
- Optional ABS off-road switch. (Off-road feature is not available on all ECUs - See Chart 1.)

FIGURE 2 - *BENDIX® WS-24™ WHEEL SPEED SENSORS*

FIGURE 3 - *BENDIX® M-32™ AND M-40X™ MODULATORS*

The Automatic Traction Control (ATC) function uses the following additional components:

- Traction control valve (may be integral to the service brake relay valve or a stand-alone device)
- Dash-mounted ATC status/indicator lamp
- J1939 serial communication to engine control module
- Stop lamp switch input (may be provided using the ECU hardware input or J1939)
- Optional ATC off-road switch

The Hill Start (HSA) function uses the following components:

- Traction Control Valve (TCV)
- Dash-mounted HSA status/indicator lamp
- Dash-mounted Enable/Disable switch
- RV-3 Pressure Reducing Valve
- DC-4 Double Check valve

ECU MOUNTING

Bendix® EC-80™ controllers are cab-mounted. They are not protected against moisture and must be mounted in an environmentally protected location.

All wire harness connectors must be properly seated. The use of secondary locks is strongly recommended.

⚠ CAUTION

All unused ECU connectors must be covered and receive any necessary protection from moisture, etc.

ECUs utilize connectors from the AMP MCP 2.8 product family.

HARDWARE CONFIGURATIONS

Bendix® EC-80™ ABS Controllers

Bendix EC-80 ABS controllers support four sensor/four modulator (4S/4M) applications. Certain models support Power Line Carrier (PLC) communications, with all models supporting 12 volt installations. *See Chart 1 for more details.*

Bendix EC-80 ATC Controllers

Bendix EC-80 ATC controllers support applications up to six sensor/six modulator (6S/6M) installations with ATC and drag torque control. They can support HSA functions. All 12 volt models support Power Line Carrier (PLC). 24 volt models do not support PLC. *See Chart 1 for more details.*

BENDIX EC-80 CONTROLLERS WITH PLC

Since March 1, 2001, all towing vehicles must have an in-cab trailer ABS indicator lamp. Trailers transmit the status of the trailer ABS over the power line (the blue wire of the J560 connector) to the tractor using a PLC signal. *See Figures 4 and 5.*

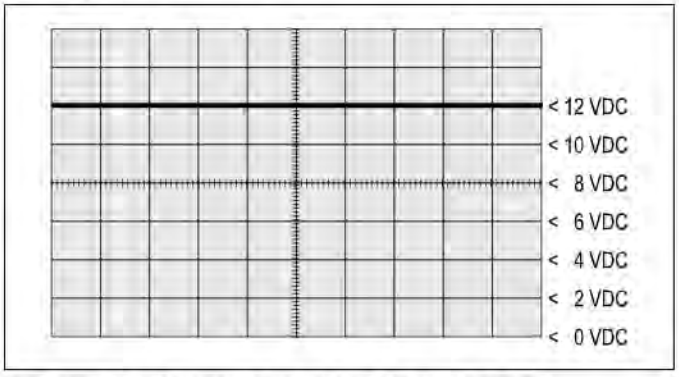


FIGURE 4 - *POWER LINE WITHOUT PLC SIGNAL*

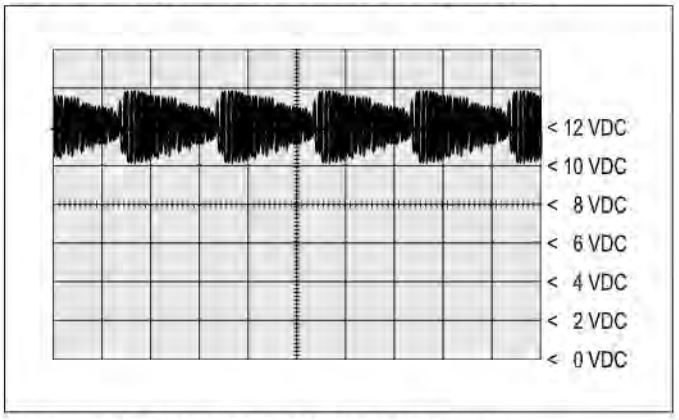


FIGURE 5 - *POWER LINE WITH PLC SIGNAL*

Typically the signal is broadcast by the trailer ABS ECU. The application of PLC technology for the heavy vehicle industry is known as "PLC4Trucks." The Bendix EC-80

ECU	Mounting	Input Voltage	Sensors	PMVs	ATC	Blink Codes	Serial Communication J1939	PLC	ABS Off-Road	ATC Off-Road	Retarder Relay
Bendix EC-80 ABS controller	Cab	12	4	4	-	✔	✔	-	-	-	✔
Bendix EC-80 ABS PLC controller	Cab	12	4	4	-	✔	✔	✔	-	-	✔
Bendix EC-80 ATC controller	Cab	12	4/6	4/5/6	✔	✔	✔	✔	✔	✔	✔
Bendix EC-80 ATC controller	Cab	24	4/6	4/5/6	✔	✔	✔	-	✔	✔	✔

CHART 1 - *BENDIX® EC-80™ CONTROLLERS AVAILABLE*

PLC controller and the Bendix EC-80 ATC controller (12 volt versions) support PLC communications in accordance with SAE J2497.

Identifying a Bendix EC-80 Controller with PLC

Refer to the information panel on the ECU label to see if the controller provides PLC.

An oscilloscope can be used to measure or identify the presence of a PLC signal on the power line. The PLC signal is an amplitude and frequency-modulated signal. Depending on the filtering and load on the power line, the PLC signal amplitude can range from 5.0 mVp-p to 7.0 Vp-p. Suggested oscilloscope settings are AC coupling, 1 volt/div, 100 µsec/div. The signal should be measured at the ignition power input of the Bendix EC-80 controller.

Note: An ABS trailer equipped with PLC or a PLC diagnostic tool must be connected to the vehicle in order to generate a PLC signal on the power line.

To confirm if a specific ECU uses PLC or not, see the Controller Specifications box below.

BENDIX EC-80 CONTROLLER INPUTS

Battery and Ignition Inputs

The ECU operates at a nominal supply voltage of 12 or 24 volts, depending on the ECU. The battery input is connected through a 30 amp fuse directly to the battery.

The ignition input is applied by the ignition switch through a 5 amp fuse.

Ground Input

The Bendix EC-80 controller supports one ground input. *See pages 35-37 for electrical system schematics.*

ABS Indicator Lamp Ground Input

Bendix EC-80 ECUs require a second ground input (X1-12) for the ABS indicator lamp. The X1 wire harness connector contains an ABS indicator lamp interlock (X1-15), which shorts the ABS indicator lamp circuit (X1-18) to ground if the connector is removed from the ECU.

Bendix® WS-24™ Wheel Speed Sensors

Wheel speed data is provided to the Bendix EC-80 controller from the Bendix® WS-24™ wheel speed sensor (see Figure 2). Vehicles have an exciter ring (or "tone ring") as part of the wheel assembly, and as the wheel turns, the teeth of the exciter ring pass the wheel speed sensor, generating an AC signal. The Bendix EC-80 controller receives the AC signal, which varies in voltage and frequency as the wheel speed changes.

Vehicle axle configurations and ATC features determine the number of Bendix WS-24™ wheel speed sensors that must be used. A vehicle with a single rear axle requires four wheel speed sensors. Vehicles with two rear axles can utilize six wheel speed sensors for optimal ABS and ATC performance.

Diagnostic Blink Code Switch

A momentary switch that grounds the ABS indicator lamp output is used to place the ECU into the diagnostic blink code mode and is typically located on the vehicle's dash panel.

ABS OFF-ROAD SWITCH AND INDICATOR LAMP OPERATION

⚠ WARNING

The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be affected. When the ECU is placed in the ABS off-road mode, the ABS indicator lamp will flash constantly to notify the vehicle operator that the off-road mode is active.

Bendix EC-80 ATC controllers use a dash-mounted switch to place the ECU into the ABS off-road mode. In some cases, ECUs may also be put into the ABS off-road mode by one of the other vehicle control modules, using a J1939 message to the Bendix EC-80 controller.

If you need to know if a specific ECU uses a J1939 message to operate the lamp, see the Controller Specifications box below.

Stop Lamp Switch (SLS)

Bendix EC-80 ATC ECUs monitor the vehicle stop lamp status. Certain vehicle functions, such as ATC and All-Wheel Drive (AWD), use the status of the stop lamp to know the driver's intention. This can be provided to the ECU via J1939 communications or hardware input.

BENDIX EC-80 CONTROLLER OUTPUTS

Bendix® M-32™, M-32QR™ and M-40X™ Pressure Modulator Valves (PMV)

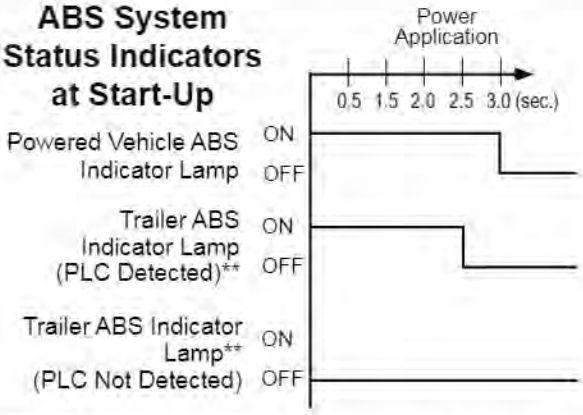
The Bendix M-32, M-32QR and M-40X pressure modulator valves (PMV) are operated by the Bendix EC-80 controller to modify driver applied air pressure to the service brakes during ABS or ATC activation (See pages 6-8). The PMV is an electro-pneumatic control valve and is the last valve that air passes through on its way to the brake chamber. The modulator hold and release solenoids are activated to precisely modify the brake pressure during an antilock braking event. The hold solenoid is normally open and the release solenoid is normally closed.

Controller Specifications: *If you need to know exact information about an ECU e.g. if it uses PLC, serial communications, etc., e-mail ABS@Bendix.com, specifying the ECU part number, or call: 1-800-AIR-BRAKE, 1-800-247-2725, option 2, then 1, and speak to the Bendix TechTeam.*

Dash Lamps

	Mode		ABS Lamp	ATC Lamp	Trailer ABS Lamp	HSA Lamp	Comments
At Vehicle Startup	**Ignition on** - start up (trailer with PLC)		ON for 3 seconds*	ON for 2.5 seconds*	ON for 3 seconds**	ON for 3 seconds*	* If any of the described lamp behaviors do not occur — or if the lamp remains on during operation — have the vehicle serviced by a qualified mechanic as soon as possible to restore full system functionality. ** Some vehicle manufacturers may illuminate the trailer ABS indicator lamp at power-up regardless of whether a PLC signal is detected from the trailer or not. Consult the vehicle manufacturer's documentation for more details.
	3 seconds after ignition (with no Diagnostic Trouble Codes)		Lamp OFF*	Lamp OFF*	Lamp OFF**	Lamp OFF*	
Special Mode Operation	**ABS Off-Road Mode**	Normal	Lamp flashes slowly (every 2.5 seconds)	Lamp OFF	• Uses dash switch • Not for firm road surfaces • Allows more wheel lock-up (less ABS intervention) • Mode only applies under 25 mph (Over 25 mph, the system reverts to full ABS - including ATC, and ATC lamp goes off.)		
		During an ATC Event		Flashes quickly			
	— OR, depending on vehicle options (a vehicle can have *either* ABS off-road *or* HSA) —						
	Vehicles with Hill Start Feature: During HSA Mode					Lamp OFF	• The HSA lamp is illuminated only at power-up, or if an HSA DTC is present • If the driver disables HSA, the HSA lamp will flash slowly
	Deep Mud/ Snow/ Mode	Normal	OFF	Flashes slowly (every 2.5 seconds)	• Uses dash switch • Increases allowable wheel slip during ATC interventions • Not for firm road surfaces		
		During an ATC Event	OFF	Flashes quickly			
	During an Automatic Traction Control (ATC) Event			Flashes quickly			• Reduces wheel slip during acceleration at low speeds
	During Dynamometer Mode			Lamp ON (ATC Disabled)			• Disables ATC monitoring functions • When not in Dynamometer Mode, an illuminated lamp indicates an ATC DTC is present

ABS System Status Indicators at Start-Up



ATC System Status Indicator at Start-Up

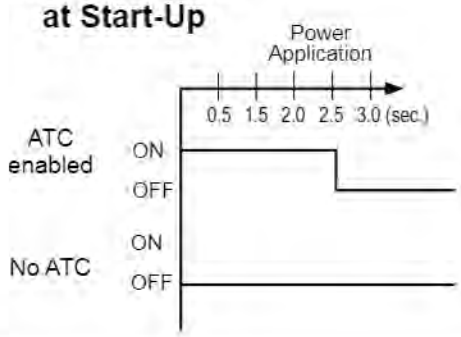


CHART 2 - *BENDIX® EC-80™ INDICATOR LAMP BEHAVIOR*

Traction Control Valve (TCV)

Bendix EC-80 ATC controllers will activate the TCV during differential braking ATC events. The TCV may be a separate valve or integrated into the rear axle relay valve.

ABS Indicator Lamp Control with Optional Diagnostic Blink Code Switch

Bendix® EC-80™ controllers have internal circuitry to control the ABS indicator lamp on the dash panel.

The ABS Lamp Illuminates:

1. During power-up (e.g. when the vehicle is started) and turns off after the self-test is completed, providing no **Diagnostic Trouble Codes (DTCs)** are present on the tractor.
2. If the ECU is unplugged or has no power.
3. When the ECU is placed into the ABS off-road mode (the lamp flashes rapidly).
4. To display blink codes for diagnostic purposes after the external diagnostic switch is activated.

Certain Bendix® EC-80™ controllers communicate with other vehicle control modules to operate the ABS indicator lamp using. *To confirm if a specific ECU uses* serial communications, *see the Controller Specifications box on page 4.*

Indicator Lamp Control Using Serial Communications Links

As mentioned above, depending on the vehicle manufacturer, the dash indicator lamps (ABS, ATC and trailer ABS) may be controlled using serial communications link. In these cases, the Bendix EC-80 controller will send a serial communications message over the J1939 links indicating the required status of the lamp(s). Another vehicle control module receives the message and controls the indicator lamp(s).

Retarder Relay Disable Output

The retarder relay disable output may be used to control a retarder disable relay.

When configured to use this output, the ECU will energize the retarder disable relay and inhibit the use of the retarder as needed.

SAE J1939 Serial Communications

A Controller Area Network (CAN) data link (SAE J1939) is provided for communication. This link is used for various functions, such as:

- To disable retarding devices during ABS operation
- To request that the torque converter disable lock-up during ABS operation
- To share information such as wheel speed and ECU status with other vehicle control modules

Bendix EC-80 ATC controllers utilize the J1939 data link for ATC and drag torque control functions.

Trailer ABS Indicator Lamp Control

Certain models of the Bendix EC-80 controller activate a trailer ABS indicator lamp (located on the dash panel) that indicates the status of the trailer ABS unit on one, or more trailers or dollies. Typically, the Bendix EC-80 controller directly controls the trailer ABS indicator lamp based on the information it receives from the trailer ABS.

Alternatively, some vehicles require the Bendix EC-80 controller to activate the trailer ABS indicator lamp by communicating with other vehicle controllers using serial communications. *To confirm if a specific ECU uses* serial communications, *see the Controller Specifications box on page 4.*

ATC Lamp Output/ATC Off-Road Switch Input

The ATC dash lamp is controlled by the Bendix EC-80 ATC ECU. The ATC lamp illuminates:

1. During power-up (e.g. when the vehicle is started for approximately 2.5 seconds) and turns off after the self-test is completed, providing no Diagnostic Trouble Codes are present.
2. When ATC is disabled for any reason.
3. During an ATC event (the lamp will flash rapidly at a rate of 2.5/second).
4. When the ECU is placed in the ATC off-road mode (the lamp will flash steadily every 2.5 seconds). This notifies the vehicle operator that the off-road mode is active.

Interaxle Differential Lock Control (AWD Transfer Case)

A Bendix EC-80 ATC ECU can control the interaxle differential lock (AWD transfer case). This is recommended on AWD vehicles, but the ECU must be specially configured to provide this feature. *For help with configuring an ECU, use the information in the Controller Specifications box on page 4 to contact Bendix.*

POWER-UP SEQUENCE

⚠ WARNING

The vehicle operator should verify proper operation of all installed indicator lamps (ABS, ATC, and trailer ABS) when applying ignition power and during vehicle operation. *See Chart 2 on page 5.*

Lamps that do not illuminate as expected when ignition power is applied, or remain illuminated, indicate the need for maintenance.

ABS Indicator Lamp Operation

The ECU will illuminate the ABS indicator lamp for approximately three seconds when ignition power is applied, after which the lamp will extinguish if no Diagnostic Trouble Codes are detected.

The ECU will illuminate the ABS indicator lamp whenever full ABS operation is not available due to a Diagnostic Trouble Code. In most cases, partial ABS is still available.

ATC Status/Indicator Lamp Operation

The ECU will illuminate the ATC lamp for approximately 2.5 seconds when ignition power is applied, after which the lamp will extinguish, if no Diagnostic Trouble Codes are detected.

The ECU will illuminate the ATC indicator lamp whenever ATC is disabled due to a Diagnostic Trouble Code.

Trailer ABS Indicator Lamp Operation

Certain models of the ECU will control the Trailer ABS indicator lamp when a PLC signal (SAE J2497) from a trailer ABS ECU is detected.

Pressure Modulator Valve Chuff Test

Bendix® EC-80™ controllers will perform a Bendix-patented Pressure Modulator Valve (PMV) Chuff Test. The Chuff Test is an electrical and pneumatic PMV test that can assist maintenance personnel in verifying proper PMV wiring and installation.

With brake pressure applied, a properly installed PMV will perform one sharp audible exhaust of air by activating the hold solenoid twice and the release solenoid once. If the PMV is wired incorrectly, it will produce two exhausts of air, or none at all.

The Bendix EC-80 controller will perform a PMV chuff test on all installed modulators in the following order:

- Steer Axle Right PMV
- Steer Axle Left PMV
- Drive Axle Right PMV
- Drive Axle Left PMV
- Additional Axle Right PMV
- Additional Axle Left PMV

The pattern will then repeat itself. *See Figure 6.*

The ECU will not perform the PMV Chuff Test when wheel speed sensors show that the vehicle is in motion.

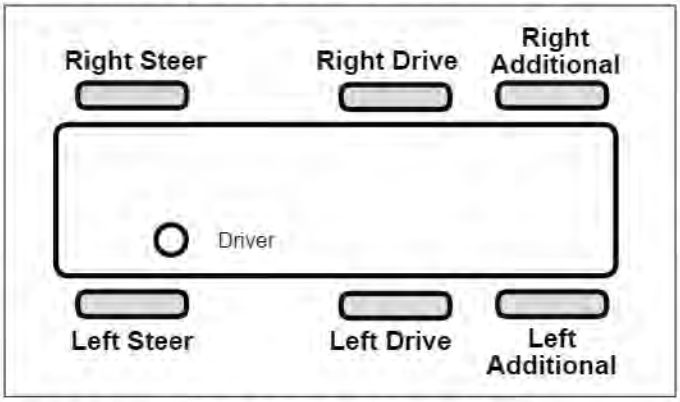


FIGURE 6 - *VEHICLE ORIENTATION (TYPICAL)*

ABS OPERATION

Bendix® ABS uses wheel speed sensors, ABS modulator valves, and an ECU to control either four or six wheels of a vehicle. By monitoring individual wheel turning motion during braking, and adjusting or pulsing the brake pressure at each wheel, the Bendix EC-80 controller is able to optimize slip between the tire and the road surface. When excessive wheel slip, or wheel lock-up, is detected, the Bendix EC-80 controller will activate the pressure modulator valves to simulate a driver pumping the brakes. However, the Bendix EC-80 controller is able to pump the brakes on individual wheels (or pairs of wheels), independently, and with greater speed and accuracy than a driver.

Steer Axle Control

Although both wheels of the steer axle have their own wheel speed sensor and pressure modulator valve, the Bendix EC-80 controller blends the applied braking force between the two steering axle brakes. This Bendix-patented brake application control, called Modified Individual Control (MIC), is designed to help reduce steering wheel pull during an ABS event on road surfaces with poor traction (or areas of poor traction, e.g., asphalt road surfaces with patches of ice).

Single Drive Axle Control (4x2 Vehicle)

For vehicles with a single rear drive axle (4x2), the brakes are operated independently by the Bendix EC-80 controller, based on the individual wheel behavior.

Dual Drive Axle Control (4S/4M Configuration)

For vehicles with dual drive axles (6x4) using a 4S/4M configuration, one ABS modulator controls both right-side rear wheels, and the other modulator controls both left-side rear wheels. Both wheels on each side receive equal brake pressure during an ABS stop. The rear wheel speed sensors must be installed on the axle with the lightest load.

Dual Rear Axle Control (6S/6M Configuration)

For vehicles with dual rear axles (6x4, 6x2) using a 6S/6M configuration, the rear wheels are controlled independently. Therefore, brake application pressure at each wheel is adjusted according to the individual wheel behavior on the road surface.

6x2 Vehicles with 6S/5M Configuration

6x2 vehicles can utilize a 6S/5M configuration, with the additional axle (a non-driven rear axle) having two sensors, but only one pressure modulator valve. In this case, the PMV controls both wheels on the additional axle. The additional axle wheels would receive equal brake pressure, based on the wheel that is currently experiencing the most wheel slip.

Normal Braking

During normal braking, brake pressure is delivered through the ABS PMV and into the brake chamber. If the ECU does not detect excessive wheel slip, it will not activate ABS control, and the vehicle stops with normal braking.

Retarder Brake System Control

On surfaces with low traction, application of the retarder can lead to high levels of wheel slip at the drive axle wheels, which can adversely affect vehicle stability.

To avoid this, the Bendix EC-80 controller switches off the retarder as soon as a lock-up is detected at one (or more) of the drive axle wheels.

When the ECU is placed in the ABS off-road mode, it will switch off the retarder only when ABS is active on a steer axle wheel and a drive axle wheel.

Optional HSA Mode

As a driver begins to move a vehicle forward when stopped facing up an incline (or backs-up a vehicle when facing down a slope), vehicles without Bendix Hill Start Aid/Assist (HSA) may experience rolling downhill during the delay between the release of the brakes and providing enough torque to move the vehicle up the slope.

For vehicles with Bendix HSA, the ECU receives a J1939 message from the transmission when it will need the assistance of the brakes to avoid the vehicle rolling. The HSA components apply brake pressure to select wheel-end brakes. After three (3) seconds from the driver brake release, the HSA system releases the brake pressure. The three-second delay allows the drive-line components to activate while the vehicle is held in place.

⚠ WARNING

When using the HSA function, the ABS off-road function and the Retarder Relay output are temporarily disabled.

Optional ABS Off-Road Mode

On some road conditions, particularly when the driving surface is soft, the stopping distance with ABS may be longer than without ABS. This can occur when a locked wheel on soft ground plows up the road surface in front of the tire, changing the rolling friction value. Although vehicle stopping distance with a locked wheel may be shorter than corresponding stopping distance with ABS control, vehicle steerability and stability is reduced.

Bendix® EC-80™ ATC controllers have an optional control mode that more effectively accommodates these soft road conditions to shorten stopping distance while maintaining optimal vehicle steerability and stability.

⚠ WARNING

The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be reduced. The flashing ABS indicator lamp communicates the status of this mode to the driver.

The vehicle manufacturer should provide the optional ABS off-road function only for vehicles that operate on unpaved surfaces or that are used in off-road applications. The vehicle OEM is responsible for ensuring that vehicles equipped with the ABS off-road function meet all FMVSS-121 requirements and have adequate operator indicators and instructions.

The vehicle operator activates the off-road function with a switch on the dash panel. A flashing ABS indicator lamp indicates to the driver that the ABS off-road function is engaged. To exit the ABS off-road mode, depress and release the switch.

All-Wheel Drive (AWD) Vehicles

AWD vehicles with an engaged interaxle differential (steer axle to rear axle)/AWD transfer case may have negative effects on ABS performance. Optimum ABS performance is achieved when the lockable differentials are disengaged, allowing individual wheel control.

Bendix EC-80 ATC controllers can be programmed specifically for this configuration to control the differential lock/unlock solenoid in the AWD transfer case. When programmed to do so, the ECU will disengage the locked interaxle/AWD transfer case during an ABS event and reengage it once the ABS event has ended.

ATC OPERATION

ATC Functional Overview

Just as ABS improves vehicle stability during braking, ATC improves vehicle stability and traction during vehicle acceleration. The Bendix EC-80 ATC controller's ATC function uses the same wheel speed information and modulator control as the ABS function. The ECU detects excessive drive wheel speed; compares the speed of the front, non-driven wheels; and reacts to help bring the wheel spin under control. The ECU can be configured to use engine torque limiting and/or differential braking to control wheel spin. For optimal ATC performance, both methods are recommended.

ATC Lamp Operation

The ATC lamp illuminates:

1. During power-up (e.g. when the vehicle is started for approximately 2.5 seconds) and turns off after the self-test is completed, providing no Diagnostic Trouble Codes are present.
2. When ATC is disabled for any reason.

3. During an ATC event (the lamp will flash rapidly at a rate of 2.5/second). When ATC is no longer active, the ATC active/indicator lamp turns off.
4. When the ECU is placed in the ATC off-road mode (the lamp will flash steadily every 2.5 seconds). This notifies the vehicle operator that the off-road mode is active.

Differential Braking

Differential braking is automatically activated when drive wheel(s) on one side of the vehicle are spinning. This typically occurs on asphalt road surfaces with patches of ice. The traction system will then lightly apply the brake to the drive wheel(s) that are spinning. The vehicle differential will then drive the wheels on the other side of the vehicle.

Differential braking is available at vehicle speeds up to 25 MPH.

Disabling ATC Differential Braking

ATC differential braking is disabled under the following conditions:

1. During power-up (e.g. when the vehicle is started), until the ECU detects a service brake application.
2. If the ECU receives a J1939 message indicating that the vehicle is parked.
3. When the Dynamometer Test Mode is active. The Dynamometer Test Mode is entered using the diagnostic blink code switch or by using a diagnostic tool (such as Bendix® ACom® Diagnostics).
4. In response to a serial communications request from a diagnostic tool.
5. During brake torque limiting to avoid overheating of the brakes.
6. When certain Diagnostic Trouble Code conditions are detected.

Engine Torque Limiting (ETL) with *Smart ATC*™ Traction Control

The Bendix® EC-80™ controller uses Engine Torque Limiting to control drive axle wheel slip. This is communicated to the engine control module (using J1939), and is available at all vehicle speeds.

Bendix® Smart ATC™ Traction Control

The Bendix EC-80 ATC controller has an additional feature known as Smart ATC™ traction control. Smart ATC™ traction control monitors the accelerator pedal position (using J1939) to help provide optimum traction and vehicle stability. By knowing the driver's intention and adapting the target slip of the drive wheels to the driving situation, the Smart ATC™ traction control allows higher wheel slip when the accelerator pedal is applied above a preset level.

The target wheel slip is decreased when driving through a curve for improved stability.

Disabling ATC Engine Control and Smart ATC™ Traction Control

ATC Engine Control and Smart ATC™ traction control will be disabled under the following conditions:

1. In response to a serial communications request from an off-board tool.
2. At power-up until the ECU detects a service brake application.
3. If the ECU receives a J1939 message indicating that the vehicle is parked.
4. If the Dynamometer Test Mode is active. This may be accomplished via an off-board tool or the diagnostic blink code switch.
5. When certain Diagnostic Trouble Code conditions are detected.

Optional ATC Off-Road Mode

In some road conditions, the vehicle operator may desire additional drive wheel slip when ATC is active. The Bendix EC-80 ATC controller has an optional control mode to permit this desired performance.

The vehicle operator can activate the off-road function with a switch on the dash panel. Alternately, a J1939 message may be used to place the vehicle in this mode. The ATC indicator lamp will flash continually to confirm that the off-road ATC function is engaged.

To exit the ATC off-road mode, depress and release the ATC off-road switch.

Drag Torque Control Functional Overview

Bendix EC-80 ATC controllers have a feature referred to as drag torque control which reduces wheel slip on a driven axle due to driveline inertia. This condition is addressed by increasing the engine torque to overcome the inertia.

Drag torque control increases vehicle stability on low-traction road surfaces during down-shifting or retarder braking.

DYNAMOMETER TEST MODE

⚠ WARNING

ATC must be disabled prior to conducting any dynamometer testing. When the Dynamometer Test Mode is enabled, ATC brake control and engine control, along with drag torque control, are turned off. This test mode is used to avoid torque reduction — or torque increase and brake control activation — when the vehicle is operated on a dynamometer for testing purpose.

The Dynamometer Test Mode may be activated by pressing and releasing the diagnostic blink code switch five (5) times or by using a hand-held or PC-based diagnostic tool.

The Dynamometer Test Mode will remain active even if power to the ECU is removed and re-applied. Press and release the blink code switch three (3) times, or use a hand-held or PC-based diagnostic tool to exit the test mode.

AUTOMATIC TIRE SIZE CALIBRATION

The ECU requires a precise rolling circumference ratio between steer axle and drive axle tires in order for ABS and ATC to perform in an optimal manner. For this reason, a learning process continuously takes place in which the precise ratio is calculated. This calculated value is stored in the ECU memory provided the following conditions are met:

1. Rolling-circumference ratio is within the permissible range.
2. Vehicle speed is greater than approximately 15 MPH.
3. No acceleration or deceleration is taking place.
4. There are no active speed sensor Diagnostic Trouble Codes (DTCs).

The ECU is provided with a ratio value of 1.00 as a default setting. If the automatic tire size alignment calculates a different value, this is used to overwrite the original figure in the memory. This process adapts the ABS and ATC function to the vehicle.

Acceptable Tire Sizes

The speed calculation for an exciter ring with 100 teeth is based on a default tire size of 510 revolutions per mile. This figure is based on the actual rolling circumference of the tires, and varies with tire size, tire wear, tire pressure, vehicle loading, etc.

The ABS response sensitivity is reduced when the actual rolling circumference is excessive on all wheels. For a 100-tooth exciter ring, the minimum number of tire revolutions per mile is 426, and the maximum is 567. The ECU will set DTCs if the number of revolutions are out of this range.

ABS PARTIAL SHUTDOWN

Depending which component the trouble code is detected on, the ABS and ATC functions may be fully or partially disabled. Even with the ABS indicator lamp on, the Bendix® EC-80™ controller may still provide ABS function on wheels that are not affected. The ECU should be serviced as soon as possible.

Steer Axle ABS Modulator Diagnostic Trouble Code

ABS on the affected wheel is disabled. ABS and ATC on all other wheels remains active.

Drive Axle/Additional Axle ABS Modulator Diagnostic Trouble Code

ATC is disabled. ABS on the affected wheel is disabled. ABS on all other wheels remains active.

Steer Axle Wheel Speed Sensor Diagnostic Trouble Code

The wheel with the Diagnostic Trouble Code is still controlled by using input from the remaining wheel speed sensor on the front axle. ABS remains active on the rear wheels. ATC is disabled.

Drive Axle/Additional Axle Wheel Speed Sensor Diagnostic Trouble Code

ATC is disabled. In a four sensor system, ABS on the affected wheel is disabled, but ABS on all other wheels remains active.

In a six sensor system, ABS remains active by using input from the remaining rear wheel speed sensor on the same side.

ATC Modulator Diagnostic Trouble Code

ATC is disabled. ABS remains active.

J1939 Communication Diagnostic Trouble Code

ATC is disabled. ABS remains active.

ECU Diagnostic Trouble Code

ABS and ATC are disabled. The system reverts to normal braking.

Voltage Diagnostic Trouble Code

While voltage is out of range, ABS and ATC are disabled. The system reverts to normal braking. When the correct voltage level is restored, full ABS and ATC function is available. Operating voltage range is 9.0 to 17.0 VDC.

Reconfiguring Bendix® EC-80™ Controllers

SYSTEM RECONFIGURATION

The Bendix® EC-80™ controller is designed to allow the technician to change the default system settings (chosen by the vehicle OEM) to provide additional or customized features. When replacing an ECU, be sure to use an equivalent Bendix® replacement part number so that the standard default settings are provided.

Depending on the version, the customizable features include ABS control settings, engine module communication, etc. Many of these settings can be reconfigured using a hand-held diagnostic tool or PC-based software, such as the Bendix® ACom® Diagnostics program.

ECU RECONFIGURATION

Reconfiguring Bendix EC-80 ABS ECUs

Reconfiguring a Bendix EC-80 ABS controller may be carried out by using the Blink Code Switch or by using a hand-held or PC-based diagnostic tool.

Note: During the reconfiguration process, and independently from any reconfiguration being carried out by the technician, standard ECUs automatically check the J1939 serial link and communicate with other vehicle modules. In particular, if the serial link shows that the vehicle has a retarder device present, the ECU will configure itself to communicate with the retarder device for improved ABS performance. For example, if the ECU detects the presence of a retarder disable relay during a reconfiguration, it will configure itself to control the relay to disable the retarding device as needed.

Reconfiguring Bendix EC-80 ATC ECUs

As with non-ATC ECUs, the Bendix EC-80 ATC ECU also carries out — independently from any reconfiguration being carried out by the technician — an automatic check of the J1939 serial link and communicates with other vehicle modules. This includes checking for ATC and retarder disable relay operation. In addition, Bendix EC-80 ATC controllers will determine the number of wheel speed sensors and PMVs installed and configure itself accordingly.

6S/5M Configuration

Bendix EC-80 ATC controllers will configure for 6S/5M operation when a reconfiguration event is initiated and the ECU detects that an additional axle PMV is wired as follows:

PMV Connector	ECU Connector
Hold	Right Additional Axle Hold
Release	Left Additional Axle Release
Common	Right Additional Axle Common

See 6S/5M System Schematic (page 37) for details.

Reconfiguration Using the Blink Code Switch

The reconfiguration procedure is the same for ATC and non-ATC ECUs. With ignition power removed from the Bendix EC-80 controller, depress the blink code switch. After the ignition power is activated, depress and release the switch seven times to initiate a reconfiguration.

Diagnostic Tool

A reconfiguration event may be initiated using a hand-held or PC-based diagnostic tool to communicate with the ECU over the SAE J1939 diagnostic link.

Troubleshooting: General

Read and follow the General Safety Guidelines on page two (2) of this document.

REMOVING THE BENDIX® EC-80™ CONTROLLER ASSEMBLY

1. Turn vehicle ignition off.
2. Remove as much contamination as possible prior to disconnecting air lines and electrical connections.
3. Note the ECU assembly mounting position on the vehicle.
4. Disconnect the electrical connectors from the ECU.
5. Remove and retain the mounting bolts that secure the ECU.

INSTALLING A NEW BENDIX® EC-80™ CONTROLLER

⚠ CAUTION

When replacing the Bendix® EC-80™ controller, verify that the unit you are installing has the correct default settings. Failure to do so could result in a loss of features, such as ATC and PLC, or noncompliance with U.S. regulations such as FMVSS 121. It is recommended to use only the correct replacement part number. However, most configuration settings can be altered using the Bendix® ACom® ABS Diagnostic Software program.

Verify correct operation of the Bendix EC-80 controller system and indicator lamps prior to putting the vehicle back into service. Towing vehicles manufactured after March 1, 2001 must support the trailer ABS indicator lamp located on the dash.

For further information, contact either the vehicle manufacturer, Bendix® or your local authorized Bendix® dealer.

1. Position and secure the Bendix EC-80 controller in the original mounting orientation using the mounting bolts retained during removal. When mounting the unit in the cab, use no more torque than is necessary to firmly secure the ECU into position. Over-tightening the mounting hardware can cause damage to the Bendix EC-80 controller.
2. Reconnect the electrical connectors to the ECU.
3. Apply power and monitor the Bendix EC-80 controller power-up sequence to verify proper system operation.

See Troubleshooting: Wiring section beginning on page 32 for more information on wiring harnesses.

Troubleshooting: Blink Codes and Diagnostic Modes

ECU DIAGNOSTICS

The Bendix® EC-80™ controller contains self-testing diagnostic circuitry that continuously checks for the normal operation of internal components and circuitry, as well as external ABS components and wiring.

Active Diagnostic Trouble Codes

When an erroneous system condition is detected, the Bendix EC-80 controller:

1. Illuminates the appropriate indicator lamp(s) and disengages part or all of the ABS and ATC functions. (*See pages 8-9.*)
2. Places the appropriate trouble code information in the ECU memory.
3. Communicates the appropriate trouble code information over the serial communications diagnostic link as required. Hand-held or PC-based diagnostic tools attach to the vehicle diagnostic connector, typically located on or under the dash (*See Figure 7*).

FIGURE 7 - *TYPICAL VEHICLE DIAGNOSTIC CONNECTOR LOCATION (J1939)*

BLINK CODES

Blink codes allow a technician to troubleshoot ABS problems without using a hand-held or PC-based diagnostic tool. Instead, information about the ABS system is communicated by the ECU using the ABS indicator lamp to display sequences of blinks.

Note: The ECU will not enter the diagnostic blink code mode if the wheel speed sensors show that the vehicle is in motion. If the ECU is in the diagnostic blink code mode and then detects vehicle motion, it will exit the blink code mode.

In addition, by operating the blink code switch as described below, one of several diagnostic modes can be entered. See Diagnostic Modes below.

Blink Code Switch Activation

When activating the blink code switch:

1. Wait at least two seconds after "ignition on." (Except when entering Reconfiguration Mode - see Reconfiguration section on page 11)
2. For the ECU to recognize that the switch is activated "on," the technician must press for at least 0.1 seconds, but less than 5 seconds. (If the switch is held for more than 5 seconds, the ECU will register a malfunctioning switch.)
3. Pauses between pressing the switch when a sequence is required, (e.g. when changing mode) must not be longer than 2 seconds.
4. After a pause of 3.5 seconds, the ECU will begin responding with output information blinks. See Figure 10 for an example.

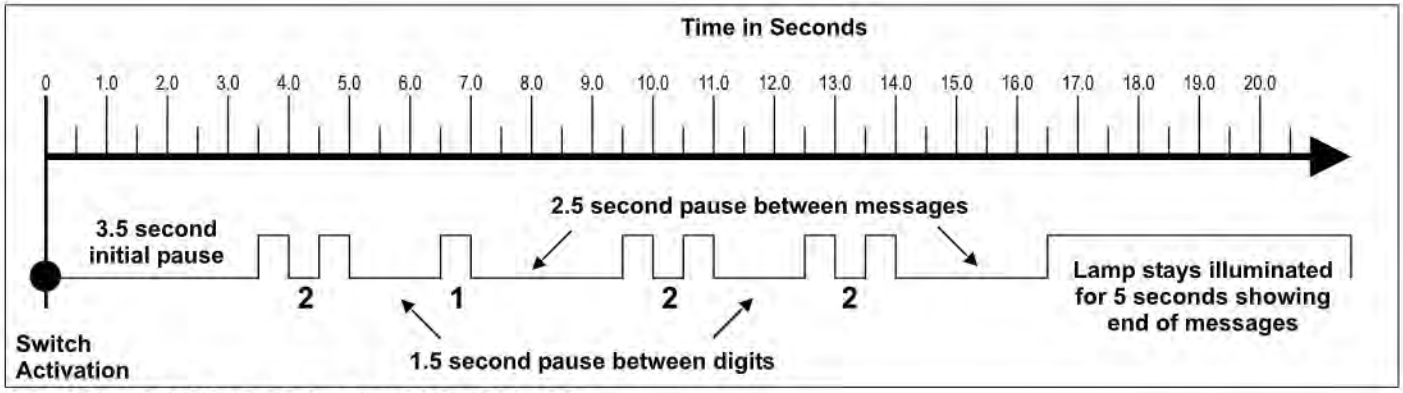


FIGURE 8 - *EXAMPLE OF BLINK CODE MESSAGE*

Blink Code Timing

The ECU responds with a sequence of blink codes. The overall blink code response from the ECU is called a "message." Each message includes, depending on the mode selected by the technician, a sequence of one or more groups of blinks. Simply record the number of blinks for each sequence and then use the troubleshooting index on page 18 for active or inactive trouble codes. Once you have located the code, you will be directed to the page that provides the applicable troubleshooting information.

NOTE:

1. Blink sequences illuminate the ABS indicator lamp for half a second, with half-second pauses between them.
2. Pauses between blink code digits are 1.5 seconds.
3. Pauses between blink code messages are 2.5 seconds.
4. The lamp remains on for five (5) seconds at the end of messages.

See Figure 8 for an example showing the message: 2,1 followed by 2,2.

Once the ABS indicator lamp begins displaying a sequence of codes, it continues until all blink code messages have been displayed and then returns to the normal operating mode. During this time, the ECU will ignore any additional blink code switch activation.

All trouble codes, with the exception of voltage and J1939 trouble codes, will remain in an active state for the remainder of the power cycle.

Voltage trouble codes will clear automatically when the voltage returns within the required limits. All ABS functions will be re-engaged.

J1939 trouble codes will clear automatically when communications are re-established.

DIAGNOSTIC MODES

In order to communicate with the ECU, the controller has several modes that the technician can select, allowing information to be retrieved, or other ECU functions to be accessed.

Diagnostic Modes

To enter the various diagnostic modes:

No. of Times to Press the Blink Code Switch	System Mode Entered
1	Active Diagnostic Trouble Code (DTC) retrieval
2	Inactive DTC retrieval
3	Clear active DTCs
4	System configuration check
5	Dynamometer Test Mode
7*	Reconfigure ECU

* To enter the Reconfiguration Mode, the switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

CHART 3 - *DIAGNOSTIC MODES*

Active Diagnostic Trouble Code Mode

For troubleshooting, typically the active and inactive Diagnostic Trouble Retrieval Modes are used. The technician presses the blink code switch once and the ABS indicator lamp flashes a first group of two codes, and if there are more trouble codes recorded, this is followed by a second set of codes, etc. (See page 18 for a directory of these codes.) All active trouble codes may also be retrieved using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom® Diagnostics software.

To clear active DTCs (as problems are fixed), simply clear (or "self-heal") by removing and re-applying ignition power. The only exception is for wheel speed sensor trouble codes, which clear when power is removed, re-applied, and the ECU detects valid wheel speed from all wheel speed sensors. Alternately, codes may be cleared by pressing the diagnostic blink code switch three (3) times (to enter the Clear Active Diagnostic Trouble Code Mode) or by using a hand-held or PC-based diagnostic tool. Hand-held or PC-based diagnostic tools are able to clear wheel speed sensor trouble codes without the vehicle being driven.

Inactive Diagnostic Trouble Code Mode

The ECU stores past trouble codes and comments (such as configuration changes) in its memory. This record is commonly referred to as "event history." When an active trouble code is cleared, the ECU stores it in the event history memory as an inactive trouble code.

Using blink codes, the technician may review all inactive trouble codes stored on the ECU. The ABS indicator lamp will display inactive diagnostic blink codes when the diagnostic blink code switch is depressed and released two times. See page 18 for the index showing trouble codes. Go to the specific troubleshooting guide page shown there for further help.

Inactive trouble codes and event history may be retrieved and cleared by using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom® Diagnostics software.

Clearing Active Diagnostic Trouble Codes

The ECU will clear active trouble codes when the diagnostic blink code switch is depressed and released three (3) times.

System Configuration Check Mode

The ABS indicator lamp will display system configuration information when the diagnostic blink code switch is depressed and released four (4) times. The lamp will blink out configuration information codes using the following patterns. *(See Chart 4).*

1st Number	System Power
1	12 Volts
2	24 Volts
2nd Number	**Wheel Speed Sensors**
4	4 Sensors
6	6 Sensors
3rd Number	**Pressure Modulator Valves**
4	4 Modulators
5	5 Modulators
6	6 Modulators
4th Number	**ABS Configuration**
1	4S/4M or 6S/6M
2	6S/4M
3	6S/5M
5th Number	**Traction Control Configuration**
2	No ATC
3	ATC Engine Control Only
4	ATC Brake Control Only
5	Full ATC (Engine Control & Brake Control)
6th Number	**Retarder Configuration**
1	No Retarder
2	J1939 Retarder
3	Retarder Relay
4	J1939 Retarder, Retarder Relay

CHART 4 - *SYSTEM CONFIGURATION CHECK*

In this mode, the ECU tells the technician — by means of a series of six blink codes — the type of ABS system that the ECU has been set up to expect. For example, if the fourth blink code seqiemce is a three, the technician knows that a 6S/5M sensor/modulator configuration has been set.

Dynamometer Test Mode

The Dynamometer Test Mode is used to disable ATC when needed (e.g. when performing any vehicle maintenance where the wheels are lifted off the ground and moving, including dyno testing). This mode is not reset by power off, power on cycling. Instead a hand-held or PC-based diagnostic tool must be used to change the setting. Alternatively, depressing and releasing the blink code switch three times will cause the ECU to exit the blink code mode.

Reconfigure ECU Mode

Vehicle reconfiguration is carried out by using the Reconfigure ECU Mode. (See page 11.) Note: To enter the Reconfiguration Mode, the blink code switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

Troubleshooting: Using Hand-Held or PC-Based Diagnostic Tools

USING HAND-HELD OR PC-BASED DIAGNOSTICS

Troubleshooting and Diagnostic Trouble Code (DTC) clearing (as well as reconfiguration) may also be carried out using hand-held or PC-based diagnostic tools such as the Bendix® Remote Diagnostic Unit (RDU™), Bendix® ACom® Diagnostics software, or the ProLink™ tool.

FIGURE 9 - *THE BENDIX® REMOTE DIAGNOSTIC UNIT (RDU)*

Bendix® RDU™ (Remote Diagnostic Unit)

The Bendix® RDU™ tool (Bendix part number K101596N001) provides the technician with a visual indication of Antilock Braking System (ABS) component Diagnostic Trouble Code (DTC) information. The RDU tool is specifically designed for use with Bendix® ABS systems and Bendix makes no claims for its operation and/or usability with other brands of ABS systems.

Features of the Bendix® RDU™ Tool

The RDU tool attaches to the 9 pin diagnostic connector in the cab of the vehicle. An adapter cable (Bendix part number 5012793) is available to connect the RDU to vehicles with a 6-pin diagnostic connector. *(See Figure 9.)*

The RDU tool allows the technician to:

- Troubleshoot ABS system component problems using DTC reporting via LEDs.
- Reset DTCs on Bendix ABS ECUs by holding a magnet over the reset in the center of the RDU tool for less than 6 seconds.
- Enter the Self-Configuration Mode used by Bendix ABS ECUs by holding a magnet over the reset area for greater than 6 seconds but less than 30 seconds.

How the Bendix RDU Operates

See Figure 7 for typical vehicle connector locations.

When the RDU tool is plugged into the diagnostic connector, all the LEDs will illuminate, and the green LED will flash four (4) times to indicate communications have been established.

If the ABS ECU has no active DTCs, only the green LED will remain illuminated.

If the ABS ECU has at least one active DTC the RDU tool displays the first DTC by illuminating the red LEDs, indicating the malfunctioning ABS component and its location on the vehicle. (See Figure 10.) If there are multiple DTCs on the ABS system, the RDU tool will display one DTC first, then once that DTC has been repaired and cleared, the next code will be displayed.

Typical Combination DTCs are:

- Right steer sensor
- Left steer sensor
- Right drive sensor
- Left drive sensor
- Right additional sensor
- Left additional sensor
- Right steer modulator
- Left steer modulator
- Right drive modulator
- Left drive modulator
- Right additional modulator
- Left additional modulator
- Traction modulator
- ECU
- Engine serial communication
- MOD red LED illuminated, shows the "Common" connection of one or more modulators is shorted to battery or ground
- VLT (Flashing indicates either over- or under-voltage condition)

To pinpoint the root cause and to ensure that the system DTC has been properly corrected, additional troubleshooting may be necessary.

Bendix® RDU™ Reset Function

The magnetic reset switch is located in the center top of the RDU tool. Activation requires a magnet with 30 gauss minimum.

The reset operations are:

1. If the magnet is held over the switch for less than six (6) seconds the "clear Diagnostic Trouble Codes" command is sent.
2. If the magnet is held over the switch for more than six (6) seconds, but less than 30 seconds, the Bendix ABS "self-configuration command" is sent.

Additionally, it is recommended at the end of any inspection that the user switches off and restores the power to the ABS ECU, then check the ABS indicator lamp operation and RDU™ tool to see if they indicate any remaining DTCs.

LED Diagnostic Trouble Codes

LFT -	Left	ECU -	ABS Controller
RHT -	Right	SEN -	Wheel Speed Sensor
DRV -	Drive Axle		
ADD -	Additional	MOD -	Pressure Modulator Valve
STR -	Steer Axle		
VLT -	Power	TRC -	Traction Control

Example: If the Diagnostic Trouble Code is "Right Steer Axle Sensor", the RDU™ unit will display one green and three red LEDs

LEDs
Green
VLT
Red
SEN
STR
RHT

FIGURE 10 - *DIAGNOSTIC TROUBLE CODES*

FIGURE 11 - *BENDIX® ACOM® DIAGNOSTICS*

Bendix® RDU™ Communication Problems

If the ABS ECU does not respond to the RDU tool's request for Diagnostic Trouble Codes, the RDU tool will illuminate each red LED in a clockwise pattern. This pattern indicates the loss of communication and will continue until the ABS ECU responds and communication has been re-established.

Possible sources of communication problems are:

1. A problem with the J1939 link at the in-cab off-board diagnostic connector (9-Pin).
2. The ECU does not support PID194.
3. No power is being supplied to the ECU and/or the diagnostic connector.
4. The J1939 bus is overloaded with information and the RDU can not arbitrate access.
5. A malfunctioning RDU tool.

Bendix® ACom® Diagnostics Software

Bendix® ACom® Diagnostics is a PC-based software program and is designed to meet RP-1210 industry standards. This software provides the technician with access to all the available ECU diagnostic information and configuration capability, including:

- ECU information
- Diagnostic trouble codes and repair information
- Configuration (ABS, ATC, and more)
- Wheel speed information
- Perform component tests
- Save and print information

When using ACom® Diagnostics software to diagnose the Bendix® EC-80™ ABS ECU, the computer's serial, parallel or USB port needs to be connected to the vehicle's diagnostic connector.

For more information on ACom Diagnostics software or RP1210 compliant tools, go to www.bendix.com or visit your local authorized Bendix parts outlet.

See pages 40-43 for Appendix: J1939 SPN and FMI codes and their Bendix blink code equivalents.

www.bendix.com

For the latest information, and for free downloads of the Bendix ACom Diagnostics software, and its User Guide, visit the Bendix website at www.bendix.com.

Bendix Technical Assistance Team

For direct telephone technical support, call the Bendix technical assistance team at:

1-800-AIR-BRAKE (1-800-247-2725, option 2,1), Monday through Friday, 8:00 A.M. to 6:00 P.M. ET, and follow the instructions in the recorded message. Or, you may send an e-mail to techteam@bendix.com to reach the Bendix technical assistance team.

Active or Inactive Diagnostic Trouble Code INDEX

How to interpret the first digit of messages received when active or inactive Diagnostic Trouble Code (DTC) Mode is entered.

1st Blink Code Number	Go Here for Troubleshooting Tests
1	No DTCs (1,1)
2	Wheel Speed Sensors - page 19-20
3	Wheel Speed Sensors - page 19-20
4	Wheel Speed Sensors - page 19-20
5	Wheel Speed Sensors - page 19-20
6	Power Supply - page 24
7	Pressure Modulator Valves - page 21-22
8	Pressure Modulator Valves - page 21-22
9	Pressure Modulator Valves - page 21-22
10	Pressure Modulator Valves - page 21-22
11	J1939 Serial Communications - page 25
12	Miscellaneous - page 27-29
13	ECU - page 26
14	Wheel Speed Sensors - page 19-20
15	Wheel Speed Sensors - page 19-20
16	Pressure Modulator Valves - page 21-22
17	Pressure Modulator Valves - page 21-22
18	Traction Control Valves - page 23

Example: For a message sequence of:

3, 2 12, 4

For the first sequence go to page 19 and for the second sequence go to page 27.

See Page 40 for Appendix: J1939 SPN and FMI Codes and their Bendix® Blink Code Equivalents

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For the latest information, and for free downloads of the Bendix® ACom® Diagnostics software, and its User Guide, visit the Bendix website at www.bendix.com.

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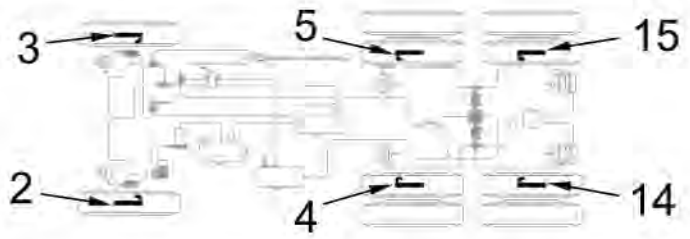
Troubleshooting Diagnostic Trouble Codes: Wheel Speed Sensors

1st. Blink Code	Location
2	Left Steer Axle Sensor
3	Right Steer Axle Sensor
4	Left Drive Axle Sensor
5	Right Drive Axle Sensor
14	Left Additional Axle Sensor
15	Right Additional Axle Sensor



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Excessive Air Gap	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
2	Output Low at Drive-off	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
3	Open or Shorted	Verify 1500 – 2500 ohms across sensor leads. Verify no continuity between sensor leads and ground or voltage. Verify no continuity between sensor leads and other sensors. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
4	Loss of Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
5	Wheel End	Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check mechanical function of brake. Check for kinked or restricted air lines.
6	Erratic Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
7	Tire Size Calibration	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth
10	Configuration Error	ECU is configured for four sensors, but has detected the presence of additional sensors. Verify sensor wiring and ECU configuration.

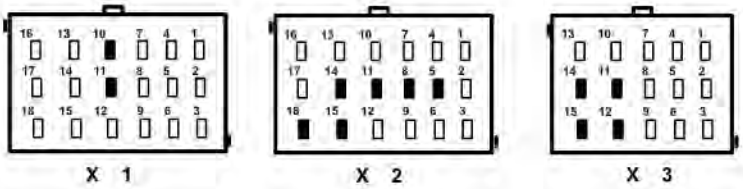
Speed Sensor Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.
2. Wheel speed sensor measurements should read:

Location	Measurement
Sensor	1500 - 2500 Ohms
Sensor to voltage or ground	Open Circuit (no continuity)
Sensor output voltage	>0.25 of VAC sensor output at ~ 0.5 revs/sec.

3. Clear DTC after issue is corrected. The dynamic sensor DTC will remain until the power is cycled to the ABS ECU and vehicle is driven above 15 MPH or DTC was cleared using either the diagnostic blink code switch or diagnostic tool.

