



CHANGE RECORD

REV	ORIGINATOR	APPROVAL 1	APPROVAL 2	APPROVAL 3	SEC./PG.	COMMENT	DATE
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1 ABBREVIATIONS

ACRONYM	DESCRIPTION
4G	EControls 4 th Generation Engine Control Platform
AL	Adaptive Learn
BP	Barometric Pressure
CAN	Controller Area Network
CCP	CAN Calibration Protocol
CHT	Cylinder Head Temperature
CKP	Crank Sensor
CL	Closed Loop
CNG	Compressed Natural Gas
DBW	Drive-By-Wire
DC	Direct Current
DIG	Digital
DM	Diagnostic Message
DMM	Digital Multi-Meter (high impedance)
DST	Diagnostic Scan Tool
DTC	Diagnostic Trouble Code
DVOM	Digital Voltage and Ohm Meter (high impedance)
ECI	EControls Inc.
ECIPP	EControls Inc. Proprietary Protocol
ECM	Engine Control Module
ECOM	EControls COMMunication Interface
ECT	Engine Coolant Temperature
ECU	Engine Control Unit
EDIS	<u>E</u> Controls <u>D</u> isplay and <u>I</u> nterface <u>S</u> oftware
EEPROM	Electrically Erasable Programmable Read-Only Memory
EGO	Exhaust Gas Oxygen Sensor, typically heated
EMWT	Exhaust Manifold Water Temperature
EPR	Electronic Pressure Regulator
ERWT	Exhaust Manifold Riser Temperature
ETB	Electronic Throttle Body
ETC	Electronic Throttle Control
FDR	Flight Data Recorder
FMI	Failure Mode Indicator
FO	Firing Order
FP	Fuel Pressure
FPP	Foot Pedal Position

ACRONYM	DESCRIPTION
FRP	Fuel Rail Pressure
FRT	Fuel Rail Temperature
FSO	Fuel Shut Off
FSS	Fault Snapshot
FT	Fuel Temperature
GCP	Global Control Platform
HDGCP	Heavy-Duty Global Control Platform (On-Road Heavy-Duty)
HEGO	Heated Exhaust Gas Oxygen Sensor (same as HO2S)
HO2S	Heated Oxygen Sensor (same as HEGO)
IAC	Idle Air Control
IAT	Intake Air Temperature
ICAV	Instant Crank Angle Velocity
IVS	Idle Validation Switch
LDGCP	Light-Duty Global Control Platform (Industrial, Smart/Logic Coil)
LED	Light Emitting Diode
LPG	Liquefied Propane Gas
MAP	Manifold Absolute Pressure
MDGCP	Medium-Duty Global Control Platform (Industrial, Dumb Coil)
MGCP	Marine Global Control Platform
μP	Microprocessor
Mfg	Manufacture
MIL	Malfunction Indicator Lamp
NG	Natural Gas
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacture
PC	Personal Computer
PCU	Powertrain Control Unit
PD	Pull-down Resistor/Channel
PFI	Port Fuel Injection
PGN	Parameter Group Number
PU	Pull-up Resistor/Channel
PUD	Pull-up/Pull-down Resistor/Channel
PWM	Pulse Width Modulated
RAM	Random Access Memory
RLV	Redundant Lockoff Verification
RPM	Revolutions Per Minute
Rx	Receive
SAE	Society of Automotive Engineering

ACRONYM	DESCRIPTION
SA	Source Address
SPFI	Sequential Port Fuel Injection
SPN	Suspect Parameter Number
Tach	Tachometer
TBI	Throttle Body Injection
TBD	To be Determined
TDC	Top Dead Center
TIP	Throttle Inlet Pressure
TMAP	Temperature and Manifold Absolute Pressure
TOP	Turbine Outlet Pressure
TPS	Throttle Position Sensor
TSC	Torque/Speed Control
Tx	Transmit
UEGO	Universal Exhaust Gas Oxygen Sensor (also called wide-range EGO)
USB	Universal Serial Bus
VBat	Battery voltage
VDC	Voltage, Direct Current
VR	Variable Reluctance
Vsw	Switched, Ignition Voltage
WGP	Waste-Gate Pressure

2 OVERVIEW

This manual is intended to be used as an aid for original equipment manufacturers (OEMs) and/or EControls' customers to author technical and training publications. Certain portions of this manual are only intended for use by the OEM to understand the fault detection system. This manual defines the diagnostics and recommended troubleshooting procedures associated with an EControls fourth generation (4G) engine control module (ECM) for use on industrial, heavy-duty gas, and marine engines. Sections of it are also common to the EControls Continuous Flow Valve (CFV) module.

This manual is organized in the following manner:

DTC	[Fault DTC]	SPN	[Fault SPN]	FMI	[Fault FMI]
<u>DTC XXXX- Diagnostic Condition</u>					
[Block Diagram of Circuit]					
Circuit/Hardware: [Name of related circuit, sensor or hardware component]					
Circuit/Hardware Description: [Description of Circuit or hardware component]					
Fault Enabled in Calibration?			TBD* (Application-Specific)		
Emissions-related Fault?			[YES/NO]		
Check Condition:			[Condition under which 4G checks for active fault]		
Fault Set Conditions (as defined in calibration):					
• [Fault Set Condition #1]			TBD*	units	
• [Fault Set Condition #2, etc...]			TBD*	units	
Possible Causes: [Description of Possible Causes for fault]					
Corrective Actions (see section 4.1 for descriptions of individual faults):					
Shutdown		CL Disable key cyc.		Power Derate 2	Hard Warning
Never Forget		AL Disable		Low Rev Limit	MIL Persist Disable
Turn on MIL		AL Disable key cyc.		Force Idle	Stopped Check
CL Disable		Power Derate 1		Soft Warning	

Figure 1: 1st Page of Diagnostic Information for a Given Fault

DTC XXXX- Diagnostic Condition

Note: Helpful tips used to aid troubleshooting – includes one or more of the following:

Diagnostic Aids

- ☐ Tip #1
- ☐ Tip #2 ...

Figure 2: 2nd Page of Diagnostic Information for a Given Fault

The fields shaded in gray on Page 1 for each fault require OEM-input to complete, and are intended to reflect customer-specific or application specific diagnostic configurations. Values and settings for these fields can be found for each fault in corresponding cells of the 4G_cal.xlsm calibration spreadsheet when loaded with the application-specific engine calibration (Figure 3).

Fault Description	Enable	Shutdown	Never Forget	Turn On MIL	CL Disable	Key-SPC	AL Disable	Key-SPC	Power Derate 1	Power Derate 2	Low Rev Limit	Force Idle	Soft Warning	Hard Warning	MIL Persist Disable	Stopped Check	MDs Control System	Flash Code	SPN	FMI	Fault Condition(s)
MAP high pressure	X	X				X	X											108	106	16	MAP pressure > 12.00 psia and TPS < 8.0 % and RPM > 800 rpm to unlatch, MAP pressure must be < 10.00 psia

Enable Switch

Corrective Actions

Fault Set Condition(s)

Figure 3: Individual Fault on 4G_cal.xlsm Diagnostics page

3 PC TARGET COMMUNICATION

The preferred DST for communicating faults and initiating ECM controlled diagnostic tests is the personal computer-based EControls Display and Interface Software (EDIS). This multifunction software program is used as a communication gateway between the target (i.e. ECM) and a PC for displaying diagnostic data, displaying and recording real-time engine data, and displaying and changing calibration data. EDIS communicates with ECI ECMs using the ECOM device, which is a USB-to-CAN interface device that works on all versions of Windows 2000, Windows XP, Windows Vista, Windows 7, and Windows 8. Communication is established between EDIS and the target device by communicating over the CAN bus using the EControls proprietary protocol (ECIPP). Fault and other diagnostic information is also available over CAN using the standard SAE-J1939 and SAE J1979 protocols.

3.1 EDIS and ECOM Installation and Usage

Specific details on using EDIS and ECOM, including software/driver installation and use in managing diagnostic and fault information can be found in the reference documents listed below. EControls recommends having copies of these reference documents available during use of both EDIS and ECOM products. Please visit the EControls website to access these documents.

- *ECOM Software Driver Installation Procedure*
- *4G EDIS Introduction Manual*
- *4G Calibration Spreadsheet Introduction Manual*
- *4G CAN Communication Overview*

4 DIAGNOSTIC CALIBRATION AND CORRECTIVE ACTIONS

4.1 Individual Fault Configuration

Each fault within the ECM is capable of being uniquely configured in the engine's diagnostic calibration to cause one or more corrective actions while a given fault is active. Table 2 identifies the configuration options and corrective actions available for configuration of each fault. The desired action is set by the OEM calibration engineers.

Table 1: Diagnostic Corrective Actions

Corrective Action	Description
Enable	Enables the fault for fault detection
Shutdown	Cause an engine shutdown when fault becomes active
Never Forget	Retain fault as historic/previously active until cleared by a technician and does not allow historic fault to be "auto-cleared". If the fault also has the Turn on MIL action enabled, the MIL output will remain active until the fault is cleared.
Turn on MIL	Turn on MIL output when fault becomes active
CL Disable	Disable closed-loop while the fault is active
CL Disable Key-Cycle	Disable closed-loop while the fault is active and for the remainder of the key cycle
AL Disable	Disable adaptive learn while the fault is active
AL Disable Key-Cycle	Disable adaptive learn while the fault is active and for the remainder of the key cycle
Power Derate 1	Limit TPS to the Power Derate 1 percent set in the diagnostic calibration while the fault is active. The Power Derate 1 TPS percent should be set higher than Power Derate 2 as Power Derate 2 adds a higher level of protection.
Power Derate 2	Limit TPS to the Power Derate 2 percent set in the diagnostic calibration while the fault is active. If the calibration is set to "Latched for Key-Cycle" Power Derate 2 remains active until engine speed and FPP conditions are satisfied. The Power Derate 2 TPS percent should be set lower than Power Derate 1 as Power Derate 2 adds a higher level of protection.
Low Rev Limit	Limit RPM to the Low Rev Limit speed set in the diagnostic calibration while fault is active. If calibration is set to "Latched for Key-Cycle" Low Rev Limit remains active until engine speed and FPP conditions are satisfied.
Forced Idle	Limit RPM to the Forced Idle speed set in the diagnostic calibration while the fault is active and for the remainder of the key cycle
Soft Warning	Turn on the soft warning output when the fault becomes active
Hard Warning	Turn on the hard warning output when the fault becomes active
MIL Persist Disable	Selecting MIL Persist Disable will exclude the fault from affecting the MIL output state based on the "MIL start cycle minimum persistence" functionality.

Stopped Check	Run fault detection/checking while the engine is in a key-on, engine-off condition. NOTE: It is recommended that this feature only be used for general sensor faults (high/low voltage) and some output drivers
NOx Control System	Selecting NOx Control System indicates that the fault should be considered part of the NOx Control System for emissions-related purposes. Historic/previously active faults that are part of the NOx Control System are retained for at least the amount of engine hours specified by the NOx Control System fault retention setting. Prior to this set time these faults may not be cleared by scan tools or the auto-clearing functionality.

4.2 Historic Fault Configuration

Historic faults keep track of all faults that have been active on the ECM according to various configurable parameters. Table 2 and the list below describe some general fault system options relating to how historic faults can be configured and are persisted. Please check your engine calibration for the specific mode and configuration that is in use.

- **Fault Retention Memory** - Depending on the engine calibration, historic faults will be persisted in either permanent memory or until battery power is removed. In battery supported memory, faults will be cleared if the battery power is removed from the ECM. In permanent memory, a technician must use a service tool to manually clear faults.
- **Start cycles for fault auto-clearing** - Number of engine stopped-running cycles before clearing a fault automatically. If a value of 0 is used then all faults will be retained until manually cleared (automatic clearing is disabled).
- **Fault active minimum on-time** – This value determines MIL illumination behavior after an active fault has gone inactive. If it is set to zero, then the MIL will extinguish as soon as the fault goes inactive. If it is set to a value > 0, then the MIL will be continuously illuminated for the selected number of seconds after the fault goes inactive, even if the fault does not reactivate.
- **MIL start cycle minimum persistence** – This value determines MIL illumination behavior after an active fault has gone inactive. If it is set to zero, then the MIL will extinguish as soon as the fault goes inactive (subject to the minimum active on-time above). If it is set to a value > 0, then the MIL will be continuously illuminated for this many subsequent engine start cycles even if the fault does not reactivate. For example, a value of 1 will only cause the MIL to stay on during the current engine run cycle in which the fault went active. A value of 4 will cause the MIL to stay on during the current run cycle and 3 subsequent engine start cycles. This setting applies to all faults.
- **NOx Control System fault retention** – This setting specifies the number of engine runtime hours that NOx Control System faults will be retained. Prior to this set time these faults will not be erasable via scan tools or the “Start cycle for auto-clearing” functionality. Once the configured amount of time has elapsed since the last occurrence of a fault it will become clearable via scan tools or by the auto-clearing functionality. Setting the value to 0 disables allowing clearing of NOx Control System faults after a time period, effectively preventing them from ever being cleared via a scan tool.
- **Clear active power derate from scan tool** - This setting specifies whether or not active “Power Derate” conditions may be cleared using a scan tool over the J1939 or ISO 15765 protocols. This controls clearing of both active “Power Derate 1” and “Power Derate 2” faults as well as key-cycle latched “Power Derate 2” states.

Table 2: General Fault System Configuration

General Fault System Configuration (see the 'Derate' page for more options)	
Fault retention memory	Battery power retained
Key-on engine stopped hard/soft warning behavior	On for bulb-check
Fault active minimum on-time	3.0 seconds
MIL start cycle minimum persistence	0 start cycles
Start cycles for fault auto-clearing	50 start cycles
Min voltage for fault checks during cranking	8.0 volts
NOx Control System fault retention	9600.0 hours
Clear active power derate from scantool	Allowed

For the SAE-J1939 protocol historic faults are broadcast and cleared using “DM2: Previously Active Diagnostic Trouble Codes” and “DM3: Diagnostic Data Clear/Reset of Previously Active DTCs”.

For the SAE J1979 protocol emissions-related active and historic faults are obtained using Service \$03 – “Request Emission-Related Diagnostic Trouble Codes”. The fault system, as a whole, may be cleared using Service \$04 – “Clear/Reset Emission-Related Diagnostic Information”.

Historic fault information can also be viewed and cleared using the EDIS service tool as described in the EControls *4G EDIS Introduction Manual*.

4.3 Flash Codes and MIL Output

The MIL output is used to convey fault information to the equipment operator. The MIL is always on (grounded) when the system is in a key-on (Vsw) engine-off state. This provides assurance that the output is functional. If a DTC is logged as previously-active (historic) the MIL will send a single flash for the “Blink on-time” every “Blink off-time” + “Extra time between codes.”

A feature of EControls Inc. ECMs is that diagnostic trouble codes can be displayed to a technician to indicate what historic faults are present without requiring the use of a personal computer. The DTCs can be flashed over the MIL output when the engine is in key-on, engine-off situation and an auxiliary input is triggered as defined by the ‘Blink sequence input trigger’ in the calibration and seen in Table 3.

Once the ECM recognizes that the user is requesting flash codes, it will flash or blink a standard code for a standard number of times in a row. Generally, the standard code is set to 123 and the standard number of times a code is flashed is generally set to 3, however, both may be altered in the calibration. If a code other than 123 will be used as the standard code, please consult with EControls to determine whether or not the code will interfere with diagnostic DTCs. After the standard code has been flashed for the standard amount of times, the first flash code in the historic faults category will be flashed at the same rate. DTCs are flashed over

the MIL based on their order in the ECM memory map, which is fixed; DTCs are not flashed based on the order in which they set or became active. DTCs will continue to flash depending on the number of historic faults retained in memory. If there are no historic faults, the standard flash code will be repeated. Figure 4 provides an example of the MIL output during a flash code sequence based on the calibration defined in Table 3.

Table 3: Example Calibration of MIL

MIL Blink Code Timings		
Blink sequence input trigger	Aux PU1 = Gnd	▼
Blink sequence input Aux DIG configuration	Default	▼
Blink sequence input switch type	Toggle switch	▼
Delay before start of code blinking	1000	ms
Blink on-time	500	ms
Blink off-time	500	ms
Time between digits in a code	1000	ms
Extra time between code repeats	2000	ms
Extra time between codes	4000	ms
Extra time before starting codes over	2000	ms
Number of times to repeat a code	2	
Default first code (always output)	123	
Key-on engine-off stored fault MIL on-time	4500	ms
Key-on engine-off stored fault MIL off-time	500	ms

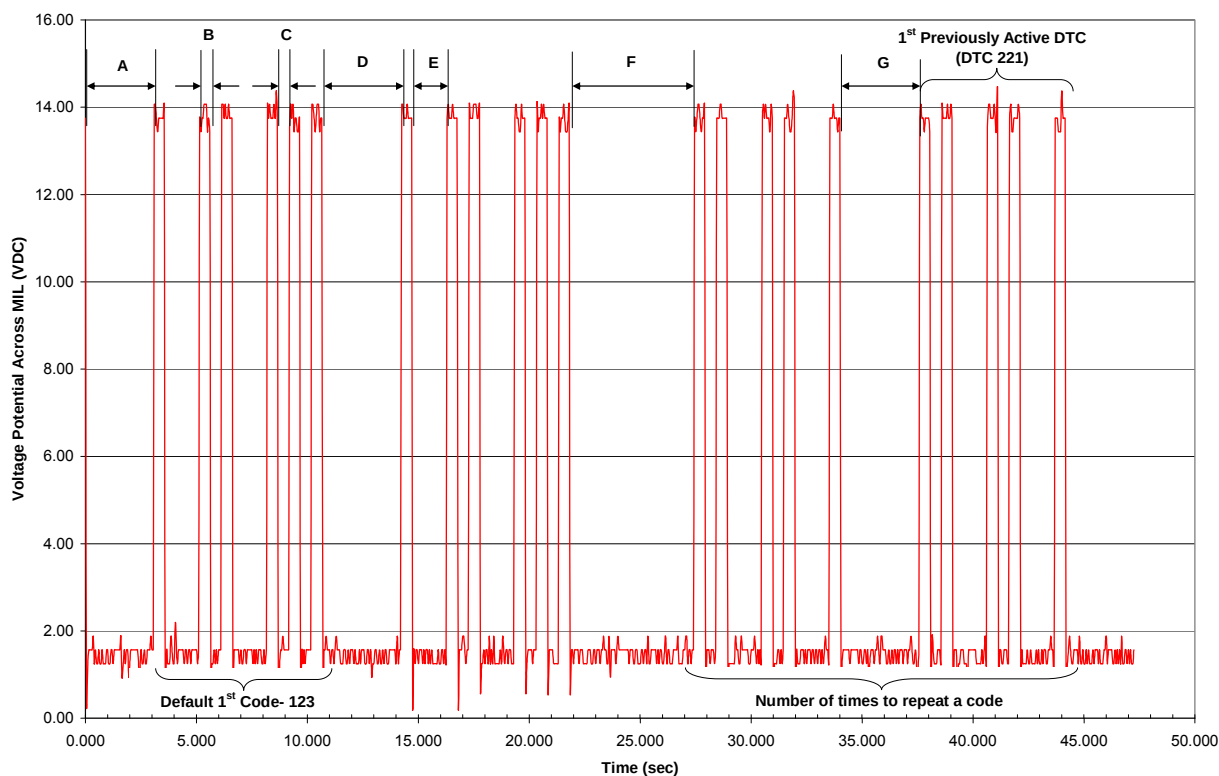


Figure 4: Electrical Pattern of MIL Output During a Flash Code Sequence

A= Delay before start of code blinking + Extra time before starting codes over
Ex. 1000 ms + 2000 ms= 3000 ms

B= Blink on-time
Ex. 500 ms

C= Blink off-time
Ex. 500 ms

D= Blink off-time + Time between digits in a code + Extra time between code repeats
Ex. 500 ms + 1000 ms + 2000 ms= 3500 ms

E= Blink off-time + Time between digits in a code
Ex. 500 ms + 1000 ms= 1500 ms

F= Blink off-time + Time between digits in a code + Extra time between codes
Ex. 500 ms + 1000 ms + 4000 ms= 5500 ms

G= Blink off-time + Extra time between code repeats + Time between digits in a code
Ex. 500 ms + 2000 ms + 1000 ms= 3500 ms

5 SAE J1939 DIAGNOSTICS SUPPORT

Faults may be acquired over the CAN network through standard J1939-based diagnostic scan tools or multi-function display units. This section summarizes the J1939 diagnostic features that are supported by EControls controllers - for full details on the specifics of each supported J1939 diagnostic feature, please refer to SAE J1939-73 (Application Layer – Diagnostics). Detailed information about each supported DTC can be found in Section 7.2, and all diagnostic trouble codes can also be accessed through an independent mechanism using the EDIS tool, as referenced in Section 3.

5.1 J1939 Diagnostic Trouble Codes

The numeric diagnostic trouble codes assigned to each fault in Section 7.2 of this manual are cross-referenced to SAE's "Recommended Practice for Diagnostic Trouble Code Definitions" (SAE J2012). While these codes are recommended, customers may define their own codes by assigning a new number to the flash code in the diagnostic calibration. This value will correspond to the DTC transmitted over J1939, displayed in EDIS, and flashed on the MIL output pin if enabled.

5.2 J1939 Diagnostics Support

The 4G ECMs support SAE J1939 CAN based diagnostic support. This includes:

- DM1: Active Diagnostic Trouble Codes
- DM2: Previously Active Diagnostic Trouble Codes
- DM3: Diagnostic Data Clear/Reset of Previously Active DTCs
- DM4: Freeze Frame Parameters
- DM5: Diagnostic Readiness (bytes 1, 2, and 3 are supported)
- DM6: Emission Related Pending DTCs
- DM11: Diagnostic Data Clear/Reset For Active DTCs
- DM12: Emissions-Related Active Diagnostic Trouble Codes
- DM19: Calibration Information
- DM23: Previously Active Emission Related Faults
- DM27: All Pending DTCs

All diagnostic trouble codes broadcast over CAN will be according to SAE J1939 DM1 and DM2. 4G ECMs are also compliant with J1939 OBD-M, supporting the Diagnostic Messages above as well as user indicators and CAN data defined in the OBD-M protocol. Faults available for broadcast and their respective SPN/FMI numbers are dependent on the application and defined for each fault in the engine calibration.

The data capture at the occurrence of a fault, known in the ECM as a fault snapshot (FSS), is available upon DM4 request. The following bytes are supported for DM4 if configured in the ECM software:

- Byte 1: Freeze Frame Length
- Byte 2-6: SPN, FMI, SPN Conversion Method, and Occurrence
- Byte 7: Manifold Absolute Pressure
- Byte 8-9: Engine Speed
- Byte 10: Engine Load (MAP based estimate)
- Byte 11: Engine Coolant Temperature
- Byte 14: Number of starts since fault was last active
- Byte 15: FSS index (used for proprietary scan tool)

Resetting active and previously active DTCs is handled through DM11 and DM3, respectively. DM1 and DM2 lamp indicators are assigned to each fault based on the fault's diagnostic action as defined in the calibration. The lamps are assigned based on the configuration outlined in Table 4.

Table 4: J1939 Diagnostic Lamp Configuration:

ECI Diagnostic Action	J1939 Lamp
MIL	MIL
Soft Warning	Amber
Hard Warning, Low Rev Limit, Shutdown	Red Stop
Power Derate 1 & 2	Protect
Forced Idle	None (use in combination with other action)

SAE J1979 DIAGNOSTICS SUPPORT

Faults may be acquired over the CAN network through the ISO 15031-5/SAE J1979 protocol using an SAE J1978-compliant diagnostic scan tool. This protocol requires general ISO 15765-4 OBD protocol support to be enabled in the calibration via the spreadsheet **Comms** page (Figure 5). Once enabled, support will be available on all enabled CAN buses.



Figure 5: ISO 15765-4 OBD Enable switch

In support of the J1979 protocol the 4G ECM relies on the following communications standards:

- ISO 15031-2/SAE J1930 – Terms, definitions, abbreviations, and acronyms
- ISO 15031-4/SAE J1978 – External Test Equipment/OBD II Scan Tool
- ISO 15031-5/SAE J1979 – Emission-related diagnostic services
- ISO 15031-6/SAE J2012 – Diagnostic trouble code (DTC) definitions

This section summarizes the J1979 diagnostic features that are supported by EControls controllers - for full details on the specifics of each supported J1979 diagnostic feature please refer to the SAE J1979 “E/E Diagnostic Test Modes” Surface Vehicle Standard. Detailed information about each supported DTC can be found in Section 7.2, and all diagnostic trouble codes can also be accessed through an independent mechanism using the EDIS tool, as referenced in Section 3.

5.3 J1979 Diagnostic Trouble Codes

The numeric diagnostic trouble codes assigned to each fault in Section 7.2 of this manual are cross-referenced to SAE’s “Recommended Practice for Diagnostic Trouble Code Definitions” (SAE J2012). While these codes are recommended, customers may define their own codes by assigning a new number to the flash code in the diagnostic calibration. This value will correspond to the DTC transmitted over J1979, displayed in EDIS, and flashed on the MIL output pin if enabled.

5.4 J1979 Diagnostics Support

The 4G ECMs support SAE J1979 CAN based diagnostic support. This includes the following services:

- Service \$01 - Request Current Powertrain Diagnostic Data
- Service \$02 - Request Powertrain Freeze Frame Data
- Service \$03 - Request Emission-Related Diagnostic Trouble Codes

- Service \$04 - Clear/Reset Emission-Related Diagnostic Information
- Service \$07 - Request Emission-Related Diagnostic Trouble Codes Detected During Current or Last Completed Driving Cycle
- Service \$09 - Request Vehicle Information

Detailed information for each of these services as well as the type and structure of the data accessed via each service is available in the SAE J1979 “E/E Diagnostic Test Modes” and SAE J1979-DA, “Digital Annex of E/E Diagnostic Test Modes” Surface Vehicle Standards.

5.4.1 Service \$01 – “Request Current Powertrain Diagnostic Data” Parameter Identifiers

This service provides access to current emission-related data values and are accessed using parameter identification (PID) values. The 4G ECM supports the following PID values:

- 0x01 – I/M Readiness Data
 - Currently only the number of emission-related DTCs and MIL status is supported
- 0x02 – Freeze Frame DTC
- 0x04 – Calculated LOAD value
- 0x05 – Engine Coolant Temperature
- 0x0A – Fuel Pressure (gauge)
 - Requires configured fuel pressure sensor input
- 0x0B – Intake Manifold Absolute Pressure
- 0x0C – Engine RPM
- 0x0D – Vehicle Speed Sensor
- 0x0F – Intake Air Temperature
- 0x1C – OBD requirements to which vehicle or engine is certified
 - Requires configured “PID 0x1C Emission support” value
- 0x21 – Distance Traveled While MIL is Activated
 - Requires configured road speed input
- 0x22 – Fuel Pressure relative to manifold vacuum
 - Requires configured fuel pressure sensor input
- 0x23 – Fuel Rail Pressure
 - Requires configured fuel pressure sensor input
- 0x30 – Number of warm-ups since DTCs cleared
- 0x31 – Distance traveled since DTCs cleared
 - Requires configured road speed input
- 0x49 – Accelerator Pedal Position D
- 0x4D – Engine run time while MIL activated
- 0x4E – Engine run time since DTCs cleared

- 0x59 – Fuel Rail Pressure (absolute)
 - Requires configured fuel pressure sensor input
- 0x5F – Emission requirements to which vehicle is designed
 - Requires configured “PID 0x5F Emission support” value
- 0x67 – Engine Coolant Temperature
- 0x85 – NOx Control System

Detailed information for each PID is available in the SAE J1979-DA, “Digital Annex of E/E Diagnostic Test Modes” Surface Vehicle Standard.

5.4.2 Service \$02 – “Request Powertrain Freeze Frame Data” Parameter Identifiers

The data captured at the occurrence of a fault, known in the ECM as a fault snapshot (FSS), is available as a “Freeze Frame” via Service \$02 – “Request Powertrain Freeze Frame Data”. The “Freeze Frame” data is requested and reported using parameter identification (PID) values. The 4G ECM supports the following PID values for freeze frame data:

- 0x02 – Freeze Frame DTC – the DTC that caused the required freeze frame data storage
- 0x04 - Calculated LOAD value
- 0x05 - Engine Coolant Temperature
- 0x0B - Intake Manifold Absolute Pressure
- 0x0C - Engine RPM

5.4.3 Service \$09 – “Request Vehicle Information” - InfoTypes

Service \$09 allows external test equipment to request vehicle-specific vehicle information. The data is requested and reported using InfoType values. The 4G ECM supports the following InfoType values:

- 0x02 – Vehicle Identification Number
- 0x04 – Calibration Identifications
- 0x0A – ECU Name

Detailed information for each InfoType is available in the SAE J1979-DA, “Digital Annex of E/E Diagnostic Test Modes” Surface Vehicle Standard.

6 DIAGNOSTIC TESTS

The 4G engine control module for spark-ignited engine applications incorporates a set of diagnostic tests that perform specific functions to aid in verifying proper engine control. This section describes the tests supported, test states, and operating criteria for each test.

Diagnostic tests are software selectable through the EDIS using the ECIPP protocol or can be initiated via CAN using CCP.

6.1 Spark Kill Test

“Coil X” disables individual cylinders at any operating condition for the duration defined in calibration or until released through software. ‘Spark Kill’ may be used in conjunction with ‘Injector Kill’ to disable up to two cylinders at any given time. Upon a state change from one cylinder to another, the test sequence will automatically re-enable the first coil prior to disabling the selected coil. This test reverts to normal operation if “Normal” state is selected, ignition voltage is cycled from high to low, or the calibrated timeout expires.

**IMPORTANT:**

This test should not be initiated prior to the “Injector Kill” test when the engine is equipped with a catalyst. If performed while the injector for the selected cylinder is firing, raw-unburned fuel and air will be present in the exhaust and will react in the catalyst resulting in extremely high catalyst substrate temperatures which can cause wash coat or substrate damage and failure.

States

- 1) Normal: State of normal operation
- 2) Coil 1: Disables coil or spark for cylinder 1 in firing order or block order
- 3) Coil 2: Disables coil or spark for cylinder 2 in firing order or block order
- 4) Coil 3: Disables coil or spark for cylinder 3 in firing order or block order
- 5) Coil 4: Disables coil or spark for cylinder 4 in firing order or block order
- 6) Coil 5: Disables coil or spark for cylinder 5 in firing order or block order
- 7) Coil 6: Disables coil or spark for cylinder 6 in firing order or block order
- 8) Coil 7: Disables coil or spark for cylinder 7 in firing order or block order
- 9) Coil 8: Disables coil or spark for cylinder 8 in firing order or block order

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished (timeout achieved)
- 4) Cannot start test

6.2 Spark Fire Test

“Coil X” activates a selected coil (‘X’ representing a given cylinder number) for ‘Y’ seconds (defined in calibration) with the engine in the “Stopped” state only. The test reverts to normal operation if the “Normal” state is selected, ignition voltage is cycled from high to low, engine speed is sensed, or the calibrated timeout expires. This test will not run in conjunction with a Compression test or following an Injector Fire test.

States

- 1) Disabled: State of normal operation
- 2) Coil 1: Activates Coil 1 in firing order or block order
- 3) Coil 2: Activates Coil 2 in firing order or block order
- 4) Coil 3: Activates Coil 3 in firing order or block order
- 5) Coil 4: Activates Coil 4 in firing order or block order
- 6) Coil 5: Activates Coil 5 in firing order or block order
- 7) Coil 6: Activates Coil 6 in firing order or block order
- 8) Coil 7: Activates Coil 7 in firing order or block order
- 9) Coil 8: Activates Coil 8 in firing order or block order

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished (timeout is reached)
- 4) Cannot start test (speed is sensed)

**IMPORTANT:**

This test should not be initiated on gaseous fueled engines in which gaseous fuel may be present in the combustion chamber, intake, or exhaust. If using this test is desirable on gaseous fueled engines, remove the spark plug wires from all spark plugs, install a spark plug tester in the desired spark plug wire and initiate the test.

6.3 DBW Test

The DBW Test permits full-authority operation of an electronic throttle via the throttle command input while the engine is in the “Stopped” state only. The main purpose of this test is to perform a rationality check on the throttle system and ensure that the connection between the ECM and the throttle is intact, and that commands are being translated to a reasonable throttle position. In order to activate DBW test, one must first turn on External Power Relays (see ‘External Power Test’ section). Once power relay state is ‘All On’ then use the foot pedal to command a desired throttle position. The Throttle Position Sensor (TPS) reading should reflect the Foot Pedal Command (FPP). The feature reverts to normal operation if “Off” state is selected, ignition voltage is lost, or engine speed is sensed.

**NOTE:**

Ensure that the foot pedal position sensor/electronic throttle control input is at 0% or idle prior to starting/operating the engine. While this test mode will revert to disabled when engine speed is sensed, the throttle command will follow the FPP % commanded by the sensor causing the engine to accelerate.

States

- 1) Off: State of normal operation
- 2) Enabled: Enables full authority control of an electronic throttle

Monitored Status

- 3) Test not started
- 4) Test is running
- 5) Test finished
- 6) Cannot start test (speed is sensed)

6.4 External Power Test

The External Power Test manually activates relays (relay power, fuel pump, and drive-by wire power) controlled by the ECM while the engine is in the “Stopped” or “Running” states. This is required for certain manual test modes in this document, and can be used in the diagnosis of specific component functionality. Reverts to normal operation if “Automatic” state is selected or ignition voltage is cycled from high to low.

States

- 1) Automatic: State of normal operation
- 2) Relay On: Activates relay power (injector and coil high-side power)
- 3) All On: Activates fuel pump and relay power

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished
- 4) Cannot start test (no ignition voltage)

6.5 Compression Test

The Compression Test disables all coils and injectors permitting cylinder compression testing. To prevent against firing coils and injectors in the event of a microprocessor reboot during low voltage cranking, the test state will be burned into EEPROM. In addition, EControls requires that the relay power fuse be removed. This test may only be activated while the engine is in the “Stopped” state. Test reverts to normal operation only when the “Normal” state is selected. This test may be initiated by selecting “Enabled” in the software or through use of a switched hardware input. This test may not be run in conjunction with Spark Fire or Injector Fire tests.

**IMPORTANT:**

Due to the liability of initiating a compression test in software, EControls burns this test state into EEPROM. As a result, this test must manually be disabled by the operator through software. EControls recommends that this test only be performed while the vehicle is in an appropriate location in the event that the diagnostic PC has a low-battery condition that may not permit re-enabling normal operation.

States

- 1) Disabled: State of normal operation
- 2) Active: Enables compression test mode

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished
- 4) Cannot start test (engine run speed is sensed > than crank speed)

**IMPORTANT:**

Due to the personal and property liability exposure with such a test, EControls requires that the diagnostic/service manual specifically identifies that removal of the coil and injector high-side relay and/or fuse(s) is required during a compression test. If procedures are not written that require removal of the relay power relay or fuse(s) and the test will only be enabled through software, EControls will require a written release-of-liability against human liability and property damage.

6.6 Spark Advance Test

The Spark Advance Test commands a calibrated base spark advance if engine speed and manifold pressure are below a calibrated limit. If engine is operated above the calibrated operating limit, base spark advance as set in the normal calibration will be used until the engine set point falls below the calibrated limit. This test may be initiated by selecting “Enabled” in the software or through use of a switched hardware input. The test reverts to normal operation when “Normal” state is selected or when ignition voltage is cycled from high to low.

States

- 1) Disabled: State of normal operation
- 2) Active: Sets spark timing to a calibrated default spark advance

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished
- 4) Cannot start test

6.7 Idle Speed Command

Idle Speed Command commands a temporary idle speed, up to X RPM as defined in calibration through modulation of an IAC motor or an electronic throttle. Reverts to normal operation when “Normal” state is selected, a throttle command input (for electronic throttle engines) above Y% (defined in calibration) is detected, a throttle position (for IAC engines) above Z% (defined in calibration) is detected, or ignition voltage is cycled from high to low.

States

- 1) Disabled: State of Normal operation
- 2) Active: Enables manual entry of engine speed into a speed entry field

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished (TPS or TCP % above limit is detected during test)
- 4) Cannot start test (TPS or TCP % above limit is detected)

**IMPORTANT:**

ECI will not permit programmed idle speeds above 800 RPM without a written release-of-liability if the engine is not equipped with a transmission position sensor.

6.8 Fuel/Spark Inhibit Input

Fuel/Spark Inhibit Input disables triggering of spark and injection of fuel when the input (analog or digital) selected meets the calibrated state. This is often linked to the fuel select switch as a neutral mode.

States

- 1) Disabled
- 2) Aux PU1 = Gnd
- 3) Aux PU2 = Gnd
- 4) Aux PU3 = Gnd
- 5) Aux DIG1 = Gnd
- 6) Aux DIG1 = V+
- 7) Aux DIG2 = Gnd
- 8) Aux DIG2 = V+
- 9) Aux DIG3 = Gnd
- 10) Aux DIG3 = V+
- 11) Aux DIG4 = Gnd
- 12) Aux DIG4 = V+
- 13) Aux DIG1 = Open
- 14) Aux DIG2 = Open
- 15) Aux DIG3 = Open
- 16) Aux DIG4 = Open

Monitored Status

- 1) Inactive/Normal: Test is inactive, state of normal operation
- 2) Active/Shutdown: Test is active and system will not inject fuel or trigger spark

7 DIAGNOSTIC TROUBLE CODE FAULT DESCRIPTIONS

7.1 DTC to SPN/FMI Cross Reference

Flash Code	Fault Description	SPN	FMI
6	Lockoff open / ground short	632	4
7	Lockoff short to power	632	3
11	Intake cam / distributor position	520800	7
16	Never crank synced at start	636	8
24	Exhaust cam position	520801	7
31	EGOH1 open / ground short	3222	4
32	EGOH1 short to power	3222	3
37	EGOH3 open / ground short	3261	4
38	EGOH3 short to power	3261	3
51	EGOH2 open / ground short	3232	4
52	EGOH2 short to power	3232	3
57	EGOH4 open / ground short	3271	4
58	EGOH4 short to power	3271	3
87	Primary fuel pressure low	94	1
87	CFV RLV charge pressure low	3601	17
88	Primary fuel pressure high	94	0
91	Primary FP low voltage	94	4
92	Primary FP high voltage	94	3
107	MAP low voltage	106	4
108	MAP high pressure	106	16
112	IAT low voltage	105	4
113	IAT high voltage	105	3
116	ECT higher than expected 1	110	15
117	ECT / CHT low voltage	110	4
118	ECT / CHT high voltage	110	3
121	TPS1 lower than TPS2	51	1
122	TPS1 low voltage	51	4
123	TPS1 high voltage	51	3
127	IAT higher than expected 2	105	0
128	Failed to reach operating temperature	110	17
129	BP low pressure	108	1
134	EGO open / lazy pre-cat 1	3217	5
140	EGO open / lazy post-cat 1	3256	5
154	EGO open / lazy pre-cat 2/post-cat 1	3227	5
160	EGO open / lazy post-cat 2	3266	5
171	AL high gasoline bank1	4237	0
172	AL low gasoline bank1	4237	1

Flash Code	Fault Description	SPN	FMI
174	AL high gasoline bank2	4239	0
175	AL low gasoline bank2	4239	1
182	FT gasoline low	174	4
183	FT gasoline high	174	3
187	FT gaseous fuel low	3468	4
187	FT gaseous fuel extremely low	3468	1
188	FT gaseous fuel high	3468	3
217	ECT higher than expected 2	110	0
219	Max govern speed override	515	15
221	TPS1 higher than TPS2	51	0
222	TPS2 low voltage	3673	4
223	TPS2 high voltage	3673	3
234	Control overboost	102	0
236	TIP/TOP active	102	2
237	TIP/TOP low voltage	102	4
238	TIP/TOP high voltage	102	3
261	Injector Loop Open or Low-Side Short to Ground (Cylinder 1)	651	5
262	Injector Coil Shorted (Cylinder 1)	651	6
264	Injector Loop Open or Low-Side Short to Ground (Cylinder 2)	652	5
265	Injector Coil Shorted (Cylinder 2)	652	6
267	Injector Loop Open or Low-Side Short to Ground (Cylinder 3)	653	5
268	Injector Coil Shorted (Cylinder 3)	653	6
270	Injector Loop Open or Low-Side Short to Ground (Cylinder 4)	654	5
271	Injector Coil Shorted (Cylinder 4)	654	6
273	Injector Loop Open or Low-Side Short to Ground (Cylinder 5)	655	5
274	Injector Coil Shorted (Cylinder 5)	655	6
276	Injector Loop Open or Low-Side Short to Ground (Cylinder 6)	656	5
277	Injector Coil Shorted (Cylinder 6)	656	6
279	Injector Loop Open or Low-Side Short to Ground (Cylinder 7)	657	5
280	Injector Coil Shorted (Cylinder 7)	657	6
282	Injector Loop Open or Low-Side Short to Ground (Cylinder 8)	658	5
283	Injector Coil Shorted (Cylinder 8)	658	6
285	Injector Loop Open or Low-Side Short to Ground (Cylinder 9)	659	5
286	Injector Coil Shorted (Cylinder 9)	659	6
288	Injector Loop Open or Low-Side Short to Ground (Cylinder 10)	660	5
289	Injector Coil Shorted (Cylinder 10)	660	6
299	Control underboost	102	1
301	Emissions/catalyst damaging misfire (Cylinder 1)	1323	31
302	Emissions/catalyst damaging misfire (Cylinder 2)	1324	31
303	Emissions/catalyst damaging misfire (Cylinder 3)	1325	31
304	Emissions/catalyst damaging misfire (Cylinder 4)	1326	31

Flash Code	Fault Description	SPN	FMI
305	Emissions/catalyst damaging misfire (Cylinder 5)	1327	31
306	Emissions/catalyst damaging misfire (Cylinder 6)	1328	31
307	Emissions/catalyst damaging misfire (Cylinder 7)	1329	31
308	Emissions/catalyst damaging misfire (Cylinder 8)	1330	31
309	Emissions/catalyst damaging misfire (Cylinder 9)	1331	31
310	Emissions/catalyst damaging misfire (Cylinder 10)	1332	31
326	Knock1 excessive signal	731	2
327	Knock1 sensor open	731	4
331	Knock2 excessive signal	520197	2
332	Knock2 sensor open	520197	4
336	Crank sync noise	636	2
337	Crank loss	636	4
341	Cam sync noise	723	2
342	Cam loss	723	4
350	External Spark Module Failure	1268	31
351	External Spark Module Coil Failure (Cylinder 1)	1268	31
352	External Spark Module Coil Failure (Cylinder 2)	1269	31
353	External Spark Module Coil Failure (Cylinder 3)	1270	31
354	External Spark Module Coil Failure (Cylinder 4)	1271	31
355	External Spark Module Coil Failure (Cylinder 5)	1272	31
356	External Spark Module Coil Failure (Cylinder 6)	1273	31
357	External Spark Module Coil Failure (Cylinder 7)	1274	31
358	External Spark Module Coil Failure (Cylinder 8)	1275	31
359	External Spark Module Coil Failure (Cylinder 9)	1276	31
359	Fuel run-out longer than expected	632	31
360	External Spark Module Coil Failure (Cylinder 10)	1277	31
420	Gasoline cat monitor	3050	11
430	Gasoline cat monitor	3051	11
502	Roadspeed loss	84	8
508	IAC ground short	520201	6
509	IAC coil open/short	520201	5
520	Oil pressure low stage 1 (sender)	100	18
521	Oil pressure high (sender)	100	0
522	Oil pressure sender low voltage	100	4
523	Oil pressure sender high voltage	100	3
524	Oil pressure low (switch)	100	1
524	Oil pressure low stage 2 (sender)	100	1
562	Voltage low	168	17
563	Voltage high	168	15
601	Flash checksum invalid	628	13
604	RAM failure	630	12
606	COP failure	629	31

Flash Code	Fault Description	SPN	FMI
615	Start relay coil open	1321	5
616	Start relay control ground short	1321	4
617	Start relay coil short to power	1321	3
627	Fpump relay coil open	1348	5
628	FPump motor loop open or high-side shorted to ground	1347	5
628	FPump relay control ground short	1348	4
629	FPump motor high-side shorted to power	1347	6
629	Fpump relay coil short to power	1348	3
642	5VE1 low voltage	1079	4
643	5VE1 high voltage	1079	3
650	MIL open	1213	5
652	5VE2 low voltage	1080	4
653	5VE2 high voltage	1080	3
670	Glow Plug Control Unit Failure	676	11
671	Glow Plug Short to Ground (Cylinder 1)	2899	4
672	Glow Plug Short to Ground (Cylinder 2)	2899	4
673	Glow Plug Short to Ground (Cylinder 3)	2899	4
674	Glow Plug Short to Ground (Cylinder 4)	2899	4
675	Glow Plug Short to Ground (Cylinder 5)	2899	4
676	Glow Plug Short to Ground (Cylinder 6)	2899	4
677	Glow Plug Short to Ground (Cylinder 7)	2899	4
678	Glow Plug Short to Ground (Cylinder 8)	2899	4
679	Glow Plug Short to Ground (Cylinder 9)	2899	4
680	Glow Plug Short to Ground (Cylinder 10)	2899	4
685	Relay coil open	1485	5
686	Relay control ground short	1485	4
687	Relay coil short to power	1485	3
698	5VE3 low voltage	3511	4
699	5VE3 high voltage	3511	3
916	Shift actuator feedback out-of-range	520226	3
919	Shift unable to reach desired gear	520226	7
920	Shift actuator or drive circuit failure	520226	31
1068	MAP higher than expected	3563	15
1087	Secondary fuel pressure low	94	1
1088	Secondary fuel pressure high	94	0
1111	Fuel rev limit	515	16
1112	Spark rev limit	515	0
1113	RPM higher than expected	515	31
1114	Unable to achieve low target speed	515	15
1121	FPP1/2 simultaneous voltages out of range (redundancy lost)	91	31
1122	FPP1/2 do not match each other or the IVS (redundancy	520199	11

Flash Code	Fault Description	SPN	FMI
	lost)		
1131	WGP high voltage	1192	3
1132	WGP low voltage	1192	4
1151	CL high LPG	4236	0
1152	CL low LPG	4236	1
1153	CL high NG	4236	0
1154	CL low NG	4236	1
1155	CL high gasoline bank1	4236	0
1156	CL low gasoline bank1	4236	1
1157	CL high gasoline bank2	4238	0
1158	CL low gasoline bank2	4238	1
1161	AL high LPG	4237	0
1162	AL low LPG	4237	1
1163	AL high NG	4237	0
1164	AL low NG	4237	1
1165	LPG cat monitor	3050	11
1166	NG cat monitor	3050	11
1171	EPR / CFV regulation pressure higher than expected	520260	0
1172	EPR / CFV regulation pressure lower than expected	520260	1
1173	EPR / CFV comm lost	520260	31
1174	EPR / CFV voltage supply high	520260	3
1175	EPR / CFV voltage supply low	520260	4
1176	EPR / CFV internal actuator fault detection	520260	12
1177	EPR / CFV internal circuitry fault detection	520260	12
1178	EPR / CFV internal comm fault detection	520260	12
1179	CFV flow higher than commanded	520260	15
1180	CFV flow lower than commanded	520260	17
1182	Fuel impurity level high	520401	0
1183	EPR autozero / lockoff failed	520803	31
1211	APS1 high voltage	3464	3
1212	APS1 low voltage	3464	4
1213	APS2 high voltage	3464	3
1214	APS2 low voltage	3464	4
1215	APS1 higher than APS2	3464	0
1216	APS1 lower than APS2	3464	1
1217	Unable to reach higher APS	3464	7
1218	Unable to reach lower APS	3464	7
1219	APS1/2 simultaneous voltages out of range	3464	31
1220	BPS1 high voltage	3465	3
1221	BPS1 low voltage	3465	4
1222	BPS2 high voltage	3465	3
1223	BPS2 low voltage	3465	4

