

Bendix™ FLC-20™ Camera

1.0 DESCRIPTION

The Bendix™ FLC-20™ camera is a component used in many Bendix safety systems, including:

- The Lane Departure Warning (LDW) System; and
- The Bendix® Fusion™ Active Safety System.

For more information about the Bendix Fusion System, refer to SD-61-4963, *Bendix® Fusion™ FLR-21™ Radar Sensor*, on B2Bendix.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.

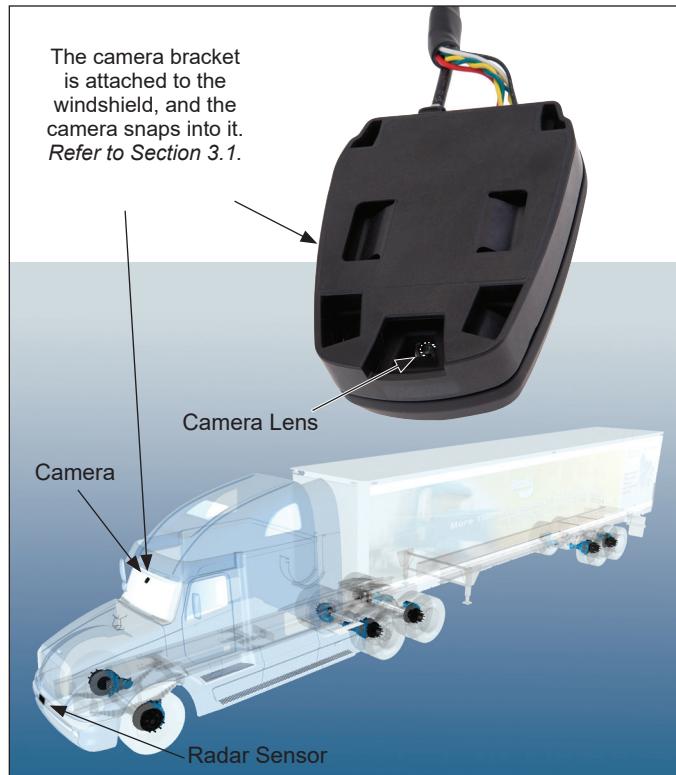


Figure 1 – Bendix FLC-20 Camera

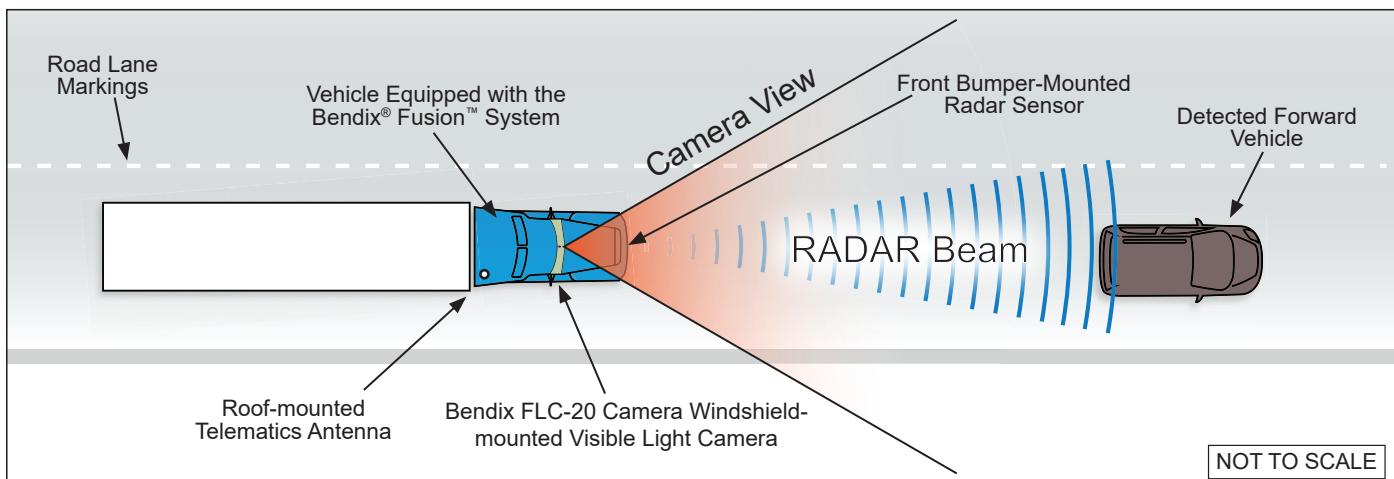


Figure 2 – Operational View

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, a Bendix® AD-9si®, AD-HF®, or AD-HFi® air dryer, be sure to drain the purge reservoir.
- ▲ Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
- ▲ Never exceed manufacturer's recommended pressures.
- ▲ You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.
- ▲ 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.

! WARNING

Improper use and/or maintenance of the Bendix® Fusion™ Active Safety 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.

! IMPORTANT

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

How to identify your FLC-20 Camera Part Number:



Look for the Bendix® brand logo on the camera label. Refer to Section 3.1 for how to remove the camera from the bracket to view the label.

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2.0 TROUBLESHOOTING

2.1 SAFETY GUIDELINES

Read and follow the General Safety Guidelines shown in this document.

IMPORTANT

All vehicle Diagnostic Trouble Codes (DTCs) related to the engine, transmission, instrument cluster, engine cruise control, and Bendix® Antilock Braking System (ABS), Automatic Traction Control (ATC), or Electronic Stability Program (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

If a problem with the Bendix FLC-20 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 Original Equipment Manufacturer (OEM) displays, see the vehicle manual to find the method used to show the system status.