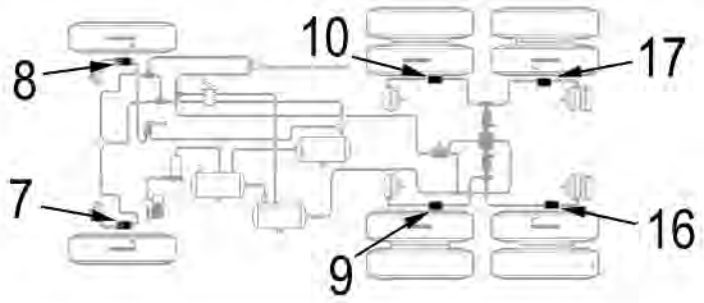
Cab-mount ECU: Looking into wire harness connector



Connector	Pin	Wheel Speed Sensor Location
X1 18 Way	10	Right Drive Axle (+)
	11	Right Drive Axle (-)
X2 18 Way	5	Left Steer Axle (+)
	8	Left Steer Axle (-)
	11	Right Steer Axle (+)
	14	Right Steer Axle (-)
	15	Left Drive Axle (+)
	18	Left Drive Axle (-)
X3 15 Way (if Bendix® EC-80™ ATC ECU is configured for 6 sensors)	11	Left Additional Axle (+)
	14	Left Additional Axle (-)
	12	Right Additional Axle (+)
	15	Right Additional Axle (-)

Troubleshooting Diagnostic Trouble Codes: Pressure Modulator Valves

1st. Blink Code	Location
7	Left Steer Axle
8	Right Steer Axle
9	Left Drive Axle
10	Right Drive Axle
16	Left Additional Axle
17	Right Additional Axle



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Release Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
2	Release Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
3	Release Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
4	Hold Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
5	Hold Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
6	Hold Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
7	CMN Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
8	Configuration Error	A mis-match exists between the ECU configuration and the modulator installation and wiring. Verify PMV wiring and installation. Verify ECU configuration.

Pressure Modulator Valve Repair Tests:

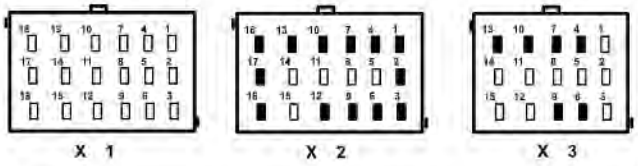
1. Take all measurements at ECU harness connector pins in order to check wire harness and PMV. Probe the connector carefully so that the terminals are not damaged.
2. Pressure modulator resistance should read:

Location	Measurement
Release to Common	4.9 to 5.5 Ohms
Hold to Common	4.9 to 5.5 Ohms
Release to Hold	9.8 to 11.0 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

⚠ CAUTION

When troubleshooting modulator trouble codes, check inactive trouble codes and event history for over-voltage or trouble codes. If one of these is found, troubleshoot these trouble codes first, before the PMV.

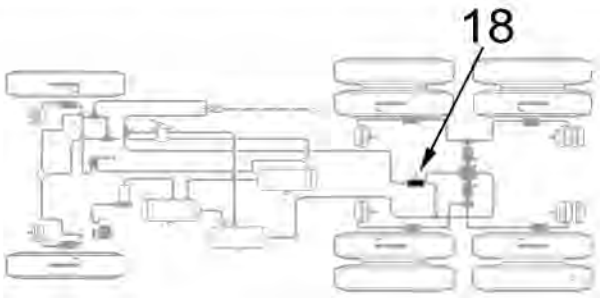
Cab-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location
X2 18 Way	1	Left Steer Axle Hold
	2	Left Steer Axle Release
	3	Left Steer Axle Common
	4	Right Steer Axle Hold
	6	Right Steer Axle Common
	7	Right Steer Axle Release
	9	Right Drive Axle Common
	10	Right Drive Axle Hold
	13	Right Drive Axle Release
	12	Left Drive Axle Common
	16	Left Drive Axle Hold
	17	Left Drive Axle Release
X3 15 Way (if Bendix® EC-80™ ATC ECU is configured for 6 sensors)	4	Left Additional Axle Hold
	6	Left Additional Axle Common
	7	Left Additional Axle Release
	9	Right Additional Axle Common
	10	Right Additional Axle Hold
	13	Right Additional Axle Release

Troubleshooting Diagnostic Trouble Codes: Traction Control Valves

1st. Blink Code	Location
18	Traction Control Valve



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	TCV Solenoid Shorted to Ground	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and ground. Check for corroded/damaged wiring or connectors between ECU and TCV.
2	TCV Solenoid Shorted to Voltage	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and voltage. Check for corroded/damaged wiring or connectors between ECU and TCV.
3	TCV Solenoid Open Circuit	Verify 7 to 19 ohms between TCV and TCV common. Check for corroded/damaged wiring or connectors between ECU and TCV.
4	TCV Configuration Error	The ECU is not configured for ATC, but has detected the presence of a TCV. Verify TCV wiring. Inspect for the presence of a TCV. Verify ECU configuration.

Automatic Traction Control Valve Inspections should include:

- Looking for kinked air hoses, inside the harness socket for removed or corroded connector pins; and a test to verify that the ATC valve solenoids are functioning correctly.

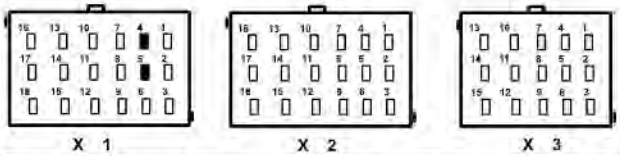
Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and traction control valve. Probe the connector carefully so that the terminals are not damaged.
2. Tractor Control Valve resistance measurements should read:

Location	Measurement
TCV to TCV Common	7 to 19 Ohms
TCV or TCV Common to Voltage or Ground	Open Circuit (no continuity)

Cab-mount ECU:

Looking into wire harness connector



Connector	Pin	Traction Control Test
X1	4	Traction Control Valve Common
18 Way	5	Traction Control Valve

Troubleshooting Diagnostic Trouble Codes: Power Supply

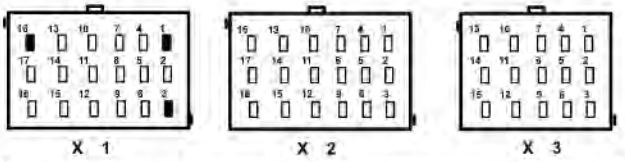
1st. Blink Code	Location
6	Power Supply

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Battery Voltage Too Low	Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
2	Battery Voltage Too High	Measure battery voltage under load. Ensure that battery voltage is correct for the ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.

Power Supply Tests:

1. Take all measurements at ECU harness connector.
2. Place a load (e.g. an 1157 stop lamp) across battery or ignition and ground connection, measure ignition and battery voltage with the load. Ignition-to-Ground should measure between 9 to 17 VDC. Battery-to-Ground should also measure between 9 to 17 VDC.
3. Check for damaged wiring, damaged or corroded connectors and connections.
4. Check condition of vehicle battery and associated components, ground connection good and tight.
5. Check alternator output for excessive noise.

Cab-mount ECU:
Looking into wire harness connector



Connector	Pin	Power Supply Test
X1 18 Way	1	Ground
	3	Ignition
	16	Battery

Troubleshooting Diagnostic Trouble Codes: J1939 Serial Communications

1st. Blink Code	Location
11	J1939

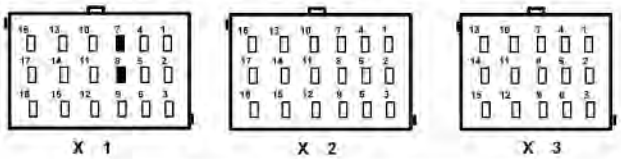
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	J1939 Serial Link Loss of Communications	Loss of communications between the Bendix® EC-80™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
2	J1939 Electronic Retarder Timeout or Invalid Signal (ERC1)	Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of retarder on the J1939 link. Verify ECU Configuration. Verify that the retarder is configured to broadcast ERC1. Check for other devices inhibiting J1939 communications.
3	J1939 Electronic Engine Controller 1, Timeout or Invalid Signal (EEC1)	Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of ECU on the J1939 link. Verify ECU Configuration. Verify the ECU is configured to broadcast EEC1. Check for other devices inhibiting J1939 communications.
4	J1939 Electronic Engine Controller 2 Timeout or Invalid Message (EEC2)	Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of Engine ECU on the J1939 link. Verify ECU Configuration. Verify that there is an EEC2 broadcast from the address configured in the ABS ECU. Check for other devices inhibiting J1939 communications.
10	J1939 Transmission Loss of Communications, ETC1 Message	Loss of communications between the Bendix EC-80 controller and the transmission ECU over the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of engine ECU on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
15	J1939 Engine Loss of Communications, EEC3 Message	Loss of communications between the Bendix EC-80 controller and the engine ECU over the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of engine ECU on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
16	J1939 Engine Loss of Communications, ETC2 Message	Loss of communications between the Bendix EC-80 controller and the transmission ECU over the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of engine ECU on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.

J1939 Troubleshooting Tests:

1. Take all measurements at ECU harness connector.
2. Check for damaged or reversed J1939 wiring.
3. Check for corroded or damaged wiring connector problems such as opens or shorts to voltage or ground.
4. Check for other J1939 devices which may be loading down (inhibiting) J1939 communication.

Cab-mount ECU:

Looking into wire harness connector



Connector	Pin	J1939
X1	7	J1939 Low
18 Way	8	J1939 High

Troubleshooting Diagnostic Trouble Codes: ECU

1st. Blink Code	Location
13	ECU

2nd Blink Code	Diagnostic Trouble Code Description (With HEX designation)	Repair Information
1	ECU DTC (5F3)	Check for damaged or corroded connectors. Check for damaged wiring. Clear trouble codes. If Diagnostic Trouble Codes return, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2, then 1) for further troubleshooting assistance.
2	ECU DTC (5CD)	
3	ECU DTC (10)	
4	ECU DTC (2678C)	
5	ECU DTC (1C)	
6	ECU DTC (6CD)	
7	Configuration mismatch	Verify components installed match ECU configuration
8	ECU DTC (56)	Check for damaged or corroded connectors. Check for damaged wiring. Clear trouble codes. If Diagnostic Trouble Codes return, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725 , option 2, then 1) for further troubleshooting assistance.
9	ECU DTC (CAC3)	
10	ECU DTC (5FC)	
11	ECU DTC (F1A)	
12	ECU DTC (F14)	
13	Configuration mismatch	Verify components installed match ECU configuration
14	ECU DTC (C6)	Check for damaged or corroded connectors. Check for damaged wiring. Clear trouble codes. If Diagnostic Trouble Codes return, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725 , option 2, then 1) for further troubleshooting assistance.
15	ECU DTC (CF)	
16	ECU DTC (C0)	
17	ECU DTC (C8C)	
18	ECU DTC (CC)	
19	ECU DTC (63)	
20	ECU DTC (6E)	
21	ECU DTC (6C)	
22	ECU DTC (63C)	
26	Valve Configuration Mismatch	Verify number of modulators wired matches components installed match ECU configuration

Troubleshooting Diagnostic Trouble Codes: Miscellaneous

1st. Blink Code	Location
12	Miscellaneous

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Stop Lamp Switch Not Detected	ECU has not detected the presence of the stop lamp switch since ignition power was applied (note that stop lamp switch input may be applied to the Bendix® EC-80™ controller using either hardwire input or J1939). Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
2	Stop Lamp Switch Defective	Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
3	ATC Disabled or Dynamometer Test Mode Active	ECU has been placed in the Dynamometer Test Mode by either the diagnostic blink code switch or a hand-held or PC-based diagnostic tool. ATC is disabled.
4	Retarder Relay Open Circuit or Shorted to Ground	Verify vehicle contains a retarder relay. Verify ECU configuration. Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of Bendix EC-80 controller and ground. Verify condition and wiring of the retarder relay.
5	Retarder Relay Circuit Shorted to Voltage	Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of Bendix EC-80 controller and voltage. Verify condition and wiring of the retarder relay.
6	ABS Indicator Lamp Circuit Fault	Check operation of diagnostic blink code switch. Check wiring of diagnostic blink code switch, and ABS WL. Verify ABS WL ground input.
7	Common Shorted to Ground	Verify no continuity between the CMN of all PMVs, (HSA, TCV, and Diff Lock Solenoid — Bendix EC-80 ATC options) and ground. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, (HSA, TCV, and Diff Lock Solenoid — Bendix EC-80 ATC options).
8	Common Shorted to Voltage	Verify no continuity between the CMN of all PMVs, (HSA, TCV, and Diff Lock Solenoid — Bendix EC-80 ATC options) and voltage. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, (HSA, TCV, and Diff Lock Solenoid — Bendix EC-80 ATC options).
9	ATC Disabled to Prevent Brake Fade	ATC is temporarily disabled to prevent excessive heating of the foundation brakes.
11	Wheel Speed Sensors Reversed on an Axle	Sensors are reversed (left to right) on one of the axles. Verify proper installation, connection, and wiring of the sensors.
12	Diff. Lock Solenoid Shorted to Ground or Open Circuit	Verify no continuity between the Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.

Troubleshooting Diagnostic Trouble Codes: Miscellaneous

1st. Blink Code	Location
12	Miscellaneous

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
13	Diff. Lock Solenoid Shorted to Voltage	Verify no continuity between the Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.
17	ABS disabled due to off-road mode	The ABS indicator lamp will be flashing, indicating the ECU is in the off-road ABS mode. Remove and re-apply ignition power.
19	Maximum number of PMV cycles exceeded	Replace all PMV valves and clear the DTC.
20	Maximum Number of TCV Cycles Exceeded	Replace all TCV valves and clear the DTC.
21	ABS Disabled Due to Engaged Interlock	The ABS indicator lamp will be flashing to indicate that the ECU is in the ABS Off-road Mode. Remove and re-apply ignition power.
23	I/O 3 Shorted High	Check for short circuit condition between voltage and the I/O 3 circuit. Verify the resistance between the Input/Output and voltage is open.
24	HSA Lamp Open Circuit or Shorted to GND	Verify that the resistance measured between the battery and HSA lamp output of the ECU is open. Check the wiring between the ECU and the HSA lamp. Check the condition and wiring of the HSA lamp.
25	HSA Valve Solenoid is Shorted to GND	Verify that there is no resistance measured between ground and the HSA solenoid. Check for corroded or damaged wiring or connectors between the ECU and the HSA solenoid.
26	HSA Valve Solenoid is Shorted to Voltage	Verify that there is no resistance measured between voltage and the HSA solenoid. Check for corroded or damaged wiring or connectors between the ECU and the HSA solenoid.
28	Air system/ Mechanical Component	Verify brakes are operating correctly. Verify that there is not over-braking at one or more wheel end(s). Check the pneumatic plumbing and the exhaust port of the PCVs, TCVs, and relay valves and confirm that the air is being exhausted from all brake chambers. Verify tire sizes on the vehicle match the ABS ECU configuration. Verify wheel speed sensors and tone ring are properly adjusted and in good condition.
29	Air system/ Mechanical Component	Verify tires are in good condition. Verify pneumatic hoses are not twisted or kinked. Verify that the brakes are operating correctly. Verify that the wheel speed sensor and tone ring are properly adjusted. Verify tire size.
31	HSA Lamp Shorted to Voltage	Verify that there is no resistance measured between the battery and HSA lamp output of the ECU. Check the wiring between the ECU and HSA lamp. Check the HSA lamp and condition of its wiring.
33	HSA Lamp Solenoid Open Circuit	Verify resistance across the HSA solenoid. Check the ECU and HSA solenoid for corroded or damaged wiring and/or connectors.

Miscellaneous Troubleshooting

For all tests below, take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.

Stop Lamp Switch Test

1. With the service brake applied, measure the system voltage (9 to 17 VDC) stop lamp switch input to ECU.

Test	Measurement
Stop Lamp Switch to Ground	9 to 17 VDC

2. Apply and release service brake, does lamp extinguish?
3. Verify brake lamp switch is connected to ECU via hard wire or J1939.
4. With service brake released, check for presence of stop lamp bulb.

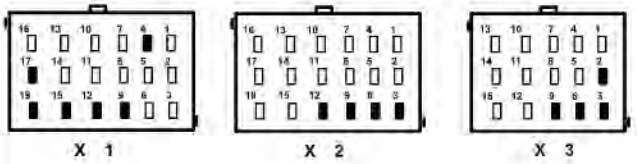
Dynamometer Test Mode (ATC Indicator Lamp Continuously Illuminated)

1. Clear the Dynamometer Test Mode by depressing and releasing the blink code switch three times (or use an off-board diagnostic tool).

ABS Indicator Lamp

1. Verify diagnostic blink code switch is open when not activated.

Cab-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location
X1 18 Way	4	TCV Common
	9	Stop Lamp Switch
	12	ABS WL Ground
	15	ABS WL Interlock
	17	Retarder
	18	ABS WL
X2 18 Way	3	PMV Left Steer Axle Common
	6	PMV Right Steer Axle Common
	9	PMV Right Drive Axle Common
	12	PMV Left Drive Axle Common
X3 15 Way	2	Diff Lock Solenoid
	3	Diff Lock Solenoid Common
	6	PMV Left Additional Axle Common
	9	PMV Right Additional Axle Common

Retarder Relay

1. Measure resistance between retarder disable output of Bendix® EC-80™ controller and voltage / ground.

Test	Measurement
Retarder disable to Voltage or Ground	Open Circuit (no continuity)

2. Verify vehicle has retarder relay.
3. Verify proper wiring from ECU to retarder relay.

PMV Commons

1. Measure resistance between any common (PMV, TCV, and Diff.) and voltage or ground.

Test	Measurement
Any PMV, TCV, or Diff. Common to Voltage or Ground	Open Circuit (no continuity)

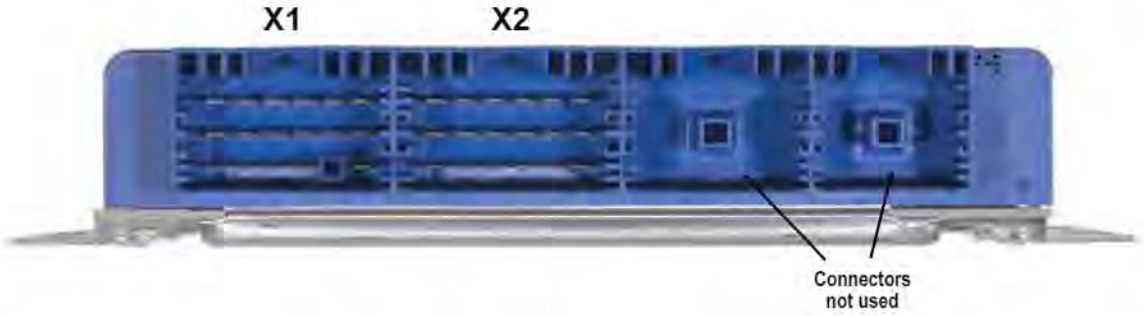
Differential Lock Solenoid

1. Measure resistance between Diff lock solenoid and voltage or ground.

Test	Measurement
Diff. Lock Solenoid to Voltage or Ground	Open Circuit (no continuity)

Troubleshooting: Connectors and Harnesses

Bendix® EC-80™ ABS Controller Wire Harness Connector Part Numbers and Pin Assignments: Bendix EC-80 ABS CAB



Bendix EC-80 ABS Controller

Bendix EC-80 ABS versions utilize two AMP connectors for wire harness connections.

Connector Designation	Number of Contacts	AMP Part Number
X1	17	1718091-1
X2	18	8-968974-1

Bendix EC-80 ABS X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Ground	7	J1939 Low	13	**Not Used**
2	Trailer ABS WL	8	J1939 High	14	**Not Used**
3	Ignition	**9**	**Not Used**	15	ABS WL Interlock
4	**Not Used**	10	WSS DA Right (+)	16	Battery
5	**Not Used**	11	WSS DA Right (-)	17	Retarder
6	**Not Used**	12	ABS WL Ground	18	ABS WL

Bendix EC-80 ABS X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	PMV SA Left HLD	7	PMV SA Right REL	13	PMV DA Right REL
2	PMV SA Left REL	8	WSS SA Left (-)	14	WSS SA Right (-)
3	PMV SA Left CMN	9	PMV DA Right CMN	15	WSS DA Left (+)
4	PMV SA Right HLD	10	PMV DA Right HLD	16	PMV DA Left HLD
5	WSS SA Left (+)	11	WSS SA Right (+)	17	PMV DA Left REL
6	PMV SA Right CMN	12	PMV DA Left CMN	18	WSS DA Left (-)

Troubleshooting: Connectors and Harnesses
(Continued)

Bendix® EC-80™ ATC Controller Wire Harness Connector Part Numbers and Pin Assignments:

Bendix EC-80 ATC Controller

Bendix EC-80 ATC versions utilize three AMP connectors for wire harness connections.

Connector Designation	Number of Contacts	AMP Part Number
X1	17	1718091-1
X2	18	8-968974-1
X3	15	8-968973-1

Bendix EC-80 ATC X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Ground	7	J1939 Low	13	Not Used
2	Trailer ABS WL	8	J1939 High	14	Not Used
3	Ignition	9	SLS	15	ABS WL Interlock
4	TCV CMN	10	WSS DA Right (+)	16	Battery
5	TCV	11	WSS DA Right (-)	17	Retarder
6	ATC Lamp/ATC ORS	12	ABS WL Ground	18	ABS WL

Bendix EC-80 ATC X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	PMV SA Left HLD	7	PMV SA Right REL	13	PMV DA Right REL
2	PMV SA Left REL	8	WSS SA Left (-)	14	WSS SA Right (-)
3	PMV SA Left CMN	9	PMV DA Right CMN	15	WSS DA Left (+)
4	PMV SA Right HLD	10	PMV DA Right HLD	16	PMV DA Left HLD
5	WSS SA Left (+)	11	WSS SA Right (+)	17	PMV DA Left REL
6	PMV SA Right CMN	12	PMV DA Left CMN	18	WSS DA Left (-)

Bendix EC-80 ATC X3 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	ABS ORS	6	PMV AA Left CMN	11	WSS AA Left (+)
2	Diff. Lock SOL[1]	7	PMV AA Left REL	12	WSS AA Right (+)
3	Diff. Lock SOL CMN[1]	8	Input/Output 3	13	PMV AA Right REL
4	PMV AA Left HLD	9	PMV AA Right CMN	14	WSS AA Left (-)
5	Input/Output 2	10	PMV AA Right HLD	15	WSS AA Right (-)

[1]AWD vehicles only. (AWD Transfer Case)

Troubleshooting: Wiring

ABS/ATC WIRING

ECU Wiring Harness Connectors

Bendix® EC-80™ controllers are designed to interface with AMP MCP 2.8 connectors as referenced in Chart 4. Follow all AMP requirements for the repair of wire harnesses.

All wire harness connectors must be properly seated. The use of secondary locks is strongly advised.

⚠ CAUTION

All unused ECU connectors must be covered and receive proper environmental protection.

ABS Wiring Requirements

As a matter of good practice and to ensure maximum system robustness, always use the maximum size wire supported by the wire harness connectors for battery, ignition, ground, PMV, TCV, Interaxle Differential Lock and indicator lamp circuits.

All sensor and serial communications circuits (J1939) must use twisted pair wiring (one to two twists per inch). See the appropriate SAE document for additional details.

⚠ WARNING

All wires must be carefully routed to avoid contact with rotating elements. Wiring must be properly secured approximately every 6 to 12 inches using UV stabilized, non-metallic hose clamps or bow-tie cable ties to prevent pinching, binding or fraying.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

Battery and ground wires should be kept to a minimum length.

If convoluted tubing is used, its I.D. must match the size of the wire bundle as closely as possible.

⚠ CAUTION

Wire harness lengths must be carefully selected for the vehicle. Harnesses that are too long increase the possibility of electrical interference and wire damage. Excess lengths of wire are not to be wound to form coils, instead re-route, repair or replace wire harness. Do not attempt to stretch harnesses that are too short, since mechanical strain can result in wire breakage.

ABS Component	Connector	Wire Terminal	Wire Seal/ Plug	Terminal Lock	Terminal Crimp Tool
Controller Harness 17-Way AMP MCP 2.8 (X1)	 1718091-1	 927768-9 1 - 2.5 mm² X1-12 & 18	N/A	 967634	 539723-2
Controller Harness 18-Way AMP MCP 2.8 (X2)	 8-968974-1	 968874 2.5 - 4 mm²	N/A	N/A	
Controller Harness 15-Way AMP MCP 2.8 (X3)	 8-968973-1	 968873 1.0 - 2.5 mm²	N/A	N/A	
ABS Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-2	 929975-1	N/A	N/A	 539635-1
ATC Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-3		N/A	N/A	
ABS Modulator Harness 3-pin Packard Metri-Pack 280 Series	 12040977	 12077411	 12015323	 12034145	 12155975

WS-24™ Wheel Speed Sensor Connectors

Deutsch DTM06 series | Deutsch DT04 series | Standard round two pin

CHART 5 - *BENDIX® EC-80™ CONTROLLER COMPONENT CONNECTORS*

Troubleshooting: Wiring

(CONTINUED)

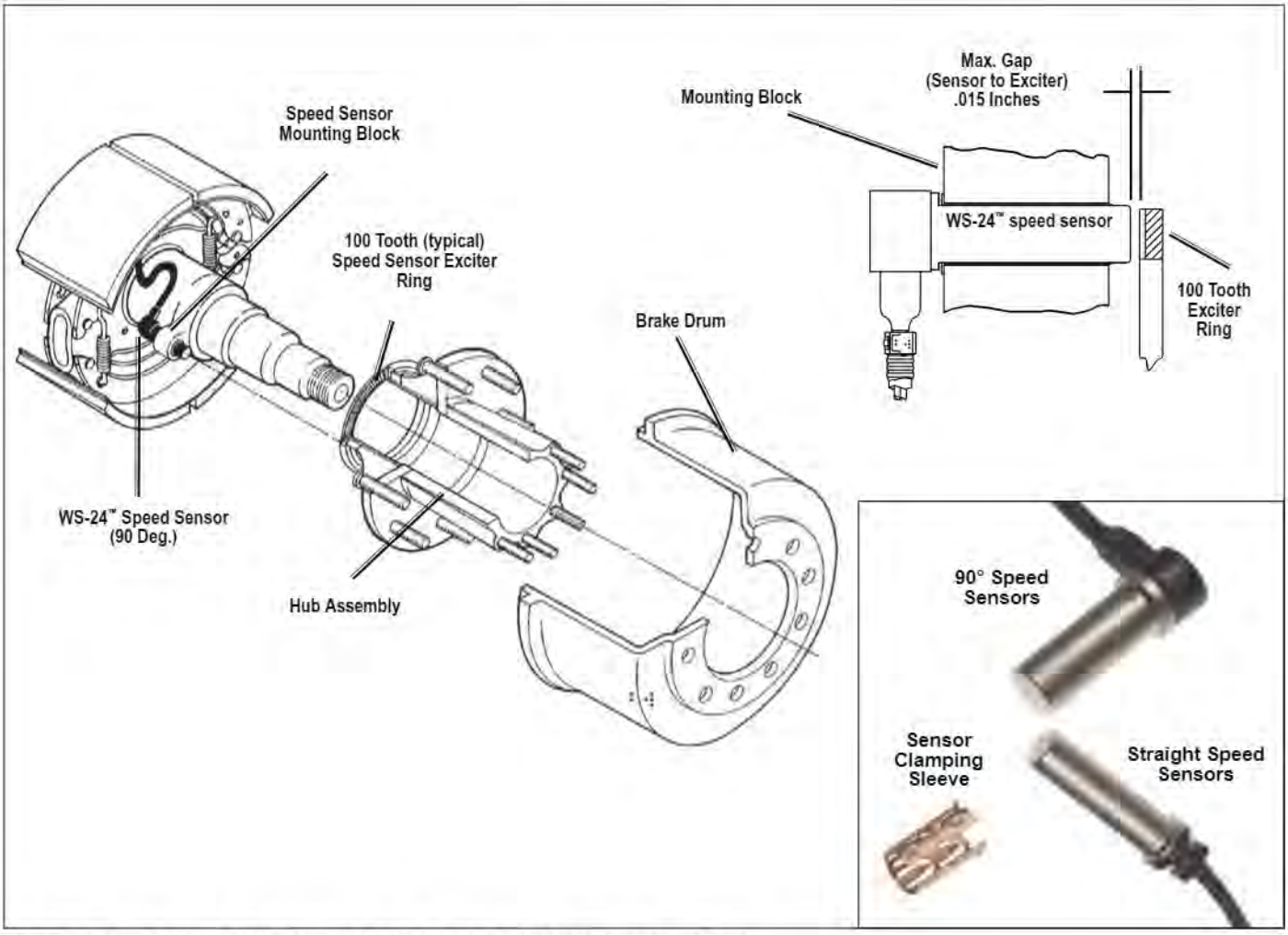


FIGURE 12 - ***BENDIX® WS-24™ WHEEL SPEED SENSOR INSTALLATION***

Wheel Speed Sensor Wiring

Route sensor wiring coming out of the wheel ends away from moving brake components. Sensor wiring needs to be secured to the axle to prevent excess cable length and wiring damage. It is required that cable ties be installed to the sensor wire within 3 inches (76.2 mm) of the sensor head to provide strain relief.

Following the axle, the sensor wires must be attached along the length of the service brake hoses using cable ties with ultraviolet protection and secured every 6 to 8 inches (152 to 203 mm). Sufficient – but not excessive – cable length must be provided to permit full suspension travel and steering axle movement. Install wires so that they cannot touch rotating elements such as wheels, brake discs or drive shafts. Radiation protection may be necessary in the area of brake discs.

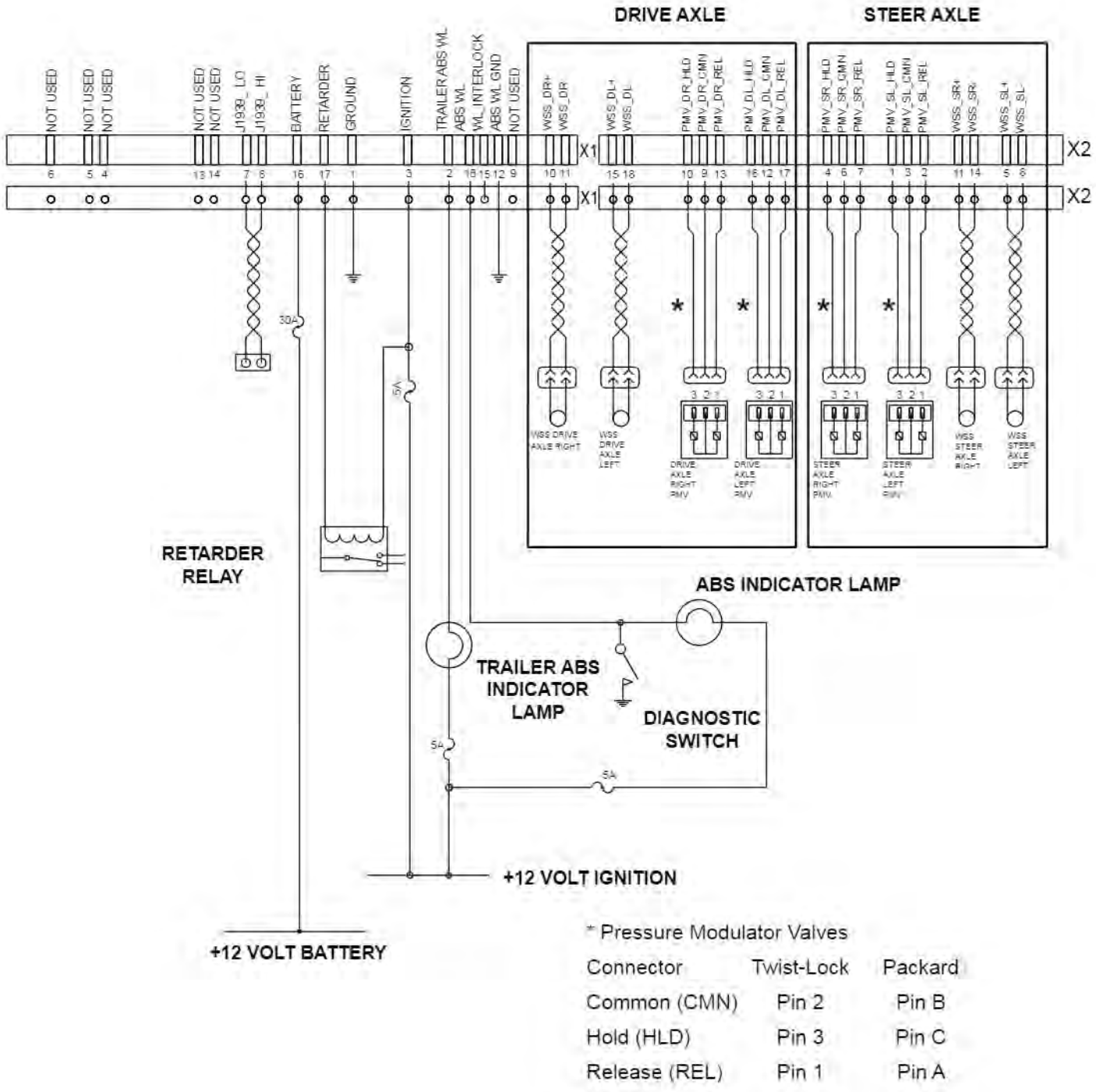
Bendix does not recommend using standard tie-wraps to secure wiring harnesses directly to rubber air lines. This may cause premature wiring failure from the pressure exerted on the wiring when air pressure is applied through the air line. Non-metallic hose clamps or bow-tie tie-wraps are preferred.

The use of grommets or other suitable protection is required whenever the cable must pass through metallic frame members.

All sensor wiring must utilize twisted pair wire, with approximately one to two twists per inch.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

Troubleshooting: Bendix® EC-80™ ABS Wiring Schematic (4S/4M)



* Pressure Modulator Valves

Connector	Twist-Lock	Packard
Common (CMN)	Pin 2	Pin B
Hold (HLD)	Pin 3	Pin C
Release (REL)	Pin 1	Pin A

FIGURE 16 - *BENDIX® EC-80™ ABS WIRING SCHEMATIC (4S/4M)*

Troubleshooting: Bendix® EC-80™ ATC Wiring Schematic (6S/6M)

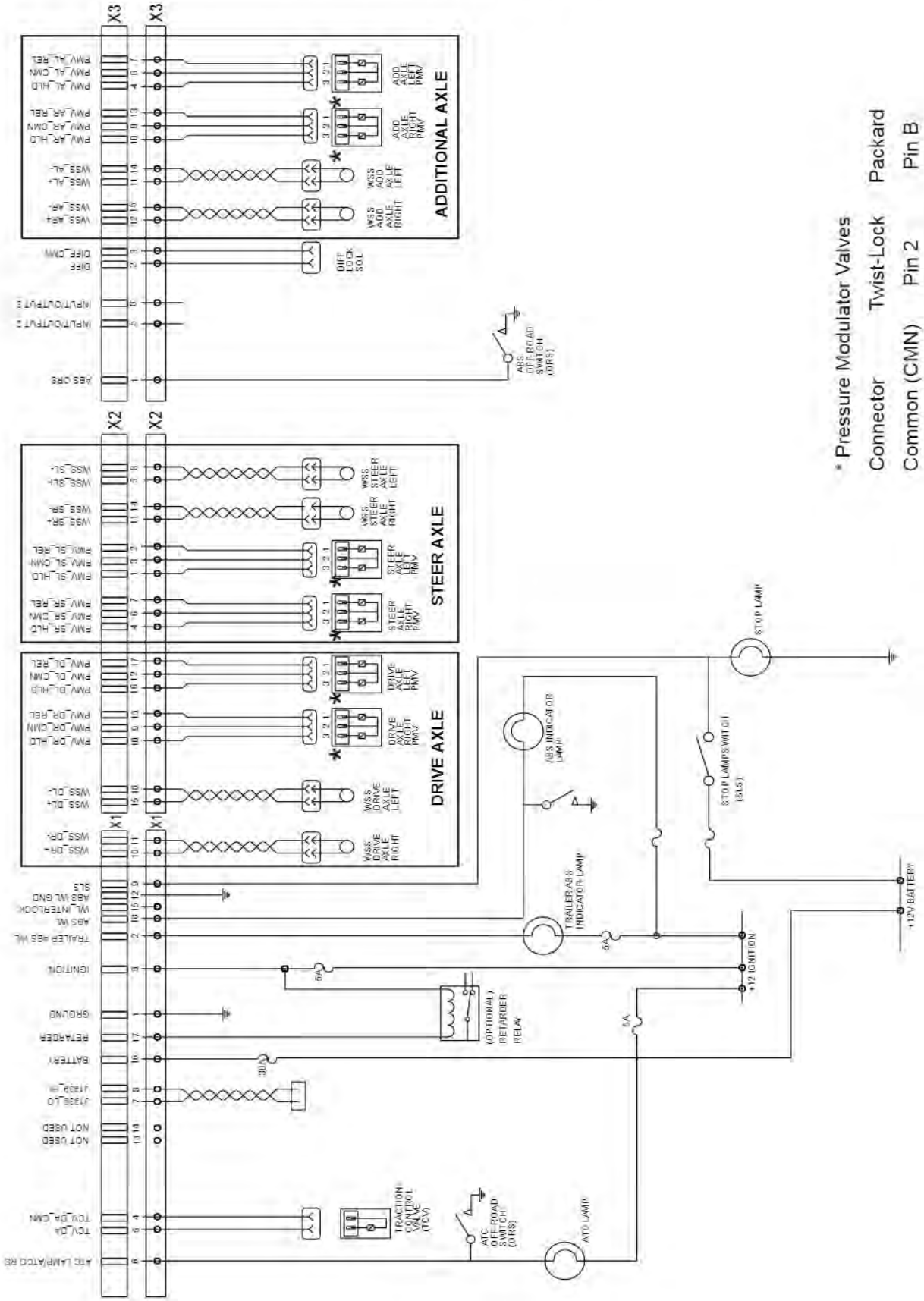


FIGURE 17 - *BENDIX® EC-80™ ABS WIRING SCHEMATIC (6S/6M)*

Troubleshooting: Bendix® EC-80™ ATC Wiring Schematic (6S/5M)

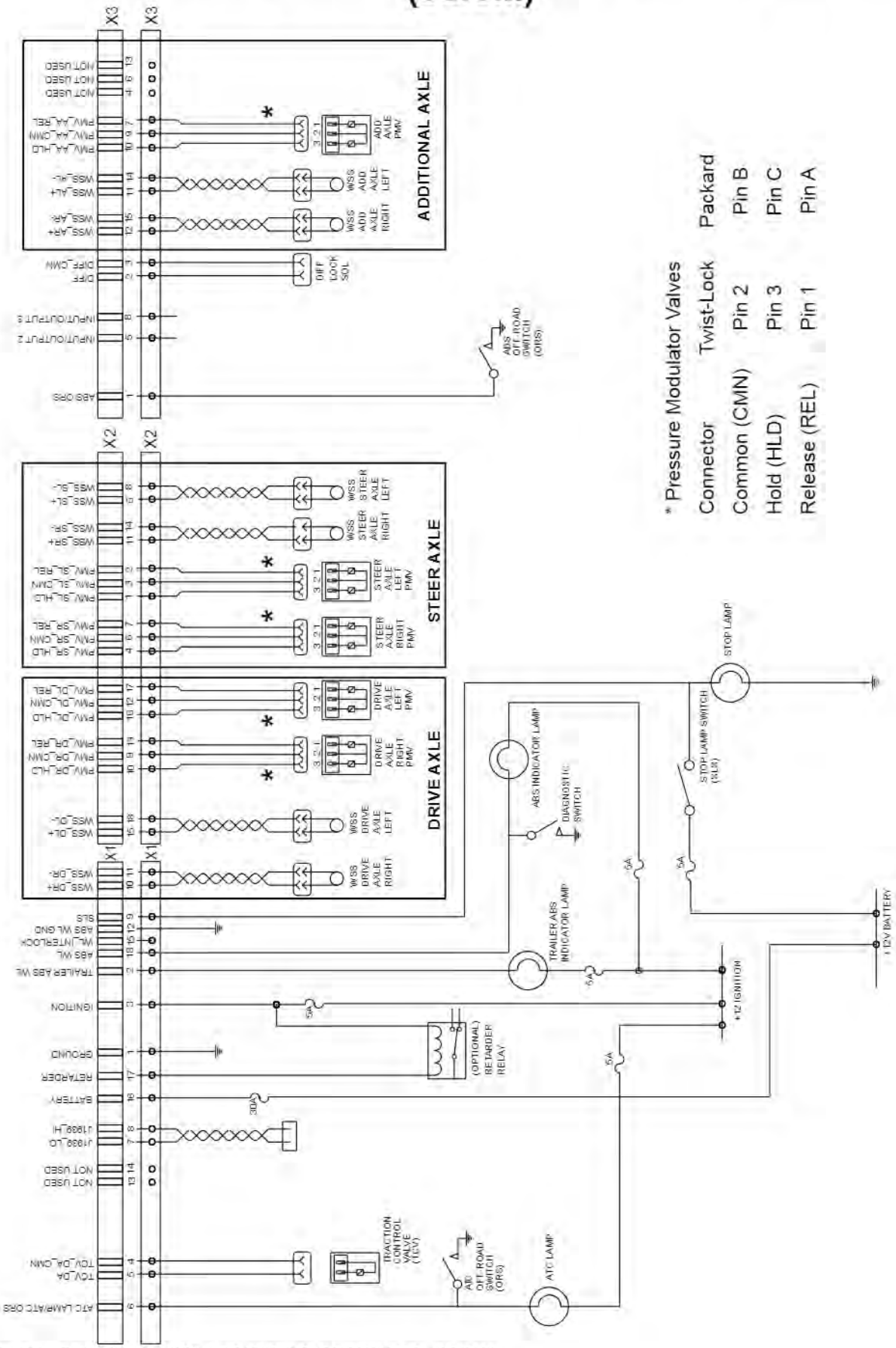


FIGURE 18 - *BENDIX® EC-80™ ATC WIRING SCHEMATIC (6S/5M)*

NOTES

GLOSSARY

ABS — Antilock Brake System.

ABS Event — Impending wheel lock situation that causes the ABS controller to activate the modulator valve(s).

ABS Indicator Lamp — An amber lamp which indicates the operating status of an antilock system. When the indicator lamp is on, ABS is disabled and the vehicle reverts to normal brake operation.

Air Gap — Distance between the Sensor and tone ring.

ASR — Automatic Slip Regulation. Another name for traction control.

ATC — Automatic Traction Control. An additional ABS function in which engine torque is controlled and brakes are applied differentially to enhance vehicle traction.

ATC/ESP Lamp — A lamp that indicates when stability functions, including traction control, roll stability program or yaw control are operating.

Channel — A controlled wheel site.

CAN — Controller Area Network. J1939 is an SAE version of the CAN link.

Clear Codes — System to erase historical diagnostic trouble codes from the ECU, from either the Diagnostic Switch or from a hand-held diagnostic tool (only repaired diagnostic trouble codes may be cleared).

Configuration — The primary objective is to identify a "normal" set of sensors and modulators for the Electronic Control Unit, so that it will identify future missing sensors and modulators.

Diagnostic Connector — Diagnostic receptacle in vehicle cab for connection of J1587 hand-held or PC-based test equipment. The tester can initiate test sequences, and can also read system parameters.

Diagnostic Switch — A switch used to activate blinks codes.

Differential Braking — Application of brake force to a spinning wheel so that torque can be applied to wheels which are not slipping.

ECU — Electronic Control Unit.

ESP — Electronic Stability Program. Full stability function that includes RSP & YC subfunctions.

Diagnostic Trouble Code — A condition that interferes with the generation or transmission of response or control signals in the vehicle's ABS system that could lead to the functionality of the ABS system becoming inoperable in whole or in part.

FMVSS-121 — Federal Motor Vehicle Safety Standard which regulates air brake systems.

HSA — Hill Start Assist. HSA interfaces between the transmission and braking system to help the driver prevent the vehicle from rolling downhill when moving up a steep incline from a stationary position.

IR — Independent Regulation. A control method in which a wheel is controlled at optimum slip, a point where retardation and stability are maximized. The brake pressure that is best for the wheel in question is directed individually into each brake chamber.

J1587 — The SAE heavy-duty standard diagnostic data link.

J1708 — An SAE standard which defines the hardware and software protocol for implementing 9600 baud heavy vehicle data links. J1587 version of a J1708 data link.

J1939 — A high speed data link used for communications between the ABS ECU engine, transmission and retarders.

LAS — Lateral Acceleration Sensor.

MIR — Modified Independent Regulation. A method of controlling the opposite sides of a steer axle during ABS operation so that torque steer and stopping distance are minimized.

PLC — Power Line Carrier. The serial communication protocol used to communicate with the trailer over the blue full time power wire.

PMV — Pressure Modulator Valve. An air valve which is used to vent or block air to the brake chambers to limit or reduce brake torque.

QR — Quick Release. Quick release valves allow faster release of air from the brake chamber after a brake application. To balance the system, quick release valves have hold off springs that produce higher crack pressures (when the valves open).

Relay Valve — Increases the application speed of the service brake. Installed near brakes with larger air chambers (type 24 or 30). The treadle valve activates the relay valve with an air signal. The relay valve then connects its supply port to its delivery ports. Equal length air hose must connect the delivery ports of the relay valve to the brake chambers.

Retarder Relay — A relay which is used to disable a retarder when ABS is triggered.

RSP — Roll Stability Program. An all-axle ABS solution that helps reduce vehicle speed by applying all vehicle brakes as needed, reducing the tendency to roll over.

SAS — Steering Angle Sensor.

Sensor Clamping Sleeve — A beryllium copper sleeve which has fingers cut into it. It is pressed between an ABS sensor and mounting hole to hold the sensor in place.

Stored Diagnostic Trouble Codes — A diagnostic trouble code that occurred.

TCS — Traction Control System, another name for ATC or ASR.

Tone Ring — A ring that is usually pressed into a wheel hub that has a series of teeth (usually 100) and provides actuation for the speed sensor. Note maximum run out is .008.

YC — Yaw Control. Helps stabilize rotational dynamics of vehicle.

YRS — Yaw Rate Sensor.

Appendix: J1939 SPN and FMI Codes and their Bendix Blink Code Equivalents

APPENDIX: J1939 SPN and FMI Codes and their Bendix Blink Code Equivalents					
SPN (J1939)	FMI (J1939)	General	Bendix Blink Code Equivalent(s)		Diagnostic Trouble Code Description
			(1st Digit)	(2nd Digit)	
154	13	Miscellaneous	12	23	I/O 2 or I/O 3 Shorted High
168	3	Power Supply	6	2	Battery Voltage Too High
168	4	Power Supply	6	1	Battery Voltage Too Low
564	3	Miscellaneous	12	13	Diff Lock Solenoid Shorted to Voltage
564	4	Miscellaneous	12	12	Diff Lock Solenoid Shorted to Ground or Open Circuit
575	14	Miscellaneous	12	17	ABS Disabled Due to Off-Road Mode
576	14	Miscellaneous	12	3	ATC Disabled or Dynamometer Test Mode Active
612	14	Miscellaneous	12	21	ABS Disabled Due to Engaged Differential Lock
614	3	Miscellaneous	12	23	IO3 Solenoid Shorted to Voltage
615	14	Miscellaneous	12	19	Maximum Number of PMV Cycles Exceeded
615	14	Miscellaneous	12	20	Maximum Number of TCV Cycles Exceeded
629	2	ECU	13	4	ECU (2678C)
629	2	ECU	13	5	ECU (1C)
629	2	ECU	13	7	Configuration Mismatch
629	2	ECU	13	17	ECU (C8C)
629	8	Miscellaneous	12	29	Air System/Mechanical Component
629	12	ECU	13	3	ECU (10)
629	12	ECU	13	14	ECU (C6)
629	12	ECU	13	15	ECU (CF)
629	12	ECU	13	16	ECU (C0)
629	14	Miscellaneous	12	28	Air System/Mechanical Component
629	14	ECU	13	1	ECU (5F3)
630	12	ECU	13	6	ECU (6CD)
630	12	ECU	13	19	ECU (63)
630	12	ECU	13	20	ECU (6E)
630	12	ECU	13	10	ECU (5FC)
630	13	ECU	13	13	Configuration Mismatch
630	13	ECU	13	2	ECU (5CD)
630	13	ECU	13	8	ECU (56)
630	13	ECU	13	9	ECU (CA3C)
630	13	ECU	13	18	ECU (CC)
630	13	ECU	13	21	ECU (6C)
630	13	ECU	13	22	ECU (63C)
630	13	ECU	13	25	VIN Mismatch
630	13	ECU	13	26	Valve Configuration Mismatch
639	2	J1939	11	3	J1939 Engine (EEC1) Electronic Engine Controller Loss of Communication or Time Out
639	2	J1939	11	2	J1939 Electronic Retarder Timeout or Invalid Signal (ERC1)
639	2	J1939	11	4	J1939 Electronic Engine Controller 2 Timeout or Invalid Message (EEC2)
639	2	J1939	11	7	Timeout or Invalid Data on ETC7 or VP15 Transmission Message for HSA
639	2	J1939	11	8	Timeout or Invalid Data on XBR Message

APPENDIX: J1939 SPN and FMI Codes and their Bendix Blink Code Equivalents					
SPN (J1939)	FMI (J1939)	General	Bendix Blink Code Equivalent(s)		Diagnostic Trouble Code Description
			(1st Digit)	(2nd Digit)	
639	2	J1939	11	10	J1939 Transmission (ETC1) Electronic Transmission Controller, loss of communication message or time out
639	2	J1939	11	11	AUXIO CAN Message Timeout
639	2	J1939	11	12	J1939 Hill Start Aid Switch Signal Not Available
639	2	J1939	11	15	J1939 Engine (EEC3) Electronic Transmission Controller loss of communications or time out
639	2	J1939	11	16	J1939 Transmission (ETC2) Electronic Transmission Controller loss of communications or time out
639	2	J1939	11	3	J1939 Engine (EEC1) Electronic Engine Controller loss of communications between EC-80 ECU and other devices
639	2	J1939	11	2	J1939 Retarder (ERC1) Electronic Retarder Controller loss of communications or time out
639	2	J1939	11	4	J1939 Engine (EEC2) Electronic Engine Controller loss of communications or time out
639	2	J1939	11	10	J1939 Transmission Loss of Communications, ETC1 message
639	2	J1939	11	15	J1939 Engine Loss of Communications, EEC2 message
639	2	J1939	11	16	J1939 Transmission Loss of Communications, ETC2 message
639	12	J1939	11	1	J1939 Serial Link Loss of Communication Between EC-80 ECU and Other Devices
789	1	Wheel Speed Sensor	2	1	SA Left WSS Excessive Air Gap
789	2	Wheel Speed Sensor	2	3	SA Left WSS Open or Shorted
789	7	Wheel Speed Sensor	2	5	SA Left WSS Wheel End
789	8	Wheel Speed Sensor	2	6	SA Left WSS Erratic Sensor Signal
789	9	Wheel Speed Sensor	2	2	SA Left WSS Output Low @ Drive-Off
789	10	Wheel Speed Sensor	2	4	SA Left WSS Loss of Sensor Signal
789	13	Wheel Speed Sensor	2	7	SA Left WSS Tire Size Calibration
790	1	Wheel Speed Sensor	3	1	SA Right WSS Excessive Air Gap
790	2	Wheel Speed Sensor	3	3	SA Right WSS Open or Shorted
790	7	Wheel Speed Sensor	3	5	SA Right WSS Wheel End
790	8	Wheel Speed Sensor	3	6	SA Right WSS Erratic Sensor Signal
790	9	Wheel Speed Sensor	3	2	SA Right WSS Output Low @ Drive-Off
790	10	Wheel Speed Sensor	3	4	SA Right WSS Loss of Sensor Signal
790	13	Wheel Speed Sensor	3	7	SA Right WSS Tire Size Calibration
791	1	Wheel Speed Sensor	4	1	DA Left WSS Excessive Air Gap
791	2	Wheel Speed Sensor	4	3	DA Left WSS Open or Shorted
791	7	Wheel Speed Sensor	4	5	DA Left WSS Wheel End
791	8	Wheel Speed Sensor	4	6	DA Left WSS Erratic Sensor Signal
791	9	Wheel Speed Sensor	4	2	DA Left WSS Output Low @ Drive-Off
791	10	Wheel Speed Sensor	4	4	DA Left WSS Loss of Sensor Signal
791	13	Wheel Speed Sensor	4	7	DA Left WSS Tire Size Calibration
792	1	Wheel Speed Sensor	5	1	DA Right WSS Excessive Air Gap
792	2	Wheel Speed Sensor	5	3	DA Right WSS Open or Shorted
792	7	Wheel Speed Sensor	5	5	DA Right WSS Wheel End
792	8	Wheel Speed Sensor	5	6	DA Right WSS Erratic Sensor Signal
792	9	Wheel Speed Sensor	5	2	DA Right WSS Output Low @ Drive-Off
792	10	Wheel Speed Sensor	5	4	DA Right WSS Loss of Sensor Signal
792	13	Wheel Speed Sensor	5	7	DA Right WSS Tire Size Calibration
793	1	Wheel Speed Sensor	14	1	AA Left WSS Excessive Air Gap

APPENDIX: J1939 SPN and FMI Codes and their Bendix Blink Code Equivalents					
SPN (J1939)	FMI (J1939)	General	Bendix Blink Code Equivalent(s)		Diagnostic Trouble Code Description
			(1st Digit)	(2nd Digit)	
793	2	Wheel Speed Sensor	14	3	AA Left WSS Open or Shorted
793	7	Wheel Speed Sensor	14	5	AA Left WSS Wheel End
793	8	Wheel Speed Sensor	14	6	AA Left WSS Erratic Sensor Signal
793	9	Wheel Speed Sensor	14	2	AA Left WSS Output Low @ Drive-Off
793	10	Wheel Speed Sensor	14	4	AA Left WSS Loss of Sensor Signal
794	1	Wheel Speed Sensor	15	1	AA Right WSS Excessive Air Gap
794	2	Wheel Speed Sensor	15	3	AA Right WSS Open or Shorted
794	7	Wheel Speed Sensor	15	5	AA Right WSS Wheel End
794	8	Wheel Speed Sensor	15	6	AA Right WSS Erratic Sensor Signal
794	10	Wheel Speed Sensor	15	4	AA Right WSS Loss of Sensor Signal
794	14	Wheel Speed Sensor	15	2	AA Right WSS Output Low @ Drive-Off
795	5	Pressure Modulator Valve	7	7	SA Left PMV CMN Open Circuit
795	13	Pressure Modulator Valve	7	8	SA Left PMV Configuration Error
796	5	Pressure Modulator Valve	8	7	SA Right PMV CMN Open Circuit
796	13	Pressure Modulator Valve	8	8	SA Right PMV Configuration Error
797	5	Pressure Modulator Valve	9	7	DA Left PMV CMN Open Circuit
797	13	Pressure Modulator Valve	9	8	DA Left PMV Configuration Error
798	5	Pressure Modulator Valve	10	7	DA Right PMV CMN Open Circuit
798	13	Pressure Modulator Valve	10	8	DA Right PMV Configuration Error
799	5	Pressure Modulator Valve	16	7	AA Left PMV CMN Open Circuit
799	13	Pressure Modulator Valve	16	8	AA Left PMV Configuration Error
800	5	Pressure Modulator Valve	17	7	AA Right PMV CMN Open Circuit
800	13	Pressure Modulator Valve	17	8	AA Right PMV Configuration Error
801	2	Miscellaneous	12	4	Retarder Relay Open Circuit or Shorted to Ground
801	3	Miscellaneous	12	5	Retarder Relay Circuit Shorted to Voltage
802	3	Miscellaneous	12	8	PMV/TCV/Diff Lock Common Shorted to Voltage
802	4	Miscellaneous	12	7	PMV/TCV/Diff Lock Common Shorted to Ground
802	12	ECU	13	11	ECU (F1A)
802	12	ECU	13	12	ECU (F14)
805	14	Miscellaneous	12	9	ATC Disabled to Prevent Brake Fade
806	3	TCV	18	2	TCV Solenoid Shorted to Voltage
806	4	TCV	18	1	TCV Solenoid Shorted to Ground
806	5	TCV	18	3	TCV Solenoid Open Circuit
806	13	TCV	18	4	TCV Configuration Error
810	7	Miscellaneous	12	11	Wheel Speed Sensors Reversed on an Axle
811	2	Miscellaneous	12	6	ABS Warning Lamp Circuit
815	13	Wheel Speed Sensor	14	10	Additional Axle WSS Configuration Error
932	3	Pressure Modulator Valve	7	5	SA Left PMV HLD Solenoid Shorted to Voltage
932	4	Pressure Modulator Valve	7	4	SA Left PMV HLD Solenoid Shorted to Ground
932	5	Pressure Modulator Valve	7	6	SA Left PMV HLD Solenoid Open Circuit
933	3	Pressure Modulator Valve	8	5	SA Right PMV HLD Solenoid Shorted to Voltage
933	4	Pressure Modulator Valve	8	4	SA Right PMV HLD Solenoid Shorted to Ground
933	5	Pressure Modulator Valve	8	6	SA Right PMV HLD Solenoid Open Circuit

APPENDIX: J1939 SPN and FMI Codes and their Bendix Blink Code Equivalents					
SPN (J1939)	FMI (J1939)	General	Bendix Blink Code Equivalent(s)		Diagnostic Trouble Code Description
			(1st Digit)	(2nd Digit)	
934	3	Pressure Modulator Valve	9	5	DA Left PMV HLD Solenoid Shorted to Voltage
934	4	Pressure Modulator Valve	9	4	DA Left PMV HLD Solenoid Shorted to Ground
934	5	Pressure Modulator Valve	9	6	DA Left PMV HLD Solenoid Open Circuit
935	3	Pressure Modulator Valve	10	5	DA Right PMV HLD Solenoid Shorted to Voltage
935	4	Pressure Modulator Valve	10	4	DA Right PMV HLD Solenoid Shorted to Ground
935	5	Pressure Modulator Valve	10	6	DA Right PMV HLD Solenoid Open Circuit
936	3	Pressure Modulator Valve	16	5	AA Left PMV HLD Solenoid Shorted to Voltage
936	4	Pressure Modulator Valve	16	4	AA Left PMV HLD Solenoid Shorted to Ground
936	5	Pressure Modulator Valve	16	6	AA Left PMV HLD Solenoid Open Circuit
937	3	Pressure Modulator Valve	17	5	AA Right PMV HLD Solenoid Shorted to Voltage
937	4	Pressure Modulator Valve	17	4	AA Right PMV HLD Solenoid Shorted to Ground
937	5	Pressure Modulator Valve	17	6	AA Right PMV HLD Solenoid Open Circuit
938	3	Pressure Modulator Valve	7	2	SA Left PMV REL Solenoid Shorted to Voltage
938	4	Pressure Modulator Valve	7	1	SA Left PMV REL Solenoid Shorted to Ground
938	5	Pressure Modulator Valve	7	3	SA Left PMV REL Solenoid Open Circuit
939	3	Pressure Modulator Valve	8	2	SA Right PMV REL Solenoid Shorted to Voltage
939	4	Pressure Modulator Valve	8	1	SA Right PMV REL Solenoid Shorted to Ground
939	5	Pressure Modulator Valve	8	3	SA Right PMV REL Solenoid Open Circuit
940	3	Pressure Modulator Valve	9	2	DA Left PMV REL Solenoid Shorted to Voltage
940	4	Pressure Modulator Valve	9	1	DA Left PMV REL Solenoid Shorted to Ground
940	5	Pressure Modulator Valve	9	3	DA Left PMV REL Solenoid Open Circuit
941	3	Pressure Modulator Valve	10	2	DA Right PMV REL Solenoid Shorted to Voltage
941	4	Pressure Modulator Valve	10	1	DA Right PMV REL Solenoid Shorted to Ground
941	5	Pressure Modulator Valve	10	3	DA Right PMV REL Solenoid Open Circuit
942	3	Pressure Modulator Valve	16	2	AA Left PMV REL Solenoid Shorted to Voltage
942	4	Pressure Modulator Valve	16	1	AA Left PMV REL Solenoid Shorted to Ground
942	5	Pressure Modulator Valve	16	3	AA Left PMV REL Solenoid Open Circuit
943	3	Pressure Modulator Valve	17	2	AA Right PMV REL Solenoid Shorted to Voltage
943	4	Pressure Modulator Valve	17	1	AA Right PMV REL Solenoid Shorted to Ground
943	5	Pressure Modulator Valve	17	3	AA Right PMV REL Solenoid Open Circuit
1045	2	Miscellaneous	12	2	Stop Lamp Switch Defective
1045	7	Miscellaneous	12	1	Stop Lamp Switch Not Detected
2622	2	Miscellaneous	12	24	HSA Lamp Open Circuit or Shorted to Ground
2622	3	Miscellaneous	12	26	HSA Valve Solenoid Shorted to Voltage
2622	3	Miscellaneous	12	31	HSA Lamp Shorted to Voltage
2622	4	Miscellaneous	12	25	HSA Valve Solenoid Shorted to Ground
2622	5	Miscellaneous	12	33	HSA Valve Solenoid Open Circuit

Bendix

Service Data

SD-64-20124

Bendix™ AutoVue® FLC20™ Camera

(See SD-61-4963 for the Bendix® Wingman® Fusion™ Driver Assistance System)

1.0 DESCRIPTION

The Bendix™ AutoVue® FLC20™ camera is a component used in many Bendix safety systems, including:

- The AutoVue Lane Departure Warning (LDW) System; and
- the Bendix Wingman Fusion Driver Assistance System.