Flash Code	Fault Description	SPN	FMI
1224	BPS1 higher than BPS2	3465	0
1225	BPS1 lower than BPS2	3465	1
1226	Unable to reach higher BPS	3465	7
1227	Unable to reach lower BPS	3465	7
1228	BPS1/2 simultaneous voltages out of range	3465	31
1311	Misfire detected (Cylinder 1)	1323	11
1312	Misfire detected (Cylinder 2)	1324	11
1313	Misfire detected (Cylinder 3)	1325	11
1314	Misfire detected (Cylinder 4)	1326	11
1315	Misfire detected (Cylinder 5)	1327	11
1316	Misfire detected (Cylinder 6)	1328	11
1317	Misfire detected (Cylinder 7)	1329	11
1318	Misfire detected (Cylinder 8)	1330	11
1319	Misfire detected (Cylinder 9)	1331	11
1320	Misfire detected (Cylinder 10)	1332	11
1325	Knock retard at limit	731	15
1351	Spark Plug or Coil Failure (Cylinder 1)	1268	11
1352	Spark Plug or Coil Failure (Cylinder 2)	1269	11
1353	Spark Plug or Coil Failure (Cylinder 3)	1270	11
1354	Spark Plug or Coil Failure (Cylinder 4)	1271	11
1355	Spark Plug or Coil Failure (Cylinder 5)	1272	11
1356	Spark Plug or Coil Failure (Cylinder 6)	1273	11
1357	Spark Plug or Coil Failure (Cylinder 7)	1274	11
1358	Spark Plug or Coil Failure (Cylinder 8)	1275	11
1359	Spark Plug or Coil Failure (Cylinder 9)	1276	11
1360	Spark Plug or Coil Failure (Cylinder 10)	1277	11
1411	EMWT1 high voltage	441	3
1412	EMWT2 high voltage	442	3
1413	EMWT1 low voltage	441	4
1414	EMWT2 low voltage	442	4
1415	EMWT1 higher than expected level 1	441	15
1416	EMWT2 higher than expected level 1	442	15
1417	EMWT1 higher than expected level 2	441	0
1418	EMWT2 higher than expected level 2	442	0
1421	ERWT1 high voltage	1385	3
1422	ERWT2 high voltage	1386	3
1423	ERWT1 low voltage	1385	4
1424	ERWT2 low voltage	1386	4
1425	ERWT1 higher than expected level 1	1385	15
1425	AUX Temperature 3 high	703	0
1425	AUX Temperature 3 low	703	1
1426	ERWT2 higher than expected level 1	1386	15

Flash Code	Fault Description	SPN	FMI
1426	AUX Temperature delta T 1 high	1385	0
1426	AUX Temperature delta T 1 low	1385	1
1427	ERWT1 higher than expected level 2	1385	0
1427	AUX Temperature 1 low	1385	1
1428	ERWT2 higher than expected level 2	1386	0
1428	AUX Temperature 1 high	1385	0
1435	AUX Temperature 4 high	704	0
1435	AUX Temperature 4 low	704	1
1436	AUX Temperature delta T 2 high	1386	0
1436	AUX Temperature delta T 2 low	1386	1
1437	AUX Temperature 2 low	1386	1
1438	AUX Temperature 2 high	1386	0
1470	AUX Pressure 3 high	703	0
1470	AUX Pressure 3 low	703	1
1470	AUX Pressure 4 high	704	0
1470	AUX Pressure 4 low	704	1
1471	AUX Pressure delta P 1 high	1387	0
1471	AUX Pressure delta P 1 low	1387	1
1471	AUX Pressure delta P 2 high	1388	0
1471	AUX Pressure delta P 2 low	1388	1
1472	AUX Pressure 1 low	1387	1
1472	AUX Pressure 2 low	1388	1
1473	AUX Pressure 1 high	1387	0
1473	AUX Pressure 2 high	1388	0
1511	AUX analog PU1 high	701	3
1512	AUX analog PU1 low	701	4
1513	AUX analog PU2 high	702	3
1514	AUX analog PU2 low	702	4
1515	AUX analog PD1 high	710	3
1516	AUX analog PD1 low	710	4
1517	AUX analog PU3 high	703	3
1518	AUX analog PU3 low	703	4
1521	CHT higher than expected 1	110	16
1522	CHT higher than expected 2	110	0
1531	IVS/Brake/Trans-Park interlock failure	0	31
1541	AUX analog PUD1 high	704	3
1542	AUX analog PUD1 low	704	4
1543	AUX analog PUD2 high	705	3
1544	AUX analog PUD2 low	705	4
1545	AUX analog PUD3 high	706	3
1546	AUX analog PUD3 low	706	4
1547	AUX analog PUD4 high	713	3

Flash Code	Fault Description	SPN	FMI
1548	AUX analog PUD4 low	713	4
1551	AUX DIG1 high	707	3
1552	AUX DIG1 low	707	4
1553	AUX DIG2 high	708	3
1554	AUX DIG2 low	708	4
1555	Water Intrusion Detection	709	3
1555	AUX DIG3 high	709	3
1556	AUX DIG3 low	709	4
1561	AUX analog PD2 high	711	3
1562	AUX analog PD2 low	711	4
1563	AUX analog PD3 high	712	3
1564	AUX analog PD3 low	712	4
1565	AUX analog PUD5 high	0	3
1566	AUX analog PUD5 low	0	4
1567	AUX analog PUD6 high	714	3
1568	AUX analog PUD6 low	714	4
1569	AUX analog PUD7 high	715	3
1571	AUX analog PUD7 low	715	4
1572	AUX DIG4 high	716	3
1573	AUX DIG4 low	716	4
1574	AUX DIG5 high	520202	3
1575	AUX DIG5 low	520202	4
1576	AUX DIG6 high	520203	3
1577	AUX DIG6 low	520203	4
1578	AUX DIG7 high	520204	3
1579	AUX DIG7 low	520204	4
1581	AUX DIG8 high	520205	3
1582	AUX DIG8 low	520205	4
1583	AUX DIG9 high	520206	3
1584	AUX DIG9 low	520206	4
1585	AUX DIG10 high	520207	3
1586	AUX DIG10 low	520207	4
1589	AUX DIG11 high	520209	3
1591	AUX DIG11 low	520209	4
1592	AUX DIG12 high	520210	3
1593	AUX DIG12 low	520210	4
1601	Envirotech receipt lost	4490	18
1602	Relay off high voltage	1485	4
1603	Relay on low voltage	1485	4
1604	Service Interval Expired	1350	31
1611	5VE1/2 simultaneous out-of-range	1079	31
1612	RTI 1 loss	629	31

Flash Code	Fault Description	SPN	FMI
1613	RTI 2 loss	629	31
1614	RTI 3 loss	629	31
1615	A/D loss	629	31
1616	Invalid interrupt	629	31
1621	Rx Inactive	0	31
1622	Rx Noise	0	31
1623	Invalid Packet Format	0	31
1624	Shutdown Request	0	31
1625	Shutdown Request	1110	31
1626	CAN1 Tx failure	639	12
1627	CAN1 Rx failure	639	12
1628	CAN1 address conflict failure	639	13
1629	J1939 TSC1 message receipt lost	695	9
1630	J1939 ETC message receipt lost	91	19
1631	PWM1-Gauge1 open / ground short	697	5
1632	PWM1-Gauge1 short to power	697	3
1633	PWM2-Gauge2 open / ground short	698	5
1634	PWM2-Gauge2 short to power	698	3
1635	PWM3-Gauge3 open / ground short	699	5
1636	PWM3-Gauge3 short to power	699	3
1637	PWM4-Gauge4 open / ground short	700	5
1638	PWM4-Gauge4 short to power	700	3
1639	PWM5 open / ground short	924	5
1640	PWM5 short to power	924	3
1641	Buzzer control ground short	920	4
1642	Buzzer open	920	5
1643	Buzzer control short to power	920	3
1644	MIL control ground short	1213	4
1645	MIL control short to power	1213	3
1646	CAN2 Tx failure	1231	12
1647	CAN3 Tx failure	1235	12
1648	CAN2 Rx failure	1231	12
1649	CAN3 Rx failure	1235	12
1650	CAN2 address conflict failure	1231	13
1651	J1939 ETC message loss while in-gear	91	9
1653	CAN3 address conflict failure	1235	13
1661	PWM6 open / ground short	925	5
1662	PWM6 short to power	925	3
1663	PWM7 open / ground short	926	5
1664	PWM7 short to power	926	3
1665	PWM8 open / ground short	2646	5
1666	PWM8 short to power	2646	3

Flash Code	Fault Description	SPN	FMI
1669	PWM9 open / ground short	2647	5
1670	PWM9 short to power	2647	3
1671	Brake output open / ground short	1074	4
1672	Brake output short to power	1074	3
1673	Calibration Configuration Error	1634	13
1674	Hardware ID Failure	1634	2
1675	Start command stuck active	1675	3
1676	PWM10 open / ground short	2648	5
1677	PWM10 short to power	2648	3
1678	PWM11 open / ground short	2649	5
1679	PWM11 short to power	2649	3
1680	PWM12 open / ground short	2650	5
1681	PWM12 short to power	2650	3
1682	PWM13 open / ground short	2651	5
1683	PWM13 short to power	2651	3
1684	PWM14 open / ground short	2652	5
1685	PWM14 short to power	2652	3
1686	PWM15 open / ground short	2653	5
1687	PWM15 short to power	2653	3
1688	PWM16 open / ground short	2654	5
1689	PWM16 short to power	2654	3
1690	PWM17 open / ground short	2655	5
1691	PWM17 short to power	2655	3
1692	PWM18 open / ground short	2656	5
1693	PWM18 short to power	2656	3
1694	PWM19 open / ground short	2657	5
1695	PWM19 short to power	2657	3
1696	PWM20 open / ground short	2658	5
1697	PWM20 short to power	2658	3
1698	PWM21 open / ground short	2659	5
1699	PWM21 short to power	2659	3
1700	PWM22 open / ground short	2660	5
1701	PWM22 short to power	2660	3
1702	PWM23 open / ground short	2661	5
1703	PWM23 short to power	2661	3
2111	Unable to reach lower TPS	51	7
2112	Unable to reach higher TPS	51	7
2115	FPP1 higher than IVS limit	91	0
2116	FPP2 higher than IVS limit	29	0
2120	FPP1 invalid voltage and FPP2 disagrees with IVS (redundancy lost)	520199	11
2121	FPP1 lower than FPP2	91	18

Flash Code	Fault Description	SPN	FMI
2122	FPP1 high voltage	91	3
2123	FPP1 low voltage	91	4
2125	FPP2 invalid voltage and FPP1 disagrees with IVS (redundancy lost)	520199	11
2126	FPP1 higher than FPP2	91	16
2127	FPP2 low voltage	29	4
2128	FPP2 high voltage	29	3
2130	IVS stuck at-idle, FPP1/2 match	558	5
2131	IVS stuck off-idle, FPP1/2 match	558	6
2135	TPS1/2 simultaneous voltages out of range	51	31
2139	FPP1 lower than IVS limit	91	1
2140	FPP2 lower than IVS limit	29	1
2229	BP high pressure	108	0
2261	CR Injector High-Side Short to Ground (Cylinder 1)	2651	5
2262	CR Injector Low-Side Short to Power (Cylinder 1)	2651	3
2264	CR Injector High-Side Short to Ground (Cylinder 2)	2652	5
2265	CR Injector Low-Side Short to Power (Cylinder 2)	2652	3
2267	CR Injector High-Side Short to Ground (Cylinder 3)	2653	5
2268	CR Injector Low-Side Short to Power (Cylinder 3)	2653	3
2270	CR Injector High-Side Short to Ground (Cylinder 4)	2654	5
2271	CR Injector Low-Side Short to Power (Cylinder 4)	2654	3
2273	CR Injector High-Side Short to Ground (Cylinder 5)	2655	5
2274	CR Injector Low-Side Short to Power (Cylinder 5)	2655	3
2276	CR Injector High-Side Short to Ground (Cylinder 6)	2656	5
2277	CR Injector Low-Side Short to Power (Cylinder 6)	2656	3
2279	CR Injector High-Side Short to Ground (Cylinder 7)	2657	5
2280	CR Injector Low-Side Short to Power (Cylinder 7)	2657	3
2282	CR Injector High-Side Short to Ground (Cylinder 8)	2658	5
2283	CR Injector Low-Side Short to Power (Cylinder 8)	2658	3
2295	Secondary FP low voltage	94	4
2296	Secondary FP high voltage	94	3
2300	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 1)	1268	5
2301	Primary Coil Shorted (current measurement required)(Cylinder 1)	1268	6
2303	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 2)	1269	5
2304	Primary Coil Shorted (current measurement required)(Cylinder 2)	1269	6
2306	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 3)	1270	5
2307	Primary Coil Shorted (current measurement	1270	6

Flash Code	Fault Description	SPN	FMI
	required)(Cylinder 3)		
2309	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 4)	1271	5
2310	Primary Coil Shorted (current measurement required)(Cylinder 4)	1271	6
2312	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 5)	1272	5
2313	Primary Coil Shorted (current measurement required)(Cylinder 5)	1272	6
2315	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 6)	1273	5
2316	Primary Coil Shorted (current measurement required)(Cylinder 6)	1273	6
2318	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 7)	1274	5
2319	Primary Coil Shorted (current measurement required)(Cylinder 7)	1274	6
2321	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 8)	1275	5
2322	Primary Coil Shorted (current measurement required)(Cylinder 8)	1275	6
2324	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 9)	1276	5
2325	Primary Coil Shorted (current measurement required)(Cylinder 8)	1276	6
2327	Primary Loop Open or Low-Side Short to Ground (curr. meas. reqd)(Cylinder 10)	1277	5
2328	Primary Coil Shorted (current measurement required)(Cylinder 10)	1277	6
2428	Exhaust gas temperature high	173	0
2618	Tach output ground short	645	4
2619	Tach output short to power	645	3
2665	CFV RLV test failed	3601	7
3001	Glow Plug Open/Power Short (Cylinder 1)	2899	3
3002	Glow Plug Open/Power Short (Cylinder 2)	2899	3
3003	Glow Plug Open/Power Short (Cylinder 3)	2899	3
3004	Glow Plug Open/Power Short (Cylinder 4)	2899	3
3005	Glow Plug Open/Power Short (Cylinder 5)	2899	3
3006	Glow Plug Open/Power Short (Cylinder 6)	2899	3
3007	Glow Plug Open/Power Short (Cylinder 7)	2899	3
3008	Glow Plug Open/Power Short (Cylinder 8)	2899	3
3009	Glow Plug Open/Power Short (Cylinder 9)	2899	3
3010	Glow Plug Open/Power Short (Cylinder 10)	2899	3

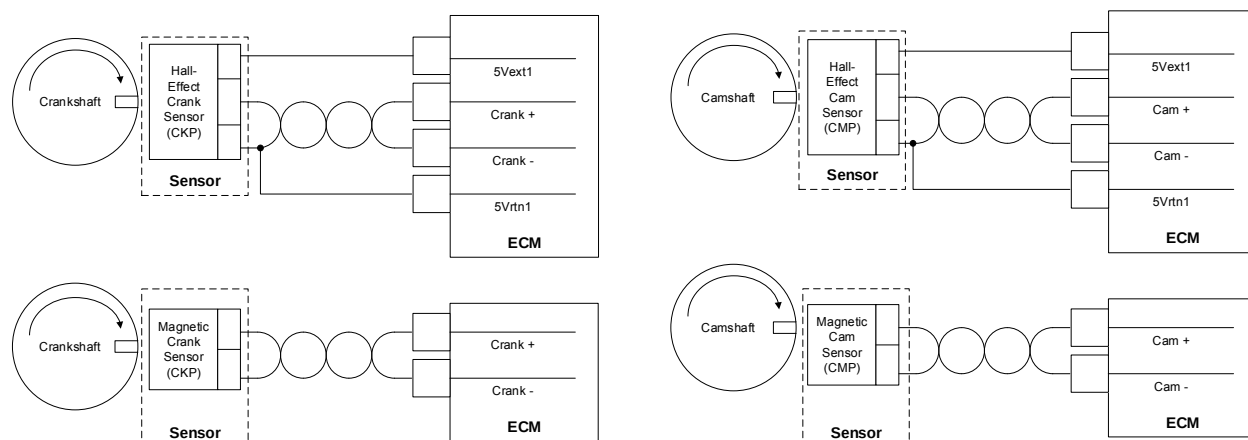
Flash Code	Fault Description	SPN	FMI
3011	UEGO1 internal processor fault	3221	31
3012	UEGO1 heater supply high voltage	3222	3
3013	UEGO1 heater supply low voltage	3222	4
3014	UEGO1 cal resistor voltage high	3221	3
3015	UEGO1 cal resistor voltage low	3221	4
3016	UEGO1 return voltage shorted high	3056	3
3017	UEGO1 return voltage shorted low	3056	4
3018	UEGO1 pump voltage shorted high	3218	3
3019	UEGO1 pump voltage shorted low	3218	4
3020	UEGO1 sense cell voltage high	3217	3
3021	UEGO1 sense cell voltage low	3217	4
3022	UEGO1 pump voltage at high drive limit	3225	3
3023	UEGO1 pump voltage at low drive limit	3225	4
3024	UEGO1 sense cell slow to warm up	3222	10
3025	UEGO1 pump cell slow to warm up	3225	10
3026	UEGO1 sense cell impedance high	3222	0
3027	UEGO1 pump cell impedance high	3225	0
3028	UEGO1 pump cell impedance low	3225	1
3029	UEGO1 drift is out-of-tolerance	3221	15
3030	UEGO1 drift is out-of-tolerance - level 2	3221	16
3031	UEGO1 heater open / ground short	3222	4
3032	UEGO1 heater short to power	3222	3
3033	UEGO2 internal processor fault	3260	31
3034	UEGO2 drift is out-of-tolerance	3260	15
3035	UEGO2 drift is out-of-tolerance - level 2	3260	16
3036	UEGO2 heater supply high voltage	3261	3
3037	UEGO2 heater supply low voltage	3261	4
3038	UEGO2 cal resistor voltage high	3260	3
3039	UEGO2 cal resistor voltage low	3260	4
3040	UEGO2 return voltage shorted high	3057	3
3041	UEGO2 return voltage shorted low	3057	4
3042	UEGO2 pump voltage shorted high	3257	3
3043	UEGO2 pump voltage shorted low	3257	4
3044	UEGO2 sense cell voltage high	3256	3
3045	UEGO2 sense cell voltage low	3256	4
3046	UEGO2 pump voltage at high drive limit	3264	3
3047	UEGO2 pump voltage at low drive limit	3264	4
3048	UEGO2 sense cell slow to warm up	3261	10
3049	UEGO2 pump cell slow to warm up	3264	10
3050	UEGO2 sense cell impedance high	3261	0
3051	UEGO2 pump cell impedance high	3264	0
3052	UEGO2 pump cell impedance low	3264	1

Flash Code	Fault Description	SPN	FMI
3053	UEGO2 heater open / ground short	3261	4
3054	UEGO2 heater short to power	3261	3
3100	CR Injection Bank Boost Voltage Low (bank 1)	3100	4
3101	CR Injection Bank Boost Voltage Low (bank 2)	3101	4
3102	CR Injection Bank Internal Fault (Bank 1)	3102	31
3103	CR Injection Bank Internal Fault (Bank 2)	3103	31
3104	IMV Loop Open or Short to Ground	3104	5
3105	IMV Coil Short or Short to Power	3105	6
3999	DBW drive current high	0	6
3999	HBA drive current high	0	6
3999	HBB drive current high	0	6
3999	AUX analog PUD8 high	0	31
3999	AUX analog PUD8 low	0	31
3999	AUX analog PUD9 high	0	31
3999	AUX analog PUD9 low	0	31
3999	AUX analog PUD10 high	0	31
3999	AUX analog PUD10 low	0	31
3999	AUX analog PUD11 high	0	31
3999	AUX analog PUD11 low	0	31
3999	AUX analog PUD12 high	0	31
3999	AUX analog PUD12 low	0	31
3999	AUX analog PUD13 high	0	31
3999	AUX analog PUD13 low	0	31
3999	AUX analog PUD14 high	0	31
3999	AUX analog PUD14 low	0	31
3999	AUX analog PUD15 high	0	31
3999	AUX analog PUD15 low	0	31
3999	AUX analog PUD16 high	0	31
3999	AUX analog PUD16 low	0	31
3999	AUX analog PUD17 high	0	31
3999	AUX analog PUD17 low	0	31
3999	AUX analog PUD18 high	0	31
3999	AUX analog PUD18 low	0	31
3999	AUX analog PUD19 high	0	31
3999	AUX analog PUD19 low	0	31
3999	AUX analog PUD20 high	0	31
3999	AUX analog PUD20 low	0	31
3999	AUX analog PUD21 high	0	31
3999	AUX analog PUD21 low	0	31
3999	AUX analog PUD22 high	0	31
3999	AUX analog PUD22 low	0	31
3999	AUX analog PUD23 high	0	31

Flash Code	Fault Description	SPN	FMI
3999	AUX analog PUD23 low	0	31
3999	AUX analog PUD24 high	0	31
3999	AUX analog PUD24 low	0	31
3999	AUX analog PUD25 high	0	31
3999	AUX analog PUD25 low	0	31
3999	AUX DIG13 high	0	31
3999	AUX DIG13 low	0	31
3999	AUX DIG14 high	0	31
3999	AUX DIG14 low	0	31
3999	AUX DIG15 high	0	31
3999	AUX DIG15 low	0	31
3999	AUX DIG16 high	0	31
3999	AUX DIG16 low	0	31
3999	AUX DIG17 high	0	31
3999	AUX DIG17 low	0	31
3999	AUX DIG18 high	0	31
3999	AUX DIG18 low	0	31
3999	AUX DIG19 high	0	31
3999	AUX DIG19 low	0	31
3999	AUX DIG20 high	0	31
3999	AUX DIG20 low	0	31
3999	AUX DIG21 high	0	31
3999	AUX DIG21 low	0	31
3999	AUX DIG22 high	0	31
3999	AUX DIG22 low	0	31
3999	AUX DIG23 high	0	31
3999	AUX DIG23 low	0	31
3999	AUX DIG24 high	0	31
3999	AUX DIG24 low	0	31
3999	AUX DIG25 high	0	31
3999	AUX DIG25 low	0	31
3999	Catalyst monitor - exhaust P low	4755	1
3999	Catalyst monitor - exhaust P high	4755	0
3999	UEGO1 internal supply voltage low	0	31
3999	UEGO2 internal supply voltage low	0	31
3999	Cooling water flow lower than expected	110	1

7.2 DTC Descriptions & Diagnostic Information

See the following pages for fault descriptions and diagnostic information, by DTC. Please note that fault descriptions and diagnostic information is in process – and will be provided in subsequent revisions to this document – for those DTCs not shown.

DTC 16 - CRANK AND/OR CAM COULD NOT SYNCHRONIZE DURING START

DTC	16	SPN	8	FMI	636
Hardware: Crankshaft Position Sensor/Camshaft Position Sensor					
Hardware Description: The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block adjacent to a “coded” trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control. The camshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block or valve train adjacent to a “coded” trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination of the camshaft position is necessary to identify the stroke (or cycle) of the engine to properly activate the fuel injection system and ignition (for coil-on-plug engines) for precise engine control.					
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)		
Emissions-related Fault?			YES		
Check Condition:			Engine Cranking or Running		
Fault Set Conditions (as defined in calibration):					
• Cranking revs without sync >				crknever	revs
• RPM>				crknoise_rpm	rpm

(continued from previous page)

Possible Causes:

The ECM must see a valid crankshaft position and camshaft position (if applicable) signal properly aligned during cranking before it can synchronize the injection and ignition systems to initiate starting. If engine speed > x RPM and the crank and/or cam (if applicable) cannot synchronize within y cranking revs (NOTE: x and y defined in application-specific calibration), this fault will set.

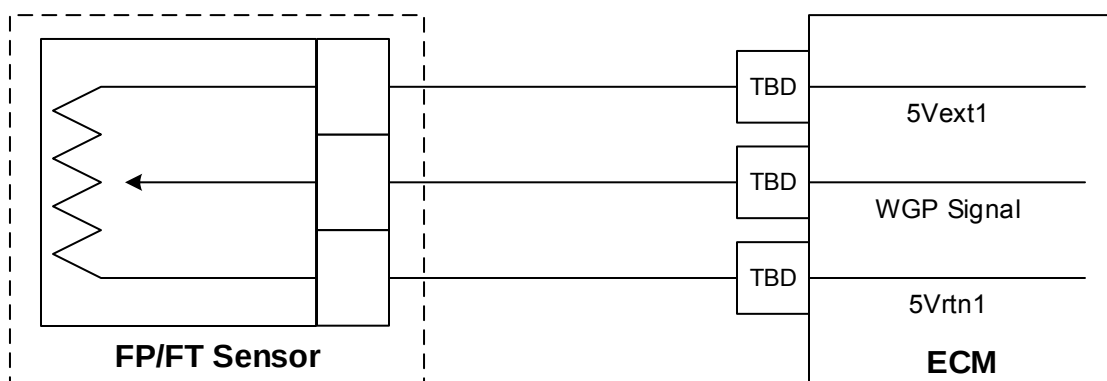
Typically, conditions triggering this fault will result in an engine that will not start or run.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

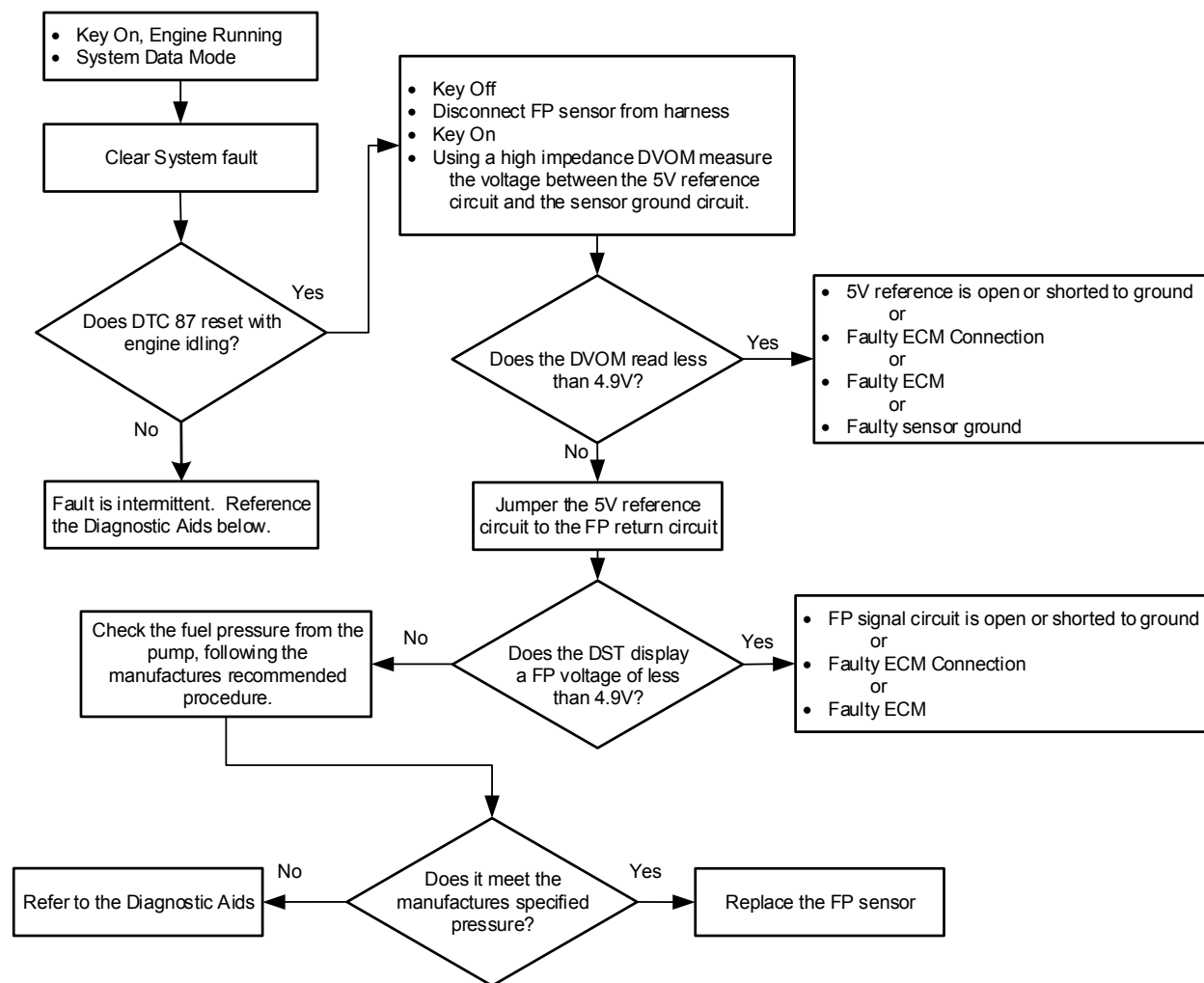
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

- ☐ Check that crankshaft and/or camshaft position sensor(s) is/are securely connected to harness
- ☐ Check that crankshaft and/or camshaft position sensor(s) is/are securely installed into engine block
- ☐ Check crankshaft and/or camshaft position sensor(s) circuit(s) wiring for open circuit

DTC 87 - PRIMARY FUEL PRESSURE LOW (LIQUID FUELS)

DTC	87	SPN	94	FMI	1		
Hardware: Liquid Fuel Pressure and Temperature Sensor							
Hardware Description: The fuel pressure sensor is installed inline in the gasoline fuel supply line and is used to provide fuel pressure feedback to the ECM. The ECM sets a target rail pressure based on running conditions and then the fuel pump is PWM controlled through a low side driver in the ECM. The fuel pressure sensor feedback is used to determine when the actual rail pressure has reached the target rail pressure.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• Primary FP fault mode:				TBD*			
• run time wait for fuel pressure high/low faults:				TBD*	seconds		
• Non-Common-Rail Primary fuel pressure <				TBD*	psia		
• or Common-Rail (target - actual) fuel pressure >				TBD*	bar		
Possible Causes: Fuel pressure problem with engine, Fuel pressure sensor failure, fuel pressure sensor circuit shorted to ground, faulty ECM							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 87 - PRIMARY FUEL PRESSURE LOW (TROUBLE TREE)**Diagnostic Aids**

Fuel Filter – If a fuel filter is dirty, the fuel flow to the fuel pump may be restricted. Check filter and replace if necessary.

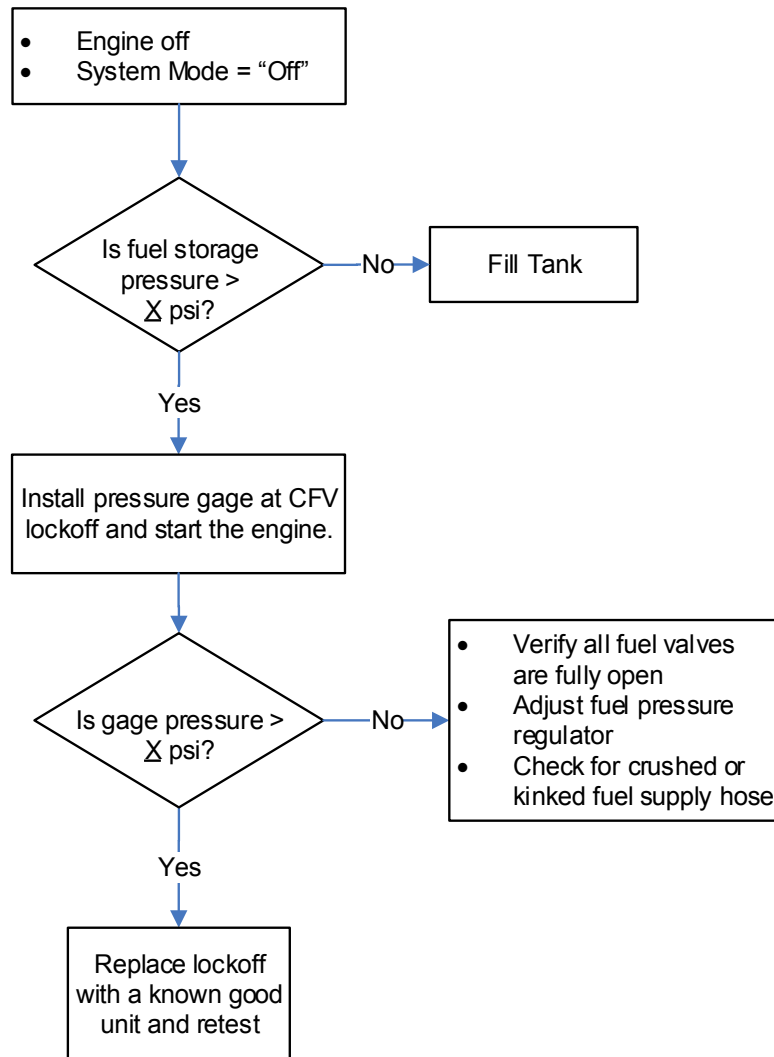
Fuel Line Restrictions – Check fuel line for kinks or pinched areas. Correct any fuel line or fitting restrictions.

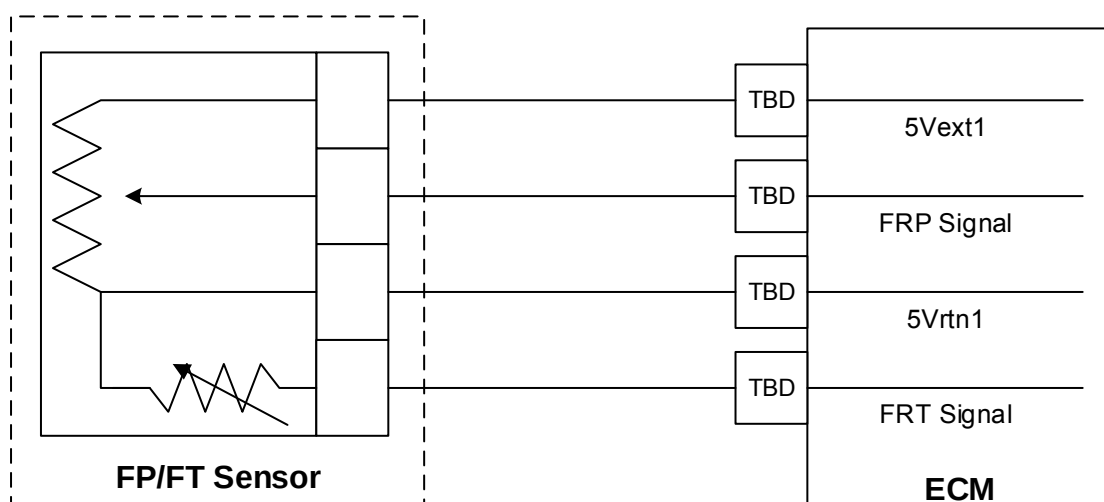
Vapor Lock – Fuel system or pump temperature above the vapor pressure of the fuel.

Refer to Intermittent Diagnostics for additional aids.

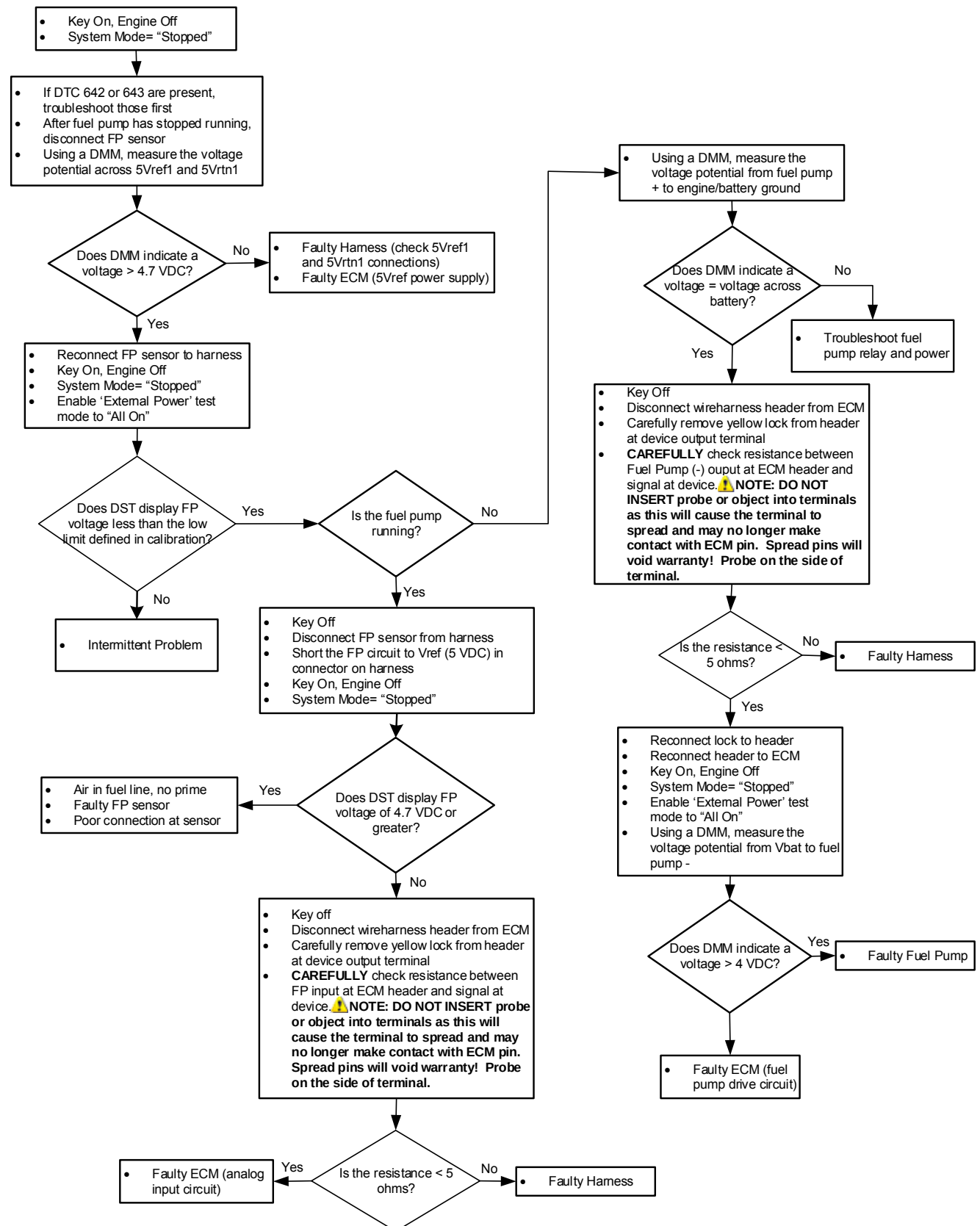
DTC 87 - CFV RLV CHARGE PRESSURE LOW

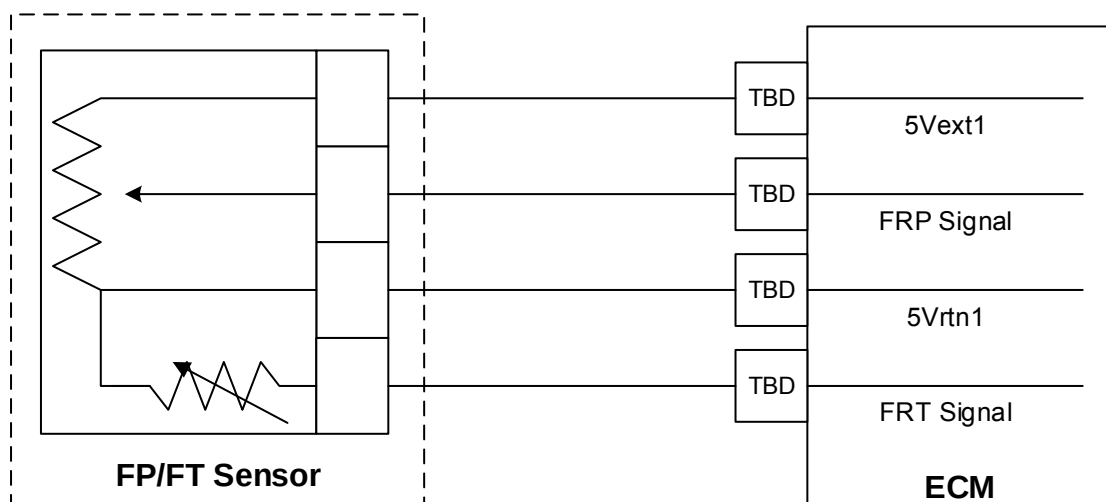
DTC	87	SPN	3601	FMI	17		
Hardware: CFV							
Description:							
The fourth generation of EControls' gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator (1st Stage) and a precision Continuous Flow Valve (2nd Stage). The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates the 1st Stage to control the fuel pressure and the 2nd Stage to control the metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• CFV interstage pressure <				TBD*	psia		
Possible Causes:							
The CFV RLV charge pressure low fault is activated when the CFV RLV charge pressure commanded results in a pressure lower than the CFV RLV minimum test pressure (the inter-stage pressure could not be raised above the minimum test pressure).							
• X =							
This may occur if the fuel tank is empty or the tank pressure is low. The latch value for this fault defines the number of times the ECM will attempt to charge the CFV before the fault is set.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 87 - CFV CHARGE PRESSURE LOW (TROUBLE TREE)

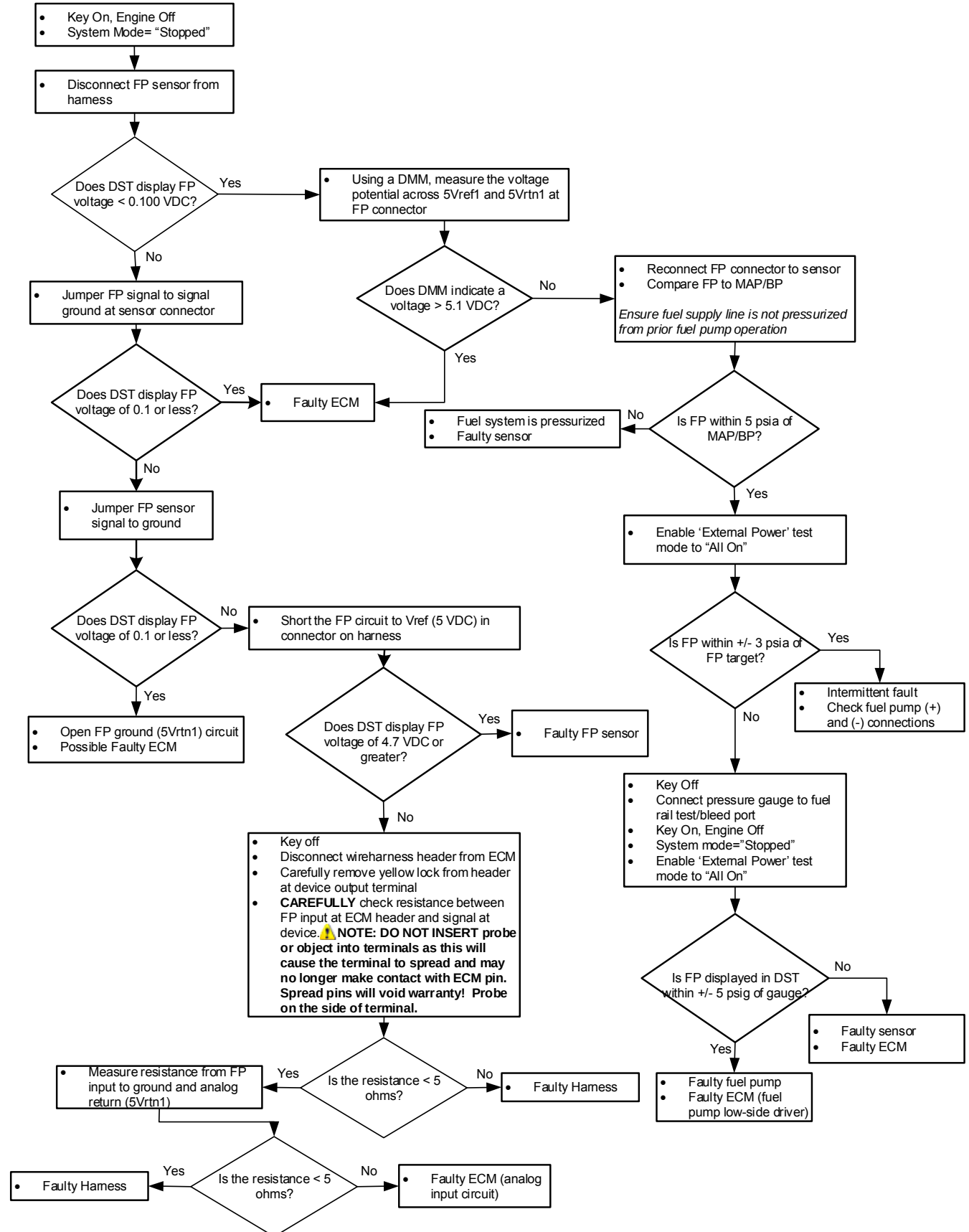
DTC 91 - FP (FUEL PRESSURE) LOW VOLTAGE

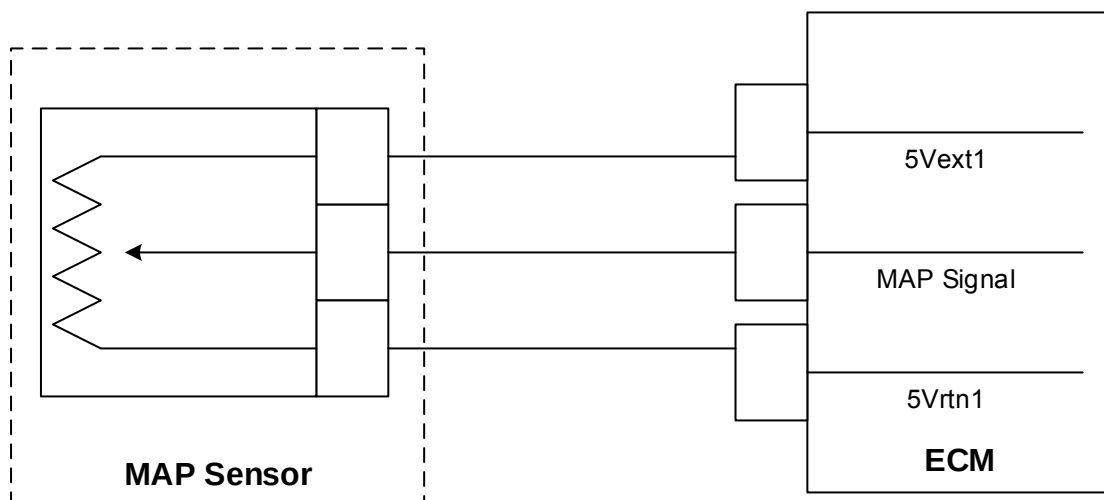
DTC	91	SPN	94	FMI	4		
Hardware: Liquid Fuel Pressure and Temperature Sensor							
Hardware Description: The fuel pressure sensor is installed inline in the gasoline fuel supply line and is used to provide fuel pressure feedback to the ECM for closed-loop fuel pressure control of the fuel supply pump.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• Primary FP voltage <				TBD*	volts		
Possible Causes: This fault will set when the FP sensor voltage feedback is sensed as lower than the sensor should normally produce as set in the diagnostic calibration. The limit is generally set at 0.10 VDC. In many cases, this condition is caused by the FP sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the FP circuit in the wire harness, a loss of sensor reference voltage, or a failure of the sensor.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 91 - FP (FUEL PRESSURE) LOW VOLTAGE (TROUBLE TREE)

DTC 92 - FP (FUEL PRESSURE) HIGH VOLTAGE

DTC	92	SPN	94	FMI	3		
Hardware: Liquid Fuel Pressure and Temperature Sensor							
Hardware Description: The fuel pressure sensor is installed inline in the gasoline fuel supply line and is used to provide fuel pressure feedback to the ECM for closed-loop fuel pressure control of the fuel supply pump.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• Primary FP voltage >				TBD*	volts		
Possible Causes: This fault will set if the signal voltage is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the FP circuit in the wire harness or a failure of the sensor.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

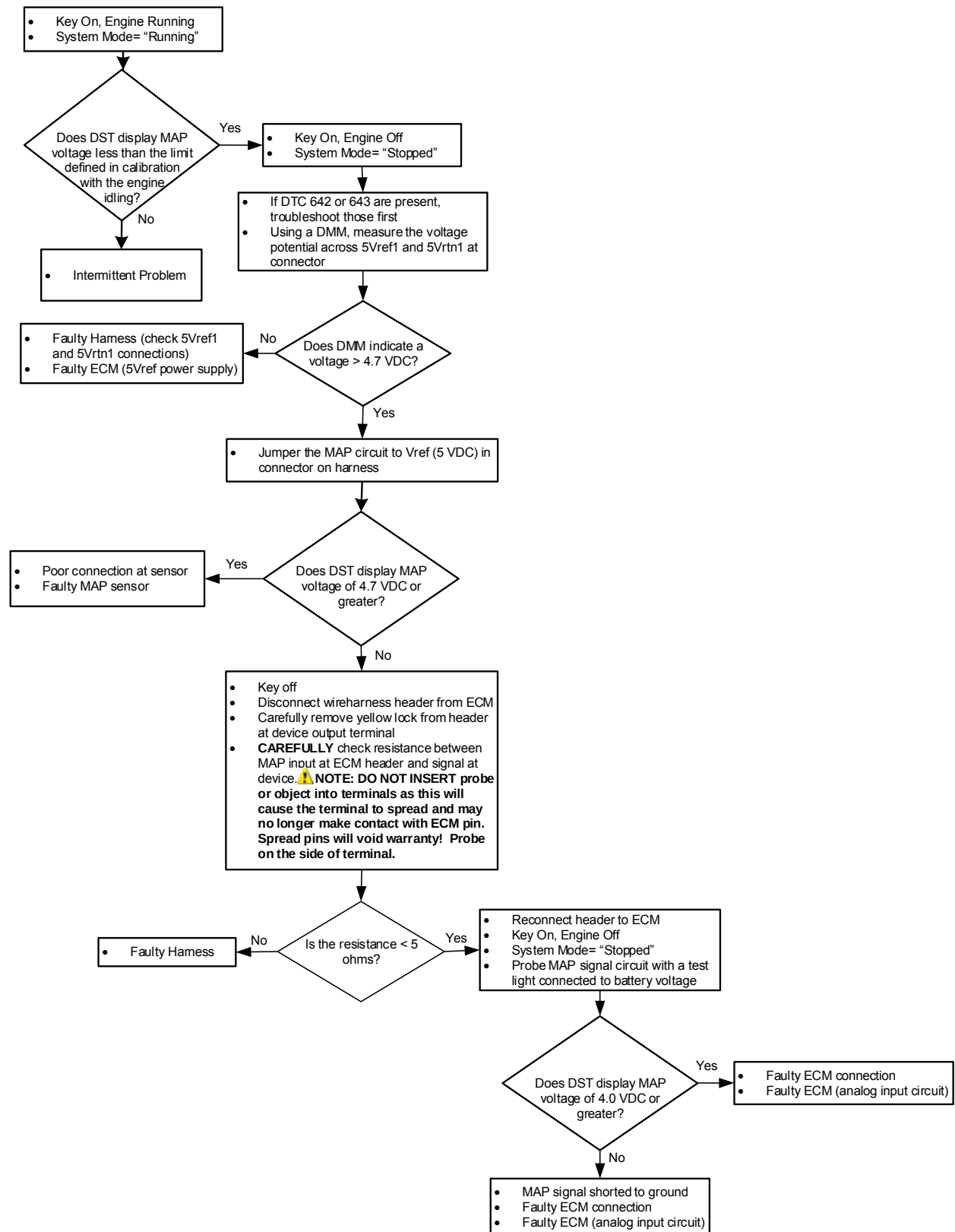
DTC 92 - FP (FUEL PRESSURE) HIGH VOLTAGE (TROUBLE TREE)

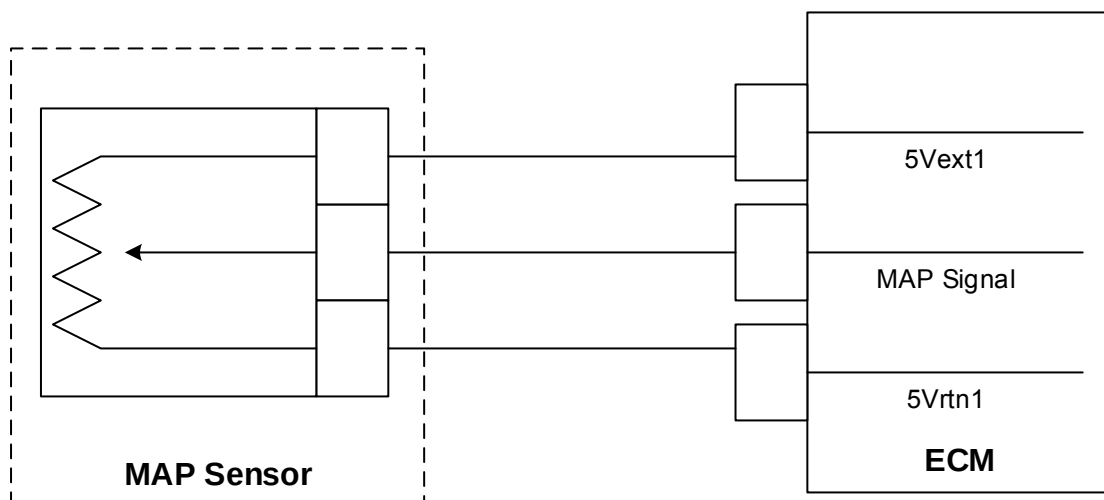
DTC 107 - MAP LOW VOLTAGE

DTC	107	SPN	106	FMI	4
Hardware: Manifold Absolute Pressure Sensor					
Hardware Description: The Manifold Absolute Pressure sensor is a pressure transducer connected to the intake manifold. It is used to measure the pressure of air in the manifold prior to induction into the engine. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the engine, which thereby determines the required fuel flow rate.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Cranking or Running			
Fault Set Conditions (as defined in calibration):					
• MAP voltage <				TBD*	volts
• and TPS >				TBD*	%
• and RPM <				TBD*	rpm
• to unlatch, MAP voltage must be >				TBD*	volts
Possible Causes: This fault will set when the MAP sensor voltage feedback is sensed as lower than what the sensor should normally produce as set in the diagnostic calibration. The limit is generally set at 0.10 VDC. In many cases, this condition is caused by the MAP sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the MAP circuit in the wire harness, a loss of sensor reference voltage, or a failure of the sensor. When this fault occurs, the ECM operates in a limp home mode in which an estimated MAP based on TPS feedback is used to fuel the engine. If the MAP sensor is integrated in a TMAP sensor and an IAT High Voltage fault (DTC 113) is also present, the sensor is likely disconnected from the wire harness.					