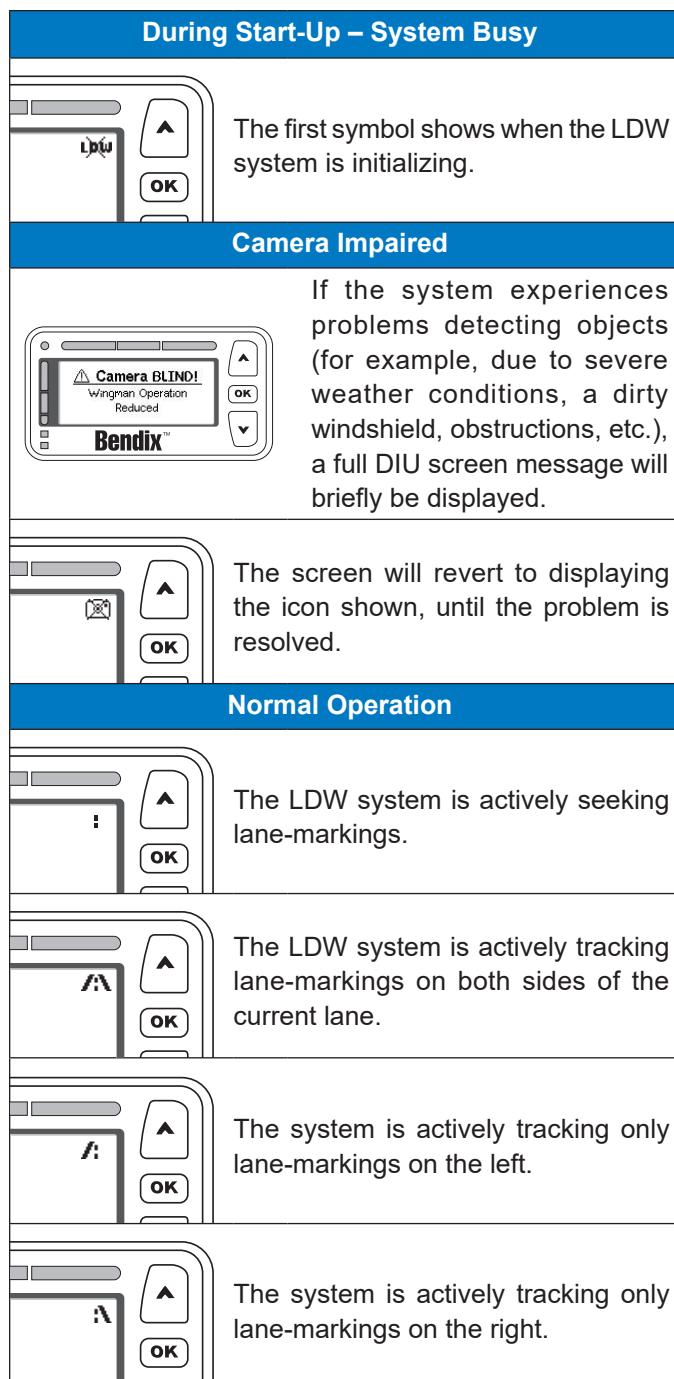


Figure 3 – Normal Bendix DIU Screens Showing LDW System Status

Diagnostic Trouble Code (DTC) Set

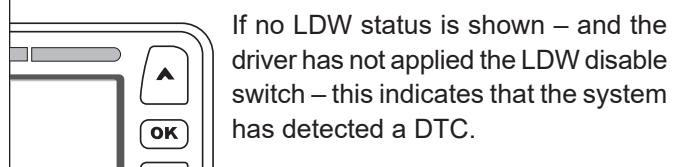


Figure 4 – Bendix DIU Screen Showing LDW System Status

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

2.3 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® Fusion™ Active Safety System 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 Rand McNally® Web Portal Processor, and a functioning On Board Computer (OBC)/Telematics system: The enable/disable switch used by the 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.

2.4 SETTING DIAGNOSTIC TROUBLE CODES (DTCs)

If, during operation, the Bendix Fusion system detects a problem with the FLC-20 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 or all features of the Fusion system or LDW system will not be available.

If the system experiences problems detecting objects (for example, due to severe weather conditions, a dirty windshield, obstructions, etc.), a DTC will typically be set.

2.5 BENDIX® ACOM® DIAGNOSTIC SOFTWARE

Bendix® ACom® Diagnostic Software is a PC-based software program available to purchase from bendix.com. 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.

IMPORTANT

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

2.6 DIAGNOSTIC TROUBLE CODES

Use a J1939 detection software to find the DTC(s) and refer to Table 1 to find the service action code to use. The service actions to take may then be found in Table 2.

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

Refer to Table 1 for Diagnostic Trouble Codes (DTCs) and Table 2 for each DTC's corresponding service action.

SPN	FMI	DTC	Diagnostic Trouble Code (DTC) Description	Service Action Code (Refer to Table 2)
70	9	64	J1939: Engine controller message missing - CCVS1	M
	19	149	J1939: Engine controller signal error - CCVS1 Parking Brake	N
84	2	200	J1939: Engine controller signal invalid - CCVS1 Vehicle Speed	N
	9	64	J1939: Engine controller message missing - CCVS1	M
		201	J1939: Engine controller signal missing - CCVS1 Vehicle Speed	M
	19	64	J1939: Engine controller message missing - CCVS1	M
		73	J1939: Brake controller signal error - EBC2 Wheel Speed	N
190	2	179	J1939: Engine controller signal invalid - Engine Speed	N
	9	172	J1939: Engine controller signal invalid - EEC1 Engine Speed	N
	19	152	J1939: Engine controller signal error - EEC1 Engine Speed	N
234	12	142	Internal Error	D
597	2	74	J1939: Brake controller signal error - EBC1 Brake Switch	N
	19			
625	9	72	Private CAN: Error frame threshold exceeded	V
628	2	11	Internal Error	D
		36	Image Processor software version error	I
630	2	19	Calibration not complete	Q
		47	SPC Calibration not complete	Q
		50	Dynamic Calibration out of range	Q
		51	Dynamic Calibration not complete	Q
		59	Vehicle Calibration not complete	Q
	19	198	Brake controller mismatch - Fusion	I
639	9	18	J1939 Bus Fault	M
	31			M
879	9	184	J1939: Vehicle controller signal invalid - Left Turn Signal	N
881	9	185	J1939: Vehicle controller signal invalid - Right Turn Signal	N
904	2	178	J1939: Brake controller signal error - EBC2 Front Axle Speed	N
	9	131	J1939: Brake controller message missing - EBC2	M
	19	151	J1939: Brake controller signal error - EBC2 Vehicle Speed	N
917	9	78	J1939: Vehicle controller message missing - VDHR	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 – Diagnostic Trouble Codes (DTCs)