For more information about the Bendix® Wingman® Fusion™ System, *See Service Data Sheet, SD-61-4963.* For free downloads of Service Data Sheets, visit the Bendix website at: www.bendix.com.

This document covers installation, troubleshooting, and replacement for this 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.

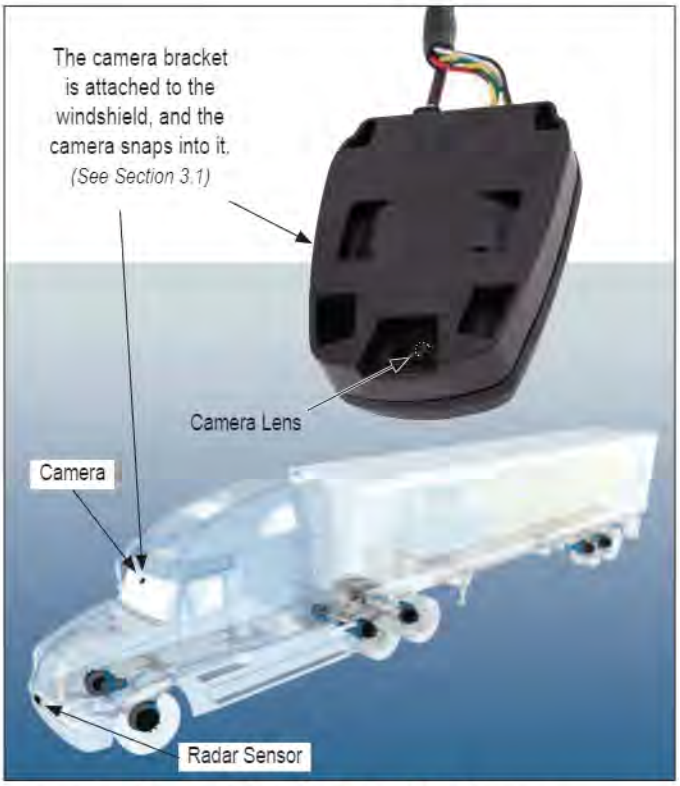


Figure 1 – Bendix™ AutoVue® FLC20™ Camera

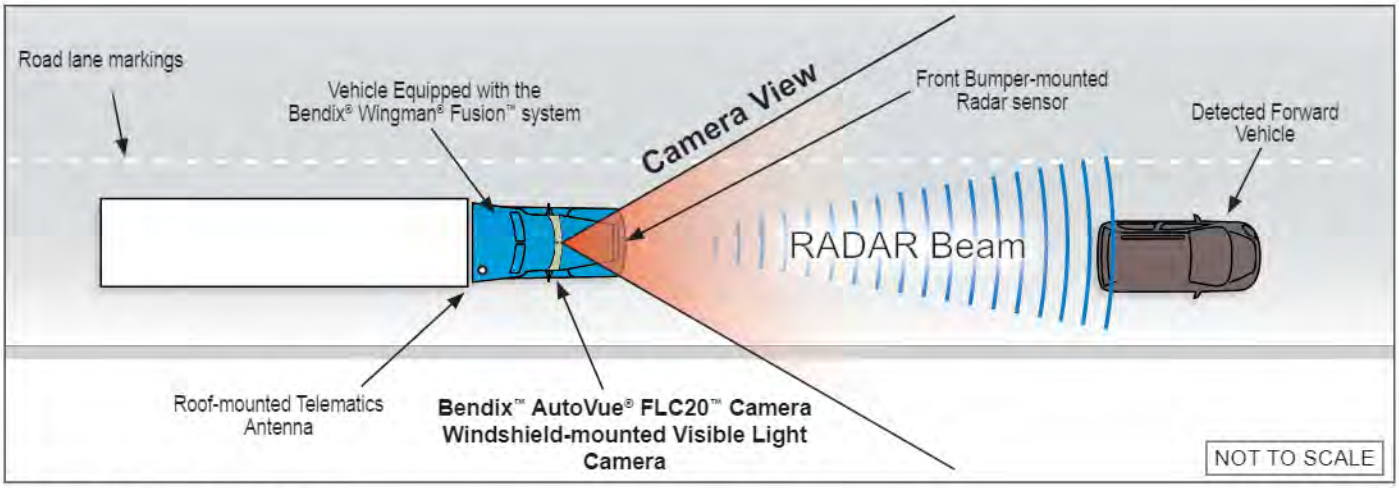


Figure 2 – Operational View

1.1 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, or a Bendix® AD-9si® 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 Bendix® Wingman® Fusion™ Driver Assistance System can result in a collision causing property damage, serious injuries, or death. Be sure to read, understand, and carefully follow the instructions in the Operator's Manual, BW2681.

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. 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.

IMPORTANT: It is the responsibility of the driver to remain vigilant and change driving practices depending on traffic and road conditions.

How to identify if the vehicle has the Bendix® Wingman® Fusion™ Driver Assistance System:

Look for the Bendix® brand logo on the camera label. *(See Section 3.1 for how to remove the camera from the bracket to view the label.)*

SERVICE DATA SHEET INDEX

2.0 TROUBLESHOOTING

2.1 SAFETY GUIDELINES

Read and follow the General Safety Guidelines shown on page two of this document.

IMPORTANT

All vehicle Diagnostic Trouble Codes (DTCs) related to the engine, transmission, instrument cluster, engine cruise control and Bendix® ABS, ATC or ESP® systems must first be resolved, with no DTCs present during the vehicle operation while in cruise control, before trying to resolve camera DTCs.

IMPORTANT

System Problems. If a problem with the Bendix™ AutoVue® FLC20™ camera is detected, it should be serviced as soon as possible to restore full functionality.

2.2 BENDIX® DRIVER INTERFACE UNIT (DIU™) LANE DEPARTURE WARNING SYSTEM ICONS

See Figure 3 and Figure 4. In the case of vehicles that use a Bendix® Driver Interface Unit (DIU™), the top right corner of the display is used to show an icon. For other OEM displays, see the vehicle manual to find the method used to show the system status.

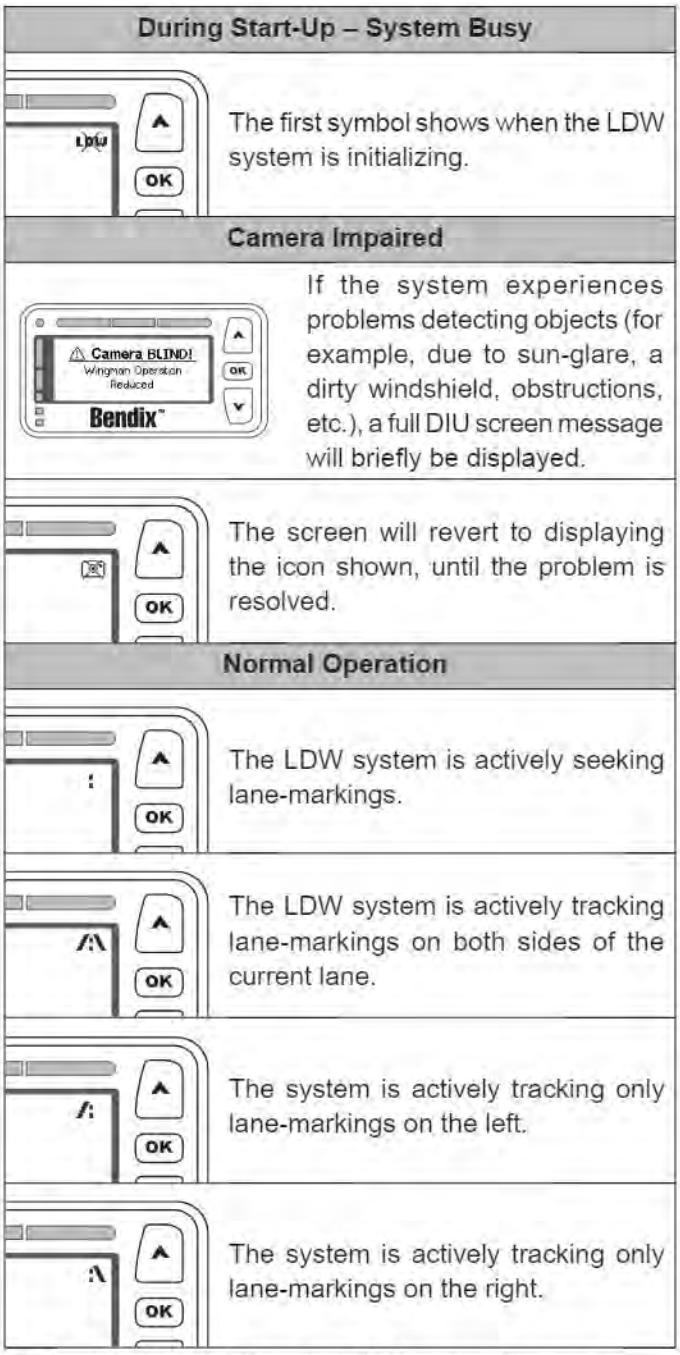


Figure 3 – Normal Bendix DIU Screens Showing LDW System Status

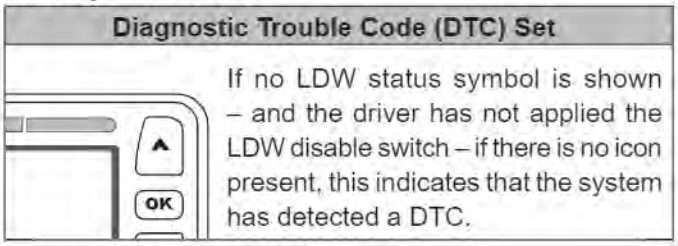


Figure 4 – Bendix DIU Screen Showing LDW System Status

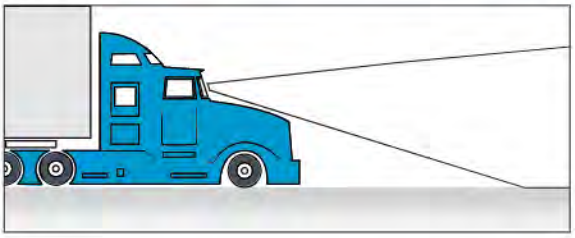
In these cases, the OE vehicle dash display will also alert the operator that there is a DTC present.

2.3 CAMERA TEST IMAGE

Take a Test Image using Bendix® ACom® Diagnostic Software

Troubleshooting a camera may be assisted by viewing a test image from the camera to ensure it is not blocked, or has another problem.

- Open Bendix® ACom® Diagnostic Software and select “FLC20” from the opening page list, and the “Start with ECU” button.
- Select “Snapshot” from the choices.



1. Click “Read”. A camera snapshot is taken. (5 minutes approximately.)

2. Inspect the image.

3. Save, if needed, using “Export”.

2.4 TEMPORARILY DISABLE THE LANE DEPARTURE WARNING (LDW)

To avoid erroneous LDW warnings in areas such as construction zones – where the non-standard or overlapping road markings present might cause false alerts – the Bendix® Wingman® Fusion™ Driver Assistance System (Fusion) has an enable/disable switch. The Bendix switch design or a similar OEM switch may be used. *See Figure 5*.

Figure 5 – Example of an LDW Enable/Disable Switch.

For vehicles that have the LDW switch hard-wired to the SafetyDirect® by Bendix CVS Web Portal Processor, and a functioning On Board Computer (OBC)/Telematics system: The enable/disable switch used by the Lane Departure Warning (LDW) system also functions – when depressed for six (6) seconds – to activate a manual request to transmit the last five seconds and next five seconds of buffered video data.

2.5 SETTING DIAGNOSTIC TROUBLE CODES

If, during operation, the Bendix Wingman Fusion system detects a problem with the Bendix™ AutoVue® FLC20™ camera, a DTC will be set and – depending on the OEM – the driver will be alerted on the dash display with an icon or similar method. In these cases, some features of the Fusion system will not be available.

If, for an extended period of time, the system detects that the camera is blocked by dirt, snow, ice, etc., a DTC will typically be set.

2.6 BENDIX® ACOM® DIAGNOSTIC SOFTWARE

Bendix® ACom® Diagnostic Software is a PC-based software program available as a free download from the Bendix web site (www.bendix.com) or on a CD from the online Bendix Literature Center (order BW2329). This software provides the technician with access to all the available Electronic Control Unit (ECU) diagnostic information and configuration capability. For Fusion system diagnostics, use the current version of Bendix ACom Diagnostic Software. *See Figure 6.*

Figure 6 – Bendix® ACom® Diagnostic Software

2.7 STARTING BENDIX® ACOM® DIAGNOSTIC SOFTWARE

The Bendix® ACom® Diagnostic Software can be started from the desktop shortcut, or from the main Windows® screen with "Start...Programs...Bendix...ACom Diagnostic Software." *See Figure 7.* To begin, the technician selects "FLC20" from the Starter screen, then "Start with ECU" from the Diagnostic Control panel.

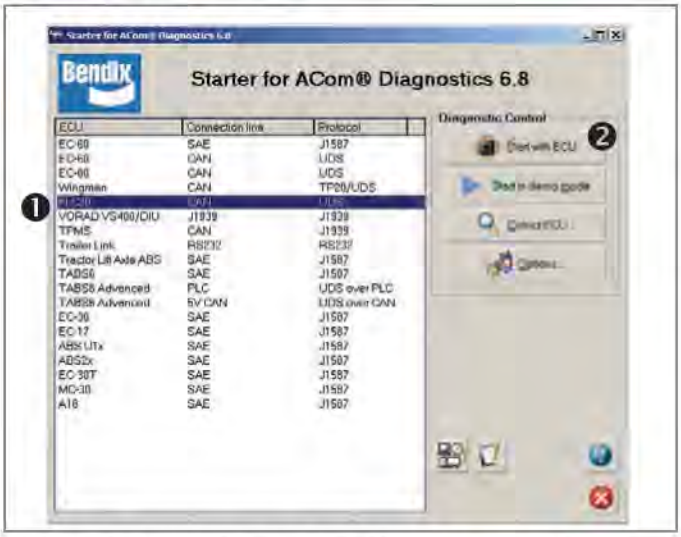


Figure 7 – Starting Bendix® ACom® Diagnostic Software

NOTE: When using ACom Diagnostic Software for the first time, the service technician will be asked to select the communication adapter for both the Bendix® AutoVue® FLC20™ camera and Bendix® ABS and Stability Controllers. While both controllers will use the same physical adapter, the technician will need to indicate which communication protocol to use for each. Once a successful connection has been made, these steps will no longer be necessary.

The *Bendix ACom Diagnostic Software for ABS User Guide* is available for download at www.bendix.com and should be used as a reference to all functions of the ACom service tool. *See Figure 8.*

Figure 8 – Bendix ACom Diagnostic Software - Hardware Interface Screen

2.8 READING DIAGNOSTIC TROUBLE CODES (DTCs)

If the system generates a Diagnostic Trouble Code (DTC), where a lamp or icon is illuminated on the instrument cluster, use a current version of ACom Diagnostic Software to troubleshoot. Select "FLC20" from the starter screen, then "Start with ECU". Click "DTC" to show the DTCs. *See Section 2.9 for a complete table showing DTCs and troubleshooting information.*

2.9 DIAGNOSTIC TROUBLE CODES (DTCs)

Use a J1939 detection software to find the DTC code(s) and use the Table in Section 2.10 to find the service action code to use. The service actions to take may then be found in the Table shown in Section 2.11.

If the troubleshooting devices available to the technician provide SPN (Suspect Parameter Number) and FMI (Failure Mode Identifier) code combinations, *refer to Appendix A.*

2.10 TABLE OF DIAGNOSTIC TROUBLE CODES (DTCs) AND SERVICE ACTION CODES

Look in the left column below for the DTC and find the Service Action Code to follow in Table 2 (Section 2.11).

Table 1: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes		Go to the Service Action Code List in Table 2 (Pages 11-14)
DTC	**Description**	
1	High Battery Voltage	B
2	Low Battery Voltage	
3-10	Internal Error	A
11	Internal Error	
12	Internal Error	
13	Internal Error	Q
14-16	Internal Error	A
17	Internal Error	Q
18	J1939 bus fault	M
19	Calibration not complete	Q
20	Internal Error	
21-35	Internal Error	A
36	Image Processor software version error	I
37-42	Internal Error	A
43	Calibration data corrupt	Q
44-46	Internal Error	A
47	SPC Calibration not complete	Q
48-49	Internal Error	A
50	Dynamic Calibration out of range	Q
51	Dynamic Calibration not complete	
52-57	Internal Error	A
58	Internal Error	Q
59	Vehicle Calibration not complete	
60	Image Processor Calibration error	
61	Internal Error	A
62	J1939: LD Message missing	M
63	J1939: VDC2 Message missing	
64	J1939: CCVS1 Message missing	
65	J1939: OEL Message missing	
66	J1939: OEL Turn Signal error value	N
67	J1939: LD Right Turn error value	
68	J1939: LD Left Turn error value	
69	J1939: VDC2 Steering Wheel error value	
70	J1939: VDC2 Yaw Rate error value	
71	J1939: VDC2 Lateral Accl error value	
72	Private CAN: Bus Off	V
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.		

Table 1 – DTC Code to Service Action Code. (Pages 8–10)

Table 1: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes		Go to the Service Action Code List in Table 2 (Pages 11-14)
DTC	**Description**	
73	J1939: EBC2 Wheel speed error value	N
74	J1939: EBC1 Brake Switch error value	
75	J1939: LCMD Right Turn error value	
76	J1939: LCMD Left Turn error value	
77	Internal Error	A
78	J1939: VDHR missing message	M
79	J1939: LCMD missing message	
80	J1939: OEL Hazard Switch error value	N
81-86, 128-129	Internal Error	A
130	J1939: TCO1 message missing	M
131	J1939: EBC2 message missing	
132	J1939: EBC1 message missing	
133	Camera Lens Angle error	Q
134	J1939: Missing FLIC J1939 message	M
139	J1939: Missing ABS FLC Status message	E
140	Image Processor software version error	I
141	Internal Error	A
142	Internal Error	I
143-145	Internal Error	A
146	Camera lens blocked	C
147	Camera temperature too high	A
148	J1939: LDW Enable Switch error value	N
149	J1939: CCVS1 Parking Brake Switch error value	
150	J1939: EBC1 EBS Brake Switch error value	
151	J1939: EBC2 Vehicle Speed error value	
152	J1939: EEC1 Engine Speed error value	
153	J1939: FLIC Warning Command error value	
154	J1939: FLIC Buzzer error value	
155	J1939: LCMD Low Beam Headlamp error value	
156	J1939: LCMD High Beam Headlamp error value	
157	J1939: LD Low Beam Headlamp error value	
158	J1939: LD High Beam Headlamp error value	
159	J1939: OEL Turn Signal Switch error value	
160	J1939: OEL High-Low Beam Switch error value	
161	J1939: OEL High Beam Status error value	
162	J1939: OEL Wiper error value	
163	J1939: TCO1 Vehicle Speed error value	
164	J1939: VP37 Left Turn Signal error value	
165	J1939: VP37 Right Turn Signal error value	
166	J1939: VP37 High Headlamp error value	
167	J1939: VP37 Hazard Lamp error value	
168	J1939: VP37 Wiper Status error value	
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.		

Table 1 – DTC Code to Service Action Code. (Pages 8–10)

Table 1: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes		Go to the Service Action Code List in Table 2 (Pages 11-14)
DTC	**Description**	
172	J1939: EEC1 Engine Speed signal missing	M
173	J1939: FLIC Warning Command signal missing	
174	J1939: LDW Buzzer signal missing	
176	J1939: VDC2 Steering Wheel Angle Sensor signal missing	
178	J1939: EBC2 Front Axle Speed signal invalid	P
179	J1939: EEC1 Engine Speed signal invalid	
180	J1939: OEL Turn Signal Switch signal invalid	
181	J1939: TCO1 Tachograph Vehicle Speed signal invalid	
182	J1939: VDC2 Steering Wheel Angle signal invalid	
183	J1939: OEL High Beam Headlamp signal missing	M
184	J1939: Left Turn signal missing	
185	J1939: Right Turn signal missing	
186	J1939: Windshield Wiper Signal signal missing	
187	J1939: OWW Wiper Signal error value	N
188	J1939: OEL High Beam Status error value	N
189	J1939: VDC2 Yaw Rate signal invalid	P
190	J1939: VDC2 Yaw Rate signal missing	M
191	J1939: VDC2 Lateral Accl signal invalid	P
192	J1939: VDC2 Lateral Accl signal missing	M
193	J1939: FLIC Buzzer signal invalid	P
194	J1939: OEL Hazard Switch signal missing	M
195	J1939: OEL Turn Signal Switch signal missing	
196	J1939: EBC1 EBS Brake Switch signal missing	
197	J1939: TCO1 Vehicle Speed signal missing	
198	Fusion mis-match between ABS and camera	Q
199	J1939: Missing OWW J1939 message	M
200	J1939: CCVS1 Vehicle Speed signal invalid	P
201	J1939: CCVS1 Vehicle Speed signal missing	M
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.		

Table 1 – DTC Code to Service Action Code. (Pages 8–10)

2.11 TABLE OF SERVICE ACTION CODES

Recommended service actions for the Diagnostic Trouble Code(s) [DTCs] found. *For SPN (Suspect Parameter Number) and FMI (Failure Mode Identifier) code combinations, see Appendix B.*

Service Action Code	Recommended Service
A	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes**: • 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). **Perform the following:** • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
B	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes**: These Diagnostic Trouble Codes (DTCs) result from incorrect ignition, battery supply voltage, or wiring harness issues as measured at the camera. Review the following Sections: • 2.12 *Troubleshooting Diagnostic Trouble Codes: Power Supply; Ignition Voltage Too Low; Ignition Voltage Too High; Power Supply Tests.* • 2.16 *Troubleshooting Wiring Harnesses.* **Perform the following:** • Verify ignition supply voltage to the camera is between 9 to 32 Volts DC (VDC); • Visually check for damaged or poorly crimped connectors; • Visually check for damage wiring; and • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
C	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes**: • These DTCs may arise from infrequent conditions that could occur normally. **Perform the following:** • Check for lens obstruction. Clean dirt, packed snow or ice from the lens, if present. *See Appendix A to take a test image with the camera to help check that the view is clear.* • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes (DTCs).* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 2 – Service Action Codes to Recommended Service (Pages 11-14)

Service Action Code	Recommended Service
E	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible causes:** • Camera mounting is improper. **Perform the following:** • Go to Section 3.0, measure and see if the camera was mounted properly on the windshield. If an improper mounting arrangement is discovered, follow the instructions included in this document to remove the camera. The adhesive cannot be re-used, but order the approved bracket with adhesive (Bendix part number K109285) to install and re-mount the camera onto the windshield. • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
I	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes**: • The system using the camera has either the incorrect/outdated software version, or wasn't updated properly during a firmware upgrade. **Perform the following:** • Attempt an update of the software using a PC with Bendix® ACom® Diagnostic Software installed to facilitate the update. Make sure that the update program reports a successful download. • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
M	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes**: • The system using the camera has not found the J1939 signal(s) it is expecting from one or more sources. This could be accompanied by other active DTCs from the same source. Review the following Section: • 2.13 *Serial Data (J1939) Troubleshooting Procedure.* **Perform the following:** • Check the expected source(s) of the signal to identify why the signals have invalid data. A communication link may be disconnected, the power fuse disconnected or blown, or a change was made to the controller that was incorrect. • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 2 – Service Action Codes to Recommended Service (Pages 11-14)

Service Action Code	Recommended Service
N	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible causes:** • The system using the camera has found J1939 signal(s) it is expecting, however the values indicated that there is a malfunctioning component and/or wiring error. • Some examples of components, cameras or switches that produce J1939 signals are: brake pressure switches; steering angle sensors; lighting indicators (high/low beam lights, turn signals); windshield wiper status; various engine torque signals; Bendix® Wingman® Fusion™ Driver Assistance System components; and wheel speed sensors. **Perform the following:** • Check the engine, cab/body controller, Bendix Wingman Fusion components, 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. After addressing the possible causes, perform the following: • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, see the Bendix Wingman Fusion System (SD-61-4963) Service Data Sheet for more troubleshooting information, or call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
P	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible causes:** • The Bendix™ AutoVue™ FLC20™ camera finds an expected J1939 source, but the signal's value is out of the normal operating range. Review the following Sections: • 3.6 *Camera Interchangeability.* • 2.13 *Serial Data (J1939) Troubleshooting Procedure.* **Perform the following:** • Check engine, cab/body controller or ABS for DTCs using the manufacturer's diagnostic procedures. The controller that broadcasts the signal indicates that a camera or switch input is producing a value that is out of the normal operating range. • After addressing the possible causes, perform the following: • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes.* If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 2 – Service Action Codes to Recommended Service (Pages 11-14)

Service Action Code	Recommended Service
Q	**This DTC is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes:** • The camera is indicating that it is either not calibrated or an error has occurred. **Perform the following:** • The ABS controller may be disconnected or configuration from the ABS controller may be sending invalid information. • Go to Section 3.0, measure and see if the camera was mounted properly on the windshield. If an improper mounting arrangement is discovered, follow the instructions included in this document to remove the camera. The adhesive cannot be re-used, but order the approved bracket with adhesive (Bendix part number K109285) to install and re-mount the camera onto the windshield. After addressing the possible causes, perform the following: • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes*. If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
V	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning camera. Do not replace the camera.** **Possible Causes**: • The system using the camera has not found the signal(s) it is expecting from the private communications link. This could be accompanied by other active DTCs from the same source. Review the following Section: • 2.15 *Private Communications Network Test Procedure*. **Perform the following:** • Check the expected source(s) of the signal to identify why the signals have invalid data. The private communications link may be disconnected, have improper terminations, power fuse disconnected or blown, or a change was made to the controller that was incorrect. • Clear the camera's DTCs using the procedure in Section 2.17 *Clearing Diagnostic Trouble Codes*. If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Representatives are available 8:00 a.m.-6:00 p.m. ET, Monday - Friday to assist you.
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 2 – Service Action Codes to Recommended Service (Pages 11-14)

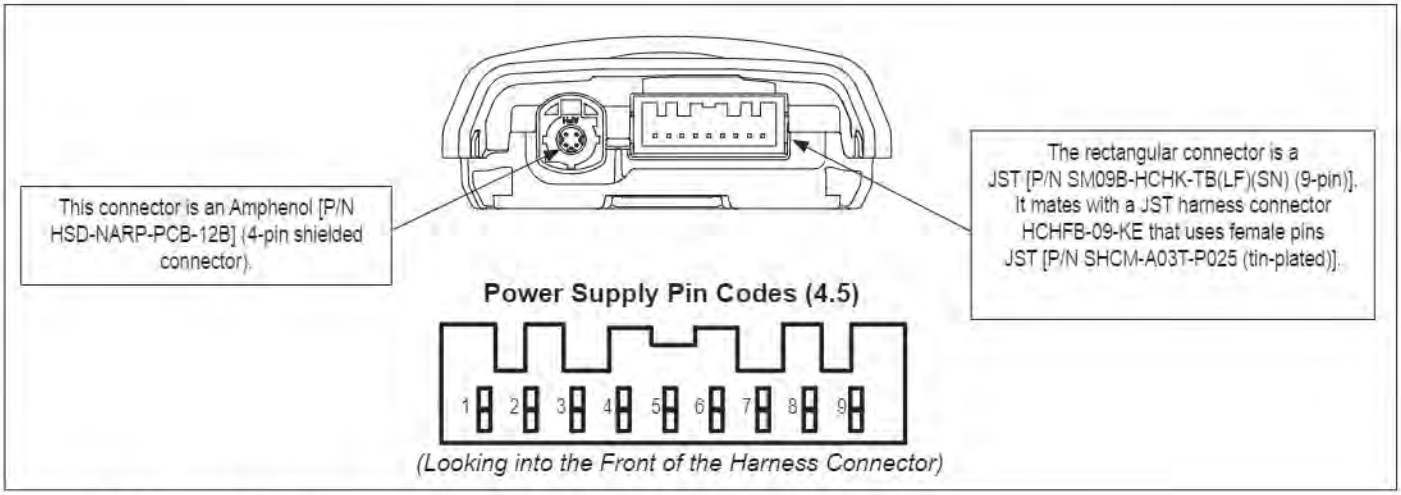


Figure 9 – Camera and Harness Connector Views

Pin #	Description	Nominal Voltage	Nominal Current
1	Module Power	14V/28V (9~32V)	200mA/100mA
2	Not Used	—	—
3	J1939 Low	5V	85mA
4	J1939 High	5V	85mA
5	Not Used	—	—
6	Private Communications Low	5V	85mA
7	Private Communications High	5V	85mA
8	Ground GND (-)	0.000V	200mA/100mA
9	Ignition Wake-Up	14V/28V (7~32V)	20mA/10mA

Table 3 – Harness Connector Pins

2.12 TROUBLESHOOTING DIAGNOSTIC TROUBLE CODES: POWER SUPPLY

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.

CONNECTOR PIN-OUT & POWER REQUIREMENTS

The camera has two connectors. *See Figure 3.*

POWER SUPPLY TESTS

1. Take all measurements at the camera's harness connector.
2. Place a load (e.g. 1157 stop lamp) 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 VDC (Volts DC).
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.

2.13 SERIAL DATA (PRIVATE COMMUNICATIONS) TROUBLESHOOTING PROCEDURE

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

⚠ CAUTION

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. Check for damaged or reversed Private Communications wiring.

   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. Only those devices that are outside of the problem point from other devices will not receive, or be able to, transmit data messages.

3. 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 and possibly the camera sensor. Replacement of the entire harness is recommended. If the terminals of the camera sensor are corroded, replacement of the sensor is recommended.

4. 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 Electronic Control Unit (ECU) pins for shorts to ground and power pins and resistance between the Private Communications HIGH or Private Communications LOW input circuits.

5. Unplug the camera harness. With the ignition switch off, measure the resistance (ohms) using a multimeter between harness pins 6 and 7. The reading should be approximately 120 ohms. If it is not, the vehicle wiring should be investigated.

2.14 POWER TROUBLESHOOTING PROCEDURES

1. Unplug the camera. With the ignition switch ON, using a multimeter, measure the voltage, between harness pin 9 and ground. The measurement should indicate 10 to 16 VDC (Volts DC). If this is not the case, the vehicle wiring should be investigated using procedures described by the manufacturer.
2. Unplug the camera. With the ignition switch OFF, using a multimeter, measure the voltage, between harness pin 9 and ground. The measurement should indicate zero VDC. If this is not the case, the vehicle wiring should be investigated using procedures described by the manufacturer.
3. Unplug the camera. With the ignition switch OFF, using a multimeter, measure the voltage, between harness pin 1 and ground. The measurement should indicate 10 to 16 VDC. If this is not the case, the vehicle wiring should be investigated using procedures described by the manufacturer.

2.15 COMMUNICATIONS (J1939) TEST AND TROUBLESHOOTING PROCEDURES

The Bendix™ AutoVue® FLC20™ camera requires several J1939 messages from various ECUs. The camera will set a Diagnostic Trouble Code (DTC) if one of the messages from one of the expected ECUs is not present. Go to the Service Data Sheet for the particular ECU for full troubleshooting information.

Reference Documents:

- The Bendix® Wingman® Fusion™ Driver Assistance System (SD-61-4963)
- The Bendix® ESP® EC-80™ Controller (SD-13-4986)
- The SafetyDirect® By Bendix CVS Web Portal Processor (SD-65-21025)

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

⚠ CAUTION

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

2. Check for damaged or reversed J1939 wiring.

   If the J1939 HIGH, ***or*** J1939 LOW, wiring circuits are damaged, such as shorting together, the entire J1939 link will be lost. The problem may be intermittent, enabling the J1939 link to operate normally sometimes. If this occurs, multiple diagnostic trouble codes will be logged in multiple engine and vehicle controllers.

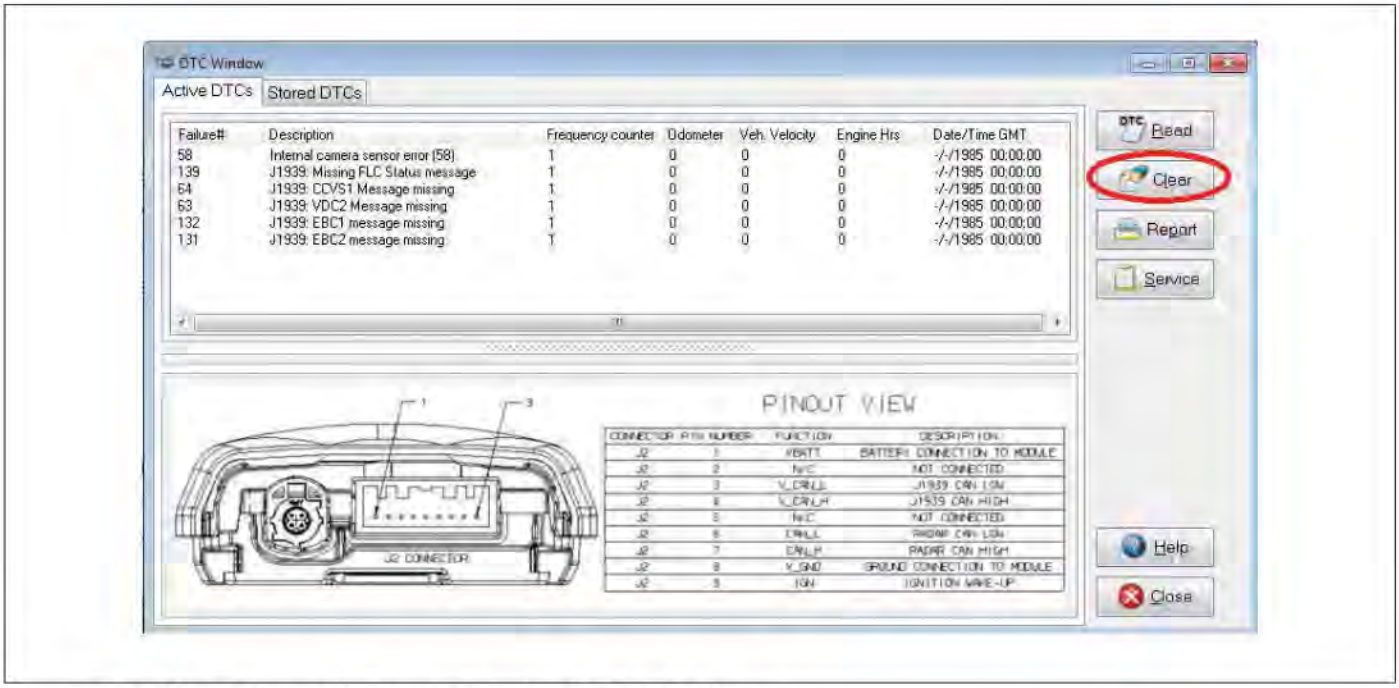


Figure 10 – Clear Diagnostic Trouble Codes (DTCs) Button

If the J1939 HIGH, ***and*** J1939 LOW, wiring circuits are reversed, communication over the entire J1939 link will not be lost. Only those devices that are outside of the problem point from other devices will not receive, or be able to transmit, data messages.

3. Check for poorly-crimped, corroded, contaminated or damaged wiring connector problems such as opens or shorts to voltage or ground.

   If the connector terminals are corroded or damaged, this may be an indication of water intrusion into the wiring system and possibly into the sensor. Replacement of the entire harness is recommended. If the terminals of the sensor are corroded, replacement of the sensor is recommended.

4. Check for other J1939 devices which may be inhibiting J1939 communication. The service technician should consult the vehicle manufacturer's procedures for other J1939 troubleshooting procedures. 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 J1939 HIGH or J1939 LOW input circuits.

5. Unplug the camera harness. With the ignition OFF, measure the resistance (Ohms) using a multimeter between harness pins 3 and 4. The reading should be approximately 60 Ohms. If this is not the case, the vehicle wiring should be investigated.

2.16 PRIVATE COMMUNICATIONS NETWORK TEST PROCEDURE

The Bendix™ AutoVue® FLC20™ camera requires private network messages to and from the Bendix® Wingman® Fusion™ system. The camera will set a Diagnostic Trouble Code (DTC) if these messages are not present, or if there is a problem with the private communications system. Go to the *Bendix Wingman Fusion System Service Data Sheet (SD-61-4963)* for full troubleshooting information.

2.17 TROUBLESHOOTING WIRING HARNESSES

All wire harness connectors must be properly seated to maintain electrical connectivity. Push the mating connectors until they click. When replacing a Bendix Fusion FLC20 camera, check that the wire harness connectors are free of damage, including corrosion, before plugging into a new camera. Check for corroded or damaged wiring connector problems such as opens or shorts to voltage or ground.

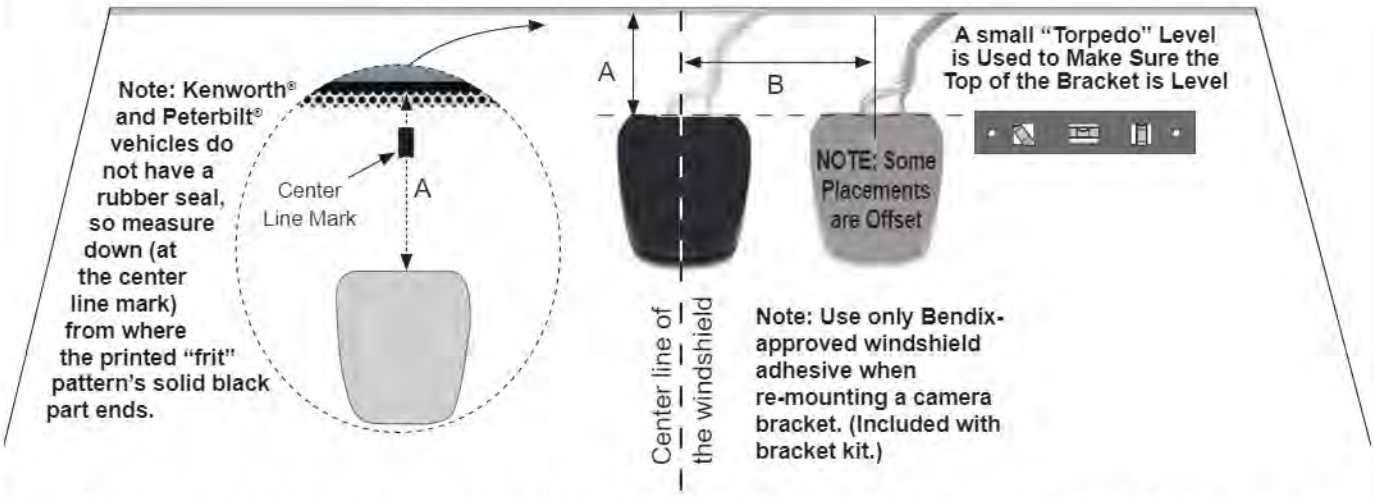
If the connector terminals are corroded, this may be an indication of water intrusion into the wiring system and possibly into the camera (presumably from a cracked windshield). Replacement of the entire harness is recommended. If the terminals of the camera are corroded, replacement of the camera is recommended.

2.18 CLEARING DIAGNOSTIC TROUBLE CODES (DTCs)

Cycle the ignition power, or use the Bendix® ACom® Diagnostic Software (version 6.8.3.2 or higher) to clear DTCs after troubleshooting – and correcting – any problem with the system. *See Figure 10.*

3.0 TYPICAL INSTALLATION

The Bendix™ AutoVue® FLC20™ camera is installed on the windshield at a position determined by Bendix engineering and the OEM. *See Figure 11.* (When replacing a camera bracket, temporarily mark the location of the top of the original bracket to help position the replacement.)



During troubleshooting, if you need to check that the camera bracket is installed at the correct point on the windshield, use the Make/Model columns to find the correct vertical distance "A" (and "B" if applicable).

Center the Top of the Bendix™ AutoVue® FLC20™ camera at the location specified in this table

Vehicle OEM*	Vehicle Model	Distance "A" ±⅛ in. (3 mm)	Distance "B" ±⅛ in. (3 mm)	Comments
Kenworth®	T680® / T880®	1.4 in. (35 mm)	0	Windshields have a mark at the center line. Measure down from the lower edge of the printed border.
Mack®	CXU613® / CHU®	2 in. (51 mm)	6 in. (152 mm)	Measure down from the lower edge of the rubber seal. Note the offset B.
Navistar® International®	ProStar®	2 in. (51 mm)	6 in. (152 mm)	Measure down from the lower edge of the rubber seal. [There is a grey mask area that is 1.8 in (45 mm) high.]
Peterbilt®	PB 579® / PB 567®	1.4 in. (35 mm)	0	Windshields have a mark at the center line. Measure down from the lower edge of the printed border.
Volvo®	VNM® / VNL®	2 in. (51 mm)	0	Measure down from the lower edge of the rubber seal.

* All trademarks shown here are the property of their respective owners and are used for reference only

Figure 11 – Bracket installation Coordinates

⚠ WARNING

Whenever re-installing or replacing a camera – for example, after a windshield is replaced – the recommended position for the vehicle must be used. Failure to install the camera in the correct position can result in system Diagnostic Trouble Codes being set, and system performance degradation.

The ambient temperature must be in the range of 50-100° F. Thoroughly clean the area of the windshield where the camera will be installed with a lint-free cloth and a 50-50 water/isopropyl alcohol solution. Make certain that there is no grease or contamination present and that the windshield is completely dry before installing the bracket.

Use removable tape or a non-permanent marker pen to indicate where the top of the bracket will be installed. Remove the protective film from the tape covering the adhesive on the bracket and, using a small "torpedo" level to be sure that it is level, install the bracket on the glass, holding firmly [a minimum of 62 lb. (28.1 kg.) pressure] in place for ten (10) seconds. Wait at least twenty minutes before installing the camera, at which point a 50% bond strength is created. The full bond between the bracket and windshield is achieved after 72 hours.

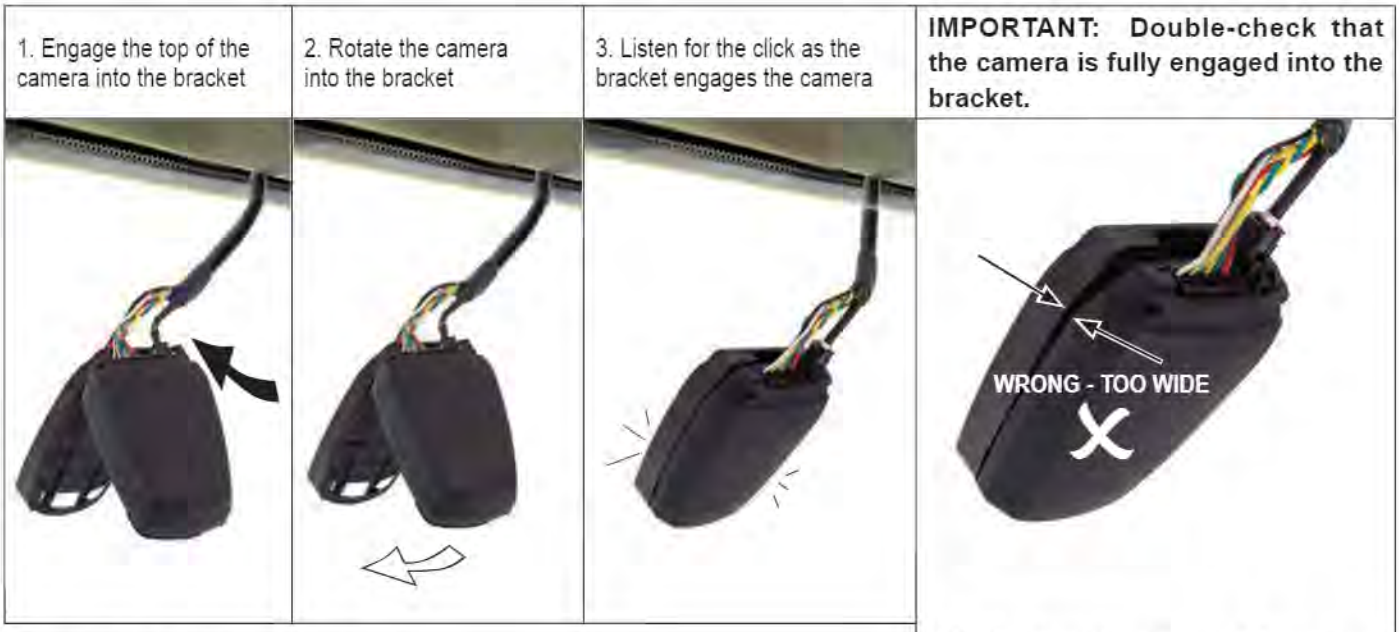


Figure 12 – Camera Installation

To install the camera into the bracket, *See Figure 12.*

1. Engage the top of the camera into the bracket. There are two channels in the camera that need to line up with the bracket housing, so check to be sure that both sides engage into the bracket.
2. While maintaining the engagement at the top of the camera, rotate the rest of the camera body about that hinge point, towards the bracket.
3. When the camera and bracket meet, there are retaining clips built into the bracket that will snap into place, holding the camera in position.

⚠ IMPORTANT

4. **Double-check that the camera is fully engaged into the bracket, by verifying that the channel between them has the same gap all the way around. Pull gently on the camera to check that the tabs at the top and bottom are engaged and that there is no play.** *See Figure 12.*
5. Remove any tape, or temporary marks made, during the installation.

3.1 CAMERA REMOVAL

⚠ CAUTION

Do not use a twisting action when releasing the tabs. Insert the screwdrivers and pry by moving the handles towards each other a small amount. Never twist the screwdrivers as the tabs may break! Replace the bracket if the tab is broken.

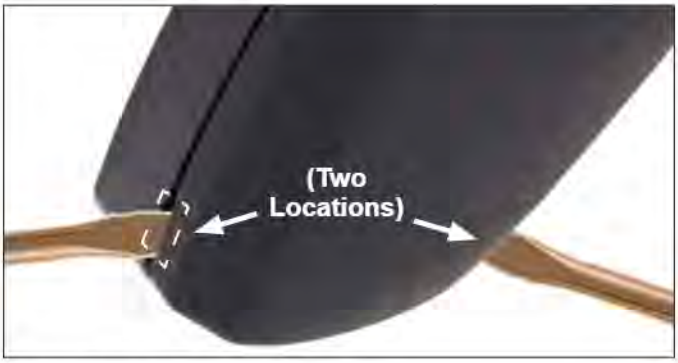


Figure 13 – Camera Release

See Figure 13. If a camera needs to be removed, locate the two locations at the lower corners where the camera and bracket meet.

1. Insert two medium-sized flat-blade screwdrivers into the slots, fully seating them.
2. *Then – **gently prying by moving the screwdriver handles away from the windshield a small amount** – push against the retaining clips to release the camera.*

3.2 BRACKET REMOVAL

The camera must be removed prior to this procedure. The preferred method for removing a bracket ideally requires two technicians. Using a heat-gun, one of the technicians gradually applies heat to the outside of the windshield at the location of the adhesive, while the other gently applies a prying force to the bracket while being careful not to damage the windshield.

As soon as the ideal temperature is reached, the bracket will release. Allow the windshield to completely cool down before cleaning the glass and installing a replacement bracket.

When replacing brackets, use only replacements with the same part number or a direct superceding replacement number supplied by Bendix or OEM. If you have questions, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).

NOTE: Some OEMs may offer the windshield with the bracket pre-installed. Contact the dealer for more information.

3.3 DASH SWITCHES AND LAMPS

Each OEM has their own method for displaying the system status to the driver, and typically there will be a switch on the dash board to allow the driver to temporarily disable the system. Refer to the OEM Operator's Manual for system indicator lamp(s) used for the Bendix™ AutoVue® FLC20™ camera, and whether there is a bulb-check illumination at vehicle power-up. *See Figure 14 for some examples of OEM icons used at the time this document was published.*

Dash/Switch Icon. (The design will vary by vehicle OEM. In some cases, the switch and lamps may be separate.)	International®	Kenworth®
		
Mack®	Peterbilt®	Volvo®
		

* All trademarks shown here are the property of their respective owners and are used for reference only.

Figure 14 – Dash Switch Icons

Additionally, the system self-monitors and will set a Diagnostic Trouble Code (DTC) that will typically alert the driver using a similar icon on the dash display or by a status lamp. See Section 2.0 *"Troubleshooting"* (page 4), for more information.

3.4 MAINTENANCE

In normal use, the Bendix AutoVue FLC20 camera needs only a clean, properly maintained windshield to ensure a clear view of the road ahead. Protect the camera lens whenever the inside of the windshield is cleaned. You may check that the camera's view is clear by taking a test image *(See Appendix A)*.

3.5 CAMERA INTERCHANGEABILITY

When replacing cameras only use replacements with the same part number (or a direct superceding replacement number supplied by Bendix).

⚠ WARNING

Cameras of different vehicle models and model years must not be interchanged. The use of an incorrect camera can lead to Diagnostic Trouble Codes (DTCs) being set, and performance degradation – including unnecessary system interventions and the potential for situations where interventions do not occur when they would normally.