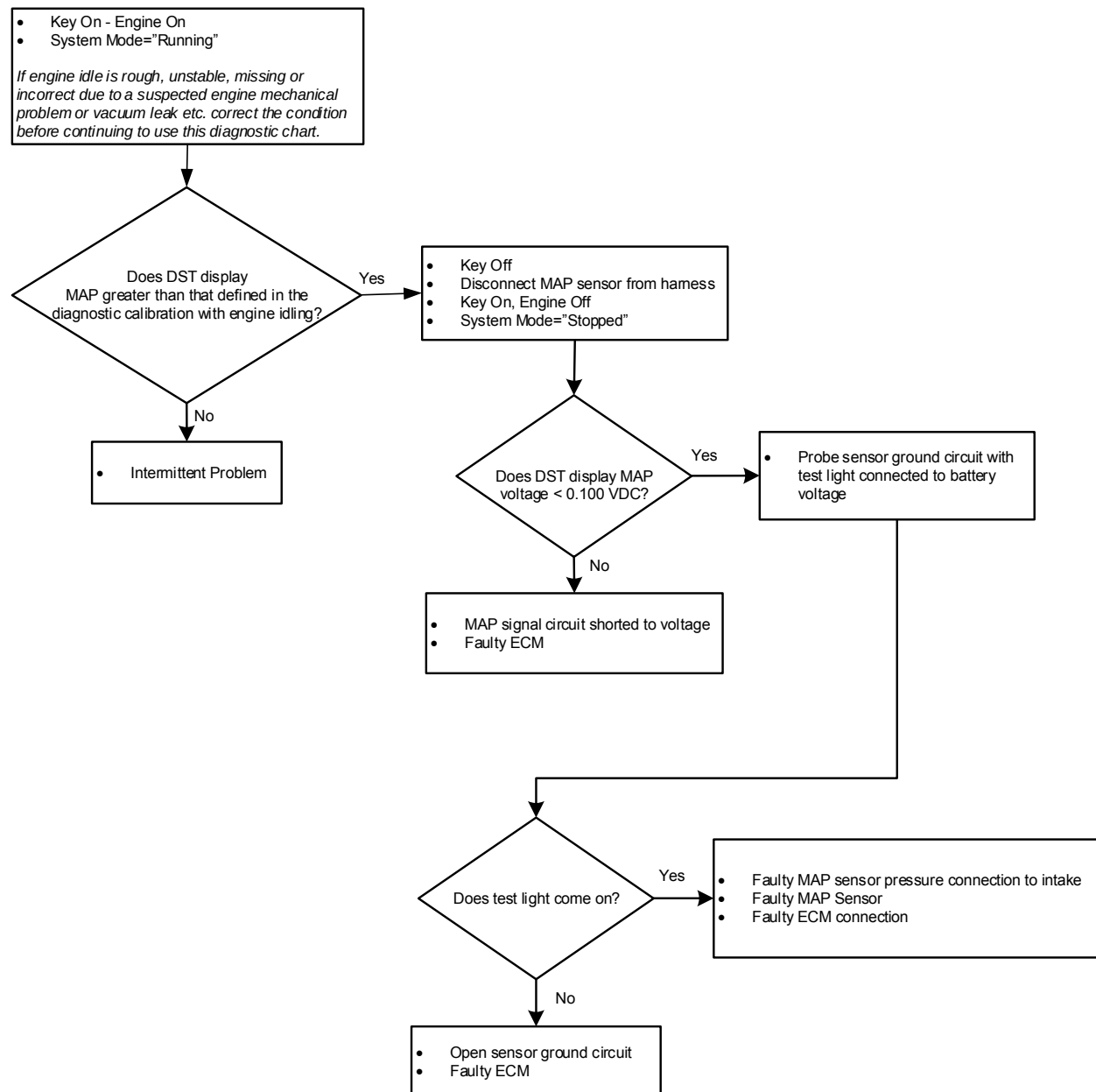
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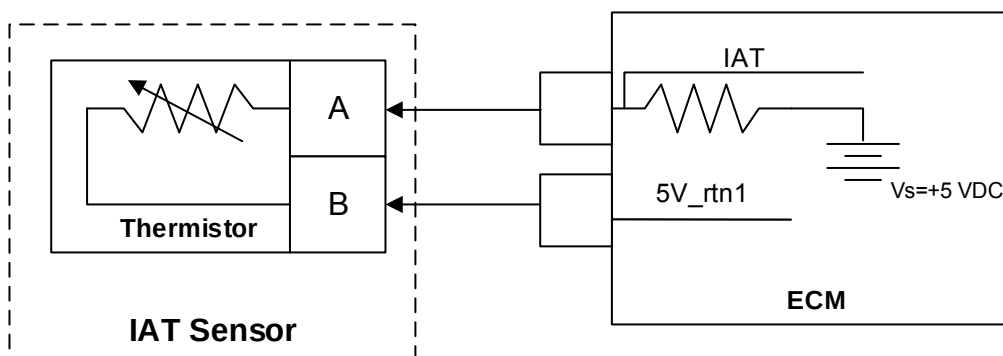
<i>Corrective Actions</i> (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 107 - MAP LOW VOLTAGE (Trouble Tree)

DTC 108 - MAP HIGH PRESSURE

DTC	108	SPN	106	FMI	16		
Hardware: Manifold Absolute Pressure Sensor							
Hardware Description: The Manifold Absolute Pressure sensor is a pressure transducer connected to the intake manifold. It is used to measure the pressure of air in the manifold prior to induction into the engine. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the engine, which thereby determines the required fuel flow rate.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Cranking or Running					
Fault Set Conditions (as defined in calibration):							
• MAP pressure >				TBD*	psia		
• and TPS <				TBD*	%		
• and RPM >				TBD*	rpm		
• to unlatch, MAP pressure must be <				TBD*	psia		
Possible Causes: This fault will set when the MAP reading is higher than it should be for the given TPS, and RPM. When the fault is set the engine will typically operate in a limp home mode using an estimated MAP based on TPS feedback.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 108 - MAP HIGH PRESSURE (Trouble Tree)

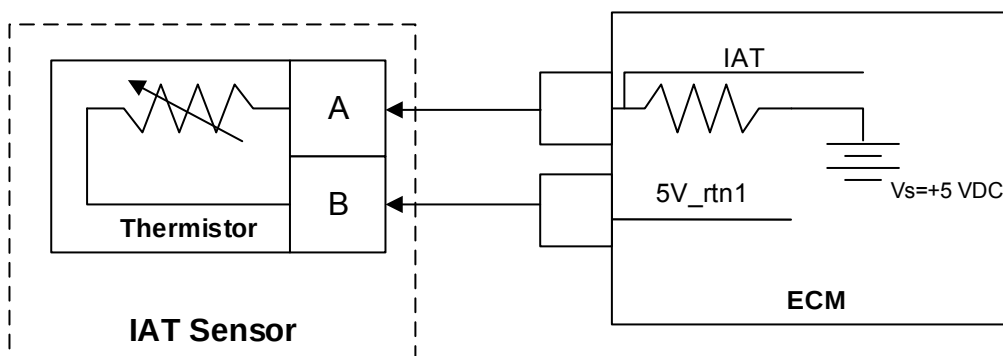
DTC 111 - IAT HIGHER THAN EXPECTED STAGE 1

DTC	111	SPN	105	FMI	15		
Hardware: Intake Air Temperature Sensor							
Hardware Description: The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• run-time wait for all IAT HiExp faults:				TBD*	seconds		
• IAT >				TBD*	deg F		
• and RPM >				TBD*	rpm		
Possible Causes: This fault will set if the Intake Air Temperature is greater than the stage 1 limit and the operating condition is at a speed greater than defined in the diagnostic calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

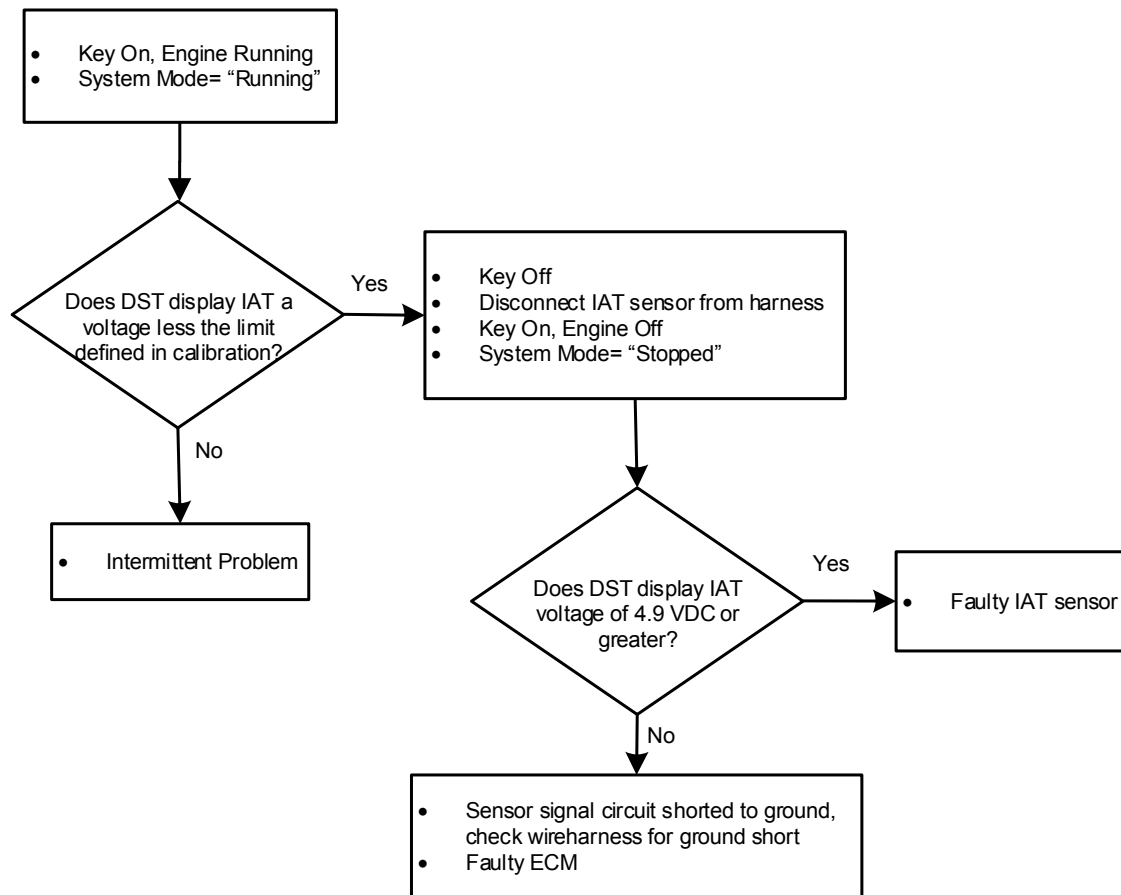
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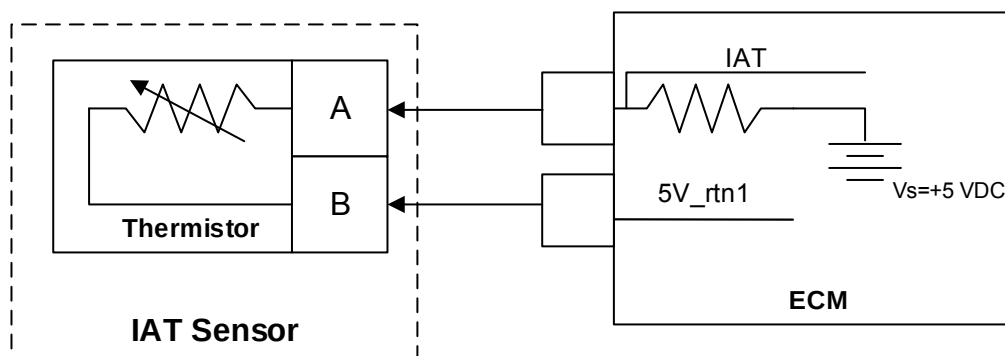
Diagnostic Aids

- ☐ This fault will set when inlet air is hotter than normal. The most common cause of high inlet air temperature is a result of a problem with routing of the inlet air. Ensure inlet plumbing sources are external, is cool, and is not too close to the exhaust at any point.
- ☐ Inspect the inlet air system for cracks or breaks that may allow unwanted underhood air to enter the engine.
- ☐ If no problem is found, replace the IAT sensor with a known good part and retest.

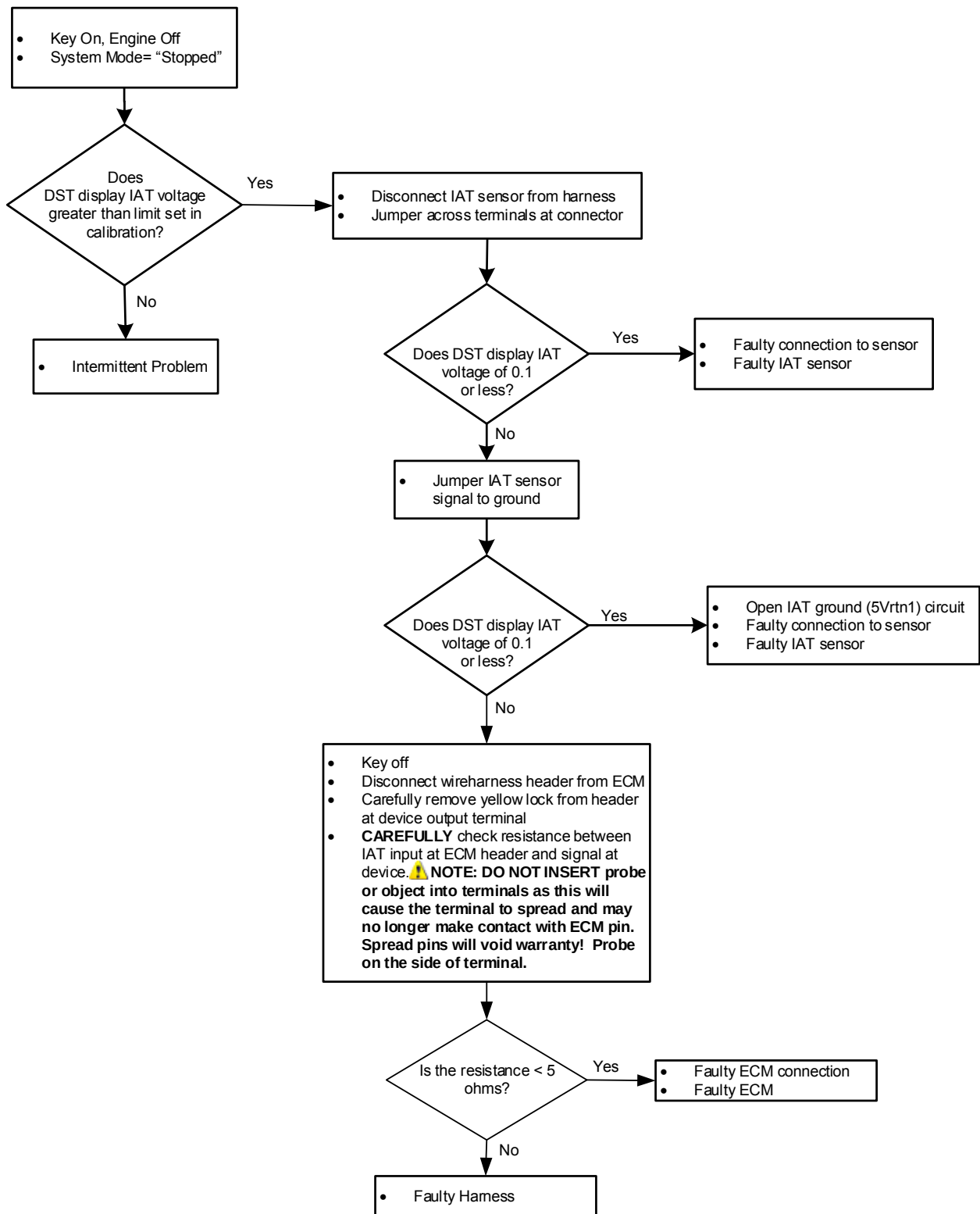
DTC 112 - IAT LOW VOLTAGE

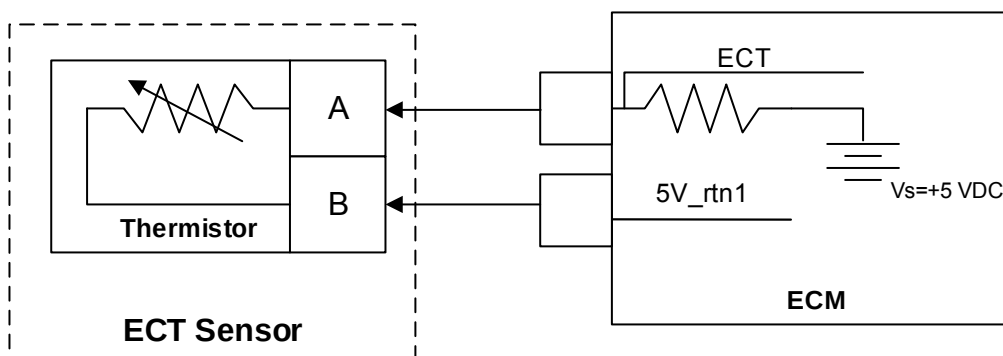
DTC	112	SPN	105	FMI	4		
Hardware: Intake Air Temperature Sensor							
Hardware Description: The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			NO				
Check Condition:			Engine Running				
Fault Set Conditions (as defined in calibration):							
• IAT voltage <				TBD*	volts		
Possible Causes: This fault will set if the signal voltage is less than the low voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 0.100 VDC. The ECM will use a default value for the IAT sensor in the event of this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 112 - IAT LOW VOLTAGE (Trouble Tree)

DTC 113 - IAT HIGH VOLTAGE

DTC	113	SPN	105	FMI	3		
Hardware: Intake Air Temperature Sensor							
Hardware Description: The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• IAT voltage >				TBD*	volts		
Possible Causes: This fault will set if the signal voltage is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the IAT sensor being disconnected from the engine harness, an open-circuit or short-to-power of the IAT circuit in the wireharness, or a failure of the sensor. The ECM will use a default value for the IAT sensor in the event of this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 113 - IAT HIGH VOLTAGE (Trouble Tree)

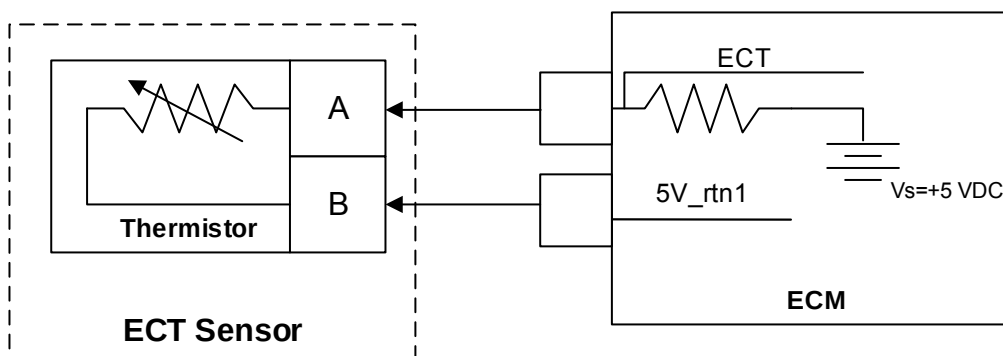
DTC 116 - ECT HIGHER THAN EXPECTED (STAGE 1)

DTC	116	SPN	110	FMI	15		
Hardware: Engine Coolant Temperature Sensor							
Hardware Description: The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• ECT >				TBD*	deg F		
• and RPM >				TBD*	rpm		
• and run-time >				TBD*	seconds		
Possible Causes: When the coolant exceeds <u>x</u> deg. F and engine RPM exceeds <u>y</u> RPM for the latch time this fault will set, in order to help protect the engine in the event of over temperature.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

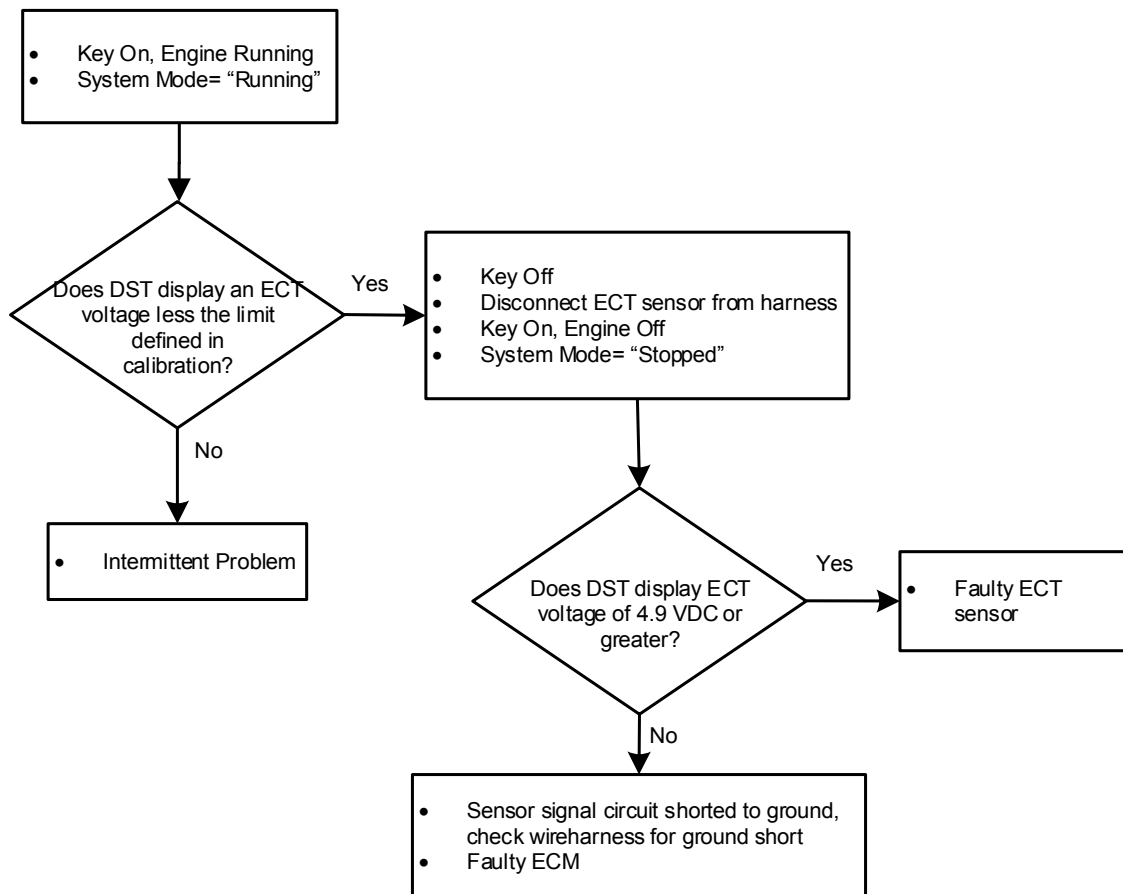
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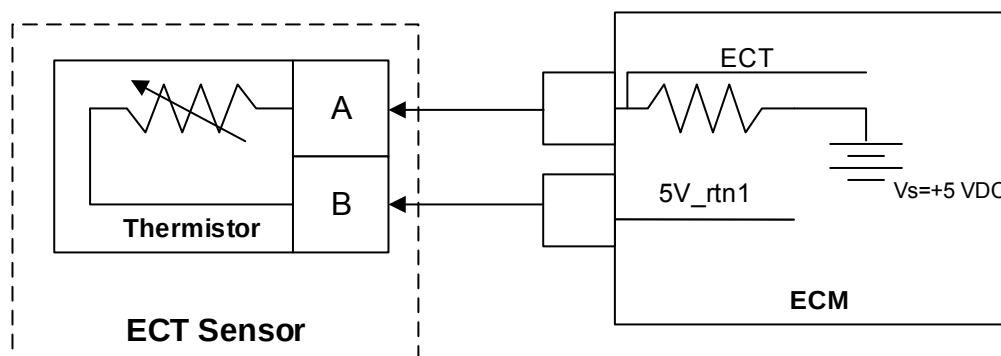
Diagnostic Aids

- ☐ If the “ECT High Voltage” fault is also present, follow the troubleshooting procedures for that fault as it may have caused “ECT Higher Than Expected 1.”
- ☐ If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:
 - o Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking.
 - o Ensure that there is no trapped air in the cooling path.
 - o Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free.
 - o Check that the fan is operating properly.
 - o Check that the thermostat is not stuck closed.
- ☐ If the cooling system utilizes a water-to-water heat exchanger:
 - o Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking.
 - o Ensure that there is no trapped air in the cooling path.
 - o Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free.
 - o Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected.
 - o Check that the thermostat is not stuck closed.
 - o Check that the raw water pump/impeller is tact and that it is not restricted.

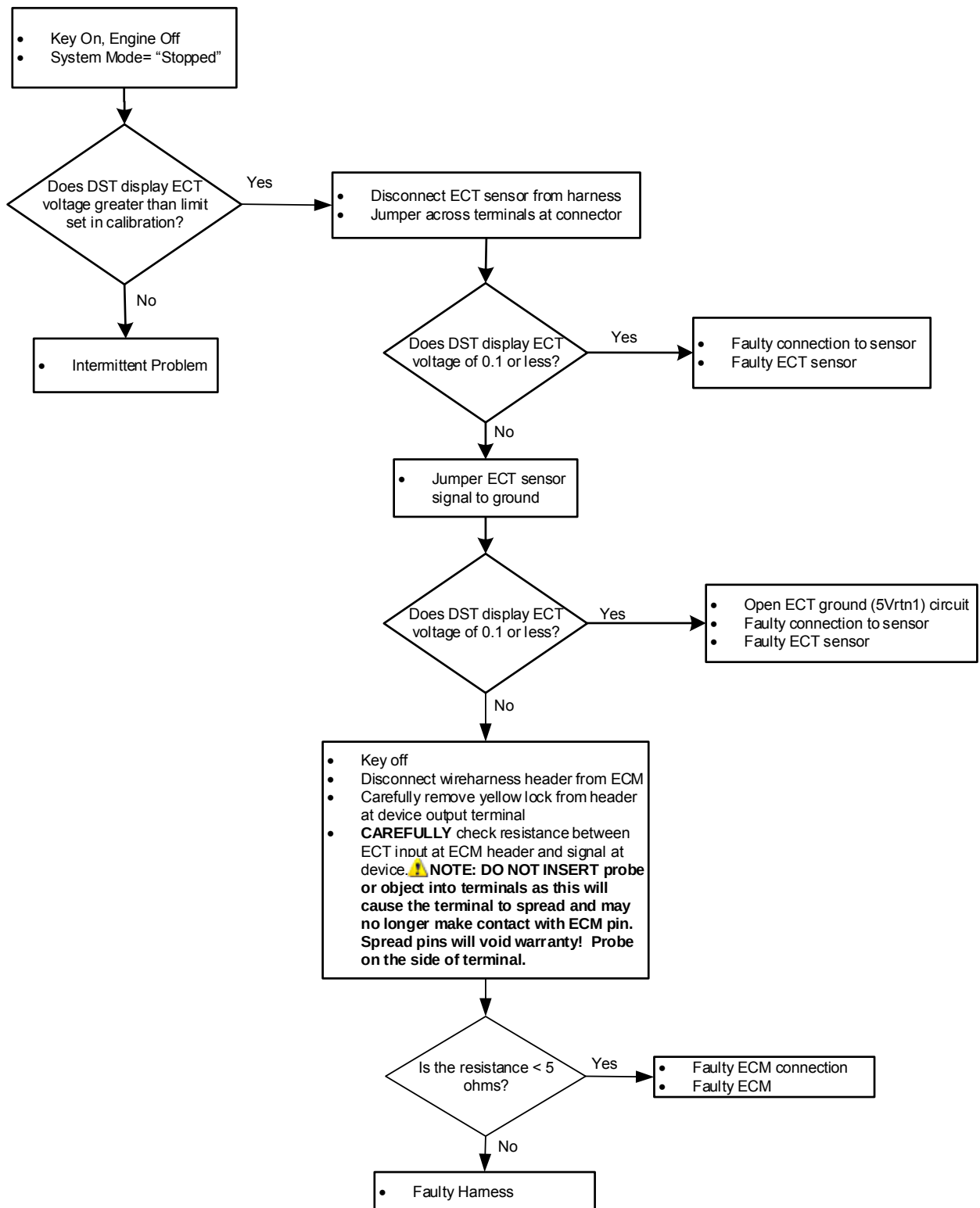
DTC 117 - ECT / CHT LOW VOLTAGE

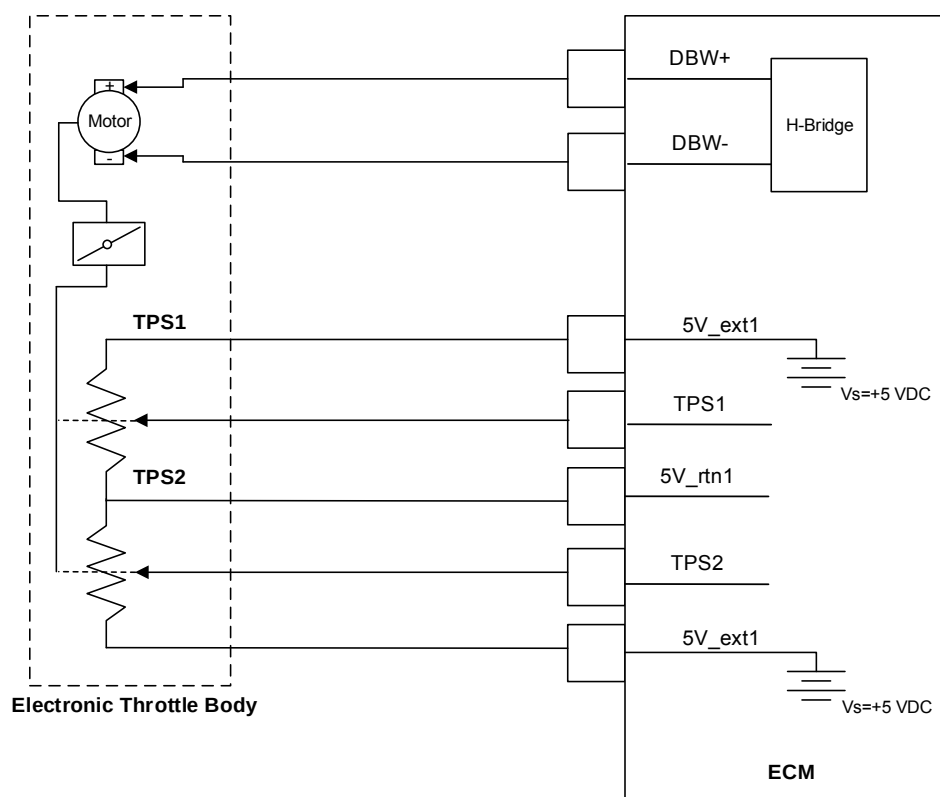
DTC	116	SPN	110	FMI	4		
Hardware: Engine Coolant Temperature Sensor							
Hardware Description: The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• ECT voltage <				TBD*	volts		
Possible Causes: This fault will set if the signal voltage is less than the limit defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 0.10 VDC. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 117 - ECT / CHT LOW VOLTAGE (Trouble Tree)

DTC 118 - ECT / CHT HIGH VOLTAGE

DTC	116	SPN	110	FMI	3		
Hardware: Engine Coolant Temperature Sensor							
Hardware Description: The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			NO				
Check Condition:			Engine Running				
Fault Set Conditions (as defined in calibration):							
• ECT voltage >				TBD*	volts		
Possible Causes: This fault will set if the signal voltage is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the CHT/ECT sensor being disconnected from the engine harness, an open-circuit or short-to-power of the CHT/ECT circuit in the wire harness, or a failure of the sensor. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

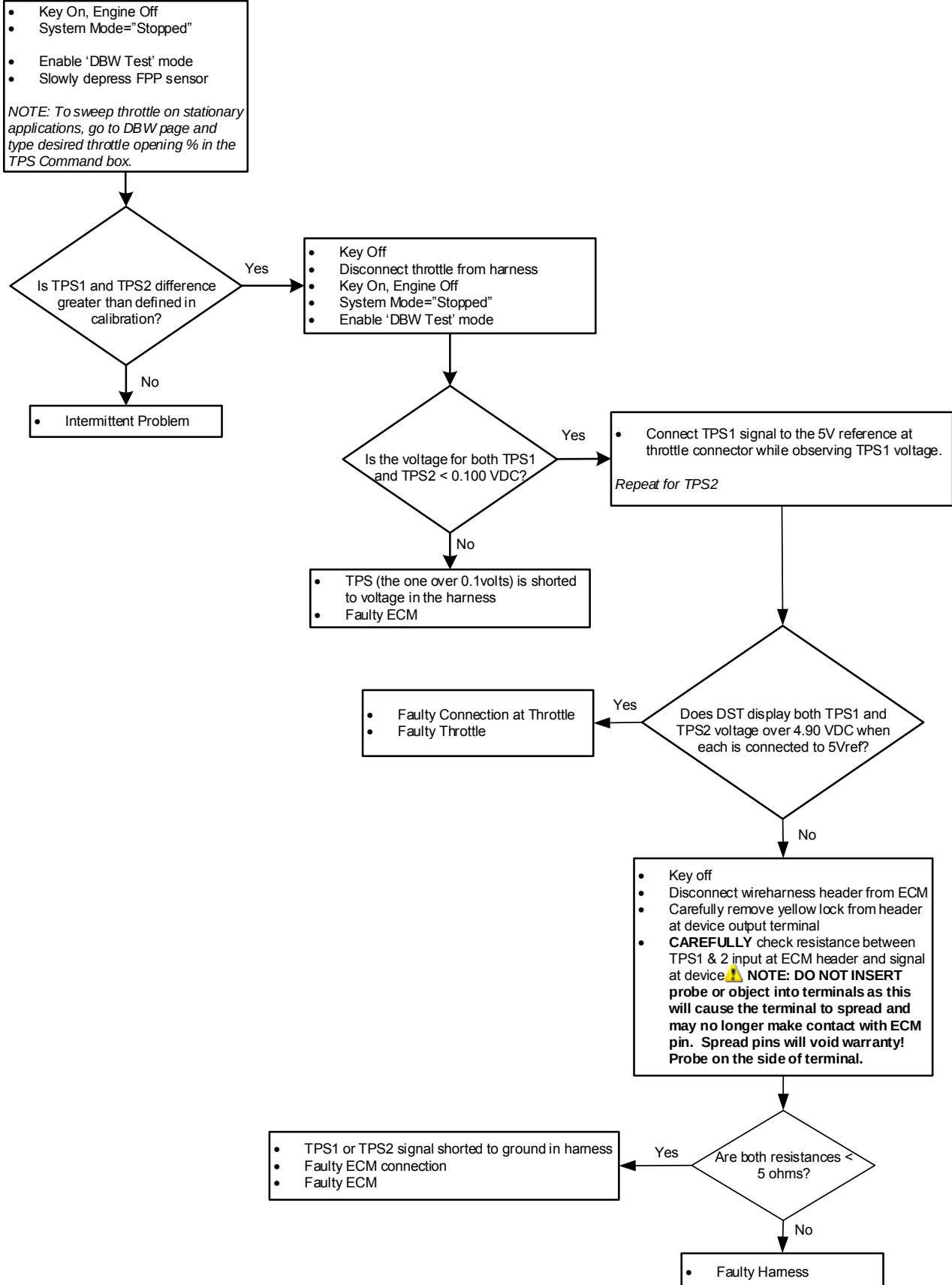
DTC 118 - ECT / CHT HIGH VOLTAGE (Trouble Tree)

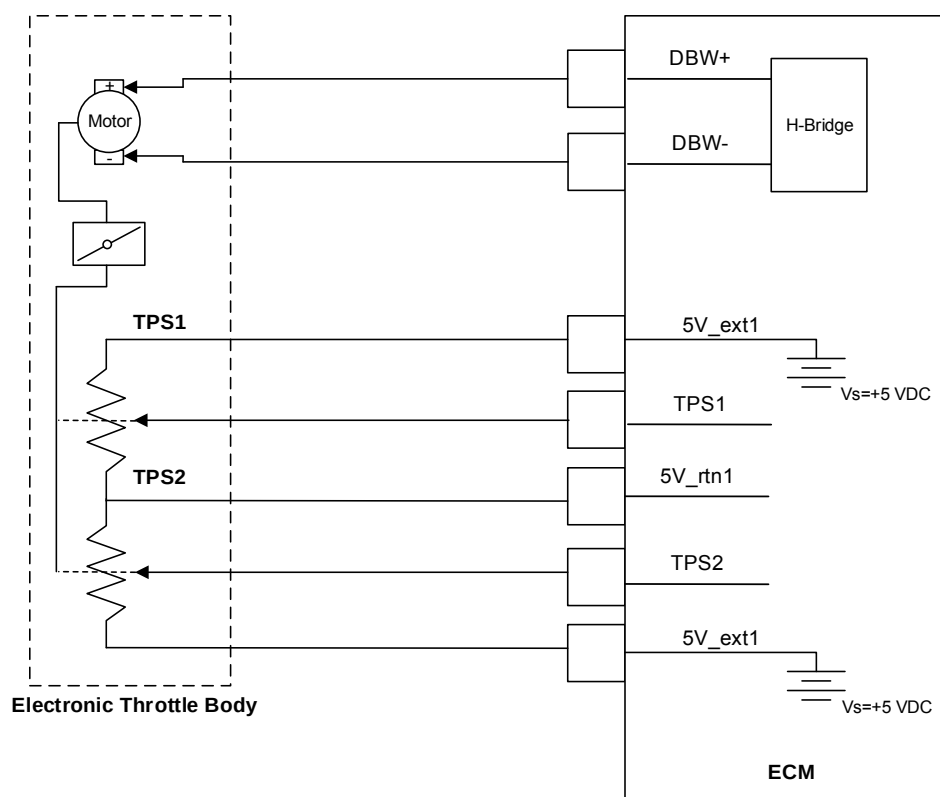
DTC 121 – TPS1 % LOWER THAN TPS2 %

DTC	121	SPN	51	FMI	1
Hardware: Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)					
Hardware Description: The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions. The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In mechanical throttle bodies this sensor is typically used to help improve return-to-idle governing when working in combination with an Idle Air Control motor. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine Cranking, or Running			

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Fault Set Conditions (as defined in calibration):							
• (TPS1% - TPS2%) <				TBD*		volts	
Possible Causes: This fault will set if TPS1 % is lower than TPS2 % by the amount defined in the diagnostic calibration. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

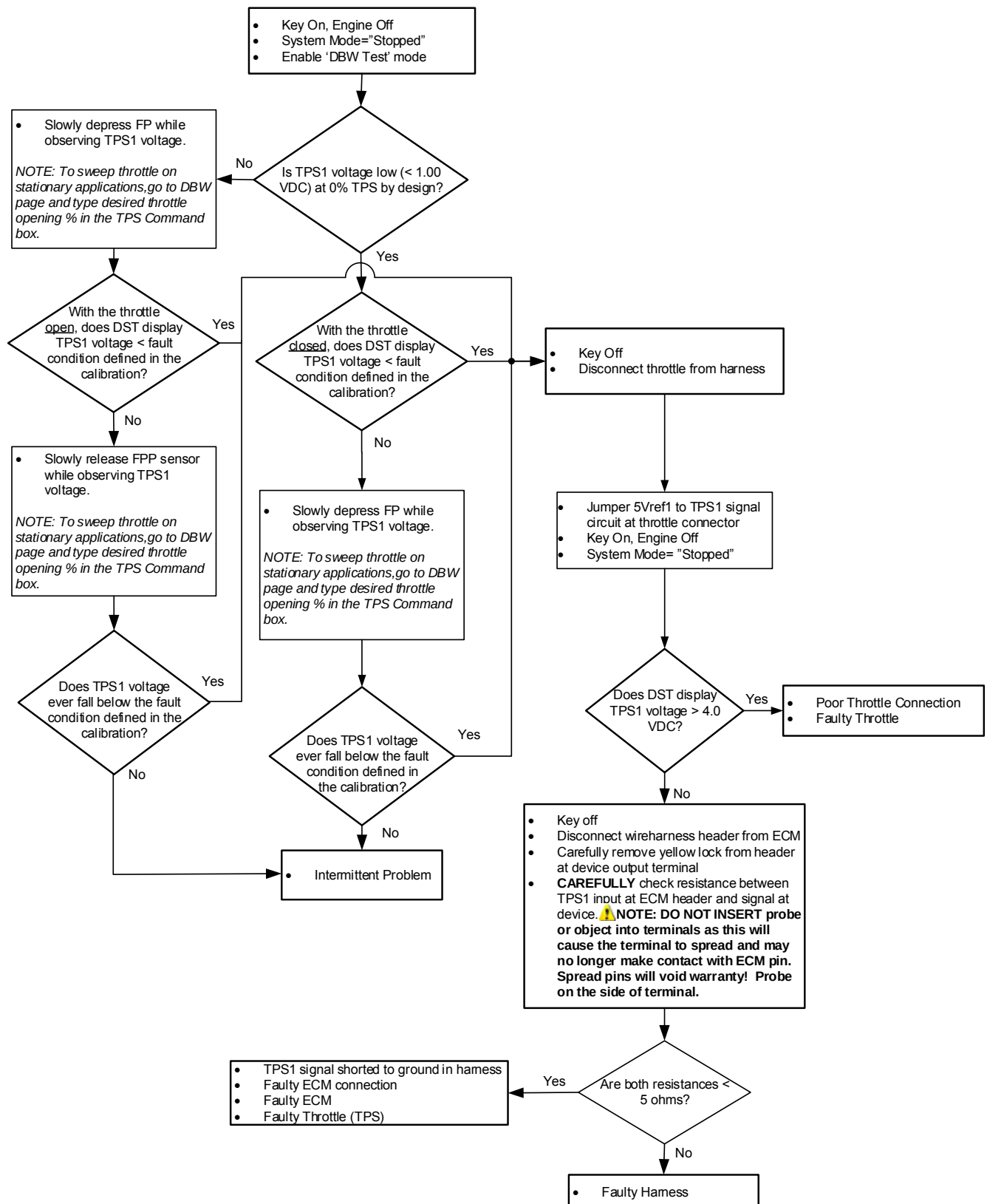
DTC 121 – TPS1 % LOWER THAN TPS2 % (Trouble Tree)