SPN	FMI	DTC	Diagnostic Trouble Code (DTC) Description	Service Action Code (Refer to Table 2)
1121	9	132	J1939: Brake controller message missing - EBC1	M
		196	J1939: Brake controller signal invalid - EBC1 Brake Switch	N
	19	150	J1939: Brake controller signal error - EBC1 Brake Switch	N
1624	2	181	J1939: Vehicle controller signal invalid - TCO1 Tachograph Vehicle Speed	N
	9	130	J1939: Vehicle controller message missing - TCO1	M
		197	J1939: Vehicle controller signal invalid - TCO1 Vehicle Speed	N
	19	163	J1939: Vehicle controller signal error - TCO1 Vehicle Speed	N
1705	3	1	High Battery Voltage	B
	4	2	Low Battery Voltage	B
	7	146	Camera lens blocked	C
1705	11	133	Brake Controller Mismatch - Incorrect Camera Lens Angle	Q
1705	3, 4, 7-10, 12, 14-16, 21-35, 37-42	13	Internal Error	D
		17, 20	Internal Error	D
		43	Calibration data corrupt	Q
		44-46, 48, 49, 52-57	Internal Error	D
	12	60	Image Processor Calibration error	Q
		61, 77, 81-86, 128, 129	Internal Error	D
		140	Incompatible software version - Image Processor	I
		141, 143-145	Internal Error	D
	13	19	Calibration not complete	Q
		47	SPC Calibration not complete	Q
		50	Dynamic Calibration out of range	Q
		51	Dynamic Calibration not complete	Q
		58	Internal Error	D
		59	Vehicle Calibration not complete	Q
	14	11	Internal Error	D
		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.

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Table 1 – Diagnostic Trouble Codes (DTCs)

SPN	FMI	DTC	Diagnostic Trouble Code (DTC) Description	Service Action Code (Refer to Table 2)
1705	31	3, 4, 7-10, 12	Internal Error	D
		13	Internal Error	D
		14-16	Internal Error	D
		17, 20	Internal Error	D
		21-35, 37-42	Internal Error	D
		43	Calibration data corrupt	Q
		44-46, 48, 49, 52-57	Internal Error	D
		58	Internal Error	D
		60	Image Processor Calibration error	Q
		61, 77, 81-86, 128-129	Internal Error	D
		140	Incompatible software version - Image Processor	I
		141, 143-145	Internal Error	D
		147	Camera temperature too high	A
1807	2	182	J1939: Brake controller signal invalid - VDC2 Steering Wheel Angle	N
	9	176	J1939: Brake controller signal invalid - VDC2 Steering Angle Sensor	N
	19	69	J1939: Brake controller signal error - VDC2 Steering Wheel	N
1808	2	189	J1939: Brake controller signal invalid - VDC2 Yaw Rate	N
	9	63	J1939: Brake controller message missing - VDC2	M
		190	J1939: Brake controller signal invalid - VDC2 Yaw Rate	N
	19	70	J1939: Brake controller signal error - VDC2 Yaw Rate	N
1809	2	191	J1939: Vehicle controller signal invalid - VDC2 Lateral Accel	N
	9	192	J1939: Brake controller signal missing - VDC2 Lateral Accel	M
	19	71	J1939: Brake controller signal error - Lateral Accell	N
2347	19	156	J1939: Vehicle controller signal error - LCMD High Beam Headlamp	N
2348	19	158	J1939: Vehicle controller signal error - LD High Beam Headlamp	N
2349	19	155	J1939: Vehicle controller signal error - LCMD Low Beam Headlamp	N
2350	19	157	J1939: Vehicle controller signal error - LD Low Beam Headlamp	N
2367	19	76	J1939: Vehicle controller signal error - LCMD Left Turn	N
2368	2	164	J1939: Vehicle controller signal error - VP37 Left Turn Signal	N
	19	68	J1939: Vehicle controller signal error - LD Left Turn	N
2369	9	79	J1939: Vehicle controller message missing - LCMD	M
	19	75	J1939: Vehicle controller signal error - LCMD Right Turn	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.

Table 1 – Diagnostic Trouble Codes (DTCs)

SPN	FMI	DTC	Diagnostic Trouble Code (DTC) Description	Service Action Code (Refer to Table 2)
2370	2	165	J1939: Vehicle controller signal error - VP37 Right Turn Signal	N
	9	62	J1939: Vehicle controller message missing - LD	M
	19	67	J1939: Vehicle controller signal error - LD Right Turn	N
2550	9	139	J1939: Brake controller message missing - Prop FLC Status	M
2863	14	199	J1939: Vehicle controller message missing - OWW	M
	19	187	J1939: Vehicle controller signal error - OWW Wiper	N
2874	19	160	J1939: Vehicle controller signal error - OEL High-Low Beam Switch	N
2875	9	194	J1939: Brake controller signal invalid - OEL Hazard Switch	N
	19	80	J1939: Vehicle controller signal error - OEL Hazard Switch	N
2876	2	180	J1939: Vehicle controller signal invalid - OEL Turn Signal Switch	N
	9	65	J1939: Vehicle controller message missing - OEL	M
		195	J1939: Vehicle controller signal invalid - OEL Turn Signal	N
	19	66	J1939: Vehicle controller signal error - OEL Turn Signal	N
3564	4	153	J1939: Vehicle controller signal error - FLIC LDW Enable Command	N
	9	173	J1939: Vehicle controller signal invalid - FLIC LDW Enable Command	N
	14	134	J1939: Vehicle controller message missing - FLIC	M
	19	153	J1939: Vehicle controller signal error - FLIC LDW Enable Command	N
4011	9	183	J1939: Vehicle controller signal invalid - OEL High Beam Headlamp	N
516096	19	148	J1939: Vehicle controller signal error - LDW Enable Switch	N
516097	2	193	J1939: Vehicle controller signal invalid - FLIC Prop Speaker	N
	9	174	J1939: Speaker controller signal invalid - FLIC Prop Speaker	N
	18	193	J1939: Vehicle controller signal invalid - FLIC Prop Speaker	N
	19	154	J1939: LDW Speaker controller signal error - FLIC Prop Speaker	N
516098	2	188	J1939: Vehicle controller signal error - OEL High Beam	N
	19	161	J1939: Vehicle controller signal error - OEL High Beam Status	N
516099	9	186	J1939: Vehicle controller signal invalid - Windshield Wiper	N
	19	162	J1939: Vehicle controller signal error - OEL Wiper	N
516100	19	164	J1939: Vehicle controller signal error - VP37 Left Turn Signal	N
516101	19	165	J1939: Vehicle controller signal error - VP37 Right Turn Signal	N
516102	19	166	J1939: Vehicle controller signal error - VP37 High Headlamp	N
516103	19	167	J1939: Vehicle controller signal error - VP37 Hazard Lamp	N
516104	19	168	J1939: Vehicle controller signal error - VP37 Wiper Status	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.