Cameras are designed specifically for particular vehicle and model. DTCs caused by relocating cameras to an incorrect vehicle may result in the vehicle system using the camera to be partially or fully unavailable.

If you have questions, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).

Bendix AutoVue FLC20 cameras are powered by the Mobileye System-on-Chip EyeQ processor with state-of-the-art-vision algorithms.

3.6 IMPORTANT NOTE ON TELEMATICS WIRING

Where a vehicle does not have an On Board Computer/ Telematics (OBC/T) system – in order to prevent interference to the SafetyDirect by Bendix CVS Web Portal Processor – disconnect from the OBC/T harness (any wiring harness provisionally installed in the vehicle for potential use for Telematics) from the main vehicle harness. Re-connect the harness only when an OBC/T system is installed. *(See Appendix C)*.

APPENDIX A - SPN (SUSPECT PARAMETER NUMBER) AND FMI (FAILURE MODE IDENTIFIER) CODES TO SERVICE ACTION CODES

Look up the SPN/FMI code found and see the Service Action Code to use. The Table in Section 2.11 (pages 11-14) explains the service actions to take.

For an equivalent table sorted by Diagnostic Trouble Codes (DTCs) to service action codes, see Section 2.10 (pages 8-10).

Appendix A				
SPN/FMI Codes to Service Action Codes				
SPN	**FMI**	**DTC**	**Diagnostic Trouble Codes (DTC) Description**	**Service Action Code *(See 2.11)***
70	9	64	J1939: CCVS1 Message missing	M
	19	149	J1939: CCVS1 Parking Brake Switch error value	N
84	2	200	J1939: CCVS1 Vehicle Speed signal invalid	P
	9	64, 201	J1939: CCVS1 Vehicle Speed signal missing	M
	19	63, 73	J1939: EBC2 Wheel speed error value	N
190	2	179	J1939: EEC1 Engine Speed signal invalid	P
	9	172	J1939: EEC1 Engine Speed signal missing	M
	19	152	J1939: EEC1 Engine Speed error value	N
234	12	142	Internal Error	I
597	2	74	J1939: EBC1 Brake Switch error value	N
	19			
625	9	72	Private CAN: Bus Off	V
628	2	11	Internal Error	A
	11	36	Image Processor software version error	I
630	2	19	Calibration not complete	Q
		47	SPC Calibration not complete	
		50	Dynamic Calibration out of range	
		51	Dynamic Calibration not complete	
		59	Vehicle Calibration not complete	
	19	198	Fusion mismatch between ABS and camera	
639	9	18	J1939 bus fault	M
	31			
879	9	184	J1939: Left Turn signal missing	
881	9	185	J1939: Right Turn signal missing	
904	2	178	J1939: EBC2 Front Axle Speed signal invalid	P
	9	131	J1939: EBC2 message missing	M
	19	151	J1939: EBC2 Vehicle Speed error value	N
917	9	78	J1939: VDHR missing message	M
1121	9	132	J1939: EBC1 message missing	
		196	J1939: EBC1 EBS Brake Switch signal missing	
	19	150	J1939: EBC1 EBS Brake Switch error value	N

Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix A SPN/FMI Codes to Service Action Codes				
SPN	**FMI**	**DTC**	**Diagnostic Trouble Codes (DTC) Description**	**Service Action Code *(See 2.11)***
1624	2	181	J1939: TCO1 Tachograph Vehicle Speed signal invalid	P
	9	130	J1939: TCO1 message missing	M
		197	J1939: TCO1 Vehicle Speed signal missing	
	19	163	J1939: TCO1 Vehicle Speed error value	N
1705	3	1	High Battery Voltage	B
	4	2	Low Battery Voltage	
	7	146	Camera lens blocked	C
1705	11	133	Camera Lens Angle error	Q
1705	12	3, 4, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 40, 41, 42	Internal Error	A
		43	Calibration data corrupt	Q
		44, 45, 46, 48, 49, 52, 53, 54, 55, 56, 57	Internal Error	A
		60	Image Processor Calibration error	Q
		61, 77, 81, 82, 83, 84, 85, 86, 128, 129, 138	Internal Error	A
		140	Image Processor software version error	I
		141, 143, 144, 145	Internal Error	A
	13	19	Calibration not complete	Q
		47	SPC Calibration not complete	
		50	Dynamic Calibration out of range	
		51	Dynamic Calibration not complete	
		58	Internal Error	
		59	Vehicle Calibration not complete	
	14	11	Internal Error	A
		36	Image Processor software version error	I
	15	147	Camera temperature too high	A
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.				

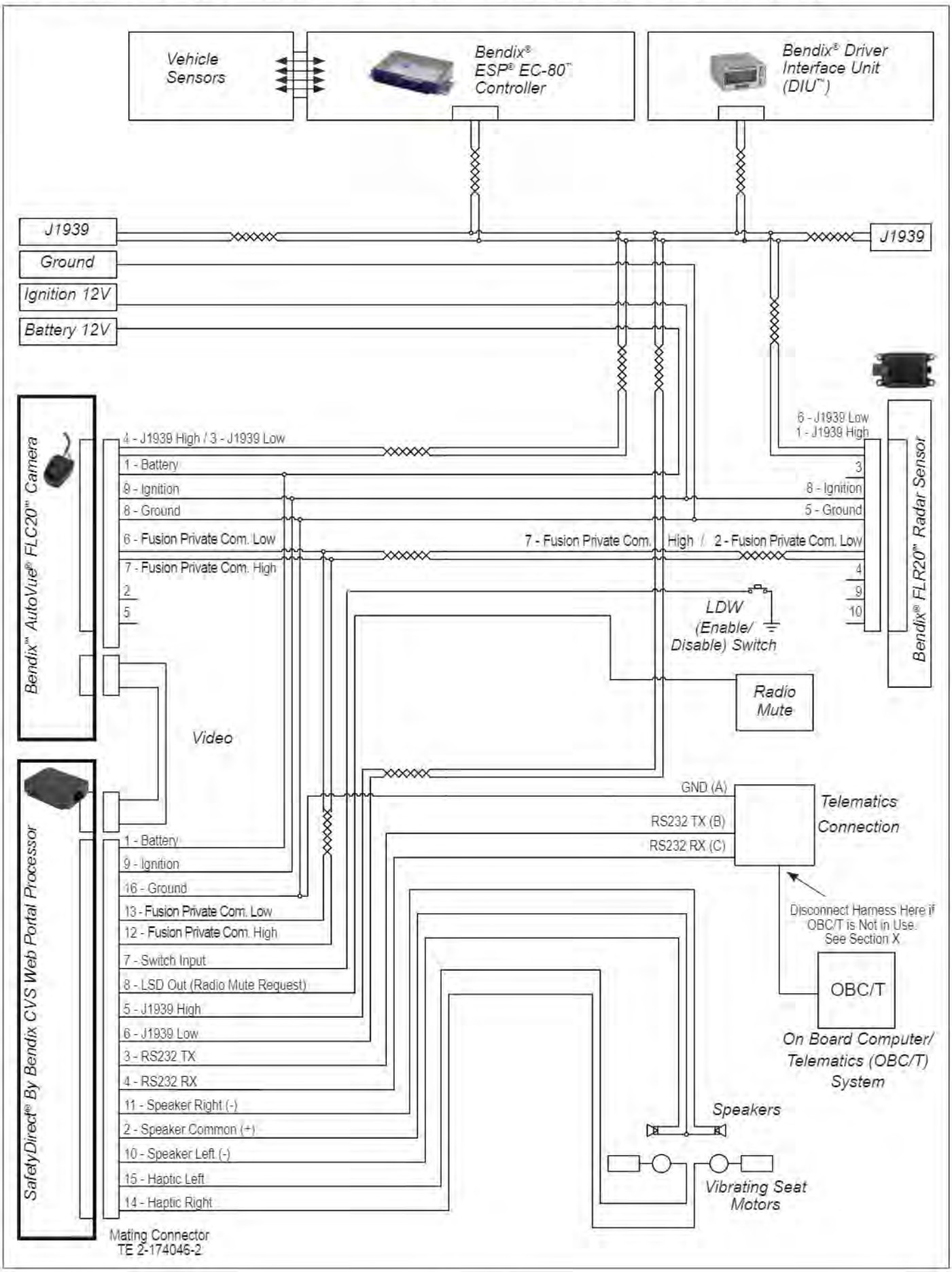
Appendix A SPN/FMI Codes to Service Action Codes				
SPN	**FMI**	**DTC**	**Diagnostic Trouble Codes (DTC) Description**	**Service Action Code *(See 2.11)***
1705	31	3, 4, 7-10, 12-17, 20-42	Internal Error	A
		43	Calibration data corrupt	Q
		44-46, 48-49, 52-58	Internal Error	A
		60	Image Processor Calibration error	Q
		61, 77, 81-86, 128-129, 138	Internal Error	A
		140	Image Processor software version error	I
		141, 143-145	Internal Error	A
		147	Camera temperature too high	
1807	2	182	J1939: VDC2 Steering Wheel Angle signal invalid	P
	9	176	J1939: VDC2 Steering Wheel Angle Sensor signal missing	M
	19	69	J1939: VDC2 Steering Wheel error value	N
1808	2	189	J1939: VDC2 Yaw Rate signal invalid	P
	9	63	J1939: VDC2 Message missing	M
		190	J1939: VDC2 Yaw Rate signal missing	
	19	70	J1939: VDC2 Yaw Rate error value	N
1809	2	191	J1939: VDC2 Lateral Accl signal invalid	P
	9	192	J1939: VDC2 Lateral Accl signal missing	M
	19	71	J1939: VDC2 Lateral Accl error value	N
2347	19	156	J1939: LCMD High Beam Headlamp error value	
2348	19	158	J1939: LD High Beam Headlamp error value	
2349	19	155	J1939: LCMD Low Beam Headlamp error value	
2350	19	157	J1939: LD Low Beam Headlamp error value	
2367	19	76	J1939: LCMD Left Turn error value	
2368	2	164	J1939: VP37 Left Turn Signal error value	
	19	68	J1939: LD Left Turn error value	
2369	9	79	J1939: LCMD missing message	M
	19	75	J1939: LCMD Right Turn error value	N
2370	2	165	J1939: VP37 Right Turn Signal error value	M
	9	62	J1939: LD Message missing	
	19	67	J1939: LD Right Turn error value	N
2550	9	139	J1939: Missing ABS FLC Status message	E
2863	14	199	J1939: Missing OWW J1939 message	M
	19	187	J1939: OWW Wiper Signal error value	N
2874	19	160	J1939: OEL High-Low Beam Switch error value	N
2875	9	194	J1939: OEL Hazard Switch signal missing	M
	19	80	J1939: OEL Hazard Switch error value	N

Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix A				
SPN/FMI Codes to Service Action Codes				
SPN	**FMI**	**DTC**	**Diagnostic Trouble Codes (DTC) Description**	**Service Action Code *(See 2.11)***
2876	2	180	J1939: OEL Turn Signal Switch signal invalid	P
	9	65	J1939: OEL Message missing	M
		195	J1939: OEL Turn Signal Switch signal missing	
	19	66	J1939: OEL Turn Signal error value	N
3564	4	153	J1939: FLIC Warning Command error value	
	9	173	J1939: FLIC Warning Command signal missing	M
	14	134	J1939: Missing FLIC J1939 message	
	19	153	J1939: FLIC Warning Command error value	N
4011	9	183	J1939: OEL High Beam Headlamp signal missing	M
516096	19	148	J1939: LDW Enable Switch error value	N
516097	2	193	J1939: FLIC Buzzer signal invalid	P
	9	174	J1939: LDW Buzzer signal missing	M
	18	193	J1939: FLIC Buzzer signal invalid	P
	19	154	J1939: FLIC Buzzer error value	N
516098	2	188	J1939: OEL High Beam Status error value	
	19	161	J1939: OEL High Beam Status error value	
516099	9	186	J1939: Windshield Wiper signal missing	M
	19	162	J1939: OEL Wiper error value	N
516100	19	164	J1939: VP37 Left Turn Signal error value	
516101	19	165	J1939: VP37 Right Turn Signal error value	
516102	19	166	J1939: VP37 High Headlamp error value	
516103	19	167	J1939: VP37 Hazard Lamp error value	
516104	19	168	J1939: VP37 Wiper Status error value	
Note: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.				

Appendix A (Pages 21–24)

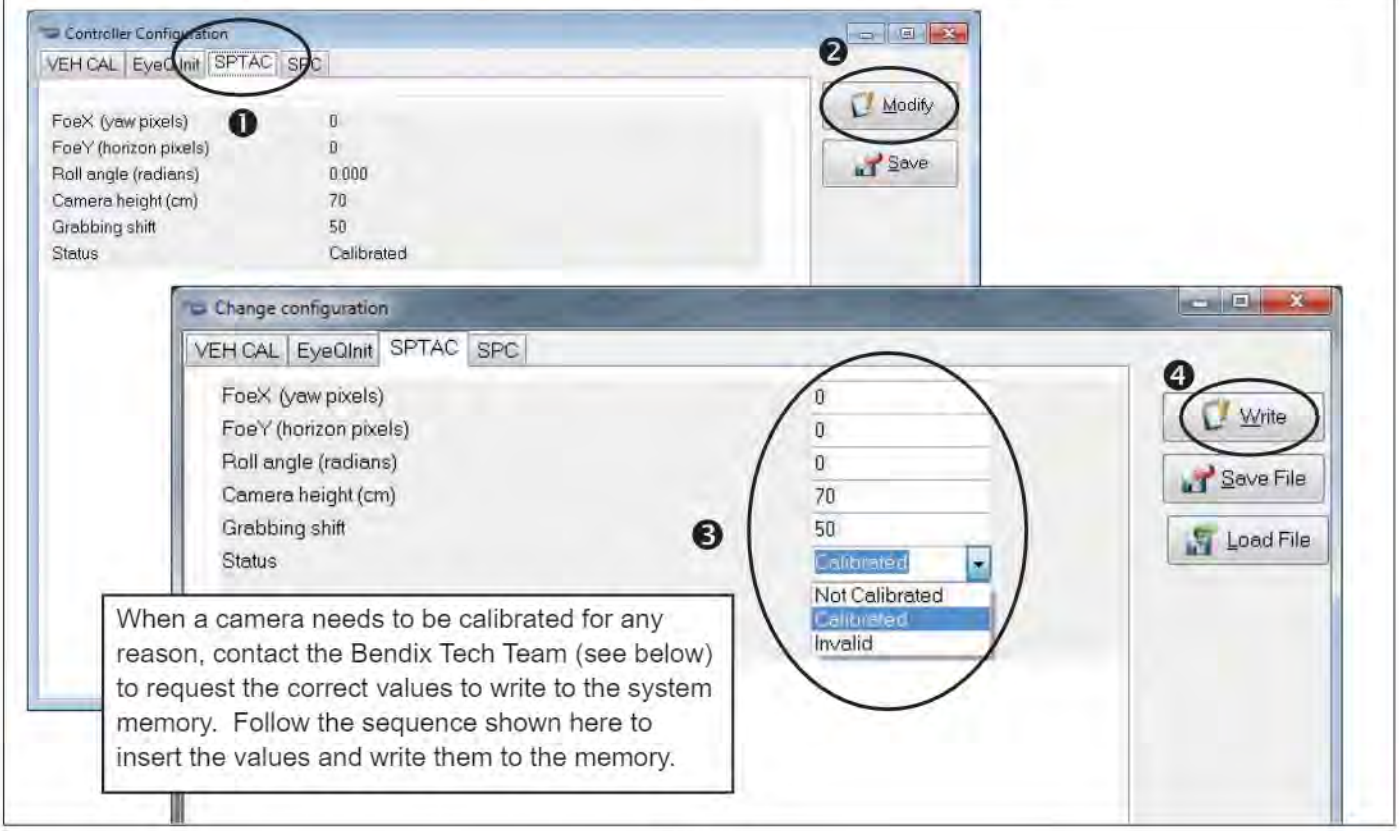
APPENDIX B - BENDIX® WINGMAN® FUSION™ SYSTEM COMPONENT SCHEMATIC



APPENDIX C - CONTROLLER CONFIGURATION CHANGES

Appendix C

Controller Configuration Screens



Appendix C

ADDITIONAL SUPPORT AT WWW.BENDIX.COM / 1-800-AIR-BRAKE (1-800-247-2725, OPTION 2)

For the latest information, and for free downloads of the Bendix® ACom® Diagnostics software, and its User Guide, visit the Bendix website at: www.bendix.com.

For direct telephone technical support, the Bendix Tech Team is available at 1-800-AIR-BRAKE (1-800-247-2725, option 2). Follow the instructions in the recorded message.

The Bendix Tech Team can also be reached by e-mail at: techteam@bendix.com.

Reference Documents:

- The Bendix® Wingman® Fusion™ Driver Assistance System (SD-61-4963)
- The Bendix® ESP® EC-80™ Controller (SD-13-4986)
- The SafetyDirect® By Bendix CVS Web Portal Processor (SD-65-21025)

Trademark acknowledgements:

Any references in this manual to FREIGHTLINER, INTERNATIONAL, KENWORTH, MACK, PETERBILT, PROSTAR, STERLING, VOLVO, WESTERN STAR, and any other company or trademark are solely for identification and cross reference purposes. The trademarks are the property of their respective companies and are not affiliated with or endorsing Bendix Commercial Vehicle Systems LLC. Bendix Commercial Vehicle Systems LLC does not represent any parts shown as products manufactured or remanufactured by the companies so named herein.

Bendix

Service Data

SD-65-21025

The SafetyDirect® By Bendix CVS Web Portal Processor

FIGURE 1 - *SAFETYDIRECT® WEB PORTAL PROCESSOR*

1.0 DESCRIPTION

The SafetyDirect® Web Portal Processor is a component used to collect complex safety data and supply it to the vehicle's On Board Computer (OBC)/Telematics system for transfer to the SafetyDirect web site.

This document covers troubleshooting the processor when used with the Bendix® Wingman® Fusion™ system and its safety systems, including:

- Lane Departure Warning (LDW) Systems;
- Over-Speed Alert & Action (OAA); and
- Collision Mitigation Technology (CMT).

(For information about the Bendix Wingman Fusion system, see Service Data Sheet, SD-61-4963).

For free downloads of Service Data Sheets, visit the Bendix website at: www.bendix.com.

⚠ WARNING

Bendix safety technologies complement safe driving practices and are not intended to enable or encourage aggressive driving. 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.

1.1 BENDIX® WINGMAN® FUSION™ SYSTEM COMPONENTS

FIGURE 2 - *MAIN BENDIX® WINGMAN® FUSION® SYSTEM COMPONENTS*

The Bendix Wingman Fusion system has five major components (*See Figure 2*).

1. A Bendix™ Autovue® FLC20™ Camera is a visible-light spectrum camera mounted on the inside of the windshield.
2. The SafetyDirect Web Portal Processor described in this document, normally located in the overhead compartment above the windshield, near the camera.
3. A Bendix® Wingman® FLR20™ radar, located at the front of the vehicle close to – or on – the bumper.
4. A Bendix® ESP® EC-80™ Controller – located in the cab of the vehicle – controls the antilock braking and full stability functions for the vehicle, using a set of wheel-speed, yaw, steering-angle and load sensors. In the Bendix Wingman Fusion system, the controller also manages any actions requested by the Fusion system.
5. A Bendix® Driver Interface Unit (DIU) – or similar OEM dashboard display – communicates between the driver and the Bendix Wingman Fusion system. A set of visual, text, and audible indicators and alerts are provided.

SD SHEET INDEX

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, or a Bendix® AD-9si® 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. 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, 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 Bendix® Wingman® Advanced™-equipped vehicle.**
- **You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.**

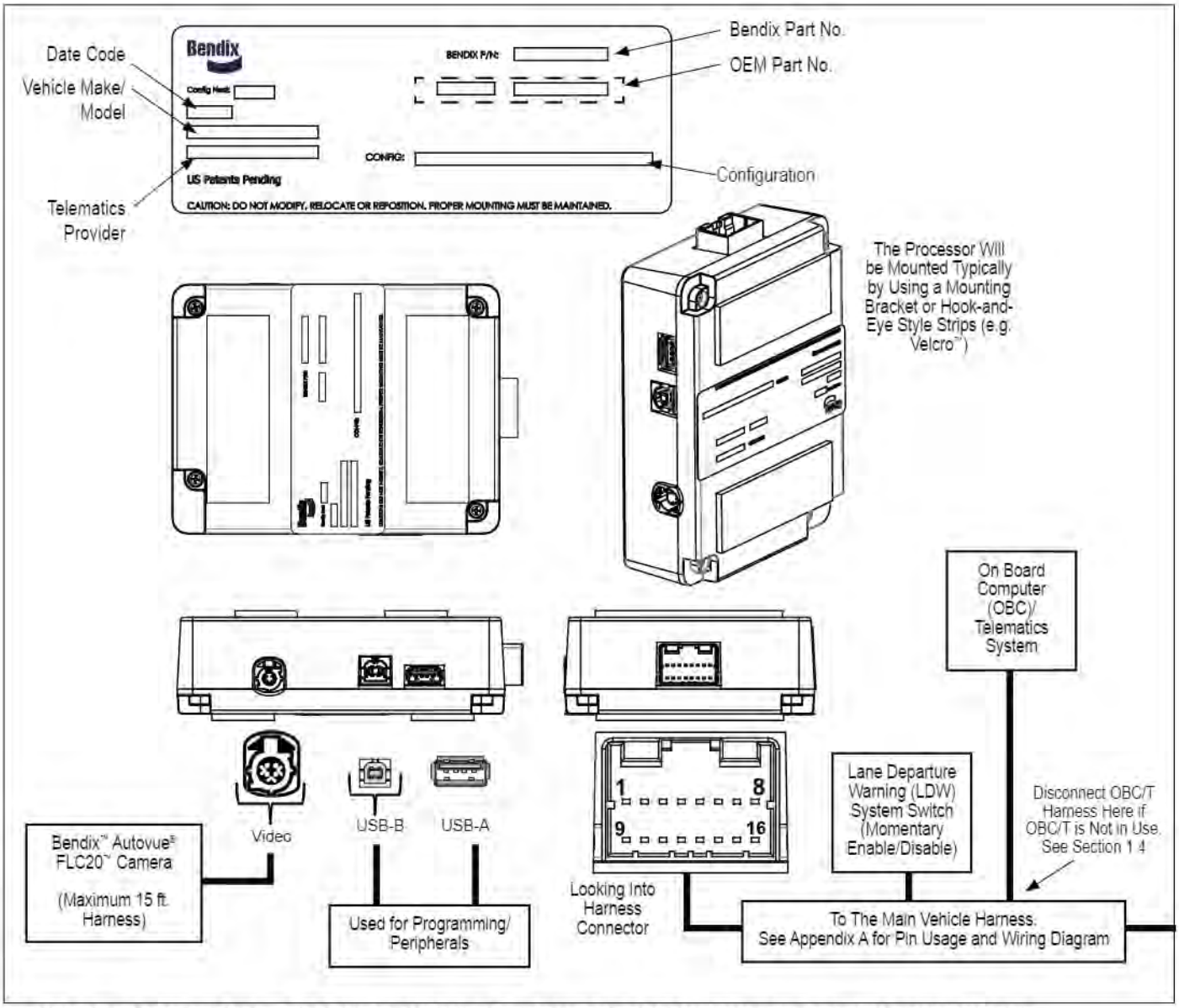


FIGURE 3 - *SAFETYDIRECT® BY BENDIX CVS WEB PORTAL PROCESSOR FUSION® SYSTEM CONNECTIONS*

1.2 CONNECTIONS

The processor has four connection locations. *See Figure 3.*

1.3 ENABLE/DISABLE SWITCH FUNCTIONS

In the case of vehicles configured to do so, the enable/disable switch used by the Lane Departure Warning (LDW) system also functions – when depressed for six (6) seconds – to activate a request from the SafetyDirect® By Bendix CVS Web Portal Processor to the On Board Computer (OBC)/Telematics system to transmit the last three (3) minutes of buffered video data.

1.4 IMPORTANT NOTE ON TELEMATICS WIRING

Where a vehicle does not have an On Board Computer (OBC)/Telematics system – in order to prevent interference to the SafetyDirect Web Portal Processor – disconnect from the OBC/T harness (any wiring harness provisionally installed in the vehicle for potential use for Telematics) from the main vehicle harness. Re-connect the harness only when an OBC/Telematics system is installed. *(See Appendix B).*

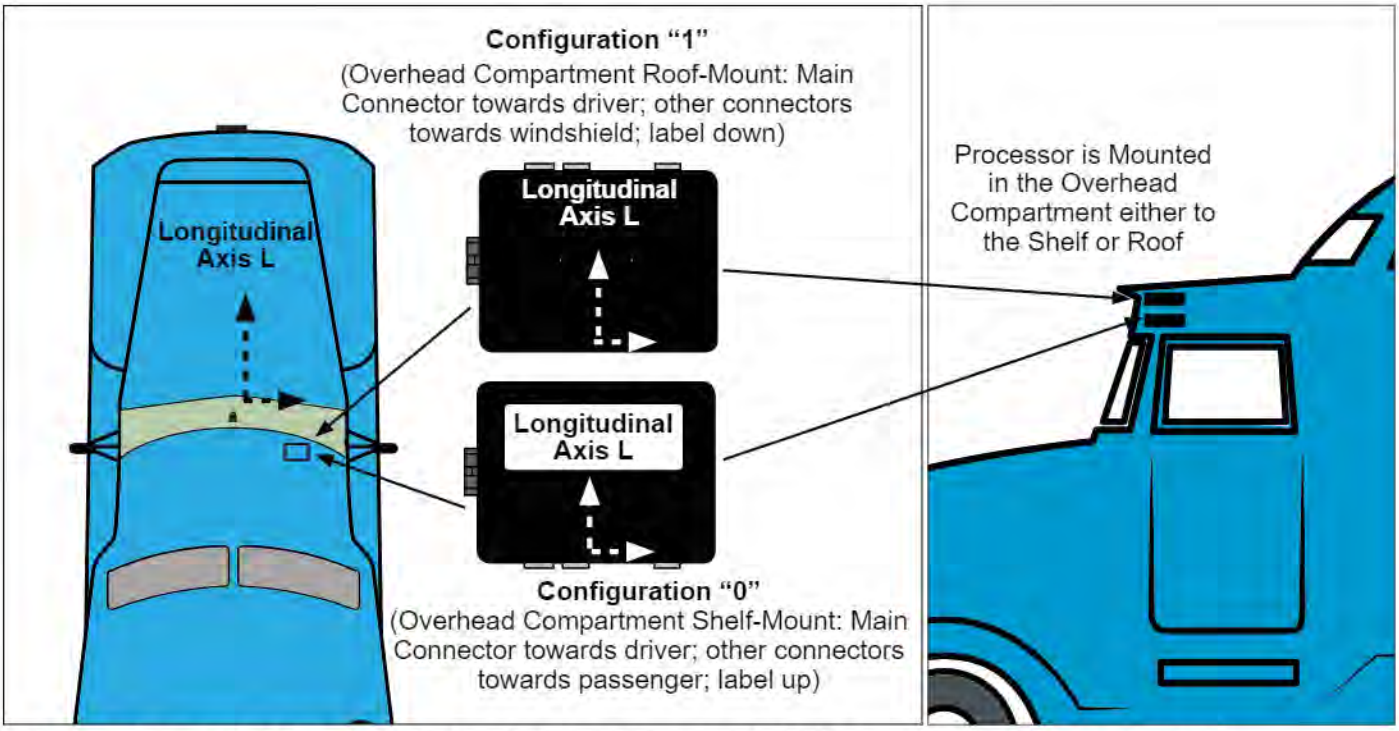


FIGURE 4 - *SAFETYDIRECT® BY BENDIX CVS WEB PORTAL PROCESSOR PERMISSIBLE CONFIGURATIONS*

1.5 ORIENTATION

It is critical that the processor be installed in the expected orientation to the vehicle longitudinal line. *See Figure 4.*

The SafetyDirect® By Bendix CVS Web Portal Processor must be installed in the vehicle using a method that keeps the processor stable and permanently mounted in the same orientation. The two most used orientations are shown in Figure 4. The exact mounting location varies by the OEM, and vehicle model, and should remain consistent for all vehicles in that category. The processor is mounted inside the cab in the overhead compartment to help provide the shortest length for the video cable. The maximum length permitted is 15 feet (4.5 m). In most cases a mounting bracket or professional-quality, hook-and-eye fastening material (e.g. "Velcro™", or similar) may be used.

⚠ IMPORTANT

Misalignment may result in variation in the reporting of excessive braking and turning.

1.6 MAINTENANCE

In normal use, the SafetyDirect Web Portal Processor needs no maintenance. Protect the Processor from damage or being moved from its set location in the overhead compartment.

1.7 SAFETYDIRECT WEB PORTAL PROCESSOR INTERCHANGEABILITY

When replacing SafetyDirect Web Portal Processors only use replacements with the same part number (or a direct superceding replacement number supplied by Bendix).

⚠ WARNING

SafetyDirect Web Portal Processors of different vehicle models and model years must not be interchanged. The use of an incorrect SafetyDirect Web Portal Processor can lead to Diagnostic Trouble Codes (DTCs) being set, and performance degradation – including unnecessary system interventions and the potential for situations where interventions do not occur when they would normally.

SafetyDirect Web Portal Processors are designed specifically for particular vehicle and model. DTCs caused by relocating SafetyDirect Web Portal Processors to an incorrect vehicle may result in the vehicle system using the SafetyDirect Web Portal Processor to be partially or fully unavailable.

If you have questions, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).

2.0 TROUBLESHOOTING

2.1 GENERAL SAFETY GUIDELINES

Read and follow the General Safety Guidelines shown on page two of this document.

Bendix safety technologies complement safe driving practices and are not intended to enable or encourage aggressive driving. 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.

IMPORTANT

All vehicle Diagnostic Trouble Codes (DTCs) related to the engine, transmission, instrument cluster, engine cruise control and Bendix® ABS, ATC or ESP® systems must first be resolved, with no DTCs present during the vehicle operation while in cruise control, before trying to resolve SafetyDirect® By Bendix CVS Web Portal Processor DTCs.

IMPORTANT

System Problems. If a problem with the SafetyDirect Web Portal Processor is detected, it should be serviced as soon as possible to restore full functionality.

2.2 SETTING DIAGNOSTIC TROUBLE CODES

If, during operation, the Bendix® Wingman® Fusion™ system detects a problem with the SafetyDirect® Web Portal Processor, a DTC will be set and – depending on the OEM – the driver will be alerted by the dash display an icon or similar method. In these cases, some features of Bendix Wingman Fusion system will not be available.

2.3 PC-BASED DIAGNOSTIC SOFTWARE

Use a PC-based software program to provide the technician with the processor diagnostic information and configuration capability.

See Table 1 For SPN (Suspect Parameter Number) and FMI (Failure Mode Identifier) code combinations.

For Bendix Wingman Fusion system diagnostics, use Bendix® ACom® Diagnostic Software version 6.9 or higher.

IMPORTANT

Please note that Bendix ACom Diagnostic Software ***version 6.9 or higher*** is required for troubleshooting the SafetyDirect Web Portal Processor. Further revisions to this document will include more details of Bendix ACom Diagnostic Software troubleshooting functionality; see the bendix web site www.bendix.com for updates to this document.

Table of System Diagnostic Trouble Codes (DTCs)

Refer to the DTC(s) found and determine the action(s) to take.

Table of Diagnostic Trouble Codes (DTCs), Causes and Recommended Actions				
SPN	**FMI**	**DTC Name**	**Condition Found**	**Suggested Remedial Action(s)**
0084	**02**	**Vehicle's Speed Value Not Found.**	The J1939 Data Bus speed value is not present.	• Check J1939 Data Bus connection. • Is the vehicle's J1939 Data Bus functioning? • If no problems were found during the checks above, replace the processor and re-test.
0084	**15**	**Vehicle's Speed Value is Out-of-Range.**	The J1939 Data Bus speed value is outside the expected range.	• Check J1939 Data Bus connection. • Is the vehicle's J1939 Data Bus functioning? • If no problems were found during the checks above, replace the processor and re-test.
0625	**02**	**Wingman® Fusion™ Private Communications Receive Failure.**	Failure of processor to receive on Private Data Bus.	• Check J1939 Data Bus connection. • Is the vehicle's J1939 Data Bus functioning? • If no problems were found during the checks above, replace the processor and re-test.
0628	**31**	**Software Corrupted. (SDP is Disabled. No Warnings Will be Generated.)**	The internal Electronic Control Unit (ECU) checksum does not match the calculated value.	• Replace the processor and re-test.
0639	**02**	**J1939 Data Bus Not Found. Receive and/or Transmit Not Present. (SDP is Disabled. No Warnings Will be Generated.)**	The processor is not transmitting on the J1939 Data Bus.	• Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors and loose connections. Using procedures described by the vehicle manufacturer, verify the presence of the J1939 link. Check for other devices inhibiting J1939 communications. • If no problems were found during the checks above, replace the processor and re-test.
For technical support, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) Monday through Friday, 8:00 a.m. to 6:00 p.m. ET. The Bendix Tech Team can also be reached by e-mail at: techteam@bendix.com.				

FIGURE 1 - *TABLE OF DIAGNOSTIC TROUBLE CODES (PAGES 6-9)*

the Bendix Tech Team is available at 1-800-AIR-BRAKE (1-800-247-2725, option 2)

Table of Diagnostic Trouble Codes (DTCs), Causes and Recommended Actions				
SPN	**FMI**	**DTC Name**	**Condition Found**	**Suggested Remedial Action(s)**
1564	**02**	**FLC20 CCD Input Failure.**	Private communications messages with the camera are not present as expected.	• Check the wiring between the camera and the processor. • See the camera SD Sheet SD-64-20124 for more information.
1702	**02**	**Switch Failure. (SDP is Disabled. No Warnings Will be Generated.)**	Private communications input message signals switch failure in switch state field or discrete momentary switch input is stuck in the 'pressed' state for more than 60 seconds.	• Check the wiring between the enable/disable switch and the processor. • Test by temporarily installing a known good switch. • If no problems were found with the wiring, and the test with a good switch did not solve the problem, replace the processor and re-test.
1703	**03**	**The Right Speaker is Shorted to Power. (SDP is Disabled. No Warnings Will be Generated.)**	The resistance from right speaker positive or negative output pins to power input is less than 10Ω during sound generation.	• Check the wiring between the right speaker and the processor. • Test by temporarily installing a known good speaker in the right speaker location. • If no problems were found with the wiring, and the test with a good speaker did not solve the problem, replace the processor and re-test.
1703	**05**	**The Right Speaker Has an Open Circuit. (SDP is Disabled. No Warnings Will be Generated.)**	Resistance between right speaker output pins is greater than 40Ω during sound generation.	• Check the wiring between the right speaker and the processor. • Test by temporarily installing a known good speaker in the right speaker location. • If no problems were found with the wiring, and the test with a good speaker did not solve the problem, replace the processor and re-test.
For technical support, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) Monday through Friday, 8:00 a.m. to 6:00 p.m. ET. The Bendix Tech Team can also be reached by e-mail at: techteam@bendix.com.				

FIGURE 1 - *TABLE OF DIAGNOSTIC TROUBLE CODES (PAGES 6-9)*

Table of Diagnostic Trouble Codes (DTCs), Causes and Recommended Actions				
SPN	**FMI**	**DTC Name**	**Condition Found**	**Suggested Remedial Action(s)**
1703	**06**	**The Right Speaker is Shorted to Ground. (SDP is Disabled. No Warnings Will be Generated.)**	Resistance between right speaker positive or negative output pins and ground is less than 10Ω during sound generation. OR Resistance between right speaker positive and negative output pins is less than 7Ω during sound generation.	• Check the wiring between the right speaker and the processor. • Test by temporarily installing a known good speaker in the right speaker location. • If no problems were found with the wiring, and the test with a good speaker did not solve the problem, replace the processor and re-test.
1704	**03**	**The Left Speaker is Shorted to Power. (No Warnings Will be Generated.)**	Resistance from left speaker positive or negative output pins to power input is less than 10Ω during sound generation.	• Check the wiring between the left speaker and the processor. • Test by temporarily installing a known good speaker in the left speaker location. • If no problems were found with the wiring, and the test with a good speaker did not solve the problem, replace the processor and re-test.
1704	**05**	**The Left Speaker Has an Open Circuit. (No Warnings Will be Generated.)**	Resistance between left speaker output pins is greater than 40Ω during sound generation.	• Check the wiring between the left speaker and the processor. • Test by temporarily installing a known good speaker in the left speaker location. • If no problems were found with the wiring, and the test with a good speaker did not solve the problem, replace the processor and re-test.
1704	**06**	**The Left Speaker is Shorted to Ground. (No Warnings Will be Generated.)**	Resistance between left speaker positive or negative output pins and ground is less than 10Ω during sound generation. OR Resistance between left speaker positive and negative output pins is less than 7Ω during sound generation.	• Check the wiring between the left speaker and the processor. • Test by temporarily installing a known good speaker in the left speaker location. • If no problems were found with the wiring, and the test with a good speaker did not solve the problem, replace the processor and re-test.
For technical support, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) Monday through Friday, 8:00 a.m. to 6:00 p.m. ET. The Bendix Tech Team can also be reached by e-mail at: techteam@bendix.com.				

FIGURE 1 - *TABLE OF DIAGNOSTIC TROUBLE CODES (PAGES 6-9)*

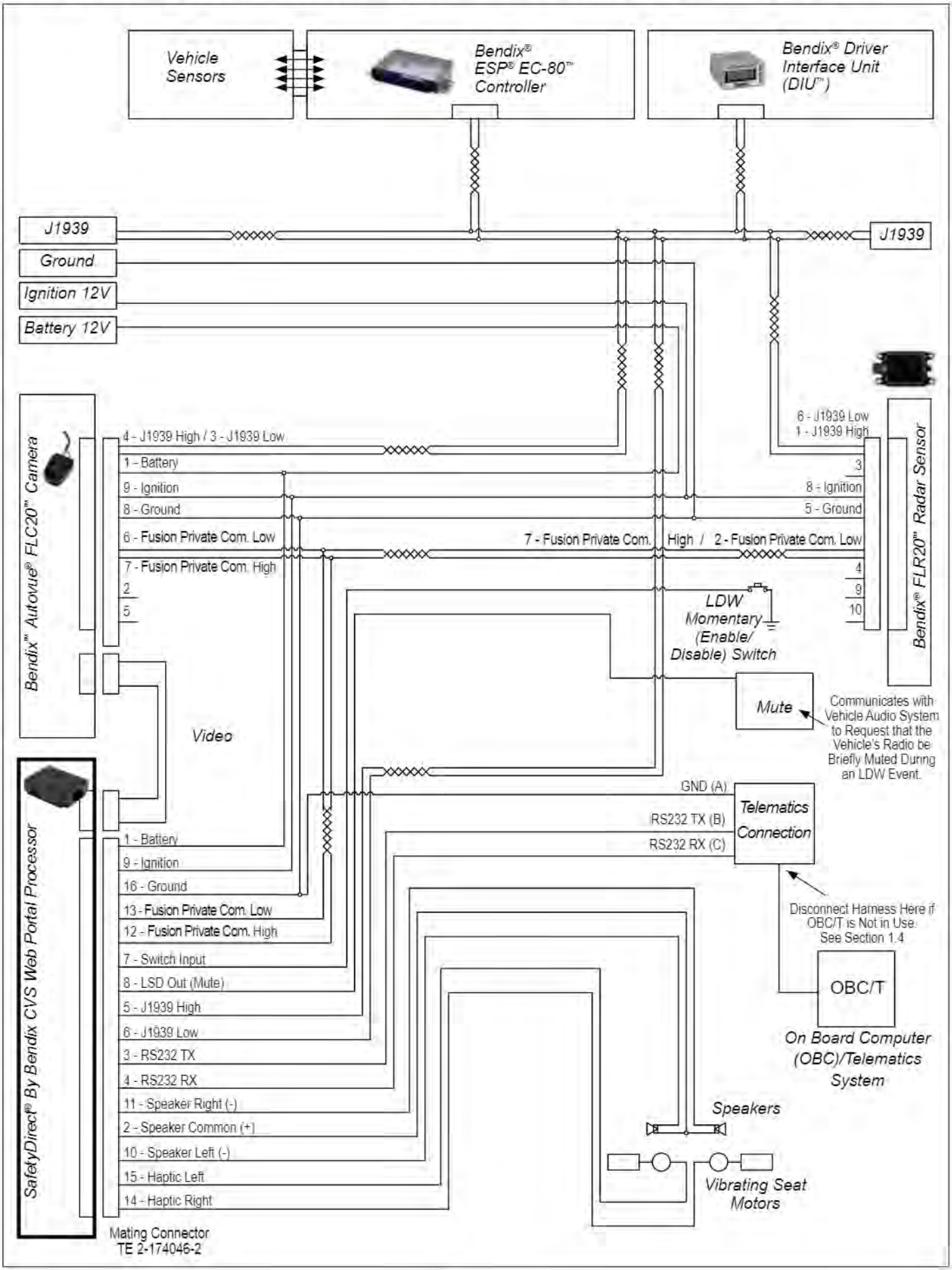
Table of Diagnostic Trouble Codes (DTCs), Causes and Recommended Actions				
SPN	**FMI**	**DTC Name**	**Condition Found**	**Suggested Remedial Action(s)**
1705	03	**The Input Voltage is Too High.**	Input voltage is above 16V.	• Measure the ignition voltage. Ensure that ignition voltage is not greater than 16 VDC. Check the vehicle battery and associated components. • Inspect for damaged wiring, damaged or corroded connectors and loose connections. Check the wiring between the ignition and the processor. • If no problems were found during the checks above, replace the processor and re-test.
1705	04	**The Input Voltage is Too Low.**	Input voltage is below 9.5V.	• Check the ignition voltage. • Measure the ignition voltage under load. Ensure that the ignition voltage is greater than 10 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. • Check the wiring between the ignition and the processor. • If no problems were found during the checks above, replace the processor and re-test.
1705	05	**The Enabled Lamp or Status Lamp Output Open.**	Resistance from enabled or status output to ground is greater than 140KΩ while output is not energized.	• Check the wiring between the processor and the switch or status lamp. • Test by temporarily installing a known good switch/status lamp. • If no problems were found with the wiring, and the test with a good switch/status lamp did not solve the problem, replace the processor and re-test.
		(Note: the green "enabled" lamp output **will not** illuminate if this DTC is present)		
1705	06	**Enabled Lamp or Status Lamp Output Short to Power.**	Current into enabled or status output pin is greater than 4.5A while the output is energized.	• Check the wiring between the processor and the switch or status lamp. • Test by temporarily installing a known good switch/status lamp. • If no problems were found with the wiring, and the test with a good switch/status lamp did not solve the problem, replace the processor and re-test.
		(Note: the green "enabled" lamp output **will not** illuminate if this DTC is present)		
1705	31	**Internal Failure.**	Internal failure.	• Check the camera cable. • Test by temporarily installing a known good camera. • If no problems were found with the cable and the test with a good camera did not solve the problem, replace the processor and re-test.
For all other DTCs, or problems after re-testing a replacement processor, contact the Bendix Tech Team.				
For technical support, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) Monday through Friday, 8:00 a.m. to 6:00 p.m. ET. The Bendix Tech Team can also be reached by e-mail at: techteam@bendix.com.				

FIGURE 1 - *TABLE OF DIAGNOSTIC TROUBLE CODES (PAGES 6-9)*

2.4 CLEARING DIAGNOSTIC TROUBLE CODES (DTCs)

Cycle the ignition power. Power off the vehicle for at least one (1) minute, and then start the engine and run it at idle for at least 15 seconds. If the error returns, call Bendix at 1-800-AIR-BRAKE (1-800-247-2725), option 2, for assistance.

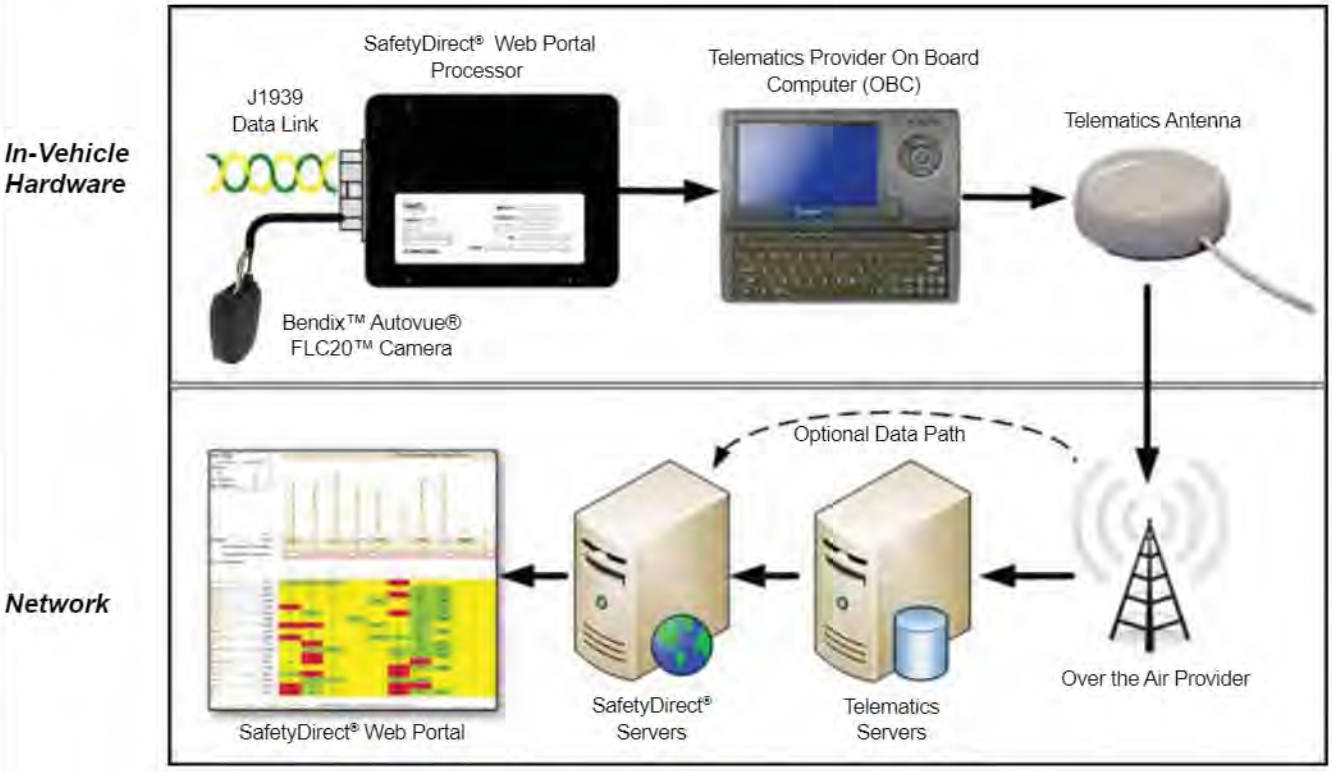
APPENDIX A - BENDIX® WINGMAN® FUSION™ SYSTEM COMPONENT SCHEMATIC



Appendix B

The SafetyDirect® Web Portal Processor

The system has the ability to collect relevant driver and vehicle performance data via the the SafetyDirect® Web Portal Processor and the J1939 Private communications bus. When a trigger event occurs, vehicle data and, in some cases, video, is saved in the system for later download via the vehicle telematics system.



ADDITIONAL SUPPORT AT WWW.BENDIX.COM/1-800-AIR-BRAKE (1-800-247-2725, OPTION 2)

For the latest information – and for free downloads of the Bendix® ACom® Diagnostics software – and its User Guide, visit the Bendix website at: www.bendix.com.

For direct telephone technical support, the Bendix Tech Team is available at 1-800-AIR-BRAKE (1-800-247-2725, option 2) Monday through Friday, 8:00 A.M. to 6:00 P.M. ET. Follow the instructions in the recorded message.

The Bendix Tech Team can also be reached by e-mail at: techteam@bendix.com.

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The Bendix® Wingman® Fusion™ Driver Assistance System

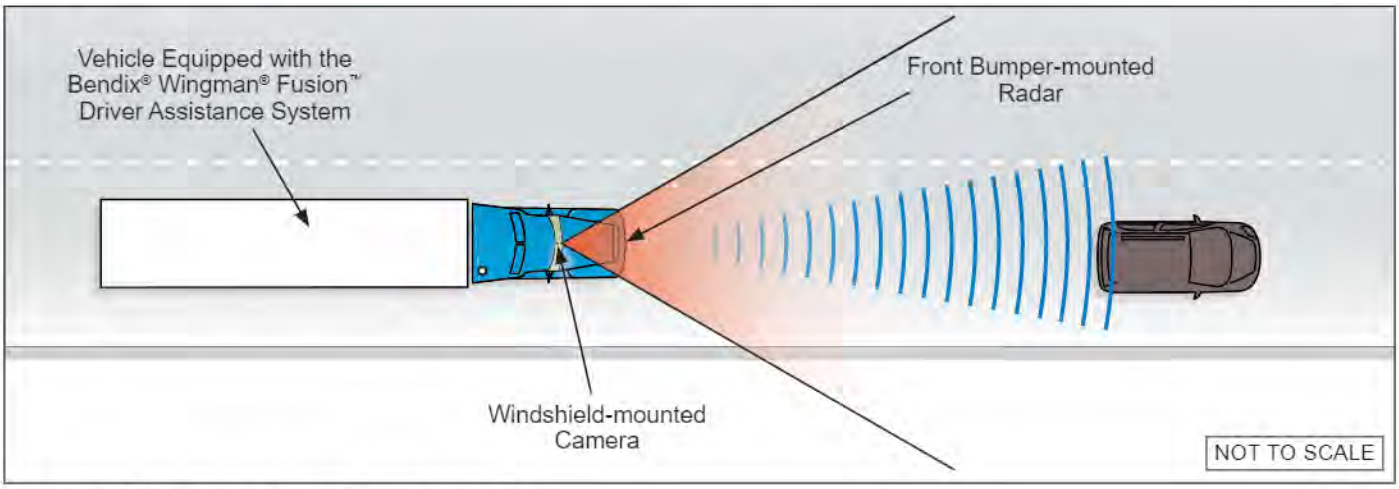


Figure 1 – The System Uses a Camera and Radar

⚠ 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.

Integrating camera, radar and brakes, the Bendix® Wingman® Fusion™ Driver Assistance System (Fusion) provides the following alerts and actions:

- Stationary Vehicle Braking (SVB);
- Enhanced Collision Mitigation Braking (CMB);
- Active Cruise with Braking (ACB);
- Overspeed Alert and Action (OAA);
- Lane Departure Warnings (LDW);
- Stationary Object Alerts (SOA); and
- Alert Prioritization.

Note: The system, depending on configuration, may record data and video of certain events and, when integrated with a telematics provider, can transmit this information for viewing on the SafetyDirect® by Bendix CVS web portal. Currently, the system does not integrate alerts from Bendix® BlindSpotter® or SmarTire® Tire Pressure Monitoring System (TPMS) by Bendix CVS.

Figure 2 – Major Bendix Wingman Fusion System Components

The major components that are used in the Fusion system are the Bendix® ESP® EC–80™ Controller; the Bendix® Wingman® FLR20™ Radar; the Bendix AutoVue FLC20 Camera (powered by the Mobileye® System-on-Chip EyeQ processor with state-of-the-art vision algorithms); the Bendix Driver Interface Unit (DIU™) or OEM dash display; the SafetyDirect Web Portal Processor; and the vehicle's telematics system. *See Figure 2.*

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, or a Bendix® AD-9si® 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 Bendix® Wingman® Fusion™ Driver Assistance System can result in a collision causing property damage, serious injuries, or death. Be sure to read, understand, and carefully follow the instructions in the Operator's Manual, BW2681.

⚠ 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. 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.

IMPORTANT: It is the responsibility of the driver to remain vigilant and change driving practices depending on traffic and road conditions.

SD Sheet Index

Appendices

Features of the Bendix® Wingman® Fusion™ Driver Assistance System (Fusion)

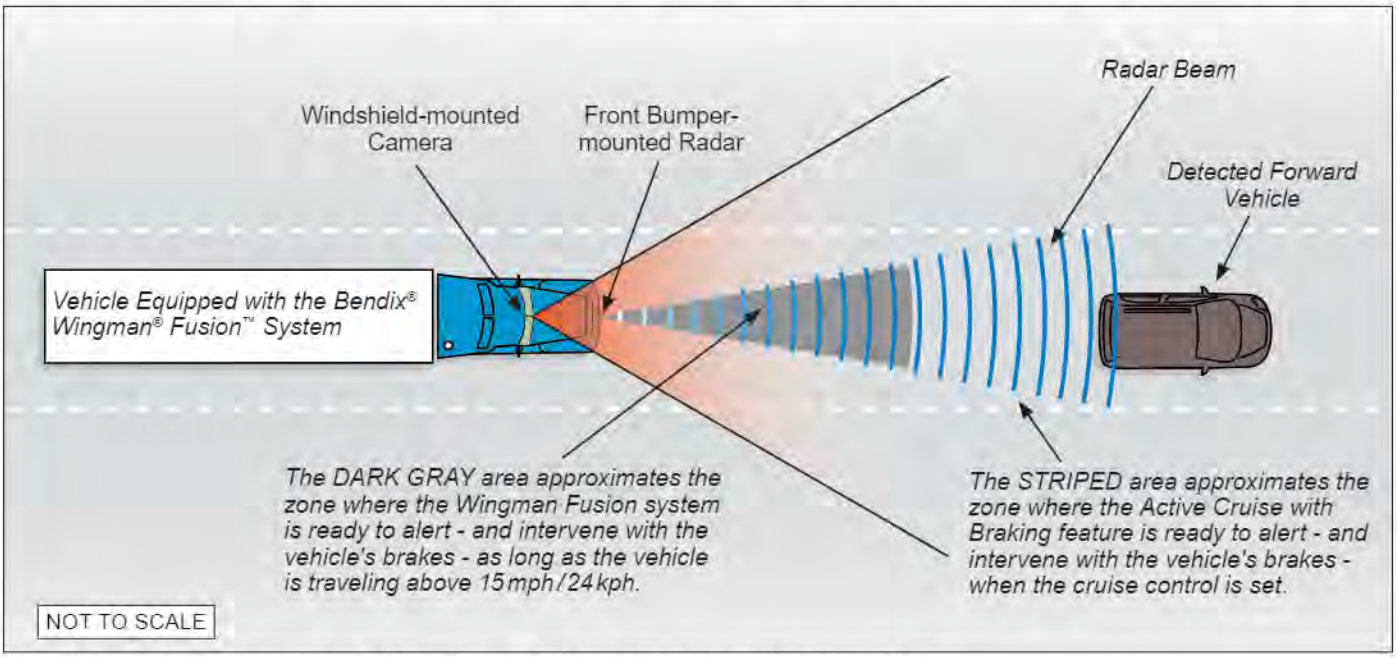


Figure 3 – Bendix® Wingman® Fusion™ Driver Assistance System Intervention Zone

PART ONE: ACTIVE CRUISE CONTROL WITH BRAKING

The active cruise control with braking feature is an additional upgrade of ordinary cruise control. When using cruise control, the Bendix® Wingman® Fusion™ Driver Assistance System (Fusion) will maintain the set speed, and also will intervene – as needed – to help maintain a set following distance behind a detected forward vehicle.