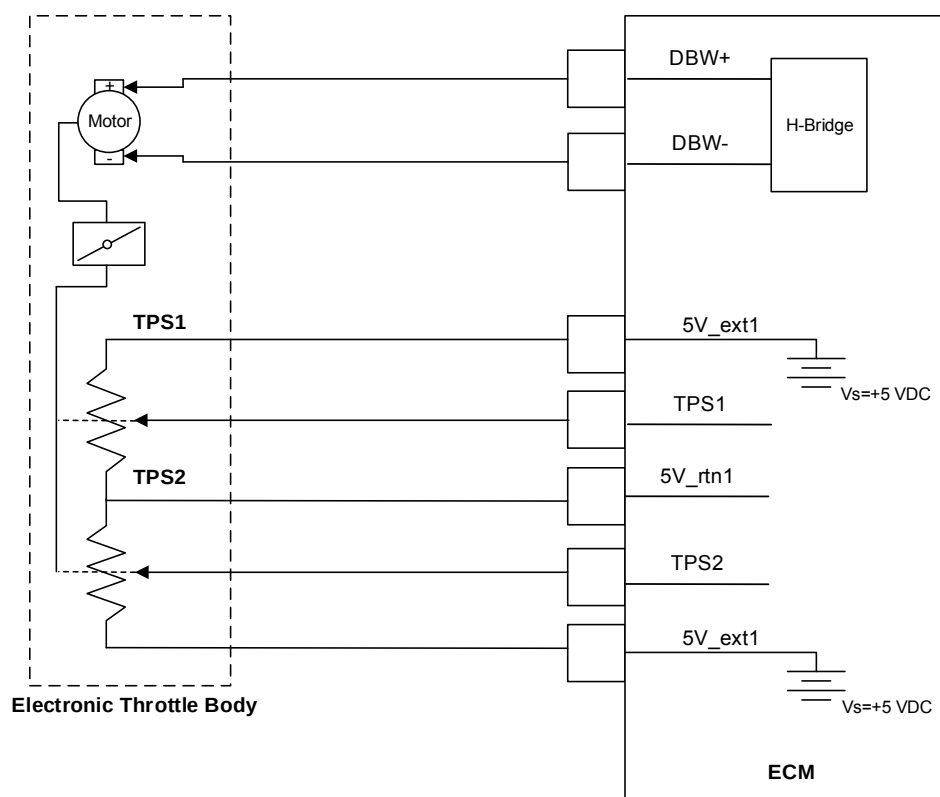
DTC 122 - TPS1 SIGNAL VOLTAGE LOW

DTC	122	SPN	51	FMI	4
Hardware: Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)					
Hardware Description: The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions. The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In mechanical throttle bodies this sensor is typically used to help improve return-to-idle governing when working in combination with an Idle Air Control motor. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			

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Fault Set Conditions (as defined in calibration):							
• TPS1 voltage <				TBD*		volts	
Possible Causes:							
This fault will set if TPS1 voltage is lower than the low voltage limit as defined in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the TPS sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TPS circuit in the wire harness, or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

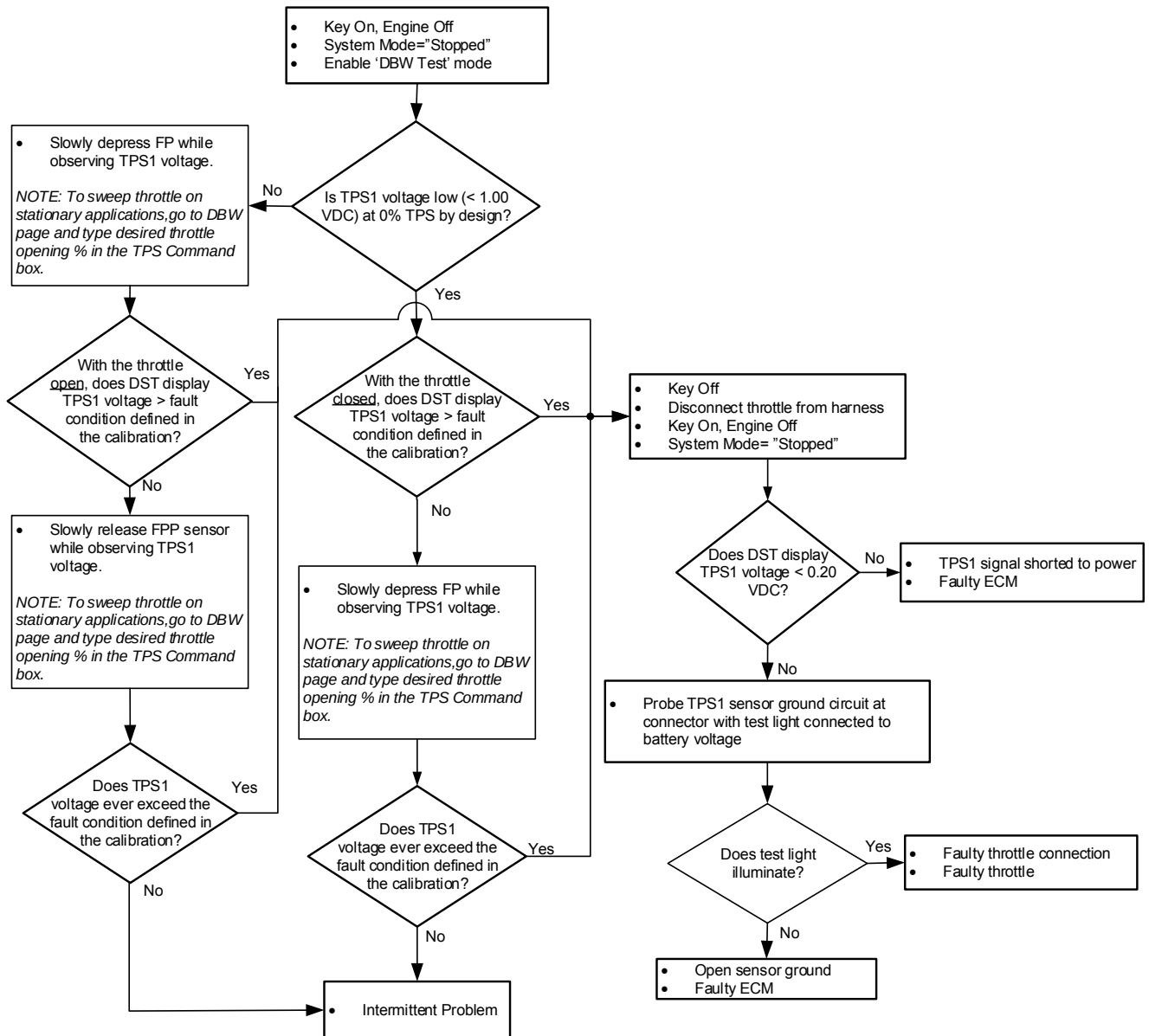
DTC 122 - TPS1 SIGNAL VOLTAGE LOW (Trouble Tree)

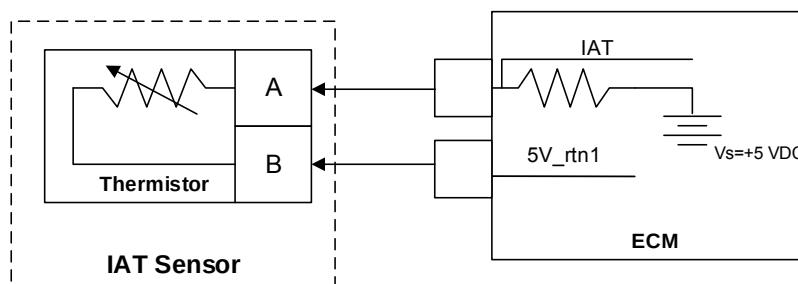
DTC 123 - TPS1 SIGNAL VOLTAGE HIGH

DTC	122	SPN	51	FMI	3
Hardware: Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)					
Hardware Description: The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions. The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In mechanical throttle bodies this sensor is typically used to help improve return-to-idle governing when working in combination with an Idle Air Control motor. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			

(continued from previous page)

Fault Set Conditions (as defined in calibration):							
• TPS1 voltage >				TBD*		volts	
Possible Causes: This fault will set if TPS1 voltage is higher than the limit set in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the TPS circuit in the wireharness or a failure of the sensor.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 123 - TPS1 HIGH VOLTAGE (Trouble Tree)

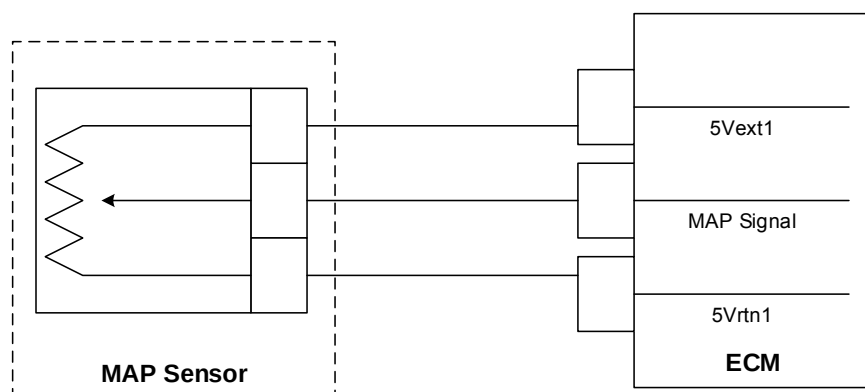
DTC 127 - IAT HIGHER THAN EXPECTED STAGE 2

DTC	127	SPN	105	FMI	0		
Hardware: Intake Air Temperature Sensor							
Hardware Description: The Intake Air Temperature sensor is a thermistor (temperature sensitive resistor) located in the intake manifold of the engine. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine. The ECM provides a voltage divider circuit so that when the air is cool, the signal reads higher voltage, and lower when warm. The Manifold Air Temperature is a calculated value based mainly on the IAT sensor at high airflow and influenced more by the ECT/CHT at low airflow. It is used to monitor incoming air and the output, in conjunction with other sensors, is used to determine the airflow to the engine, and ignition timing.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• IAT >				TBD*	deg F		
• and RPM >				TBD*	rpm		
Possible Causes: This fault will set if the Intake Air Temperature is greater than the stage 2 limit and engine speed is greater than defined in the diagnostic calibration. Generally, a severe course of action will be set to prevent possible damage to the engine, specifically due to knock or detonation which cannot be sensed on some engines due to the lack of knock sensors. During this active fault, maximum throttle position is limited and a visual/audible warning will be activated.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

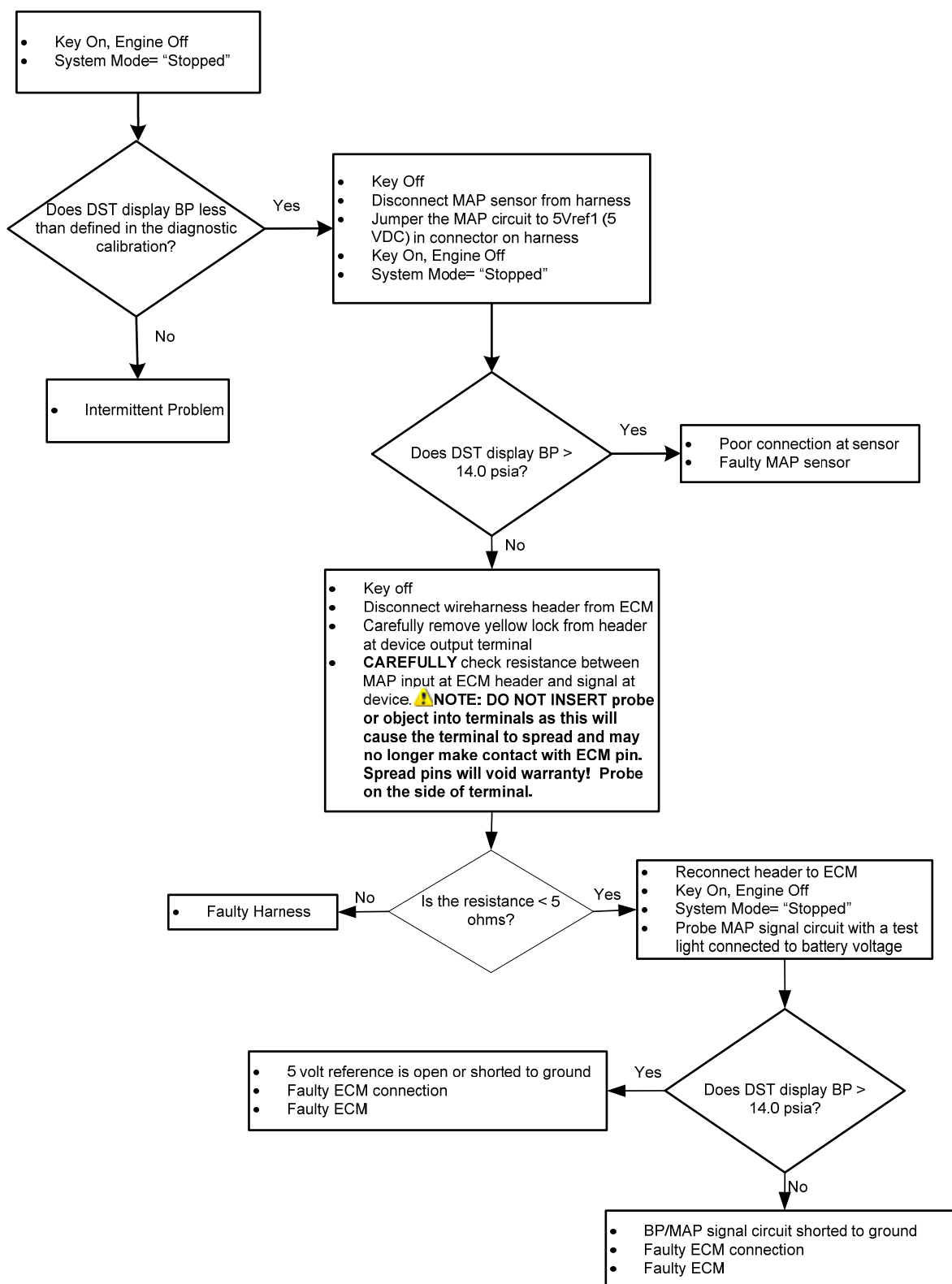
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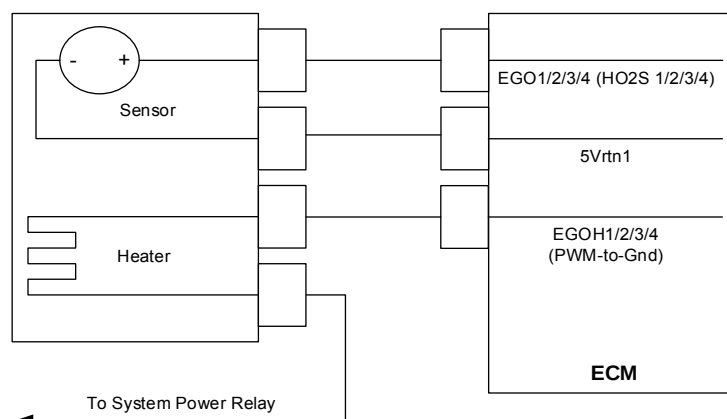
Diagnostic Aids

- ☐ This fault will set when inlet air is hotter than normal. The most common cause of high inlet air temperature is a result of a problem with routing of the inlet air. Ensure inlet plumbing sources are external, is cool, and is not too close to the exhaust at any point.
- ☐ Inspect the inlet air system for cracks or breaks that may allow unwanted under-hood air to enter the engine.
- ☐ If no problem is found, replace the IAT sensor with a known good part and retest.

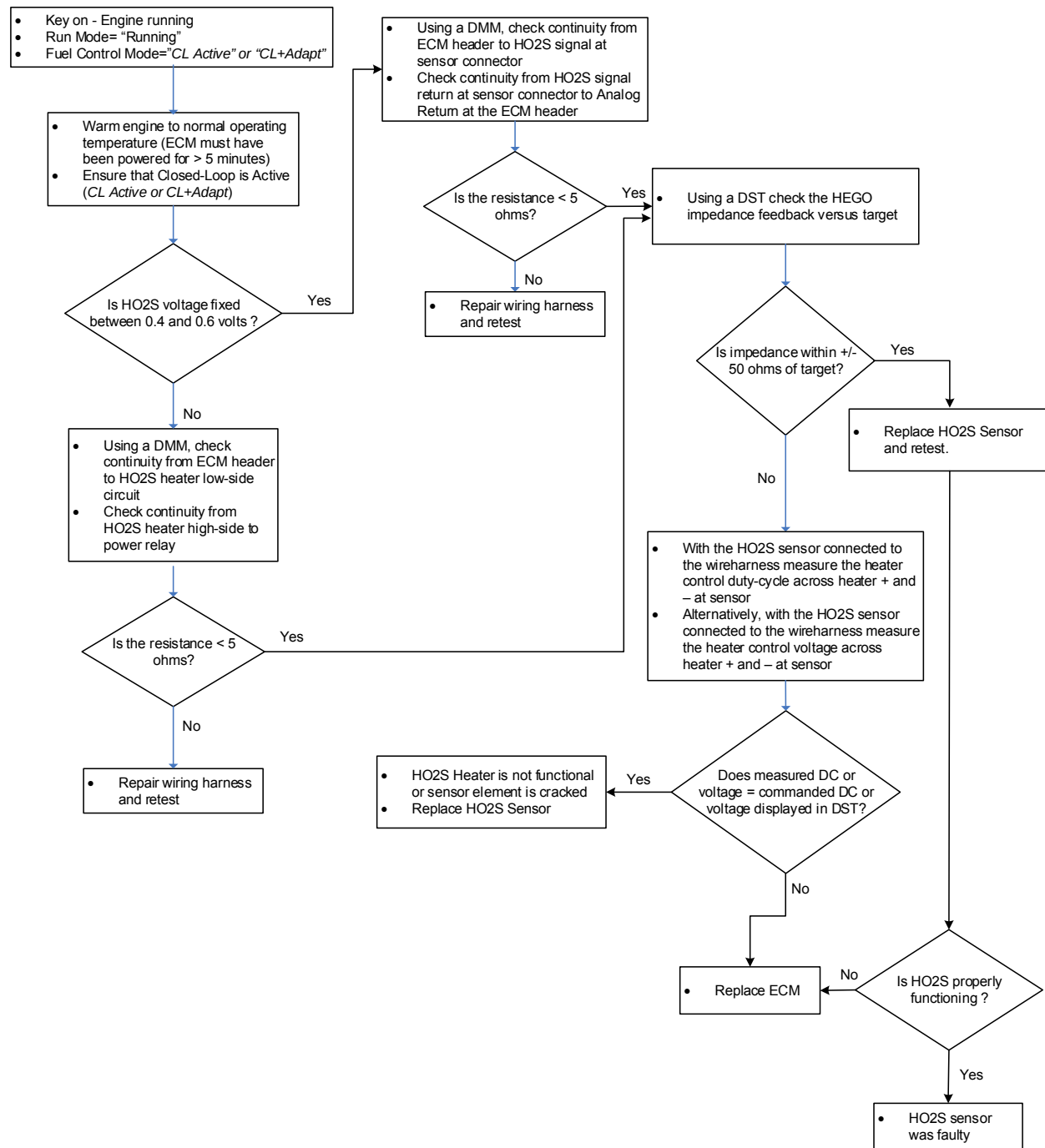
DTC 129 - BP LOW PRESSURE

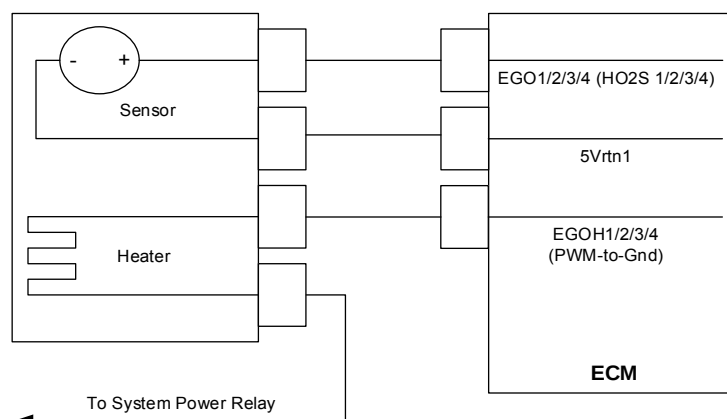
DTC	129	SPN	108	FMI	1		
Hardware: Barometric Temperature / Manifold Absolute Pressure Sensor							
Hardware Description: Barometric Pressure is estimated from the MAP sensor at key-on and in some calibrations during low speed/high load operation as defined in the engine’s calibration. The barometric pressure value is used for fuel and airflow calculations and equivalence ratio targets based on altitude.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Off or after BP estimate during low-speed/high load operation					
Fault Set Conditions (as defined in calibration):							
• BP pressure <				TBD*	psia		
Possible Causes: This fault sets if the barometric pressure is lower than <u>the minimum set pressure (psia)</u> as defined in the diagnostic calibration. In the event of an active fault, the MIL is illuminated for the remainder of the key on cycle, an audible warning and/or a secondary warning lamp is activated, and the Adaptive Learn function is disabled to prevent improper learning and population of the table.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 129 - BP LOW PRESSURE (Trouble Tree)

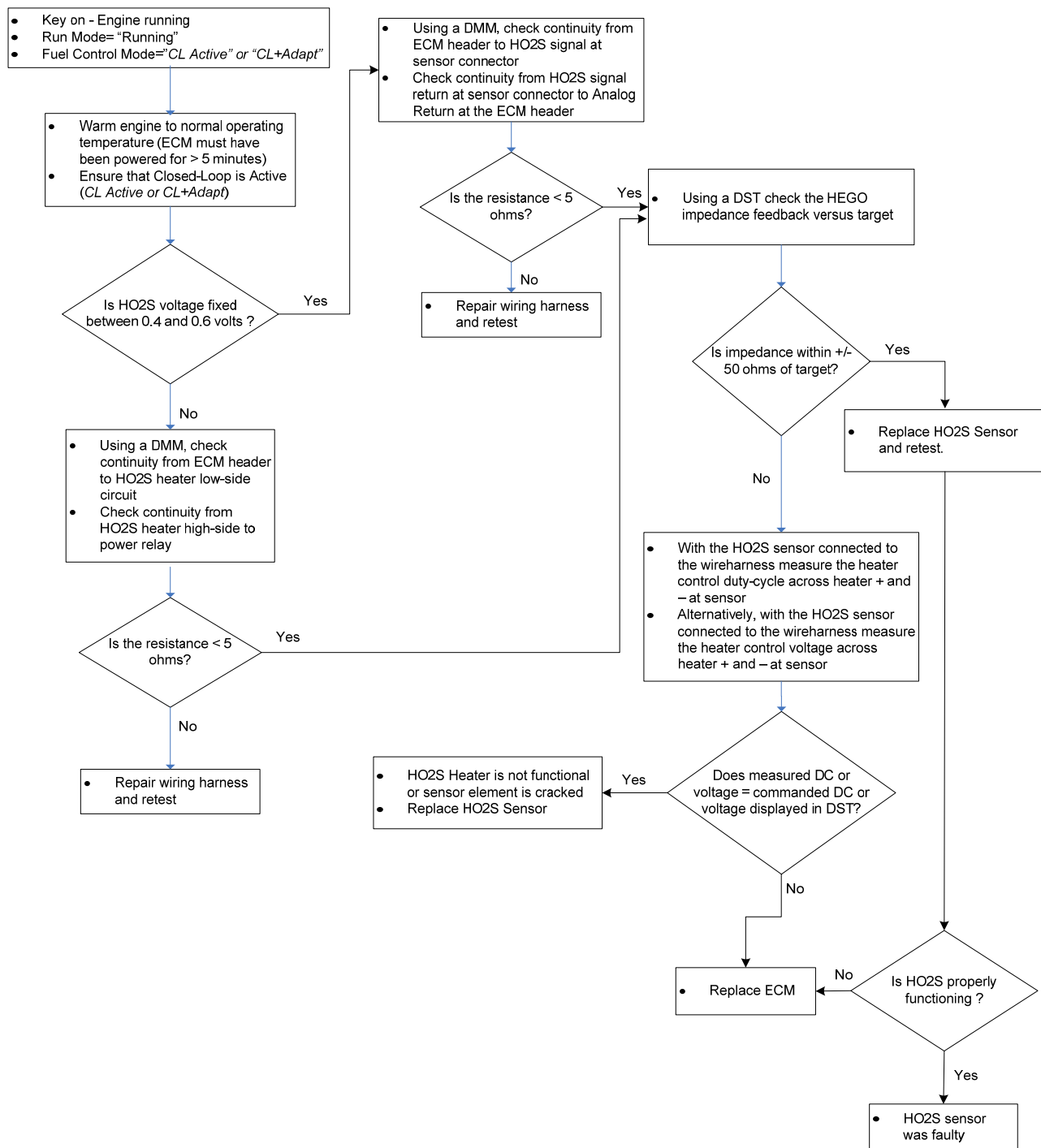
DTC 134 – EGO1 OPEN / LAZY (HO2S1)

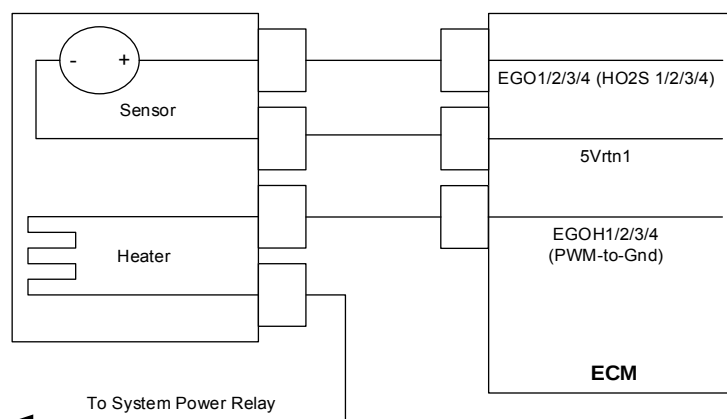
DTC	134	SPN	3217	FMI	5		
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)							
Hardware Description: The HEGO/HO2S sensor is a switching-type sensor about stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear analog output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			YES				
Check Condition:			Engine Running				
Fault Set Conditions (as defined in calibration):							
• EGO cold persistently >				TBD*	seconds		
Possible Causes: This fault will set if the sensor element is cold, non-responsive, or inactive for x seconds as defined in the diagnostic calibration. Cold, non-responsive, or inactive are determined based on two criteria 1) a measurement of the feedback sense element (zirconia) to determine its temperature or 2) a lack of change in sensor feedback.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 134 – EGO1 OPEN / LAZY (HO2S1) (Trouble Tree)

DTC 140 – EGO3 OPEN / LAZY (HO2S3)

DTC	140	SPN	3256	FMI	5		
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 2/After Catalyst)							
Hardware Description: In a post-catalyst configuration the HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either “CL Active” or “CL + Adapt” control modes.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			YES				
Check Condition:			Engine Running				
Fault Set Conditions (as defined in calibration):							
• EGO cold persistently >				TBD*	seconds		
Possible Causes: This fault will set if the sensor element is cold, non-responsive, or inactive for x seconds as defined in the diagnostic calibration. Cold, non-responsive, or inactive are determined based on two criteria 1) a measurement of the feedback sense element (zirconia) to determine its temperature or 2) a lack of change in sensor feedback.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 140 – EGO3 OPEN / LAZY (HO2S3) (Trouble Tree)

DTC 154 – EGO2 OPEN / LAZY (HO2S2)

DTC	154	SPN	3227	FMI	5
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 2/Bank 1- After Catalyst or Bank2-Sensor 1/Bank 2- Before Catalyst)					
Hardware Description: In a pre-catalyst configuration the HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. In a post-catalyst configuration the HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either “CL Active” or “CL + Adapt” control modes.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• EGO cold persistently >				TBD*	Seconds

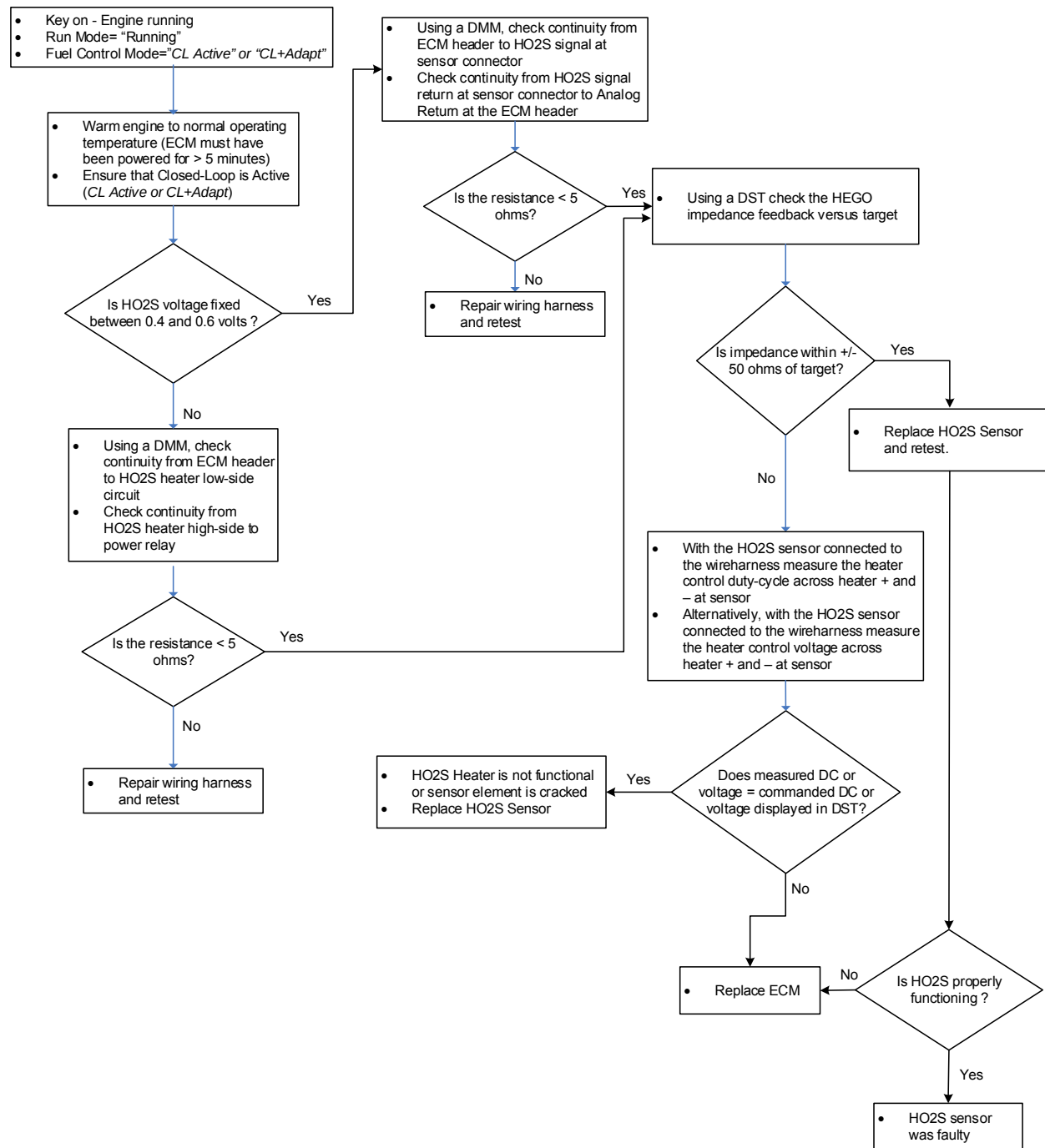
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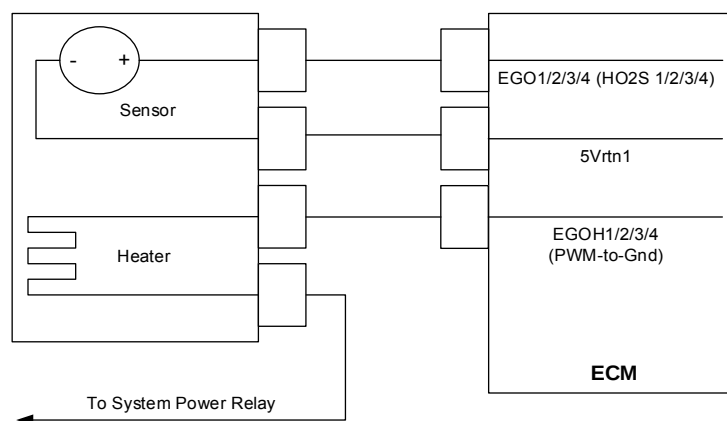
Possible Causes:

This fault will set if the sensor element is cold, non-responsive, or inactive for $\underline{x}$ seconds as defined in the diagnostic calibration. Cold, non-responsive, or inactive are determined based on two criteria 1) a measurement of the feedback sense element (zirconia) to determine its temperature or 2) a lack of change in sensor feedback. If used as a pre-catalyst sensor, this fault should disable closed-loop when it is active and adaptive learn for the key-cycle.

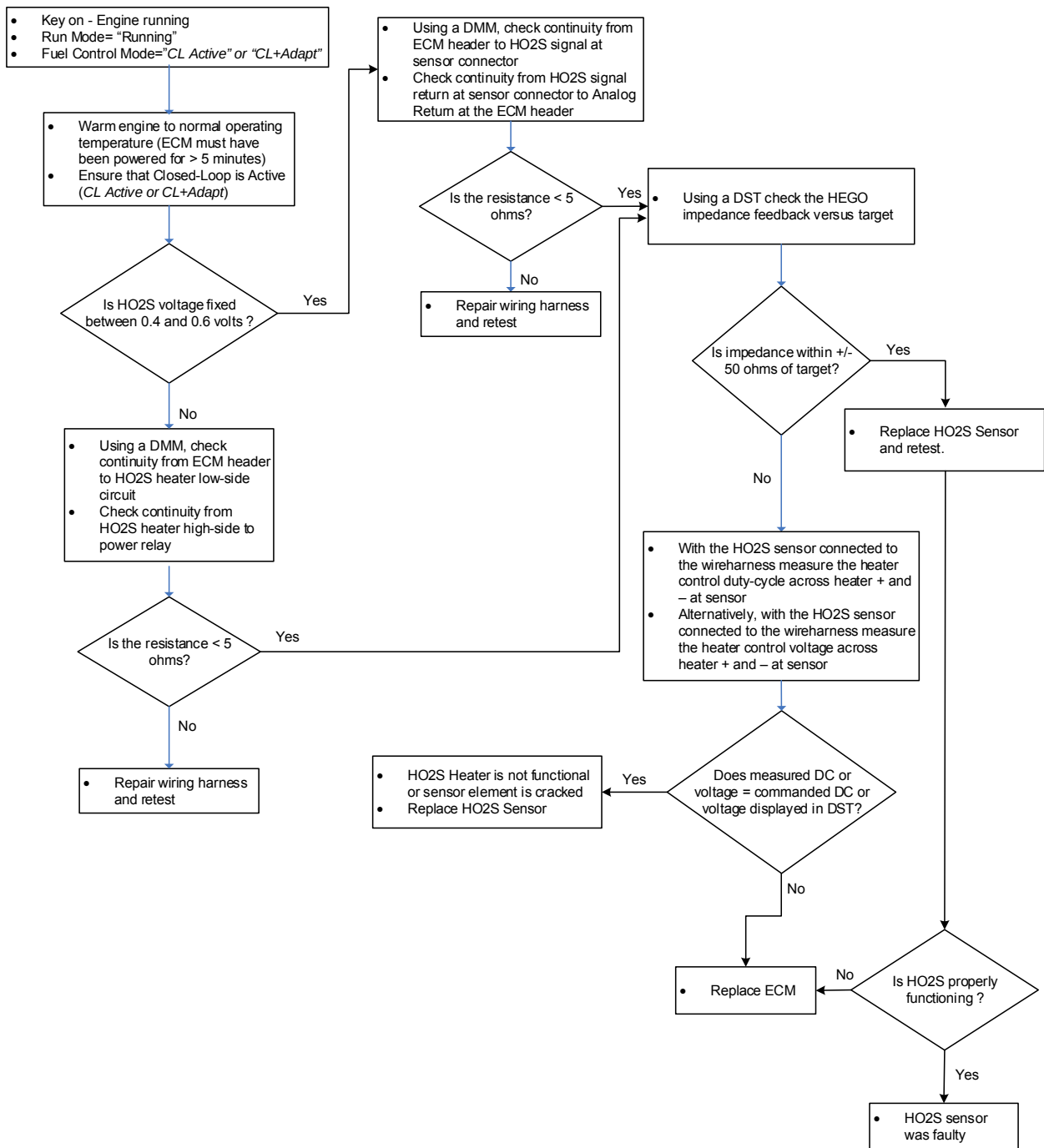
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

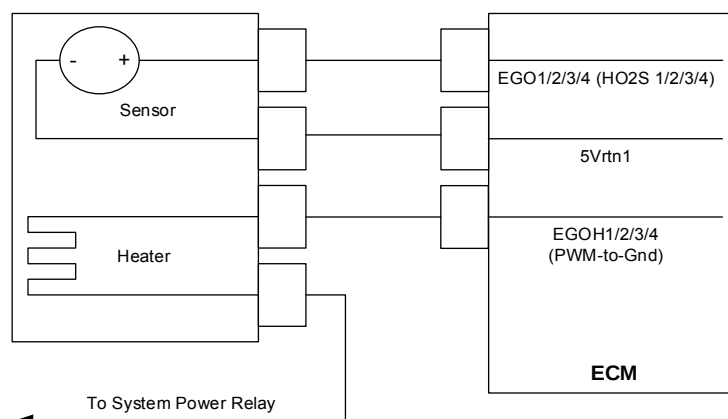
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 154 – EGO2 OPEN / LAZY (HO2S2) (Trouble Tree)

DTC 160 – EGO4 OPEN / LAZY (HO2S4)

DTC	160	SPN	3266	FMI	5		
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)							
Hardware Description: In a post-catalyst configuration the HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either “CL Active” or “CL + Adapt” control modes.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			YES				
Check Condition:			Engine Running				
Fault Set Conditions (as defined in calibration):							
• EGO cold persistently >				TBD*	seconds		
Possible Causes: This fault will set if the sensor element is cold, non-responsive, or inactive for x seconds as defined in the diagnostic calibration. Cold, non-responsive, or inactive are determined based on two criteria 1) a measurement of the feedback sense element (zirconia) to determine its temperature or 2) a lack of change in sensor feedback.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 160 – EGO4 OPEN / LAZY (HO2S4) (Trouble Tree)

DTC 171 – ADAPTIVE LEARN BANK 1 HIGH (GASOLINE)

DTC	171	SPN	4237	FMI	0
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Hardware Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• AL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the fuel injection system, 3) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck closed.

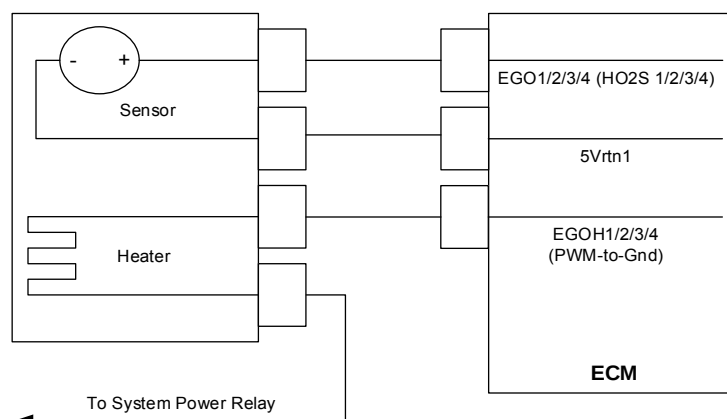
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mis-positioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Injectors - System will be lean if an injector driver or driver circuit fails. The system will also be lean if an injector fails in a closed manner or is dirty.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ Air in Fuel - If the fuel return hose/line is too close to the fuel supply pickup in the fuel tank, air may become entrapped in the pump or supply line causing a lean condition and driveability problems.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including oxygenated fuels.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 172 – ADAPTIVE LEARN BANK 1 LOW (GASOLINE)

DTC	172	SPN	4237	FMI	1
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Hardware Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• AL_BM <			TBD*	%	
• and RPM >=			TBD*	rpm	
• and RPM <=			TBD*	rpm	
• and MAP >=			TBD*	psia	
• and MAP <=			TBD*	psia	

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the fuel injection system, 2) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck open.

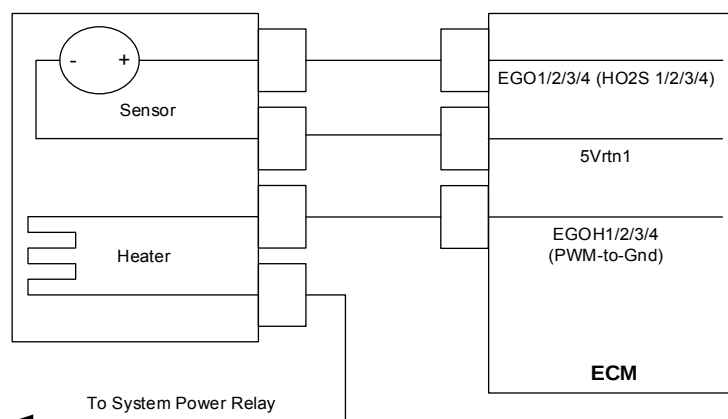
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mis-positioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Injectors - System will be rich if an injector driver or driver circuit fails shorted-to-ground. The system will also be rich if an injector fails in an open.
- ☐ Fuel Pressure - System will be rich if fuel pressure is too high. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 174 - ADAPTIVE LEARN BANK 2 HIGH (GASOLINE)

DTC	172	SPN	4239	FMI	1
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-Before Catalyst)					
Hardware Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• AL_BM >			TBD*	%	
• and RPM >=			TBD*	rpm	
• and RPM <=			TBD*	rpm	
• and MAP >=			TBD*	psia	
• and MAP <=			TBD*	psia	

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the fuel injection system, 3) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck closed.

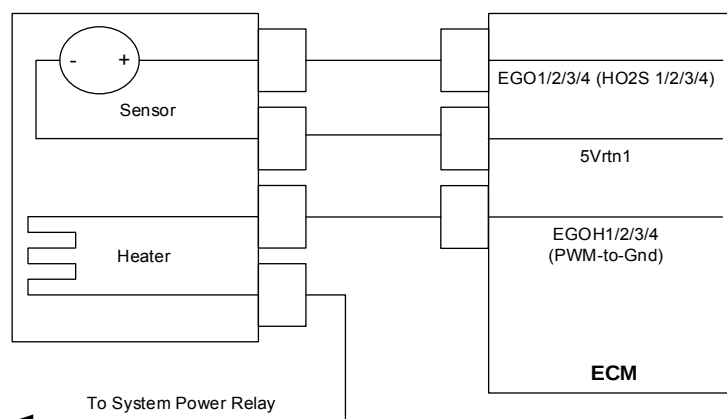
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Injectors - System will be lean if an injector driver or driver circuit fails. The system will also be lean if an injector fails in a closed manner or is dirty.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ Air in Fuel - If the fuel return hose/line is too close to the fuel supply pickup in the fuel tank, air may become entrapped in the pump or supply line causing a lean condition and driveability problems.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including oxygenated fuels.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 175 - ADAPTIVE LEARN BANK 2 LOW (GASOLINE)

DTC	175	SPN	4239	FMI	1
Hardware: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-Before Catalyst)					
Hardware Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• AL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the fuel injection system, 2) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck open.