Table 1 – Diagnostic Trouble Codes (DTCs)

2.8 TABLE OF SERVICE ACTION CODES

Refer to Table 2 for the recommended service actions for the Diagnostic Trouble Code(s) (DTC) found.

Service Action Code	Recommended Service
A	<p>This DTC is rarely an indicator of a malfunctioning camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> Some error conditions may occur at extreme high temperatures. These DTCs must be diagnosed with the ambient temperature above 32°F (0°C) and below 100°F (38°C). <p>Perform the following:</p> <ul style="list-style-type: none"> Clear the camera's DTCs. If possible, swap the camera with a sister vehicle that has no DTCs to see if the fault follows the part or the vehicle. If the DTCs will not clear or the DTCs return while the camera is within the operating temperatures specified above, replace the camera.
B	<p>This DTC is not an indicator of a malfunctioning camera. <u>Do not</u> replace the camera unless the following tests are performed and verified to be accurate per defined tests.</p> <p>Possible Causes:</p> <p>These DTCs result from incorrect ignition, battery supply voltage, or wiring harness issues as measured at the camera.</p> <p><i>Review Section 2.9 Troubleshooting Diagnostic Trouble Codes.</i></p> <p>Perform the following:</p> <ul style="list-style-type: none"> Using an 1157 stop lamp bulb to create a load, verify ignition supply voltage to the camera is 14 Volts DC (VDC). Visually check for damaged or poorly crimped connectors. Visually check for damaged wiring. Clear the camera's DTCs. If possible, swap the camera with a sister vehicle that has no DTCs to see if the fault follows the part or the vehicle.
C	<p>This DTC is not an indicator of a malfunctioning camera. <u>Do not</u> replace the camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> These DTCs may arise from infrequent conditions that could occur normally. <p>Perform the following:</p> <ul style="list-style-type: none"> Check for lens obstruction. Clean dirt, packed snow, or ice from the windshield in front of the lens, if present. Clear the camera's DTCs.
<p><i>NOTE: The system will not report newly active J1939 DTCs until the engine has been running for 15 seconds.</i></p> <p><i>Do not attempt to diagnose J1939 DTCs without the engine running.</i></p> <p>Call the Bendix Tech Team at 1-800-AIR-BRAKE (1-800-247-2725), option 2, for troubleshooting assistance.</p>	

Table 2 – Service Action Codes to Recommended Service

Service Action Code	Recommended Service
D	<p>This DTC is potentially an indicator of a malfunctioning camera.</p> <p>Perform the following before replacing the camera:</p> <ul style="list-style-type: none"> Repair and clear all other vehicle DTCs. Check the power and ground (use the steps identified in <i>service action code B</i> or <i>Section 2.9</i>). Clear the camera's DTCs. Confirm the camera's DTCs will not clear when installed in a "sister truck." If all previous steps do not clear the DTCs, replace the camera.
I	<p>This DTC is not an indicator of a malfunctioning camera. <i>Do not</i> replace the camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> The system has detected an incompatibility in the system configuration or between the intended rake angle stored in the EC-80 and the FLC-20 hardware rake angle. <ul style="list-style-type: none"> » 0: Not Available » 1: -22.5° Connector Down » 2: -10.3° Connector Down » 3: 17° Connector Up » 4: 23.9° Connector Up » 5: 29.2° Connector Up » 6 to 255: Reserved <p>Perform the following:</p> <ul style="list-style-type: none"> Check the hardware version of the FLC-20 camera to confirm it is correct for the vehicle; if necessary, replace the camera with the correct version. If the FLC-20 hardware is correct for the vehicle, contact the Bendix Tech Team. Clear the camera's DTCs.
M	<p>This DTC is not an indicator of a malfunctioning camera. <i>Do not</i> replace the camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> The camera is missing the J1939 messages it is expecting from one or more sources. This could be accompanied by other active DTCs from the same source. <p><i>Review Section 2.10 Serial Data (J1939) Troubleshooting Procedure.</i></p> <p>Perform the following:</p> <ul style="list-style-type: none"> Check the expected source(s) of the signal to identify why the messages are not being transmitted. A communication link may be disconnected, the power fuse disconnected or blown, or a change was made to the controller supplying the message that was incorrect. Confirm there were no software updates on suspect sources that could have impacted the broadcast of the missing message. Once the source of the missing information has been corrected, clear the camera's DTCs.

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

Service Action Code	Recommended Service
N	<p>This DTC is not an indicator of a malfunctioning camera. <u>Do not</u> replace the camera.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • The system using the camera has found J1939 signal(s) it is expecting, but the values are invalid or erroneous, indicating 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 Fusion Active Safety System components; and wheel speed sensors. <p>Perform the following:</p> <ul style="list-style-type: none"> • Check the Bendix Fusion components or the ABS for DTCs. • Check the engine and cab/body controllers for active DTCs using the manufacturer's diagnostic procedures. NOTE: If the controller that broadcasts the signal or wiring is faulty, these issues must be addressed prior to attempting to clear the camera DTCs. <p>After addressing the possible causes, perform the following:</p> <ul style="list-style-type: none"> • Clear the camera's DTCs.
Q	<p>This DTC is not an indicator of a malfunctioning camera. <u>Do not</u> replace the camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> • The camera is indicating that it is either not calibrated or an error has occurred. Camera calibration is learned at the ignition cycle of the vehicle. This calibration is stored in the ABS controller and is a message broadcast at system start-up. • Camera mounting is improper and the camera on-road alignment learned an out-of-range value. • The ABS controller may be disconnected or configuration from the ABS controller may be sending invalid information. <p>Perform the following:</p> <ul style="list-style-type: none"> • Remove battery power to the vehicle to confirm that power is being removed. • Cycle the ignition power. Confirm all system components are turning off (there should be no ignition voltage with the key in the off position). Turn the key back on. Repeat the key cycle up to 15 times, giving adequate time for all components to fully shut down between cycles. • Verify proper mounting per 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. Order the approved bracket with adhesive per the OE build sheet to install and re-mount the camera onto the windshield. <p>NOTE: If both the camera and ABS controller are being replaced at the same time, a Single Pole Target Auto-Calibration (SPTAC) will be required to configure the camera (SPTAC target part number K159472). It is not necessary to perform an SPTAC when a camera is replaced and the ABS controller has not been replaced.</p> <ul style="list-style-type: none"> • Clear the camera's DTCs.