Using a radar sensor mounted to the front of the vehicle – with a range of approximately 500 feet (152 m) – Fusion reacts to detected forward vehicles in the same lane, traveling in the same direction. *See Figure 3.*

The active cruise control with braking feature is designed to help maintain a set following distance between the vehicle and a detected forward vehicle when cruise control is set. *See the striped "Radar Beam" area in Figure 3.*

Once cruise control is set and the system is maintaining a set following distance between you and the vehicle in front, if the vehicle in front of you slows down below the cruise control's set speed, Fusion will intervene and, as necessary, in this order:

(a) reduce the engine throttle; then

(b) apply the engine retarder; then

(c) apply the foundation brakes

in an attempt to maintain the set following distance behind the vehicle ahead. NOTE: If during the intervention, it is necessary to apply the foundation brakes, the vehicle will not automatically resume the cruise control set speed.

If the vehicle ahead slows below the cruise control's set speed, but then accelerates away – and the Bendix Wingman Fusion system did not need to use the foundation brakes – the system will automatically accelerate back to the original cruise control set speed and maintain a set following distance behind any detected forward vehicles.

Because Fusion operates along with normal cruise control, all the typical features built into cruise control work as usual. For example, limits imposed by factory-set road speed governors, etc. are fully supported by the Bendix Wingman Fusion system.

PART TWO: ALERTS

Fusion also assists by giving audible and visual alerts, whether or not cruise control is on. *See Figure 4 and also Appendix K for more information on the types of alerts the driver may hear and/or see displayed.*

PART THREE: COLLISION MITIGATION TECHNOLOGY

See the striped area in Figure 3. The Bendix® Wingman® Fusion™ Driver Assistance System's collision mitigation technology is designed to be ready to alert the driver to detectable objects in front of the vehicle (whether or not cruise control is set) and react to the presence of stationary/moving vehicles in the lane ahead. Collision mitigation interventions provide the driver with an alert before an intervention occurs. The driver must immediately act to potentially avoid, or lessen the severity of, a collision.

PART FOUR: OVERSPEED ALERT & ACTION (OAA)

The Fusion System has the ability to assist the driver by recognizing US and Canadian speed limit signs. This allows the system to display the current posted speed limit and alert the driver when overspeed thresholds are detected.

International travel: When changing between regions which post speeds in miles and those which post in kilometers, the speed limit sign recognition feature will not function until the correct U.S./metric selection has been made.

PART FIVE: LANE DEPARTURE WARNING

Bendix Wingman Fusion will monitor the visible lane markings on the road and when an unexpected lane change – a lane change without an activated turn signal – takes place, the system will alert the driver to make a correction. Tired, distracted, or inattentive drivers are alerted and can take remedial actions.

PART SIX: SAFETY DATA RECORDING AND TRANSMISSION

Many Fusion-equipped vehicles use the SafetyDirect® by Bendix CVS Web Portal Processor and the vehicle's telematics processor to record vehicle and driver safety data after safety system events. Data collected includes signals on the vehicle communication network, images and video from the Bendix® AutoVue® FLC20™ camera, and internally generated data. Telematics devices transmit this data and video to the SafetyDirect website.

1.0 INTRODUCTION TO TROUBLESHOOTING SECTION

This section introduces three initial steps to accurately troubleshoot the Bendix® Wingman® Fusion™ system.

We recommend reading this introductory section – as well as the *Troubleshooting/Diagnostics Section (2.0)* – before performing any troubleshooting.

When diagnosing the Bendix Wingman Fusion system, a current version of Bendix® ACom® Diagnostic Software (version 6.9 or higher) is required. This software is available as a free download from www.bendix.com.

1.1 TROUBLESHOOTING BASICS

Troubleshooting Basics (1.1)	
Questions	**Next Steps**
1. Have the driver run the Power-Up Self-Test.	**Power-Up Self-Test** This is a self-diagnostic check to determine if the system operation is normal. 1. Park the vehicle. Power off. 2. Put the key into the ignition and turn to the "ignition power" position. 3. Toggle the cruise control switch at least once, and leave it in the "on" position. 4. Start the vehicle, but do not drive away. 5. **Note that if the cruise control is in the "off" position, or if the vehicle is moving, this test will not run.** The self-test will start after 15 seconds, and takes approximately five (5) seconds to complete. (Note that other vehicle system self-tests, e.g. the ABS "chuff" test, may run during the initial 15 seconds after ignition "on.") As the Bendix Wingman Fusion system self-test runs, the driver should hear a short set of beeps. The test checks the engine, transmission, and brake systems to make sure they are communicating. In addition, depending on the vehicle, the test may briefly display a distance alert message and/or cause the Forward Vehicle Detected icon in the instrument cluster to illuminate; this is normal.
2. Does the driver hear a long warning beep?	If no problem is found and the test is passed, no additional beeps/lamps will be displayed nor will a trouble code be set. If the system has found an issue that will prevent it from functioning properly, **a long warning beep will sound** to alert the driver, and a Diagnostic Trouble Code (DTC) will be logged in the system (typically with a status indicator/dash icon illuminated). For descriptions of all DTCs, *see Section 2.5: Diagnostic Trouble Codes.*
3. Have the driver describe the system behavior that they believe shows it is not working properly.	When diagnosing the system, especially in cases where there are no DTCs logged, find out which part of the system behavior appears to be operating improperly.
4. Fill out the Troubleshooting Checklist *(pages 7–8)* and create a DTC report *(Appendix F)*	*The Checklist and DTC Report will clarify the problem and be necessary if a call to the Bendix Tech Team is needed.* *Also See Section 1.3: Narrowing Down the Problem.*
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 1 – Troubleshooting Basics

Troubleshooting Checklist *(Pages 7–8)*	
Detailed Scenarios and Tests	**Record Driver's Answers for Follow-up with Bendix**
Does the vehicle maintain its set speed when cruise control is switched on and set?	Yes ☐ No ☐ _____
Is the cruise control "set" icon displayed?	Yes ☐ No ☐ _____
While following a forward vehicle within radar range and the cruise control is switched on and set, record your response to the following:	
Is the "forward vehicle detected" icon displayed?	Yes ☐ No ☐ _____
What color is the icon?	Icon Color _____
When the forward vehicle slows down, does the truck also slow down to maintain the set distance?	Yes ☐ No ☐ _____
With engine cruise "off" and a forward vehicle present, does the audible alert become faster as the truck moves closer to the forward vehicle?	Yes ☐ No ☐ _____
With cruise control switched on and set, when the forward vehicle slows moderately or cuts in front of the truck and slows, did the driver observe any of the following conditions?	
Does the vehicle slow and the Bendix® Wingman® Fusion™ system maintain the following distance?	Yes ☐ No ☐ _____
Is the engine throttle reduced?	Yes ☐ No ☐ _____
Is the engine retarder applied?	Yes ☐ No ☐ _____
Are foundation brakes applied?	Yes ☐ No ☐ _____
Are there Diagnostic Trouble Codes (DTCs) logged?	Yes ☐ No ☐ _____
Does the truck proceed toward the forward vehicle without a following distance alert or braking intervention?	Yes ☐ No ☐ _____
With cruise control engaged, and while following a vehicle ahead in gentle curves (assuming a 3 to 3.5 second following distance):	
Does the Bendix Wingman Fusion System continue to follow the vehicle through the curves following at a constant distance?	Yes ☐ No ☐ _____
Does the truck proceed toward the forward vehicle without a following distance alert or braking intervention?	Yes ☐ No ☐ _____
With cruise engaged, when your vehicle passes a slower vehicle on the left or right on a straight or slightly curvy road:	
Does the Bendix Wingman Fusion system ignore the vehicle you are overtaking?	Yes ☐ No ☐ _____
Does it give a following distance alert?	Yes ☐ No ☐ _____

Troubleshooting Checklist *(Pages 7–8)*	
Detailed Scenarios and Tests	**Record Driver's Answers for Follow-up with Bendix**
With cruise engaged, if a faster vehicle passes your vehicle on the left or right on a straight or slightly curvy road:	
Does your vehicle throttle up and try to keep pace with the faster moving vehicle?	Yes ☐ No ☐ _____
Does it give a following distance alert?	Yes ☐ No ☐ _____
With cruise control engaged, if the vehicle ahead slows moderately or cuts in front of your truck and slows down:	
Does your vehicle slow and Bendix® Wingman® Fusion™ maintain the following distance?	Yes ☐ No ☐ _____
Is the engine throttle reduced?	Yes ☐ No ☐ _____
Is the engine retarder applied?	Yes ☐ No ☐ _____
Are the foundation brakes applied?	Yes ☐ No ☐ _____
Are there Diagnostic Trouble Codes (DTCs) logged?	Yes ☐ No ☐ _____
Does your truck proceed toward the forward vehicle without a following distance alert or braking intervention?	Yes ☐ No ☐ _____
What version of Bendix® ABS and Bendix Wingman Fusion system is installed on the vehicle? *See Section 2.3: Reading the Fusion Software Version.*	_____
What are the key system indicators? *See Section 3.1: Reading Bendix Wingman Fusion System Key Indicators.*	_____ _____ _____ _____ _____

1.3 NARROWING DOWN THE PROBLEM

Use the questions found in Table 2 below to help assess if the Bendix® Wingman® Fusion™ system is not performing correctly. Be sure to have a thorough understanding of the system's normal behavior; this will reduce the troubleshooting time. The table provides a guide to basic troubleshooting questions and possible corrective actions. Items *in Italics* cross-reference to the service procedures in this manual to repair the condition described.

If Bendix Tech Team assistance is needed, prior to calling 1-800-AIR-BRAKE (1-800-247-2725), option 2, complete the *Troubleshooting Checklist* (*See Appendix A*), to help reduce the time needed to troubleshoot the system.

Narrowing Down the Problem (1.3)	
Questions	**Next Steps**
Blocked Radar Sensor Issues	
Is mud, ice, or snow covering the radar sensor? Is anything blocking the view of the radar sensor?	Clean the radar sensor front surface immediately. Remove anything blocking the radar sensor then power cycle and read any remaining trouble codes. *Read Section 2.5: Diagnostic Trouble Codes.* *Read Appendix A3: Bendix® AutoVue® FLR20™ Radar Sensor Mounting Clearance.* If the vehicle's cruise control is set and the radar sensor is blocked by ice, snow, mud, tampering, etc. so that it cannot "see" a forward vehicle, Bendix Wingman Fusion system may log a Diagnostic Trouble Code (DTC). After the blockage is removed, the DTC will clear automatically when the vehicle's ignition is cycled. Add a visual check of the radar sensor for blockage to the driver's pre-trip inspection checklist.
Potential False Warnings	
Do false alerts seem to happen in construction zones or going under bridges?	Several road scenarios have a tendency to cause false warnings, including construction zones and bridges. Unless these false warnings are frequent, the system is likely reacting normally. The driver should not set the cruise control in construction zones. If driver complaints persist, continue asking questions to more narrowly define the driving condition presenting the problems. Review proper operating conditions in the operator's manual.
Mounting Problems	
Is the radar sensor mounting location (bumper or cross-member) damaged? Does the system seem to not "see" as far as it "used to", or warn on many more overhead bridges/signs than previously?	Re-align the radar sensor vertically and laterally. Use the following procedures: • Inspect the radar mounting. A solid mounting surface is necessary in order to hold the alignment. If the bumper or mounting cross-member is damaged, replace it first, then align the radar sensor. • Appendix B1 - Go to Appendix B1 and use the flowchart to find out the procedure(s) needed. Follow the actions directed in the procedure(s) and align the radar. • Appendix B4 - Check the vertical alignment and adjust if needed.
Does the mounting bracket look damaged or tampered with?	Other than expected surface scratches or some discoloration over time, there should be no visible damage to the radar sensor bracket assembly or the bumper. If no visible damage is found, realign the radar sensor vertically and laterally. • Check the Vertical Alignment (Appendix B4) and adjust if needed. • Check the Lateral Alignment (Appendix B2 & B3) and adjust if needed. The radar sensor needs a solid mounting surface in order to hold the alignment. If the radar sensor alignment can not be held in place, the bracket assembly must be replaced, and/or if the bumper or mounting cross-member is damaged, replace it as needed. Where replacing either or both of these, align the radar sensor using the procedure shown in Appendix C.
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 2 – Narrowing Down the Problem (Pages 9–10)

Narrowing Down the Problem (1.3)	
Questions	**Next Steps**
Other Questions	
Has the system worked without problems in the past but is not working as expected now?	This is a good indication that something has changed – such as misalignment of the radar sensor. Review the following questions with the driver to further diagnose the problem.
Has the radar sensor been changed recently?	If so, the new radar sensor may be incompatible with the vehicle. In addition, check any system Diagnostic Trouble Codes (DTCs) with Bendix® ACom® Diagnostic Software. Read Section 2.5: *Diagnostic Trouble Codes.*
Did the radar sensor currently on the vehicle come from another vehicle?	The radar sensor may be incompatible with the new vehicle. Follow Section K1.15: *Radar Sensor Interchangeability* procedure and check system DTCs with Bendix ACom Diagnostic Software. Read Section 2.5: *Diagnostic Trouble Codes.*
With cruise control set, does the system consistently apply the foundation brakes when a forward vehicle slows?	This is normal operation. Continue asking the driver questions to determine if the radar system interventions are not the expected Bendix® Wingman® Fusion™ system behavior. If the radar system interventions are not typical, the radar sensor may be misaligned. • Inspect the radar mounting. A solid mounting surface is necessary in order to hold the alignment. If the bumper or mounting cross-member is damaged, replace it first, then align the radar sensor. • Appendix B1 - Go to Appendix B1 and use the flowchart to find out the procedure needed. Follow the actions directed in the procedure and align the radar. • Appendix B4 - Check the vertical alignment and adjust if needed. The service technician will need to check trouble codes as well. Read Section 2.5: *Diagnostic Trouble Codes.*
Does a DTC seem to occur when driving through the desert or in barren areas (no road signs, trees or vehicles)?	In normal operation, the active cruise control with braking feature of the Bendix Wingman Fusion system may indicate a DTC if it hasn't detected a metallic object after a pre-determined period. This is rare, but most likely to occur when driving in deserts or barren areas. If the system does set a DTC, the Bendix Wingman Fusion system provides a visible warning to the driver. In addition, the vehicle also will drop out of cruise mode, providing an audible and/or visual warning to the driver as well. The driver must pull off the road and cycle the ignition before the vehicle's cruise control can be used.
Does the system seem to disengage after an automatic braking event?	This is normal operation. The driver must set or "resume" the cruise control once again to regain the following distance function.
Does cruise control disengage sometimes when the brakes come on and not at other times?	This is normal operation. When traveling with lightly loaded trailers, or "bobtail", the active cruise control with braking feature of Bendix Wingman Fusion system may continue to function even after an automatic brake application. No driver input is needed.
Does the connector or wiring appear damaged?	Wires can become corroded if the radar sensor is not plugged in properly. Clean the connectors on the wire harness, as well as the radar sensor, and reattach. If wires are chafed, replace the wire harness. Also, check for trouble codes. Read Section 2.5: *Diagnostic Trouble Codes*, and Section 2.11: *Troubleshooting Wiring Harnesses.*
Does the system generate a DTC going down a grade when using ACB (Active Cruise-control with Braking) to slow the vehicle, but the code goes away later?	This is normal operation. The active cruise control with braking feature of Bendix Wingman Fusion system is not intended to be used on grades. Verify there are no DTCs. Proper downgrade driving techniques should be used. Read Section 2.5: *Diagnostic Trouble Codes.*
Does the radar sensor have noticeable damage beyond normal discoloration or surface scratches?	The radar sensor and bracket are very durable. However, if the radar sensor housing or cover is cracked or broken, immediately look for trouble codes via Bendix ACom Diagnostic Software (version 6.9 or higher) and replace the damaged radar sensor. Read Section 2.5: *Diagnostic Trouble Codes*, and Appendix A3: *Radar Sensor Mounting Clearance.*
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 2 – Narrowing Down the Problem (Pages 9–10)

1.4 OVERVIEW OF POSSIBLE ISSUES

Some customer issues are actually misunderstandings of how the Bendix® Wingman® Fusion™ system performs normally. Use Table 3 below to learn the causes of potential issues if the Fusion system is not performing correctly. Some issues can be investigated by a visual inspection. Others may cause a Diagnostic Trouble Code (DTC) to be logged: *See Section 2.5: Diagnostic Trouble Codes*.

Overview of Possible Issues (1.4)	
Issue	**Description**
Vehicle Diagnostic Trouble Codes (DTCs)	The Bendix Wingman Fusion system will not operate and will set a DTC if any of the following vehicle systems also show a DTC: engine, engine cruise, instrument cluster, Bendix® ABS, Bendix® ATC, Bendix® ESP®, or transmission. These components must be repaired and cleared of DTCs before troubleshooting the Wingman Fusion system. (*NOTE: Clearing the vehicle DTCs may be the only step needed to reestablish full Fusion system functionality. See Section 2.6: Clearing Diagnostic Trouble Codes (DTCs)*
System familiarity	Verify the system functionality. Is it operating normally or not? Drivers who are unfamiliar with the system may report dissatisfaction over the way it beeps or how it activates the brakes. Use Section 1.0: *Introduction to Troubleshooting*, Section 2.5: *Diagnostic Trouble Codes*, and Section 1.1: *Troubleshooting Basics* to verify if the system is functioning normally; then continue.
DTCs caused by temporary operating conditions	Some DTCs indicate a temporary condition and will clear when that condition is no longer present. If these persist, further investigation is warranted. *See Section 1.1: Troubleshooting Basics.*
Radar sensor blocked	If the system doesn't seem to work at all, the radar sensor may possibly be blocked. A DTC will also be set. Visually inspect it, clear the blockage, turn the ignition on and run through a power cycle. *See Appendix A3 for more information about radar mounting and clearances.*
Damaged radar sensor or bracket	If the vehicle has been in an accident, it is likely the radar sensor will need to be re-aligned or replaced. Inspect the radar sensor and housing for damage. Radar sensor discoloration or small scratches may be acceptable. Significant damage (such as cracks or broken pieces) will require radar sensor replacement. Regardless of the exterior condition, check for DTCs outlined in the Section 2.5: *Diagnostic Trouble Codes (DTCs)* to determine if radar sensor replacement is necessary.
Damaged connector or wiring	Visually inspect the connector and wire harness for corrosion or chafing. Refer to Sections 2.7: *Troubleshooting Diagnostic Trouble Codes: Power Supply* and *2.8 Serial Data (J1939) Communications Link* of this document for additional troubleshooting.
Radar sensor misalignment	Inspect the front of the vehicle. If a) it has been damaged; or b) the vehicle does not track straight, either of these conditions must be repaired before troubleshooting the Bendix Wingman Fusion system. If there is a DTC set or if the system does not function, the radar sensor may be severely misaligned and the Wingman Fusion system will not operate until this is corrected. *See Appendix B - Radar Alignment.*
J1939 network problems	If the entire system is non-functional, it may be a J1939 network problem. Follow the instructions in Section 2.8: *Serial Data (J1939) Communications Link.*
Power to radar sensor problems	If the entire system is non-functional, another likely cause may be a lack of power to the radar sensor. Follow the instructions in Section 2.7: *Troubleshooting Diagnostic Trouble Codes: Power Supply.*
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table 3 – Review of Possible Issues

1.5 IMPORTANT NOTE ON TELEMATICS WIRING

Where a vehicle does not have an On Board Computer/ Telematics (OBC/T) system – in order to prevent interference to the SafetyDirect® By Bendix CVS Web Portal Processor – disconnect the OBC/T harness (any wiring harness provisionally installed in the vehicle for potential use for Telematics) from the main vehicle harness. Re-connect the harness only when an OBC/T system is installed. *(See Appendix K, Figure K6).*

2.0 TROUBLESHOOTING/ DIAGNOSTICS SECTION

IMPORTANT NOTE: All vehicle Diagnostic Trouble Codes (DTCs) related to the engine, transmission, instrument cluster, engine cruise control and Bendix® ABS, ATC or ESP® systems must first be resolved–with no trouble codes present during the vehicle operation while in cruise control–before attempting to diagnose Bendix® Wingman® Fusion™ system DTCs.

Important examples are VDC2 and EBC DTCs which are typically related to the brake controller. The hierarchy of Electronic Control Units (ECUs) determines that any DTCs on the brake controller must be resolved before attempting to troubleshoot the Wingman Fusion system.

2.1 BENDIX® ACOM® DIAGNOSTIC SOFTWARE

Bendix® ACom® Diagnostic Software is a PC-based software program available as a free download from the Bendix web site (www.bendix.com) or on a CD from the online Bendix Literature Center (order BW2329). This software provides the technician with access to all the available ECU diagnostic information and configuration capability. For Wingman Fusion system diagnostics, use ACom Diagnostic Software version 6.9 or higher.

Figure 4 – Bendix ACom Diagnostic Software

STARTING BENDIX ACOM DIAGNOSTIC SOFTWARE

The Bendix ACom Diagnostic Software can be started from the desktop shortcut, or from the main Windows® screen with "Start...Programs...Bendix...ACom Diagnostic Software." *See Figure 5 plus* ***Appendices F and G***. To begin, the technician selects "Wingman" from the Starter screen, then "Start with ECU" from the Diagnostic Control panel.

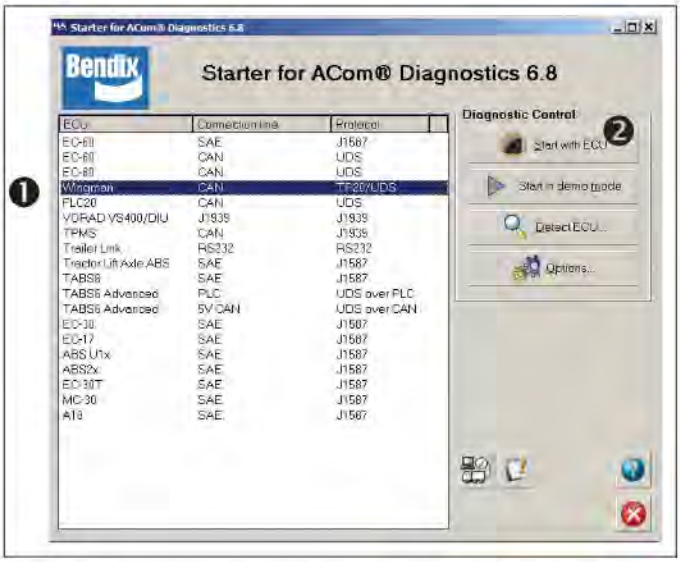


Figure 5 – Starting Bendix ACom Diagnostic Software

NOTE: When using ACom Diagnostic Software for the first time, the service technician will be asked to select the communication adapter for both the Bendix Wingman Fusion system and Bendix ABS and stability controllers. While both controllers will use the same physical adapter, the technician will need to indicate which communication protocol to use for each. Once a successful connection has been made, these steps will no longer be necessary.

The *Bendix ACom Diagnostic Software for ABS User Guide* is available for download at www.bendix.com and should be used as a reference to all functions of the ACom service tool.

2.2 READING DIAGNOSTIC TROUBLE CODES (DTCs)

If the system generates a Diagnostic Trouble Code (DTC), where a lamp or icon is illuminated on the instrument cluster, then a current version of Bendix® ACom® Diagnostic Software is required. Select "Wingman®" from the starter screen, then "Start with ECU". Click "DTC" to show the DTCs. ***See Appendix C for screen shots.*** *See Section 2.5 for a complete table showing DTCs and troubleshooting information.*

2.3 READING THE SYSTEM SOFTWARE VERSION

If during troubleshooting, you are asked for the Bendix® Wingman® Fusion™ system software version, the number is found on the "Wingman Fusion System Status" tab. *See Figure 6. Also, see Section 3.1 for other system indicators.*

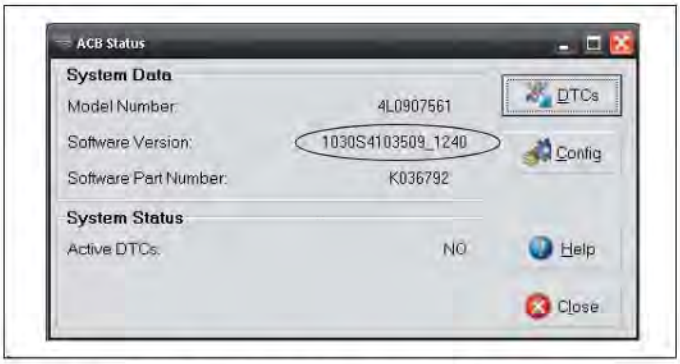
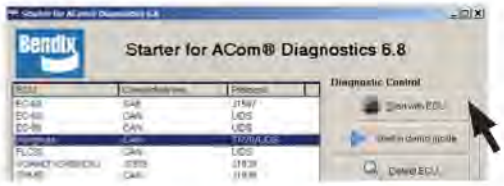


Figure 6 – Bendix® ACom® Diagnostic Software Starter Screen Showing Software Version

2.4 HOW TO GENERATE A BENDIX WINGMAN FUSION SYSTEM DIAGNOSTIC TROUBLE CODE (DTC) REPORT

1. Click the Bendix ACom Diagnostic Software desktop icon.

2. Select "Wingman" from the starter screen.
   Click "start with ECU".



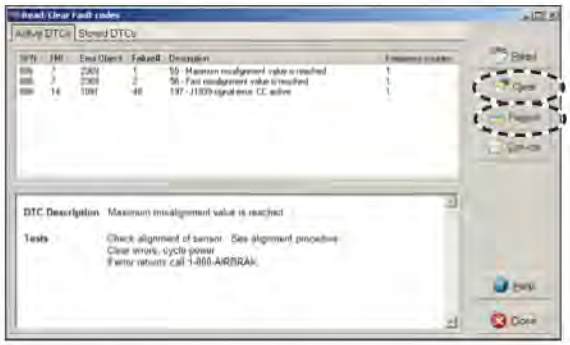
3. Read the Bendix Wingman Fusion system status screen.

A. Take Note of: Model #, Software Version, Software P/N, Active DTCs

B. Click DTCs

4. Click "Read". Active DTCs are shown along with descriptions of the codes and tests that can be run to troubleshoot the code. You can also select "stored DTCs" to show inactive DTCs.

5. Click "Clear" to clear all active DTCs. Click "Report" to get the Bendix® ACom® Diagnostic Software report.



6. Fill in the requested information: Company, location, technician, date/time, VIN, and click "OK".

7. Select how you want the report displayed or printed. Then click "OK".

8. Finally, the event report is generated. This can be saved if desired.

9. You can also use the shortcut menu at the top of the screen and select: Wingman Status; DTCs; and Controller Configuration.

ADDITIONAL SUPPORT AT WWW.BENDIX.COM / 1-800 AIR BRAKE (1-800-247-2725), OPTION 2

For the latest information, and for free downloads of the Bendix ACom Diagnostic Software, and its User Guide, visit the Bendix website at: www.bendix.com.

You will also find a current list of compatible RP1210 data link adapters for ABS and the Bendix® Wingman® ACB system.

For direct telephone technical support, contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2. For assistance, follow the instructions in the recorded message. Be sure to have a filled-out Troubleshooting Checklist *(pages 7–8)* and a Bendix ACom Diagnostic Software DTC report *(Section 2.4)* ready before calling.

You can also reach the Bendix Tech Team by e-mail at: techteam@bendix.com.

2.5 TABLE OF BENDIX® WINGMAN® FUSION™ DIAGNOSTIC TROUBLE CODES (DTCs)

NOTE: Bendix® FLR10™ radar sensors use a different set of DTCs – see SD-61-4962.

For DTC(s), refer to Table 4A. [Alternately, see a table sorted by SPN (Suspect Parameter Number) and FMI (Failure Mode Identifier) code combinations in Appendix M.]

In Table 4A, find the DTC(s) found in column one and determine the Service Action Code(s) to look up in Table 4B.

Table 4A: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes				Go to the Service Action Code List in Table 4B *(Pages 21–26)*
DTC	**Description**	**SPN**	**FMI**	
1–2	Internal radar sensor error	886	12	A
3	Antenna is dirty or partially blocked	886	17	B
4	Battery voltage too low	886	4	C
5	Battery voltage too high	886	3	
6–10	Internal radar sensor error	630	12	A
11	J1939 Error Frame limit reached: J1939 wiring error.	639	19	Y
12	Radar detects intermittent loss of J1939 messages from vehicle components	639	9	
13–14	Not used	#N/A	#N/A	Not Used
15	Internal radar sensor error	886	12	A
16	Antenna is dirty or partially blocked	886	1	D
17–18	Internal radar sensor error	630	12	A
19	Not used	#N/A	#N/A	Not Used
20	Internal radar sensor error	630	12	A
21	Not used	#N/A	#N/A	Not Used
22	Internal radar sensor error	886	14	A
23–27	Internal radar sensor error	886	12	
28	Internal radar sensor error	1799	14	D
29	J1939 signal: Missing AEBS2 message	5681	14	
30	J1939 signal: Missing CCVS1 message	527	14	E
31	J1939 signal: Missing CVW message	1760	14	F
32	J1939 signal: Missing EBC1 message	1243	14	
33	J1939 signal: Missing EBC2 message	904	14	
34	J1939 signal: Missing EBC5 message	2919	14	
35	J1939 signal: Missing EEC1 message	190	14	
36	J1939 signal: Missing EEC2 message	91	14	
37	J1939 signal: Missing ERC1_DR message	520	9	
38	J1939 signal: Missing ERC1_XR message	520	14	
39	Not used	#N/A	#N/A	Not Used
40	J1939 signal: Missing OEL message	2876	14	F
41	Not used	#N/A	#N/A	Not Used
42	J1939 signal: Missing VDC2 message	1807	14	F
43	Not used	#N/A	#N/A	Not Used
44	J1939 signal: Missing EBC3 message	1091	14	F
45	Not used	#N/A	#N/A	Not Used
46	Radar sensor is misaligned	886	7	G

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table 4A – DTC Code to Service Action Code. (Pages 15 – 20)

Table 4A: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes				Go to the Service Action Code List in Table 4B *(Pages 21–26)*
DTC	**Description**	**SPN**	**FMI**	
47	Internal radar sensor error	886	12	A
48	Internal radar sensor error	630	14	A
49–53	Not used	#N/A	#N/A	Not Used
54	Internal radar sensor error	630	12	A
55–58	Not used	#N/A	#N/A	Not Used
59	Internal radar sensor error	886	31	A
60	Internal radar sensor error	886	12	
61	Internal radar sensor error	886	14	
62	Not used	#N/A	#N/A	Not Used
63	Internal radar sensor error	886	12	A
64–65	Not used	#N/A	#N/A	Not Used
66	Internal radar sensor error	886	12	A
67	Internal radar sensor error	886	8	
68–77	Internal radar sensor error	886	12	
78	Bendix® ABS J1939 proprietary message signal missing or error state	2551	14	H
79–81	Internal radar sensor error	886	12	A
82	Active Cruise Control braking overuse	3839	0	J
83	J1939 signal: ACC1 Engine not properly configured for Bendix® Wingman®	5606	13	K
84–85	Internal radar sensor error	630	12	A
86	CMT Configuration mismatch between brake controller and radar sensor	886	13	L
87	J1939 signal: Missing VDC1 message	1814	14	E
88	CMT braking overuse	2920	0	M
89–91	Not used	#N/A	#N/A	Not Used
92	J1939 signal: Invalid CCVS2 wheel speed	84	2	N
93	J1939 signal: Error in CCVS1 wheel speed	84	19	P
94	J1939 signal: Not available CCVS1 wheel speed	84	9	R
95	J1939 signal: Invalid CCVS1 CC speed	86	2	N
96	J1939 signal: Error in CCVS1 CC speed	86	19	P
97	J1939 signal: Not available CCVS1 CC speed	86	9	R
98	J1939 signal: Error CCVS1 CC active	595	19	P
99	J1939 signal: Not available CCVS1 CC active	595	9	R
100	J1939 signal: Error in CCVS1 CC enable	596	19	P
101	J1939 signal: Not available CCVS1 CC enable	596	9	R
102–103	Not used	#N/A	#N/A	Not Used
104	J1939 signal: Invalid CVW GCVW	1760	2	N
105	J1939 signal: Error in CVW gross combination vehicle weight (GCVW)	1760	19	P
106	J1939 signal: Not available CVW GCVW	1760	9	R
107	J1939 signal: Error in EBC1 brake switch	1121	19	P
108	J1939 signal: Not available EBC1 brake switch	1121	9	R
109	J1939 signal: Error in EBC1 ABS fully operational	1243	19	P
110	J1939 Signal: Not available EBC1 ABS Operate	1243	9	R

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table 4A – DTC Code to Service Action Code. (Pages 15 – 20)

Table 4A: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes				Go to the Service Action Code List in Table 4B *(Pages 21–26)*
DTC	**Description**	**SPN**	**FMI**	
111	J1939 signal: Invalid EBC2 front axle	904	2	N
112	J1939 signal: Error in EBC2 front axle	904	19	P
113	J1939 signal: Not available EBC2 front axle	904	9	R
114	J1939 signal: Invalid EBC2 LF wheel	905	2	N
115	J1939 signal: Error in EBC2 LF wheel	905	19	P
116	J1939 signal: Not available EBC2 LF wheel	905	9	R
117	J1939 signal: Invalid EBC2 RF wheel	906	2	N
118	J1939 signal: Error in EBC2 RF wheel	906	19	P
119	J1939 signal: Not available EBC2 RF wheel	906	9	R
120	J1939 signal: Invalid EBC2 LR1 wheel	907	2	N
121	J1939 signal: Error in EBC2 LR1 wheel	907	19	P
122	J1939 signal: Not available EBC2 LR1 wheel	907	9	R
123	J1939 signal: Invalid EBC2 RR1 wheel	908	2	N
124	J1939 signal: Error in EBC2 RR1 wheel	908	19	P
125	J1939 signal: Not available EBC2 RR1 wheel	908	9	R
126	J1939 signal: Invalid EBC5 XBR state	2917	2	N
127	J1939 signal: Error in EBC5 XBR state	2917	19	P
128	J1939 signal: Not available EBC5 XBR state	2917	9	R
129	J1939 signal: Error in EBC5 brake use	2919	19	P
130	J1939 signal: Not available EBC5 brake use	2919	9	R
131	J1939 signal: Invalid EBC5 XBR limit	2921	2	N
132	J1939 signal: Error in EBC5 XBR limit	2921	19	P
133	J1939 signal: Not available EBC5 XBR limit	2921	9	R
134	J1939 signal: Error in EBC5 brake temp	3839	19	P
135	J1939 signal: Not available EBC5 brake temp	3839	9	R
136	J1939 signal: Invalid EC1 engine reference torque	544	2	N
137	J1939 signal: Error in EC1 engine reference torque	544	19	P
138	J1939 signal: Not available EC1 engine reference torque	544	9	R
139	J1939 signal: Invalid EEC1 engine speed	190	2	N
140	J1939 signal: Error in EEC1 engine speed	190	19	P
141	J1939 signal: Not available EEC1 engine speed	190	9	R
142	J1939 signal: Invalid EEC1 driver torque	512	2	N
143	J1939 signal: Error in EEC1 driver torque	512	19	P
144	J1939 signal: Not available EEC1 driver torque	512	9	R
145	J1939 signal: Invalid EEC1 actual torque	513	2	N
146	J1939 signal: Error in EEC1 actual torque	513	19	P
147	J1939 signal: Not available EEC1 actual torque	513	9	R
148	J1939 signal: Invalid EEC2 accelerator pedal position	91	2	N
149	J1939 signal: Error in EEC2 accelerator pedal position	91	19	P
150	J1939 signal: Not available EEC2 accelerator pedal position	91	9	R
151–154	Not used	#N/A	#N/A	Not Used
155	J1939 signal: Invalid OEL turn signal	2876	2	N
156	J1939 signal: Error in OEL turn signal	2876	19	P

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table 4A – DTC Code to Service Action Code. (Pages 15 – 20)

Table 4A: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes				Go to the Service Action Code List in Table 4B *(Pages 21–26)*
DTC	**Description**	**SPN**	**FMI**	
157	J1939 signal: Not available OEL turn signal	2876	9	R
158	J1939 signal: Error in VDC1 ROP brake control	1818	19	P
159	J1939 signal: Not available VDC1 ROP brake control	1818	9	R
160	J1939 signal: Error in VDC1 ROP engine control	1816	19	P
161	J1939 signal: Not available VDC1 ROP engine control	1816	9	R
162	J1939 signal: Error in VDC1 YC brake control	1819	19	P
163	J1939 signal: Not available VDC1 YC brake control	1819	9	R
164	J1939 signal: Error in VDC1 YC engine control	1817	19	P
165	J1939 signal: Not available VDC1 YC engine control	1817	9	R
166	J1939 signal: Invalid VDC2 steer angle	1807	2	N
167	J1939 signal: Error in VDC2 steer angle sensor	1807	19	P
168	J1939 signal: Not available VDC2 steer angle	1807	9	R
169	J1939 signal: Invalid VDC2 yaw rate	1808	2	N
170	J1939 signal: Error in VDC2 yaw rate	1808	19	P
171	J1939 signal: Not available VDC2 yaw rate	1808	9	R
172–174	Not used	#N/A	#N/A	Not Used
175	J1939 signal: Invalid TSC1 requested torque limit	518	2	N
176	J1939 signal: Error in TSC1 requested torque limit	518	19	P
177	J1939 signal: Not available TSC1 requested torque limit	518	9	R
178	Antenna is dirty or partially blocked	886	17	D
179	Vehicle Cruise Control and ACC out of sync	886	14	S
180	Radar mounting offset is out of range	886	2	T
181	J1939 signal: EBC1 ABS not fully operational	1243	2	U
182	J1939 signal: VDC1 VDC not fully operational	1814	2	V
183	J1939 signal: Error in VDC1 VDC fully operational	1814	19	P
184	J1939 signal: Not available VDC1 VDC fully operational	1814	9	R
185	ABS tire size needs recalibration	1069	13	W
186	Internal radar sensor error	630	12	A
187	J1939 signal: Error in ACC1 ACC mode	5606	2	P
188	J1939 signal: Not available ACC1 ACC mode	5606	19	R
189	J1939 signal CCVS3: Engine not properly configured for Bendix Wingman	5606	13	K
190	Internal radar sensor error	5676	14	A
191	Internal radar sensor error	2921	12	A
192–193	Internal radar sensor error	630	12	A
194	Proprietary CAN: Message counter error	625	19	X
195	Proprietary CAN: Message timeout	625	9	X
196	Proprietary CAN: Message inconsistent	625	2	X
197	Not used	#N/A	#N/A	Not Used
198	J1939 signal: Missing EC1 message	188	14	F
199	J1939 signal: Error in AEBS2 driver activation demand	5681	19	P
200	J1939 signal: Not available AEBS2 driver activation	5681	9	R
201	J1939 signal: Error in AEBS2 message checksum	5683	19	P

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table 4A – DTC Code to Service Action Code. (Pages 15 – 20)

Table 4A: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes				Go to the Service Action Code List in Table 4B *(Pages 21–26)*
DTC	**Description**	**SPN**	**FMI**	
202–204	Not used	#N/A	#N/A	Not Used
205	J1939 signal: Invalid ACC2 requested ACC distance mode	1799	2	N
206	J1939 signal: Error in ACC2 requested ACC distance mode	1799	19	P
207	J1939 signal: Not available ACC2 distance mode	1799	9	R
208	J1939 signal: Error in ACC2 ACC usage demand	5023	19	P
209	J1939 signal: Not available ACC2 ACC usage	5023	9	R
210	J1939 signal: Error in AUXIO1 trailer ABS operational	707	19	P
211	J1939 signal: Not available AUXIO trailer ABS operational	707	9	R
212	J1939 signal: Error in AUXIO1 trailer ABS detected	706	19	P
213	J1939 signal: Not available AUXIO trailer ABS detect	706	9	R
214	J1939 signal: Error in AUXIO1 trailer connected	705	19	P
215	J1939 signal: Not available AUXIO trailer connected	705	9	R
216	J1939 signal: Error in CCVS1 parking brake switch	70	19	P
217	J1939 signal: Not available CCVS1 parking brake switch	70	9	R
218	J1939 signal: Error in CCVS1 Cruise Control set switch	599	19	P
219	J1939 signal: Not available CCVS1 set switch	599	9	R
220	J1939 signal: Error in CCVS1 Cruise Control coast switch	600	19	P
221	J1939 signal: Not available CCVS1 coast switch	600	9	R
222	J1939 signal: Error in CCVS1 Cruise Control resume switch	601	19	P
223	J1939 signal: Not available CCVS1 resume switch	601	9	R
224	J1939 signal: Error in CCVS1 Cruise Control accelerate switch	602	19	P
225	J1939 signal: Not available CCVS1 ACCL switch	602	9	R
226	J1939 signal: Error in CCVS1 Cruise Control pause switch	1633	19	P
227	J1939 signal: Not available CCVS1 pause switch	1633	9	R
228	J1939 signal: Invalid EBC1 brake pedal position	521	2	N
229	J1939 signal: Error in EBC1 brake pedal position	521	19	P
230	J1939 signal: Not available EBC1 brake pedal position	521	9	R
231	J1939 signal: Error in EBC1 anti-lock braking active	563	19	P
232	J1939 signal: Not available EBC1 ABS active	563	9	R
233	J1939 signal: Error in EBC1 ASR engine control active	561	19	P
234	J1939 signal: Not available EBC1 ASR engine control active	561	9	R
235	J1939 signal: Error in EBC1 ASR brake control active	562	2	P
236	J1939 signal: Not available EBC1 ASR brake control active	562	19	R
237	J1939 signal: Error in EBC1 source address of controlling device	1481	2	P
238	J1939 signal: Not available EBC1 source address of controlling device	1481	19	R
239	J1939 signal: Invalid EBC5 XBR active control mode	2918	2	N
240	J1939 signal: Error in EBC5 XBR active control mode	2918	19	P
241	J1939 signal: Not available EBC5 XBR active control mode	2918	9	R
242–245	Not used	#N/A	#N/A	Not Used
246	J1939 signal: Invalid EC1 engine speed at idle point 1	188	2	N
247	J1939 signal: Error in EC1 engine speed at idle point 1	188	19	P
248	J1939 signal: Not available EC1 engine speed at idle point 1	188	9	R
249	J1939 signal: Invalid EEC3 nominal friction percent torque	514	2	N

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table 4A – DTC Code to Service Action Code. (Pages 15 – 20)

Table 4A: Diagnostic Trouble Codes (DTCs), Descriptions and Service Action Codes				Go to the Service Action Code List in Table 4B *(Pages 21–26)*
DTC	**Description**	**SPN**	**FMI**	
250	J1939 signal: Error in EEC3 nominal friction percent torque	514	19	P
251	J1939 signal: Not available EEC3 nominal friction percent torque	514	9	R
252	J1939 signal: Error in ETC1 transmission driveline engaged	560	19	P
253	J1939 signal: Not available ETC1 transmission driveline engaged	560	9	R
254	J1939 signal: Invalid ETC2 transmission selected gear	524	2	N
255	J1939 signal: Error in ETC2 transmission selected gear	524	19	P
256	J1939 signal: Not available ETC2 transmission selected gear	524	9	R
257	J1939 signal: Invalid ETC2 transmission actual gear ratio	526	2	N
258	J1939 signal: Error in ETC2 transmission actual gear ratio	526	19	P
259	J1939 signal: Not available ETC2 transmission actual gear ratio	526	9	R
260	J1939 signal: Invalid ETC2 transmission current gear	523	2	N
261	J1939 signal: Error in ETC2 transmission current gear	523	19	P
262	J1939 signal: Not available ETC2 transmission current gear	523	9	R
263	J1939 signal: Error in TC1 transmission requested gear	525	19	P
264	J1939 signal: Not available TC1 transmission requested gear	525	9	R
265	J1939 signal: Missing AUXIO message	701	14	F
266	J1939 signal: Missing DM1 message	1214	14	F
267	J1939 signal: Missing EEC3 message	514	14	F
268	J1939 signal: Missing ETC1 message	560	14	F
269	J1939 signal: Missing ETC2 message	524	14	F
270	J1939 signal: Missing TC1 message	525	14	F
271	J1939 signal: Missing FLC message	1705	14	F
272	J1939 signal: AUXIO trailer ABS not fully operational	707	2	V
273	Proprietary CAN: Message counter increment error	625	10	X
274	Fusion configuration mismatch between brake controller and radar sensor.	630	19	L
275	J1939 signal: Missing ETC5 message	767	14	F
276	J1939 signal: Error in ETC5 reverse switch	767	19	P
277	J1939 signal: Not available ETC5 reverse switch	767	9	R
278	J1939 signal: Error in CCVS1 brake switch	597	19	P
279	J1939 signal: Not available CCVS1 brake switch	597	9	R
280	XBR is locked-out	1196	19	S
281	Internal radar sensor error	630	12	
282	Automatic braking system was activated too many times.	2920	0	M
283	Internal radar sensor error	886	12	S
284	Fusion configuration mismatch between brake controller and radar sensor	625	13	K
285	AEBS deactivated because of factory mode	5681	13	S
286	System detected an error requiring a radar shutdown	886	18	

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table 4A – DTC Code to Service Action Code. (Pages 15 – 20)

Service Action Codes and the Recommended Service to Perform

Service Action Code *(From Table A or Appx. M)*	Table 4B: Service Action Codes and the Recommended Service to Perform **Recommended Service** *(FLR20 Radar Sensors Only)*
A	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • Some error conditions may occur at extreme high or low temperatures. These trouble codes must be diagnosed with the ambient temperature above 32°F (0°C) and below 100°F (38°C). **Perform the following:** • Clear the Bendix® Wingman® Fusion™ system trouble codes using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
B	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • These trouble codes may arise from infrequent conditions that could occur normally. **Perform the following:** • Check for sensor obstruction. Clean dirt – or packed snow or ice – from the sensor if present. • Clear the Wingman Fusion system trouble codes using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
C	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • These trouble codes result from incorrect ignition, battery supply voltage, or wiring harness issues as measured at the radar sensor. **Review the following sections:** • 2.7: *Ignition Voltage Too Low* • 2.7: *Ignition Voltage Too High* • 2.7: *Power Supply Tests* • 2.11: *Troubleshooting Wiring Harnesses* **Perform the following:** • Verify ignition supply voltage to the radar sensor is between 9 to 16 VDC. • Visually check for damaged or corroded connectors. • Visually check for damaged wiring. • Clear the Wingman Fusion system trouble codes using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	
Table 4B – Service Action Codes (Pages 21–26)	

Service Action Code *(From Table A or Appx. M)*	Table 4B: Service Action Codes and the Recommended Service to Perform **Recommended Service** *(FLR20 Radar Sensors Only)*
D	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Bendix® Wingman® Fusion™ system is indicating a required signal within a J1939 PGN message is not being sent from one or more sources. This could be accompanied by other active DTCs from the same source. **Review the following sections:** • K1.15: *Radar Sensor Interchangeability* • 2.9: *J1939 Engine Communications Test Procedure* **Perform the following:** • Check the source of the signal to identify why the signal has invalid data in the J1939 message. • Check the engine, engine retarder, and ABS for trouble codes using the manufacturer's diagnostic procedures. Either the engine, engine retarder, or the ABS are the source of the signal. The controller that broadcasts the signal must be investigated first, but the origin of the signal could be another component. Some examples are gross vehicle weight and various engine torque signals. • Clear the Bendix Wingman Fusion system DTCs using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs).* • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
E	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Wingman Fusion System is indicating a required signal within a J1939 PGN message is not being sent from one or more sources. This could be accompanied by other active DTCs from the same source. **Review the following sections:** • K1.15: *Radar Sensor Interchangeability* • 2.9: *J1939 Engine Communications Test Procedure* **Perform the following:** • Check the source of the signal to identify why the signal has invalid data in the J1939 message. • Check the engine, engine retarder, and ABS for trouble codes using the manufacturer's diagnostic procedures. Either the engine, engine retarder, or the ABS are the source of the signal. The controller that broadcasts the signal must be investigated first, but the origin of the signal could be another component. Some examples are gross vehicle weight and various engine torque signals. • Clear the Wingman Fusion system DTCs using the procedure in Section 4.4: *Clearing Diagnostic Trouble Codes (DTCs).* • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	
Table 4B – Service Action Codes (Pages 21–26)	

Service Action Code *(From Table A or Appx. M)*	Table 4B: Service Action Codes and the Recommended Service to Perform **Recommended Service** *(FLR20 Radar Sensors Only)*
F	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Bendix® Wingman® Fusion™ system is indicating a required signal within a J1939 PGN message is not being sent from one or more sources. This could be accompanied by other active DTCs from the same source. **Review the following sections:** • 1.10: *Radar Sensor Interchangeability* • 2.7: *J1939 Engine Communications Test Procedure* **Perform the following:** • Check the source of the signal to identify why the signal has invalid data in the J1939 message. • Check the engine, engine retarder, and ABS for trouble codes using the manufacturer's diagnostic procedures. Either the engine, engine retarder, or the ABS are the source of the signal. The controller that broadcasts the signal must be investigated first, but the origin of the signal could be another component. Some examples are gross vehicle weight and various engine torque signals. • Clear the Fusion system DTCs using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs).* • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
G	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • Radar sensor OUT OF ALIGNMENT **Perform the following:** • Go to *Appendix B1* and use the flowchart to find out the procedure needed. Follow the actions directed in the procedure and align the radar. • Clear the Bendix Wingman Fusion system trouble codes using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs).* • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
H	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Wingman Fusion system is indicating a required signal from the ABS controller is missing or the ABS is sending a message indicating an error. This DTC could be accompanied by other active DTCs. **Review the following sections:** • 1.10: *Radar Sensor Interchangeability* **Perform the following:** • Check the ABS for trouble codes using the Bendix's diagnostic procedures. Some examples are incorrect ABS ECU software version, incorrect parameter settings, or failure of a component in the ABS or ESP systems. • Clear the Fusion system trouble codes using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs).* • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
J	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The system was used improperly, such as use of the system on downhill grades. **Perform the following:** • Check any engine, or engine retarder trouble codes. • Clear the Fusion system trouble codes using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs).* • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	
Table 4B – Service Action Codes (Pages 21–26)	

Service Action Code *(From Table A or Appx. M)*	Table 4B: Service Action Codes and the Recommended Service to Perform **Recommended Service** *(FLR20 Radar Sensors Only)*
K	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** • The engine has a calibration setting enabling it to perform the torque and retarder control for the Bendix® Wingman® Active Cruise Control (ACC). **Possible causes:** • The "ACC-enable" setting in the engine software calibration is not set. • The engine is not equipped with an engine retarder, or does not support the engine CC option. **Perform the following:** • Check the vehicle and engine manufacturers engine configuration for an engine CC feature. • Check the engine for an engine retarder feature. • Check engine configuration for enabling the ACC function. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
L	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The controller is recognizing that there are components installed that have part numbers incompatible with the current system configuration. [For example, when a technician attempts to install a more recent radar sensor onto a vehicle with an earlier Bendix® Wingman® Fusion™ system or ACB (Active Cruise-control with Braking) system.] Contact the dealer or call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for the correct part number to use, or the re-programming steps to take for the newer part number to be accepted: **After addressing the possible causes, perform the following:** • Clear the Fusion system DTCs using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
M	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Collision Mitigation System (CMS) applied the brakes more than three times in a power cycle and system was used improperly: **After addressing the possible causes, perform the following:** • Clear the Fusion system DTCs using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • Review the operation of Bendix Wingman Fusion system with the driver. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
N	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • J1939 source of the signal is indicating a signal is producing a value that is out-of-range. **Review the following sections:** • 1.10: *Radar Sensor Interchangeability* • 2.7: *J1939 Engine Communications Test Procedure* **Perform the following:** • Check the source of the signal to identify why the signal has invalid data in the J1939 message. • Check the engine, engine retarder, and ABS for DTCs using the manufacturer's diagnostic procedures. Either the engine, engine retarder, or the ABS are the source of the signal. The controller that broadcasts the signal must be investigated first, but the origin of the signal could be another component. Some examples are gross vehicle weight and various engine torque signals. • Clear the Fusion system DTCs using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	
Table 4B – Service Action Codes (Pages 21–26)	

Service Action Code *(From Table A or Appx. M)*	Table 4B: Service Action Codes and the Recommended Service to Perform **Recommended Service** *(FLR20 Radar Sensors Only)*
P	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • J1939 source of the signal is indicating an error in the signal. **Review the following sections:** • 1.10: *Radar Sensor Interchangeability* • 2.7: *J1939 Engine Communications Test Procedure* **Perform the following:** • Check the source of the signal to identify why the signal has an error. • Check the engine, engine retarder, and ABS for trouble codes using the manufacturer's diagnostic procedures. Either the engine, engine retarder, or the ABS are the source of the signal. The controller that broadcasts the signal must be investigated first, but the origin of the signal could be another component. Some examples are gross vehicle weight and various engine torque signals. • Clear the Bendix® Wingman® Fusion™ system DTCs using the procedure in Section 2.6: Clearing Diagnostic Trouble Codes (DTCs). • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
R	**This Diagnostic Trouble Code (DTC) is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Bendix Wingman Fusion system is indicating the required data within a J1939 signal is not supported from one or more sources. **Review the following sections:** • 1.10: *Radar Sensor Interchangeability* • 2.7: *J1939 Engine Communications Test Procedure* **Perform the following:** • Check the source of the signal to identify why the signal has invalid data in the J1939 message. • Check the engine, engine retarder, and ABS for trouble codes using the manufacturer's diagnostic procedures. Either the engine, engine retarder, or the ABS are the source of the signal. The controller that broadcasts the signal must be investigated first, but the origin of the signal could be another component. Some examples are gross vehicle weight and various engine torque signals. • Clear the Fusion system DTCs using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
S	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** • Some system, signal or component caused the Fusion system to be disabled. Engine cruise control is unavailable and should not operate when the Fusion system is disabled. **Possible causes:** • Check engine, and engine retarder trouble codes. Inspect and troubleshoot the cruise control system wiring, switches, etc. for proper operation. **After addressing the possible causes, perform the following:** • Clear the Bendix Wingman Fusion system DTCs by cycling the power. Start the engine. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	
Table 4B – Service Action Codes (Pages 21–26)	

Service Action Code *(From Table A or Appx. M)*	Table 4B: Service Action Codes and the Recommended Service to Perform **Recommended Service** *(FLR20 Radar Sensors Only)*
T	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • Mounting offset incorrect. **Perform the following:** • Check the mounting offset of the radar sensor in Bendix® ACom® Diagnostic Software Configuration screen. The offset value should not exceed 500 mm. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
U	**There is not a failure of the radar sensor. Do not replace radar sensor.** **Possible causes:** • The Bendix® Wingman® Fusion™ system is indicating a required signal that indicates whether the ABS is fully operational or whether its functionality is reduced by a permanent or temporary (e.g. low voltage) defect, or not configured or not yet fully initialized, or loss of input sensors. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
V	**There is not a failure of the radar sensor. Do not replace radar sensor.** **Possible causes:** • The Fusion system is indicating that the ABS tire sizes are out of calibration. **Perform the following:** • Using ACom Diagnostic Software, connect to the ABS. Select the Controller Configuration menu and select Modify. Enter the correct tire sizes in the Tire Size [rpm] table for each axle of the vehicle. • Clear the Bendix Wingman Fusion system Diagnostic Trouble Codes (DTCs) using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
W	**There is not a failure of the radar sensor. Do not replace radar sensor.** **Possible causes:** • The Bendix Wingman Fusion system is indicating that the ABS tire sizes are out of calibration. **Perform the following:** • Using ACom Diagnostic Software, connect to the ABS. Select the Controller Configuration menu and select Modify. Enter the correct tire sizes in the Tire Size [rpm] table for each axle of the vehicle. • Clear the Bendix Wingman Fusion system Diagnostic Trouble Codes (DTCs) using the procedure in Section 2.6: *Clearing Diagnostic Trouble Codes (DTCs)*. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
X	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Bendix Wingman system is indicating an error in the messages on the Proprietary CAN bus. • Check the Proprietary CAN connections at the Camera and Radar. • Check that the resistance between Proprietary CAN+ and CAN- is between 50 and 70 ohms with the power off. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Y	**This DTC is not an indicator of a malfunctioning sensor. Do not replace the sensor.** **Possible causes:** • The Bendix Wingman system is indicating an error in the messages on the public/vehicle CAN bus. • Check the public/vehicle CAN connections at the Camera and Radar. • Check that the resistance between public/vehicle CAN+ and CAN- is between 50 and 70 ohms with the power off. • If the error returns, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2).
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	
Table 4B – Service Action Codes (Pages 21–26)	

2.6 CLEARING DIAGNOSTIC TROUBLE CODES (DTCs)

Diagnostic Trouble Codes (DTCs) may be cleared using the Bendix® ACom® Diagnostic Software (version 6.9 and higher) service tool or by cycling the ignition power. In the ACom program, click the "Clear" button located on the "Read / Clear Fault Codes" screen. Alternately, power-off the vehicle for at least one (1) minute, then start the engine and run it at idle for at least 15 seconds.