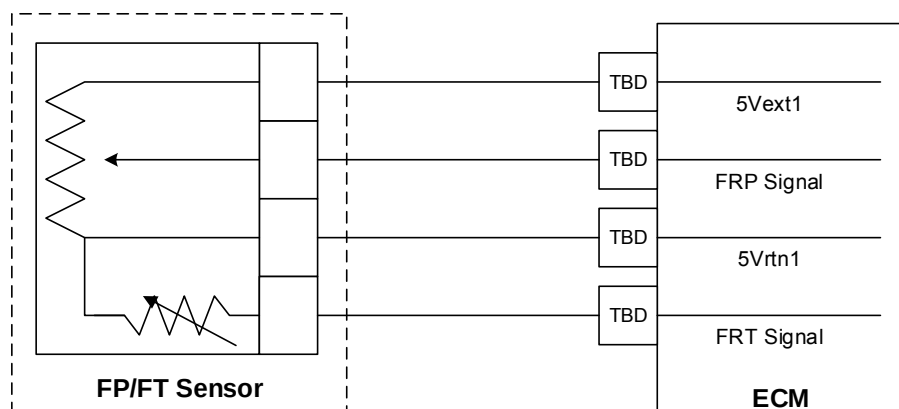
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

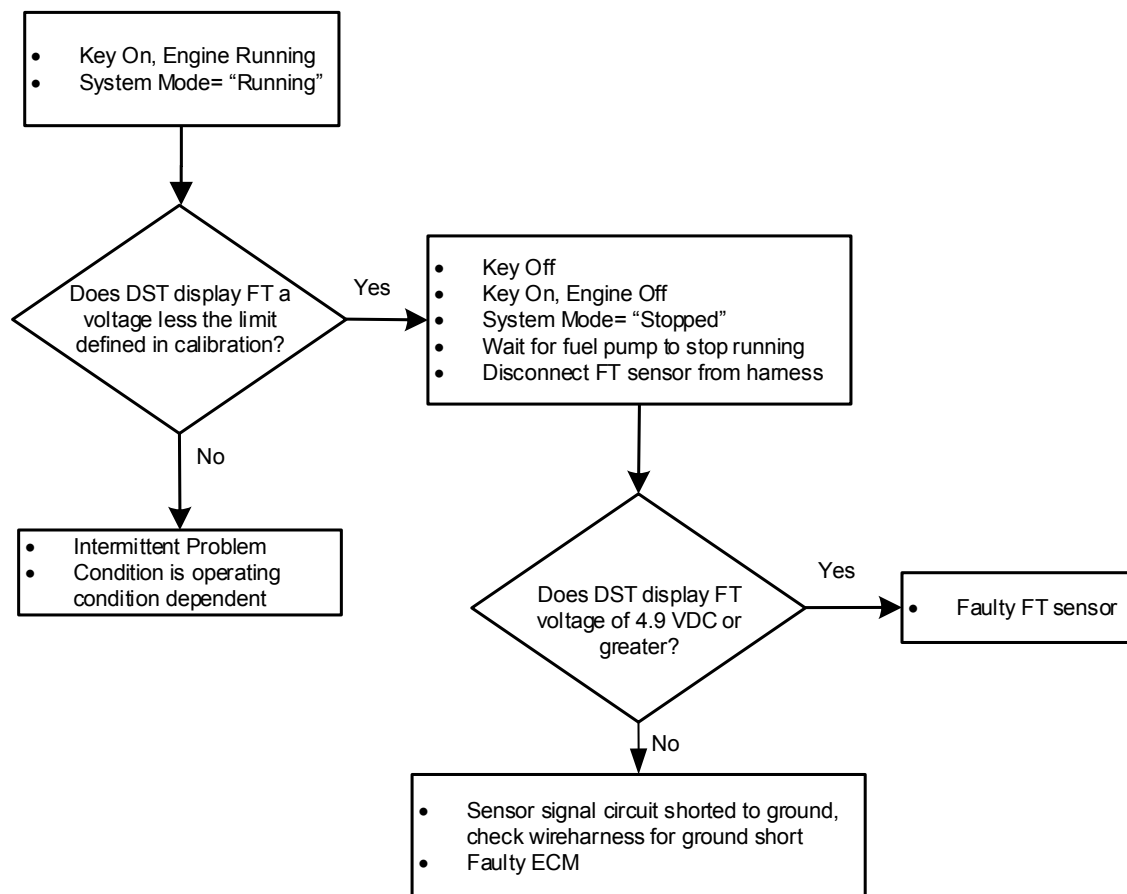
Diagnostic Aids

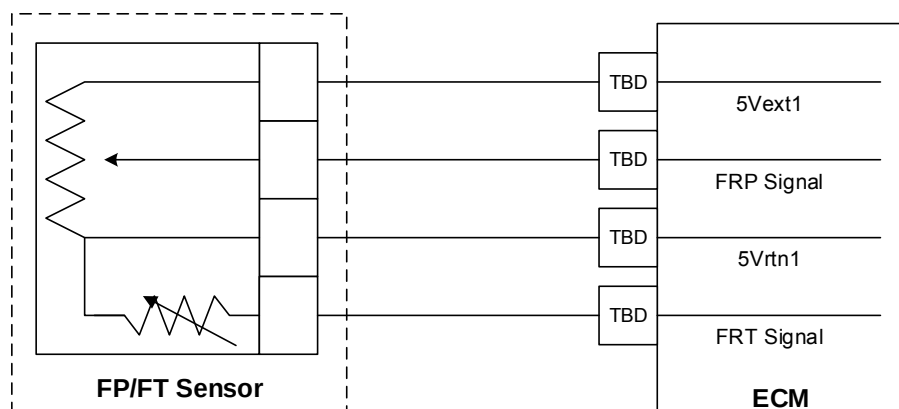
NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mis-positioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Injectors - System will be rich if an injector driver or driver circuit fails shorted-to-ground. The system will also be rich if an injector fails in an open.
- ☐ Fuel Pressure - System will be rich if fuel pressure is too high. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

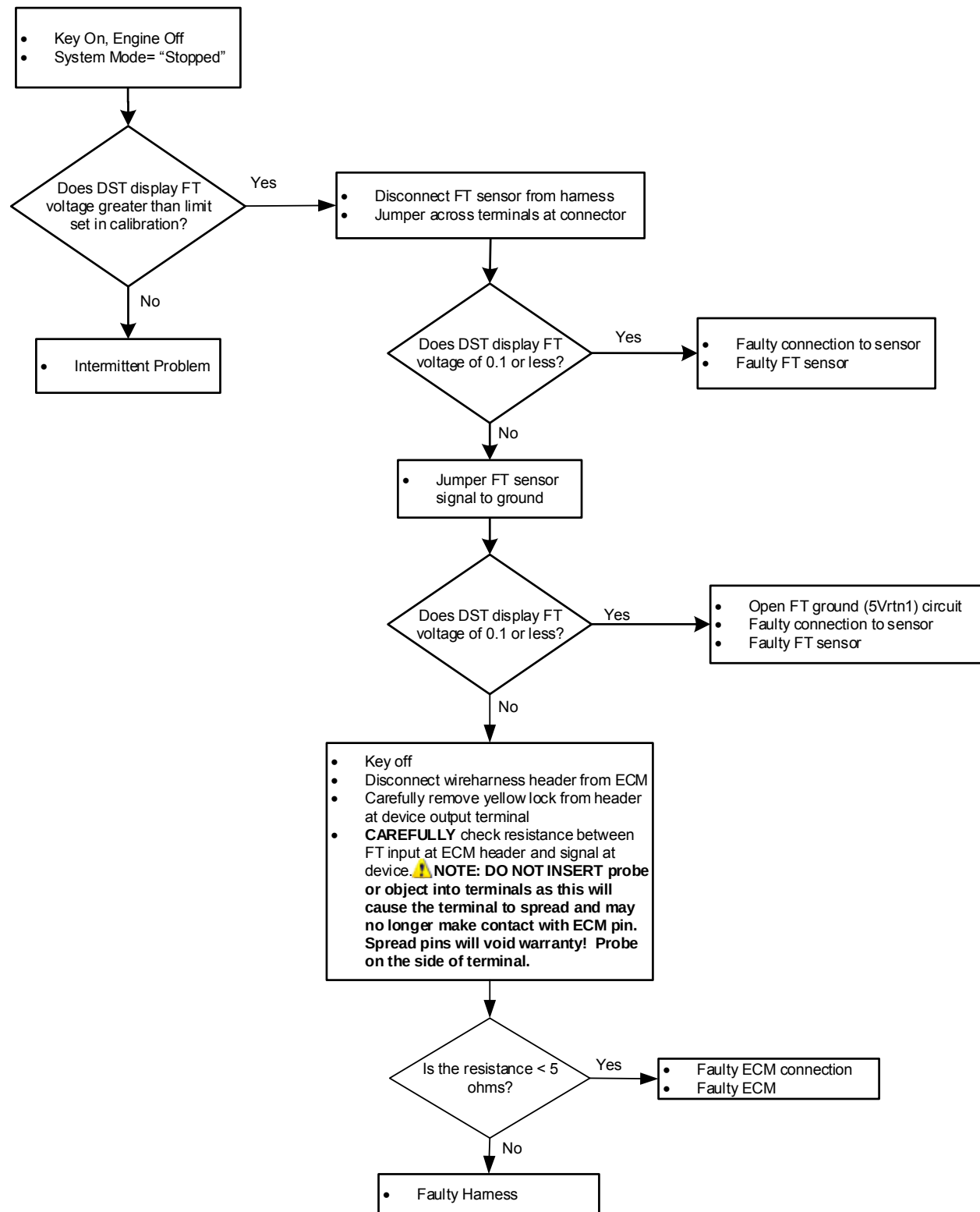
DTC 182 - FT VOLTAGE LOW (GASOLINE)

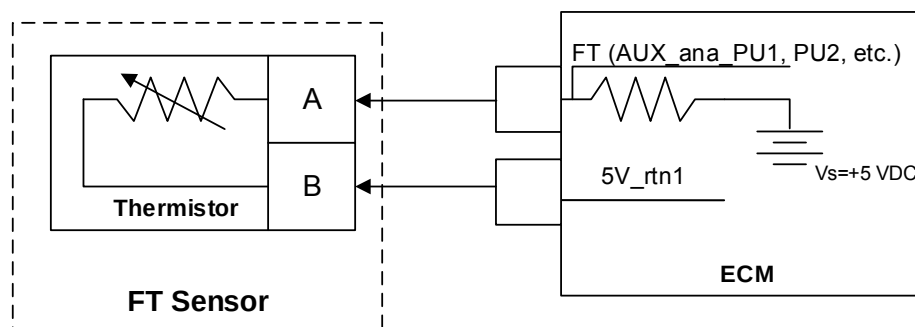
DTC	182	SPN	174	FMI	4		
Hardware: Liquid Fuel Temperature Sensor							
Hardware Description: The Fuel Temperature sensor is a thermistor (temperature sensitive resistor) integrated into the fuel pressure TMAP located in the fuel supply line between the fuel pump and the fuel rail. It is used to monitor the fuel temperature exiting the fuel pump to set a fault if the fuel temperature is too high resulting in increased fuel vapor from the fuel tank causing excessive evaporative emissions. The ECM provides a voltage divider circuit so that when the fuel is cool, the signal reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES (evaporative emissions)					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• FT voltage <				TBD*	volts		
• or fuel temp <				TBD*	deg F		
Possible Causes: This fault will set if the signal voltage is less than the low voltage limit as defined in the diagnostic calibration anytime that the engine is running. The limit is generally set to the voltage that corresponds to the fuel boiling temperature.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 182 - FT VOLTAGE LOW (GASOLINE) (Trouble Tree)

DTC 183 - FT VOLTAGE HIGH (GASOLINE)

DTC	183	SPN	174	FMI	3		
Hardware: Liquid Fuel Temperature Sensor							
Hardware Description: The Fuel Temperature sensor is a thermistor (temperature sensitive resistor) integrated into the fuel pressure TMAP located in the fuel supply line between the fuel pump and the fuel rail. It is used to monitor the fuel temperature exiting the fuel pump to set a fault if the fuel temperature is too high resulting in increased fuel vapor from the fuel tank causing excessive evaporative emissions. The ECM provides a voltage divider circuit so that when the fuel is cool, the signal reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• FT voltage >				TBD*	volts		
• or fuel temp >				TBD*	deg F		
Possible Causes: This fault will set if the signal voltage is greater than the high voltage limit as defined in the diagnostic calibration anytime that the engine is running. The limit is generally set to 4.9 VDC. During this active fault the MIL and/or secondary warning device should be activated.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

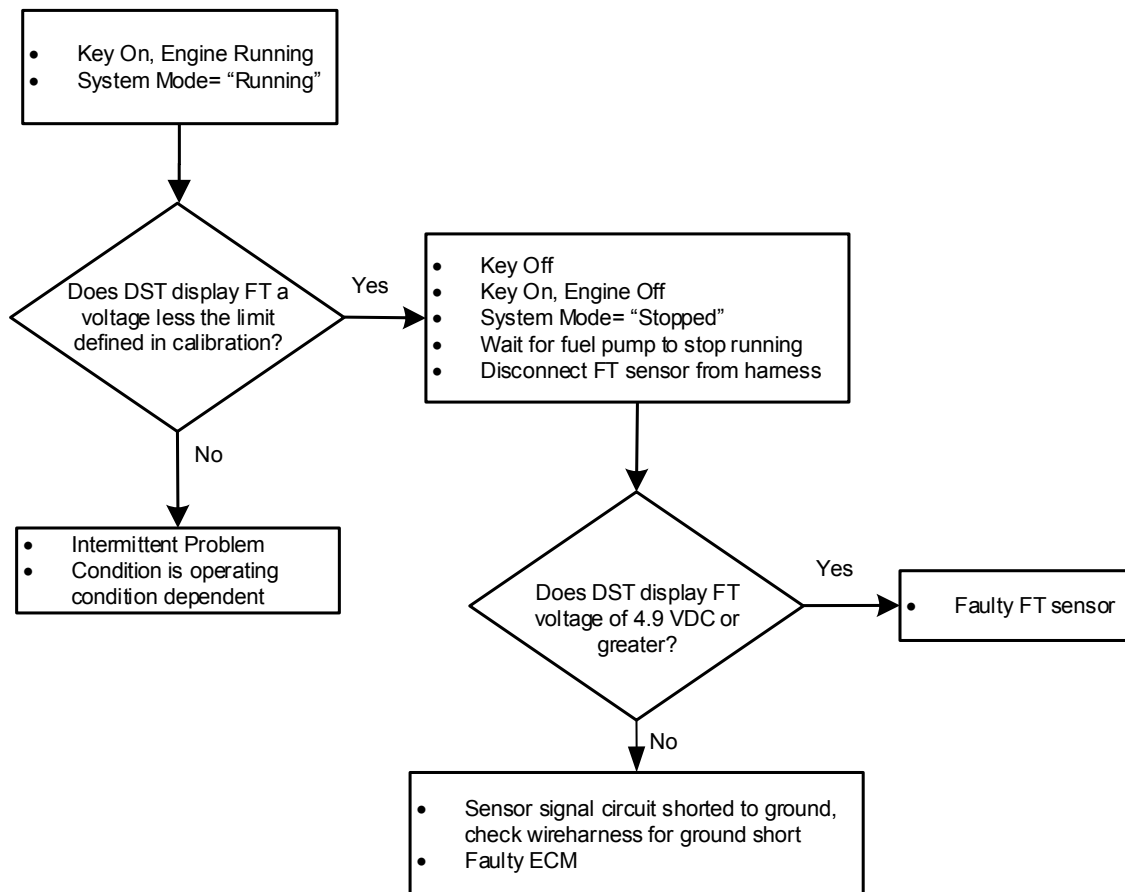
DTC 183 - FT VOLTAGE HIGH (GASOLINE) (Trouble Tree)

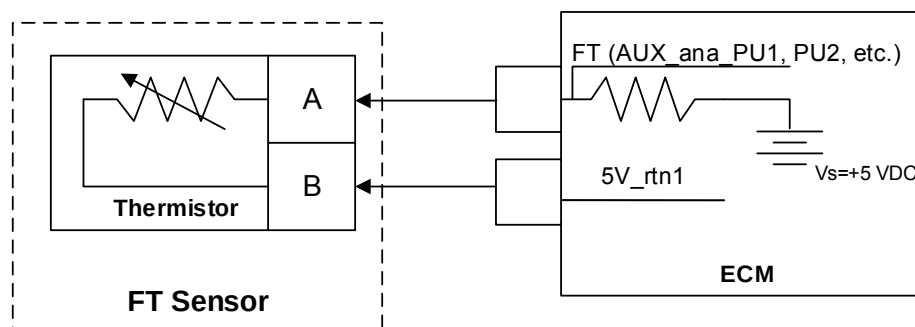
DTC 187 - GASEOUS FUEL TEMPERATURE SENDER LOW VOLTAGE

DTC	187	SPN	3468	FMI	4		
Hardware: Gaseous Fuel Temperature Sensor							
Hardware Description: The Fuel Temperature sensor is a thermistor (temperature sensitive resistor) integrated into the EPR fuel outlet. It is used to monitor the gaseous fuel temperature exiting the EPR to be used as an input in a fuel temperature estimation of the temperature entering the gaseous mixer. This information is used to calculate a real-time fuel pressure correction in order to reduce fueling errors. The ECM provides a voltage divider circuit so that when the fuel is cool, the signal reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• FT voltage <				TBD*	volts		
• or fuel temp <				TBD*	deg F		
Possible Causes: This fault will set if the signal voltage is less than the low voltage limit as defined in the diagnostic calibration anytime that the engine is running. The limit is generally set to 0.10 VDC.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

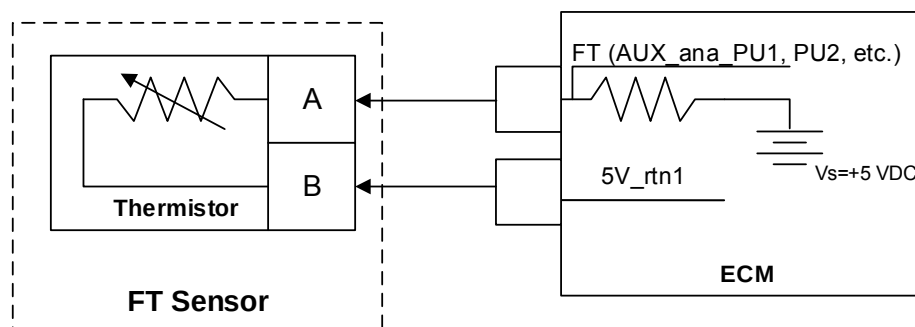
DTC 187 GASEOUS FUEL TEMPERATURE SENDER LOW VOLTAGE (TROUBLE TREE

1

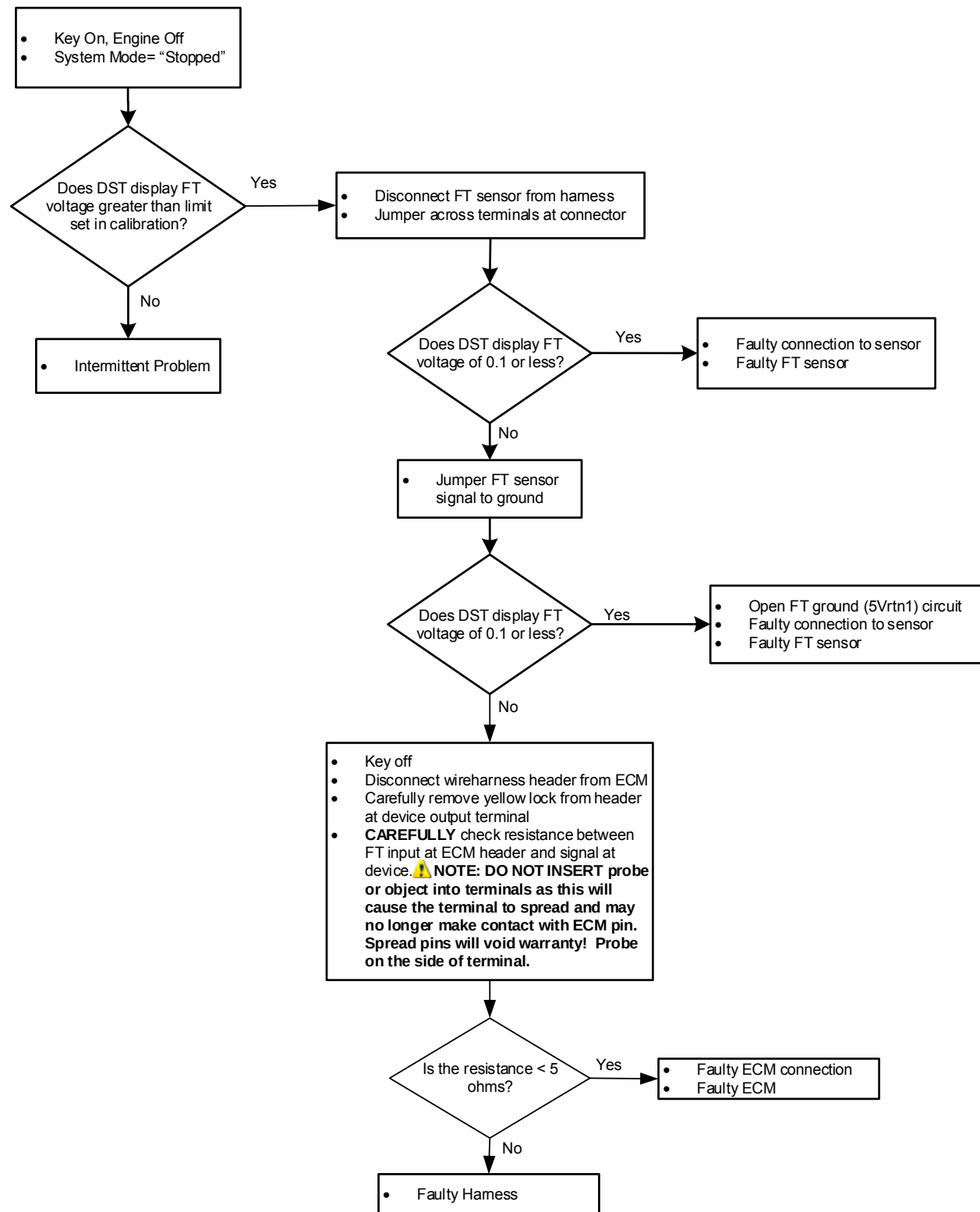


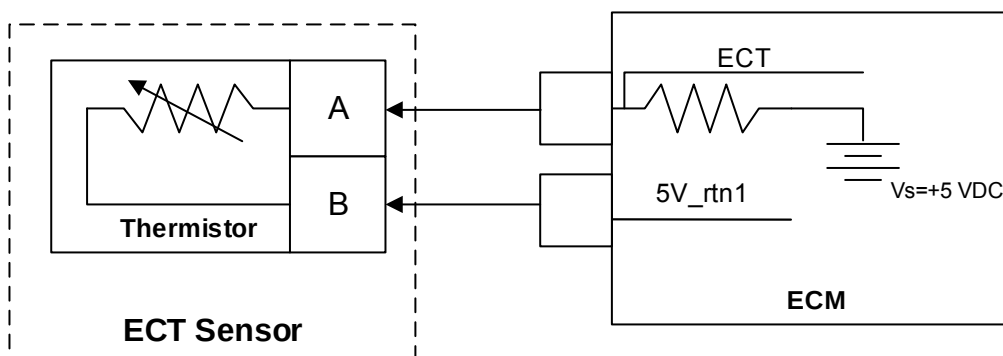
DTC 187 - FT GASEOUS FUEL EXTREMELY LOW

DTC	187	SPN	3468	FMI	1		
Hardware: Gaseous Fuel Temperature Sensor							
Hardware Description: The Fuel Temperature sensor is a thermistor (temperature sensitive resistor) integrated into the EPR fuel outlet. It is used to monitor the gaseous fuel temperature exiting the EPR to be used as an input in a fuel temperature estimation of the temperature entering the gaseous mixer. This information is used to calculate a real-time fuel pressure correction in order to reduce fueling errors. The ECM provides a voltage divider circuit so that when the fuel is cool, the signal reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• Fuel temp <				-40	deg F		
Possible Causes: This fault is not user-modifiable. It is always enabled and is intended to protect the CFV from extremely low fuel temperatures by load limiting the system when the FT falls below the target temperature given in the fault conditions.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 188 - GASEOUS FUEL TEMPERATURE SENDER HIGH VOLTAGE

DTC	188	SPN	3468	FMI	3		
Hardware: Gaseous Fuel Temperature Sensor							
Hardware Description: The Fuel Temperature sensor is a thermistor (temperature sensitive resistor) integrated into the EPR fuel outlet. It is used to monitor the gaseous fuel temperature exiting the EPR to be used as an input in a fuel temperature estimation of the temperature entering the gaseous mixer. This information is used to calculate a real-time fuel pressure correction in order to reduce fueling errors. The ECM provides a voltage divider circuit so that when the fuel is cool, the signal reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• FT voltage >				TBD*	volts		
• or fuel temp >				TBD*	deg F		
Possible Causes: This fault will set if the signal voltage is greater than the high voltage limit as defined in the diagnostic calibration anytime that the engine is running. The limit is generally set to 4.90 VDC.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 188 - GASEOUS FUEL TEMPERATURE SENDER HIGH VOLTAGE (TROUBLE TREE)

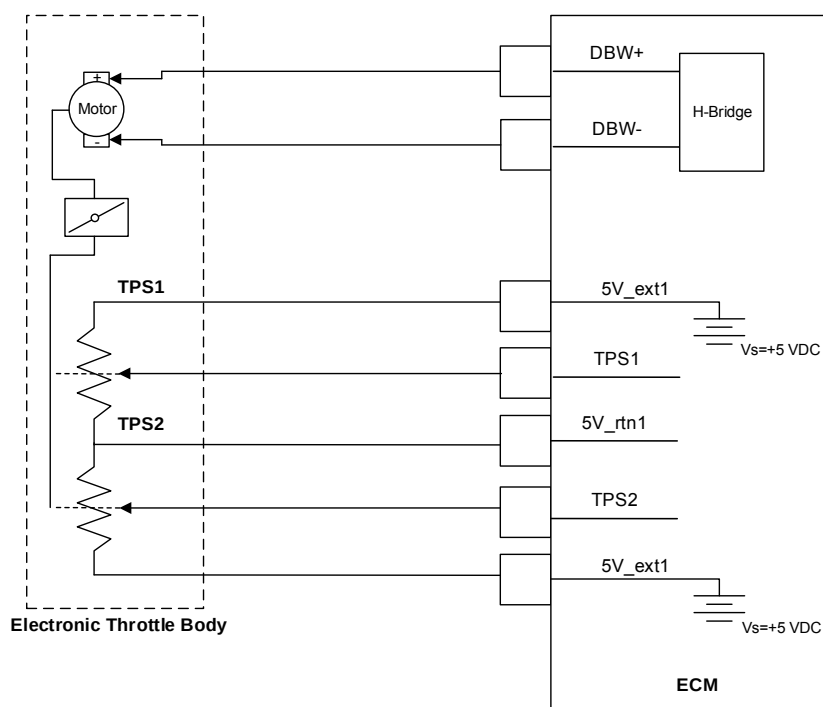
DTC 217 - ECT HIGHER THAN EXPECTED 2

DTC	217	SPN	110	FMI	0		
Hardware: Engine Coolant Temperature Sensor							
Hardware Description: The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• ECT >				TBD*	deg F		
• and RPM >				TBD*	rpm		
• and run-time >				TBD*	seconds		
Possible Causes: This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

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Diagnostic Aids:

- ☐ If the “ECT High Voltage” fault is also present, follow the troubleshooting procedures for that fault as it may have caused “ECT Higher Than Expected 2.”
- ☐ If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:
 - o Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
 - o Ensure that there is no trapped air in the cooling path
 - o Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - o Check that the fan is operating properly
 - o Check that the thermostat is not stuck closed
- ☐ If the cooling system utilizes a water-to-water heat exchanger:
 - o Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
 - o Ensure that there is no trapped air in the cooling path
 - o Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - o Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
 - o Check that the thermostat is not stuck closed
 - o Check that the raw water pump/impeller is tact and that it is not restricted

DTC 219 - RPM HIGHER THAN MAX ALLOWED GOVERNED SPEED

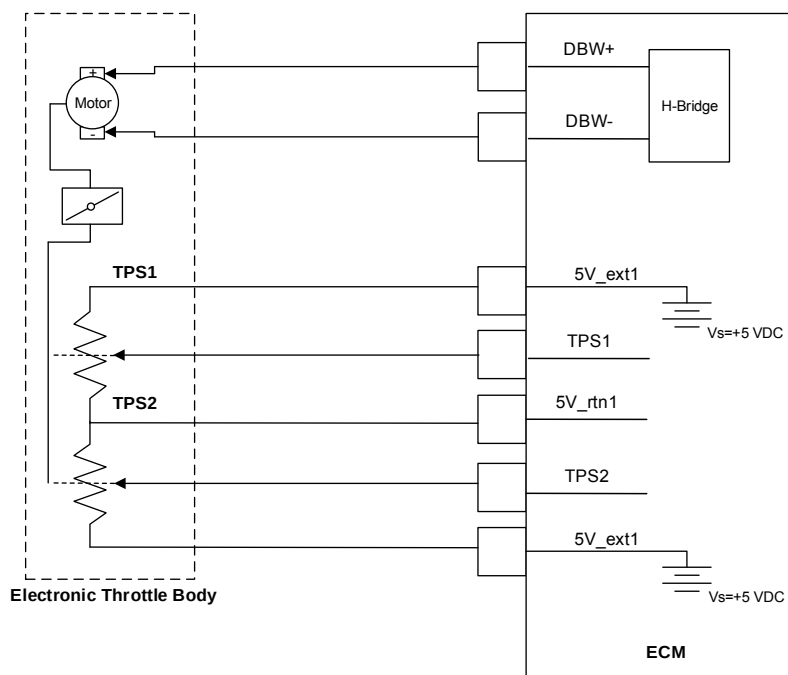
DTC	219	SPN	515	FMI	15		
Hardware: Max Govern Speed Override- Crankshaft Position Sensor							
Description: The Max Allowed Governed Speed overrides any higher max governor speeds programmed by the user. This fault is designed to help prevent engine or equipment damage.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• RPM >				TBD*	rpm		
Possible Causes: This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

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Diagnostic Aid:

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- ☐ Check mechanical operation of the throttle
- ☐ Check the engine intake for large air leaks downstream of the throttle body

DTC 221 - TPS1 % HIGHER THAN TPS2 %

DTC	221	SPN	51	FMI	0
Hardware: Throttle Body-Throttle Position Sensor 1 & 2 (electronic throttle body only)					
Hardware Description: The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions. The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• (TPS1% - TPS2%) >				TBD*	%

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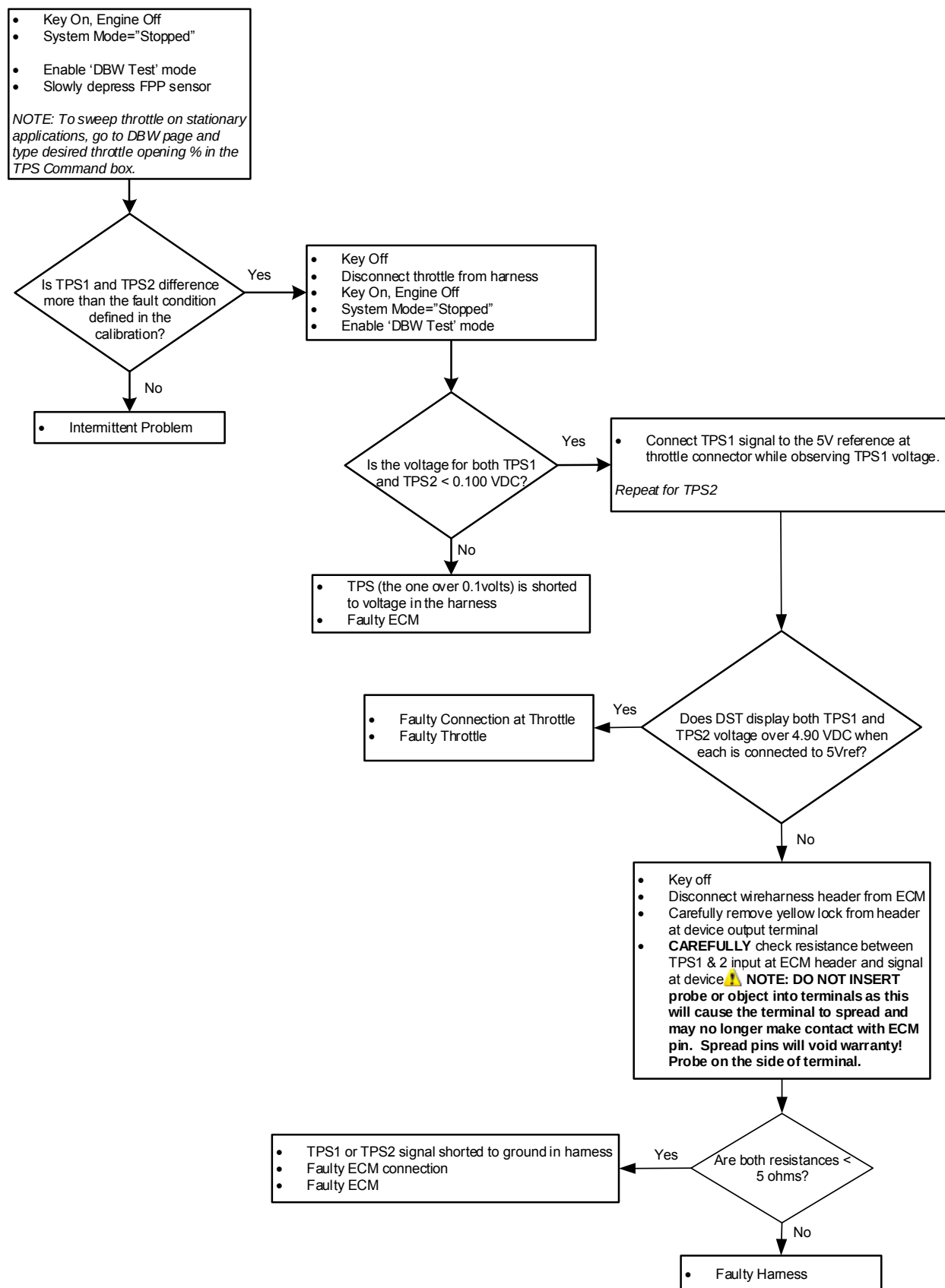
Possible Causes:

This fault will set if TPS1 % is higher than TPS2 % by the amount defined in the diagnostic calibration. At this point the throttle is considered to be out of specification, or there is a problem with the TPS signal circuit. During this active fault, an audible/visual alert device is activated and either an engine shutdown should be triggered or throttle control is set to use the higher of the two feedback signals for control in combination with a low rev limit and/or power derate.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 221 - TPS1 % HIGHER THAN TPS2 % (TROUBLE TREE)



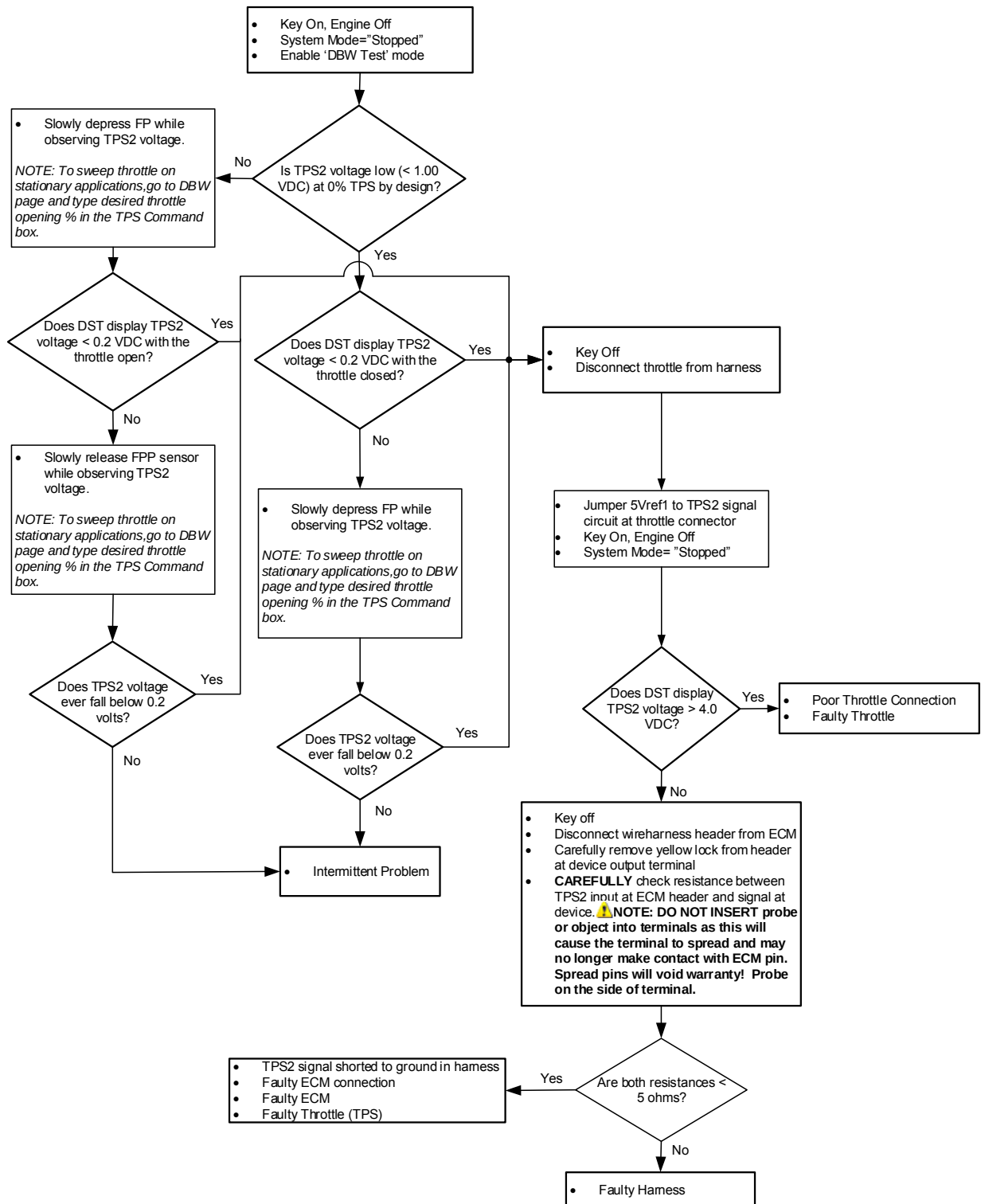
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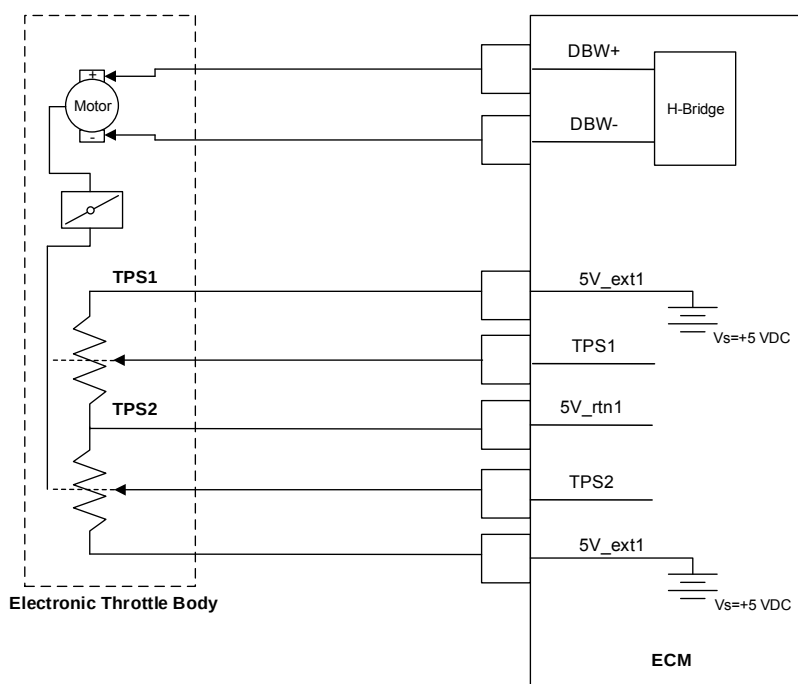
Possible Causes:

This fault will set if TPS2 voltage is lower than the low voltage limit as defined in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the TPS sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TPS circuit in the wire harness, or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 222 - TPS2 SIGNAL VOLTAGE LOW (TROUBLE TREE)

DTC 223 - TPS2 SIGNAL VOLTAGE HIGH

DTC	223	SPN	3673	FMI	3
Hardware: Throttle Body-Throttle Position Sensor 2 (electronic throttle body only)					
Hardware Description: The throttle controls the airflow through the engine, directly affecting the power output of the engine. When the throttle is electronically controlled in an Electronic Throttle Body it can be used to control the idle stability and limit engine speed based on operating conditions. The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle plate position, and is located within the throttle body. The output of the TPS is linear with angular position. The TPS input(s) provide angular position feedback of the throttle plate. In an Electronic Throttle Body multiple position feedback sensors (usually two counteracting potentiometers/hall-effects) are used to perform speed governing with improved safety and redundancy.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• TPS2 voltage >				TBD*	volts

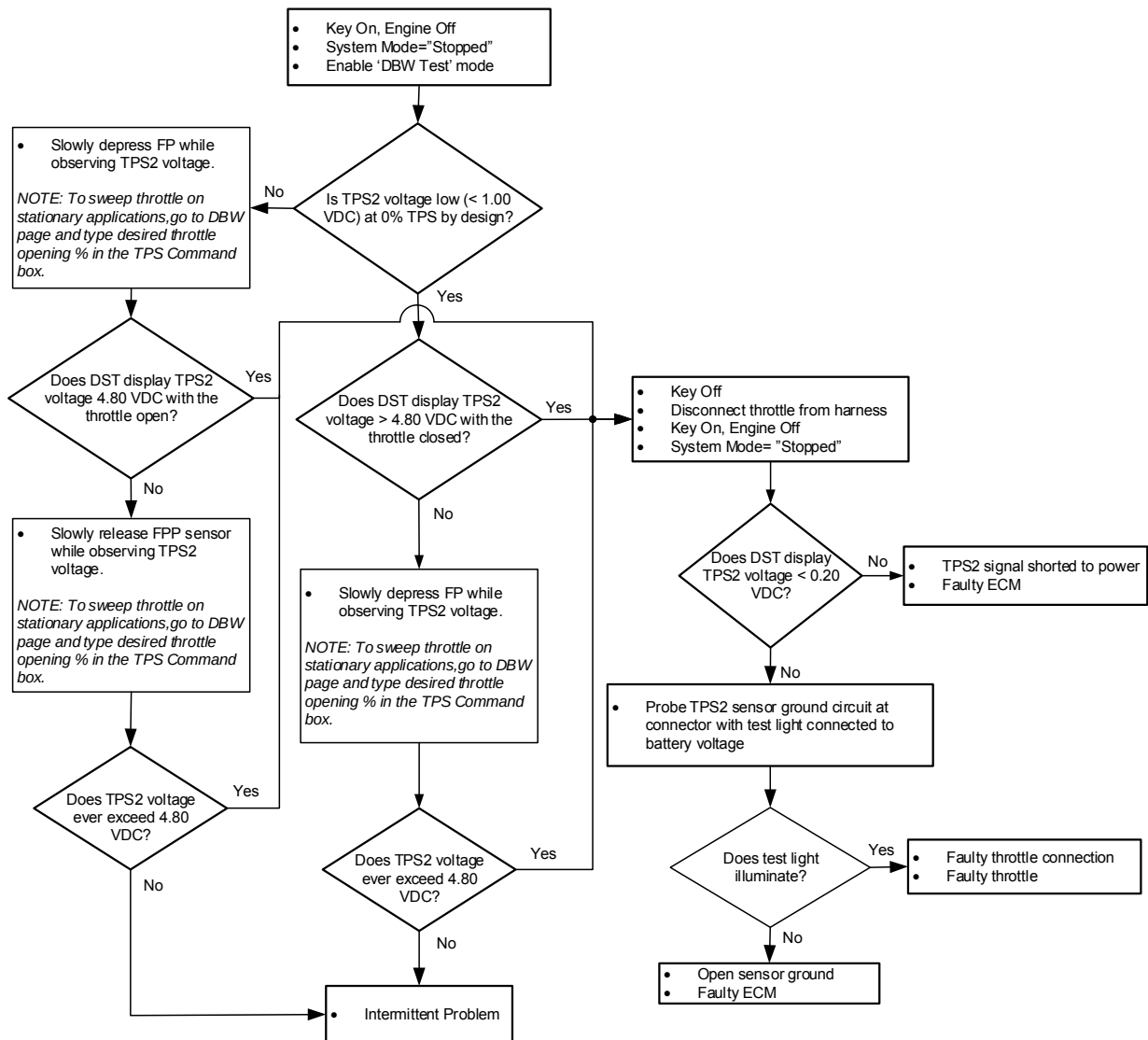
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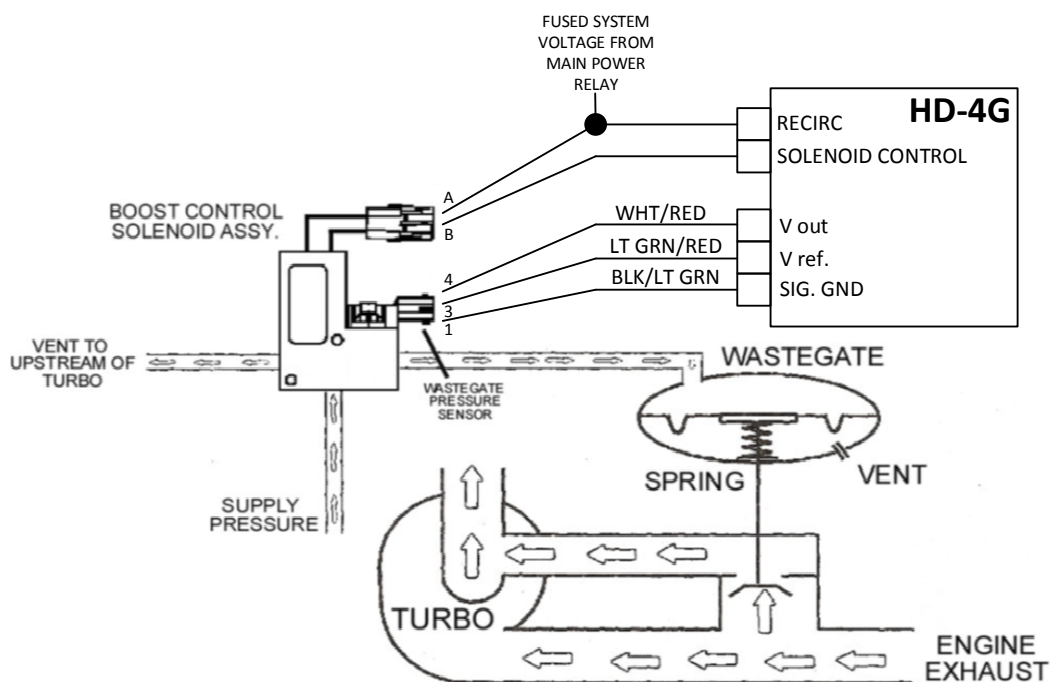
Possible Causes:

This fault will set if TPS2 voltage is higher than the limit set in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the TPS circuit in the wire harness or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 223 - TPS2 SIGNAL VOLTAGE HIGH

DTC 234 – BOOST CONTROL OVERBOOST FAILURE

DTC	234	SPN	102	FMI	0
Hardware: TIP sensor- boost pressure measurement					
Hardware Description: The boost control circuit uses a proportional control valve to control the pressure delivered to the wastegate. The pressure source is application specific. Typically the pressure source is either the pressure delivered by the turbo compressor or a constantly regulated ‘ON Vehicle’ pressure supply source (pump). The Boost control valve can proportionally route the pressure to either the wastegate or purge the pressure into the filtered ambient air stream. If the Boost control valve completely purges the supply pressure, the spring within the wastegate holds the valve closed allowing the compressor to make maximum boost. Once pressure is applied to the wastegate, the amount of boost is reduced. The TIP sensor provides information to the ECM identifying the amount of boost available.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
• P > P target +				TBD*	psi
• and P >				TBD*	psia
• and P target >=				TBD*	psia
• and dP/dt >=				TBD*	psi/sec
with P = TIP (turbo) or MAP (super)					

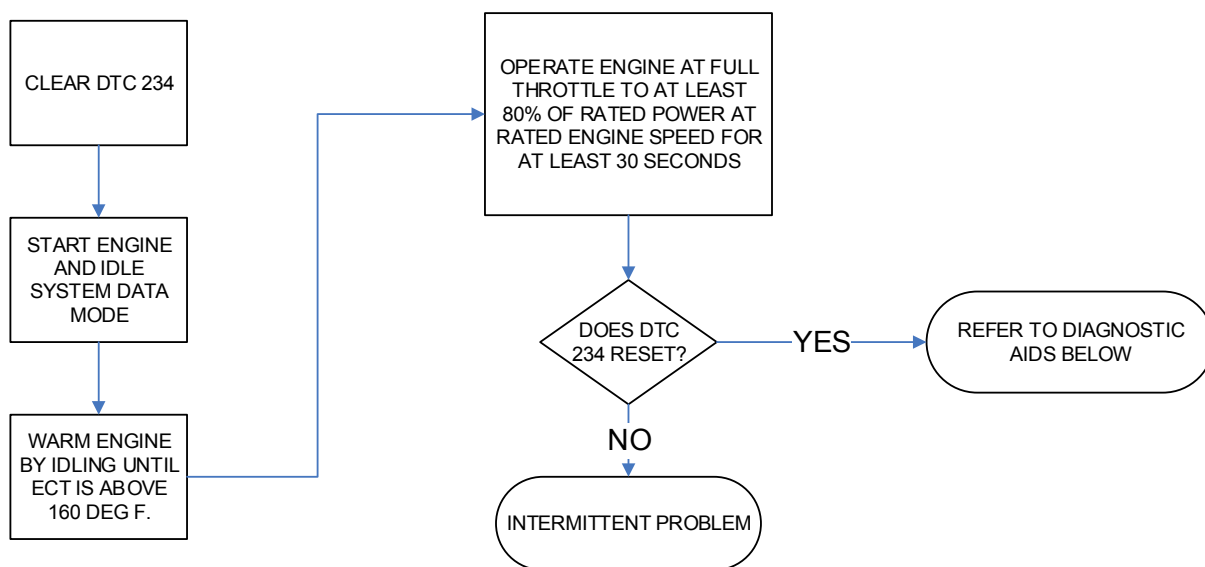
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Possible Causes:

This fault will set when the engine is running and the TIP sensor is reading “X” psi above the commanded level continuously for “Y” seconds and TIP is > “Z” psia. The MIL light will be illuminated for the remainder of the key on cycle and the boost delivered to the engine will be limited by the throttle to maintain the engine in a “Power Derate” mode.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

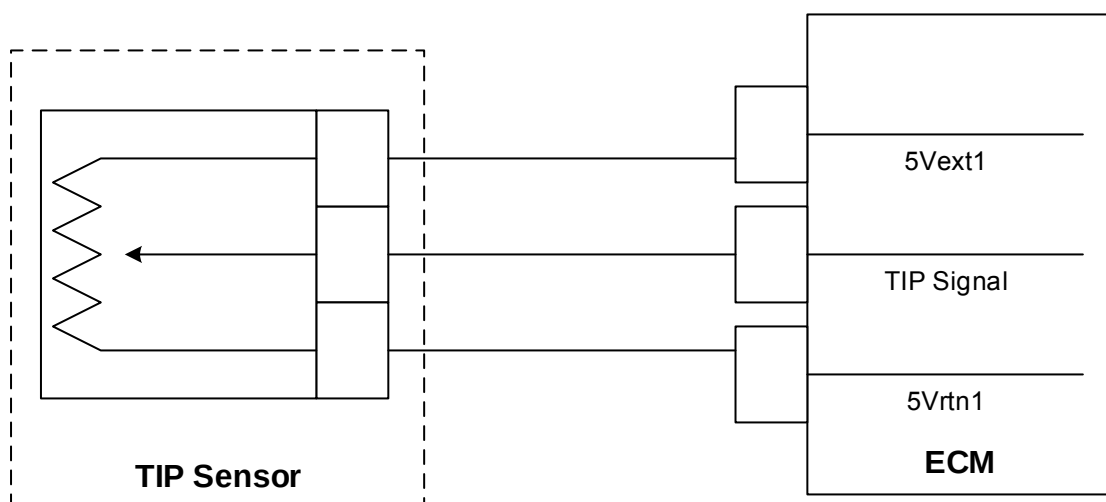
DTC 234 – BOOST CONTROL OVERBOOST FAILURE (TROUBLE TREE)

PRESSURE REGULATOR – If the pressure regulator that reduces the vehicle air pressure down to 1.6 bar is not providing enough pressure, DTC 234 may result.

