Dorman Training Center Presents:

HD VEHICLE MULTIPLEXING

PART 3

DORMAN TRAINING CENTER

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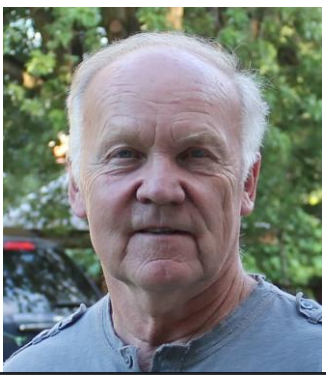
Instructor

- Owner, O&K Truck and Auto Repairs Ltd.
- ATTP Master Instructor, New York State
- Author, “Medium/Heavy Duty Truck Electricity and Electronics”
- Training provider for various Associations, industry and various NY State agencies
- Developed trainings that range from four hours to multiple days, specializing in brakes, electrical, regulations and many other subjects relating to our industry.
- Member of various organizations such as SAE, CVSA, TANY



Sulev “Swede” Oun

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What will be covered

- Continuation of Multiplex “CAN” Part 1 and 2.
- Diagnostic strategies pertaining to “CAN”
- Utilizing common tools for diagnosing.
- Looking at resources for information.
- Recommended wiring repair practices.
- Diagnostic Case

Part 3 is a continuation of the journey we started in Part 1.
It’s advisable to review Parts 1 and 2.

3

Wake Up

“General Awareness about Wakeup”

Many controllers are programmed for a sleep mode when not being used. **It’s a time strategy**. There are too many wakeup and sleep strategies to describe everyone used, but we’ll look at some common strategies you might encounter.

- Some modules might need a wakeup message from another module to wakeup.
- Some networks might only require ignition power to wakeup “all” the connected modules.
- Some networks might have an extra circuit applying voltage on a network to wakeup. The voltage would be a signal, not a power source for the module(s).
- In some networks a master module (Power Mode Master) wakes up and starts talking, which initiates wakeup of all the other modules.

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Why would you care?

Diagnostics such as:

- **Isolating modules for testing.**
- **Parasitic draw testing.**

Tip: If not sure, disconnect major modules last when isolating. If modules start going offline, change the order of disconnecting modules to see which module is putting the others to sleep when missing.

Important! Think backwards. Try to decide which modules would not be relevant to the fault/issue you are trying to tackle. That should also include the legs of these modules connecting to the network. This could be a diagnostic time saver.

"Impossible, Improbable, Probable"
"Keep It Simple"

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Time out examples

From an Isuzu Campaign Service bulletin via NHTSA Recall.

- **After determining there is a fault, turn the engine control switch to "Lock" position.**
- **Wait at least three minutes and then disconnect the negative battery cable.**

IMPORTANT! The ECM may malfunction if the battery is disconnected within three minutes of turning the "Engine Control Switch" off.

Another example. This one is from Freightliner Business M2 Workshop Manual.

➢ **Awake State and Sleep State**

The Bulkhead Module, Chassis Module (CHM), and instrumentation control unit (ICU) are as a group, in an awake state or a sleep state depending on vehicle conditions. When any of these electronic components are awakened, the remaining components wake up if they are not already awake. When the BHM, CHM and ICU are in an awake state, the odometer reading appears on the dash driver display screen.

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Time out examples cont.

One of the following actions will cause the BHM, CHM, or ICU to go into an awake state:

- **Opening the door switch.**
- **Turning on the Hazard switch.**
- **Turning the ignition switch to any position other than off.**
- **Turning on the headlight/parking light switch.**
- **Depressing the service brake.**

The BHM, CHM, and ICU will enter a sleep state when they are no longer actively controlling any outputs or responding to any inputs and all other power down requirements.

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Time out examples cont.

To check whether or not the electrical system is going into a sleep state:

1. **Enter the vehicle.**
2. **Shut the door.**
3. **Remove your foot from the service brake.**
4. **Make sure the ignition switch and hazard switch are in the off position.**

NOTE: One minute after these conditions are met, and provided that one of the parameters in Table 1 has not been added to the BHM, the odometer reading should disappear, the electrical system is not going to sleep.

The following is one of the parameters from Table 1:

Parameter Part Number	Description	Hours
	Switched Center Pin Power	24

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Food for thought

If various modules are looking at the same sensor values, where is the source?
For example, what modules need to see vehicle speed? PCM, TCM, ICM?
Which modules get the hard-wired values, and which modules are networked with these values?
Think of all the possible modules and different systems involved in trucks.
"PCM, Chassis, Body, Transmission, ABS, etc. How about 3rd party involving body-builders. Each one with their own acronyms.
Would you know the following: I-CAN, B-CAN, A-CAN, F-CAN, V-CAN, MSM, MSB, MUX, EOH? That's just a small example.
I Wouldn't. But I would need to know it to walk through diagrams as an example.
That's why information is important.
Important! Try looking at explanations, definitions, operation and description as a first step.

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General Diagnostics Processes

Starting with Scan tool communication issues.
"No communications (with any module)"
Note: This might be any module or any specific network (affecting that network) or entire vehicle.

- Start with the DLC power, ground and terminal contact issues.
- Gateway not connecting DLC to networks.
- Network short to power or short to ground.

✓ What happens if you get a U-code for "Bus-Offline"?
✓ How can you diagnose it without duplicating the fault?
✓ How can you retrieve that fault code if that bus is offline?

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Possible causes

- **"Voltage Drop" causing a loss of communication during high electrical loads such as during cranking. Note: See Dorman Training Center videos for good voltage drop training.**
- **Short in circuit.**
- **Circuit noise induced from failed components such as an alternator.**
- **Improper pair-twisting.**

U-codes for shorts and opens.

These tend to be more specific in description such as open termination.

That's a good thing because you know what you can measure(see Multiplex Part 2)

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Common Examples

Erratic Communication:

- **Loose connections**
- **Electrical noise**

Note: Sometimes even open or incorrect termination resistance can cause this also.

Open Termination:

- **Terminating resistor, also;**
- **An open circuit near the terminating resistor.**

NOTE: Make total network resistance as first test. Follow through also with a test at each module that contains terminating resistor.

Refer to Multiplex Part 2

- **60 ohms: Good.**
- **120 ohms: One terminating resistor missing.**
- **0 ohms: Short between CAN high and CAN low.**
- **40 ohms: An additional resister has been added.**
- **OL: Open circuit**

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Summary (up to this point)

Depending upon the issue, you might want to ask yourself the following questions (found in many diagnostics recommendations).

- **Are there any lamps, warnings or messages displayed?**

Tip: Get in the habit at initial power up to check bulb/indicator operation.

"I can't remember if the light was on or not when vehicle came in".

- **Do all the systems operate properly? (Make sure you know how they are meant to operate).**
- **Can the scan tool communicate with all the modules?**
- **Are there any controller (module) codes?**
  - **Are they current?**
  - **Are they history?**
- **Are terminating resistors used?**
- **Where are they?**

NOTE: Big one for trucks!!

- **Are any aftermarket devices tied into the networks or systems?**

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Back To The Basics

- **If a code is set at "key-on" it's a hard code and should be a straightforward diagnosis.**

Operating conditions that might cause faults to occur:

- **Hot or Cold.**
- **Connections reacting to vibrations and flexing.**
- **Shorts related to harness position (flexing/touching, improper securement).**
- **Module power voltage drops.**

Note: this can happen when power is shared with other systems/components.

"Cause and Effect"

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Using Repair Information

- Utilize network descriptions if available.
- Check network code flowchart whether you have a code "OR NOT" to see if anything sticks out or for important information such as location of resistors, master/gateway module info/locations and wake up strategies.
- Check for any pinpoint values that you might be comfortable with.
- Checkout diagrams for twisted pair network to isolate from other components.