Drive the vehicle and, on a test track or suitable section of roadway, verify proper operation.

If the error returns, call Bendix at 1-800-AIR-BRAKE (1-800-247-2725), option 2, for assistance.

2.7 TROUBLESHOOTING DIAGNOSTIC TROUBLE CODES: POWER SUPPLY

IGNITION VOLTAGE TOO LOW

Measure the ignition voltage under load. Ensure that the ignition voltage is greater than 10 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.

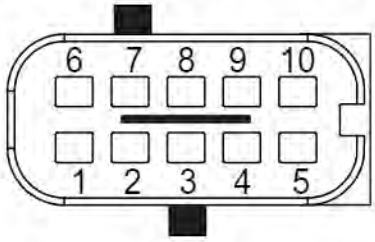
IGNITION VOLTAGE TOO HIGH

Measure the ignition voltage. Ensure that ignition voltage is not greater than 16 VDC (Volts DC). 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 radar sensor harness connector.
2. Place a load (e.g. 1157 stop lamp) across the supply voltage and ground connection. Measure the voltage with the load. The supply voltage on pin 8 to ground should measure between 10 to 16 VDC (volts DC).
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.

Power Supply Pin Codes (4.5)



(Looking into the Front of the Harness Connector)

Pin #	Description
1	J1939 High
2	Private Communications High
3	Not Used
4	Not Used
5	Radar Sensor Ground GND (-)
6	J1939 Low
7	Private Communications Low
8	Supply Voltage IGN (+)
9	Not Used
10	Not Used

Table 5 – Harness Connector Pins

2.8 SERIAL DATA (J1939) COMMUNICATIONS LINK

Check for a loss of communications between the Bendix® Wingman® Fusion™ system radar sensor, the ABS controller, the engine ECU, and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors and loose connections. Using procedures described by the vehicle manufacturer, verify the presence of the engine ECU and the ABS controller on the J1939 link.

Verify the engine ECU configuration. Check for other devices inhibiting J1939 communications.

Note: The Wingman Fusion system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose FLR J1939 DTCs without the engine running.

2.9 PRIVATE COMMUNICATIONS NETWORK TEST PROCEDURE

The Fusion system requires private network messages to and from the other devices in the system. If these messages are not present, or if there is a problem with the private communications system, a DTC will be set.

2.10 ENGINE COMMUNICATIONS (J1939) TEST PROCEDURE

The Bendix® Wingman® Fusion™ system requires several J1939 messages from the engine Electronic Control Unit (ECU) to control the engine and retarder torque for distance control and braking. The Fusion system will set a Diagnostic Trouble Code (DTC) if one of these messages is not present.

Use the engine manufacturer's diagnostic test procedures to verify that there are no errors present in the engine that may prevent the Wingman Fusion system from controlling the engine or retarder torque.

Note: The Fusion system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.

2.11 J1939 TROUBLESHOOTING PROCEDURE

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

⚠ CAUTION

Do not insert probes into the back of the connector as this will damage the seal around the wire.

⚠ CAUTION

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

Note: The Fusion system will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.

2. Check for damaged or reversed J1939 wiring.

   If the J1939 HIGH or J1939 LOW wiring circuits are damaged, such as shorting together, the entire J1939 link will be lost. The problem may be intermittent, enabling the J1939 link to operate normally sometimes. If this occurs, multiple DTCs will be logged in multiple engine and vehicle controllers.

   If the J1939 HIGH and J1939 LOW wiring circuits are reversed, communication over the entire J1939 link will not be lost. Only those devices that are outside of the problem point from other devices will not receive, or be able to transmit, data messages.

3. 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 and possibly into the radar sensor. Replacement of the entire harness is recommended. If the terminals of the radar sensor are corroded, replacement of the radar sensor is recommended.

4. Check for other J1939 devices which may be inhibiting J1939 communication. The service technician should consult the vehicle manufacturer's procedures for other J1939 troubleshooting procedures. 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 J1939 HIGH or J1939 LOW input circuits.

5. Unplug the radar sensor. With the ignition switch off, measure the resistance (ohms) using a multimeter between harness pins 1 and 6. The reading should be approximately 60 ohms. If it is not, the vehicle wiring should be investigated using procedures described by the manufacturer.

2.12 TROUBLESHOOTING WIRING HARNESSES

All wire harness connectors must be properly seated to maintain environmental seals. Push the mating connector until it seals with a click. When replacing a Fusion radar sensor, check that the wire harness connector is free of corrosion before plugging into a new radar sensor. 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 and possibly into the radar sensor. Replacement of the entire harness is recommended. If the terminals of the radar sensor are corroded, replacement of radar sensor is recommended.

3.0 OTHER SYSTEM FEATURES

3.1 READING BENDIX® WINGMAN® FUSION™ SYSTEM KEY INDICATORS

To check the Bendix® Wingman® Fusion™ system key indicators such as software version number, use Bendix® ACom® Diagnostic Software version 6.9 or higher. From the ACom software main menu, the technician highlights Advanced, then clicks "Start with ECU". The Fusion Status screen will appear. Clicking "Config" will display the key system indicators. *See Section 4.21 for an example of reading the software version. See Figure 7 for an example of ACom software configuration information. See Appendix G.*

NOTE: ACom Diagnostic Software is also used for troubleshooting Bendix® ESP®, ATC, and ABS systems.

Figure 7 – Bendix® ACom® Screen Showing Configuration Number

3.2 BENDIX WINGMAN FUSION SYSTEM DIAGNOSTIC TROUBLE CODE (DTC) SELF-CLEARING

Many of the Diagnostic Trouble Codes (DTCs) will automatically clear when the cause of the problem is corrected. When the technician troubleshoots a DTC, it is recommended that Bendix ACom Diagnostic Software (version 6.9 or higher) be used to clear the DTCs as directed by the repair procedure.

Some codes will clear immediately and the functionality will resume. Some codes will clear after powering off the ignition for about 15 seconds and then turning it back on. Other codes will clear after the engine runs for about 15 seconds.

If the vehicle's cruise control can be engaged, that indicates all Fusion system trouble codes have been cleared.

3.3 FOLLOWING DISTANCE ADJUSTMENT SWITCH (OPTIONAL)

If the vehicle is equipped with the following distance adjustment switch and the following distance does not change after an adjustment is made, the switch, wiring, or a controller on the vehicle should be checked using the diagnostic procedures described by the vehicle manufacturer. The radar sensor receives the driver's desired following distance on the J1939 data communication link from a controller on the vehicle. No DTC will be set if the vehicle is not equipped with a following distance adjustment switch.

3.4 CONFIGURING BENDIX® WINGMAN® FUSION™ SYSTEM FOLLOWING DISTANCE ALERTS

Multiple alert and distance setting strategies, known as Following Distance Alert (FDA) configurations, can be chosen using Bendix® ACom® Diagnostic Software (version 6.9 or higher). In current versions of the ACom software, the service technician will find a selection box called "Configuration Number" which gives the service technician the choices shown in Figure 8 and in Table 6.

See Appendix B for an example of following distance alerts for systems where a Bendix® Driver Interface Unit (DIU™) is used. See Appendix F for information about how to change the FDA settings and enable momentary beeping.

Configuring Bendix Wingman Fusion System Following Distance Alerts (FDA) (5.4)					
Configuration No.	Option	Farthest Following Distance	Medium Following Distance	Closest Following Distance	Default Advanced Following Distance (seconds)
		Slow Audible Alert (sec.)	Medium Speed Audible Alert (sec.)	Fast Audible Alert (sec.)	
1	City	—	—	0.5	2.8
	Highway >37 mph (60 kph)	1.5	1.0	0.5	
2	City	—	—	0.5	3.5
	Highway >37 mph (60 kph)	1.5	1.0	0.5	
3	City	—	1.5	1.0	2.8
	Highway >37 mph (60 kph)	2.0	1.5	1.0	
4	City	—	1.5	1.0	3.5
	Highway >37 mph (60 kph)	2.0	1.5	1.0	
5	City	—	1.5	1.0	3.5
	Highway >37 mph (60 kph)	3.0	2.0	1.0	
6	City	3.0	1.5	1.0	3.5
	Highway >37 mph (60 kph)	3.0	2.0	1.0	
7	City	—	—	0.2	2.8
	Highway >37 mph (60 kph)	—	—	0.2	
8 (*See Note Below*)	City	—	—	0.5	1.7
	Highway >37 mph (60 kph)	1.5	1.0	0.5	
9 (*See Note Below*)	City	—	—	0.5	2.3
	Highway >37 mph (60 kph)	1.5	1.0	0.5	

Table 6 – Configuring Following Distance Alerts (FDAs)

NOTE: Configurations 8 and 9 are available on select applications only and may not be available on your system.

Figure 8 – Configuration Number (Showing Configuration One (1) Selected) - See Also Table 6

Changing configuration allows the fleet to adjust both the following distance alerts and the following distance behind a detected forward vehicle. *See Figure 9.*

3.5 BENDIX® WINGMAN® FUSION™ SYSTEM DATA

NOTE: A license key is required from Bendix in order to engage the data collection ability of the system. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for more information.

3.5.1 DATA AVAILABILITY

Data will not be stored by the system until the "Clear Resettable Data Log" (*see Figure 9*) is selected and the proper Bendix® ACom® Diagnostic Software license key is present. Contact Bendix at 1-800-AIR-BRAKE (1-800-247-2725, option 2), for the ACom software license key and the set-up procedure.

Figure 9 – Clearing the Resettable Data Log

3.5.2 DATA OVERVIEW

At the fleet's discretion, the Fusion system makes data available (*see Figure 10*), in an ACB (Active Cruise-control with Braking) data log, regardless of whether or not Fusion is used. The log can be reset–using ACom Diagnostic Software–as often as needed.

3.5.3 EXTRACTING DATA AND SAVING A REPORT

The Bendix ACom Diagnostic Software and *User Guide* is available online at "ABS Software" link under "Services and Support" on the Bendix website (www.bendix.com). Use the *User Guide* for specific instructions on extracting data from the Wingman Fusion system.

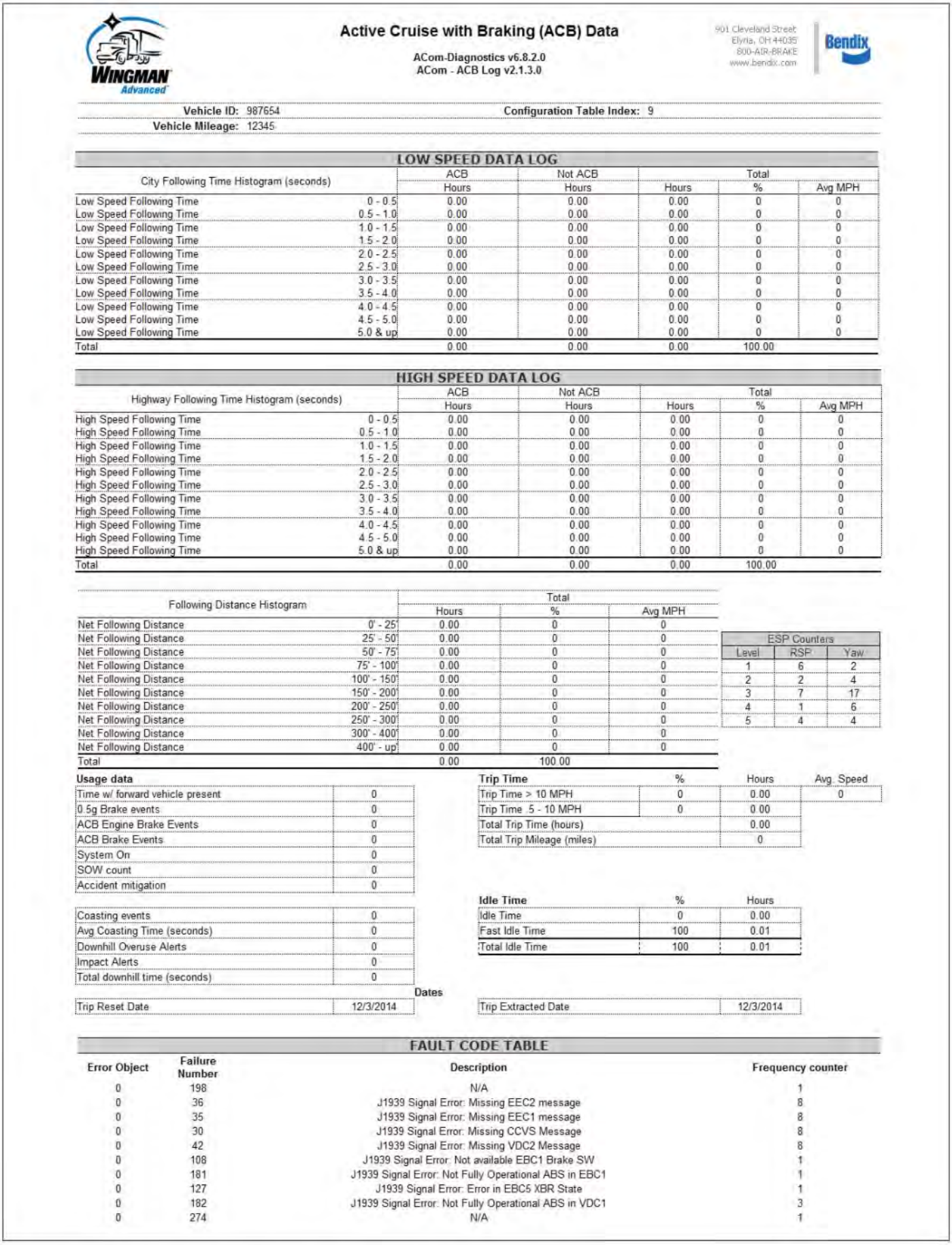
After a successful connection, the service technician will be presented with the window shown in Figure 10.

Select "Start ACB Data Log". The service technician will be asked to enter the vehicle ID and mileage. This data will be stored in the report. *See Figure 10.*

Figure 10 – Vehicle Data

The service technician can choose whether to "Print", "Print Preview", "E-mail", or "Save" the report to disk. *See Figure 11.* The data can be saved as a comma delimited file or an HTML web page file. *See Figure 12 on next page for a sample report.*

Figure 11 – Report Mode



Active Cruise with Braking (ACB) Data

ACom-Diagnostics v6.8.2.0
ACom - ACB Log v2.1.3.0

901 Cleveland Street
Elyria, OH 44035
800-AIR-BRAKE
www.bendix.com

Vehicle ID: 987654 **Configuration Table Index:** 9
Vehicle Mileage: 12345

LOW SPEED DATA LOG

City Following Time Histogram (seconds)		ACB Hours	Not ACB Hours	Total Hours	Total %	Total Avg MPH
Low Speed Following Time	0 - 0.5	0.00	0.00	0.00	0	0
Low Speed Following Time	0.5 - 1.0	0.00	0.00	0.00	0	0
Low Speed Following Time	1.0 - 1.5	0.00	0.00	0.00	0	0
Low Speed Following Time	1.5 - 2.0	0.00	0.00	0.00	0	0
Low Speed Following Time	2.0 - 2.5	0.00	0.00	0.00	0	0
Low Speed Following Time	2.5 - 3.0	0.00	0.00	0.00	0	0
Low Speed Following Time	3.0 - 3.5	0.00	0.00	0.00	0	0
Low Speed Following Time	3.5 - 4.0	0.00	0.00	0.00	0	0
Low Speed Following Time	4.0 - 4.5	0.00	0.00	0.00	0	0
Low Speed Following Time	4.5 - 5.0	0.00	0.00	0.00	0	0
Low Speed Following Time	5.0 & up	0.00	0.00	0.00	0	0
Total		0.00	0.00	0.00	100.00	

HIGH SPEED DATA LOG

Highway Following Time Histogram (seconds)		ACB Hours	Not ACB Hours	Total Hours	Total %	Total Avg MPH
High Speed Following Time	0 - 0.5	0.00	0.00	0.00	0	0
High Speed Following Time	0.5 - 1.0	0.00	0.00	0.00	0	0
High Speed Following Time	1.0 - 1.5	0.00	0.00	0.00	0	0
High Speed Following Time	1.5 - 2.0	0.00	0.00	0.00	0	0
High Speed Following Time	2.0 - 2.5	0.00	0.00	0.00	0	0
High Speed Following Time	2.5 - 3.0	0.00	0.00	0.00	0	0
High Speed Following Time	3.0 - 3.5	0.00	0.00	0.00	0	0
High Speed Following Time	3.5 - 4.0	0.00	0.00	0.00	0	0
High Speed Following Time	4.0 - 4.5	0.00	0.00	0.00	0	0
High Speed Following Time	4.5 - 5.0	0.00	0.00	0.00	0	0
High Speed Following Time	5.0 & up	0.00	0.00	0.00	0	0
Total		0.00	0.00	0.00	100.00	

Following Distance Histogram		Total Hours	Total %	Total Avg MPH
Net Following Distance	0' - 25'	0.00	0	0
Net Following Distance	25' - 50'	0.00	0	0
Net Following Distance	50' - 75'	0.00	0	0
Net Following Distance	75' - 100'	0.00	0	0
Net Following Distance	100' - 150'	0.00	0	0
Net Following Distance	150' - 200'	0.00	0	0
Net Following Distance	200' - 250'	0.00	0	0
Net Following Distance	250' - 300'	0.00	0	0
Net Following Distance	300' - 400'	0.00	0	0
Net Following Distance	400' - up	0.00	0	0
Total		0.00	100.00	

ESP Counters		
Level	RSP	Yaw
1	6	2
2	2	4
3	7	17
4	1	6
5	4	4

Usage data	
Time w/ forward vehicle present	0
0.5g Brake events	0
ACB Engine Brake Events	0
ACB Brake Events	0
System On	0
SOW count	0
Accident mitigation	0

Trip Time	%	Hours	Avg. Speed
Trip Time > 10 MPH	0	0.00	0
Trip Time .5 - 10 MPH	0	0.00	
Total Trip Time (hours)		0.00	
Total Trip Mileage (miles)		0	

Coasting events	0
Avg Coasting Time (seconds)	0
Downhill Overuse Alerts	0
Impact Alerts	0
Total downhill time (seconds)	0

Idle Time	%	Hours
Idle Time	0	0.00
Fast Idle Time	100	0.01
Total Idle Time	100	0.01

Dates

Trip Reset Date	12/3/2014
Trip Extracted Date	12/3/2014

FAULT CODE TABLE

Error Object	Failure Number	Description	Frequency counter
0	198	N/A	1
0	36	J1939 Signal Error: Missing EEC2 message	8
0	35	J1939 Signal Error: Missing EEC1 message	8
0	30	J1939 Signal Error: Missing CCVS Message	8
0	42	J1939 Signal Error: Missing VDC2 Message	8
0	108	J1939 Signal Error: Not available EBC1 Brake SW	1
0	181	J1939 Signal Error: Not Fully Operational ABS in EBC1	1
0	127	J1939 Signal Error: Error in EBC5 XBR State	1
0	182	J1939 Signal Error: Not Fully Operational ABS in VDC1	3
0	274	N/A	1

Figure 12 – Sample Bendix® Wingman® Fusion™ System Vehicle Report

APPENDIX A - RADAR MOUNTING AND INSTALLATION

Appendix A

Mounting the Bendix® FLR20™ Radar

GENERAL

⚠ WARNING

Improper use of the Bendix® Wingman® Fusion™ system can result in a collision causing property damage, serious injuries, or death.

⚠ WARNING

Under no circumstances should the radar be removed or repositioned from the original production line installation. The assembly should always be mounted in the original OEM location. If this location is not in the center of the vehicle, the mounting offset will need to be programmed through Bendix® ACom® Diagnostic Software.

⚠ CAUTION

Vehicle equipment, including bumpers, deer guards, etc. must not infringe upon the zone used by the radar sensor to emit and receive radar waves. *See Appendix A3.* Failure to comply with this requirement will impair the function of the radar. Only vehicle OEM-approved covers and/or cover panels may be installed in front of the radar.

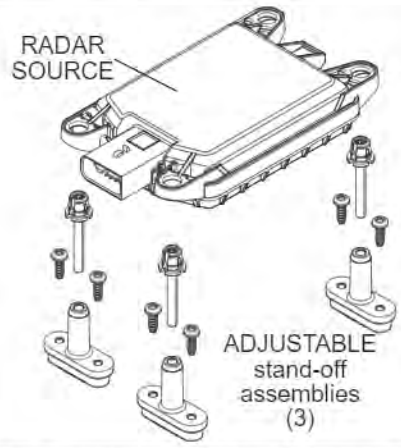
The radar sensor assembly is mounted to the front of the vehicle using an adjustable bracket. This adjustable bracket allows for the radar sensor to be properly aimed laterally and vertically to maximize Wingman Fusion system performance. When mounting a radar sensor, the wire harness connector should always point towards the passenger side of the vehicle.

A.1 Vehicle Applications

The radar sensor can be mounted and installed only on vehicles that have the Bendix Wingman Fusion system already installed. At this time the Fusion system cannot be retrofitted onto vehicles, even if that vehicle is equipped with the Bendix® ESP® stability system.

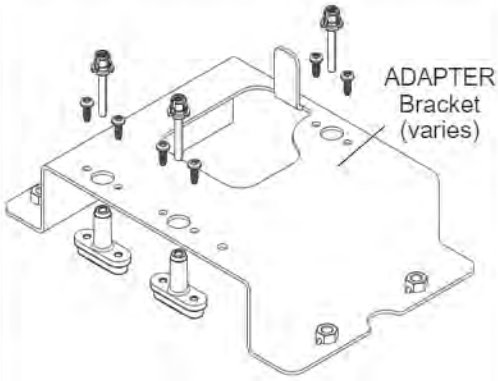
A.2 Replacement Parts

Replacement parts exist for all components shown below. Parts are available from any Bendix authorized parts supplier.



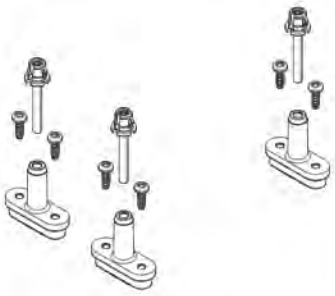
Radar Sensor with Stand-off Assemblies

- Kit K071772 includes a specifically-programmed Bendix® FLR20™ radar sensor, three stand-off adjuster assemblies, and six mounting screws.



Bracket (Varies) and Stand-off Assemblies

- Provide the bracket part number (see label) when ordering replacements. Kits will include three stand-off adjuster assemblies, and six mounting screws.



Stand-off Assemblies Only

- Kit K073199 includes three stand-off adjuster assemblies, and six mounting screws.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Bendix® FLR20™ Radar Mounting Clearance

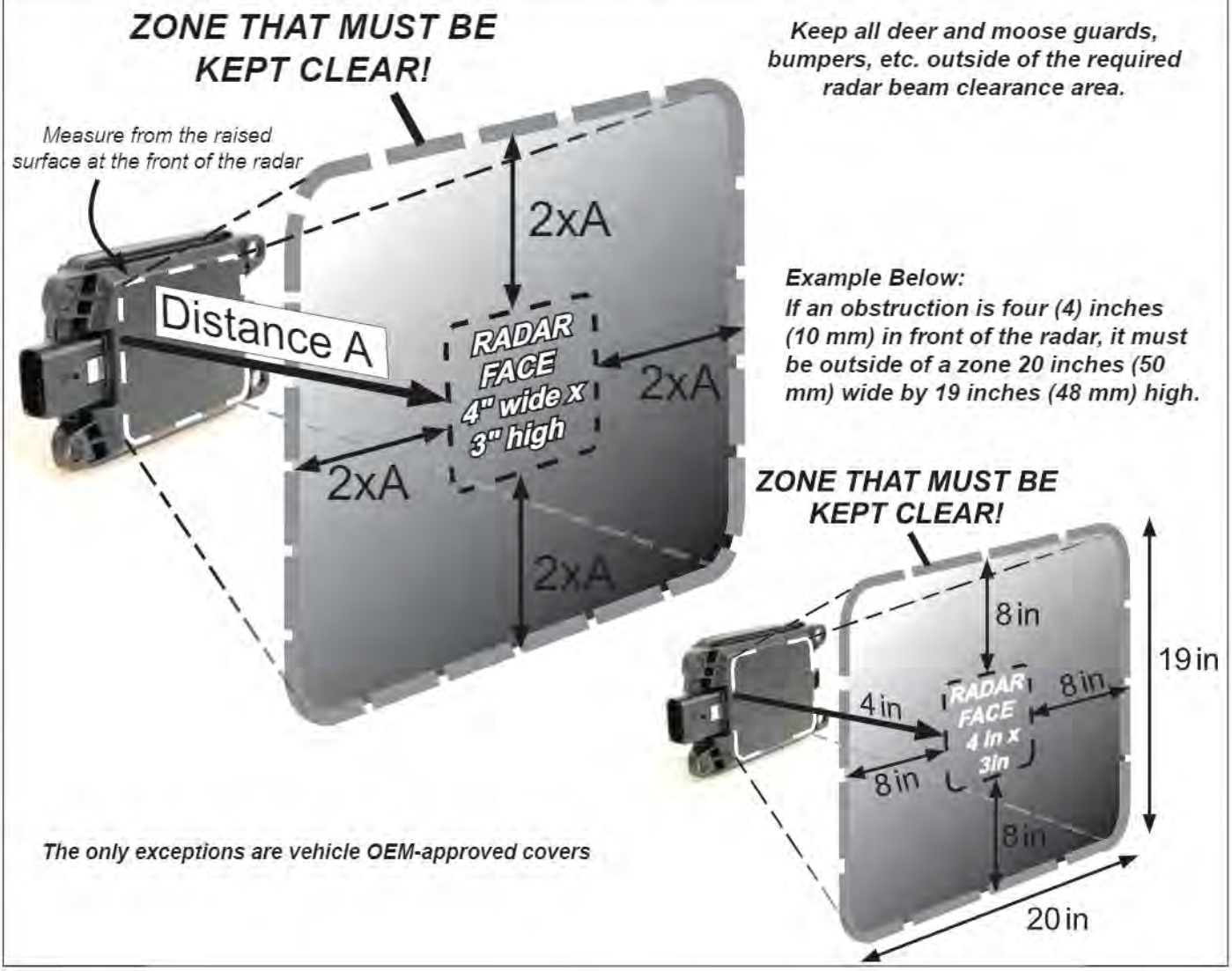
A.3 Bendix® FLR20™ Radar Sensor Mounting Clearance

⚠ CAUTION: Vehicle equipment, including bumpers, deer guards, etc. must not infringe upon the zone used by the radar sensor to emit and receive radar waves. Failure to comply with this requirement will impair the function of the radar. Only vehicle OEM-approved covers and/or cover panels may be installed directly in front of the radar.

For proper operation of your Bendix® Wingman® Fusion™ system, adhere to the following guidelines:

- The radar sensor assembly should be OEM-installed on the vehicle following all OEM specifications.
- The radar's field of view must NOT have interference from any other vehicle components such as bumpers, cow-catcher bumpers, engine blankets, seasonal decorations, or any other commonly mounted front-of-vehicle components. The radar signal is emitted from the front of the sensor with a spreading beam. In order to ensure that no adverse interference is experienced from bumpers or other nearby vehicle equipment, a suitable clearance must be maintained around the radar. This clearance must be maintained regardless if the vehicle is stationary or in motion. See the diagram below for a general guide and an example of how to calculate the zone required.

NOTE: Bendix does not certify nor offer warranty on Bendix® Wingman® systems where system performance is affected by beam obstructions of any kind or unapproved post-production covers. This document gives general guidelines that will work for most vehicles; exceptions may exist.



APPENDIX B - RADAR ALIGNMENT

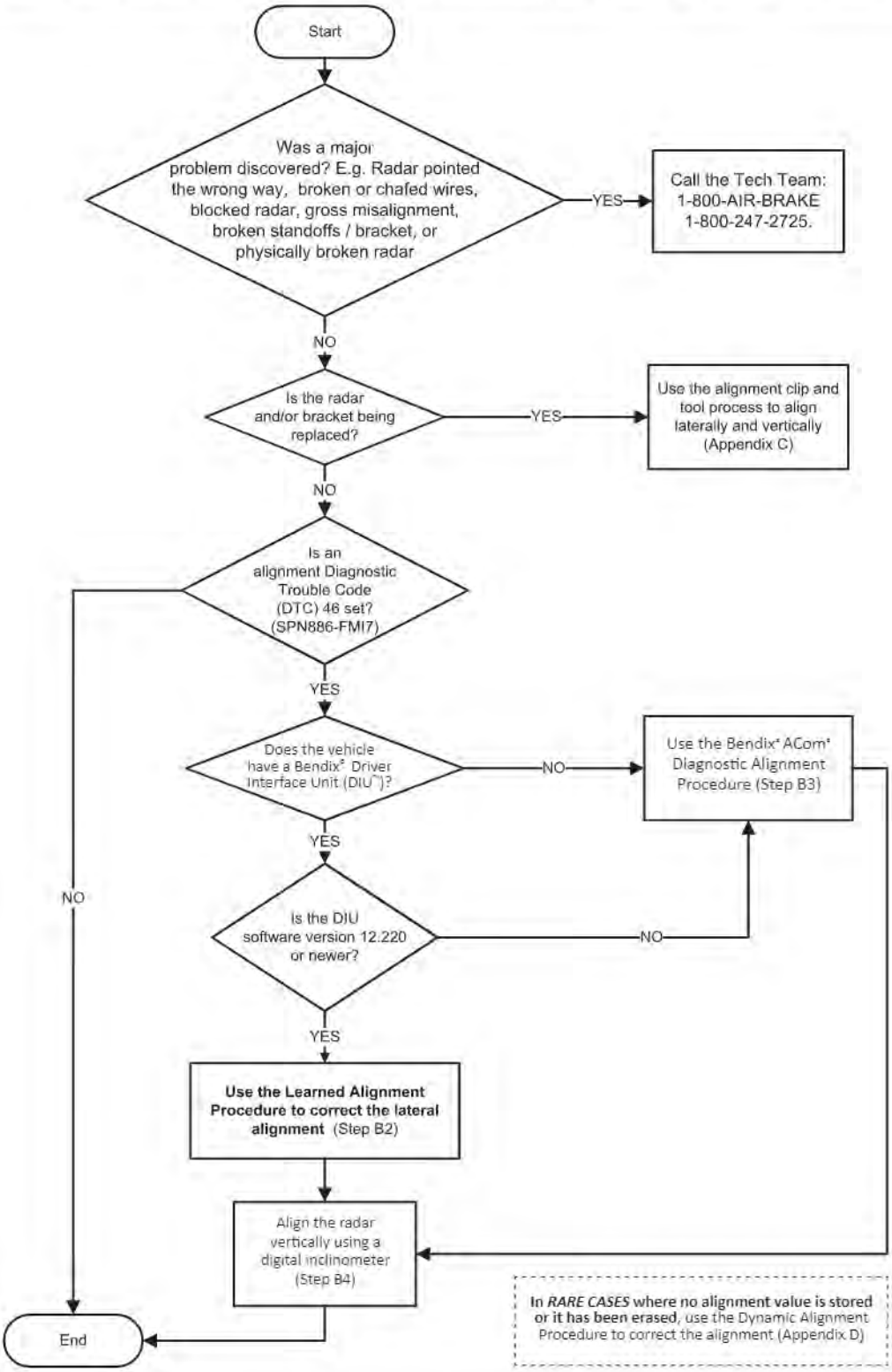
Appendix B

Bendix® FLR20™ Radar Sensor Alignment

B1.0 Radar Alignment Flowchart

For Bendix® FLR10™ radar sensors, see Bendix® Service Data Sheet (SD-61-4962).

Use this flowchart to find which section(s) of this Appendix to use.



Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix B

Bendix® FLR20™ Radar Alignment

B1.1 General Information About Adjusting The Alignment

Accurate vertical and lateral alignment of the radar sensor is critical for proper operation of Bendix® Wingman® Fusion™. If the alignment is outside a certain range it could cause false warnings, missed warnings and a Diagnostic Trouble Code (DTC) in the system.

The radar sensor is mounted to the front of the vehicle using a bracket with three stand-offs, two of which are used when making adjustments, if necessary.

It is important to use the correct stand-off when making any alignment adjustments.

A technician makes an adjustment to the lateral alignment standoff.

The vertical alignment standoff is adjusted.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix B

Bendix® FLR20™ Radar Alignment

B2 Lateral Alignment Using The Learned Alignment Screen

This is the preferred and recommended method for lateral alignments

This method is for vehicles with Bendix® Driver Interface Unit (DIU™) displays that use software whose version is 12.220 and above. To verify the DIU's software version, go to the Volume screen. The software version is displayed in the top right-hand corner.

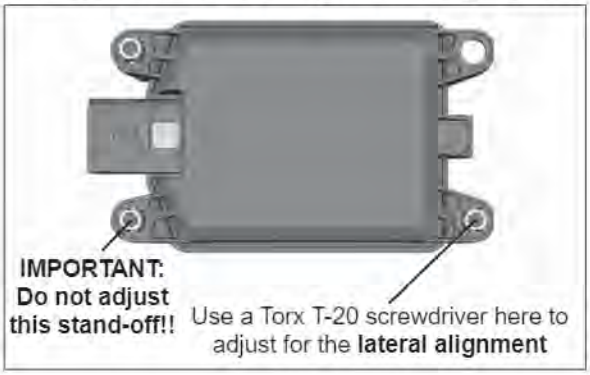
If the radar's lateral alignment is not correct, the system calculates–over the course of many hours of driving–an alignment adjustment value. The DIU displays the learned alignment value, and also shows the technician the direction to turn, and number of turns to make to the lateral alignment adjustment screen.

B2.1 Tools needed: DIU (with software version 12.220 or above), and a Torx® T-20 Screwdriver.

B2.2 Enter the DIU menu item titled "Radar" and select "Alignment Check".

B2.3 Upon selecting the "Alignment Check" menu item the following screen will be displayed:

Bendix® DIU Screen Showing learned alignment value



The example above shows a correction value of five (5) full turns counterclockwise is needed. The correction count and arrow direction displayed shows that in order to adjust the radar to be correctly aligned with the travel of the vehicle, the lateral adjustment screw (lower right screw when facing the front of the vehicle) should be turned.

B2.4 Make the adjustment shown on the Bendix DIU.

IMPORTANT: Make necessary adjustments to the alignment stand-off prior to resetting the alignment value.

B2.5 Select "Reset" and then "Exit" on the Bendix DIU screen to return to the default screen.

B2.6 Cycle the ignition power.

B2.7 **IMPORTANT: Before returning the vehicle to service, go to *Appendix B4* and check the vertical alignment.**

NOTE: The alignment process is complete after the vertical alignment has been checked (and adjusted, if necessary.) You do not need to test-drive the vehicle.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix B

Bendix® FLR20™ Radar Alignment

B3 Lateral Alignment Using Bendix® ACom® Diagnostic Software

Use this method to align the Bendix® FLR20™ radar laterally – when the vehicle does not have a Bendix DIU™, or has a DIU (but its software version is prior to 12.220)

B3.1 Tools needed: Bendix ACom Diagnostic Software, and a Torx T-20 Screwdriver

B3.2 Connect the vehicle to a laptop computer with the current release of the ACom software.

B3.3 *See the "Alignment Value" shown on the Configuration screen.*

If the alignment value shown by ACom is between -1.1° and 1.1°, this is acceptable and the system should operate normally. A value outside that range means the radar sensor should be adjusted.

The Bendix ACom Diagnostic Software Screen Showing the (Lateral) Alignment Value

Alignment Value Range (Degrees)	Service Action	Number of Full Turns of the Lateral Alignment Adjustment Screw
-2.0 to -1.8	***Adjustment Required***	6 clockwise
-1.7 to -1.6		5 clockwise
-1.5 to -1.2		4 clockwise
-1.1 to -0.8	***No Adjustment Needed***	3 clockwise *(optional)*
-0.7 to -0.5		2 clockwise *(optional)*
-0.4 to -0.3		1 clockwise *(optional)*
-0.2 to 0.2		
0.3 to 0.4		1 counterclockwise *(optional)*
0.5 to 0.7		2 counterclockwise *(optional)*
0.8 to 1.1		3 counterclockwise *(optional)*
1.2 to 1.5	***Adjustment Required***	4 counterclockwise
1.6 to 1.7		5 counterclockwise
1.8 to 2.0		6 counterclockwise

ADJUSTMENT SCREW ROTATION REQUIRED

NOTE: The maximum Alignment Value shown by the ACom software is two degrees (plus or minus).

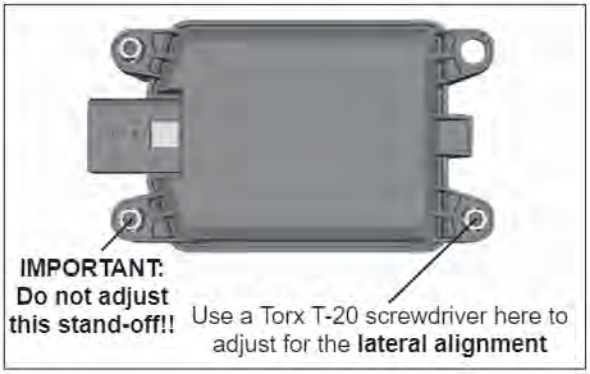
Appendix B

Bendix® FLR20™ Radar Alignment

B3 Lateral Alignment Using Bendix® ACom® Diagnostic software (Continued)

B3.4 *See the image below to see the lateral alignment adjustment screw location.*

Use Table in B3.3 on the prior page to find the number of full turns of the stand-off adjustment screw required to bring the radar sensor back into alignment. A Torx T-20 screwdriver with a mark or other indicator may help track the number of turns.

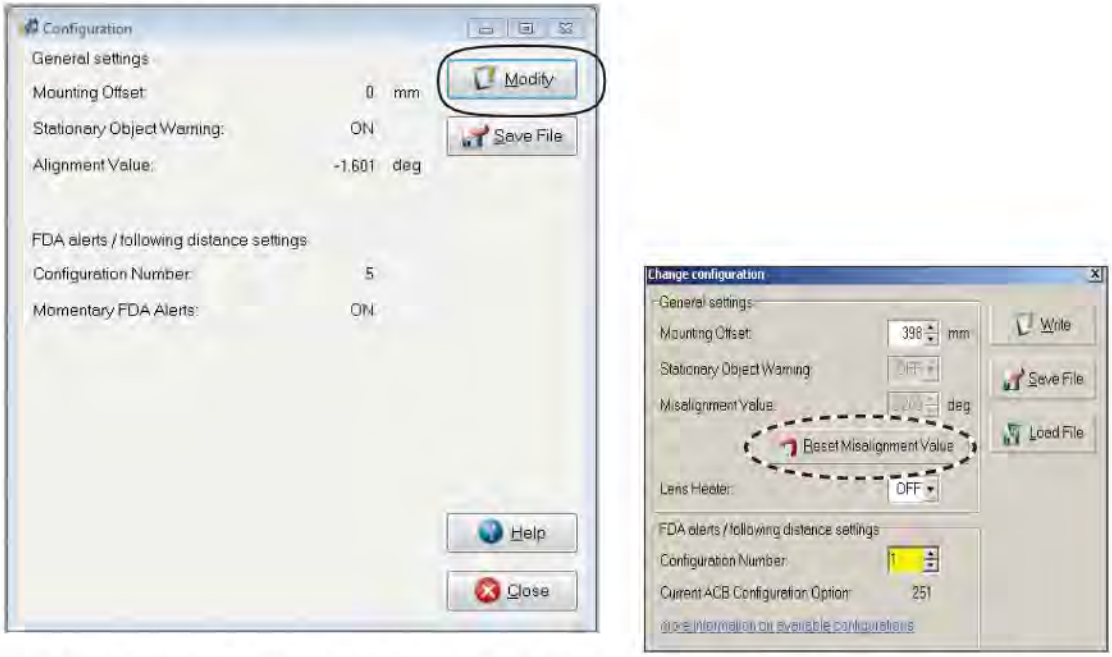


B3.5 After making the adjustment, clear the Bendix® Wingman® Fusion™ system Diagnostic Trouble Code (DTC) using the procedure in Section 4.4: *Clearing Diagnostic Trouble Codes (DTCs).*

B3.6 Then follow steps B3.7–12 to reset the alignment value stored in the system.

B3.7 **Procedure to Reset the Alignment Value.** Select Wingman Fusion system on the starter screen, and then select "Start with ECU." Select "Config" on the Wingman Fusion system Status window.

B3.8 Select "Modify" on the Configuration Status window.



Bendix® ACom® Diagnostic Software: configuration and change configuration screens

B3.9 Select "Reset Alignment Value" in the Change Configuration box. *(See Appendix H for more details.)*

B3.10 Close the Bendix ACom Diagnostic Software program and any open windows.

B3.11 Cycle the vehicle ignition.

B3.12 After the vehicle has been driven at least 20 miles at above 35 mph / 56 kph in multi-lane urban traffic, re-check the alignment value using the ACom software.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix B

Bendix® FLR20™ Radar Alignment

B4 Vertical Alignment Using An Inclinometer

B4.1 Tools Needed: A digital inclinometer, Torx T-20 screwdriver. (If a clip from the Bendix Alignment Tool kit is available, the clip may be placed over the front of the radar sensor during this process.)

B4.2 Park the vehicle on a level floor. Air suspensions must be charged and stable.

B4.3 Calibrate (or "zero") the inclinometer on a horizontal section of the frame rail. Follow the manufacturer's instructions (typically digital inclinometers have a "SET" button for this purpose).

Calibrate (or *"zero"*) the Digital Inclinometer on a cab frame rail in the direction that the vehicle travels.

B4.4 Place the calibrated digital inclinometer against the front surface of the radar, ***so that the tool is held in the same direction as it was on the rail.*** **With the digital inclinometer resting as shown below, verify that the display shows 0° (±1.5°) from vertical**, when measured by an inclinometer set to zero on the vehicle's frame.

NOTE: Complete the steps below ***only*** *if a vertical adjustment is necessary.*

B4.5 Use the Torx T-20 screwdriver to turn (by hand) the top-left adjustment stand-off. During the adjustment, observe the digital display on the inclinometer and turn the vertical alignment screw clockwise or counterclockwise depending on the vertical direction (up or down) needed, until the reading is zero degrees.

B4.6 **The radar is aligned vertically when the display is between -1.5° and 1.5°, however to achieve a more precise alignment, adjust the vertical alignment screw until the digital alignment value is near zero (0°).**

NOTE: The alignment process shown here is for Bendix® alignment brackets. For other brackets, similar alignment steps will be needed; consult the vehicle manual for full instructions.

B4.7 If used, be sure to remove the clip before returning the vehicle to service.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

APPENDIX C - RADAR ALIGNMENT USING A BENDIX® ALIGNMENT CLIP AND TOOL

Appendix C

Bendix® FLR20™ Radar Alignment

C1 Lateral Alignment Using The Bendix® Alignment Clip And Tool

This is the method to use for lateral alignment when a radar and/or bracket is replaced.

Tools needed: Bendix® alignment kit, steel clip, Torx T-20 screwdriver and a tape measure.

- One of the Bendix® Alignment Tools part no: K065284 and K096579—available from Bendix parts outlets—are used.

The alignment procedure also requires a steel clip, Bendix part number K073087.

ALIGNMENT TOOLS AVAILABLE

C1.1 Park the vehicle on a level floor. Air suspensions must be charged and stable. Install the steel clip supplied over the radar sensor.

C1.2 Attach the alignment tool onto the clip using its magnetic feet. Inspect to make sure that the alignment tool is approximately horizontal width-wise.

C1.3 Activate the lateral alignment laser light "on" switch. Place the tool into position for the first measurement. (The tool will be reversed when the second measurement is made.)

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix C

Bendix® FLR20™ Radar Alignment

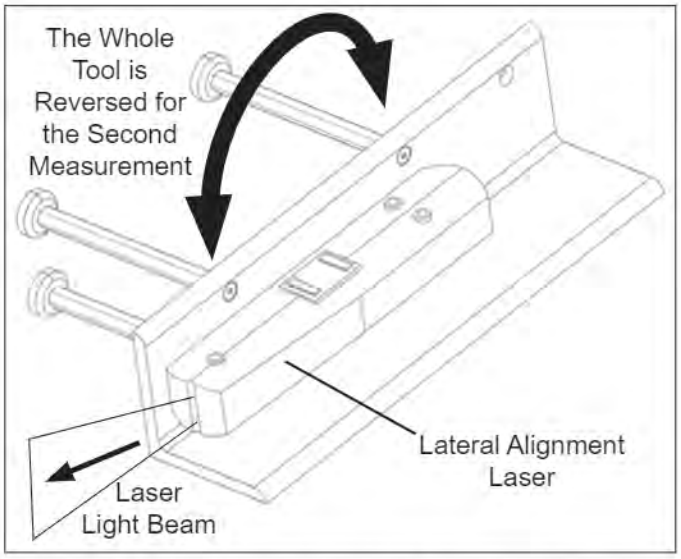
C1 Lateral Alignment Using The Bendix® Alignment Clip And Tool (continued)

C1.4 Locate symmetrical points on the front of the vehicle that are at least 12 inches (30 mm) from the vehicle's center line (such as the tow hooks). Using a ruler or tape measure, record the distance from each side to the laser light line.

LATERAL ALIGNMENT LEFT MEASUREMENT

NOTE: *The technician must be careful during the laser positioning process to double-check the values measured on each side of the truck. Be sure to check back and forth for each side of the radar sensor several times to ensure accuracy.*

C1.5 Repeat the process for the opposite side, reversing the tool, so that the laser light points to the other side of the vehicle.



C1.6 Compare the left and right distance measurements. A properly aligned radar sensor will have the same measurement from each side. If these two dimensions are within 1/8" (3 mm), no alignment is necessary and the technician can go to Step C1.10 to check the vertical alignment. If an adjustment is needed, follow the instructions in C1.7–9 on page 42

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

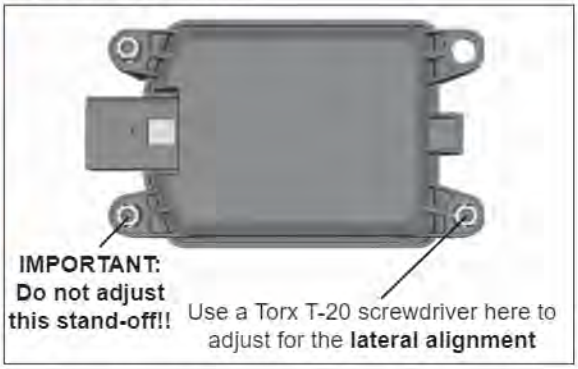
Appendix C

Bendix® FLR20™ Radar Alignment

C1 Lateral Alignment Using the Bendix® Alignment Clip and Tool (continued)

NOTE: Complete these steps only if a lateral adjustment is necessary.

C1.7 With the Bendix alignment tool still in place, use the Torx T-20 screwdriver to turn by hand the driver-side stand-off adjustment screw until the desired alignment is reached.



C1.8 Re-measure the distances from symmetrical points located at least 12" from the center line of the vehicle. Reverse the tool for each measurement, until the values are the same [within 1/8" (3 mm)].

C1.9 After the lateral alignment procedure is complete, if there is an active misalignment DTC (codes 55, 56, or 57), clear the Bendix® Wingman® Fusion™ system Diagnostic Trouble Code (DTC) using the procedure in Section 4.4: *Clearing Diagnostic Trouble Codes (DTCs)* and reset the alignment value by connecting the vehicle to a PC with Bendix® ACom® Diagnostic Software and follow steps B4.4–20 to reset the alignment value. *(Also, see Appendix H.)*

C1.10 **IMPORTANT: Before returning the vehicle to service, check the vertical alignment using the procedure outlined below.**

C1.11 [The steel clip and alignment tool should already be in place. *See C1.1–2.*]

C1.12 Calibrate (or "zero") the inclinometer on a horizontal section of the frame rail. Follow the manufacturer's instructions (typically digital inclinometers have a "SET" button for this purpose).

Calibrate (or *"zero"*) the Digital Inclinometer on a cab frame rail in the direction that the vehicle travels.

Place the calibrated digital inclinometer onto the surface of the tool, ***so that the tool is in the same direction as it was on the rail.*** **Verify that the display shows 0° (±1.5°) from vertical.**

*NOTE: Complete these steps **only** if a vertical adjustment is necessary.*

C1.13 With the Bendix alignment tool still in place, use the screwdriver to turn by hand the top-left adjustment stand-off. *See the diagram on the right.* During the adjustment, observe the digital display on the inclinometer and turn the vertical alignment screw clockwise or counterclockwise depending on the vertical direction (up or down) needed, until the reading is near zero degrees.

C1.14 **The radar is aligned vertically when the display is near zero (0°).**

NOTE: The alignment process shown here is for Bendix alignment brackets. For other brackets, similar alignment steps will be needed; consult the vehicle manual for full instructions.

NOTE: The alignment process is complete after the vertical alignment has been checked (and adjusted, if necessary.) You do not need to test-drive the vehicle.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

APPENDIX D - DYNAMIC RADAR ALIGNMENT

Appendix D

Bendix® FLR20™ Radar Dynamic Alignment Method

This procedure may be used in rare cases where the stored alignment value is not available. The vehicle must have a Bendix® Driver Interface Unit (DIU™) with a software version 12.220 or above.

D1 Lateral Alignment Using The Dynamic Alignment Method

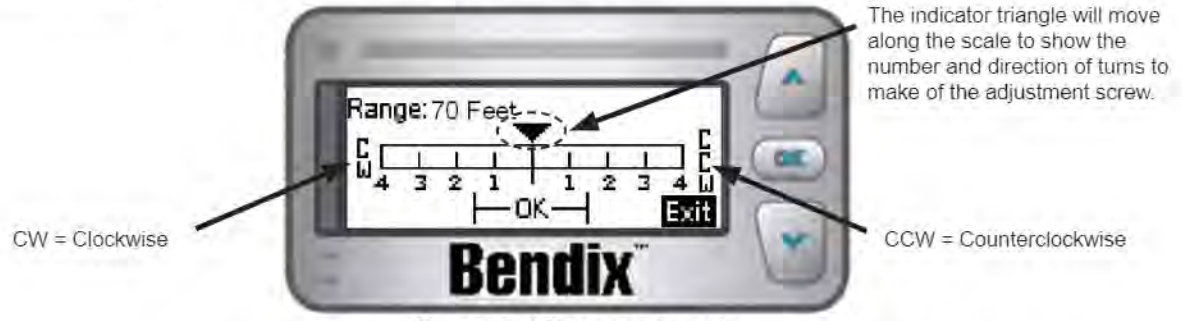
Use the flowchart B1.0 – page 36 of this document – to ensure you are using the correct alignment procedure. This procedure is used in the rare cases where a learned alignment value is not available. For example, in cases where a technician erroneously resets the alignment value before recording the Learned Alignment correction value and direction.

D1.1 Tools needed: DIU (with software version 12.220 or above), and a Torx T-20 screwdriver. The assistance of another vehicle will be necessary, plus an assistant in the cab of the vehicle with the driver.

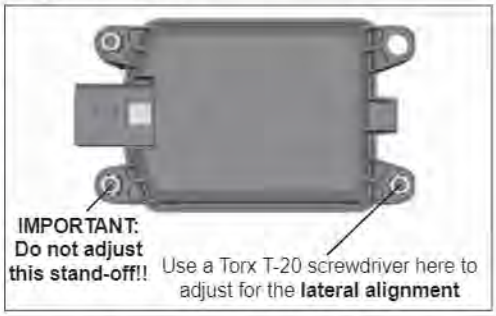
The DIU's software version can be seen in the top right-hand corner of the Volume screen. The Bendix DIU's Dynamic Alignment Screen is used to show a dynamic calculation of the alignment of the radar.

D1.2 To perform the inspection, the vehicle must be traveling behind a cooperative vehicle on a straight, level length of highway. Obeying all traffic laws, follow the vehicle in the same lane at a speed greater than 35 mph / 56 kph. For the most accurate results, the distance between the vehicles must be between 50 and 300 feet (15 to 91 meters), so the observed distance figure – displayed in the top left-hand corner of the display – helps the driver maintain the correct range. Verify that both vehicles remain in the middle of the lane during the test. The radar determines the distance and alignment to the vehicle ahead, and, if needed, calculates an alignment correction value, displayed on the screen.

D1.3 During the test, an assistant in the vehicle should observe where on the scale the triangle indicator shows the alignment correction value. Because this is a dynamic measurement, the arrow will typically move through a range of positions. Note the average position where the triangle points over a length of time. This value gives the number of turns of the lateral adjust screw clockwise (CW) or counterclockwise (CCW), in order to correct any misalignment present. *See Figure below.* The number of turns may require less than a full screw turn, e.g. halfway between 2 and 3 is 2.5 turns. The scale to the left of center shows when a clockwise (CW) adjustment is needed, and numbers to the right are for counterclockwise (CCW) adjustments.