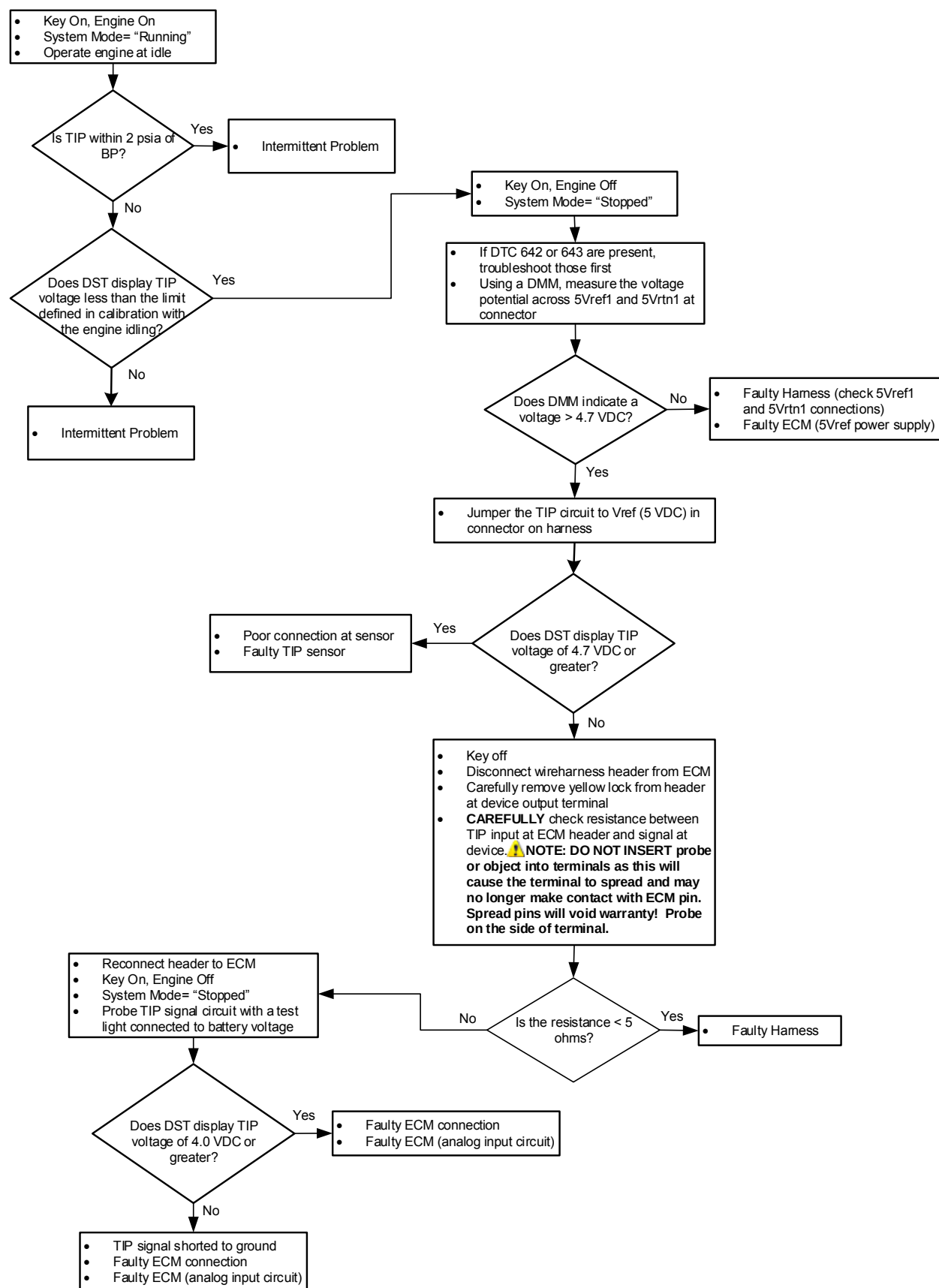
PRESSURE LINES – If the pressure line connecting the turbocharger outlet pressure to the Boost Control Valve (BCV) outlet fitting or the line connecting the solenoid fitting to the wastegate are damaged, restricted, or leaking, DTC 234 may result. Also verify the hoses are connected to the proper locations on the Boost Control Valve (BCV) and engine.

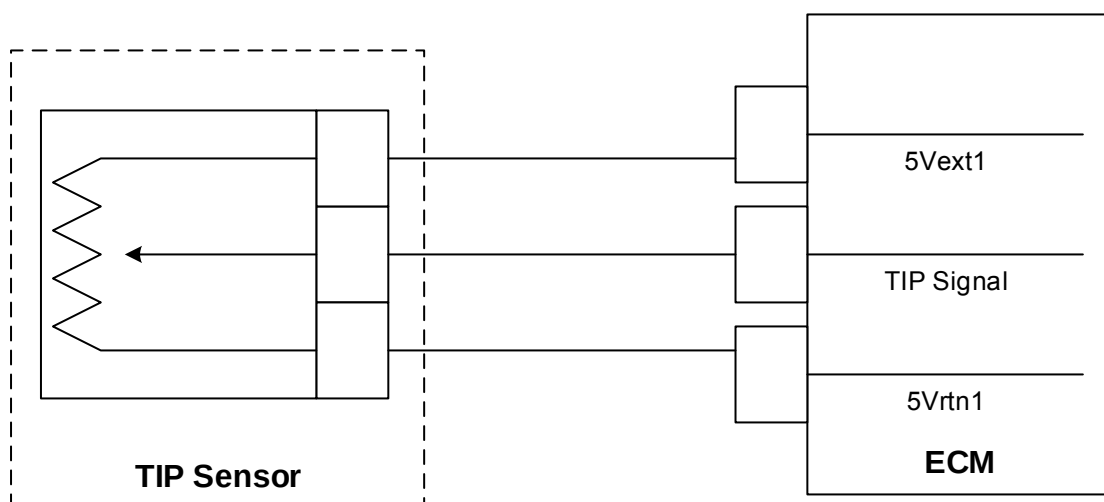
WASTEGATE – If the wastegate is stuck closed, mechanically damaged, or the diaphragm is leaking. DTC 234 may result. The wastegate diaphragm may be checked by removing the control line, closing the wastegate manually, block off the wastegate control line fitting on the wastegate and ensure the wastegate does not move for 10 seconds ensuring there are no internal leakage.

BOOST CONTROL VALVE – If the Boost Control Valve (BCV) valve will not close or leaks. DTC 234 may result. Verify the Boost Control Valve (BCV) mechanical and electrical integrity using the WGP test in the DST. If the solenoid is stuck open, verify the electrical drive circuit and then replace the Boost Control Valve (BCV) assembly.

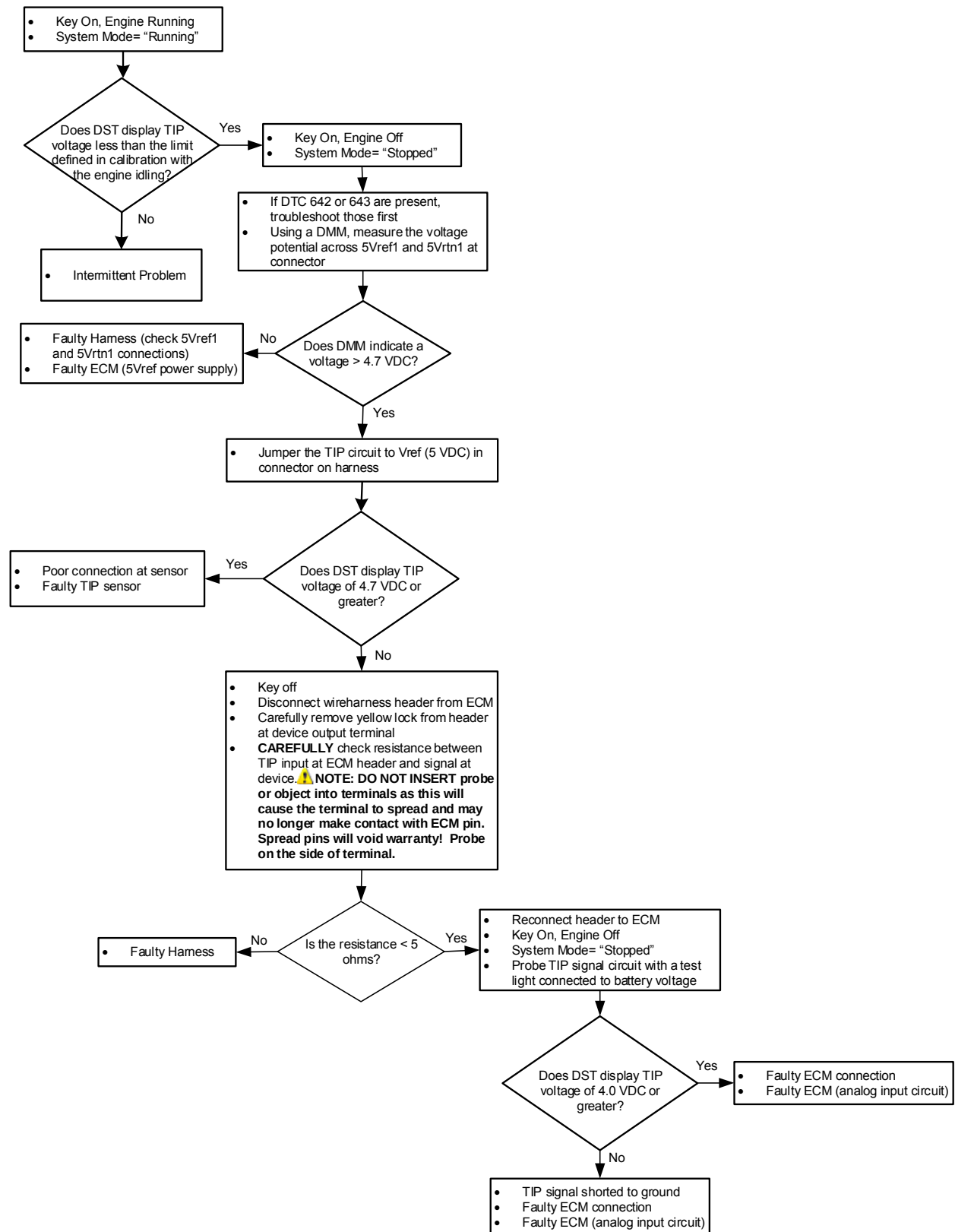
DTC 236 - TIP/TOP ACTIVE

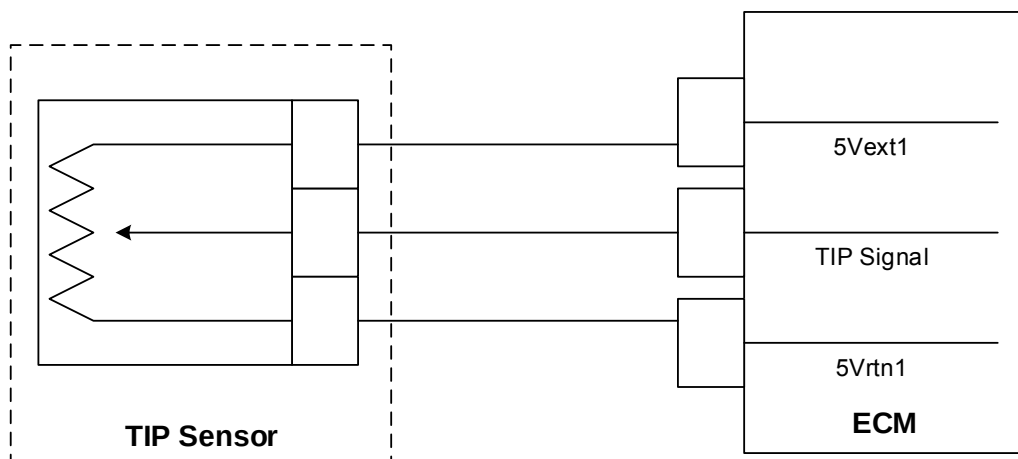
DTC	236	SPN	102	FMI	2		
Hardware: Throttle Inlet Pressure (Boost) Sensor							
Hardware Description: The Throttle Inlet Pressure sensor is a pressure transducer located in the intake air stream between the turbocharger or supercharger and the throttle. It is used to measure the boosted air pressure in the intake air stream prior to the throttle. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the throttle and is used to for boost bypass control.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• TIP < (turbo) / TOP > (supercharged)				TBD*	psia		
• and MAP > (turbo) / MAP < (supercharged)				TBD*	psia		
Possible Causes: This fault detects if the TIP sensor is pneumatically attached to the intake system and whether or not TIP is functional. It sets if MAP is rising without a corresponding change in TIP based on TIP being less than <u>x</u> psia while MAP is greater than <u>y</u> psia as defined in the diagnostic calibration. Recommended corrective action(s) include outputting a warning to the user.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 236- TIP Active Trouble Tree

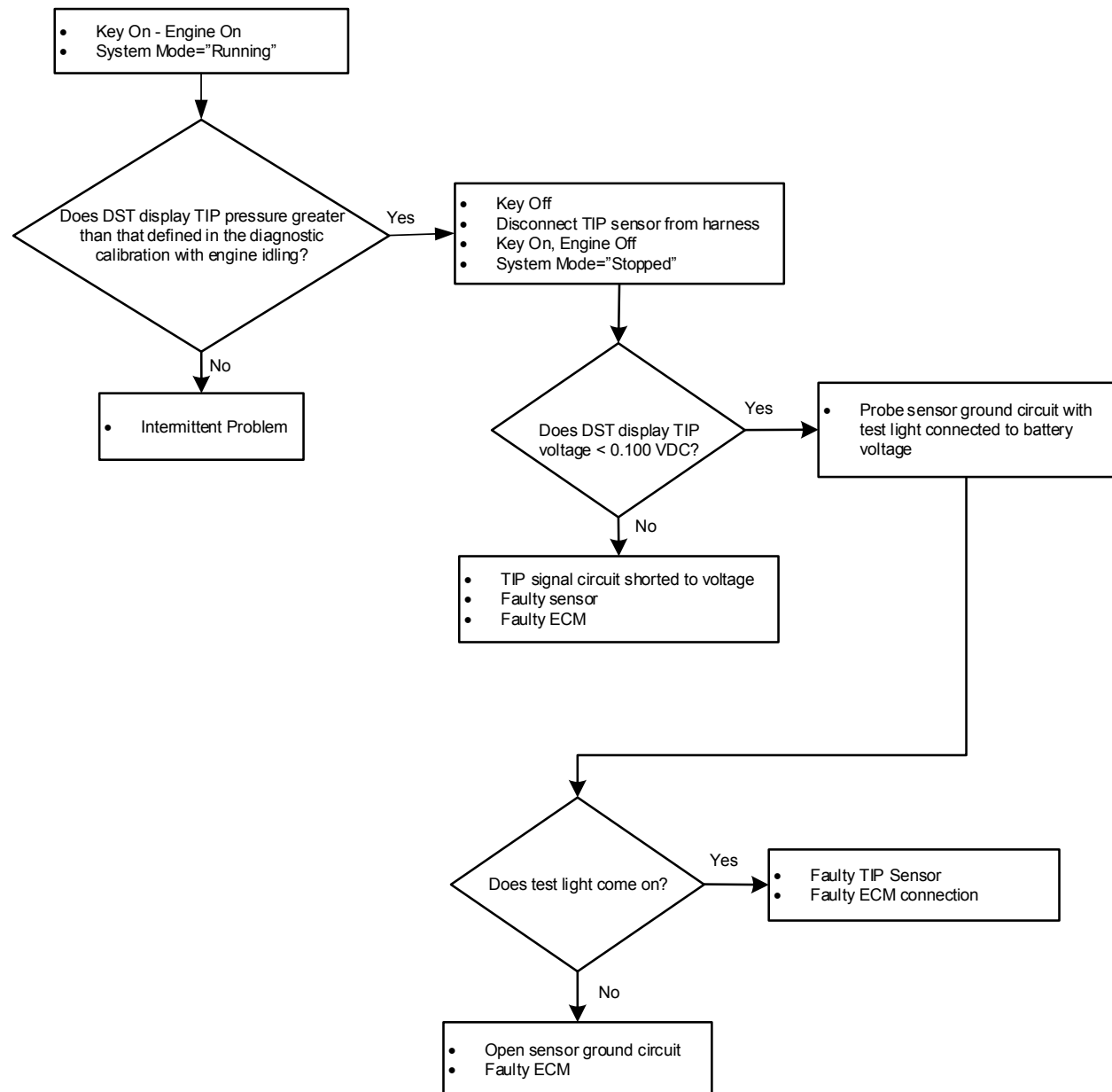
DTC 237 - TIP/TOP LOW VOLTAGE

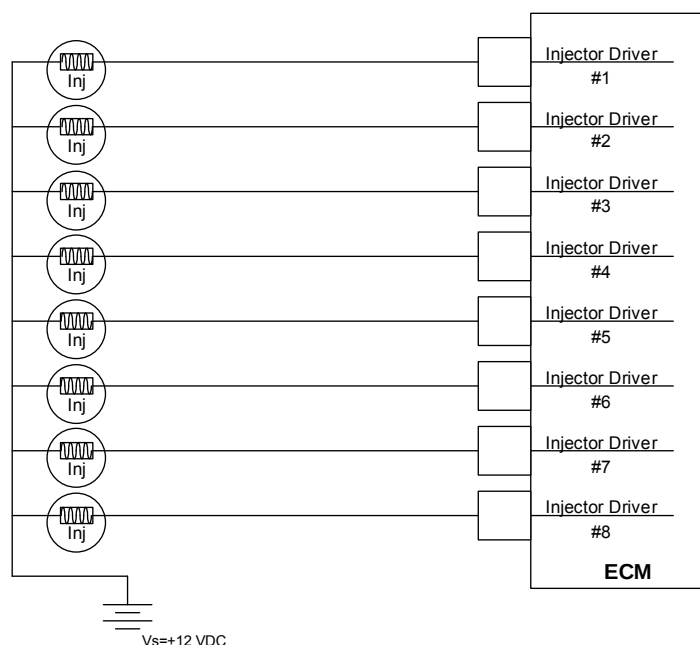
DTC	236	SPN	102	FMI	4		
Hardware: Throttle Inlet Pressure (Boost) Sensor							
Hardware Description: The Throttle Inlet Pressure sensor is a pressure transducer located in the intake air stream between the turbocharger or supercharger and the throttle. It is used to measure the boosted air pressure in the intake air stream prior to the throttle. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the throttle and is used to for boost bypass control.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• TIP/TOP voltage <				TBD*	volts		
Possible Causes: This fault will set when the TIP sensor voltage feedback is sensed as lower than the sensor should normally produce as set in the diagnostic calibration. The limit is generally set at 0.10 VDC. In many cases, this condition is caused by the TIP sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TIP circuit in the wireharness, a loss of sensor reference voltage, or a failure of the sensor. Recommended corrective action(s) include outputting a warning to the user.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 237 - TIP/TOP LOW VOLTAGE (TROUBLE TREE)

DTC 238 - TIP/TOP HIGH VOLTAGE

DTC	238	SPN	102	FMI	3		
Hardware: Throttle Inlet Pressure (Boost) Sensor							
Hardware Description: The Throttle Inlet Pressure sensor is a pressure transducer located in the intake air stream between the turbocharger or supercharger and the throttle. It is used to measure the boosted air pressure in the intake air stream prior to the throttle. The pressure reading is used in conjunction with other inputs to determine the rate of airflow to the throttle and is used to for boost bypass control.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• TIP/TOP voltage >				TBD*	volts		
• and MAP <				TBD*	psia		
Possible Causes: This fault will set when the TIP sensor voltage feedback is sensed as higher than the sensor should normally produce while MAP is lower than x psia as set in the diagnostic calibration. Under no circumstances should TIP be lower than MAP. The limit is generally set at 4.80 VDC. In many cases, this condition can be caused by the TIP circuit being shorted to a voltage source or a failure of the sensor. Recommended corrective action(s) include outputting a warning to the user.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 238 - TIP/TOP HIGH VOLTAGE (TROUBLE TREE)

DTC 261 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 1)

DTC	261	SPN	651	FMI	5
Hardware: Injector #1 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 1 st injector in the firing order or for the injector on cylinder #1 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

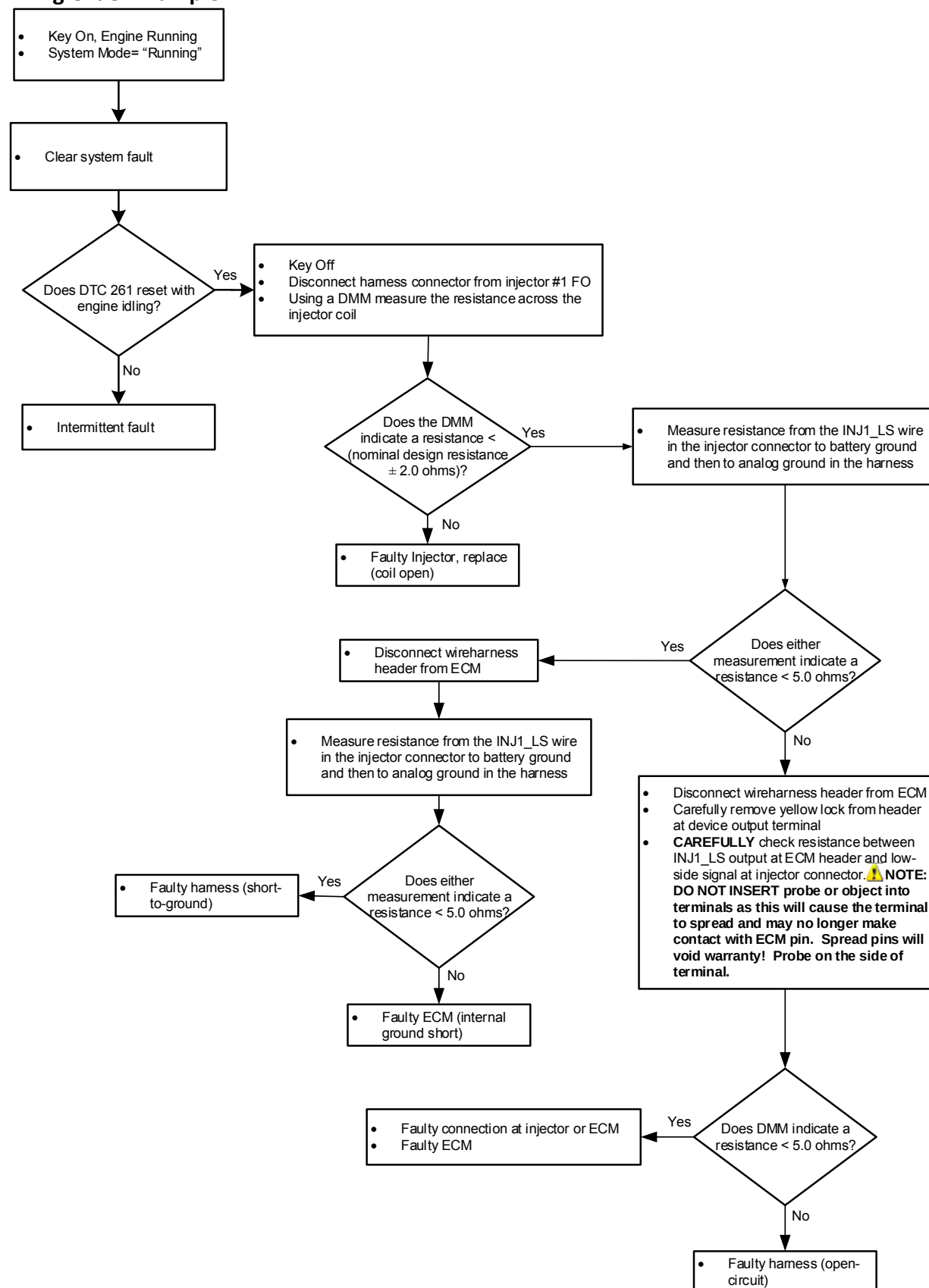
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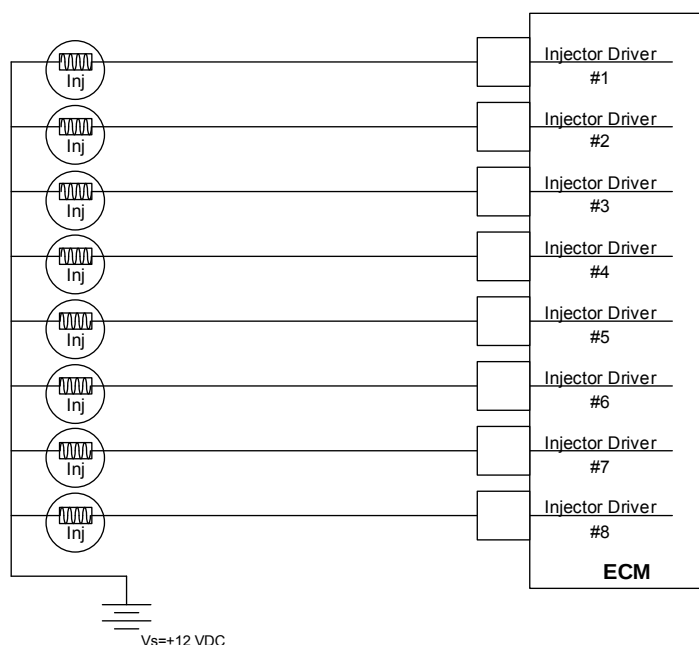
Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 261 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 1)**Firing Order Example**

DTC 262 - INJECTOR COIL SHORTED (CYLINDER 1)

DTC	262	SPN	651	FMI	6
Hardware: Injector #1 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 1 st injector in the firing order or for the injector on cylinder #1 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

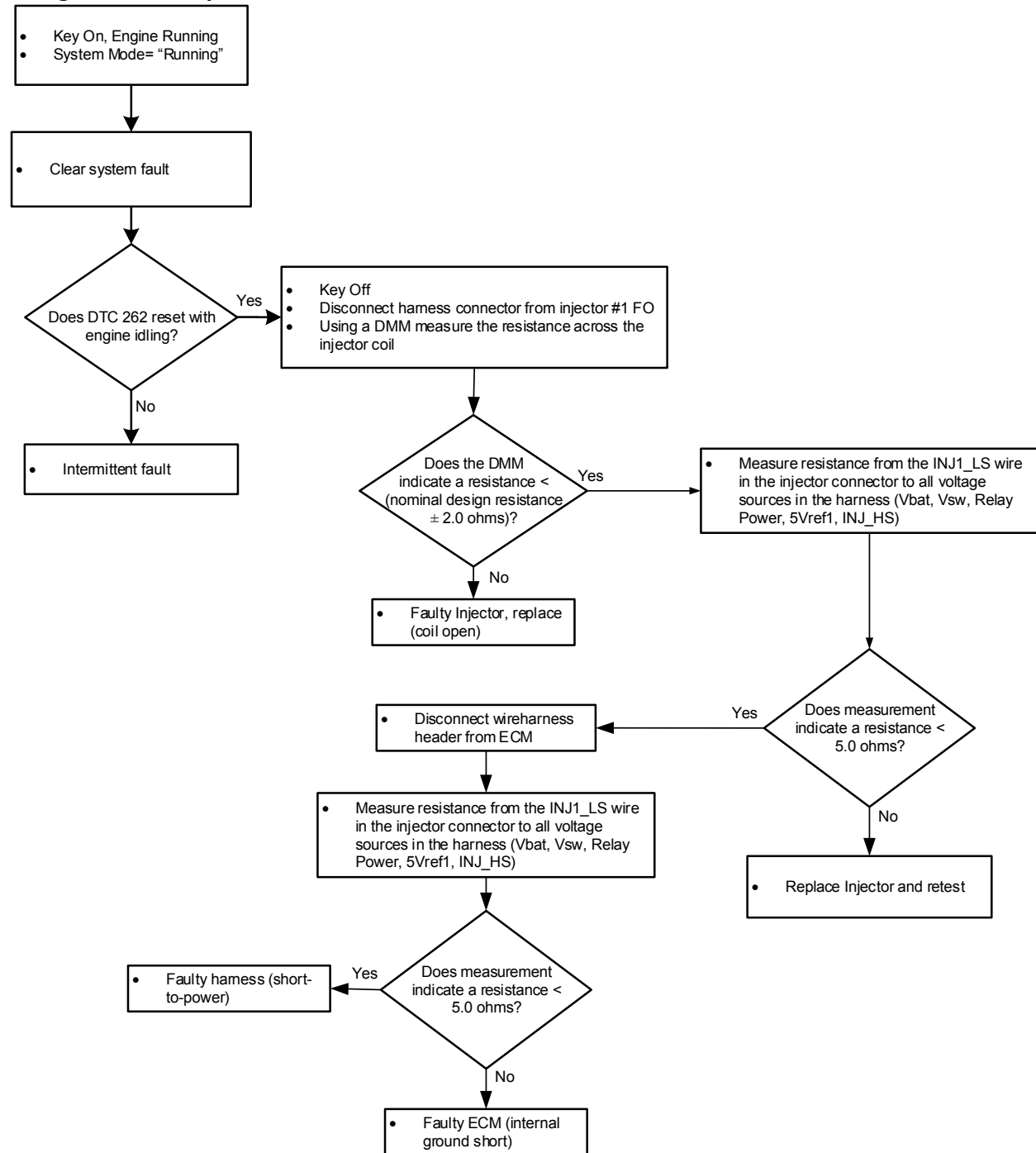
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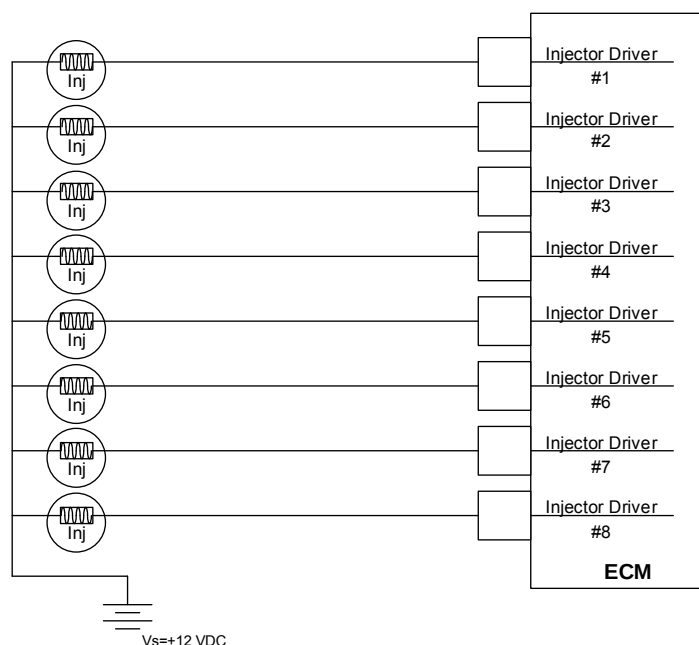
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 262 - INJECTOR COIL SHORTED (CYLINDER 1) (TROUBLE TREE)**Firing Order Example**

DTC 264 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 2)

DTC	264	SPN	652	FMI	5
Hardware: Injector #2 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 2 nd injector in the firing order or for the injector on cylinder #2 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current*"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

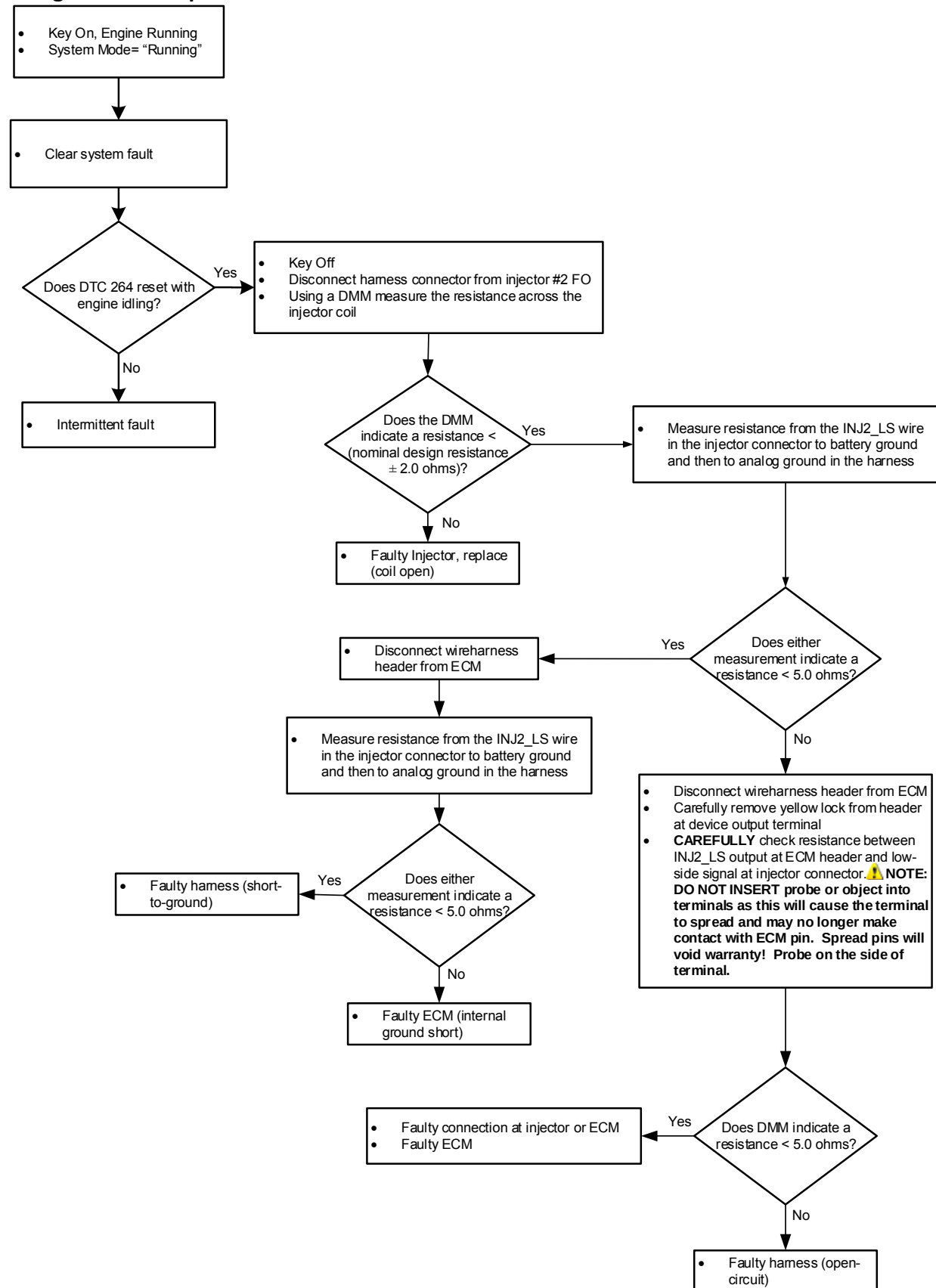
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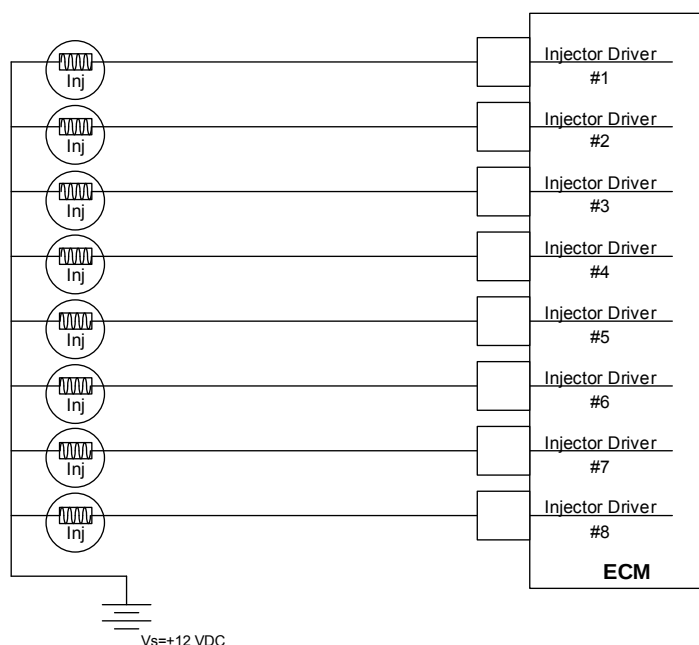
Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 264 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 2)**Firing Order Example**

DTC 265 - INJECTOR COIL SHORTED (CYLINDER 2)

DTC	265	SPN	652	FMI	6
Hardware: Injector #2 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 2 nd injector in the firing order or for the injector on cylinder #2 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

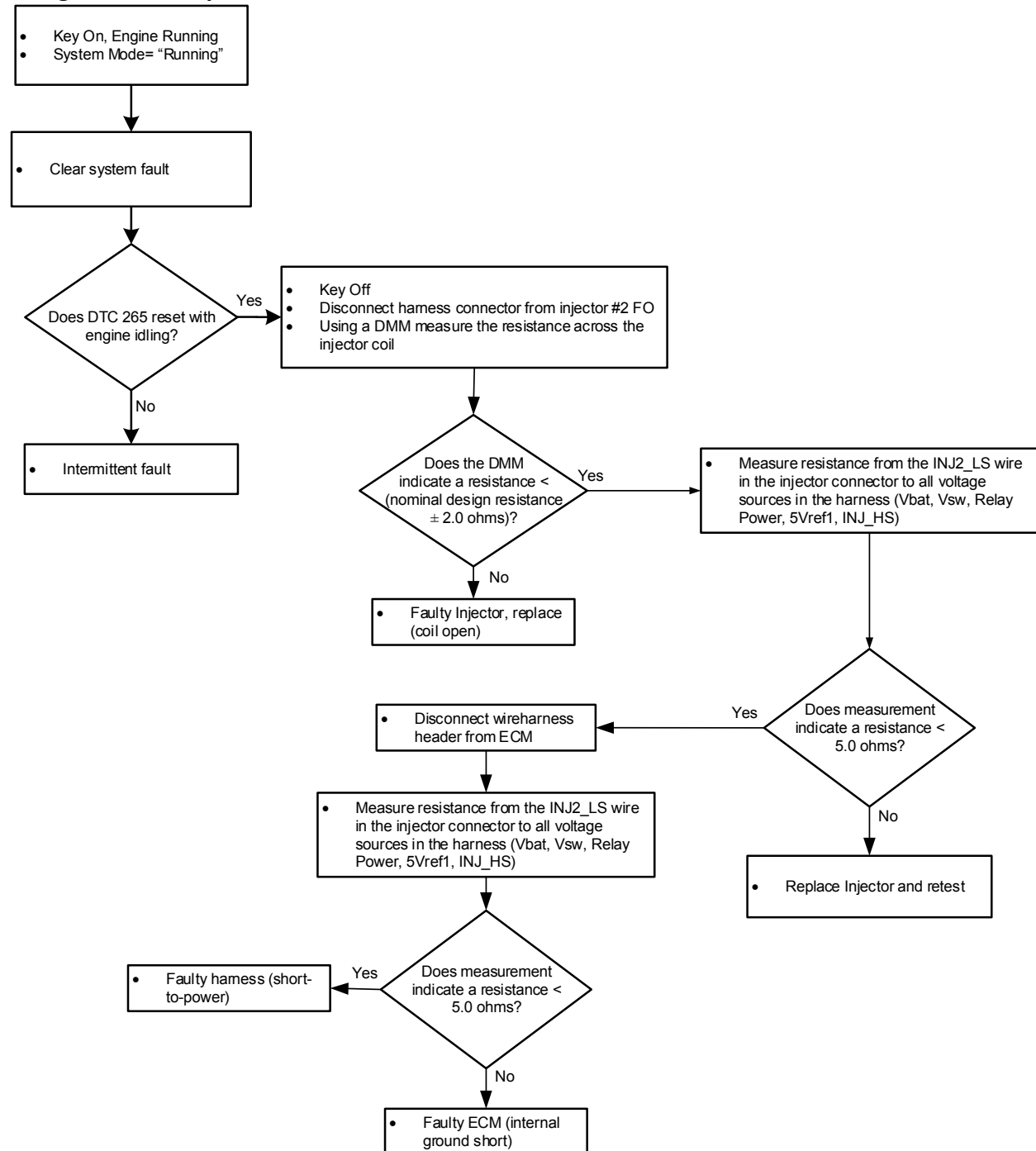
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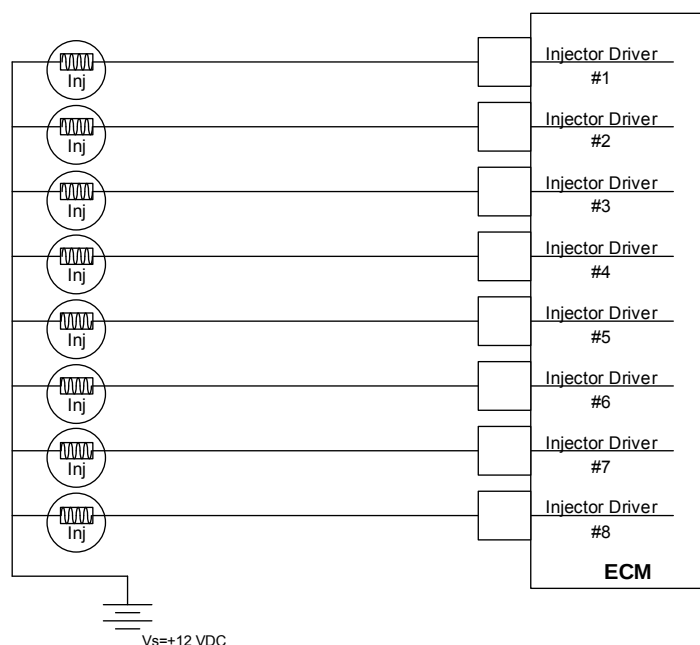
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 265 - INJECTOR COIL SHORTED (CYLINDER 2) (TROUBLE TREE)**Firing Order Example**

DTC 267 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 3)

DTC	267	SPN	653	FMI	5
Hardware: Injector #3 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 3 rd injector in the firing order or for the injector on cylinder #3 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

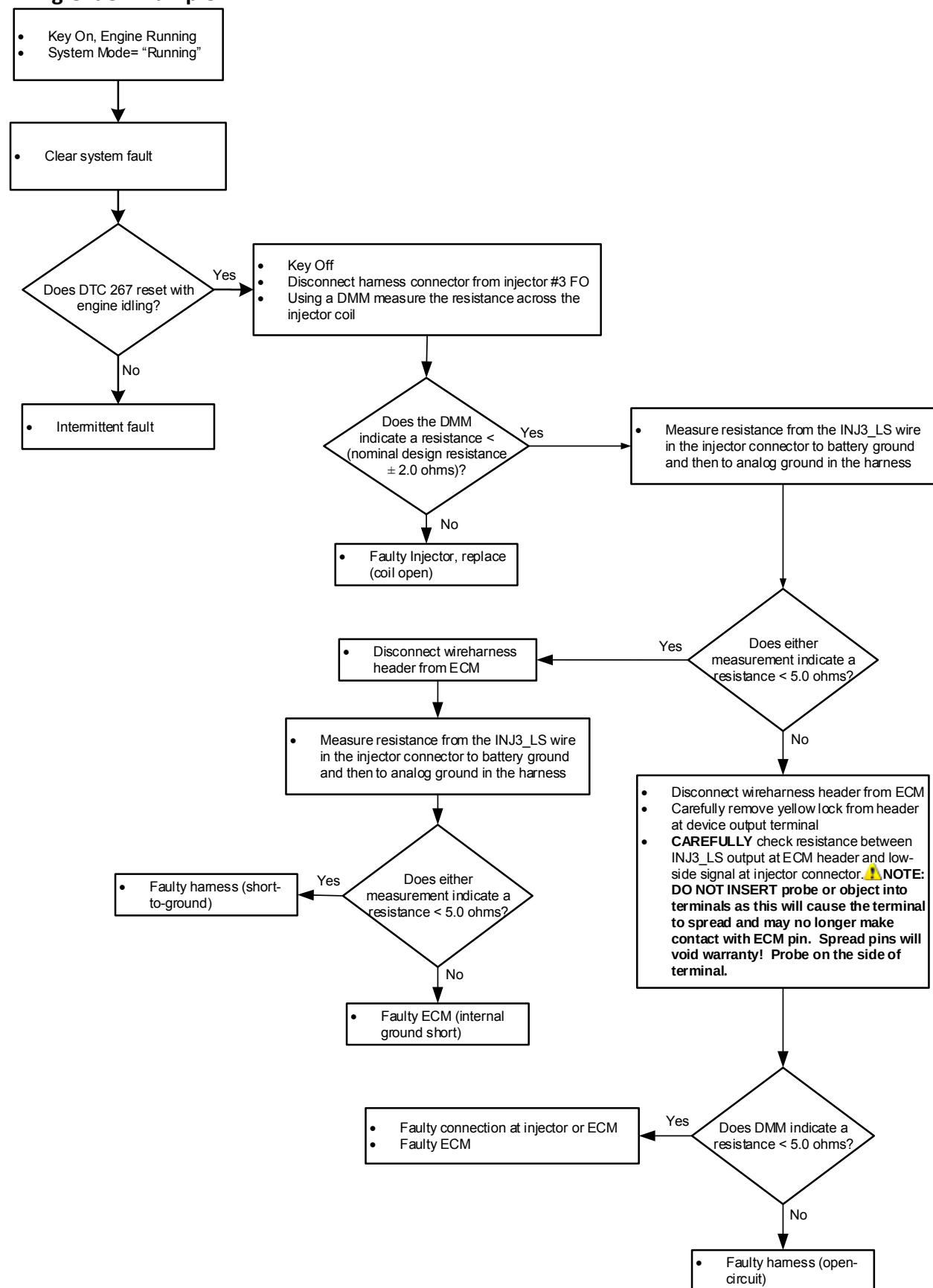
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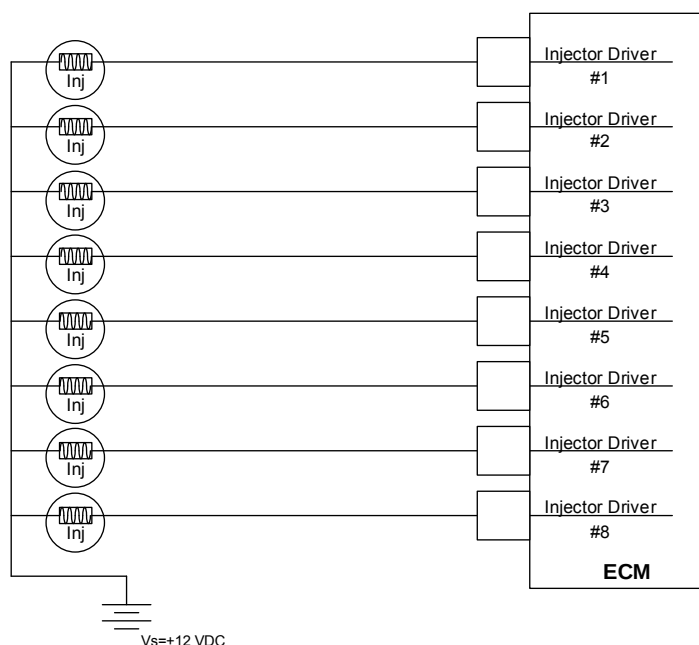
Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 267 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 3)**Firing Order Example**

DTC 268 - INJECTOR COIL SHORTED (CYLINDER 3)

DTC	268	SPN	653	FMI	6
Hardware: Injector #3 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 3 rd injector in the firing order or for the injector on cylinder #3 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