"Find the most direct route first"

- Find out what normal operation is, so you can identify abnormal operation.

➢ **Check for any Technical Service Bulletins (TSBs).**

- Quite often they contain good flow charts or calibration/update information.

NOTE: NHTSA recalls can be another good source of information.

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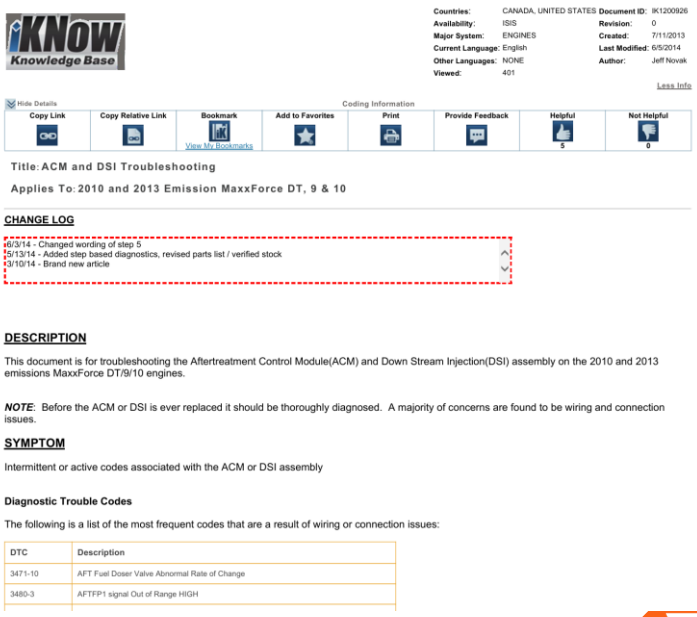
Recall examples

What can I learn from a recall besides the obvious?



iKNOW Knowledge Base

Countries: CANADA, UNITED STATES Document ID: IK1200926
Availability: ISIS Revision: 0
Major System: ENGINES Created: 7/11/2013
Current Language: English Last Modified: 6/5/2014
Other Languages: NONE Author: Jeff Novak
Viewed: 401

Less Info

Hide Details | Coding Information

Copy Link | Copy Relative Link | Bookmark (View My Bookmarks) | Add to Favorites | Print | Provide Feedback | Helpful 5 | Not Helpful 0

Title: ACM and DSI Troubleshooting

Applies To: 2010 and 2013 Emission MaxxForce DT, 9 & 10

CHANGE LOG

6/3/14 - Changed wording of step 5
5/13/14 - Added step based diagnostics, revised parts list / verified stock
3/10/14 - Brand new article

DESCRIPTION

This document is for troubleshooting the Aftertreatment Control Module(ACM) and Down Stream Injection(DSI) assembly on the 2010 and 2013 emissions MaxxForce DT/9/10 engines.

NOTE: Before the ACM or DSI is ever replaced it should be thoroughly diagnosed. A majority of concerns are found to be wiring and connection issues.

SYMPTOM

Intermittent or active codes associated with the ACM or DSI assembly

Diagnostic Trouble Codes

The following is a list of the most frequent codes that are a result of wiring or connection issues:

DTC	Description
3471-10	AFT Fuel Doser Valve Abnormal Rate of Change
3480-3	AFTFP1 signal Out of Range HIGH

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Recall examples

How about a nice free colored wiring diagram I can print and save.

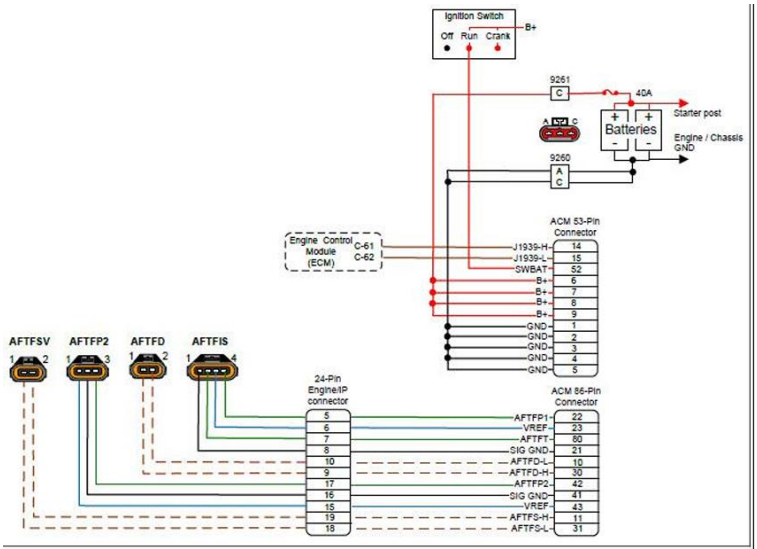

Figure # 1: MaxxForce DT/9/10 Aftertreatment wiring diagram

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Recall examples

Step 1: DSI connector inspection	
The four connectors at the DSI assembly (AFTFP1, AFTFP2, AFTFD, AFTFIS) should be checked for lose or broken pins. Verify connector pins are making proper contact by performing a pin drag test. Each of the four connectors should snap securely into place, if not then check for cracked connectors. ***Are all four connectors and pins properly secured?*** **Check all this nice information I got.**	***Yes:*** Continue to Step 2. ***No:*** Replace any connectors or pins that do not make secure connections. Retest and verify aftertreatment fault does not return.

Step 2: ACM/DSI wiring inspection	
Wiring from the ACM to DSI should be inspected for any chafing and that its properly routed. Also inspect the powers and grounds for any issues. If the issue is centralized on a particular wire or circuit then it should be load tested and wiggled to pinpoint the issue. ***Is wiring intact and properly routed?***	***Yes:*** Continue to Step 3. ***No:*** Correct any wiring issues and make sure it is properly routed. Retest and verify aftertreatment fault does not return.

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Recall examples

Known issues. Someone else did the work for us.

Thank You

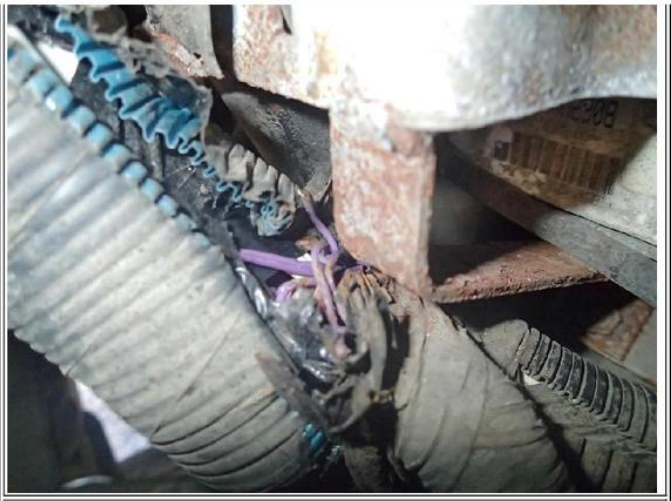

Figure #2: Harness chafing(incorrectly routed)

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Recall examples

U.S. Department of Transportation
National Highway Traffic Safety Administration

1200 New Jersey Avenue SE
Washington, DC 20590

March 5, 2024

Overloaded Electrical Circuit from Wiring Damage

Mr. Jeffery Marsee
Chief Representative, Emission and Safety
Isuzu Motors Limited
46401 Commerce Center Drive
Plymouth, MI 48170-2473

NEF-107HG
24V-157

Subject: Overloaded Electrical Circuit from Wiring Damage

Dear Mr. Marsee:

This letter serves to acknowledge Isuzu Motors Limited's notification to the National Highway Traffic Safety Administration (NHTSA) of a safety recall which will be conducted pursuant to Federal law for the product(s) listed below. Please review the following information to ensure that it conforms to your records as this information is being made available to the public. If the information does not agree with your records, please contact us immediately to discuss your concerns.