Dynamic Alignment Screen



D1.4 Alignment values less than 1.1 from the center are acceptable and do not necessarily require adjustment. (See the "OK" zone shown on the scale for this range).

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

APPENDIX E - DRIVER INTERFACE UNIT (DIU™): DISPLAYS AND ALERTS

Appendix E

Bendix® Driver Interface Unit (DIU™): Displays & Alerts

E1 Operator Interface

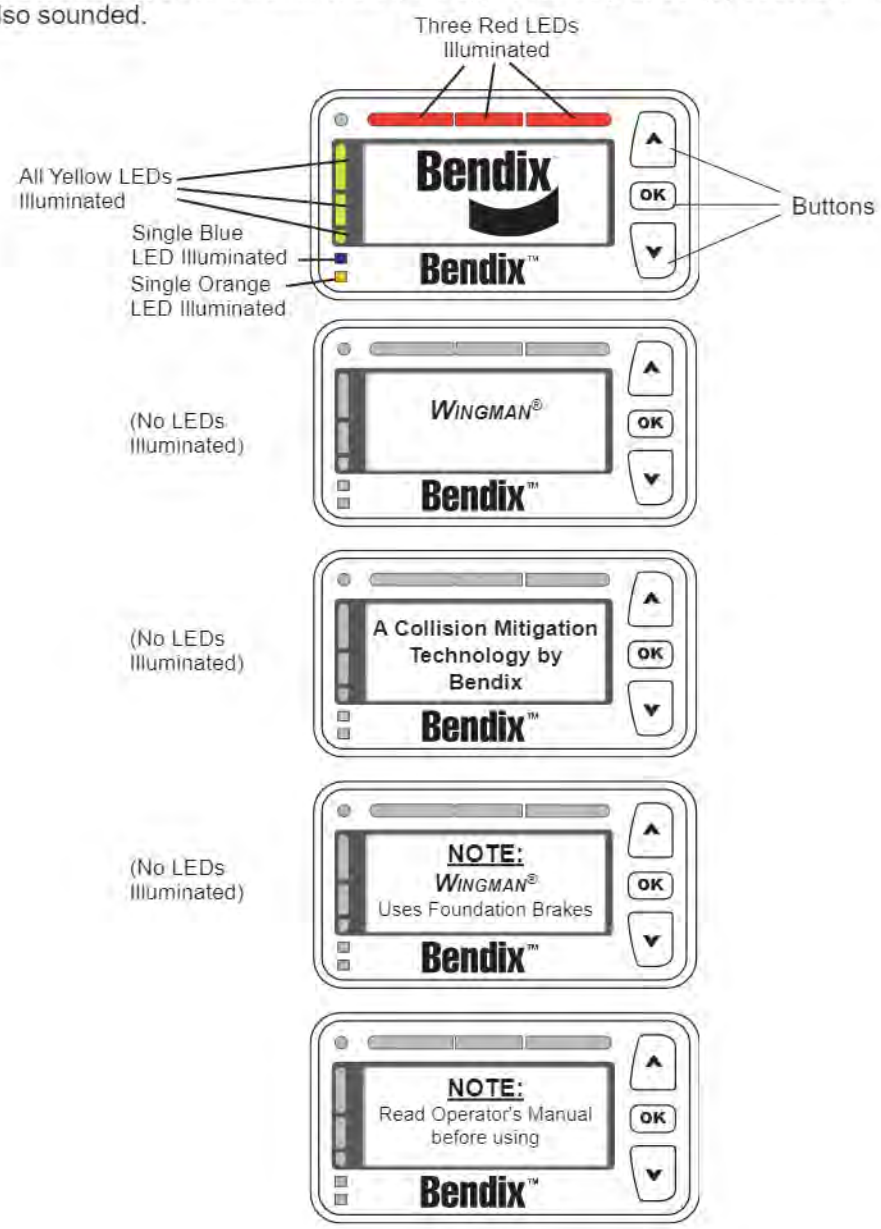
The Bendix® Wingman® Fusion™ system is either integrated into the vehicle's dash or console, or uses the Bendix® Driver Interface Unit (DIU™) to communicate with the driver. *(For integrated systems, see the vehicle operator's manual for more information.)*

This Section describes the functions of the DIU. The DIU mounts in, or on, the vehicle dash and provides the interface between the driver and the Fusion system. The DIU provides visual and audio warnings to the driver and accepts input from the driver through the "Up", "Down" and "OK" buttons.

The DIU contains an internal speaker to provide audible warnings, 2 LED arrays (one each in yellow and red), a single orange and blue LED and an LCD screen for visual warnings, and a light radar sensor to distinguish between day and night conditions.

E1.1 Start-Up Mode

At initialization, the DIU executes self-test routines during which the following screens are displayed and all LEDs are activated (power-on bulb check) for approximately three (3) seconds. If configured, a power-up tone is also sounded.



Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

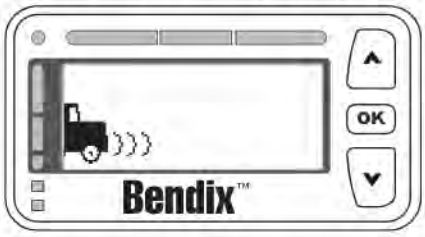
Bendix® Driver Interface Unit (DIU™): Displays & Alerts (continued)

When the initialization sequence is complete, the following screen is displayed for approximately three (3) seconds to indicate the features available to the driver.

(No LEDs Illuminated)

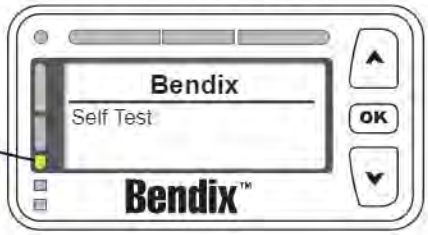
Next, the DIU will enter normal operation. Under normal operation, the screen is:

(No LEDs Illuminated)



If the Bendix® Wingman® Fusion™ system goes into self-test mode, the DIU may briefly display the "Bendix Self-Test" screen. Also, the audible distance alerts will activate, followed by a screen indicating that the self-test has run. *Below left* is the screen that will be briefly displayed if the self-test runs and passes. *Below right* is the screen that will be briefly displayed if the self-test runs and fails. If the self-test fails, a Diagnostic Trouble Code (DTC) will be set. The driver should turn off the vehicle, wait 15 seconds and then turn it back on again. If the problem persists, a qualified technician will be necessary for troubleshooting. *See the "Power-Up Self-Test" in this Service Data Sheet Section 3.1: Troubleshooting Basics for further information.*

Single Yellow LED Illuminated



(Followed by a Single Orange LED Illuminated)

E1.2 Menu Operation

Pressing the "OK" button at any time will enter the "Menu Operation Mode". The following selections will appear in a scrollable window. Some items may not appear if the feature is not configured or not allowed as shown below.

- Volume
- Dist. Setting (Distance Setting)
- Dist. Units (Distance Units)
- US/Metric
- Brightness
- System Status
- Diag. Display (Diagnostic Display)
- Demo (Demonstration. NOTE: Demo is available only when vehicle is not moving)

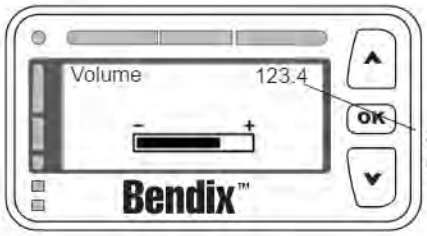
The desired menu item is highlighted using the up (▲) or down (▼) arrow buttons and selected with the "OK" button. The following sections describe each menu item.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

E1.3 Volume

Selecting "Volume" from the main menu displays the following screen:

(No LEDs Illuminated)



Software Version

Use the up (▲)/down (▼) arrow buttons to change the volume. Pressing the "OK" button exits this menu item.

The modified volume setting will be retained through ignition cycles unless configured not to do so. If not configured, the volume setting will default to 100% on each new ignition cycle.

NOTE: The DIU can be configured to limit the minimum volume setting that the driver can select. The bar shown above always represents the adjustable range based on minimum and maximum values. For example, if the minimum value is set to 50% (midpoint between lowest (70 ± 3dB) and highest (89 ± 3dB) audio levels, the bar represents an adjustable range from 50% (approx. 80dB) to 100% (approx. 89dB). Once the minimum (or maximum) has been reached, a message will be shown indicating that further adjustment is not allowed (e.g. "Minimum volume reached"). The step change per button press is approximately 2dB.

E1.4 Distance Setting (Dist. Setting)

On systems where changes are permitted, the "Distance Setting" option from the main menu will adjust the following distance that the Bendix® Wingman® Fusion™ system will attempt to maintain while in the following distance mode. Distance Settings 1, 2, 3, and 4 will have different meanings based on the configuration chosen by the driver in Bendix® ACom® Diagnostic Software (version 6.9 or higher). Generally, 4 relates to the farthest distance setting available and 1 relates to the closest distance setting available. In many of the Fusion system configurations available in ACom, two or more distance settings may be made equivalent to one another.

For more information on user configurations available through the Bendix ACom Diagnostic Software, *see Section 5.4: Configuring Bendix Wingman Fusion System Following Distance Alerts* in this Service Data Sheet for further information.

Selecting "Dist. Setting" from the main menu displays the following screen:

(No LEDs Illuminated)

** Text may vary depending on the system installed*

E1.5 Distance Units (Dist. Units) *(See also E1.6 for metric units)*

From the "Dist. Units" menu item, the driver may choose to have the following distance from the forward vehicle displayed in either seconds or feet. By default, this item is set to seconds. If the driver selects feet, the DIU will display the approximate distance from the bumper to the selected forward vehicle in feet. If the driver selects seconds, the DIU will display the approximate distance from the bumper to the selected forward vehicle in seconds.

NOTE: Following distance in seconds is calculated based on the current speed of the Fusion system-equipped truck, and the distance, in feet, away from the selected forward vehicle. For instance, if the selected forward vehicle is 88 feet (27 m) from the bumper of the Wingman Fusion system-equipped truck, and the Fusion system-equipped truck is traveling 60 mph/97 kph, then the following distance in seconds would be 1.0 seconds because a truck traveling 60 mph/97 kph can travel 88 feet (27 m) in one (1) second.

E1.6 US/Metric

From this menu item, the driver may select whether English (U.S.) or Metric units are displayed. For instance in "Metric" mode, the following distance is shown in meters. In "U.S." mode, the following distance is shown in feet.

E1.7 Brightness

Selecting Brightness from the main menu displays the following screen:

(No LEDs Illuminated)

The driver uses the up (▲)/down (▼) arrow buttons to change the LCD backlighting, LED brightness and button backlighting. Pressing the OK button exits this menu item.

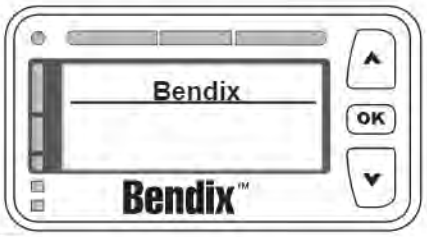
The light sensor reading determines whether the current cab lighting mode is bright (day) or dark (night). When the light mode is bright, any brightness adjustment made by the driver is applied to only the bright mode setting. Likewise, when the light radar sensor sets the light mode to dark, any brightness adjustment made by the driver is applied to only the dark mode setting. This functionality allows the driver to adjust the brightness setting for the two cab lighting conditions after which the DIU will automatically toggle between the two settings based on the light radar sensor's input. Both the bright mode setting and the dark mode setting are stored across power cycles.

NOTE: The DIU does not allow the brightness control to completely shut off the LEDs.

E1.8 System Status

This screen shows the configured features of the system and their current operational status (i.e., "Failed" or "OK"). The failed status means that some system malfunction is preventing the feature from properly operating and that the feature is not available for use by the driver at this time. Pressing "OK" exits this menu item.

(No LEDs Illuminated)



E1.9 Diagnostics

Selecting Diagnostics from the main menu displays any active Bendix® Wingman® Fusion™ system Diagnostic Trouble Code (DTC) conditions–including SAE standard diagnostic codes called J1939 SPNs (Suspect Parameter Numbers) and J1939 FMIs (Failure Mode Identifiers)–that may be present in the DIU and radar sensor. The following is a typical screen displayed in this mode when an active DTC is present:

(No LEDs Illuminated)

Note: The Forward Looking Radar (FLR) will not report newly active J1939 DTCs until the engine has been running for 15 seconds. Do not attempt to diagnose FLR J1939 DTCs without the engine running.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix E

Bendix® Driver Interface Unit (DIU™): Displays & Alerts

E2.0 Driver Demonstration Mode

Selecting Demo from the main menu starts a demonstration mode that shows the various lights, display screens, and sounds produced by the DIU – along with a brief explanation of their meaning – for the configured features. Pressing the down (▼) arrow button advances through the screens. The up (▲) arrow button has no functionality in this mode. Demonstration mode may be exited at any time by pressing the OK button.

NOTE: This mode can only be entered while the vehicle is not moving. Also, while in the demonstration mode, if the vehicle begins to move, the demonstration mode terminates.

If a screen is associated only with a configurable feature, and that feature is not configured, then that screen will not be shown in the demonstration mode.

The screens presented to the driver in the demonstration mode are shown with the following text: "Error! Reference source not found."

E3.0 Following Distance Alerts (FDAs)

One of the features of the Bendix® Wingman® Fusion™ system is the Following Distance Alert (FDA). A proprietary system combining vehicle speed, forward vehicle speed, distance, and driving scenario, FDAs are used to provide the driver with distance alerts which are intelligent, in that they will give appropriate distance alerts for the given situation. They alert the driver to objects far ahead in highway and country road driving situations, while not over-alerting in dense city traffic. They are available when the vehicle is travelling at speeds above 5 mph / 8 kph.

The radar sensor uses the DIU to communicate the FDAs to the driver. This system can be configured through Bendix® ACom® Diagnostic Software (version 6.9 or higher), for use by a fleet as a driver training tool with or without coordinating the data made available by Bendix Wingman Fusion system. In addition to being a reminder of when a driver may be dangerously close to the vehicle ahead, the following distance alerts may also be configured to reinforce safe following distance habits taught by the fleet.

The FDA is based on the following interval between the host vehicle and the object ahead. In other words, this is the time required by the host vehicle to travel forward and reach the object's current location. With the exception of the volume, the FDA may not be adjusted by the driver through the DIU. A qualified technician must connect to the vehicle through the diagnostic port and run ACom Diagnostic Software, in order to change the configuration. The volume can not be turned all the way down, but other adjustments may be made by the fleet. *See Section B1.3* for more details on volume adjustment.

The FDA system is intended only to alert the driver about following distance. For more information on alerts for forward objects with high relative velocities and sudden decelerations, *see Section B4.0: Impact Alert.*

Only objects detected in the vehicle's lane, traveling in the same direction, are considered valid objects for the FDA. For more information on stationary objects, *see Section B5.0: Stationary Object Alert.*

See Section 5.4: Configuring Bendix Wingman Fusion system Following Distance Alerts.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

⚠ WARNING

The driver is always responsible for the control and safe operation of the vehicle at all times. The Bendix Wingman Fusion system does not replace the need for a skilled, alert professional driver, reacting appropriately and in a timely manner, and using safe driving practices.

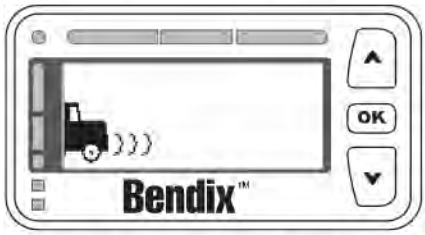
Appendix E

Bendix® Driver Interface Unit (DIU™): Displays & Alerts

E3.1 Object Detected

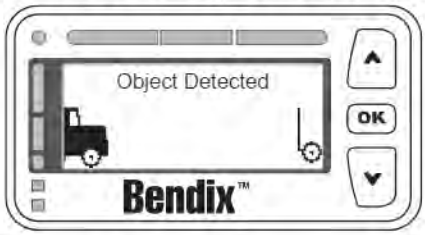
When there is no valid object detected and no other high priority alert is displayed, the DIU will stand by with the following screen:

(No LEDs Illuminated)



When a valid object is detected, and is outside the range of the first level of alert, and no other higher priority alert is displayed, the DIU will display the image shown below and no audio tones will be issued. The distance to the object will be displayed in large characters in the white space at the center of the screen (not shown) in seconds, feet, or meters, depending on the menu-selected preferences. By default, seconds will be displayed.

(No LEDs Illuminated)

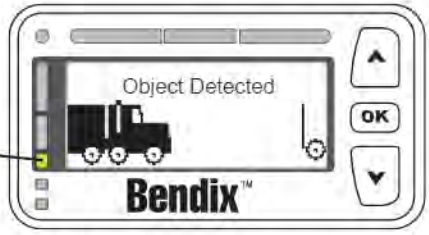


E3.2 Following Distance Alert (FDA) Level 3 *(Slow audible two-tone alert/single LED illuminated)*

When FDA Level 3 is issued, the following distance to the object/vehicle ahead has been reduced to the distance determined in the current configuration for FDA Level 3. The DIU will begin to give the driver audio and visual alerts for as long as the forward vehicle is in this zone and traveling at the same speed or slower.

The DIU will not display following distance units while in an FDA Level. For FDA Level 3, the audible alert will be a single repeating tone, and the visual alert is a single yellow LED and a screen with the vehicles slightly closer as shown below.

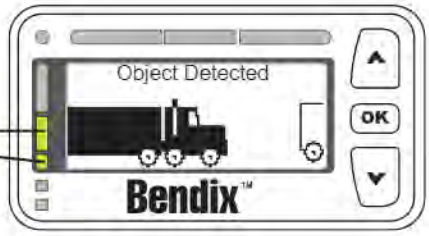
Single Yellow LED Illuminated



E3.3 Following Distance Alert (FDA) Level 2 *(Medium audible two-tone alert/two LED's illuminated)*

The DIU will give the driver audio and visual alerts for as long as the object/vehicle ahead is in this zone and traveling at the same speed or slower. The DIU will not display following distance while in an FDA Level. For FDA Level 2, the audible alert will be a repeating double tone, and the visual alert is two yellow LEDs and a screen with the vehicles closer as shown below.

Two Yellow LEDs Illuminated

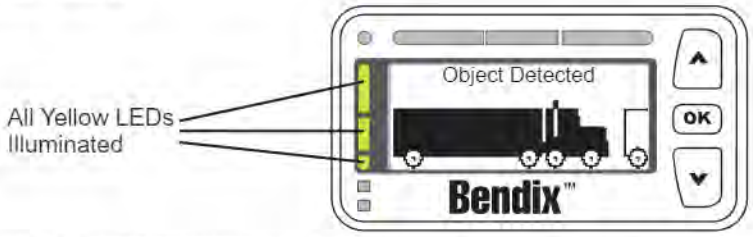


Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

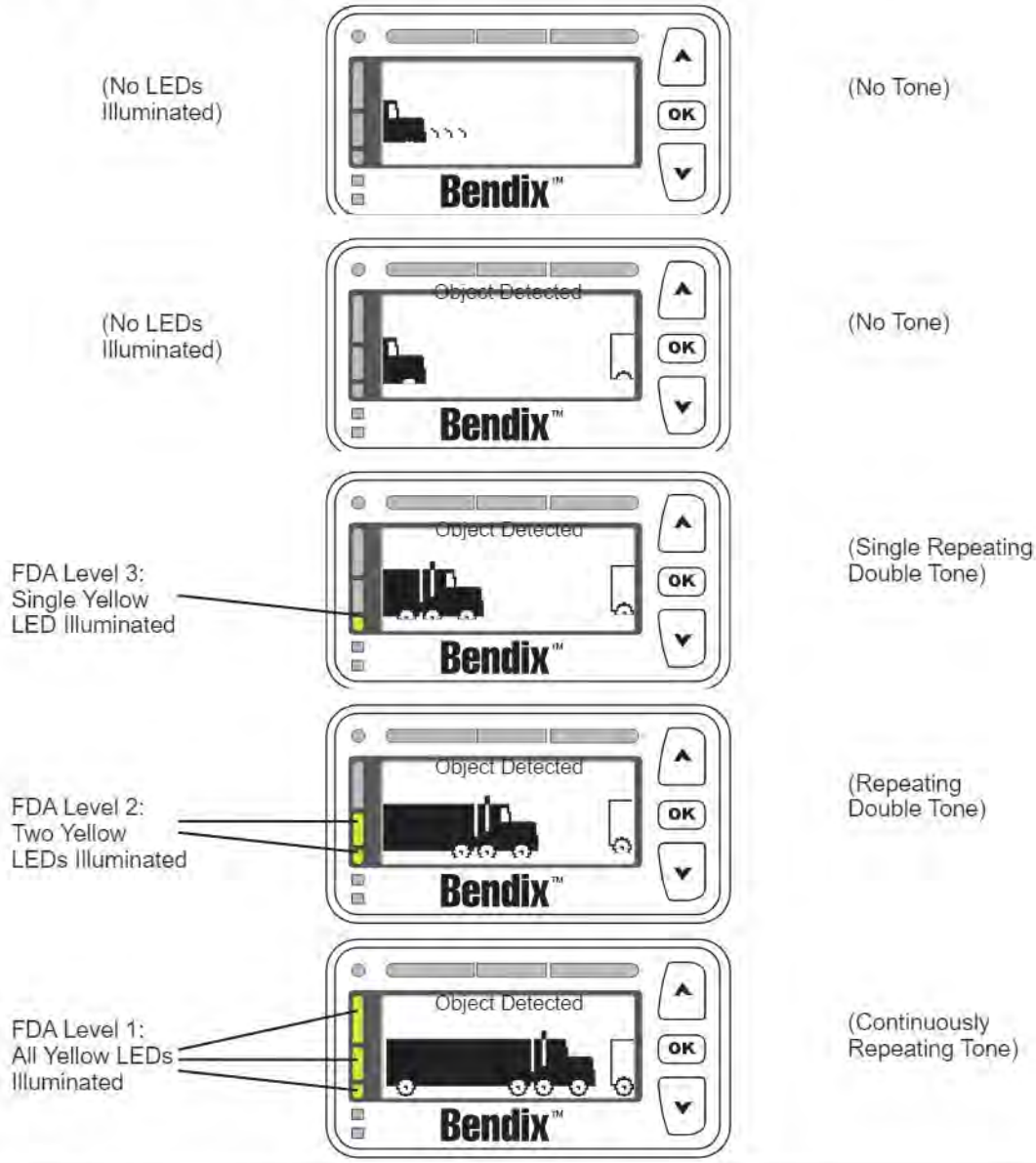
E3.4 Following Distance Alert (FDA) Level 1 *(Fast audible two-tone alert/three yellow LEDs illuminated)*

The DIU provides the driver with audio and visual alerts for as long as the vehicle ahead is in this zone and traveling at the same speed or slower. This is the closest and most urgent Following Distance Alert.

The DIU will not display following distance while in an FDA Level. For FDA Level 1, the audible alert will be a continuously repeating tone, and the visual alert is three yellow LEDs and a screen with the vehicles close as shown below:



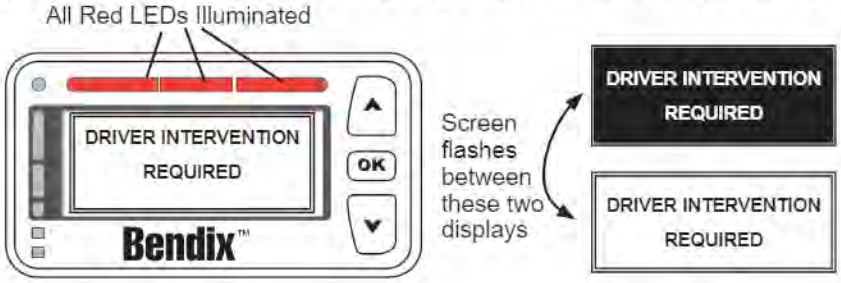
All five states of the FDA system can be seen together below.



Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

E4.0 Impact Alert (IA)

The "Impact Alert", uses a combination of distance to the vehicle ahead, plus high relative velocity, to decide when to issue a loud solid tone, as well as a visual indicator to the driver. The red LED bar across the top of the DIU will illuminate and "Wingman Adv. Requires DRIVER INTERVENTION" will flash using the two screens below:



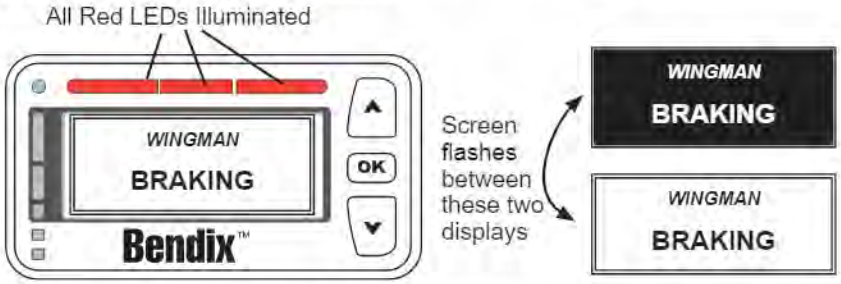
When the IA activates, the driver must immediately act to potentially avoid, or lessen the severity of, a collision.

The impact alert can not be configured or turned off.

NOTE: At most, the active cruise control with braking feature of Bendix Wingman Fusion system will apply the vehicle's brakes. The driver must apply additional braking, when necessary, in order to maintain a safe distance from the vehicle ahead.

E4.1 Collision Mitigation Braking (CMB)

If a collision is likely to occur, and the collision mitigation feature activates the foundation brakes, the tone of the alert will typically change and the display will be as shown below. The driver must immediately act to potentially avoid, or lessen the severity of, a collision.



NOTE: The collision mitigation feature of the Bendix Wingman Fusion system will apply the vehicle's brakes.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

E5.0 Stationary Object Alert (SOA)

Stationary Object Alert (SOA) is an alert given to the driver when the radar detects a sizeable, non-moving metallic object in the vehicle's path of travel. To reduce the number of false detections, such as bridges and overhead signs, a set of filters are put in place so the SOA will not warn on every stationary object. Typically the SOA is ready to alert the driver whenever the vehicle is moving above ten (10) mph / 16 kph, but some OEs/ fleets may select higher minimum speeds.

The SOA can be configured to be on or off through the display.

If a SOA is issued – up to three (3) seconds before a potential impact – the DIU will very briefly send out an alert identical to a very brief FDA Level 2: continuous tone and two yellow LEDs, with the display image switching between the two shown below.

E6.0 Stationary Vehicle Braking (SVB) Alert

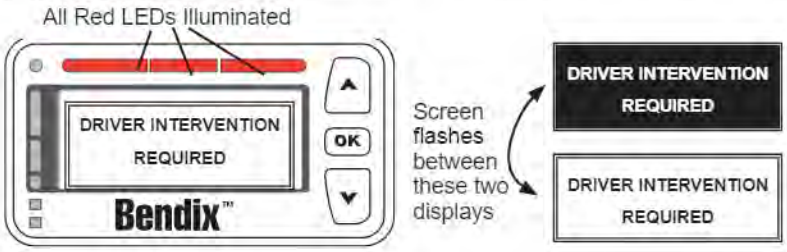
⚠ WARNING

When a large, stationary, metallic object in a vehicle's lane of travel is definitively identified as a vehicle, the driver is notified up to 3.5 seconds before impact.

***If the driver does not take action to address the potential impact that caused the alert*, Wingman Fusion can automatically engage the brakes to assist the driver in reducing the severity of or potentially avoiding a collision with that stationary vehicle. *If the system cannot definitively identify the stationary object as a vehicle*–for example, if the vehicle is not a licensed motorized vehicle, or certain types of trailers–the driver will get up to 3.0 seconds of alert to address the situation ahead; no automatic braking will be applied. Stationary Vehicle Braking is most useful when approaching a line of stopped traffic or a stalled vehicle that is not immediately recognized by the driver. Without the automatic alert and braking, it may be too late to avoid impact.**

⚠ CAUTION

The SVB is ready to alert the driver whenever the vehicle is moving above (15) mph / 24 kph, but although that figure is typical, some OEs/fleets may select higher minimum speeds. The driver should be especially careful when approaching certain types of vehicles or objects. The Bendix Wingman® Fusion™ system radar may not be able to detect vehicles with limited metal surfaces (such as recreational vehicles, horse-drawn buggies, motorcycles, logging trailers, etc.). *NOTE: Entering a curve may reduce the alert time.*



Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

E7.0 ACB (Active Cruise-control with Braking) Icon

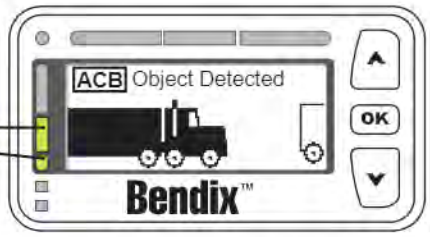
The ACB icon appears in the upper left-hand corner of the DIU's screen to indicate to the driver that the active cruise control with braking feature of the Bendix® Wingman® Fusion™ system is ready and able to intervene.

Once the driver sets cruise, the DIU will display the set speed and the ACB icon as shown below.

(No LEDs Illuminated)

When a forward vehicle is detected and either the distance to the vehicle or a following distance alert is shown, the ACB icon should remain on the screen if the active cruise control feature of the Wingman Fusion system is still engaged and ready to intervene.

Two Yellow LEDs Illuminated



NOTE: If the ACB icon is not displayed on the screen, the driver must assume that the active cruise control with braking feature of the Bendix Wingman Fusion system is not ready, or able, to intervene!

E8.0 Brake Overuse Alert

⚠ WARNING

The Bendix Wingman Fusion system provides a warning when the system is intervening and using the foundation brakes excessively. Overuse of the foundation brakes can lead to the brakes overheating and a potential loss of braking performance caused by brake fade. Using cruise control on downhill runs will cause this alert to be activated.

⚠ WARNING

Approach grades as you would normally, with the appropriate gear selected and at a safe speed. Cruise control should *NOT* be used on downhill grades.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

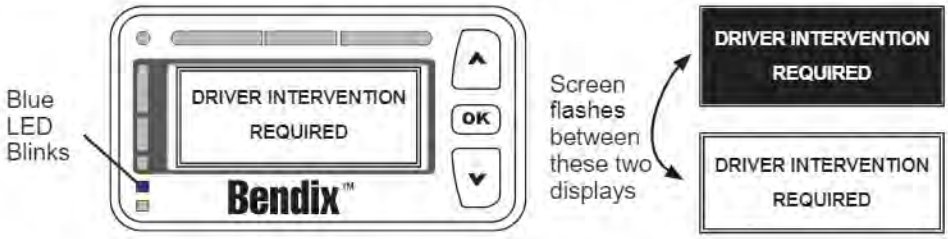
Appendix E

Bendix® Driver Interface Unit (DIU™): Displays & Alerts

⚠ CAUTION

Cruise Control should *NOT* be used on downhill grades. Approach grades as you would normally, with the appropriate gear selected and at a safe speed.

To guard against foundation brake overuse by the active cruise control with braking feature of the Bendix® Wingman® Fusion™ system, the frequency of foundation brake interventions is monitored. If the system detects a situation where the brakes are being applied too frequently by the system in a given time period, the brake overuse alert will activate. This is designed to help prevent overheating of the brakes, which may lead to brake fade and reduced vehicle braking capability. In this situation, the Brake Overuse Alert (BOA) will flash a message requesting driver intervention. Also, an audible alert will sound and a blue LED will blink on the Bendix Driver Interface Unit (DIU™), as illustrated below:



This alert will continue for 15 seconds, during which time the driver should step on the brake or turn off cruise control using the cruise control on/off switch.

If the system detects that the driver has intervened within 15 seconds after a brake overuse alert

(Typically by applying the brakes, or cancelling cruise control)

- The intervention cancels cruise control.
- After a BOA, for a period of time (typically 20 minutes), the Wingman Fusion system ***will not use the foundation brakes*** when intervening. The system will be limited to de-throttling the engine and applying the engine retarder. **NOTE: In all cases, the driver still has the ability to apply the foundation brakes if necessary. The driver should take care since overheated brakes may reduce the vehicle's braking capability.**
- The time period for this mode is measured from the time the BOA was activated and lasts approximately 20 minutes.
- NOTE: The driver will continue to receive all three alerts (Following Distance, Impact, and Stationary Object).
- Additionally, the DIU message will change to "ACB Braking Overuse" and the blue LED will remain lit, as shown below:

At the end of the "cooling-off" period, the "ACB Braking Overuse" message and the blue LED will turn off.

If the system does not detect an intervention by the driver within 15 seconds after a brake overuse alert

- **The system will shut itself off, and set a Diagnostic Trouble Code (DTC).**
- **All intervention features of the Fusion system will be disabled until the next ignition cycle.**
- NOTE: The driver will continue to receive all three alerts (Following Distance, Impact, and Stationary Object).
- **NOTE: In all cases, the driver still has the ability to apply the foundation brakes if necessary. The driver should take care since overheated brakes may reduce the vehicle's braking capability.**

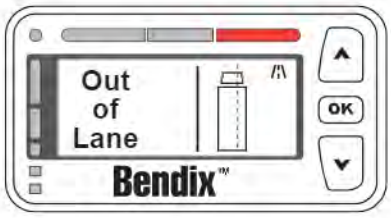
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

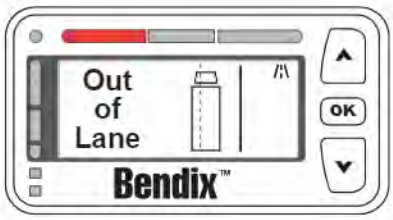
E9.0 Lane Departure Warning (LDW) Alert

⚠ WARNING

The Bendix® Wingman® Fusion™ system has the ability to warn the driver if the vehicle is not tracking in the intended roadway path. In most vehicle applications the LDW system is enabled above 37 mph / 60 kph. The driver should immediately correct the vehicle tracking and maintain the correct position in the lane.

Red LED illuminated indicates
the direction of departure





E10.0 Overspeed Alert

⚠ WARNING

The Bendix Wingman Fusion system has the ability to warn the driver if the vehicle's speed exceeds the posted legal limits. The Overspeed Alert is enabled when the vehicle is traveling greater than 5 mph/8 kph from the posted limit. The driver should immediately reduce the vehicle's speed to the posted legal limit.

Example of Overspeed Alert Display

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

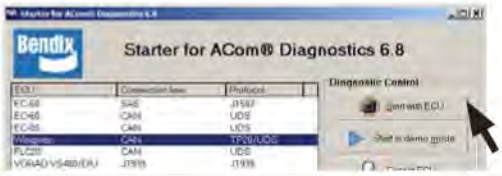
APPENDIX F - HOW TO GENERATE, READ AND RESET THE BENDIX® WINGMAN® SYSTEM DIAGNOSTIC TROUBLE CODES (DTCs) USING BENDIX® ACOM® DIAGNOSTIC SOFTWARE

Appendix F

F1: How to Generate a DTC Report with Bendix ACom Diagnostic Software

1. Select the Bendix® ACom® Diagnostic Software desktop icon.

2. Select "Wingman" from the starter screen. Click "Start with ECU".



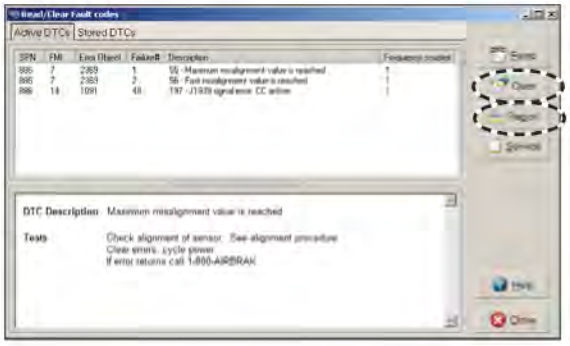
3. Read Bendix® Wingman® Fusion™ system status screen.

A. Take Note of: Model #, Software Version, Software P/N, Active DTCs

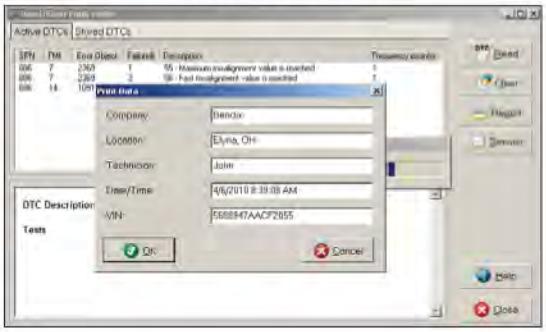
B. Click DTCs

4. Select "Read". Active DTCs are shown along with descriptions of the codes and tests that can be run to troubleshoot the code. You can select "Stored DTCs" also, to show inactive DTCs.

5. Click "Clear" to clear all active DTCs. Click "Report" to get the ACom report.



6. Fill in the requested information: Company, location, technician, date/time, VIN, and click "OK"



7. Select how you want the report displayed or printed. Then click "OK".

8. The event report is generated. This can be saved if desired.

9. You can also use the shortcut menu at the top of the screen and select: Fusion status; DTCs; and Controller Configuration.

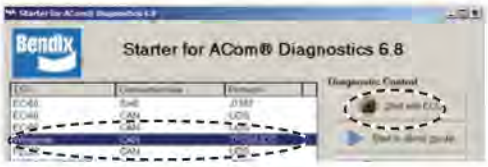
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix F

F2: Reading Bendix® Wingman® Fusion™ System Diagnostic Trouble Code (DTC) Reports with Bendix® ACom® Diagnostic Software

1. Select the Bendix® ACom® Diagnostic Software desktop icon.

2. Select “Wingman” from the starter screen. Click “Start with ECU”.



3. Select “DTC”.

For reference

4. Select "Read". Active DTCs are shown along with descriptions of the codes and tests that can be run to troubleshoot the code. You can select “Stored DTCs” also, to show inactive DTCs.

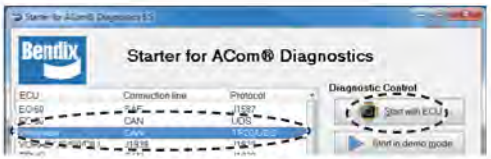
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Appendix F

F3: Clearing Bendix® Wingman® Fusion™ System Diagnostic Trouble Codes (DTCs) with Bendix® ACom® Diagnostic Software

1. Select the Bendix® ACom® Diagnostic Software desktop icon.

2. Select “Wingman” from the starter screen. Click “Start with ECU”.

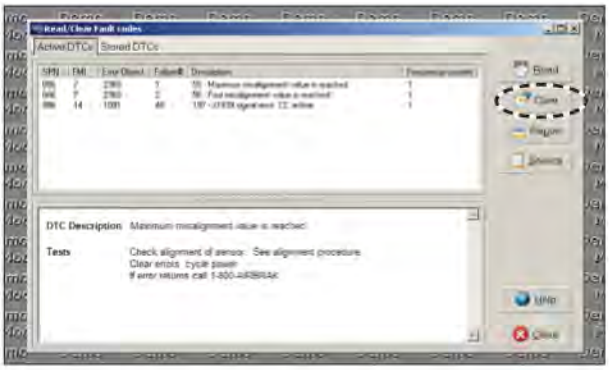


3. Select “DTC”.

For reference

4. Select "Read". Active DTCs are shown along with descriptions of the codes and tests that can be run to troubleshoot the code. You can select “Stored DTCs” also, to show inactive DTCs.

5. Select “Clear” to clear all active DTCs.



Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

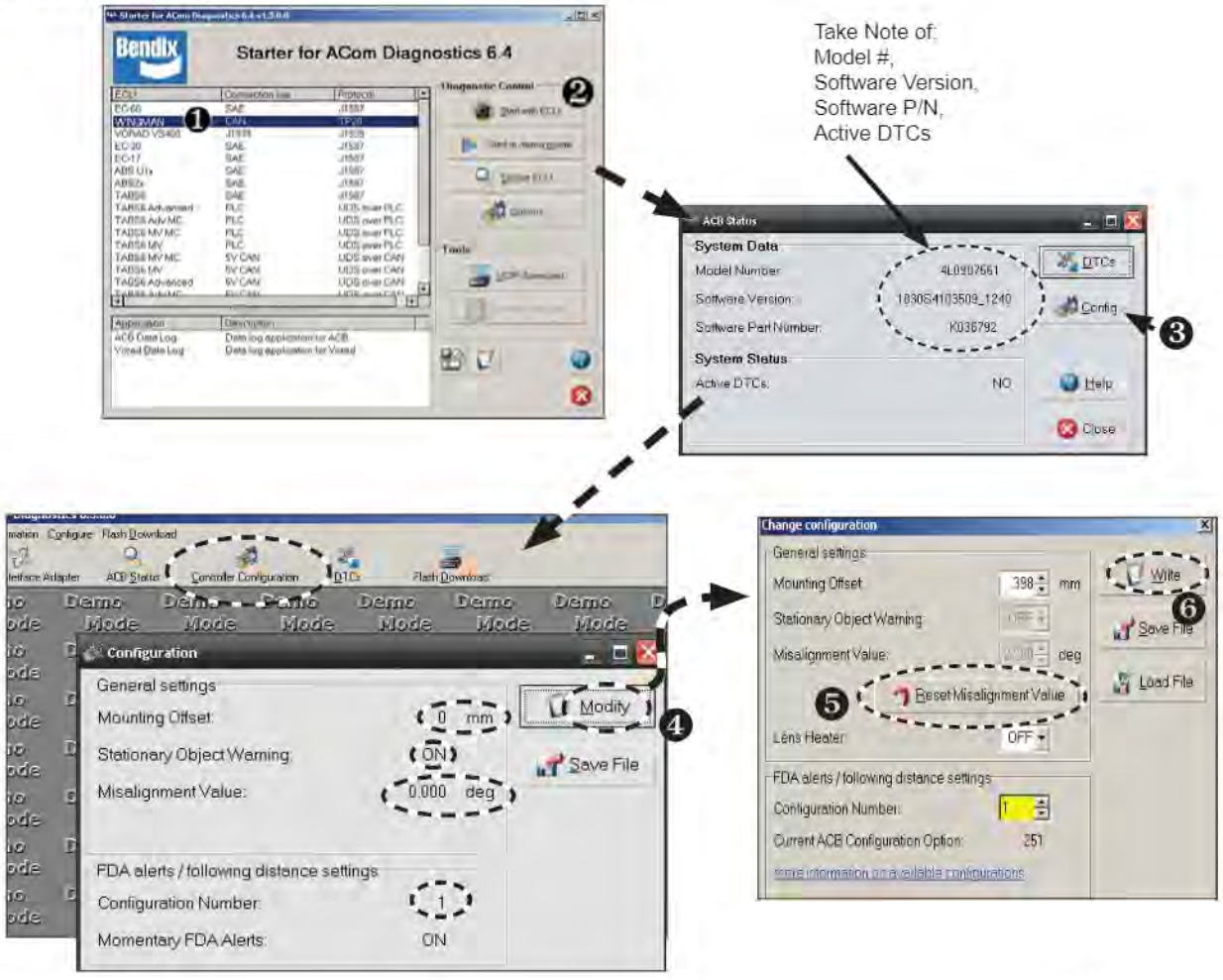
APPENDIX G - HOW TO READ KEY SYSTEM INDICATORS AND RESET ALIGNMENT VALUES

Appendix G

How to Read Key System Indicators and Reset the Alignment Value

Read System Key Indicators (Configuration)

1. Start the Bendix® ACom® Diagnostic Software and connect the computer to the vehicle.
2. Select "Advanced" and Click "Start with ECU" to display the "Fusion Status" window.
3. Click "Config" to display the indicators



System Key Indicators						
Attribute	**Description**					**See Section:**
Mounting Offset	This value should equal 0 if the radar sensor is mounted on the center line of the vehicle. If the service technician believes the radar sensor should be mounted offset from center, call 1-800-AIR-BRAKE (1-800-247-2725), option 2.					Appendix A
Stationary Object Warning Indicator	This is a status indicator for the function of stationary object warning. Available for use in Bendix® Wingman® Fusion™ system versions since 2010.					1.8
Alignment Value	Trouble code will be set if value is -1.3° or less	Abnormal operation: -0.8°	Normal operation: normal	Abnormal operation: 0.8°	Trouble code will be set if value is 1.3° or more	*(Appendix B, Sections B2 & B3)*
Configuration Number	This indicates the distance setting and following distance alert that are configured for the vehicle. Refer to Table 7 for setting information.					*Appendix J*

How To Reset The "Alignment Value"

4. From the configuration window shown above, click "Modify."
5. From the Change Configuration window, select "Reset Alignment Value."
6. Click "Write."
7. Cycle the vehicle ignition power to complete the process.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2), for troubleshooting assistance.

APPENDIX H - HOW TO CHANGE THE FOLLOWING DISTANCE ALERT (FDA) SETTINGS AND ENABLE MOMENTARY BEEPING

Appendix H

How to Change the Following Distance Alert (FDA) Settings and Enable Momentary Beeping

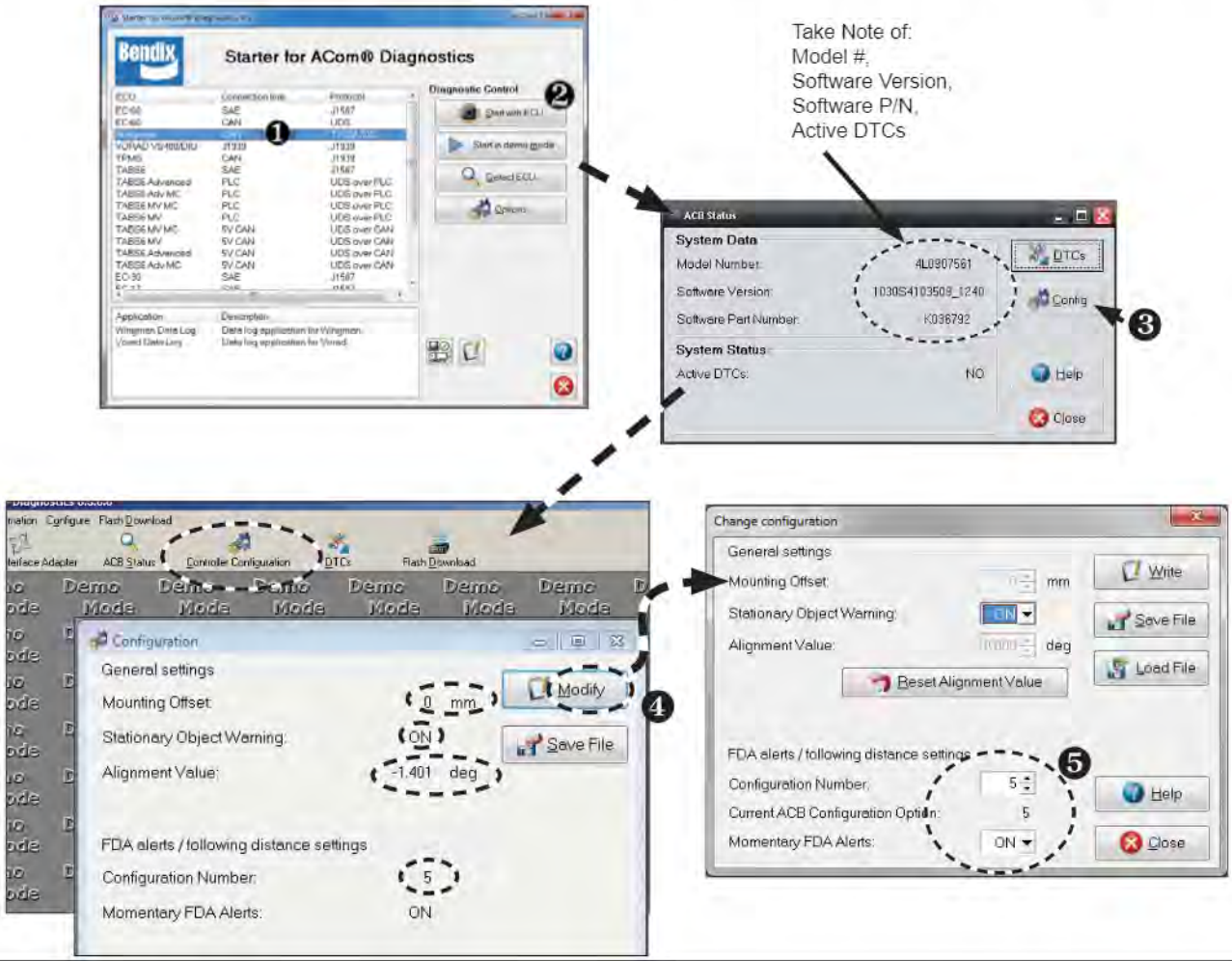
Steps to Display the Indicators

1. Start Bendix® ACom® Diagnostic Software and connect to vehicle.
2. Select "Advanced" and Click "Start with ECU" to display the "Fusion Status" window.
3. Select "Config" to display the indicators

Steps to CHANGE the indicators

Important: You will need the correct Bendix ACom Diagnostic Software license key from Bendix. Call 1-800-AIR-BRAKE (1-800-247-2725, option 2) and speak with the Tech Team if you do not already have the license key.

1. Select "Modify".
2. Modify the configuration number to change the FDA settings and also enable or disable momentary FDAs as needed.

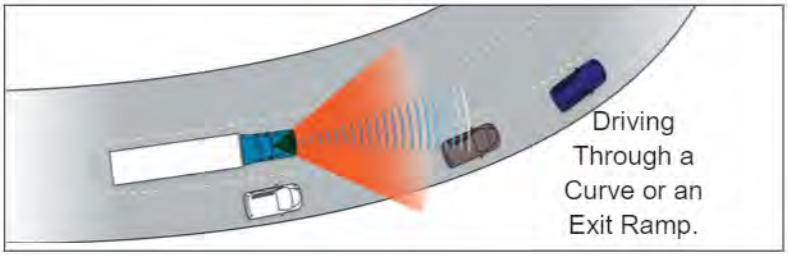


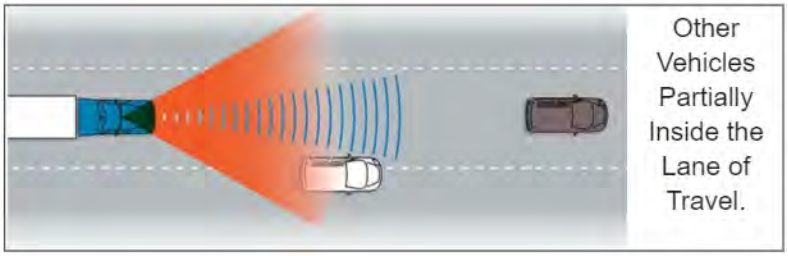
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

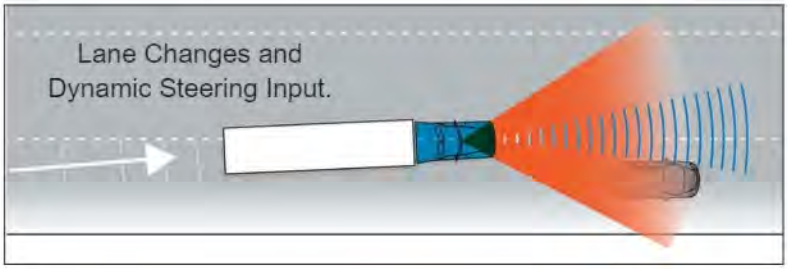
APPENDIX J - SITUATIONS THAT MAY CAUSE FALSE ALERTS BY THE BENDIX® WINGMAN® FUSION™ SYSTEM

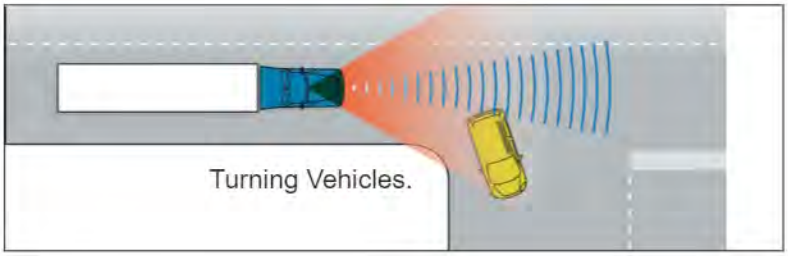
Appendix J

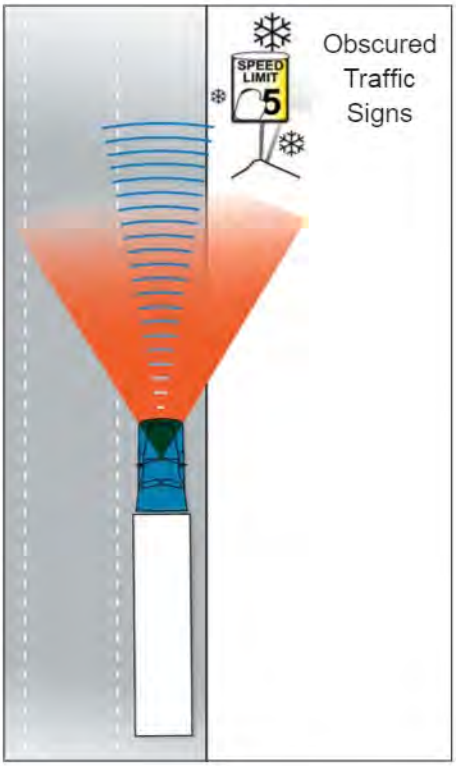
The following charts illustrate situations that may cause false alerts. The Bendix® Wingman® Fusion™ system may unexpectedly issue warnings, apply braking, or not respond.

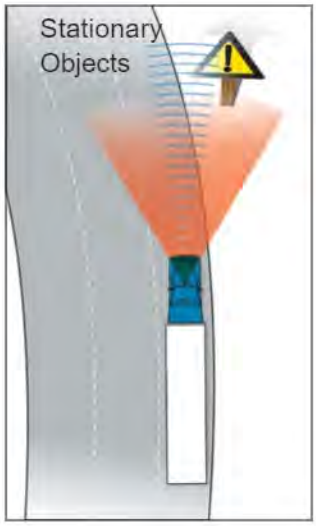












Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

APPENDIX K - SYSTEM OPERATION

K1.0 OPERATION SECTION

K1.1 IMPORTANT SAFETY INFORMATION

Read and follow the General Safety Guidelines shown on page two of this document.

⚠ 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.

This vehicle's cruise control must be used only in the same conditions that are normally recommended for ordinary cruise control.

Vehicle manufacturers may use alerts, messages, and dash arrangements that vary from the examples shown here. Consult the vehicle operator's manual for applicable details regarding use and operation.

K1.2 WHEN NOT TO USE THE BENDIX® WINGMAN® FUSION™ SYSTEM ACTIVE CRUISE CONTROL WITH BRAKING

The active cruise control with braking feature in the Bendix Wingman® Fusion™ system is automatically ready when normal cruise control is set.

⚠ CAUTION

This vehicle's cruise control must be used only in the same conditions that are normally recommended for ordinary cruise control. As noted below, there are certain situations when cruise control should *NOT* be used.