*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

Service Action Code	Recommended Service
V	<p>This DTC is not an indicator of a malfunctioning camera. <u>Do not</u> replace the camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> The FLC-20 camera has detected that the private Fusion CAN has errors. This could be caused by an ECU on the private Fusion CAN incorrectly broadcasting information or other CAN bus corruption. <p><i>Review Section 2.10 Serial Data (Private Communications) Troubleshooting Procedure.</i></p> <p>Perform the following:</p> <ul style="list-style-type: none"> 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.
W	<p>This DTC is not an indicator of a malfunctioning camera. <u>Do not</u> replace the camera.</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> The camera is indicating that a calibration generated out-of-range values due to an improperly mounted camera. <p>Perform the following:</p> <ul style="list-style-type: none"> Check to ensure the camera is properly installed into the bracket with no movement. If the bracket has been damaged or adhesive has been reused, replace with a genuine Bendix replacement part. Clear the camera's DTCs. If the DTC returns, perform the SPTAC calibration using the SPTAC target part number K159472. If the DTC does not return, perform a test drive until speed signs are recognized.

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

2.9 TROUBLESHOOTING DIAGNOSTIC TROUBLE CODES: POWER SUPPLY

All wire harness connectors must be properly seated to maintain electrical connectivity. Push the mating connectors until they click. When replacing a Bendix Fusion FLC-20 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.

CONNECTOR PIN-OUT AND POWER REQUIREMENTS

The camera has two connectors. See *Figure 6*.

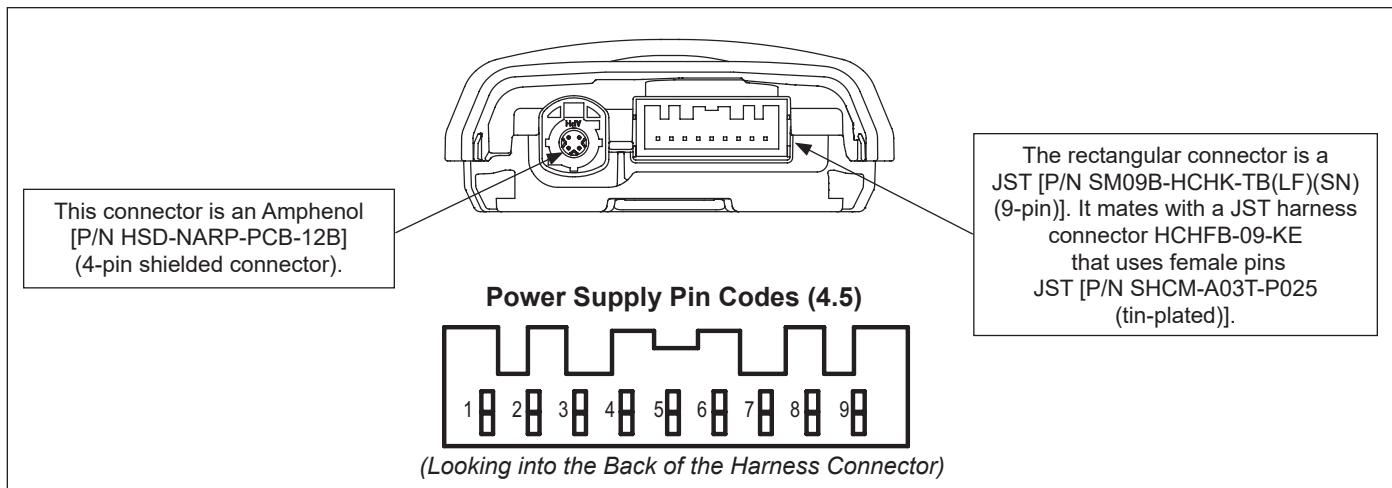


Figure 6 – Camera and Harness Connector Views

Pin #	Description	Nominal Voltage	Nominal Current
1	Module Power	14V/28V (9~32V)	200mA/100mA
2	Not Used	—	—
3	J1939 Low	2.1-2.4V	85mA
4	J1939 High	2.6-2.9V	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 (9~32V)	20mA/10mA

Table 3 – Harness Connector Pins

POWER SUPPLY AND IGNITION VOLTAGE 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. Repeat Step 2 for ignition voltage on pin 9.
4. Check for damaged wiring, damaged or corroded connectors, and loose connections.
5. Check the condition of the vehicle battery and associated components. Ensure the connection to ground is secure and tight.
6. Using the procedures described by the vehicle manufacturer, check the alternator output for excessive noise.

2.10 SERIAL DATA (PRIVATE COMMUNICATIONS) TROUBLESHOOTING PROCEDURE

The Bendix™ FLC-20™ camera requires private network messages to and from the Bendix Fusion system. The camera will set a DTC if these messages are not present, or if there is a problem with the private communications system. Refer to SD-61-4963, *Bendix® Fusion™ FLR-21™ Radar Sensor*, on B2Bendix.com for full troubleshooting information.

NOTE: Confirm there are no DTCs on other components. If there are active DTCs, they should be addressed prior to performing additional troubleshooting procedures.

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



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

2. 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. Devices that use the affected network will not be able to transmit or receive messages on that network.

3. Check for corroded or damaged wiring connector problems such as opens or shorts to voltage or ground.
4. 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.