Makes/Models/Model Years:
CHEVROLET/6500XD/2020-2024
CHEVROLET/7500XD/2023-2024
ISUZU/FTR/2019-2024
ISUZU/FVR/2022-2024

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Recall examples

Components:
ELECTRICAL SYSTEM
FORWARD COLLISION AVOIDANCE: SENSING SYSTEM: CAMERA

Potential Number of Units Affected: 2,891

Problem Description:
Isuzu Motors Limited (Isuzu) is recalling certain 2019-2024 FTR, 2020-2024 Chevrolet LCF 6500XD, 2022-2024 FVR, and 2023-2024 Chevrolet LCF 7500XD vehicles equipped with a Mobileye Collision Warning System. The Mobileye camera cable may have been routed improperly, which can result in wiring damage and an overloaded electrical circuit.

Consequence:
Overloaded electrical circuits can overheat, increasing the risk of fire. In addition, wiring damage may cause a loss of turn signal, hazard lights, and/or collision system function, increasing the risk of a crash.

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Recall examples

What can I learn from a recall besides the obvious?

Wiring for Mobileye collision warning system may have been routed incorrectly and could overheat and melt. If this happens, turn signals and hazards may not work properly. Mobileye collision avoidance information would not display.

ISUZU

IMPORTANT SERVICE INFORMATION FOR:
- ✓ SERVICE MANAGER
- ✓ SERVICE ADVISOR
- ✓ TECHNICIAN
- ✓ PARTS DEPARTMENT
- ✓ WARRANTY PERSONNEL

Campaign Service BULLETIN

BULLETIN NUMBER: CB24-R-001
ISSUE DATE: MARCH 2024
GROUP: ACCESSORIES

CV

IMPORTANT SAFETY RECALL

F-SERIES MOBILEYE CAMERA CABLE ROUTING – 24V-157

(Transport Canada 2024-134)

AFFECTED VEHICLES

- 2019-2024MY F-Series Vehicles Equipped with RPO Code I4V Mobileye Collision Warning System

INFORMATION

CONDITION

Isuzu Motors Limited has decided that a defect, which relates to motor vehicle safety, exists in certain 2019-2024MY F-Series vehicles equipped with RPO Code I4V Mobileye Collision Warning System. In the affected vehicles, the wiring for the Mobileye camera may have been routed incorrectly. As a result, the wiring could become damaged by contact with dash components and could overheat and melt. If this happens, the turn signals and hazard lights may not work properly, and the Mobileye collision avoidance information would not be displayed, increasing the **risk of a crash.** In addition, wiring that overheats and melts increases the **risk of a fire**.

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Recall examples

What is this?

Transfer the CAN low (Solid color) wires and CAN high (Striped color) wires from the old CAN reader cap into the new CAN reader cap. (See Figures 77 and 78.)

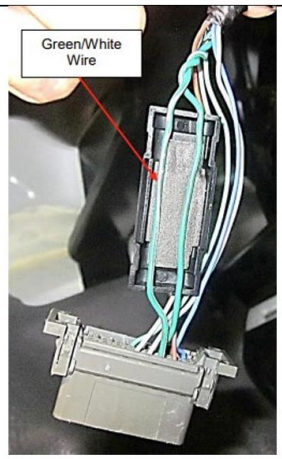

Figure 77
2019-2021 MY

Figure 78
2022-2023 MY

Recall examples

IMPORTANT: Do not switch the orientation of the CAN wires. Failure to follow these instructions carefully will result in Mobileye not working properly.

84. Align the new CAN reader so that CAN_H aligns with the CAN high (Striped color) wire and CAN_L aligns with the CAN low (Solid color) wire and snap it into the cap. (See Figures 79 and 80.)

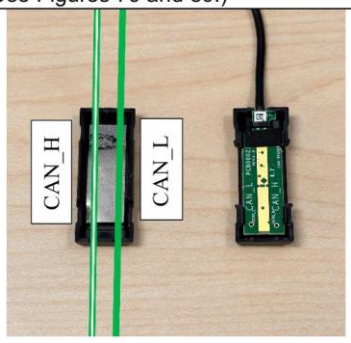

Figure 79
2019-2021 MY
a. CAN High (Green wire with stripe)
b. CAN Low (Solid green wire)

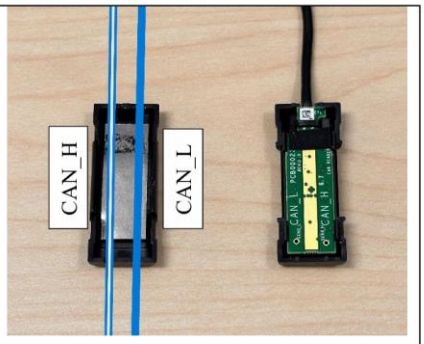

Figure 80
2022-2023 MY
a. CAN High (Blue wire with stripe)
b. CAN Low (Solid blue wire)

CAN Reader. What is it?

- A contactless means of obtaining data through the wire insulation without breaking into the wire.
- Typically, powered from the vehicles on board(existing) power supply (does not need an additional power supply circuit).
- Protected against reverse polarity.
- No set up is needed.

Benefits:

- No impact on the electronic and electrical equipment.
- Compact open-frame design allowing for connection to CAN wires even in hard-to-reach locations.

Used in telematic systems such as this "Mobileye Driver Assistance System" in this Isuzu.

However, it is another electronic component you should be aware of. For example, what if you lost this systems CAN communication?

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Wiring diagrams

Take your time on this.

- Look at legends, symbols and other identifiers for the diagram you're working with.
- Use highlighters to identify crucial wires to isolate specific wires such as power, grounds, reference volts, signals, terminating resistors.

NOTE: Take note of shared power and ground circuits.

If possible, print the diagrams out, so you can tape them together (within reason) to have an uninterrupted wiring roadmap.

By having a printed copy, you can make notes on it with any tested values etc.

This way looking at the complete picture, you might get that **"Bingo"** moment when everything comes together.

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Common issues and common tools

Most issue will wind up being network wiring and connections.

- **Lab scopes are good for looking at the messages. But what happens if there are no messages to see?**
- **DVOM and test light are still useful to look for available voltages.**
- **Test light can be used to check DLC or modules power and grounds.**
- **Signal generators can be utilized to inject a signal or resistance at a location and measure for it with a DVOM at every location that is utilized in the network following your highlighted diagram.**

This brings us to wiring and proper repairs.

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Guidelines for wire/harness repairing

When do you repair or replace wires, terminals and/or harnesses.
The following are compilation of recommendations from various sources such as Freightliner Service Bulletins.