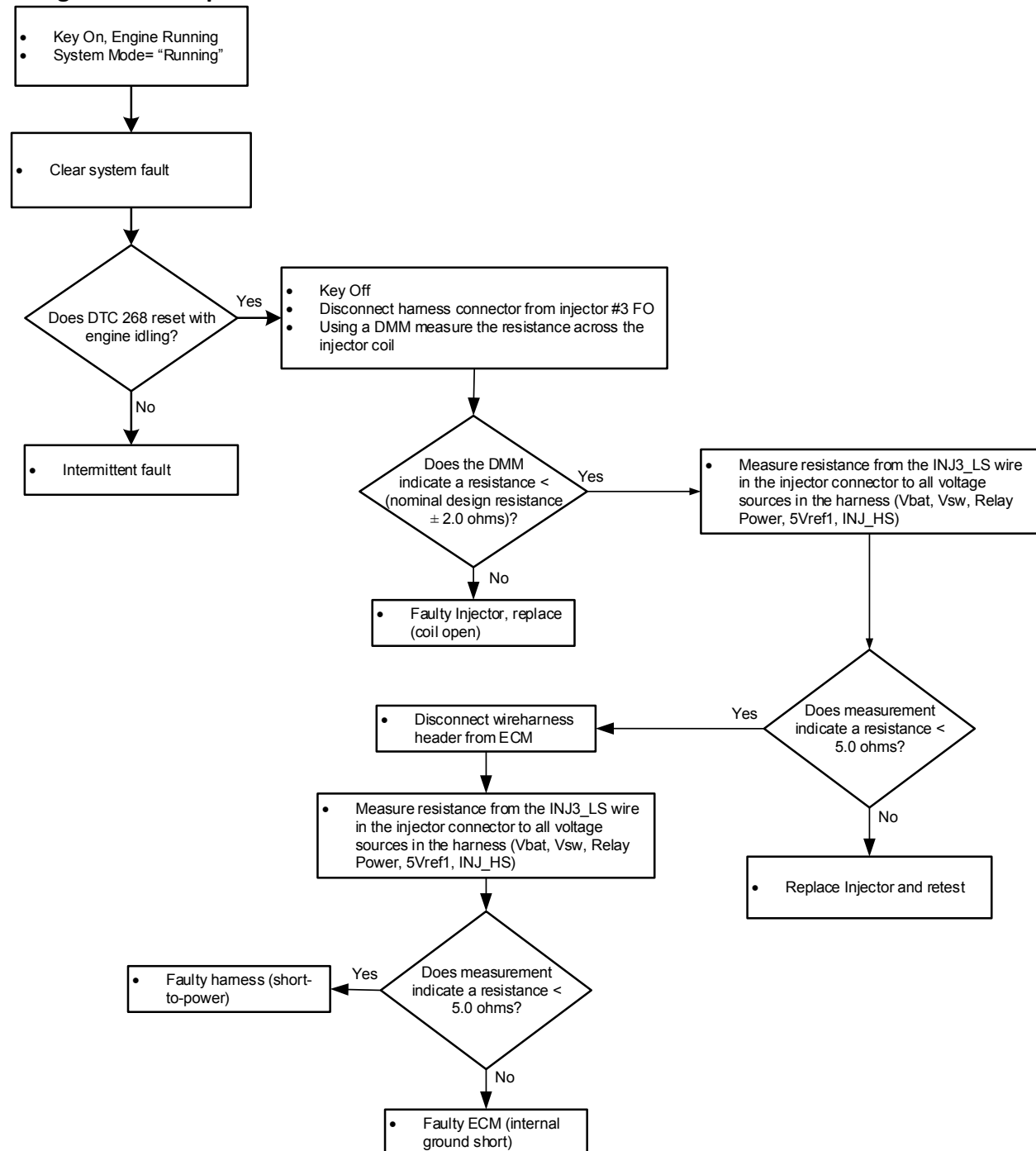
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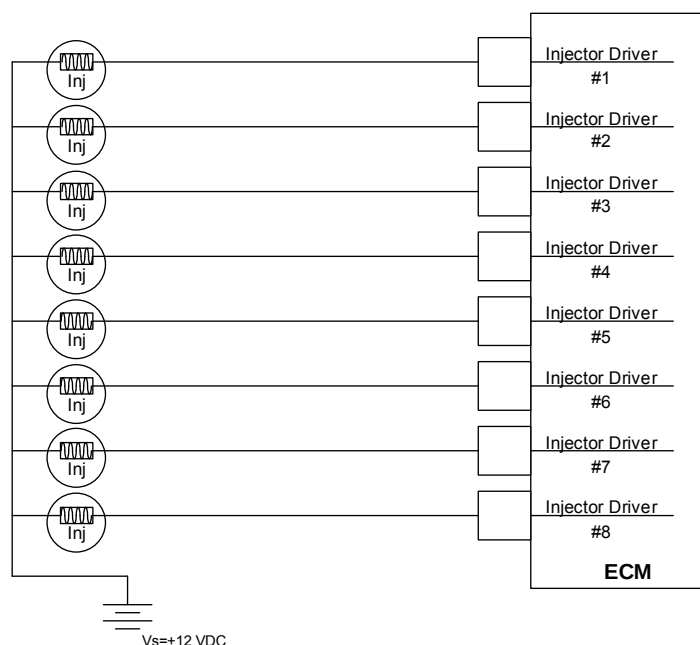
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 268 - INJECTOR COIL SHORTED (CYLINDER 3) (TROUBLE TREE)**Firing Order Example**

DTC 270 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 4)

DTC	270	SPN	654	FMI	5
Hardware: Injector #4 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 4 th injector in the firing order or for the injector on cylinder #4 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

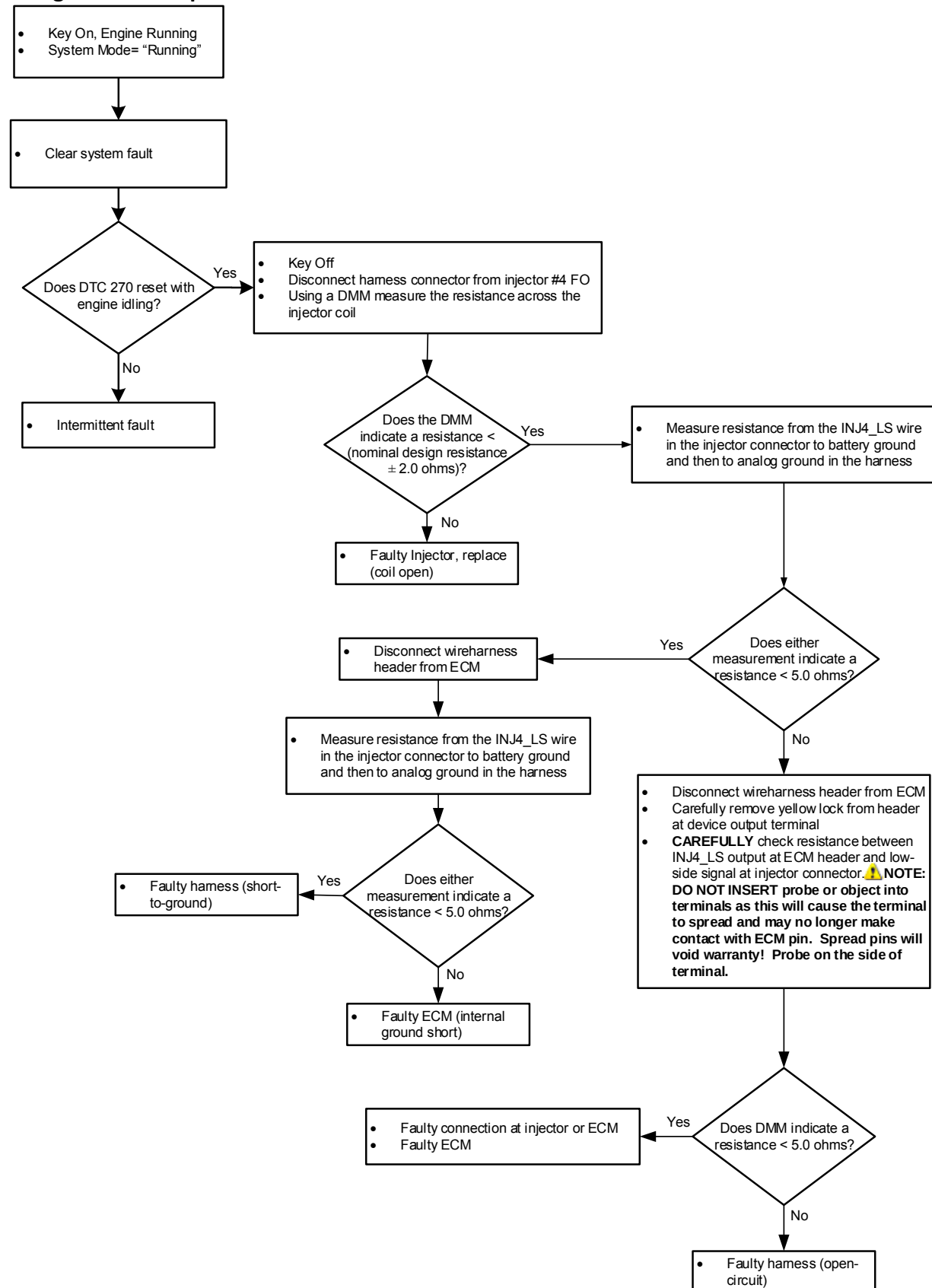
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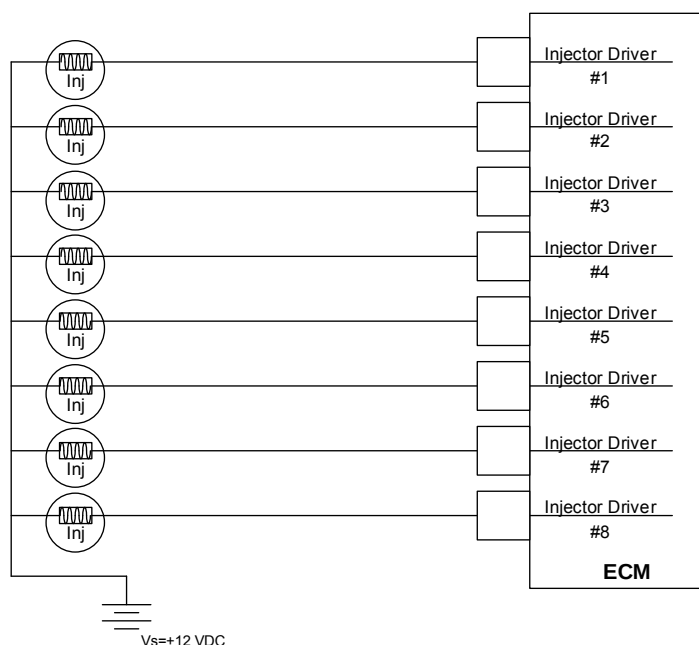
Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 270 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 4)**Firing Order Example**

DTC 271 - INJECTOR COIL SHORTED (CYLINDER 4)

DTC	271	SPN	654	FMI	6
Hardware: Injector #4 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 4 th injector in the firing order or for the injector on cylinder #4 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

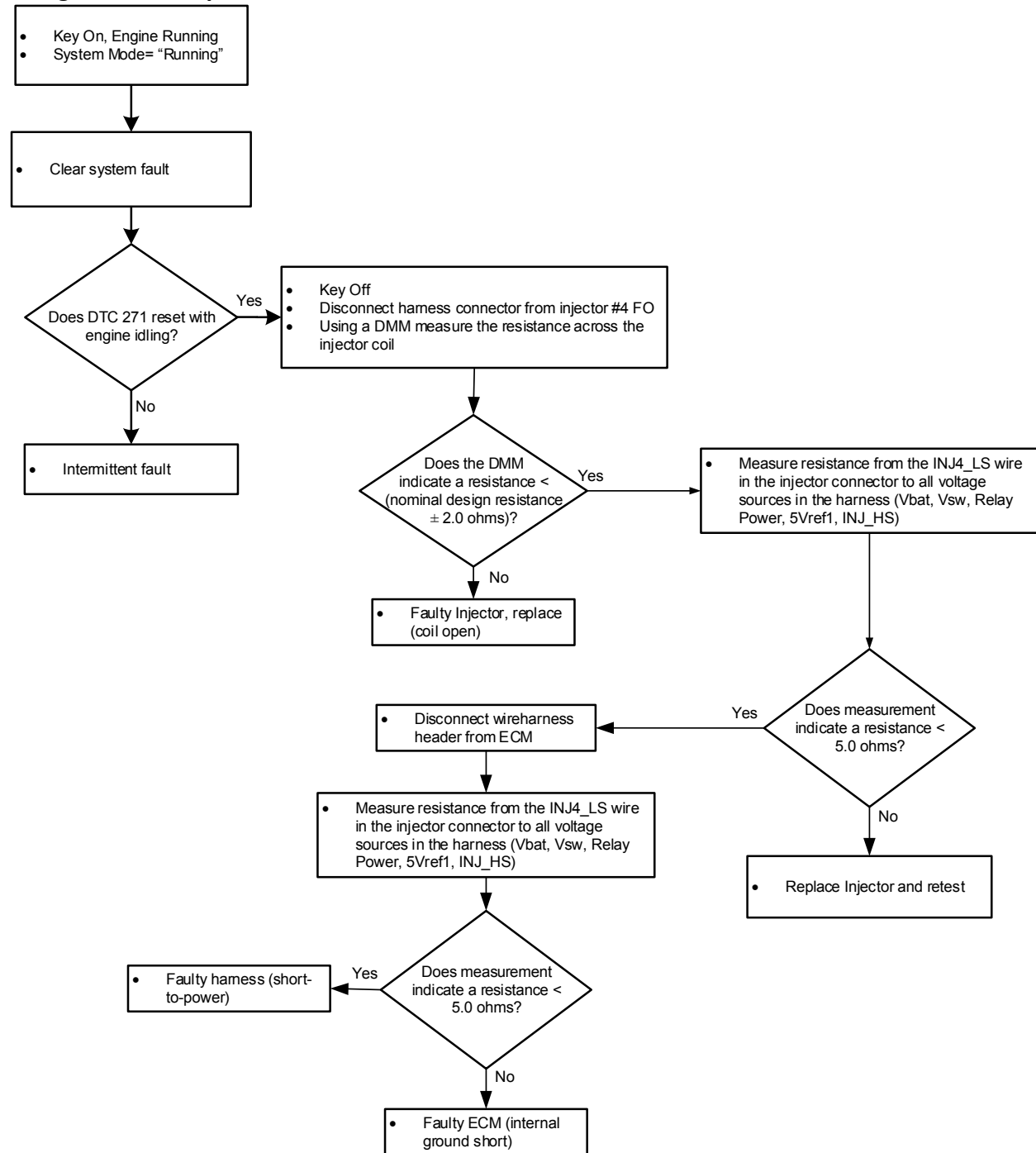
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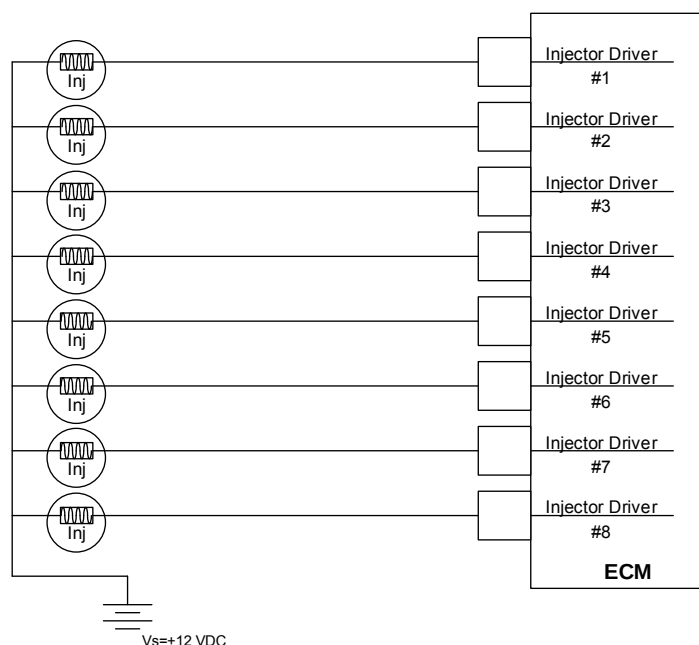
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 271 - INJECTOR COIL SHORTED (CYLINDER 4) (TROUBLE TREE)**Firing Order Example**

DTC 273 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 5)

DTC	273	SPN	655	FMI	5
Hardware: Injector 5 Coil or Driver Open Circuit or Short-to-Ground					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 5 th injector in the firing order or for the injector on cylinder #5 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

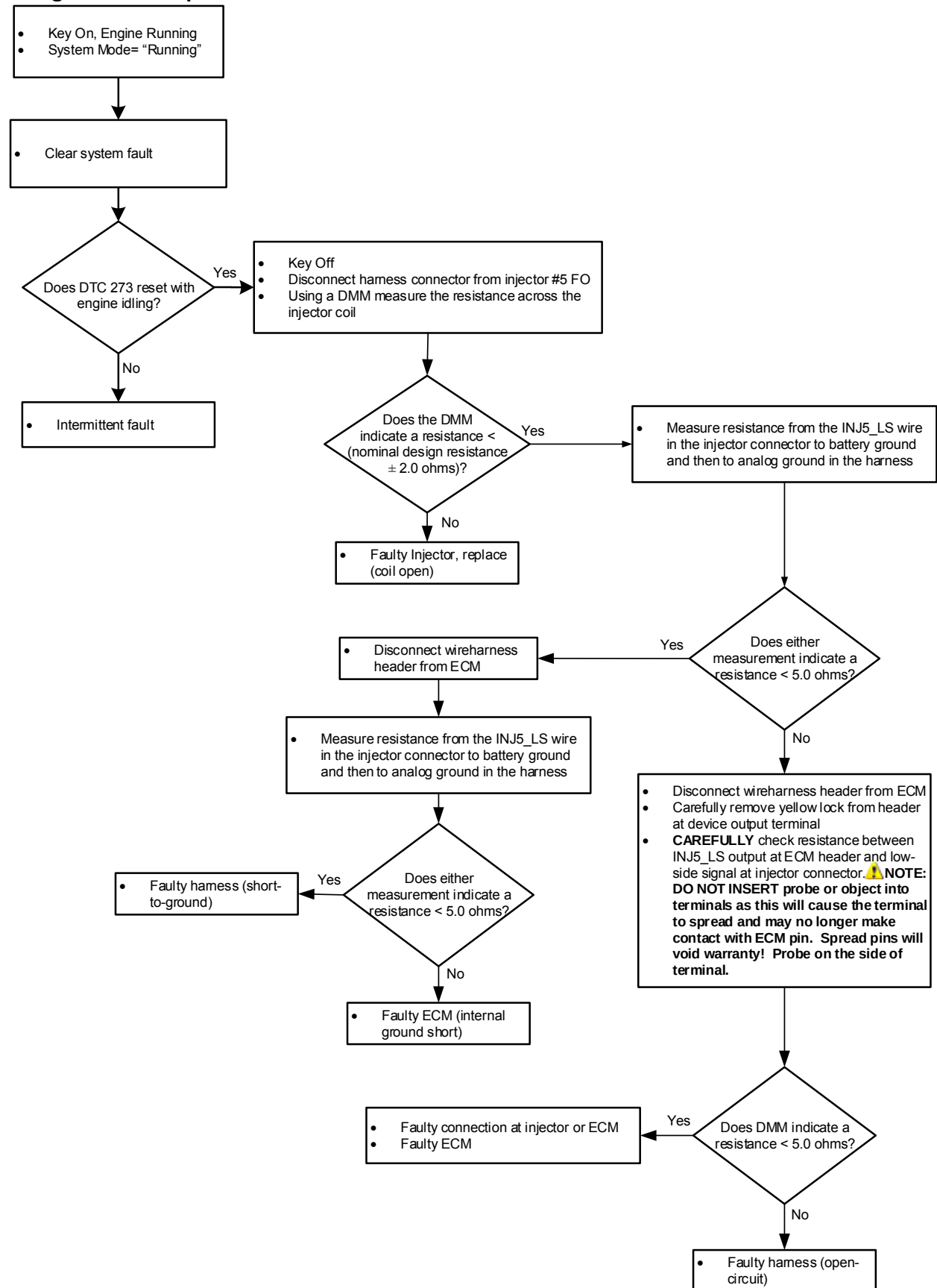
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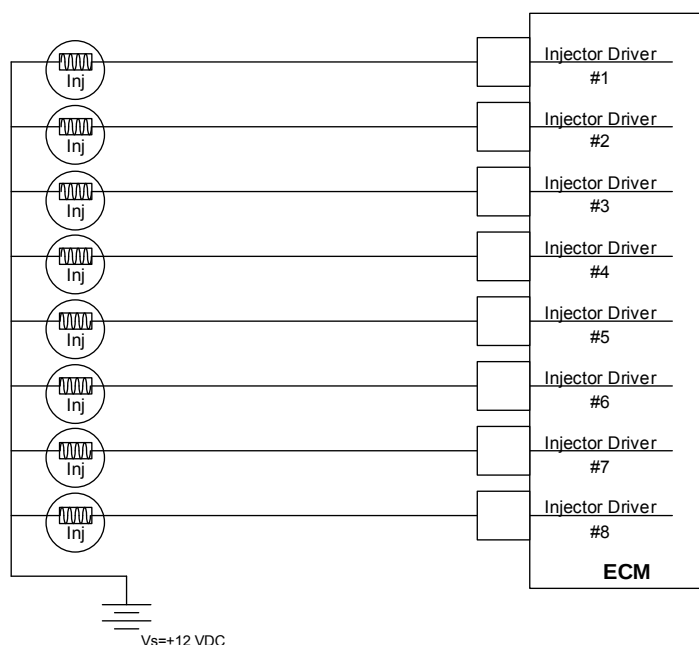
Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 273 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 5)**Firing Order Example**

DTC 274 - INJECTOR COIL SHORTED (CYLINDER 5)

DTC	274	SPN	655	FMI	6
Hardware: Injector #5 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 5 th injector in the firing order or for the injector on cylinder #5 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

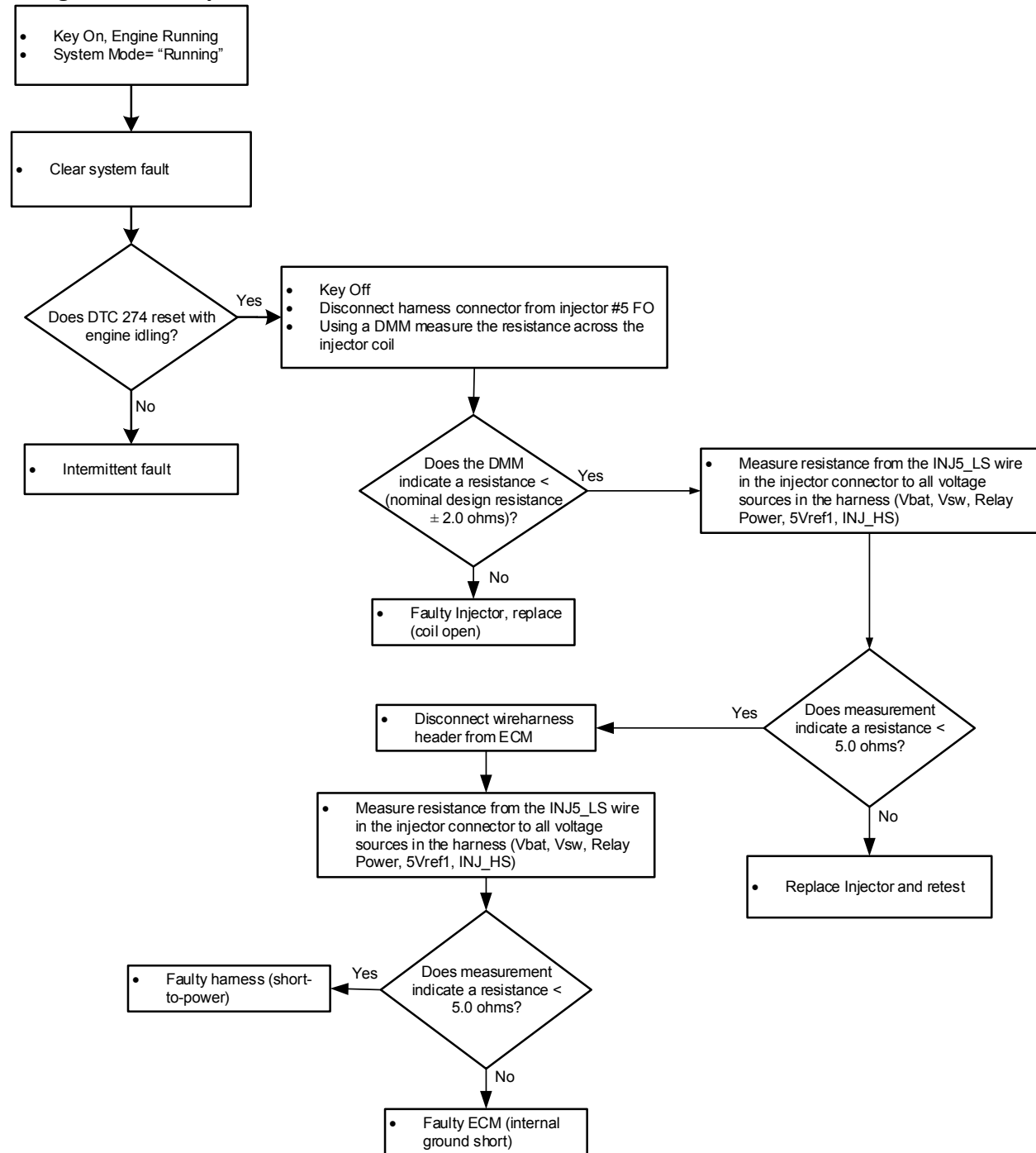
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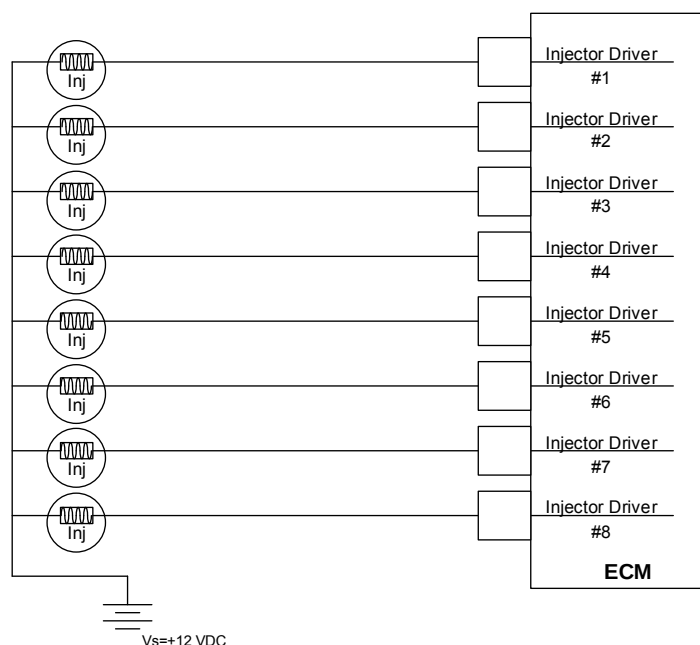
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 274 - INJECTOR COIL SHORTED (CYLINDER 5) (TROUBLE TREE)**Firing Order Example**

DTC 276 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 6)

DTC	276	SPN	656	FMI	5
Hardware: Injector #6 Coil or Driver Open Circuit or Short-to-Ground					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 6 th injector in the firing order or for the injector on cylinder #6 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

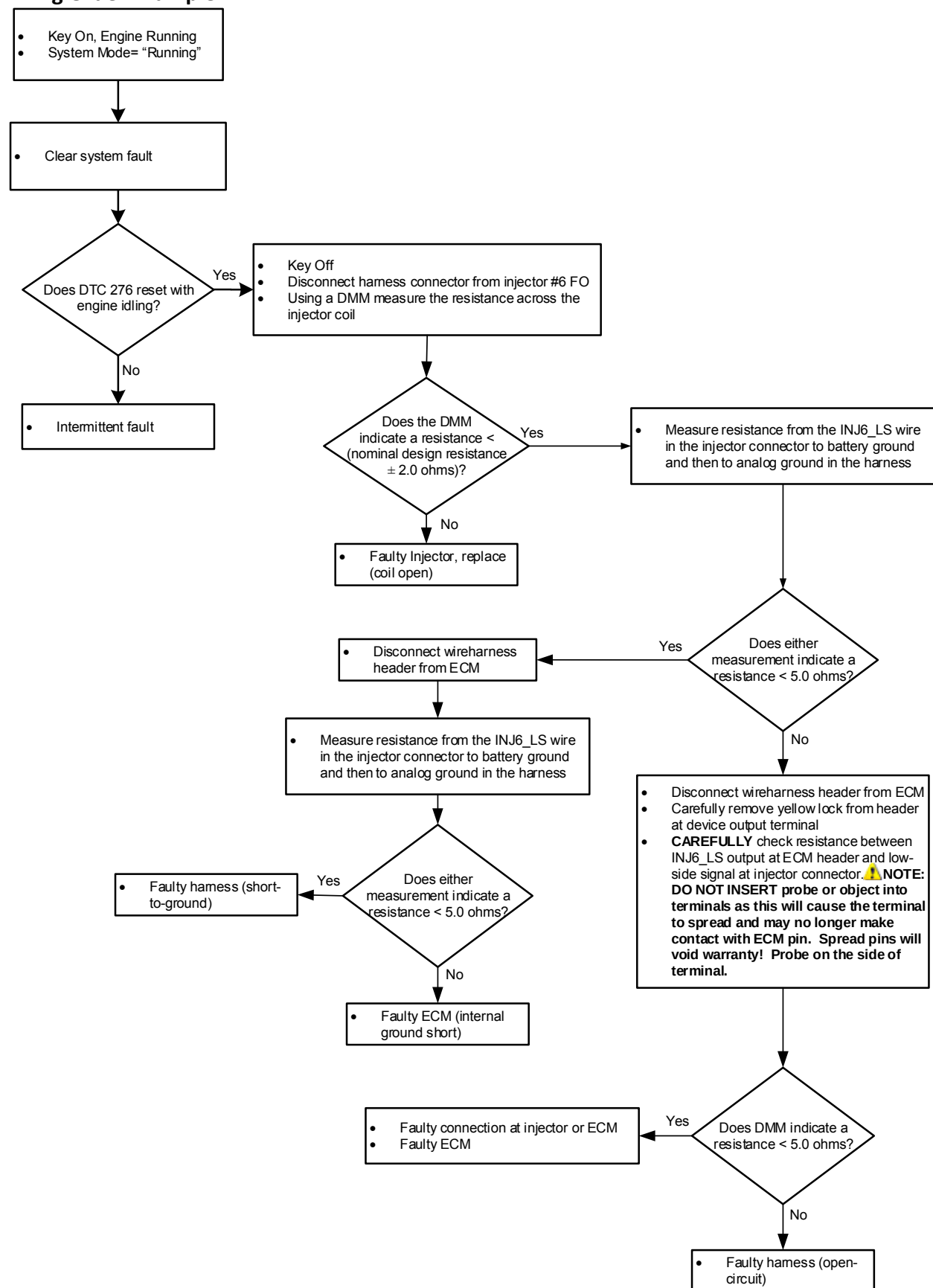
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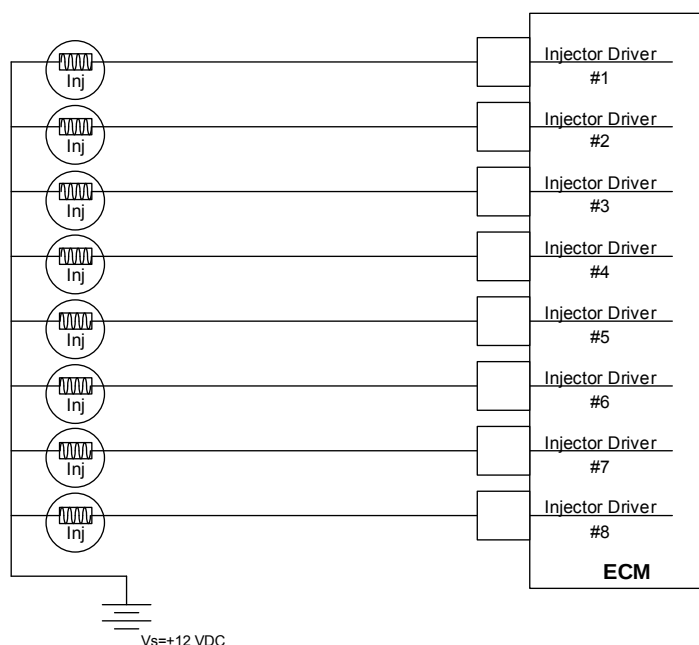
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 276 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 6)**Firing Order Example**

DTC 277 - INJECTOR COIL SHORTED (CYLINDER 6)

DTC	277	SPN	656	FMI	6
Hardware: Injector #6 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 6 th injector in the firing order or for the injector on cylinder #6 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

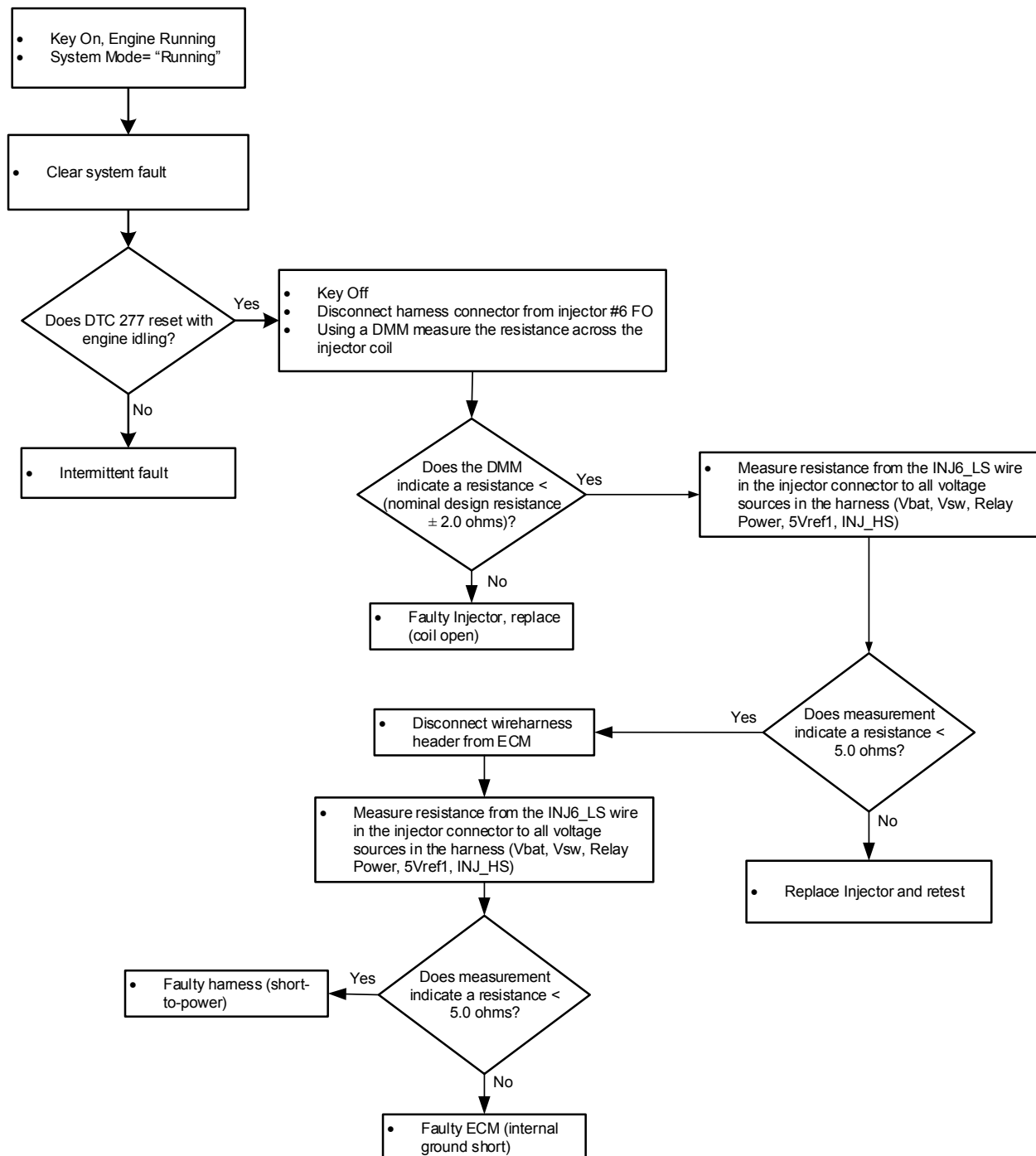
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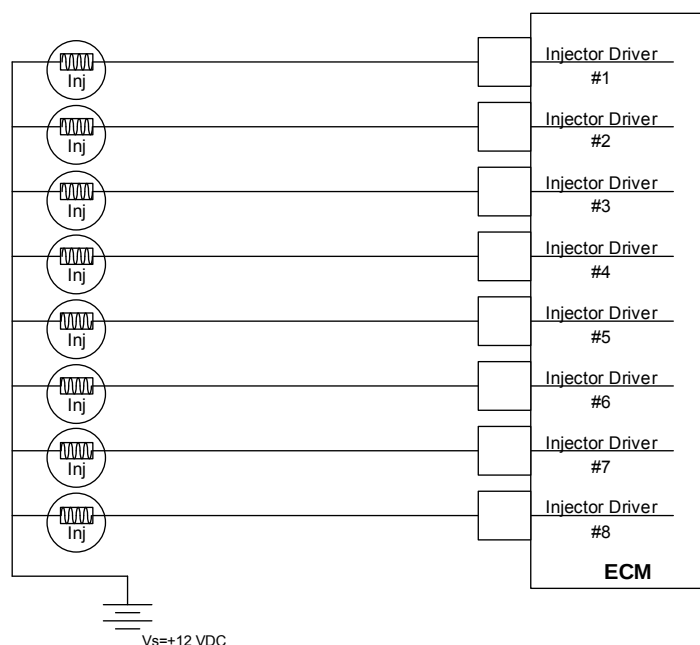
Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 277 - INJECTOR COIL SHORTED (CYLINDER 6) (TROUBLE TREE)

DTC 279 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 7)

DTC	279	SPN	657	FMI	5
Hardware: Injector #7 Coil or Driver Open Circuit or Short-to-Ground					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 7 th injector in the firing order or for the injector on cylinder #7 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

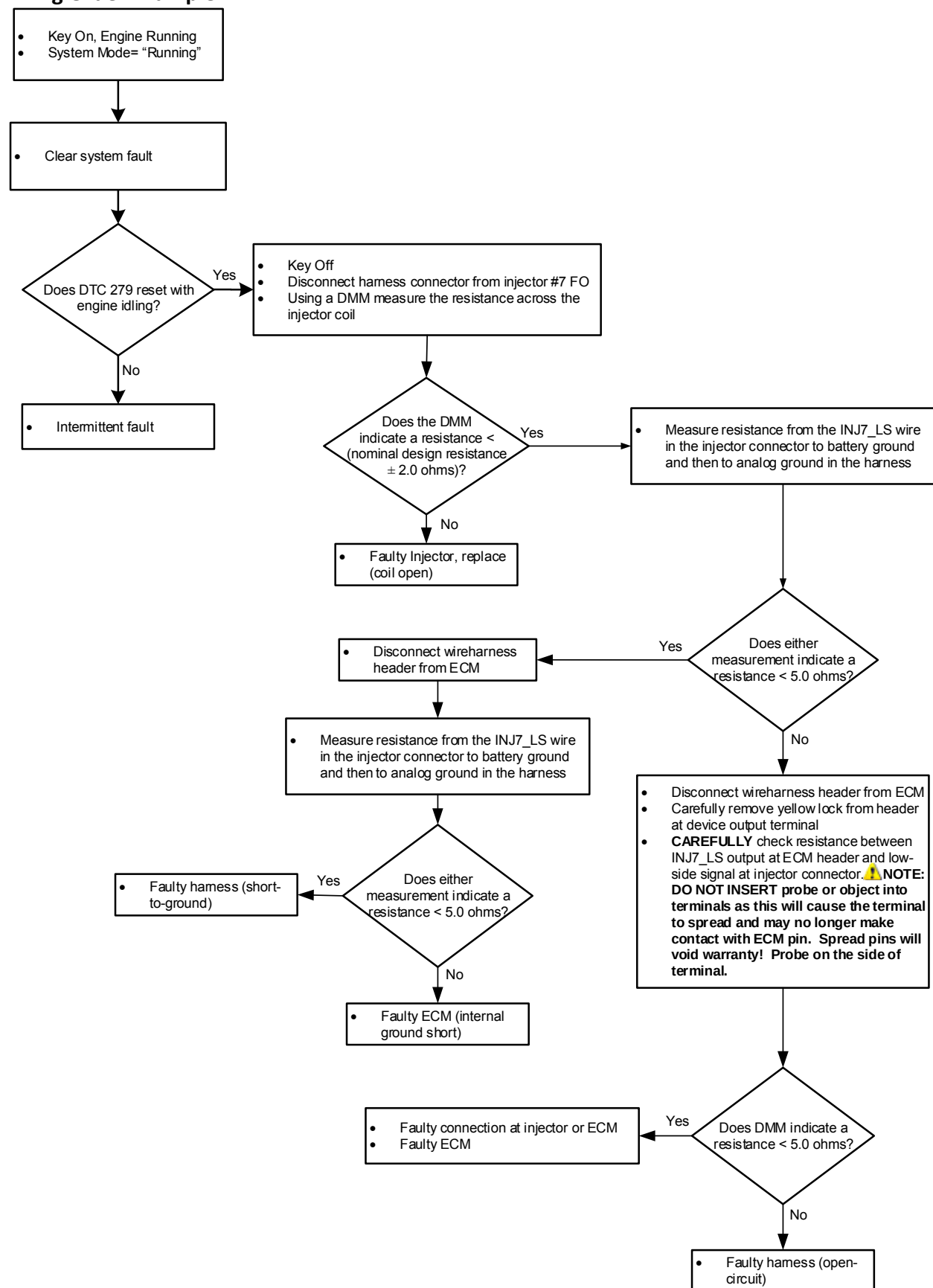
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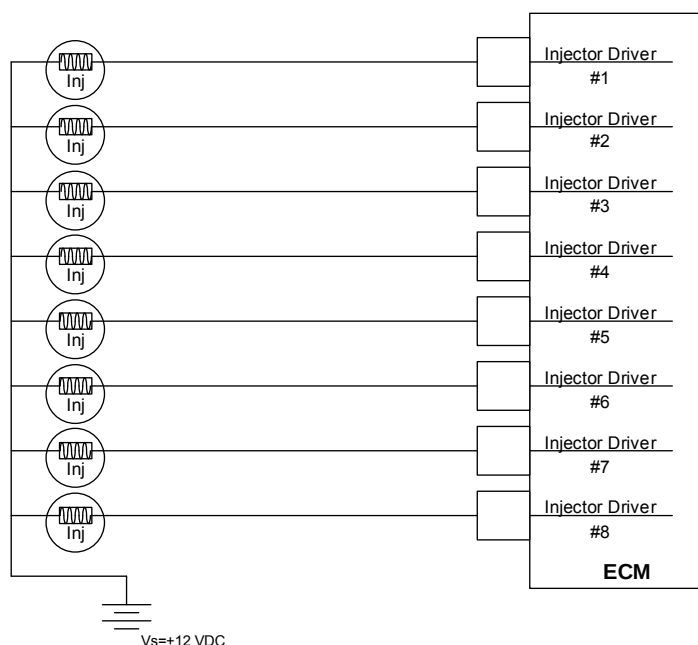
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

DTC 279 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 7)**Firing Order Example**

DTC 280 - INJECTOR COIL SHORTED (CYLINDER 7)

DTC	280	SPN	657	FMI	6
Hardware: Injector #1 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 7 th injector in the firing order or for the injector on cylinder #7 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

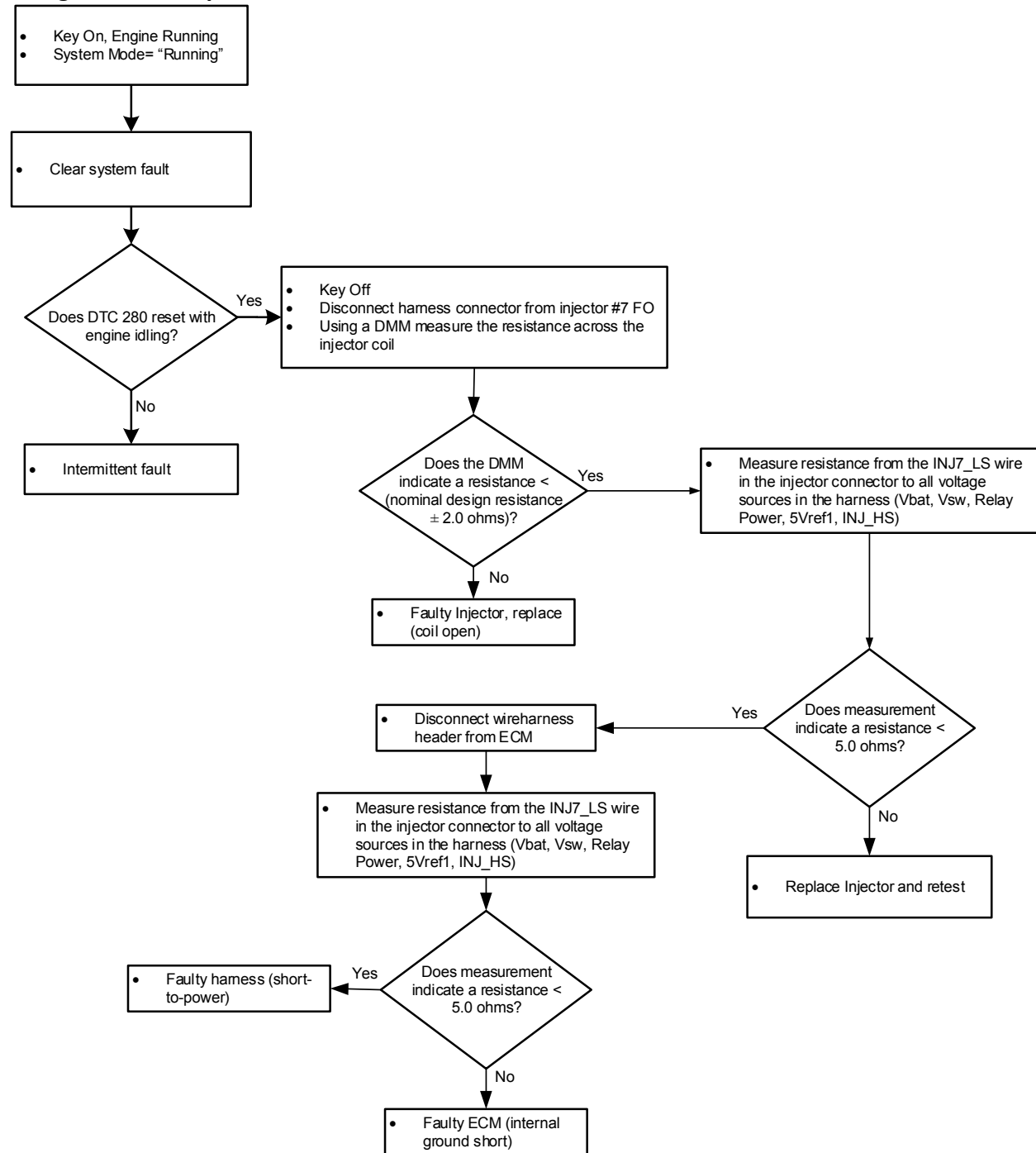
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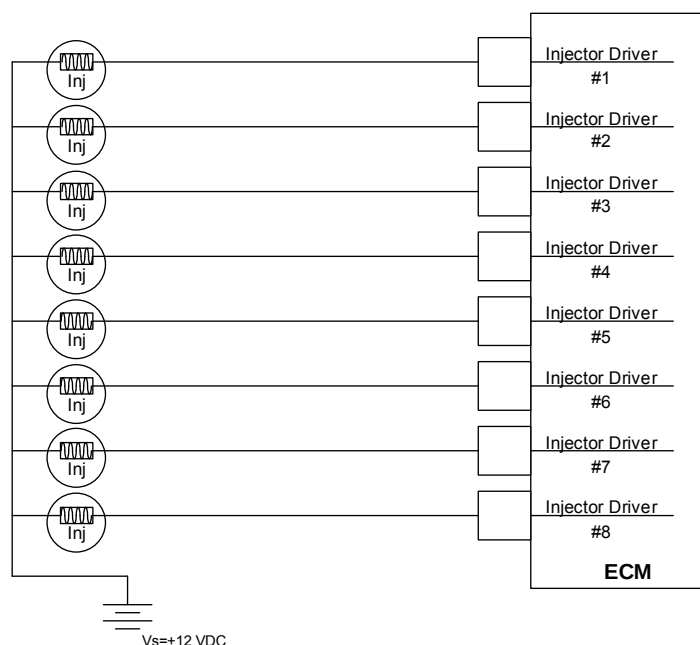
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

DTC 280 - INJECTOR COIL SHORTED (CYLINDER 7) (TROUBLE TREE)**Firing Order Example**

DTC 282 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 8)

DTC	282	SPN	658	FMI	5
Hardware: Injector #2 Coil or Driver Open Circuit or Short-to-Ground					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 8 th injector in the firing order or for the injector on cylinder #8 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