5. Check for other Private Communications devices which may be inhibiting communication. The service technician should consult the procedures for Private Communications troubleshooting. The device's power should be removed and measurements made at the FLC-20 pins for shorts to ground and power pins and resistance between the Private Communications HIGH or Private Communications LOW input circuits.

6. 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.

2.11 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 camera 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.

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 camera 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.

2.12 COMMUNICATIONS (J1939) TEST AND TROUBLESHOOTING PROCEDURES

NOTE: Confirm there are no DTCs on other components. If there are active DTCs, they should be addressed prior to performing additional troubleshooting procedures.

The FLC-20 camera requires several J1939 messages from various ECUs. The camera will set a DTC if one of the messages from one of the expected ECUs is not present. Go to the Service Data Sheet listed below for the particular ECU for full troubleshooting information.

Reference Documents:

- *Bendix® Fusion™ FLR-21™ Radar Sensor (SD-61-4963)*
- *Bendix® ESP® EC-80™ Controller (SD-13-4986)*
- *SafetyDirect® by Rand McNally® Web Portal Processor (SD-65-21025)*
- *Bendix® Fusion™ FLR-25™ Radar Sensor (SD-29-50022)*

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



Do not insert any probe into the pin on the mating connector of the sensor that is greater than the 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.

If the J1939 HIGH, **and** J1939 LOW, wiring circuits are reversed, communication over the entire J1939 link will be lost. Devices that use the affected network will not be able to transmit or receive messages on that network.

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

2.13 CLEARING DIAGNOSTIC TROUBLE CODES (DTCS)

Cycle the ignition power, or use the Bendix ACom Diagnostic Software to clear DTCs after troubleshooting – and correcting – any problem with the system.

3.0 TYPICAL INSTALLATION

The Bendix FLC-20 camera is installed on the windshield at a position determined by Bendix engineering and the OEM. See Figure 8 and refer to Table 4a for cameras mounted from the top of the windshield. See Figure 9 and refer to Table 4b for cameras mounted from the bottom of the windshield.

NOTE: When replacing a camera bracket, temporarily mark the location of the top of the original bracket to help position the replacement.

!IMPORTANT

Use only Bendix-approved windshield adhesive when re-mounting a camera bracket (included with the bracket kit). Bendix recommends replacing the bracket if the bracket and camera have been dislodged from the windshield.