Repair:

- **If less than 20% of the harness is damaged.**
- **If wire damage is greater than 6 inches, an overlay harness can be added to replace the section of damaged wire(s).**
- **If wire is smaller than 12-gauge.**
- **If wire insulation is cracked due to excessive heat from an external source isolated to one section of the wire.**
- **If corrosion is wicked no more than 1 inch from the terminal end. In this case if the damage area is over 6 inches, the harness can be repaired by adding overlay wiring over the damaged area.**

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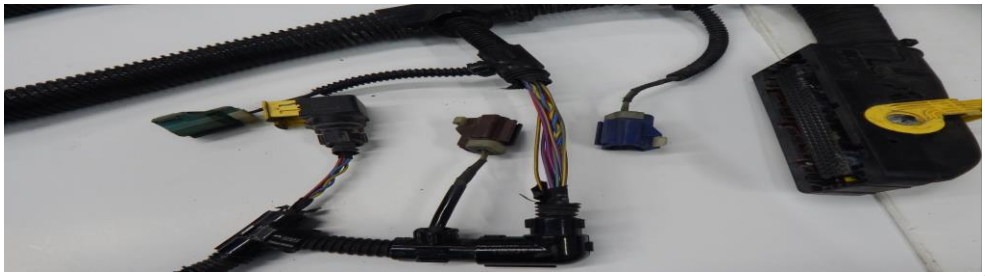
Guidelines for wire/harness repairing

Replace harness when:

- **More than 20% of harness is damaged.**
- **Wire is 12-gauge or larger.**
- **Wire insulation is cracked due to age and other environmental conditions and the damage is spread throughout the wire/harness.**
- **The harness is proprietary. Typically, harnesses used for data linking with sheathing over a twisted pair.**



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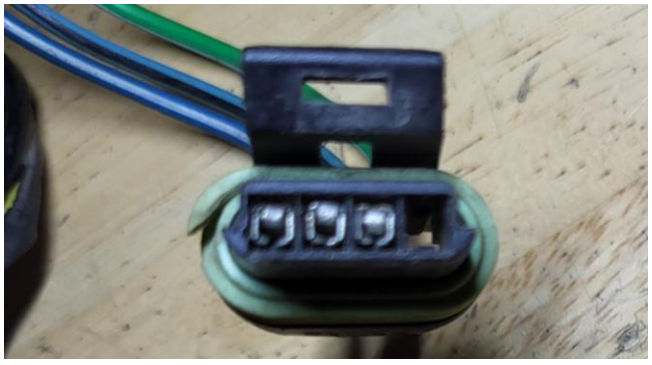
Guidelines for wire/harness repairing

What about connectors and terminals?
Consensus seems to be that damaged connectors, seals and terminals can be replaced without replacing the harness. However, a drag test is crucial for determining that decision. Don't rely on a visual alone as the determining factor.



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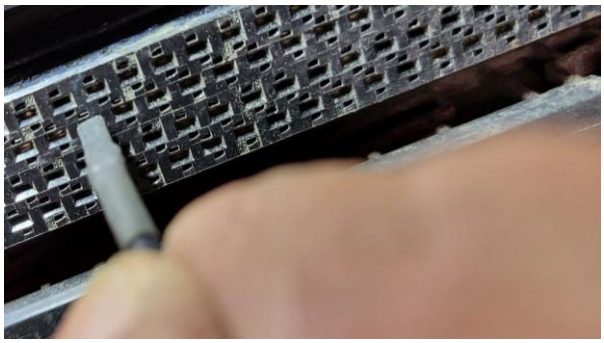
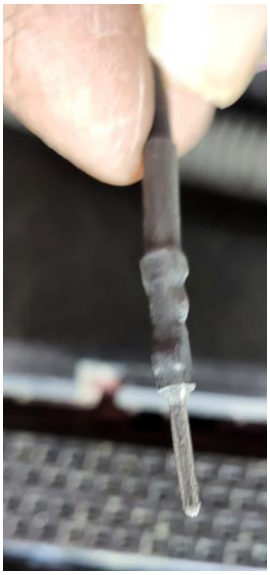
Guidelines for wire/harness repairing





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Guidelines for repairing wires and harnesses

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Guidelines for repairing wires and harnesses

Nice clean sit-down job, with a cup of coffee to keep you company.
"Someone has to do this"

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Guidelines for repairing wires and harnesses

Question??

You only have one set of wheels to go back and forth to work, go shopping and drive your family around. Your vehicle cranks, but wont start or run properly. You do a quick diagnosis, because you need your vehicle, and you discover you have a burnt section of a wiring harness preventing the engine from starting/running. Bad enough that you "should" replace the harness. However, the harness is on back order, and you might not see it for a week.

What will you do?

Welcome to the real world.

If you are like me, you will do whatever it takes to repair the harness.

Does that happen with commercial trucks, fleets, owners etc.?

YES!

Even in those cases, at a minimum, make the repairs using proper techniques to minimize any future issues.

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Guidelines for repairing wires and harnesses

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Guidelines for repairing wires and harnesses

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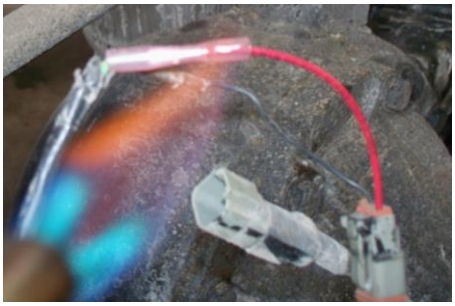
Guidelines for repairing wires and harnesses



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Guidelines for repairing wires and harnesses

I learned how to sew in the Marine Corps.
Needed to keep my uniforms spiffy. Obviously, I never told my wife we were taught those skills in boot camp. I didn't want to become the family seamstress. Not my job.

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Typical CAN testing sequence using WABCO ESC

The following is a condensed sequence I put together using a WABCO ABS system and Electronic Stability Controls (ESC). Material is from "WABCO" Maintenance Manual MM0112.

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
1807		4		SAS Datalink Fault	ATC WL	ESC Disabled	The steering wheel angle signal is not available after ignition on.	• Check CAN wiring between ABS-ECU and SAS for interruptions and short circuits. • Check for corroded or damaged wiring between the SAS and ESC Module. • Contact WABCO Customer Care Center at 855-228-3203 to check parameter setting of ABS ECU and SAS compatibility.
1807	89	7	8 + 6	Steering Ratio Fault	ATC WL	ESC Disabled	The calculated steering ratio of the vehicle is not plausible.	• Check for correct mounting of the SAS and ESC module. • If work has been performed on the vehicle which affects the steering system or front end alignment, perform SAS Calibration and ESC Initialization. Refer to Section 8.
1807	89	8	7 + 1	SAS Calibration Fault	ATC WL	ESC Disabled	The Steering Angle Sensor calibration failed.	• Verify SAS is correctly mounted. • Perform SAS Calibration and ESC Initialization. Refer to Section 8.
1807	89	9	7 + 1	SAS CAN Fault	(temp) ATC WL	ESC Disabled (temp possible)	Data communication faults with ESC module.	• Check harness between ABS ECU and SAS. • Check parameter setting of ABS ECU. • Check SAS operation if fault persists.

You retrieved codes related to SAS , CAN, ESC module and ABS ECU. What's your next step?

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Typical CAN testing sequence using WABCO ESC

Putting it all together. Did we learn enough? I hope so.

ESC CAN Datalink Fault	ATC WL	ESC Disabled	Loss of CAN communication between the ESC module and the ABS ECU.	• Check CAN wiring between ABS-ECU and ESC-module for interruptions and short circuits. • Check CAN wiring between ABS-ECU and SAS for interruptions and short circuits. • Check for corroded or damaged wiring between the ECU, SAS and ESC Module.
ESC Module Mounting Fault	ATC WL	ESC Disabled	E8 version only. The ESC module mounting is not in accordance with specification.	• Verify ESC module is securely mounted, leveled and in correct location. Contact WABCO Customer Care Center at 855-228-3203 to ensure ESC module mounting is in accordance with ABS ECU parameters.