• **Inclement Weather/Low Visibility Situations** – Do not use cruise control in inclement weather or low visibility conditions such as rain, snow, smoke, fog, ice or other severe weather conditions that may affect the performance of the Bendix Wingman Fusion system.	
• **Dense Traffic** – Do not use cruise control in heavy traffic.	
• **Sharp Curves and Winding Roads** – Do not use cruise control when traveling sharply curved or winding roadways. CAUTION: Road curvature may impact the radar's ability to track vehicles ahead in the same lane.	
• **Entrance or Exit Ramps** – Do not use cruise control when entering or exiting roadways.	
• **Downhill Grades** – Do not use cruise control on downhill grades.	
• **Construction Zones** – Do not use cruise control in construction zones.	
• **Off-Road** – Do not use cruise control in off-road conditions.	
• **Smaller Forward Vehicles** – Smaller vehicles, such as motorcycles or certain types of trailers, may be difficult for the radar to identify. It is the driver's responsibility to be aware of these types of vehicles and to slow down if necessary.	

Visit the Wingman Fusion web page – under the Products tab of www.bendix.com – for more information, along with any updates to these limitations and restrictions.

K1.3 AUTOMATIC FOUNDATION BRAKE APPLICATIONS

The vehicle automatically manages foundation brake priorities among the various vehicle systems that use the foundation brakes, such as the Bendix® Wingman® Fusion™ system, Bendix® ESP® Electronic Stability Program, Bendix® ATC (Automatic Traction Control) and Bendix® ABS (Antilock Braking System).

NOTE: Cruise Control will automatically cancel whenever the Wingman Fusion system applies the foundation brakes. The driver can verify that the cruise control is disengaged by observing that the cruise-enabled icon is no longer illuminated. The driver must resume or set cruise control in order to regain normal cruise control functionality and to reengage the active cruise control with braking feature of the Fusion system.

Additional information, and complete troubleshooting procedures for the Bendix® ESP® EC-80™ Controller, can be found in the *Bendix Service Data Sheet SD-13-4986*.

K1.4 SYSTEM COMPONENTS

The Bendix Wingman Fusion system. *(See Figure 2)* has five major components, plus indicator switches and lamps.

1. A Bendix® Wingman® FLR20™ radar is located at the front of the vehicle – either on the bumper or just behind it on a cross-member. *See Figure K1.*

Figure K1 – Component: Radar Sensor

The radar sensor is pre-aligned at the factory and no adjustment should be needed. If the radar sensor becomes misaligned (or a Diagnostic Trouble Code [DTC] is issued), either a message – or light on the dash, depending on the vehicle – lets the driver know that service is needed.

K1. A Bendix™ AutoVue® FLC20™ Camera is a visible-light spectrum camera mounted near the top and center of the windshield of the vehicle. *See Figure K2.*

Figure K2 – Component: Camera

The Bendix AutoVue system supplies feedback to the driver during Lane Departure Warning (LDW) incidents using audible alerts and/or seat vibrations. In the Bendix Fusion system, the camera supplies supplemental visual data that – along with the radar sensor – helps the system generate data about the traffic and environment around the vehicle.

3. A Bendix ESP EC-80 Controller – located in the cab of the vehicle – controls the antilock braking and full stability functions for the vehicle, using a set of wheel-speed, yaw, steering-angle and load sensors. In the Bendix Wingman Fusion system, the Controller also manages any actions requested by the Fusion system. *See Figure K3.*

Figure K3 – Component: Bendix ESP EC-80 Controller

4. A SafetyDirect® By Bendix CVS Web Portal Processor – located close to the camera in the cab of the vehicle – typically in an over the windshield compartment. *See Figure K4.*

Figure K4 – Component: SafetyDirect Web Portal Processor

The web portal processor communicates data to the vehicle's telematics system for relay to the web servers.

5. A system to communicate between the driver and the Wingman Fusion system. Depending on the OEM, the Bendix® Driver Interface Unit (DIU™) is used, or system messages are displayed via the vehicle dashboard. *See Figure K5.*

Figure K5 – Bendix Driver Interface Unit (DIU™)

A set of visual, text, and audible indicators and alerts will be provided by the Bendix DIU or OEM dash display. *For more about the Bendix DIU, see Appendix B.*

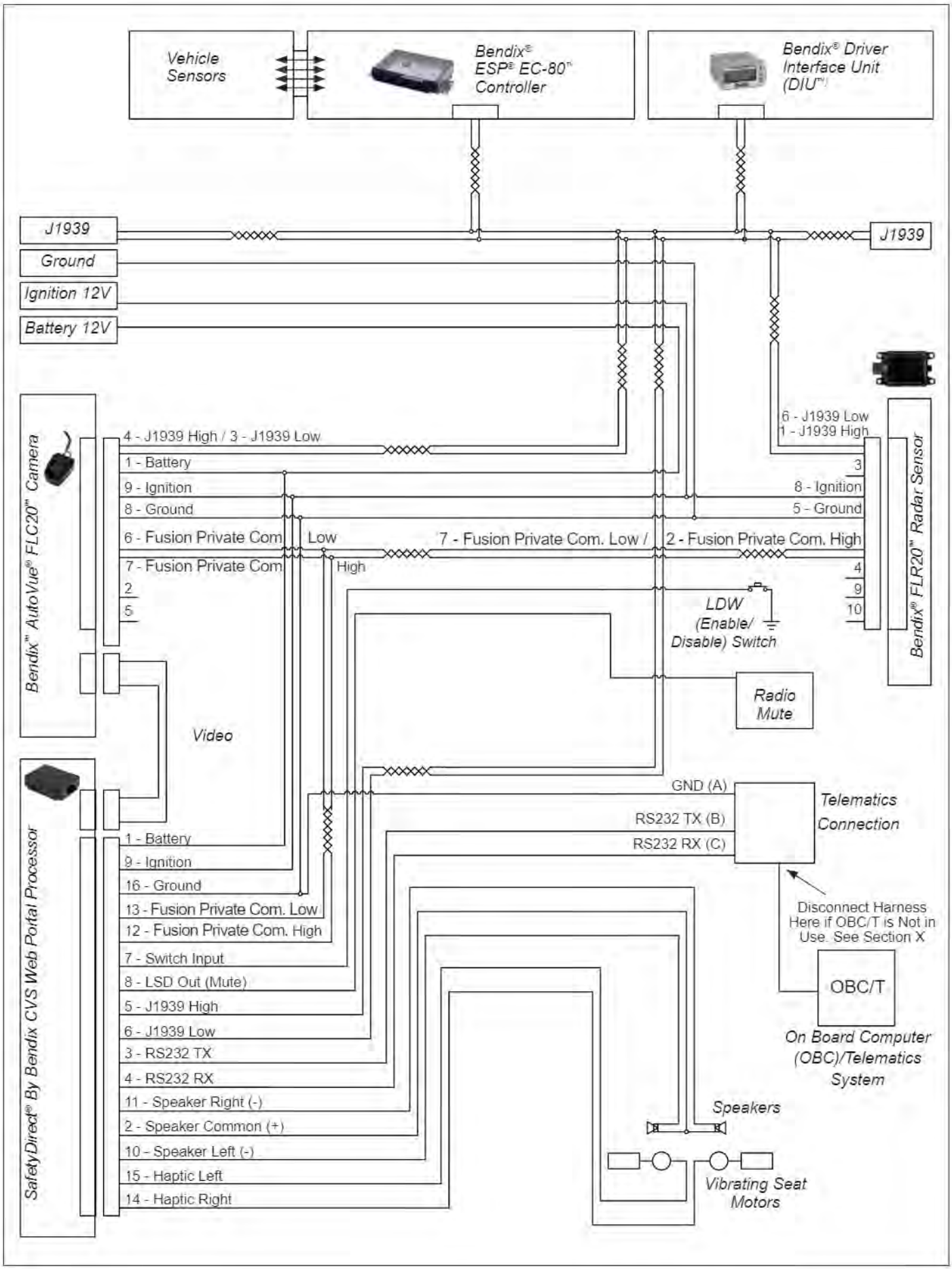


Figure K6 – Main Bendix® Wingman® Fusion™ System Component Schematic

Also see the Indications and Alerts section of Appendix K for more detailed information about the alerts.

K1.5 DASH SWITCHES AND LAMPS

Each OEM typically has a different arrangement to display the system status and to allow the driver to temporarily disable the Lane Departure Warning (LDW) system. Refer to the OEM Operator's Manual for any system indicator lamp(s). *See Figure K6 for some examples of OEM icons used at the time this document was published.*

Dash/Switch Icon. (The design will vary by vehicle OEM. In some cases, the switch and lamps may be separate.)	International®	Kenworth®
		
Mack®	Peterbilt®	Volvo®
		

* All trademarks shown here are the property of their respective owners and are used for reference only.

Figure K6 – Dash Switch Icons

K1.6 TEMPORARILY DISABLE THE LANE DEPARTURE WARNING (LDW)

To avoid erroneous LDW warnings in areas such as work zones – where the road markings present might cause false alerts – Bendix® Wingman® Fusion™ systems feature an enable/disable switch, either the Bendix design shown below or a similar OEM switch. Applying the switch will suppress alerts for fifteen minutes; the system auto-resets afterwards.

The design will vary by vehicle OEM. The switch and lamps may be separate.

Figure K7 – Example of an LDW Enable/Disable Switch

Additionally, the system self-monitors and will set a Diagnostic Trouble Code (DTC) that will typically alert the driver using a similar icon on the dash display or by a status lamp.

See Section 2 *"Troubleshooting"*, for more information. *See Figure K6 for a wiring schematic showing the connections between the various system components.*

K1.7 ACTIVATE THE BENDIX WINGMAN FUSION SYSTEM ACTIVE CRUISE CONTROL

To have the benefits of the active cruise control feature of the Fusion system, the vehicle's regular cruise control must be switched on. *See Figure K8 for examples of switches that may be used.*

Figure K8 – Examples of Cruise Control Switches

When the vehicle reaches the desired cruise speed, the driver presses the cruise control set switch to activate the system. The Wingman Fusion system will then engage and help the driver maintain a set following distance behind the vehicle traveling in front.

Once the cruise control speed is set, a cruise-enabled icon (or similar) will illuminate on the instrument panel. If the cruise-enabled or set (or similar) icon does not illuminate, the Fusion system may not function normally. Refer to the vehicle operator's manual to double-check the location of the icon, and for further troubleshooting information. There will typically be a bulb-check for the icon at vehicle start-up.

The driver can switch off the Bendix Wingman Fusion active cruise control system manually by either stepping on the brake pedal or switching off the cruise control.

IMPORTANT NOTE: Cruise control will automatically cancel whenever the Bendix Wingman Fusion system applies the foundation brakes.

K1.8 WHAT TO EXPECT WHEN USING THE BENDIX® WINGMAN® FUSION™ SYSTEM

Table K1, parts 1–2, illustrate what to expect from the Bendix® Wingman® Fusion™ system in various driving situations. Typical system indications and actions to expect from the system are illustrated.

Part 1: All driving scenarios (Cruise Control is either "on" or "off")		
What to Expect		
Situation	**Typical System Indication/Alerts**	**Typical System Actions/Cautions**
Stationary objects/vehicles ahead in the lane of travel		
A stationary–non-vehicle–object is detected ahead in the lane in which the truck is traveling.	A Stationary Object Alert (SOA) may be issued up to three (3) seconds prior to impact.	None. **⚠ WARNING** **The driver must immediately act to potentially avoid, or lessen the severity of, a collision.**
A stationary motor vehicle is detected ahead in the lane in which the truck is traveling. ***NOTE: Factors that can potentially affect the system's ability to identify a vehicle include: if the vehicle is not a licensed motorized vehicle; or certain types of trailers.***	If the vehicle is traveling above 10 mph / 16 kph, a Stationary Vehicle Alert (SVA) may be issued up to three-and-a-half (3.5) seconds prior to impact.	**⚠ WARNING** **The driver must immediately act to potentially avoid, or lessen the severity of, a collision.** If a collision is likely to occur, the Wingman Fusion system will apply the vehicle's brakes. If a collision is likely to occur the System can provide a warning and/or apply the vehicle brakes to lessen the severity or prevent impact.
Moving objects/vehicles ahead in the lane of travel		
The vehicle comes up fast behind a slower-moving detected forward vehicle.	The Following Distance Alert (FDA) will sound and a visual message/icon typically appears on the dash screen or Bendix® Driver Interface unit (DIU™) display. Depending on how close the vehicle approaches, the system may initiate an Impact Alert (IA) warning.	None. **The driver must respond as needed.**
The detected forward vehicle slows rapidly.	The Following Distance Alert (FDA), or Impact Alert (IA) warning (continuous tone) will sound and a visual message/ icon typically appears on the dash screen or DIU display.	None. **The driver must respond as needed.** If a collision is likely to occur, the collision mitigation feature will apply the vehicle's brakes.
A pedestrian, deer or dog runs in front of the truck.	None	None. **The driver must respond as needed.**
Another vehicle crosses the road perpendicular to the vehicle's path of travel – such as at an intersection.	None	None **The driver must respond as needed.**
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.		

Table K1 – Part 1 - Operational Scenarios with the Bendix Wingman Fusion System

Part 1: All driving scenarios (Cruise Control is either "on" or "off")		
What to Expect		
Situation	**Typical System Indication/Alerts**	**Typical System Actions/Cautions**
Lane Departure System Active (Lane detection icons being displayed)		
The vehicle signals a lane-change and crosses a lane-marking.	None.	None.
Traveling below 37 mph / 60 kph, the vehicle crosses a lane-marker (without the corresponding turn signal activated).	None.	None. **The driver must respond as needed.**
Traveling above 37 mph / 60 kph, the vehicle crosses a lane-marker (without the corresponding turn signal activated).	A "rumble strip" audible/ vibration/visual alert is initiated.	None. **The driver must respond as needed.** (The driver must use the turn signal when changing lanes and/or keep the vehicle within the lane markings.)
Overspeed Alert & Action International travel: When changing between regions which post speeds in miles and those which post in kilometers, the speed limit sign recognition feature will not function until the correct U.S./Metric selection has been made.		
The vehicle passes a U.S. or Canadian speed limit sign.	The DIU will display the posted speed limit.	None.
The vehicle exceeds the posted speed limit by 5 to 9 mph (8 to 14 kph).	An overspeed alert will be issued and the posted speed limit will be visually presented to the driver.	None.
The vehicle exceeds the posted speed limit by more than 10 mph / 16 kph.	An audible overspeed alert and the posted speed limit will be visually presented to the driver, to signal that the vehicle should slow down.	**If cruise control is NOT ON:** A one-second de-throttle of the engine will occur.
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.		

Table K1 – Part 1 - Operational Scenarios with the Bendix Wingman Fusion System

NOTE: The system indicators/alerts above are typical, but may vary from the descriptions shown here by vehicle manufacturer, or earlier versions of the Fusion system.

NOTE: These are examples of situations and typical Wingman Fusion system responses. However, this chart does not attempt to cover all possible situations.

⚠ Due to the inherent limitations of radar and camera technology, the enhanced Collision Mitigation Technology – on rare occasions – *may not* detect moving vehicles or stationary vehicles in the vehicle's lane of travel. Alerts, warnings, or brake interventions may not occur.

⚠ Due to the inherent limitations of radar and camera technology, the enhanced Collision Mitigation Technology – on rare occasions – *may react* to moving vehicles not in the vehicle's lane of travel. Alerts, warnings, or brake interventions may occur.

What to Expect (K1.8)		
Part 2: Cruise Control "on" and speed "set"		
Situation	**Typical System Indication/Alerts**	**Typical System Actions/Cautions**
Interactions with vehicles ahead in your lane of travel		
With no detected forward vehicle.	None.	The vehicle maintains the set speed.
With a detected forward vehicle.	The cruise control ON indicator is illuminated and the detected forward vehicle icon is illuminated.	The active cruise control with braking feature will maintain the set speed and following distance.
The detected forward vehicle slows **moderately**.	The Following Distance Alert (FDA) will sound and a visual message/icon typically appears on the dash screen or Bendix® Driver Interface Unit (DIU™) display.	**The driver must respond as needed.** If the system intervenes, the vehicle throttle will be reduced; the engine retarder engaged; and the foundation brakes applied, in that order. ***NOTE:*** *When the foundation brakes are applied, cruise control is cancelled.*
The detected forward vehicle slows **rapidly**.	The Impact Alert (IA) warning (continuous tone), will sound and a visual message/icon typically appears on the dash screen or DIU display. The FDA may also be heard.	**The driver must respond as needed.** If the system intervenes, the vehicle throttle will be reduced; the engine retarder engaged; and the foundation brakes applied, in that order. ***NOTE:*** *When the foundation brakes are applied, cruise control is cancelled.*
The detected forward vehicle cuts in front of the vehicle **but then speeds away.**	Following Distance Alerts may be given to the driver, depending on the exact system configuration set for the vehicle, and how close the vehicle cuts in front.	Vehicle maintains set speed.
Downhill grades		
Going down a grade with a detected forward vehicle. Cruise control should ***NOT*** be used on downhill grades - *see page 3.* *(See the CDL manual instructions on proper gear usage for downhill grades.)*	DO NOT USE cruise control on downhill grades.	*DO NOT USE cruise control on downhill grades.*

Table K1 – Part 2 - Operational Scenarios with the Bendix® Wingman® Fusion™ System

NOTE: The system indicators/alerts above are typical, but may vary from the descriptions shown here by vehicle manufacturer, or earlier versions of the Fusion system.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

K1.9 HOW A DRIVER INTERACTS WITH THE BENDIX® WINGMAN® FUSION™ SYSTEM

Table K2 illustrates how the Bendix® Wingman® Fusion™ system will respond to various actions a driver may take when using the Fusion system on the road.

⚠ WARNING

The driver is always responsible for the control and safe operation of the vehicle at all times. The Bendix Wingman Fusion system does not replace the need for a skilled, alert professional driver, reacting appropriately and in a timely manner, and using safe driving practices.

How a Driver Interacts with the Bendix Wingman Fusion System (1.5)	
If the driver does this:	**Expect the Wingman Fusion system to do this:**
Steps on the brake. (During a collision mitigation event.)	The driver is always in control and is able to apply full braking power.
Steps aggressively on the accelerator. (During a collision mitigation event.)	The driver is always in control. His/her actions override any Fusion system actions. Note: If cruise control is engaged, it will be overridden until the accelerator is released; then cruise control will resume the original set speed automatically.
Steps on the brake. (When in cruise.)	Cruise control will be cancelled.
Steps on the accelerator. (When in cruise.)	Cruise control will be overridden until the accelerator is released; then cruise control will resume the original set speed automatically.
Switches on the cruise control.	Nothing. The active cruise control with braking feature will not engage until the driver sets the cruise control speed.
Switches off the cruise control.	The active cruise control with braking feature will turn off; the collision mitigation feature remains active and ready to intervene. The driver will continue to hear all alerts as needed.
Sets the cruise control speed.	The active cruise control with braking feature is automatically activated. The driverr vehicle maintains a set speed and following distance behind the vehicle ahead.
Covers or blocks the radar.	The Fusion system performance will be diminished or even disabled and a Diagnostic Trouble Code (DTC) will be set. A blockage will also affect engine cruise control availability.
Uses normal cruise control "+/-" switch.	Vehicle speed increased (+) or reduced (-) to achieve the new set speed while actively maintaining following distance with the vehicle ahead, if one is present within 500 feet (152 m).
Presses the Lane Departure Warning (LDW) enable/disable switch.	The LDW system alerts will be suppressed for 15 minutes.
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.	

Table K2 – *How a Driver Interacts with the Bendix Wingman Fusion System*

NOTE: The system responses above are typical, but may vary from the descriptions shown here by vehicle manufacturer, or earlier versions of the Fusion system. These are examples of driver actions and typical Wingman Fusion system responses, however this chart does not attempt to cover all possible situations.

THE FORWARD VEHICLE DETECTED ICON

When cruise control is switched on and set, and a vehicle ahead is detected by the radar, the detected forward vehicle icon – or similar – will illuminate on the vehicle dashboard.

This is an indication to the driver that the Bendix Wingman® Fusion™ system is actively managing the distance between your vehicle and the vehicle ahead, and may intervene automatically, if needed.

See Figure K9 for examples.

Figure K9 - Forward Vehicle Detected Icons

ADJUSTING THE CRUISE CONTROL SPEED

Use the switch(es) provided by the vehicle manufacturer to set your cruise control speed. When adjusted, your set speed will typically be indicated on the vehicle dash, message center, or speedometer.

K1.10 FOLLOWING DISTANCE

Following distance refers to the time gap, measured in seconds, between your vehicle and the vehicle ahead. The actual physical distance between the two will vary based on the speeds of both vehicles; however, the set gap will remain the same for all set cruise speeds.

FOLLOWING DISTANCE ADJUSTMENT SWITCH

This Wingman Fusion system feature has an option that allows the driver to adjust the following-distance or time-gap. Feature availability is determined by the vehicle manufacturer. The switch has an increase or decrease function. Pressing increase (+) will provide a larger following distance, measured in seconds. Pressing decrease (-) will provide a shorter following distance.

K1.11 LANE DEPARTURE WARNING DIU STATUS SCREEN ICONS

See Figure K10. In the case of vehicles that use a Bendix® Driver Interface Unit (DIU™), the top right corner of the display is used to show an icon. For other OEM displays, see the vehicle manual to find the method used to show the system status.

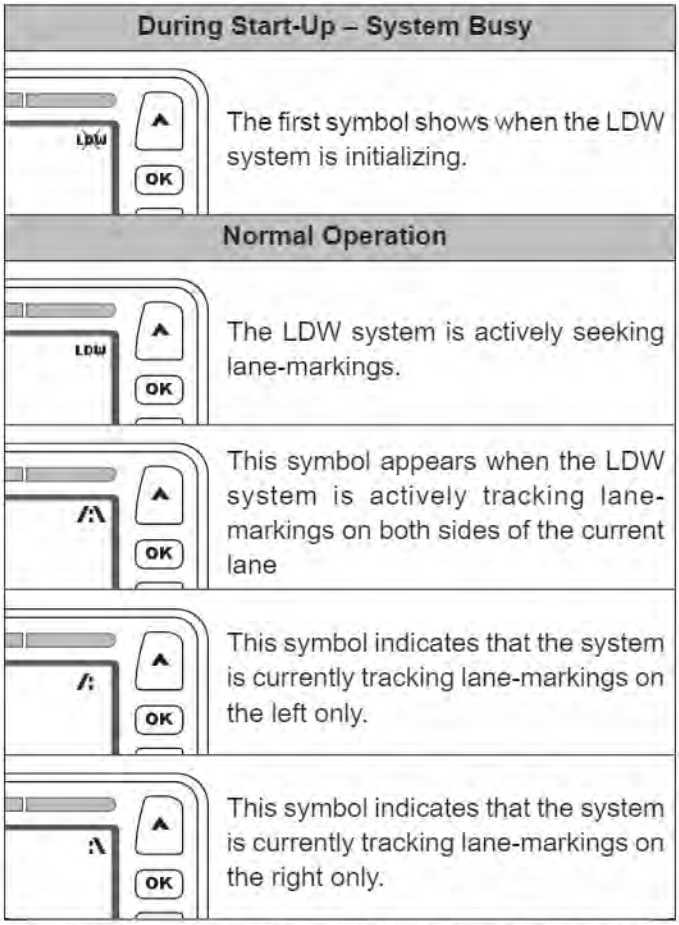


Figure K10 - Normal Bendix DIU Screens Showing LDW System Status

If none of the LDW status icons shown in Figure K10 appear on the DIU screen – and the driver has not pressed the LDW disable switch (see Section 2.3) – this indicates that the system using the Bendix® AutoVue® FLC20™ camera has detected a DTC and the system should be serviced at the earliest opportunity. *See Figure K11.*

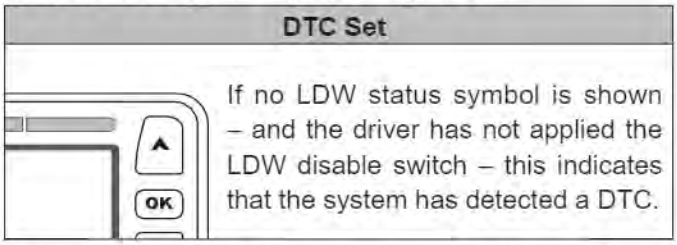


Figure K11 – Bendix DIU Screen Showing LDW System Status

In these cases, the OE vehicle dash display will also alert the operator that there is a DTC present.

K1.12 BENDIX® WINGMAN® FUSION™ SYSTEM COLLISION MITIGATION FEATURE OPERATION

Whenever the vehicle is traveling at above 15 mph / 24 kph, the Bendix® Wingman® Fusion™ system collision mitigation feature is ready to intervene, if needed. It does not require cruise control to be set. The collision mitigation feature of the Wingman Fusion system will alert you automatically, and apply the vehicle's brakes if a collision with the detected forward vehicle is likely to occur. The driver must immediately act to potentially avoid, or lessen the severity of, a collision.

Collision mitigation is ready to intervene as long as no DTCs are active in either the brake system, the Fusion system, or any other contributing vehicle system.

AUTOMATIC FOUNDATION BRAKE APPLICATIONS

The vehicle automatically manages foundation braking priorities among the various vehicle systems that use the foundation brakes, such as the Bendix Wingman Fusion system, Bendix® ESP® (Electronic Stability Program), Bendix® ATC (Automatic Traction Control), and Bendix® ABS (Antilock Braking System).

K1.13 ALERTS AND WARNINGS

The Fusion system operates differently compared to other cruise control/forward collision warning systems. It is important that the driver fully understands the system's features, especially the alerts and warnings.

Three important warnings provided by the Bendix Wingman Fusion system are the Following Distance Alert (FDA), Impact Alert (IA), and Stationary Object Alert (SOA). The driver will be alerted by any of the three warnings, whether or not the cruise control is activated.

See Appendix B, Sections 3.0–5.0, for more information about how DIUs communicate alerts.

⚠ WARNING

Any audible and/or visual alert by the system means that the vehicle is too close to the vehicle ahead and the driver must immediately act to potentially avoid, or lessen the severity of, a collision.

IMPACT ALERT (IA)/ COLLISION MITIGATION BRAKING (CMB)

⚠ WARNING

The Impact Alert (IA)/Collision Mitigation Braking (CMB) is the most severe warning issued by the Bendix Wingman Fusion system. This alert indicates that a collision with the detected forward vehicle is likely and the driver must immediately act to potentially mitigate, or lessen the severity of, a collision.

The IA/CMB is ready to alert the driver whenever the vehicle is moving above 15 mph / 24 kph.

When activated, the IA/CMB will sound and a visual message/icon typically appears on the dash screen or Bendix® Driver Interface Unit (DIU™) display. The actual sound/display method varies by vehicle manufacturer.

NOTE: The IA/CMB is typically accompanied by automatic brake interventions. The Fusion system will apply the vehicle's brakes. The driver must apply additional braking, when necessary, to maintain a safe distance from the vehicle ahead.

See Figure K12 for an example of an Impact Alert Icon.

Figure K12 – Example of Impact Alert Icon

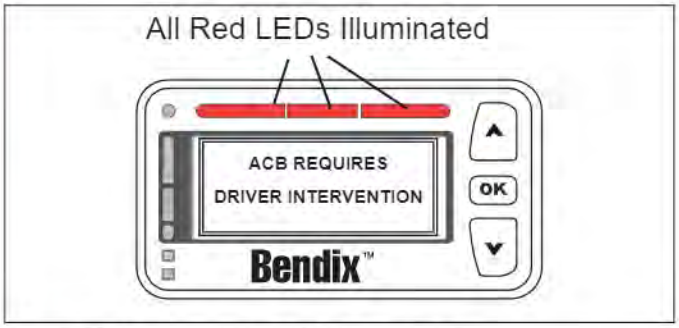


Figure K13 – Impact Alert Text and Light Pattern as Seen on the Bendix DIU

FOLLOWING DISTANCE ALERT (FDA)

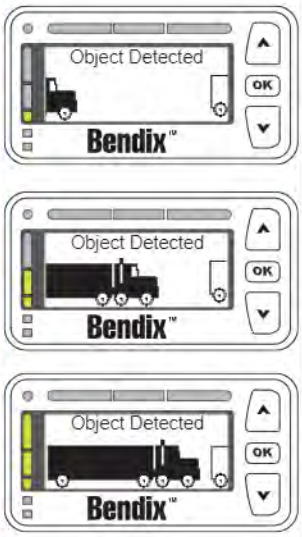
⚠ WARNING

The FDA is ready to alert the driver whenever the time between the vehicle and the detected forward vehicle is less than one-and-a-half (1.5) seconds* and decreasing. Once the audible alert is given, the driver should increase the distance between his/her vehicle and the vehicle ahead until the audible alert stops.

The FDA is ready to alert the driver whenever the vehicle is moving above 5 mph / 8 kph.

If the following distance continues to decrease, the driver will hear more rapid audible alerts. When the FDA reaches its highest level, typically a red LED also illuminates on the instrument cluster. The FDA may be accompanied by a visual alert.

*One-and-a-half (1.5) seconds is the system default and may vary by fleet/OEM.



Driver Interface Unit (DIU™) Showing Examples of Following Distance Alerts with Progressively Faster Audible Alerts.

Above: Examples of other vehicle manufacturer's displays.

Figure K14 – Following Distance Alert

STATIONARY OBJECT ALERT (SOA)

⚠ WARNING

Stationary Object Alert (SOA) – The Bendix® Wingman® Fusion™ system will give up to a three (3) second alert to the driver when approaching a detected, sizable, metallic (radar-reflective), stationary object in your lane of travel. This alert indicates that a collision with a stationary object is likely and the driver must immediately act to potentially avoid, or lessen the severity of, a collision.

⚠ CAUTION

The SOA is ready to alert the driver whenever the vehicle is moving above ten (10) mph / 16 kph. The driver should be especially careful when approaching certain types of vehicles or objects. The Fusion system radar may not be able to detect objects with limited metal surfaces (such as recreational vehicles, horse-drawn buggies, motorcycles, logging trailers, etc.). *NOTE: Entering a curve may reduce the alert time to less than three (3) seconds.*

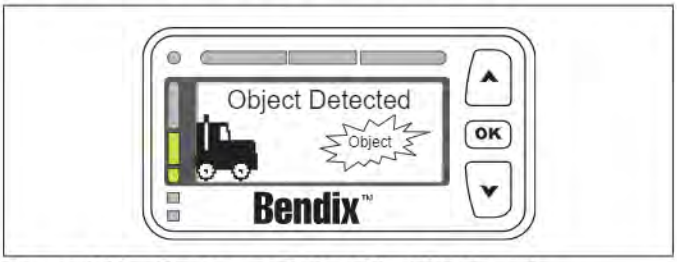


Figure K15 – Stationary Object Alert Displayed

STATIONARY VEHICLE BRAKING (SVB)

⚠ WARNING

Stationary Vehicle Braking (SVB) – When a large, stationary, metallic object in a vehicle's lane of travel is definitively identified as a vehicle, the driver is notified up to 3.5 seconds before impact. If the driver does not take action to address the potential impact that caused the alert, the Bendix® Wingman® Fusion™ system can automatically engage the brakes to assist the driver in reducing the severity of or potentially avoiding a collision with that stationary vehicle. If the system cannot definitively identify the stationary object as a vehicle — for example, if the vehicle is not a licensed motorized vehicle, or certain types of trailers — the driver will get up to 3.0 seconds of alert to address the situation ahead, but no automatic braking will be applied. Stationary Vehicle Braking is most useful when approaching a line of stopped traffic or a stalled vehicle that is not immediately recognized by the driver. Without the automatic alert and braking, it may be too late to avoid impact.

⚠ CAUTION

The SVB is ready to alert the driver whenever the vehicle is moving above 15 mph/24 kph. The driver should be especially careful when approaching certain types of vehicles or objects. The Fusion system radar may not be able to detect vehicles with limited metal surfaces (such as recreational vehicles, horse-drawn buggies, motorcycles, logging trailers, etc.). *NOTE: Entering a curve may reduce the alert time.*

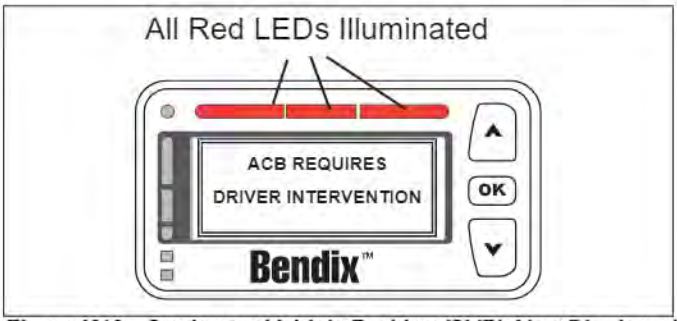


Figure K16 – Stationary Vehicle Braking (SVB) Alert Displayed

BRAKE OVERUSE ALERT

⚠ WARNING

The Bendix Wingman Fusion system provides a warning when the system is intervening and using the foundation brakes excessively. Overuse of the foundation brakes can lead to the brakes overheating and a potential loss of braking performance caused by brake fade. Using cruise control on downhill runs will cause this alert to be activated.

⚠ WARNING

Approach grades as you would normally, with the appropriate gear selected and at a safe speed. Cruise control should *NOT* be used on downhill grades.

When the system detects brake overuse, depending on the vehicle manufacturer, a text message will be displayed on the dashboard and an audible alert will be activated. The driver should intervene immediately.

Figure K17 – Brake Overuse Warning

- Once the brake overuse alert is activated, certain driver interventions that cancel cruise control – like stepping on the brake pedal or switching off cruise – will discontinue the alert. Following an overuse alert, the driver should not reset cruise control for at least 20 minutes. This gives the brakes time to cool down. If the driver chooses to reset cruise control during that 20 minute period, Fusion system interventions will be limited to de-throttling and engine retarder only. The system will automatically disable all Wingman Fusion system foundation brake applications for at least 20 minutes.
- If the system does not detect a driver intervention within 15 seconds after the brake overuse alert sounds, it will shut itself off and set a Diagnostic Trouble Code (DTC). The driver will continue to receive alerts, but ALL Wingman Fusion system interventions (de-throttling, engine retarder or brake applications) will be disabled until the next ignition cycle.

NOTE: In all cases, the driver still has the ability to apply the foundation brakes if necessary. The driver should take care since overheated brakes may reduce the vehicle's braking capability. *(See Appendix B7.0).*

LANE DEPARTURE WARNING (LDW) ALERT

⚠ WARNING

The Bendix® Wingman® Fusion™ system has the ability to warn the driver if the vehicle is not tracking in the intended roadway path. In most vehicle applications the LDW system is enabled above 37 mph. The driver should immediately correct the vehicle tracking and maintain the correct position in the lane.

Red LED illuminated indicates the direction of departure

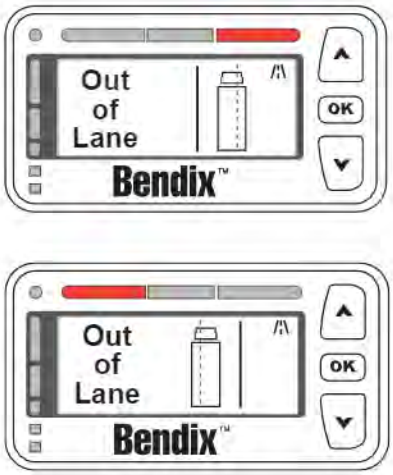


Figure K19 – Lane Departure Warning

OVERSPEED ALERT & ACTION

⚠ WARNING

The Bendix Wingman Fusion system has the ability to warn the driver if the vehicle's speed exceeds the posted legal limits. The Overspeed Alert & Action is enabled when the vehicle is traveling greater than 5mph/8kph from the posted limit. The driver should immediately reduce speed to the posted legal limit.

When the vehicle exceeds the posted speed limit by five (5) mph / eight (8) kph, an audible alert will sound to alert the driver. If the vehicle speed exceeds ten (10) mph/ 16 kph over the posted speed limit, an audible alert signals the driver to slow down and a one-second de-throttle of the engine will occur.

International travel: When changing between regions which post speeds in miles and those which post in kilometers, the speed limit sign recognition feature will not function until the correct US/Metric selection has been made.

Figure K18 – Brake Overuse Warning

K1.14 BENDIX® WINGMAN® FUSION™ SYSTEM DIAGNOSTIC TROUBLE CODES

The Bendix® Wingman® Fusion™ system is monitored and if any malfunction is detected, a Diagnostic Trouble Code (DTC) will be set and the driver will be alerted. The exact alert given depends on the vehicle manufacturer: refer to the vehicle operator's manual and Sections 3 and 4.

K1.15 RADAR SENSOR INTERCHANGEABILITY

Many variables must be considered when determining whether or not the radar sensor can be relocated from one vehicle to another vehicle. They include, but are not limited to, the version of the Bendix® ESP® stability system used on the vehicle, the instrument cluster, the vehicle Electronic Control Unit (ECU), the engine and the transmission. Contact the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) to determine if this is a viable option.

⚠ WARNING

Do not interchange radar sensors without contacting Bendix first.

K1.16 ALERT VOLUME

For Bendix Wingman Fusion systems installed on vehicles with alerts that come directly through the instrument cluster, audible alert levels are pre-set at the factory and can not be turned off, but the volume may be adjustable, depending on the OE. However, where the Bendix® Driver Interface Unit (DIU™) is used, volume adjustment is permitted.

K1.17 POTENTIAL FALSE ALERTS

Drivers should take into account the road conditions, and any other factors they are encountering, as they choose how to react to any alerts they receive from the Bendix Wingman Fusion system. *(See also Appendix J.)*

K1.171 POTENTIAL STATIONARY OBJECT FALSE ALERTS

In certain unusual traffic or roadway conditions, the Fusion system may issue a false alert. While eliminating all false alerts is not possible, if false alerts occur too frequently (more than twice a day), service the system at the earliest opportunity.

K1.172 POTENTIAL FALSE - OR MISSING - SPEED SIGN ALERTS

Some road speed signs may potentially not be able to be recognized — or be recognized incorrectly — by the system.

APPENDIX L - MAINTENANCE SECTION

L1.1 GENERAL SAFETY GUIDELINES

See Page 2 of this Service Data Sheet for the General Safety Guidelines.

L1.2 SYSTEM PREVENTIVE MAINTENANCE

The Bendix® Wingman® Fusion™ system is relatively maintenance free. The key items to keep the system functioning properly include:

1. Keep the radar front – and windshield – clean and free of obstructions.
2. Inspect for any damage to the bumper, radar, or camera to ensure that the alignment has not been compromised. **Never use the radar unit as a step.** *NOTE: If the radar sensor was originally installed behind a panel, check the panel for damage, etc. that may impact the radar's performance before reinstalling. Replace the panel, if necessary, with an original OEM supplied panel. Do not paint over the panel.*
3. Perform appropriate inspections of the braking system as required by the manufacturer to ensure brakes are in proper working order.
4. Ensure that the tires are properly inflated and that adequate tread is present.

⚠ CAUTION

Inspections – The driver should inspect the radar and camera mounting brackets regularly and keep the windshield and bumper locations clear of any mud, snow, ice build-up, or other obstructions. The installation of aftermarket deer guards, bumper guards, snow plows or similar potential obstructions is not recommended, and could impair the operation of the radar.

⚠ CAUTION

Damage/Tampering - In cases where the bumper, radar and/or windshield have sustained any damage, are misaligned, or if you suspect that a device has been tampered with, do not use the active cruise control until the vehicle has been repaired and the radar re-aligned. In addition, an indicator on the dash typically will illuminate if the system detects any of these conditions. Consult your vehicle's operator's manual or contact Bendix for more information.

NOTE: Any vehicle trouble code that disables vehicle cruise control will also cause a DTC in the Bendix Wingman Fusion system.

ADDITIONAL SUPPORT AT WWW.BENDIX.COM / 1-800 AIR BRAKE (1-800-247-2725), OPTION 2

For the latest information, and for free downloads of the Bendix ACom Diagnostic Software, and its User Guide, visit the Bendix website at: www.bendix.com.

You will also find a current list of compatible RP1210 data link adapters for ABS and the Bendix® Wingman® ACB system.

For direct telephone technical support, call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Friday, 8:00 A.M. to 6:00 P.M. ET. For assistance, follow the instructions in the recorded message. Reach the Tech Team via e-mail at: techteam@bendix.com.

APPENDIX M - SPN AND FMI CODES, DESCRIPTIONS AND SERVICE ACTIONS

For Diagnostic Trouble Codes (DTCs), refer to Table 4A on page 15.

Table M: SPN and FMI Codes, Descriptions and Service Actions			Go to the Service Action Code List in Table 4B *(Page 21)*
SPN	**FMI**	**Description**	
70	9	J1939 signal: Not available CCVS1 parking brake switch	R
	19	J1939 signal: Error in CCVS1 parking brake switch	P
84	2	J1939 signal: Invalid CCVS2 wheel speed	N
	9	J1939 signal: Not available CCVS1 wheel speed	R
	19	J1939 signal: Error in CCVS1 wheel speed	P
86	2	J1939 signal: Invalid CCVS1 CC speed	N
	9	J1939 signal: Not available CCVS1 CC speed	R
	19	J1939 signal: Error in CCVS1 CC speed	P
91	2	J1939 signal: Invalid EEC2 accelerator pedal position	N
	9	J1939 signal: Not available EEC2 accelerator pedal position	R
	14	J1939 signal: Missing EEC2 message	F
	19	J1939 signal: Error in EEC2 accelerator pedal position	P
188	2	J1939 signal: Invalid EC1 engine apeed at idle point 1	N
	9	J1939 signal: Not available EC1 engine speed at idle point 1	R
	14	J1939 signal: Missing EC1 message	F
	19	J1939 signal: Error in EC1 engine speed at idle point 1	P
190	2	J1939 signal: Invalid EEC1 engine speed	N
	9	J1939 signal: Not available EEC1 engine speed	R
	14	J1939 signal: Missing EEC1 message	F
	19	J1939 signal: Error in EEC1 engine speed	P
512	2	J1939 signal: Invalid EEC1 Driver Torque	N
	9	J1939 Signal: Not available EEC1 driver torque	R
	19	J1939 signal: Error in EEC1 driver torque	P
513	2	J1939 signal: Invalid EEC1 actual torque	N
	9	J1939 signal: Not available EEC1 actual torque	R
	19	J1939 signal: Error in EEC1 actual torque	P
514	2	J1939 signal: Invalid EEC3 nominal friction percent torque	N
	9	J1939 signal: Not available EEC3 nominal friction percent torque	R
	14	J1939 signal: Missing EEC3 message	F
	19	J1939 signal: Error in EEC3 nominal friction percent torque	P
518	2	J1939 signal: Invalid TSC1 requested torque Limit	N
	9	J1939 signal: Not available TSC1 requested torque Limit	R
	19	J1939 signal: Error in TSC1 requested torque Limit	P
520	9	J1939 signal: Missing ERC1_DR message	F
	14	J1939 signal: Missing ERC1_XR message	F

Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.

Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.

Table M – SPN and FMI Codes and their Service Action Code.

Table M: SPN and FMI Codes, Descriptions and Service Actions			Go to the Service Action Code List in Table 4B *(Page 21)*
SPN	**FMI**	**Description**	
521	2	J1939 signal: Invalid EBC1 brake pedal position	N
	9	J1939 signal: Not available EBC1 brake pedal position	R
	19	J1939 signal: Error in EBC1 brake pedal position	P
523	2	J1939 signal: Invalid ETC2 transmission current gear	N
	9	J1939 signal: Not available ETC2 transmission current gear	R
	19	J1939 signal: Error in ETC2 transmission current gear	P
524	2	J1939 signal: Invalid ETC2 transmission selected gear	N
	9	J1939 signal: Not available ETC2 transmission selected gear	R
	14	J1939 signal: Missing ETC2 message	F
	19	J1939 signal: Error in ETC2 transmission selected gear	P
525	9	J1939 signal: Not available TC1 transmission requested gear	R
	14	J1939 signal: Missing TC1 message	F
	19	J1939 signal: Error in TC1 transmission requested gear	P
526	2	J1939 signal: Invalid ETC2 transmission actual gear ratio	N
	9	J1939 signal: Not available ETC2 transmission actual gear ratio	R
	19	J1939 signal: Error in ETC2 transmission actual gear ratio	P
527	14	J1939 signal: Missing CCVS1 message	E
544	2	J1939 signal: Invalid EC1 engine reference torque	N
	9	J1939 signal: Not available EC1 engine reference torque	R
	19	J1939 signal: Error in EC1 engine reference torque	P
560	9	J1939 signal: Not available ETC1 transmission driveline engaged	R
	14	J1939 signal: Missing ETC1 message	F
	19	J1939 signal: Error in ETC1 transmission driveline engaged	P
561	9	J1939 signal: Not available EBC1 ASR engine control active	R
	19	J1939 signal: Error in EBC1 ASR engine control active	P
562	2	J1939 signal: Error in EBC1 ASR brake control active	P
	19	J1939 signal: Not available EBC1 ASR brake control active	R
563	9	J1939 signal: Not available EBC1 ABS active	R
	19	J1939 signal: Error in EBC1 anti-lock braking active	P
595	9	J1939 signal: Not available CCVS1 CC active	R
	19	J1939 signal: Error CCVS1 CC active	P
596	9	J1939 signal: Not available CCVS1 CC enable	R
	19	J1939 signal: Error in CCVS1 CC enable	P
597	9	J1939 signal: Not available CCVS1 brake switch	R
	19	J1939 signal: Error in CCVS1 brake switch	P
599	9	J1939 signal: Not available CCVS1 set switch	R
	19	J1939 signal: Error in CCVS1 cruise control set switch	P
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.			

Table M – SPN and FMI Codes and their Service Action Code.

Table M: SPN and FMI Codes, Descriptions and Service Actions			Go to the Service Action Code List in Table 4B *(Page 21)*
SPN	**FMI**	**Description**	
600	9	J1939 signal: Not available CCVS1 coast switch	R
	19	J1939 signal: Error in CCVS1 cruise control coast switch	P
601	9	J1939 signal: Not available CCVS1 resume switch	R
	19	J1939 signal: Error in CCVS1 cruise control resume switch	P
602	9	J1939 signal: Not available CCVS1 accelerate switch	R
	19	J1939 signal: Error in CCVS1 cruise control accelerate switch	P
625	2	Proprietary CAN: Message inconsistentt	X
	9	Proprietary CAN: Message timeout	X
	10	Proprietary CAN: Message counter increment error	X
	13	Fusion Configuration mismatch between brake controller and radar sensor	
	19	Proprietary CAN: Message counter error	X
630	12	Internal radar sensor error	A
	14	Internal radar sensor error	
	19	J1939 error frame limit reached: J1939 wiring error.	Y
639	9	Radar detects intermittent loss of J1939 messages from vehicle components	
	19	Radar cannot detect any J1939 messages from vehicle components	
701	14	J1939 signal: Missing AUXIO message	F
705	9	J1939 signal: Not available AUXIO trailer connected	R
	19	J1939 signal: Error in AUXIO1 trailer connected	P
706	9	J1939 signal: Not available AUXIO trailer ABS detect	R
	19	J1939 signal: Error in AUXIO1 trailer ABS detected	P
707	2	J1939 signal: AUXIO trailer ABS not fully operational	V
	9	J1939 signal: Not available AUXIO trailer ABS operational	R
	19	J1939 signal: Error in AUXIO1 trailer ABS operational	P
767	9	J1939 signal: Not available ETC5 reverse switch	R
	14	J1939 signal: Missing ETC5 message	F
	19	J1939 signal: Error in ETC5 reverse switch	P
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.			

Table M – SPN and FMI Codes and their Service Action Code.

Table M: SPN and FMI Codes, Descriptions and Service Actions			Go to the Service Action Code List in Table 4B *(Page 21)*
SPN	**FMI**	**Description**	
886	1	Antenna is dirty or partially blocked	D
	2	Radar mounting offset is out of range	T
	3	Battery voltage too high	C
	4	Battery voltage too low	C
	7	Radar sensor is misaligned	G
	8	Internal radar sensor error	A
	12	Internal radar sensor error	
	13	CMT Configuration mismatch between brake controller and radar sensor	L
	14	Internal radar sensor error	A
	14	Vehicle cruise control and ACC out of sync	S
	17	Antenna is dirty or partially blocked	B
	18	System detected an error requiring a radar shutdown	S
	31	Internal radar sensor error	A
904	2	J1939 signal: Invalid EBC2 front axle	N
	9	J1939 signal: Not available EBC2 front axle	R
	14	J1939 signal: Missing EBC2 message	F
	19	J1939 signal: Error in EBC2 front axle	P
905	2	J1939 signal: Invalid EBC2 LF wheel	N
	9	J1939 signal: Not available EBC2 LF wheel	R
	19	J1939 signal: Error in EBC2 LF wheel	P
906	2	J1939 signal: Invalid EBC2 RF wheel	N
	9	J1939 signal: Not available EBC2 RF wheel	R
	19	J1939 signal: Error in EBC2 RF wheel	P
907	2	J1939 signal: Invalid EBC2 LR1 wheel	N
	9	J1939 signal: Not available EBC2 LR1 wheel	R
	19	J1939 signal: Error in EBC2 LR1 wheel	P
908	2	J1939 signal: Invalid EBC2 RR1 wheel	N
	9	J1939 signal: Not available EBC2 RR1 wheel	R
	19	J1939 signal: Error in EBC2 RR1 wheel	P
1069	13	ABS tire size needs recalibration	W
1091	14	J1939 signal: Missing EBC3 message	F
1196	19	XBR is locked-out	S
1121	9	J1939 signal: Not available EBC1 brake switch	R
	19	J1939 signal: Error in EBC1 brake switch	P
1214	14	J1939 signal: Missing DM1 message	F
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.			

Table M – SPN and FMI Codes and their Service Action Code.

Table M: SPN and FMI Codes, Descriptions and Service Actions			Go to the Service Action Code List in Table 4B *(Page 21)*
SPN	**FMI**	**Description**	
1243	2	J1939 signal: EBC1 ABS not fully operational	U
	9	J1939 signal: Not available EBC1 ABS operate	R
	14	J1939 signal: Missing EBC1 message	F
	19	J1939 signal: Error in EBC1 ABS fully operational	P
1481	2	J1939 signal: Error in EBC1 source address of controlling device	P
	19	J1939 signal: Not available EBC1 source address of controlling device	R
1633	9	J1939 signal: Not available CCVS1 pause switch	R
	19	J1939 signal: Error in CCVS1 cruise control pause switch	P
1705	14	J1939 signal: Missing FLC message	F
1760	2	J1939 signal: Invalid CVW GCVW	N
	9	J1939 signal: Not available CVW GCVW	R
	14	J1939 signal: Missing CVW message	F
	19	J1939 signal: Error in CVW gross combination vehicle weight	P
1799	2	J1939 signal: Invalid ACC2 requested ACC distance mode	N
	9	J1939 signal: Not available ACC2 distance mode	R
	14	Internal radar sensor error	D
	19	J1939 signal: Error in ACC2 requested ACC distance mode	P
1807	2	J1939 signal: Invalid VDC2 steer angle	N
	9	J1939 signal: Not available VDC2 steer angle	R
	14	J1939 signal: Missing VDC2 message	F
	19	J1939 signal: Error in VDC2 steer angle Sensor	P
1808	2	J1939 signal: Invalid VDC2 yaw rate	N
	9	J1939 signal: Not available VDC2 yaw rate	R
	19	J1939 signal: Error in VDC2 yaw rate	P
1814	2	J1939 signal: VDC1 VDC not fully operational	V
	9	J1939 signal: Not available VDC1 VDC fully operational	R
	14	J1939 signal: Missing VDC1 message	E
	19	J1939 signal: Error in VDC1 VDC fully operational	P
1816	9	J1939 signal: Not available VDC1 ROP engine control	R
	19	J1939 signal: Error in VDC1 ROP engine control	P
1817	9	J1939 signal: Not available VDC1 YC engine control	R
	19	J1939 signal: Error in VDC1 YC engine control	P
1818	9	J1939 signal: Not available VDC1 ROP brake control	R
	19	J1939 signal: Error in VDC1 ROP brake control	P
1819	9	J1939 signal: Not available VDC1 YC brake control	R
	19	J1939 signal: Error in VDC1 YC brake control	P
2551	14	Bendix ABS J1939 Proprietary message signal missing or error state	H
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running.			
Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.			

Table M – SPN and FMI Codes and their Service Action Code.

Table M: SPN and FMI Codes, Descriptions and Service Actions			Go to the Service Action Code List in Table 4B *(Page 21)*
SPN	**FMI**	**Description**	
2876	2	J1939 signal: Invalid OEL turn signal	N
	9	J1939 signal: Not available OEL turn signal	R
	14	J1939 signal: Missing OEL message	F
	19	J1939 signal: Error in OEL turn signal	P
2917	2	J1939 signal: Invalid EBC5 XBR state	N
	9	J1939 signal: Not available EBC5 XBR state	R
	19	J1939 signal: Error in EBC5 XBR state	P
2918	2	J1939 signal: Invalid EBC5 XBR active control mode	N
	9	J1939 signal: Not available EBC5 XBR active control mode	R
	19	J1939 signal: Error in EBC5 XBR active control mode	P
2919	9	J1939 signal: Not available EBC5 brake use	R
	14	J1939 signal: Missing EBC5 message	F
	19	J1939 signal: Error in EBC5 brake use	P
2920	0	CMT braking overuse	M
2921	2	J1939 signal: Invalid EBC5 XBR limit	N
	9	J1939 signal: Not available EBC5 XBR limit	R
	12	Internal radar sensor error	A
	19	J1939 signal: Error in EBC5 XBR limit	P
3839	0	active cruise control braking overuse	J
	9	J1939 signal: Not available EBC5 brake temp	R
	19	J1939 signal: Error in EBC5 brake temp	P
5023	9	J1939 signal: Not available ACC2 ACC usage	R
	19	J1939 signal: Error in ACC2 ACC usage demand	P
5606	2	J1939 signal: Error in ACC1 ACC mode	P
	13	J1939 signal: ACC1 or CCVS3: engine not properly configured for Bendix Wingman	K
	19	J1939 signal: Not available ACC1 ACC mode	R
5676	14	Internal radar sensor error	A
5681	9	J1939 signal: Not available AEBS2 driver activation	R
	13	Fusion Configuration mismatch between brake controller and radar sensor	S
	14	J1939 signal: Missing AEBS2 message	D
	19	J1939 signal: Error in AEBS2 message checksum or driver activation demand	P
5683	19	J1939 signal: Error in AEBS2 message checksum	
Note: The system will not report newly active J1939 Diagnostic Trouble Codes (DTCs) until the engine has been running for 15 seconds. Do not attempt to diagnose J1939 DTCs without the engine running. Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725, option 2) for troubleshooting assistance.			

Table M – SPN and FMI Codes and their Service Action Code.

Reference Documents:

- The Bendix™ Autovue® FLC20™ Camera (SD-64-20124)
- The Bendix® ESP® EC-80™ Controller (SD-13-4986)
- The SafetyDirect® By Bendix CVS Web Portal Processor (SD-65-21025)

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