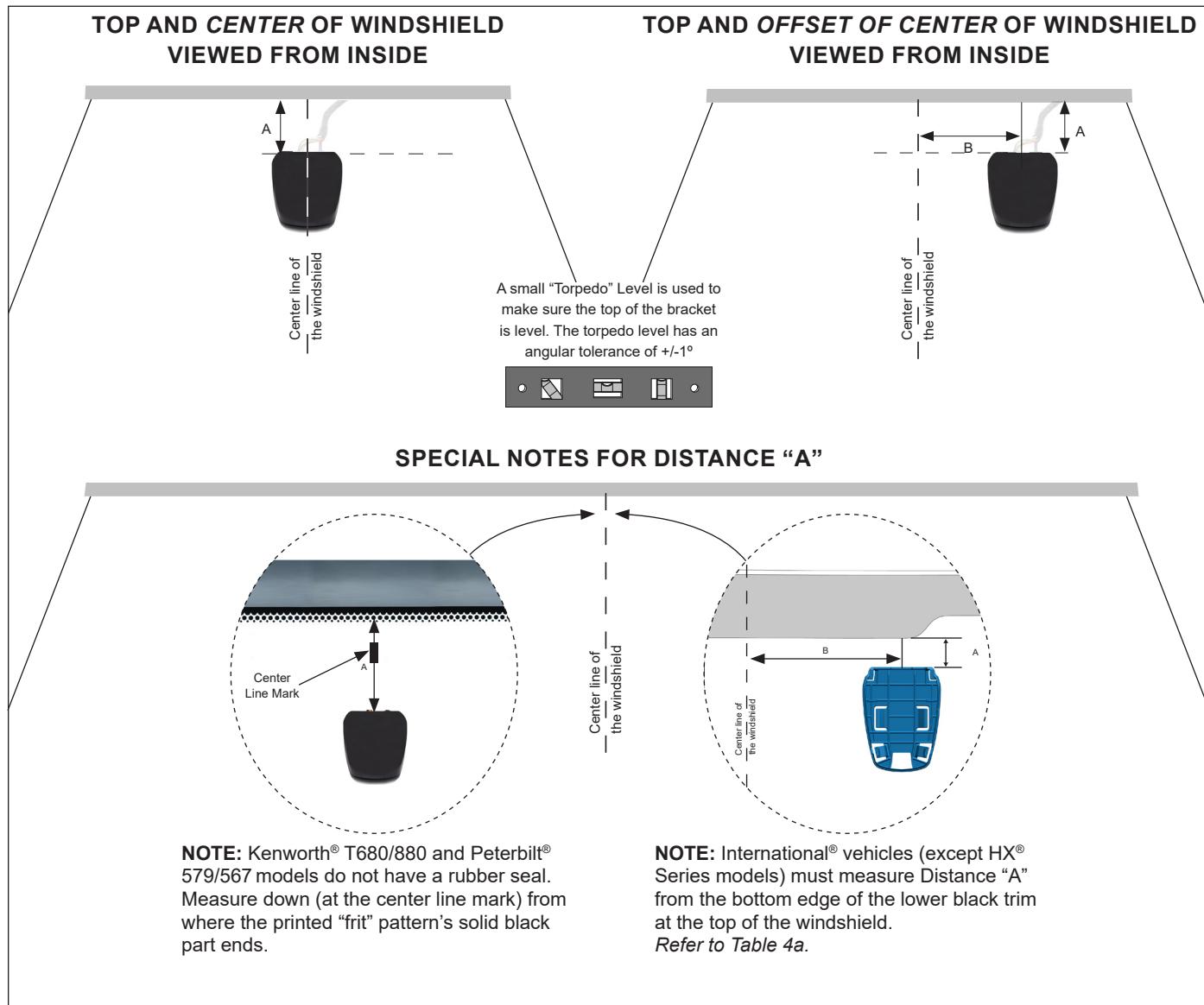


Figure 8 – Bracket Installation Coordinates from Top of Windshield

Camera Mounting from the Top of the Windshield				
Vehicle OEM*	Vehicle Model	Distance "A"	Distance "B"	Comments
Kenworth®	T280, T380, T480, T680, T880, W990	1.4 in. $\pm \frac{1}{8}$ in. (35 mm \pm 3 mm)	0	Windshields have a mark at the center line. The camera bracket is located <i>Distance "A"</i> downward from the lower edge of the printed border.
	T370	2.38 in. $\pm \frac{1}{8}$ in. (60.3 mm \pm 3 mm)	6 in. $\pm \frac{1}{8}$ in. (152 mm \pm 3 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "B"</i> from the center of the windshield. The camera bracket is located <i>Distance "A"</i> downward from the interior seal of the windscreens.
Mack®	CHU/CXU	2 in. $\pm \frac{1}{8}$ in. (51 mm \pm 3 mm)	6 in. $\pm \frac{1}{8}$ in. (152 mm \pm 3 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "B"</i> from the center. The camera bracket is located <i>Distance "A"</i> downward from the lower edge of the rubber seal.
International®	HX® Series	1.97 in. $\pm \frac{3}{16}$ in. (50 mm \pm 5 mm)	5.9 in. $\pm \frac{3}{16}$ in. (150 mm \pm 5 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "B"</i> from the center of the windshield. The camera bracket is located <i>Distance "A"</i> downward from the bottom edge of the inner black trim at the top of the windshield.
	ProStar®, LT® Series, RH™ Series, LoneStar®, DuraStar®	1.26 in. $\pm \frac{3}{8}$ in. (32 \pm 10 mm)	5.9 in. $\pm \frac{3}{16}$ in. (150 mm \pm 5 mm)	
International® IC Bus™	CE Series	7.125 in. $\pm \frac{1}{8}$ in. (180 mm \pm 3 mm)	6 in. $\pm \frac{1}{8}$ in. (152 mm \pm 3 mm)	
Peterbilt®	536, 537, 548, 579, 567	1.4 in. $\pm \frac{1}{8}$ in. (35 mm \pm 3 mm)	0	Windshields have a mark at the center line. The vertical location is between the bracket's uppermost surface and the nearest surface of the windscreens seal. The camera bracket is located <i>Distance "A"</i> downward from the lower edge of the printed border.
	337, 348	1.18 in. $\pm \frac{1}{8}$ in. (30 mm \pm 3 mm)	0	The camera bracket is located <i>Distance "A"</i> downward from the bottom of the windscreens seal.
	520	8.625 in. $\pm \frac{1}{8}$ in. (219 mm \pm 3 mm)	6 in. $\pm \frac{1}{8}$ in. (152 mm \pm 3 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "B"</i> from the center of the windshield. The camera bracket is located at <i>Distance "A"</i> from the interior upper seal of the windscreens.
Volvo®	VNM / VNL	1.3 in. $\pm \frac{1}{8}$ in. (34 mm \pm 3 mm)	0	The camera bracket is located <i>Distance "A"</i> downward from the lower edge of the rubber seal.
FCCC	Utilimaster	19.5 in. (495 mm)	3.15 in. (80 mm)	The camera bracket is located <i>Distance "A"</i> downward from the lower edge of the aluminum windscreens support and the top part of the camera bracket. <i>Distance "B"</i> is taken from the interior face of the middle windscreens support to the closest point of the camera to the support.

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

Table 4a – Camera Mounting from Top of Windshield Specifications

BOTTOM AND CENTER OF WINDSHIELD - VIEWED FROM INSIDE

A small "Torpedo" Level is used to make sure the top of the bracket is level. The torpedo level has an angular tolerance of +/-1°

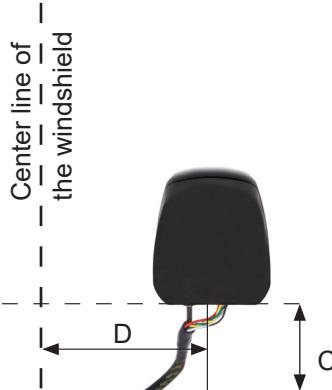


Figure 9 – Bracket Installation Coordinates from Bottom of Windshield

Camera Mounting from the Bottom of the Windshield				
Vehicle OEM*	Vehicle Model	Distance "C" ± 1/8 in. (3 mm)	Distance "D" ± 1/8 in. (3 mm)	Comments
Prevost®	H3-45	3.15 in. (80.0 mm)	5.12 in. (130 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "D"</i> from the center of the windshield. The camera bracket is located <i>Distance "C"</i> upward from the inner seal surface.
Mack®	TE	7.125 in (181 mm)	6 in. (152 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "D"</i> from the center of the windshield. Distance C is taken from the horizontal edge of the seal.
	LR	5.125 in (130 mm)	6 in. (152 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "D"</i> from the center of the windshield. The camera bracket is located <i>Distance "C"</i> upward from the lower seal edge.
Temsa™	TS35	6.75 in. (171 mm)	6 in. (152 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "D"</i> from the center of the windshield. The camera bracket is located <i>Distance "C"</i> upward from the external rubber seal.
	TS45	7.375 in. (187 mm)	6 in. (152 mm)	The camera bracket is offset to the passenger's side of the vehicle by <i>Distance "D"</i> from the center of the windshield. The camera bracket is located <i>Distance "C"</i> upward from the external rubber seal.
FCCC	Morgan Olson	5.98 in. (152 mm)	2.4 in. (61 mm)	The camera bracket is located <i>Distance "A"</i> upward from the dashboard to the lowest part of the camera bracket. <i>Distance "B"</i> is taken from the middle plane of the windshield to the middle plane of the camera toward the passenger side.

*NOTE: All measurements are along the surface of the windscreens

Table 4b – Camera Mounting from Bottom of Windshield Specifications

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, system performance degradation, and/or a collision causing property damage, serious injuries, or death.

The ambient temperature must be in the range of 50-100° F (10-38° C). 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 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 20 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.

1. Engage the top of the camera into the bracket	2. Rotate the camera into the bracket	3. Listen for the click as the bracket engages the camera	IMPORTANT: Double-check that the camera is fully engaged into the bracket.
			 <p>Verify that the channel between them has the same gap all the way around, and pull gently on the camera to check that the tabs at the top and bottom are engaged and that there is no play.</p>

Figure 10 – Camera Installation

To install the camera into the bracket, see *Figure 10*.