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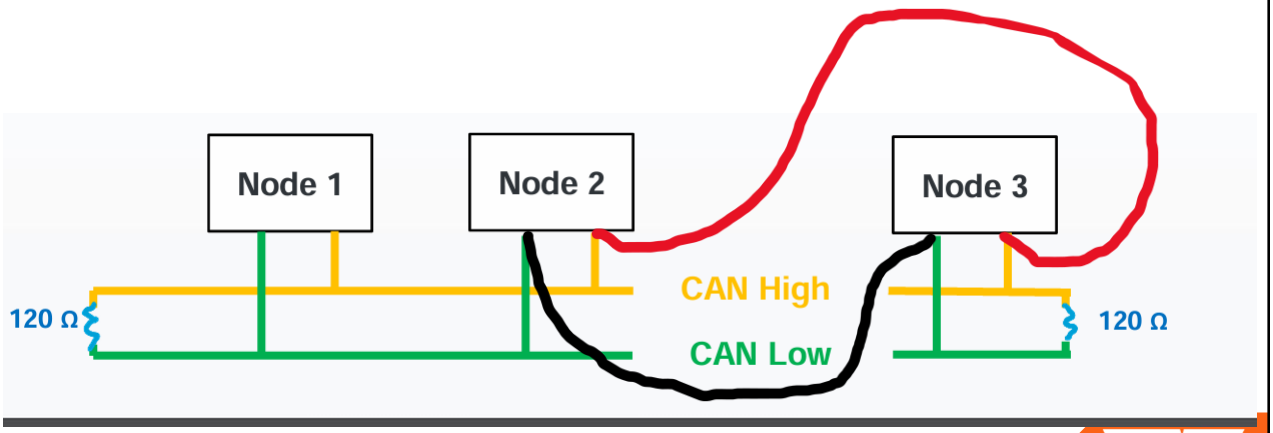
Typical CAN testing sequence using WABCO ESC

Putting it all together. Did we learn enough? I hope so.

One more tip: Identifying an open circuit is one part of diagnostics. Using an overlay(installing a temporary wire to verify that communication is back on with all the modules.



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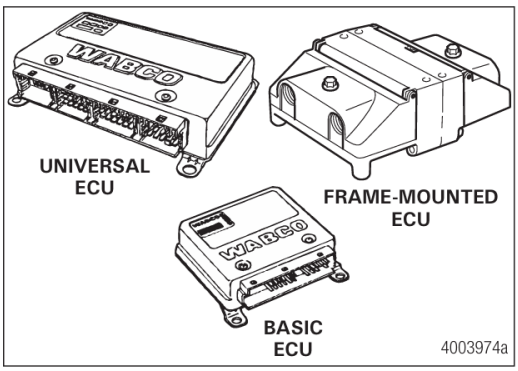
Typical CAN testing sequence using WABCO ESC

Start with understanding the system and description of components involved.

Electronic Control Unit (ECU)

- **The ECU is the control center or brain of the ABS, RSC and ESC. It receives information from the sensors, processes data and sends signals to modulators and active braking valves to achieve different tasks.**



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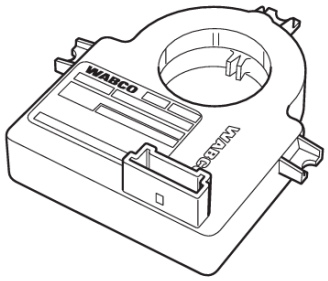
Typical CAN testing sequence using WABCO ESC

Steering Angle Sensor (SAS)

- **The SAS is part of the ESC system. The SAS delivers the drivers steering input (steering wheel position) to the ECU using dedicated ESC system internal data link. The ECU supplies the sensor with voltage and ground. The SAS must be calibrated using diagnostic tools whenever it is replaced, or when any vehicle steering components are replaced or adjusted.**



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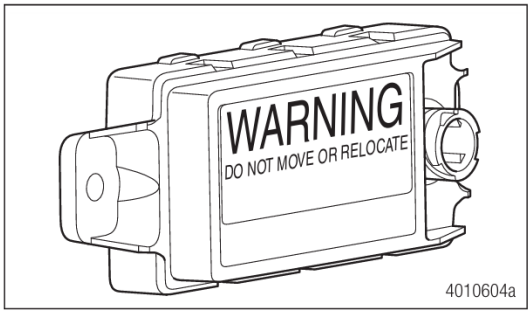
Typical CAN testing sequence using WABCO ESC

Electronic Stability Control (ESC) Module

- **The ESC module is part of the ESC system. It measures the yaw rate as well as vehicle lateral acceleration. The ESC module includes part of the ESC control algorithm. It exchanges data with the ECU via the ESC system internal data link. The ECU supplies the module with voltage and ground. "The ESC module must be initialized by diagnostic tools whenever the ECU or the ESC module is replaced".**



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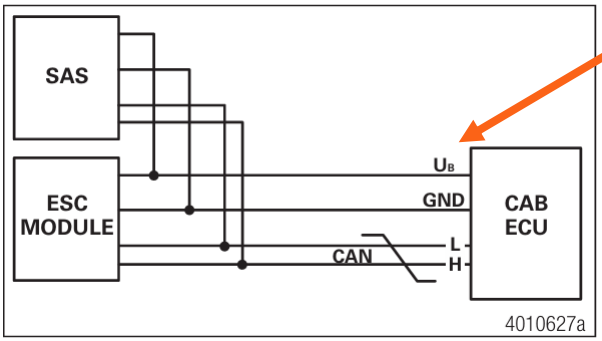
Typical CAN testing sequence using WABCO ESC

ESC CAN Network Testing

- **The ECU, SAS, and ESC module are all connected on a propriety CAN network with internal terminating resistors on each one of the components.**
- **Failure to one of the components will cause others to fault out.**



- **What is Ub?**
- **Base Voltage. Also referred to as operating/supply voltage.**

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Typical CAN testing sequence using WABCO ESC

ESC Module Testing

Electrical Checks

For the following checks, all of the ECU connectors must be plugged in as well as the "SAS". The ECU provides voltage, ground and communications to ESC module.

- **Take measurements at the ESC module harness connector.**
- **Measure Voltage supply Key ON.**
- **Measure CAN High voltage Key ON.**
- **Measure CAN Low voltage Key ON.**
- **Measure terminating resistance across CAN H and CAN L with Key OFF**

Frame mounted ECU: Measure ground resistance Key OFF to chassis ground.

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Typical CAN testing sequence using WABCO ESC

- **Verify no shorts to ground or battery on all lines.**

ESC Module Testing

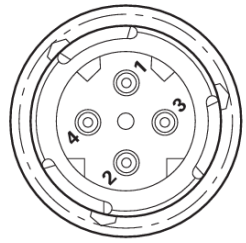
Electrical Checks Cont.

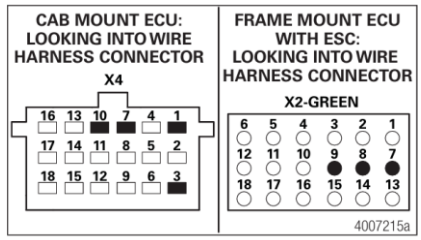
With ECU and ESC Module disconnected:

- **Verify continuity end to end on each line.**
- **Verify no continuity between pins.**

ECU	Modulator Circuit	Connector	Pins
Cab-Mounted Universal with ESC	Power Supply	X4-18 pin	7
	Ground	X4-18 pin	10
	ESC CAN-Low	X4-18 pin	1
	ESC CAN-High	X4-18 pin	3
Frame-Mounted With ESC	Power Supply	X2-Green	9
	Ground	X2-Green	External
	ESC CAN-Low	X2-Green	7
	ESC CAN-High	X2-Green	8

ESC MODULE CONNECTOR





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Typical CAN testing sequence using WABCO ESC

Electrical Check Cont.

The measurements should read as follows:

Pins	Circuit	Measurement
1	Voltage Supply to Chassis Ground	8.0-16.0V
2	(Frame-mounted only) ESC Ground to Chassis Ground	Less than 1 ohm resistance
2	(Cab-mounted only) ESC Ground	Should have continuity but will not be less than 1 ohm
3 and 4	Terminating Resistance between ESC CAN-High to ESC CAN-Low	Approximately 90 ohms
1	With ECU disconnected, check power supply for battery voltage or ground.	No continuity
2	With ECU disconnected, check ground for battery voltage or ground.	No continuity
3 and 4	With ECU disconnected, check CAN lines for battery voltage or ground.	No continuity
3	CAN High Voltage to Chassis Ground	2.5-5.0V
4	CAN Low Voltage to Chassis Ground	0.1-2.4V

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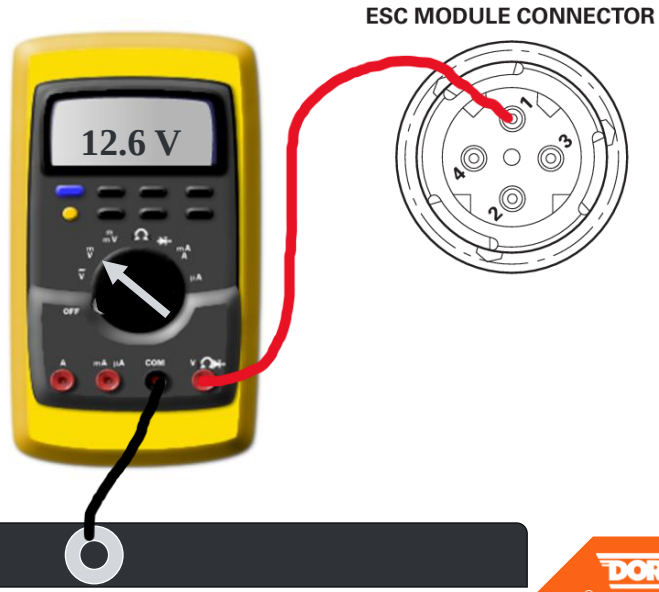
Typical CAN testing sequence using WABCO ESC

- Measure Voltage Supply Key ON.
- Pin 1 to Chassis Ground.
- 8.0 – 16.0 Volts.



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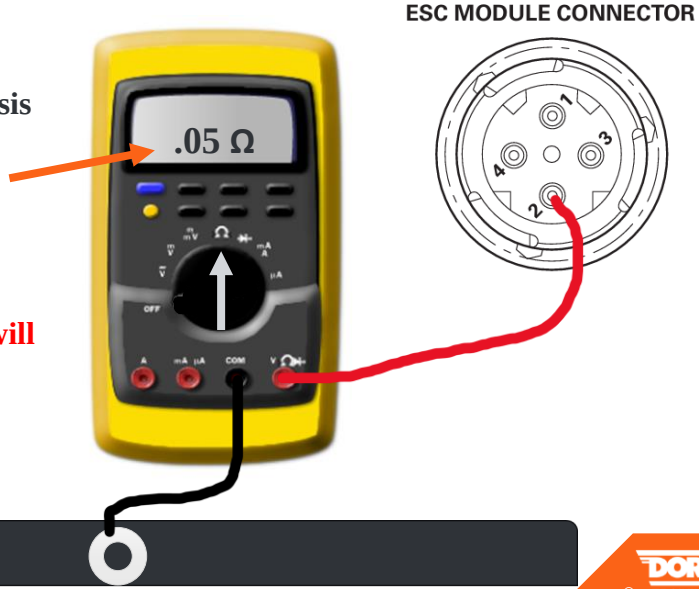
Typical CAN testing sequence using WABCO ESC

"Frame Mounted Only"

- ESC Ground (Pin 2) to Chassis Ground.
- Less than 1 ohm resistance.

"Cab Mounted"

- ESC Ground (pin 2).
- Should have continuity but will NOT be less than 1ohm.



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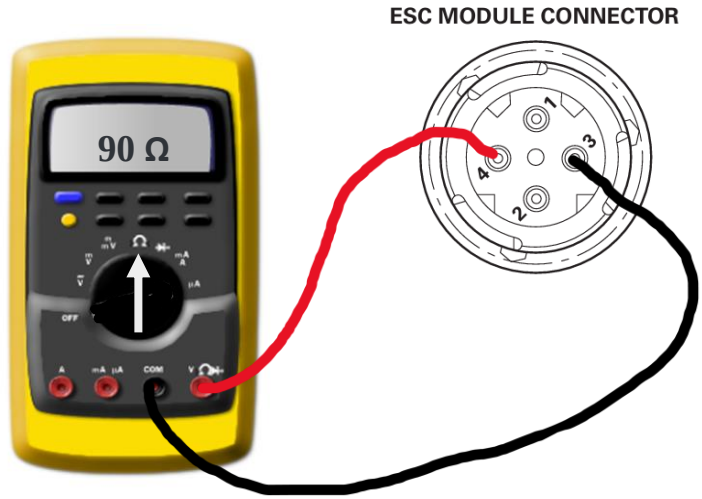
Typical CAN testing sequence using WABCO ESC

"Terminating Resistance"

- Terminating Resistance between ESC CAN-High to ESC CAN-Low.
- Pin 3 and 4.
- Approximately 90 ohms.



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Typical CAN testing sequence using WABCO ESC

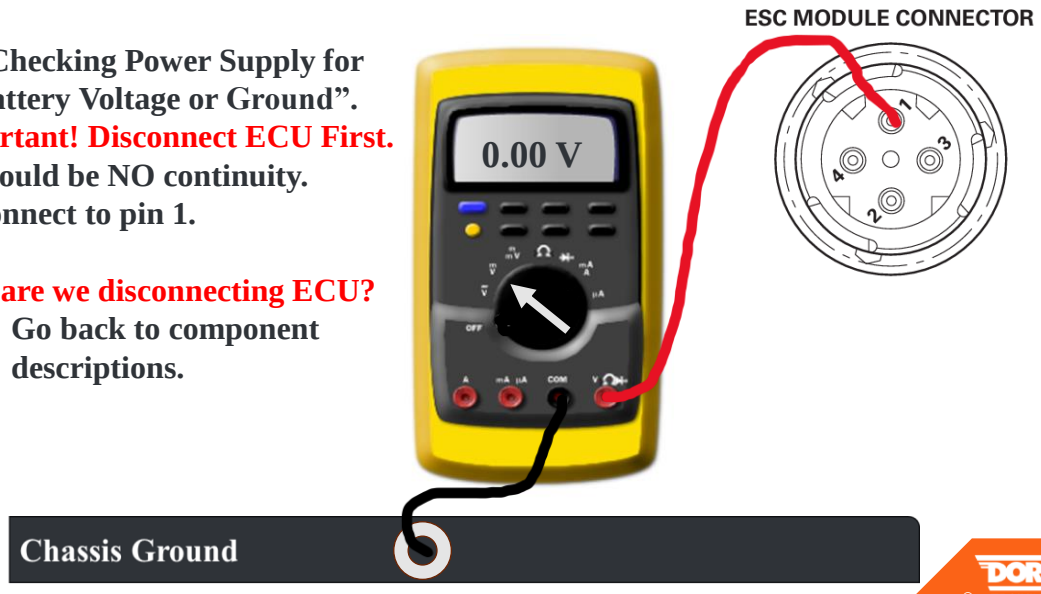
" Checking Power Supply for Battery Voltage or Ground".

Important! Disconnect ECU First.

- Should be NO continuity.
- Connect to pin 1.

Why are we disconnecting ECU?

- Go back to component descriptions.



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Typical CAN testing sequence using WABCO ESC

"Checking Ground for Battery voltage or Ground"

Important! ECU must be disconnected.

- Measurement should Show NO continuity.
- Connected to pin 2.