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 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

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 10*.

4. 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.

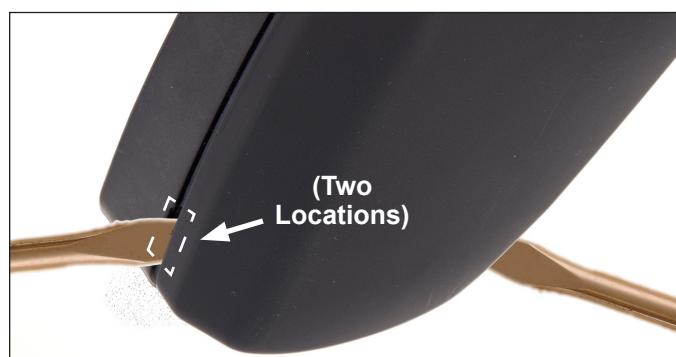


Figure 11 – Camera Release

See *Figure 11*. 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 the OEM.

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 FLC-20 camera, and whether there is a bulb-check illumination at vehicle power-up. See *Figure 12 for some examples of OEM icons used at the time this document was published.*

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

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Figure 12 – 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*, for more information.

3.4 MAINTENANCE

In normal use, the Bendix FLC-20 camera needs proper mounting and 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.

3.5 CAMERA INTERCHANGEABILITY

When replacing cameras only, use replacements with the same part number (or a direct superceding replacement number supplied by Bendix). After replacing the camera, run the engine for two (2) minutes and verify no faults are present. Once confirmed no faults are shown with the engine running, drive the vehicle for 5 – 20 miles (8 – 32 km) or until a speed sign is displayed by the system.

WARNING

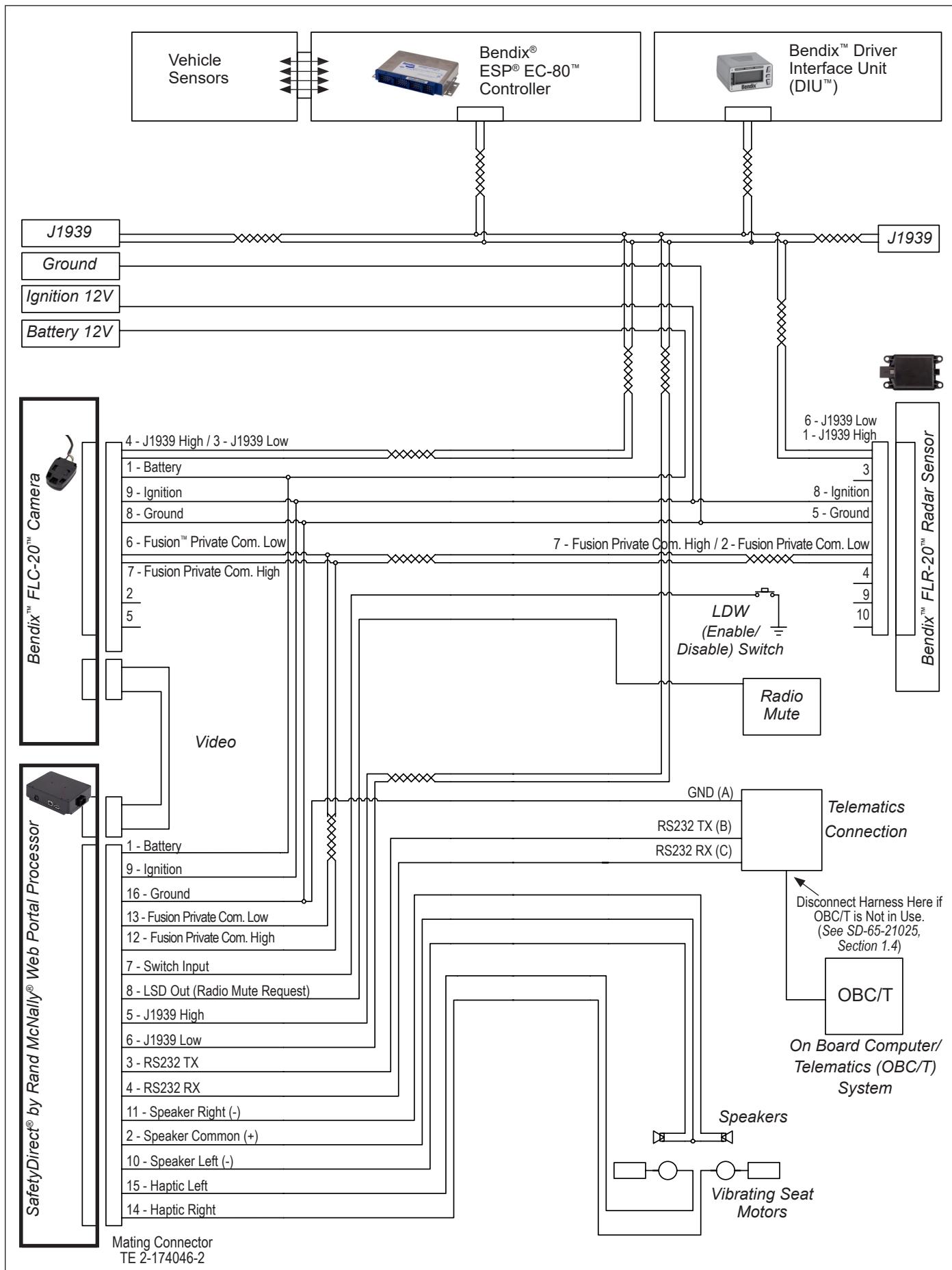
Cameras of different vehicle models and model years must not be interchanged. The use of an incorrect camera can lead to Diagnostic Trouble Codes (DTCs) being set, and performance degradation – including unnecessary system interventions and the potential for situations where interventions do not occur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

Cameras are designed specifically for a 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 FLC-20 cameras are powered by the Mobileye® System-on-Chip EyeQ® processor with state-of-the-art-vision algorithms.

APPENDIX A - BENDIX® FUSION™ SYSTEM COMPONENT SCHEMATIC





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