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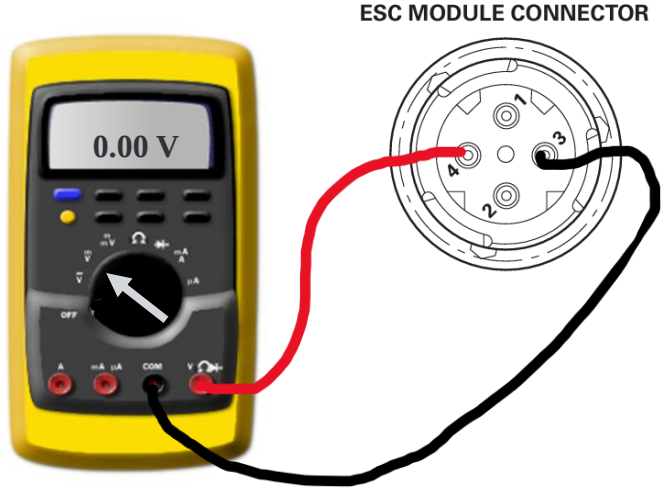
Typical CAN testing sequence using WABCO ESC

"Checking CAN lines for battery voltage or Ground"

Important! ECU must be disconnected.

- Connect between pins 3 and 4.
- Measurement should indicate NO continuity.



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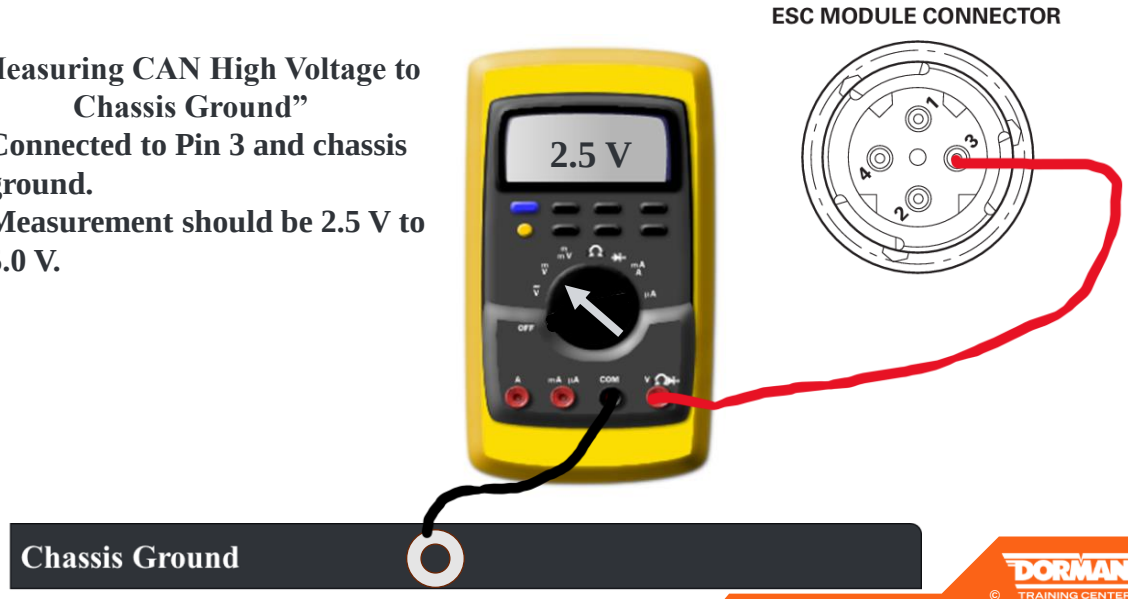
Typical CAN testing sequence using WABCO ESC

"Measuring CAN High Voltage to Chassis Ground"

- Connected to Pin 3 and chassis ground.
- Measurement should be 2.5 V to 5.0 V.



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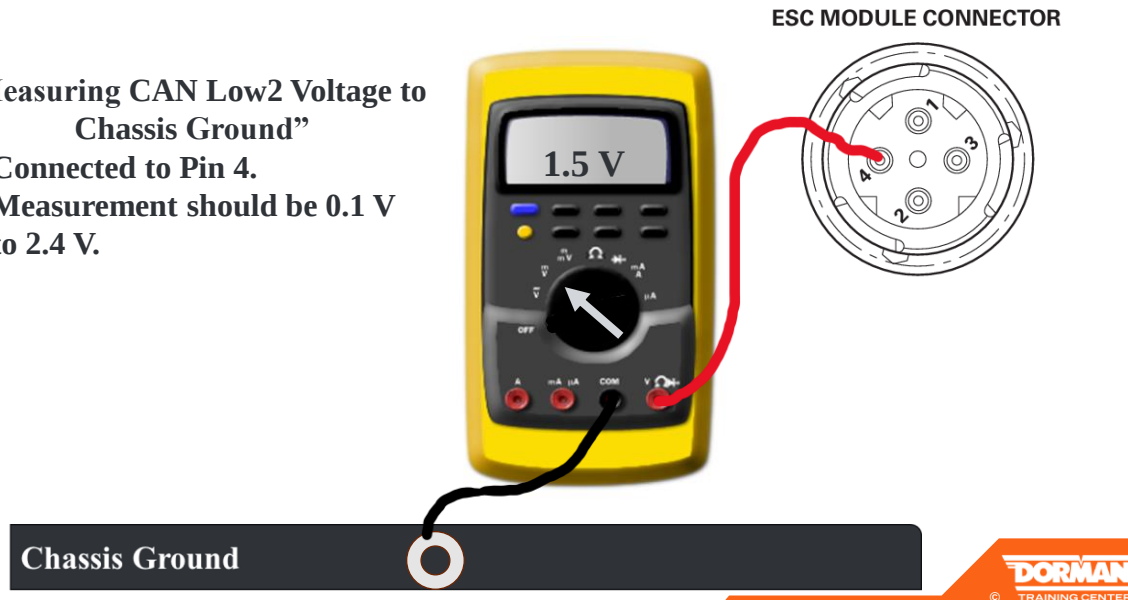
Typical CAN testing sequence using WABCO ESC

"Measuring CAN Low2 Voltage to Chassis Ground"

- Connected to Pin 4.
- Measurement should be 0.1 V to 2.4 V.



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Typical CAN testing sequence using WABCO ESC

Steering Angle Sensor (SAS) Testing

Electrical Checks

"Disconnect SAS" and check terminating resistance across Pin 1 and Pin2 of the SAS.

For the following checks, all the ECU and ESC module connectors must be plugged in as the ECU provides all voltage, ground and CAN communications. Take measurements at the SAS harness connector side.

- **Check Key On CAN Low voltage Pin 1.**
- **Check CAN High voltage Pin 4.**
- **Check Key On voltage Supply on Pin 5.**
- **Check Key Off resistance across CAN Low Pin 1 and CAN High Pin 4.**

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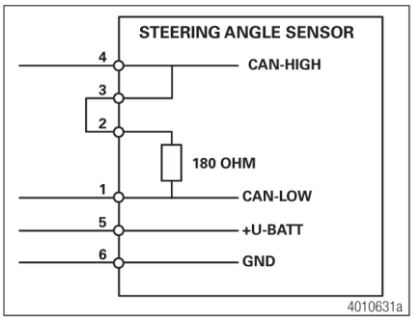
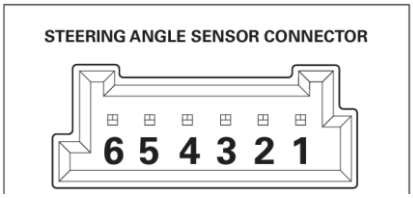
Typical CAN testing sequence using WABCO ESC

Steering Angle Sensor (SAS) Testing

Electrical Checks

Pin	Circuit
1	CAN-Low
2	Terminating Resistor
3	CAN-High
4	CAN-High
5	Power
6	Ground





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Typical CAN testing sequence using WABCO ESC

Steering Angle Sensor (SAS) Testing

Electrical Checks

Location	Measurement
WABCO SAS terminating resistor on sensor	Approximately 180 ohms
CAN High Voltage	2.5-5.0V
CAN Low Voltage	0.1-2.4V
Voltage Supply to Ground	8.0-16.0V
ESC CAN-High to ESC CAN-Low	Approximately 90 ohm
SAS harness jumper (Pin 2 to Pin 4 or Pin 2 to Pin 3)	Continuity
ESC CAN-High or CAN-Low to Power or Ground (with ECU, ESC Module and SAS unplugged)	No continuity

Revisit Multiplex Part 1, 2 and 3 and you will discover that everything we learned led us to this sequence. "Commonalities".

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Typical CAN testing sequence using WABCO ESC

J1939 Serial Communication Testing

Electrical Checks

- **If the ABS ECU is the only ECU on the J1939 datalink which cannot communicate, then take measurements at the ABS ECU connector. If other ECUs are not communicating, then troubleshoot the vehicle datalink backbone and contact the OEM for technical assistance if required.**
- **Check for devices that could be overloading the J1939 datalink slowing down communications,**
- **Verify J1939 High and Low have correct voltage readings, Key ON, while datalink communications are active.**

Important Reminder! For resistance measurements, the vehicle battery must be disconnected, and the ignition must be OFF.

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Typical CAN testing sequence using WABCO ESC

J1939 Serial Communication Testing

Electrical Checks

The measurements should read as the following:

Location	Measurement
Across J1939 High and Low	Approximately 60 ohms
J1939 Low voltage	0.1V-2.4V
J1939 High voltage	2.5V-5.0V
J1939 High or J1939 Low to Ground or Power Supply	No continuity

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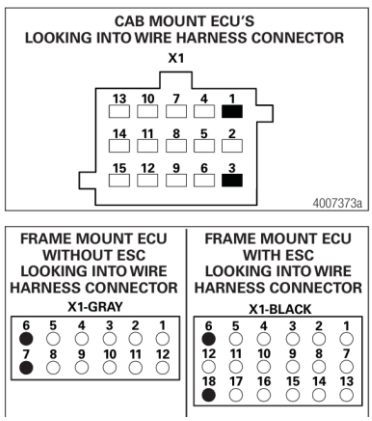
Typical CAN testing sequence using WABCO ESC

J1939 Serial Communication Testing

Electrical Checks

ECU	J1939 Datalink Circuit	Connector	Pins
Cab-Mounted All	J1939 High	X1-15 pin	3
	J1939 Low	X1-15 pin	1
Frame-Mounted Without ESC	J1939 High	X1-Gray	7
	J1939 Low	X1-Gray	6
Frame-Mounted With ESC	J1939 High	X1-Black	18
	J1939 Low	X1-Black	6



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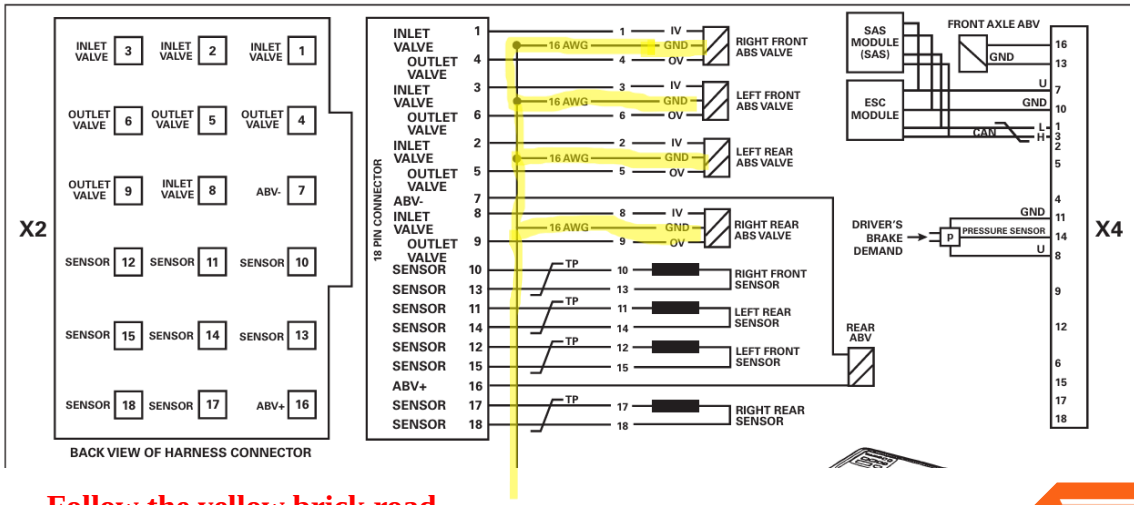
Typical CAN testing sequence using WABCO ESC

6S/6M Universal ECU with ESC wiring diagrams and connectors



Follow the yellow brick road.

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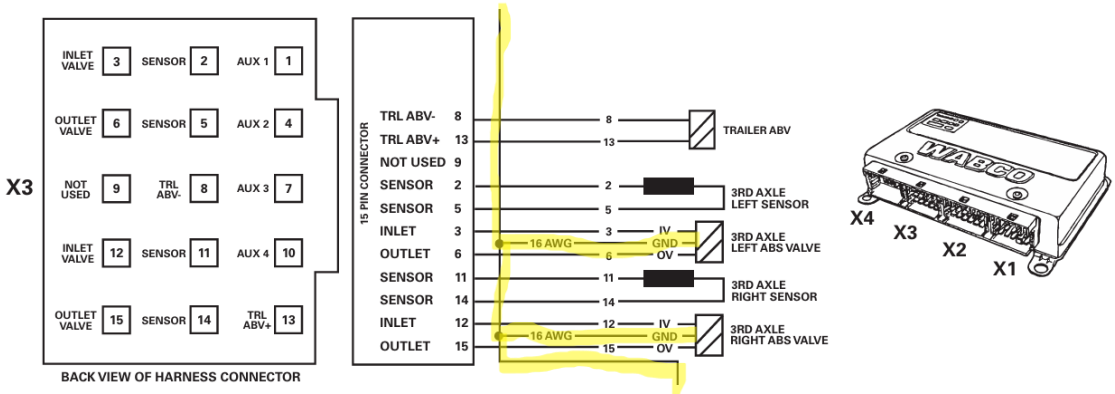
Typical CAN testing sequence using WABCO ESC

6S/6M Universal ECU with ESC wiring diagrams and connectors

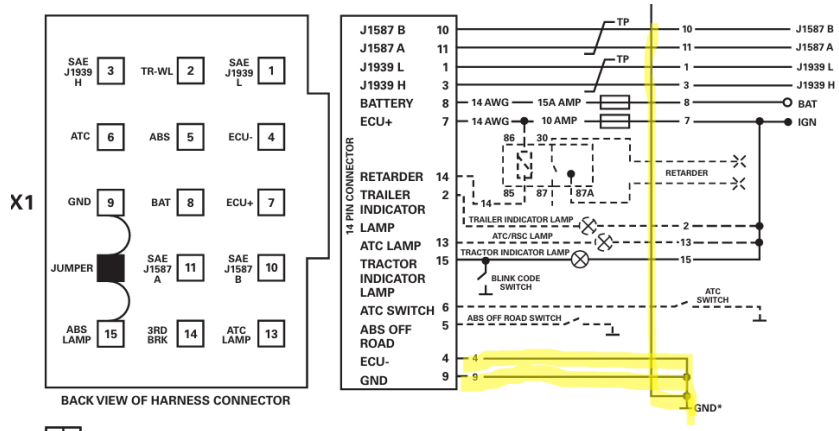


Follow the yellow brick road.

64

Typical CAN testing sequence using WABCO ESC

6S/6M Universal ECU with ESC wiring diagrams and connectors



Momentary Switch

Optional Equipment

Twisted Pair = TP
All unmarked wires should be 16 or 18 AWG.
All fuses should be blade type.
*All connected to a common star ground.

End of the road. Will the ECU/Valves function if the ground is missing.

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We offer greater freedom to fix cars and trucks
by engineering exclusive, labor-saving
and cost-effective repair solutions.

Thank You !

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