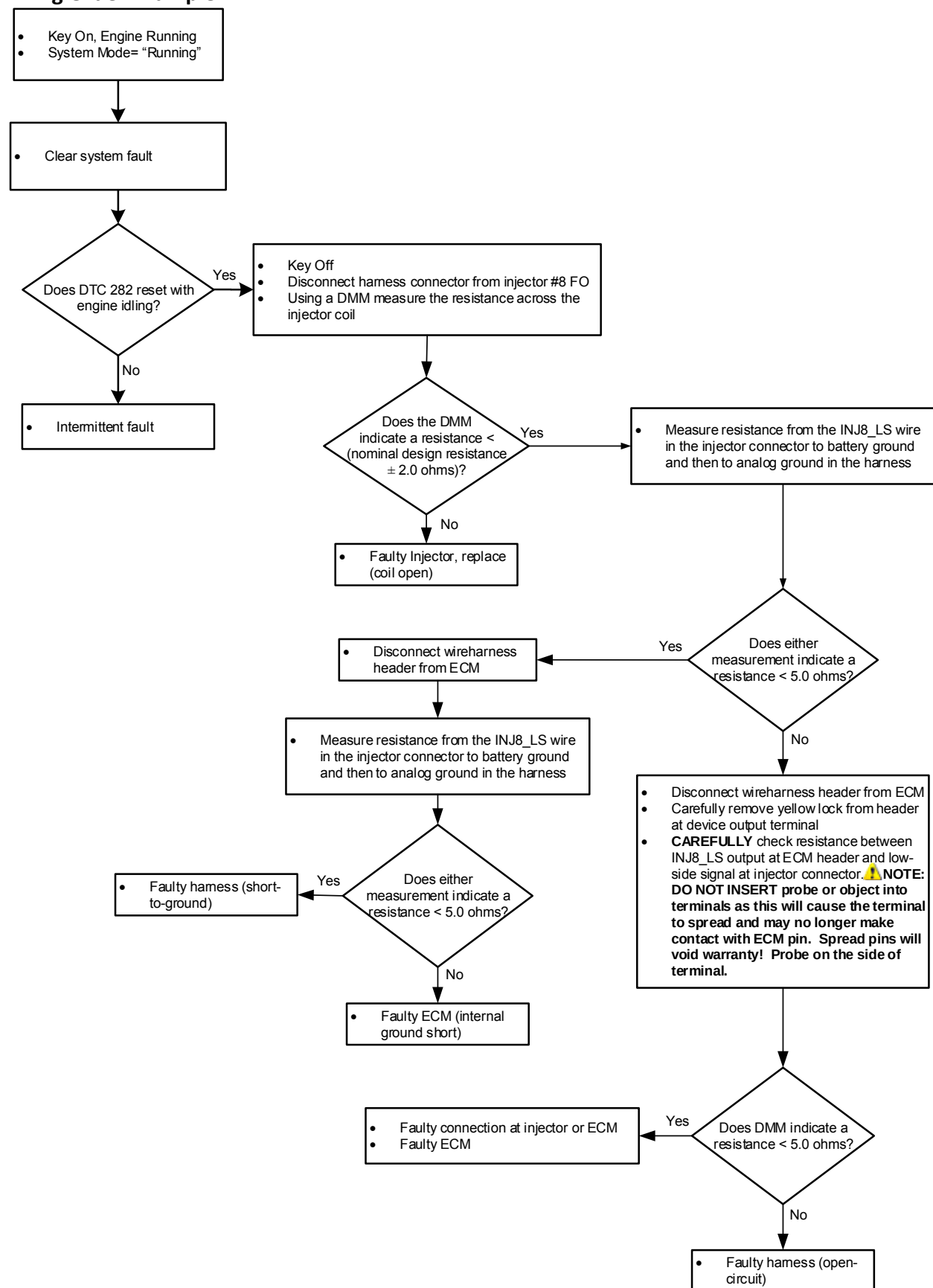
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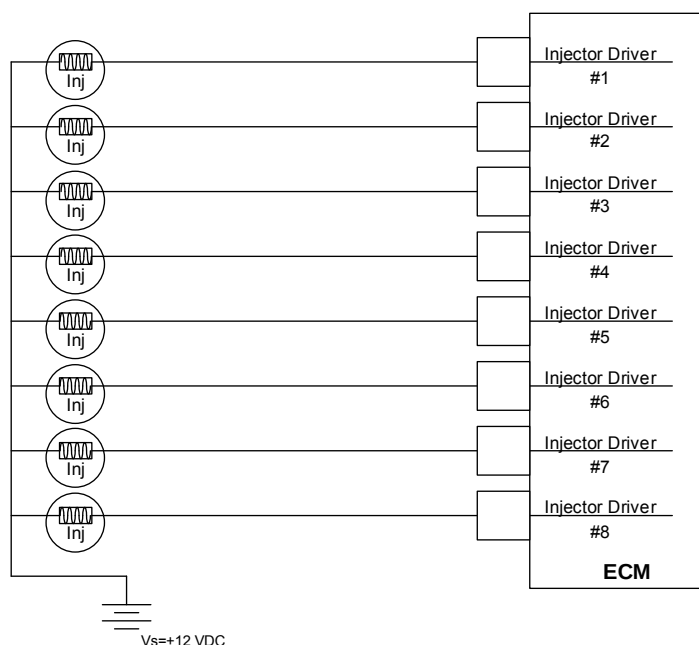
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

DTC 282 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 8)**Firing Order Example**

DTC 283 - INJECTOR COIL SHORTED (CYLINDER 8)

DTC	283	SPN	658	FMI	6
Hardware: Injector #8 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 8 th injector in the firing order or for the injector on cylinder #8 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

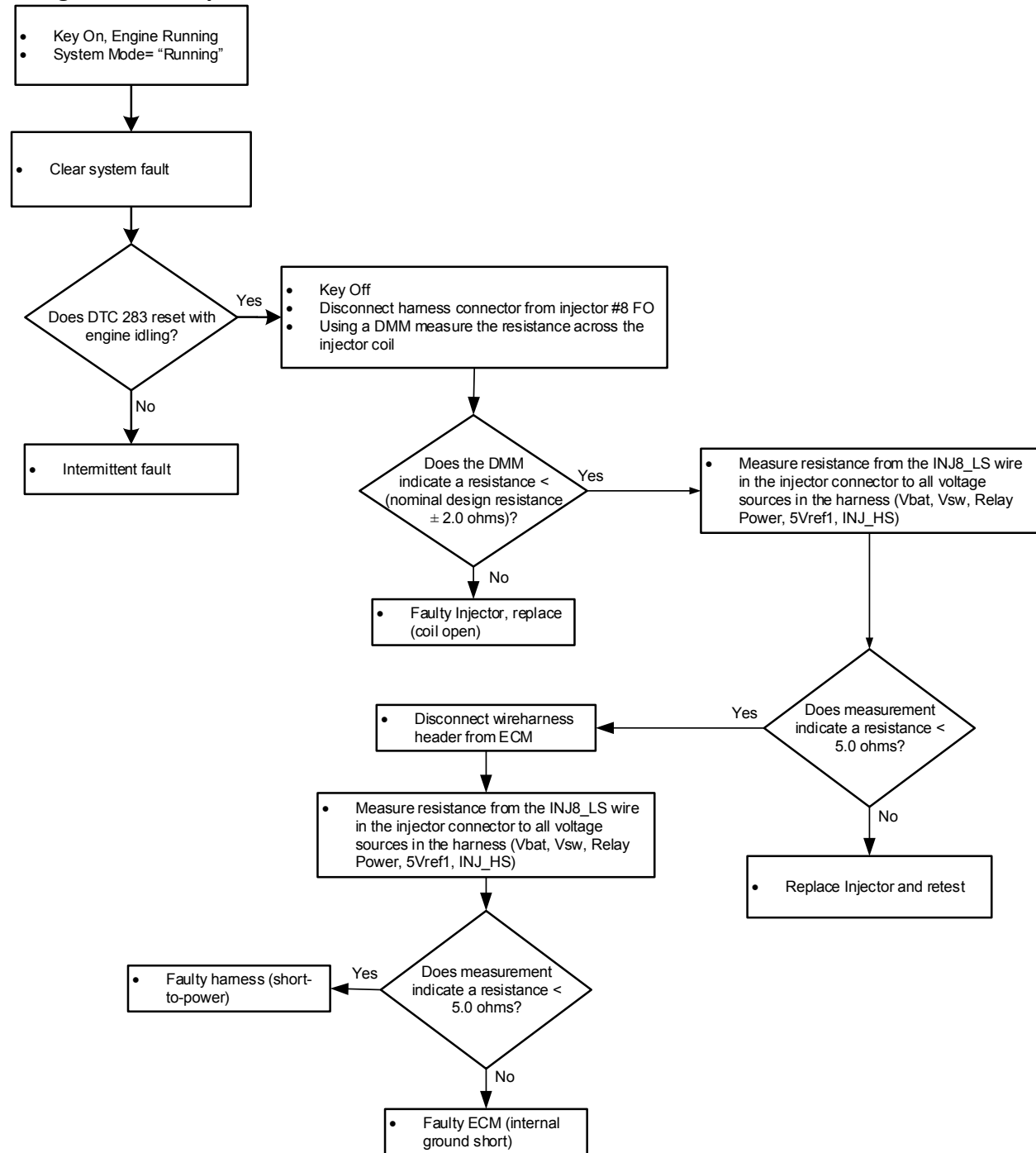
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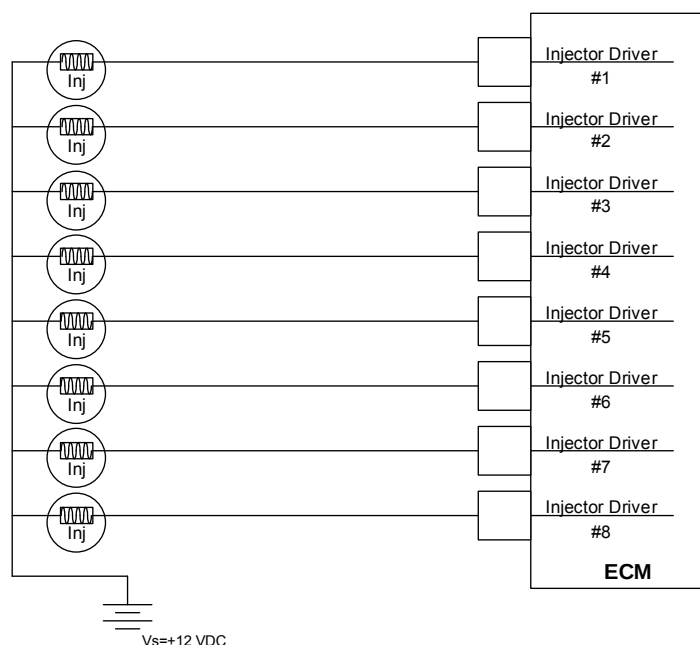
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

DTC 283 - INJECTOR COIL SHORTED (CYLINDER 8) (TROUBLE TREE)**Firing Order Example**

DTC 285 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 9)

DTC	285	SPN	659	FMI	5
Hardware: Injector #9 Coil or Driver Open Circuit or Short-to-Ground					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 9 th injector in the firing order or for the injector on cylinder #9 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

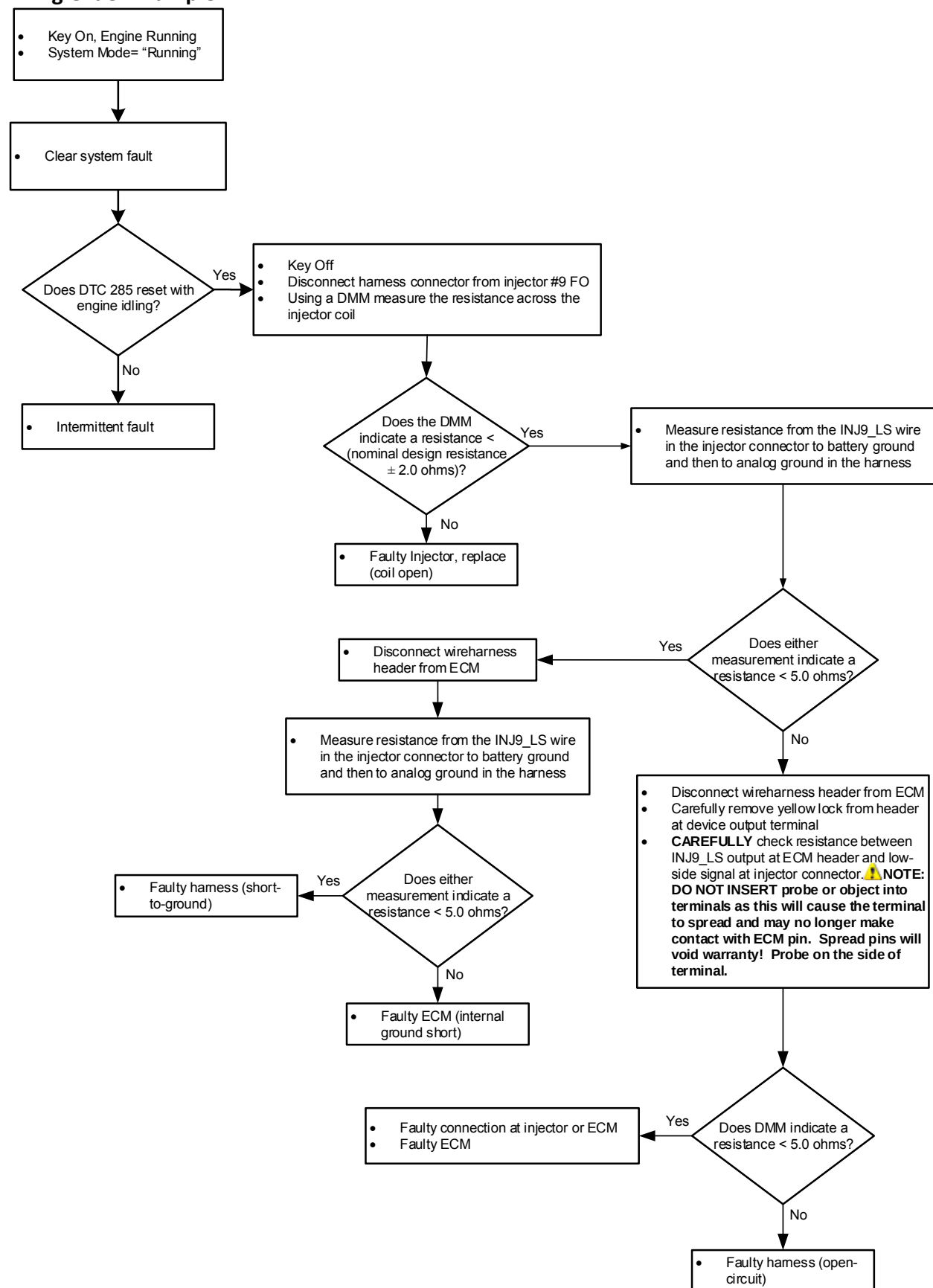
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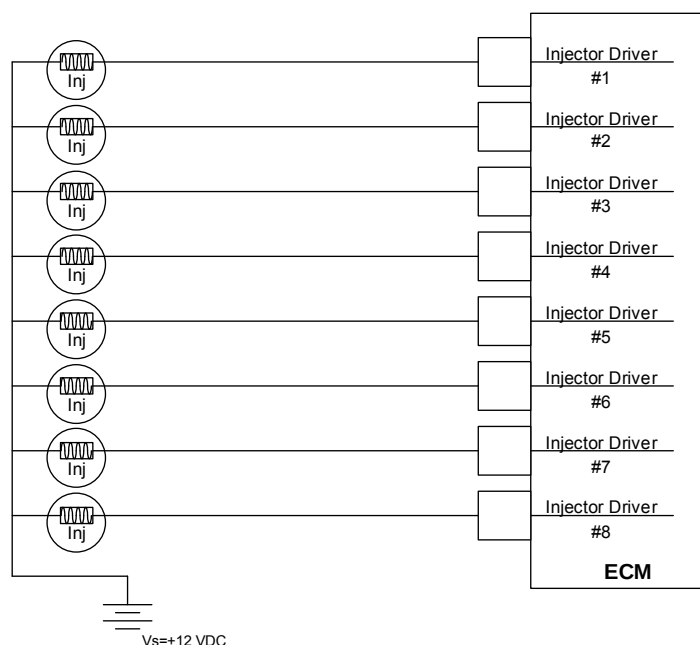
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

DTC 285 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 9)**Firing Order Example**

DTC 286 - INJECTOR COIL SHORTED (CYLINDER 9)

DTC	286	SPN	659	FMI	6
Hardware: Injector #9 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 9 th injector in the firing order or for the injector on cylinder #9 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

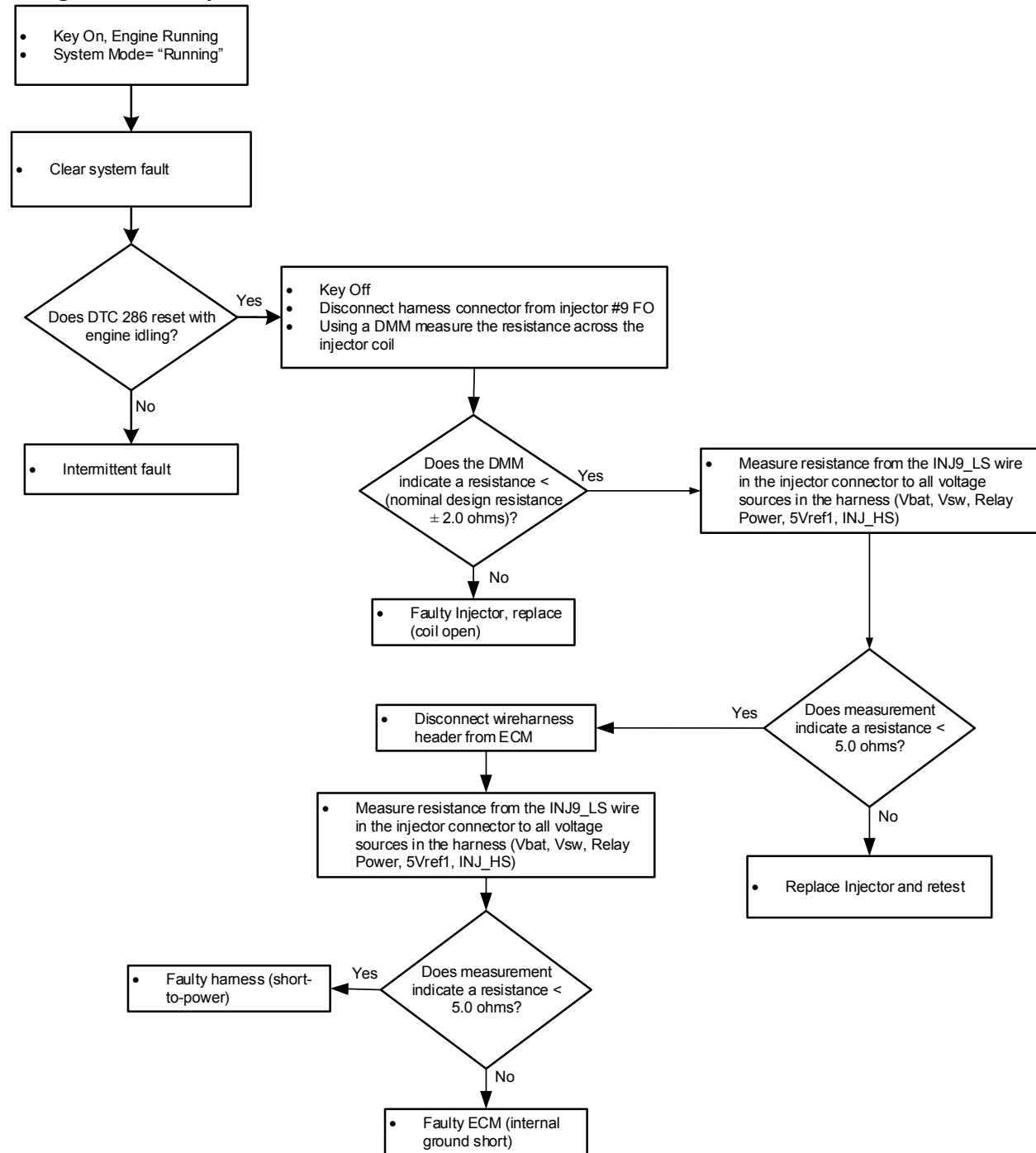
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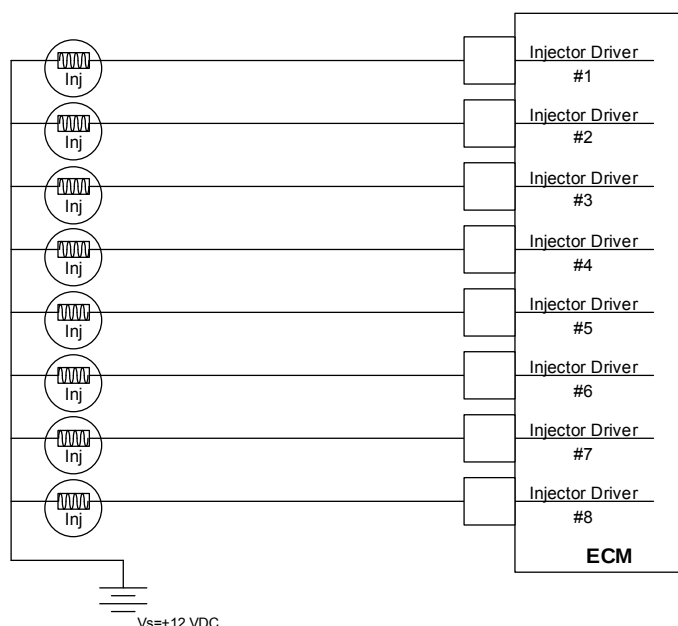
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

DTC 286 - INJECTOR COIL SHORTED (CYLINDER 9) (TROUBLE TREE)**Firing Order Example**

DTC 288 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYL. 10)

DTC	288	SPN	660	FMI	5
Hardware: Injector #10 Coil or Driver Open Circuit or Short-to-Ground					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 10 th injector in the firing order or for the injector on cylinder #10 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector off-state low-side <				TBD*	volts
• and battery voltage >				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak >				TBD*	μs
• and minimum boost voltage (target - actual) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak > "Maximum rise time to peak current*"					
• and battery voltage >				TBD*	volts

* The "Maximum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

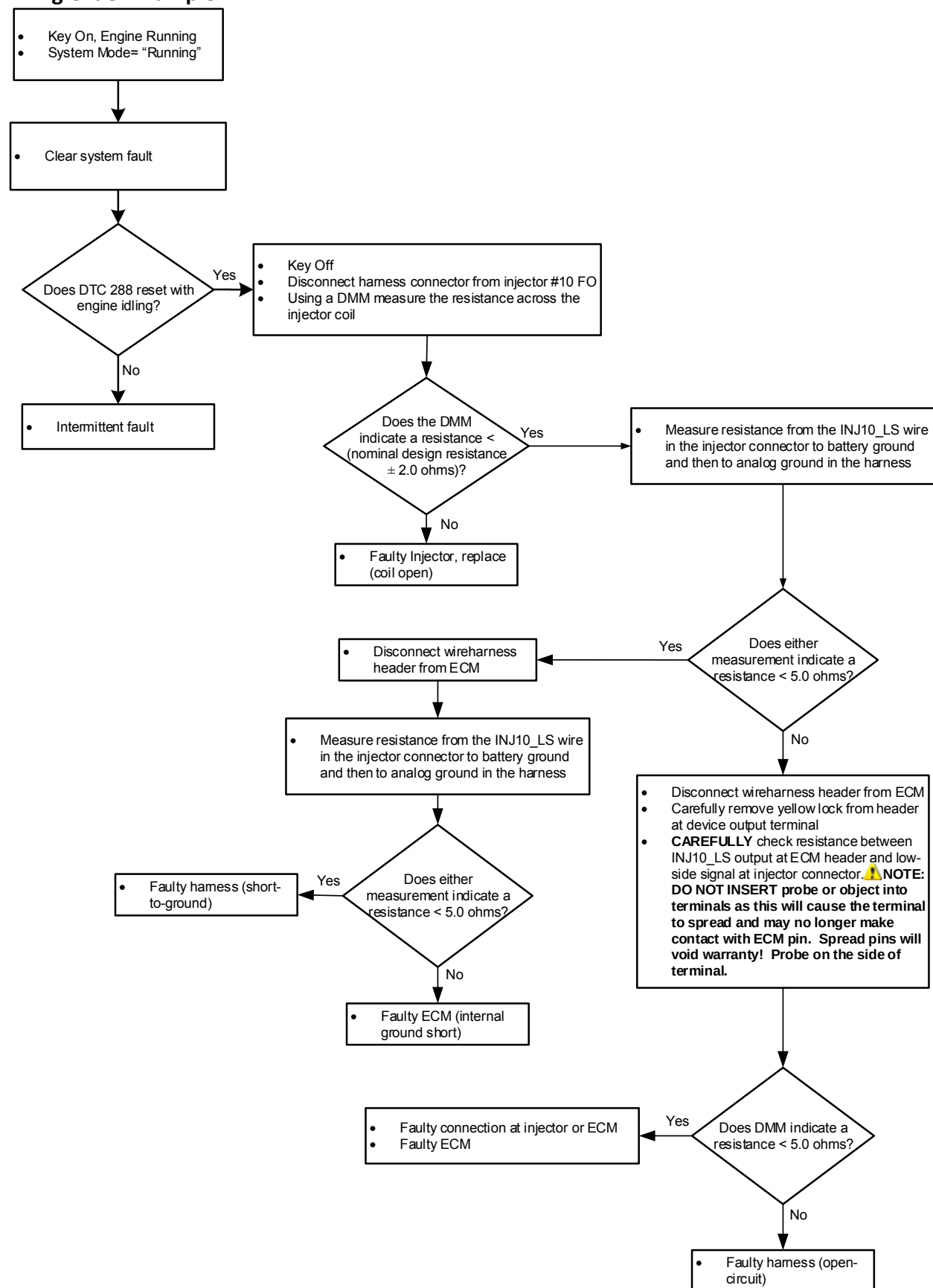
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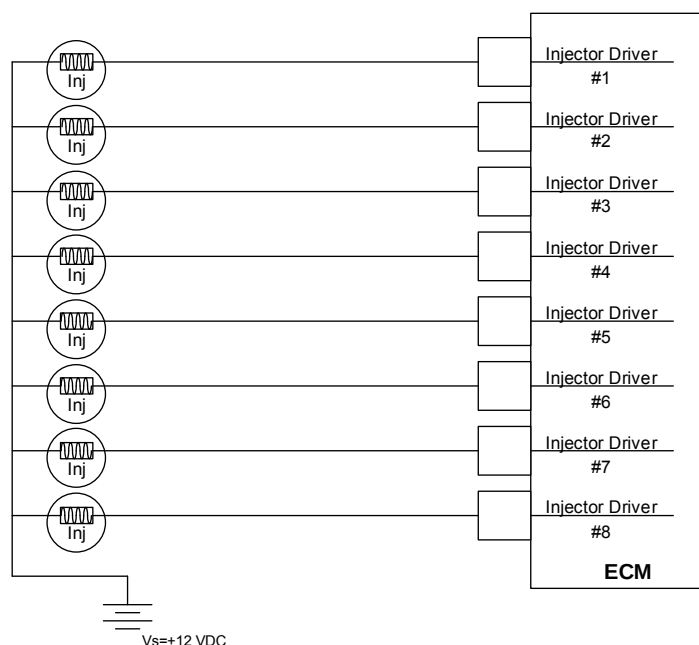
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage (y VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than x volts for the number of injector firings as defined in the diagnostic calibration.

DTC 288 - INJECTOR LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CYLINDER 10)**Firing Order Example**

DTC 289 - INJECTOR COIL SHORTED (CYLINDER 10)

DTC	289	SPN	60	FMI	6
Hardware: Injector #1 Coil or Driver					
Hardware Description: The fuel injector is an electronically controlled valve and nozzle that is controlled to deliver a precise quantity of fuel to a cylinder (Sequential Port Fuel Injection) or the entire engine (Throttle Body Injection). This fault sets for either the 10 th injector in the firing order or for the injector on cylinder #10 depending on the Firing Order/Block Order configuration of the engine's calibration.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
NON-CR INJECTOR					
• Injector on-state low-side >				TBD*	volts
• and battery voltage <				TBD*	volts
CR INJECTOR					
• Injector current rise-time to peak <				TBD*	μs
• and maximum boost voltage (actual - target) <				TBD*	volts
PEAK-AND-HOLD INJECTOR					
• Injector current rise-time to peak < "Minimum rise time to peak current"					

* The "Minimum rise time to peak current" value is specified in the "Peak and Hold Injector Driver Programming" section of the "Fuel" page.

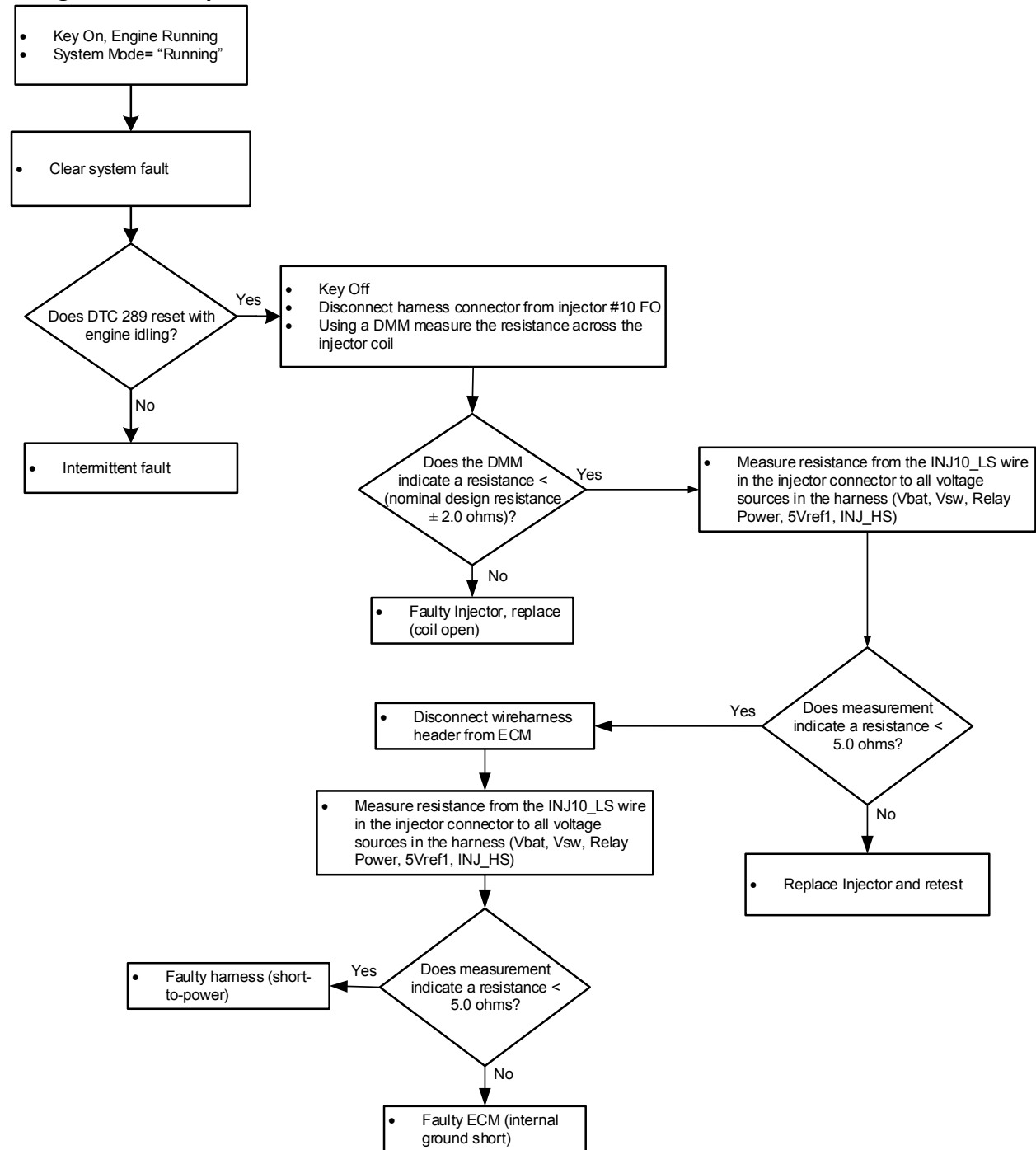
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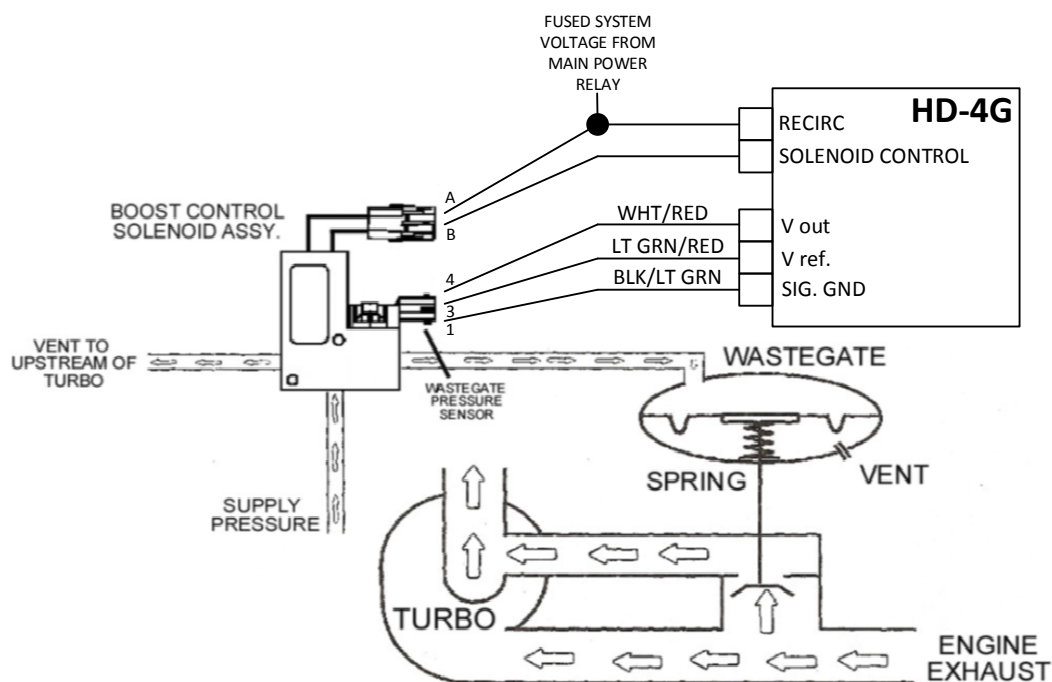
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set if the ECM detects low feedback voltage ($\underline{y}$ VDC) on the injector coil while the injector drive circuit is in the off-state and battery voltage is greater than $\underline{x}$ volts for the number of injector firings as defined in the diagnostic calibration.

DTC 289 - INJECTOR COIL SHORTED (CYLINDER 10) (TROUBLE TREE)**Firing Order Example**

DTC 299 – BOOST CONTROL UNDERBOOST FAILURE

DTC	299	SPN	102	FMI	1
Hardware: TIP sensor- boost pressure measurement					
Hardware Description: The boost control circuit uses a proportional control valve to control the pressure delivered to the wastegate. The pressure source is application specific. Typically the pressure source is either the pressure delivered by the turbo compressor or a constantly regulated ‘ON Vehicle’ pressure supply source (pump). The Boost control valve can proportionally route the pressure to either the wastegate or purge the pressure into the filtered ambient air stream. If the Boost control valve completely purges the supply pressure, the spring within the wastegate holds the valve closed allowing the compressor to make maximum boost. Once pressure is applied to the wastegate, the amount of boost is reduced. The TIP sensor provides information to the ECM identifying the amount of boost available.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine Running			
Fault Set Conditions (as defined in calibration):					
• P < P target -			TBD*	psi	
• and P target >			TBD*	psia	
• and dP/dt <=			TBD*	psi/sec	
and RPM >			TBD*	rpm	
• and ECT >			TBD*	deg F	
with P = TIP (turbo) or MAP (super)					

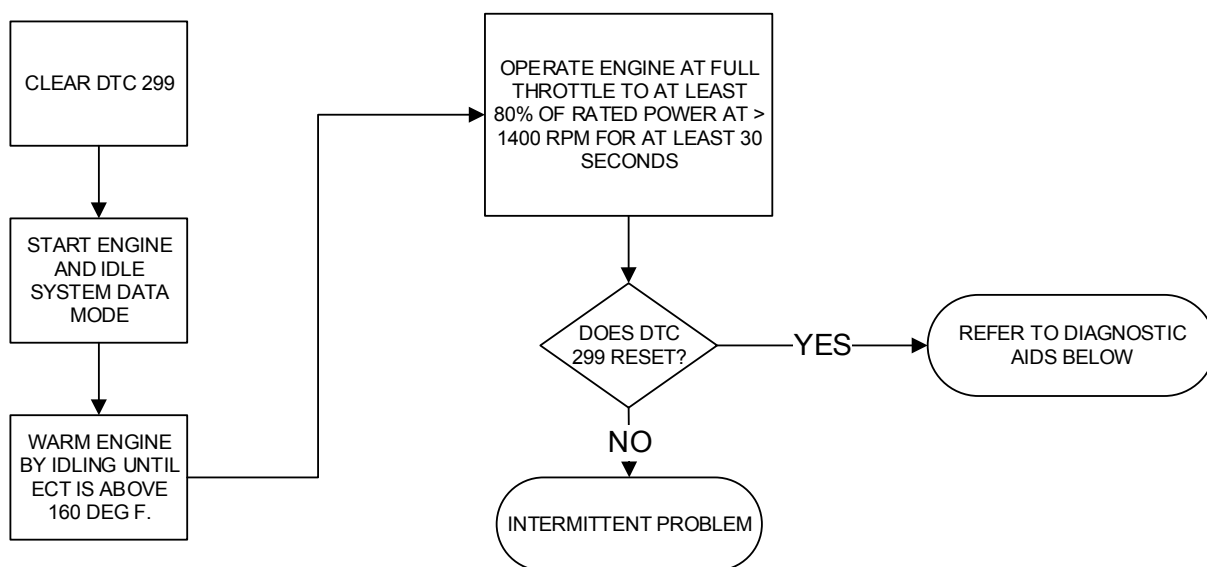
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Possible Causes:

This fault will set when the engine is running and the TIP sensor is reading x psi below the commanded level continuously for y seconds and TIP is > z psia (NOTE: x, y and z defined in diagnostic calibration). The MIL light will be illuminated for the remainder of the key on cycle, and the Adaptive Learn function will be disabled, preventing improper learning and populating of the table.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 299 – BOOST CONTROL UNDERBOOST FAILURE (TROUBLE TREE)

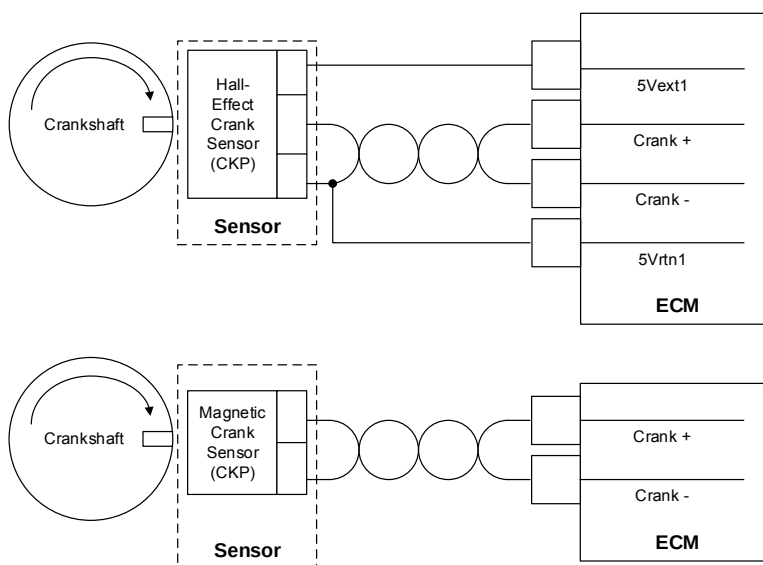
AIR INDUCTION – If the air induction systems has leaks, DTC 299 may result. Check air induction system for leaks between turbo and TIP sensor

PRESSURE REGULATOR – If the pressure regulator that reduces the vehicle air pressure down to 1.6 bar is not functioning properly and allowing too high pressure, DTC 299 may result.

PRESSURE LINES – If the vent line from the Boost Control Valve (BCV) is damaged or restricted, DTC 299 may result. Also verify the hoses are connected to the proper locations on the Boost Control Valve (BCV) and engine.

WASTEGATE – If the wastegate is stuck open or mechanically damaged, DTC 299 may result.

BOOST CONTROL VALVE – If the Boost Control Valve (BCV) valve is not operating properly, DTC 299 may result. Verify the Boost Control Valve (BCV) mechanical and electrical integrity using the WGP test in the DST. If the solenoid is stuck open, verify the electrical drive circuit and then replace the Boost Control Valve (BCV) assembly.

DTC 301 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 1)

DTC	301	SPN	1323	FMI	31
Condition: Cylinder #1 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

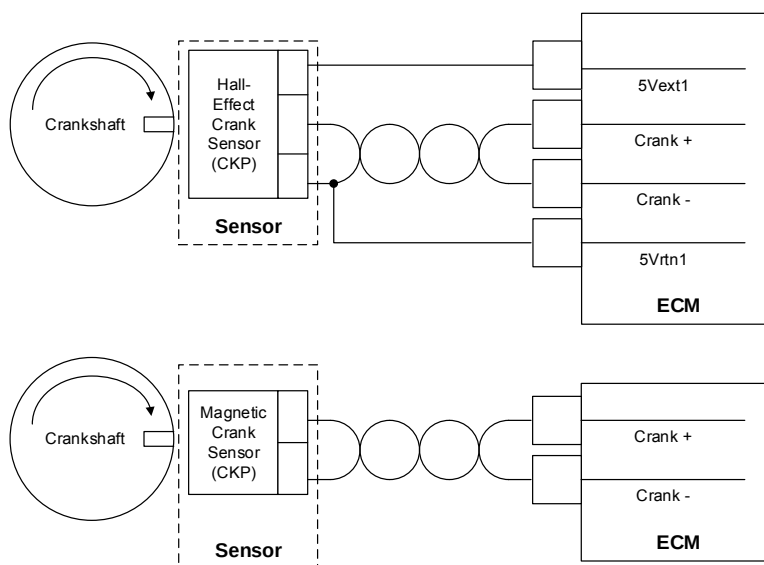
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Running					
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=		TBD*	% max				
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 301 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 1) (TROUBLE TREE)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 302 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 2)

DTC	302	SPN	1324	FMI	31
Condition: Cylinder #2 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

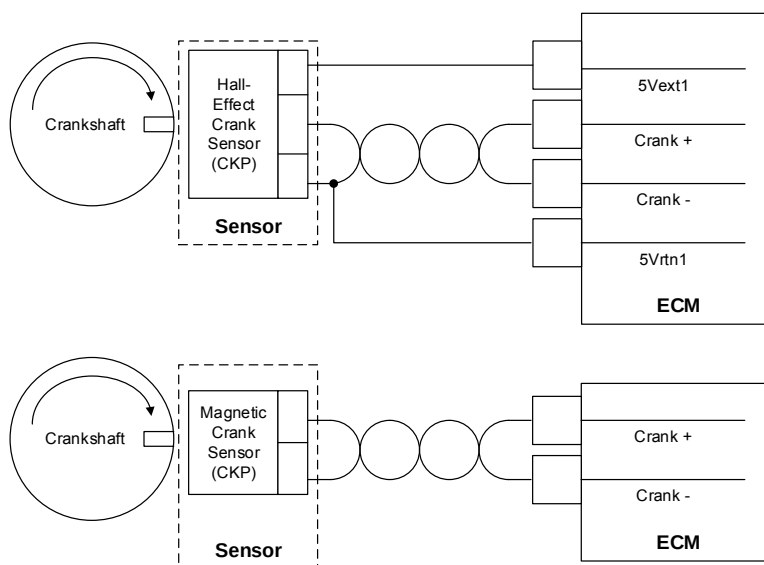
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Running					
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=		TBD*	% max				
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 302 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 2)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 303 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 3)

DTC	303	SPN	1325	FMI	31
Condition: Cylinder #3 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

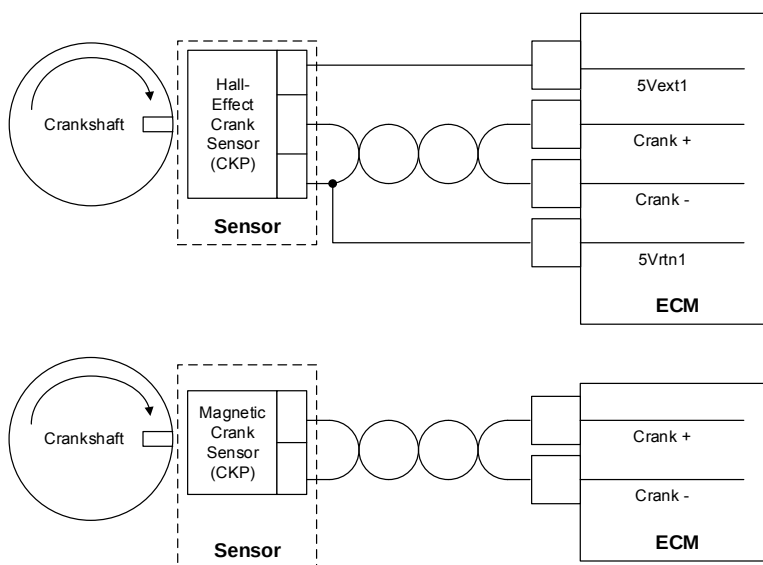
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Fault Enabled in Calibration?	TBD* (*Application-Specific – see calibration)						
Emissions-related Fault?	YES						
Check Condition:	Key On, Engine Running						
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=	TBD*	% max					
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.							
This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 303 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 3)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 304 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 4)

DTC	304	SPN	1326	FMI	31
Condition: Cylinder #4 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

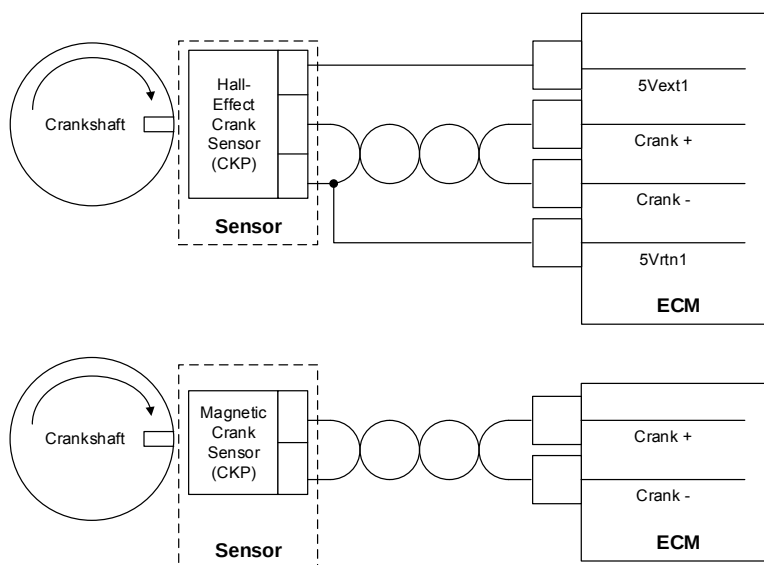
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?	TBD* (*Application-Specific – see calibration)						
Emissions-related Fault?	YES						
Check Condition:	Key On, Engine Running						
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=	TBD*	% max					
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 304 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 4)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 305 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 5)

DTC	305	SPN	1327	FMI	31
Condition: Cylinder #5 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

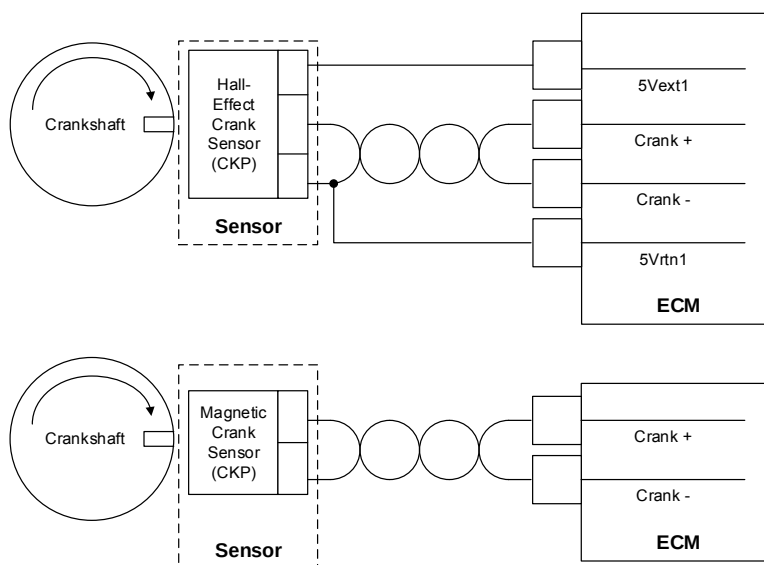
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Running					
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=		TBD*	% max				
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 305 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 5)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 306 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 6)

DTC	306	SPN	1328	FMI	31
Condition: Cylinder #6 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

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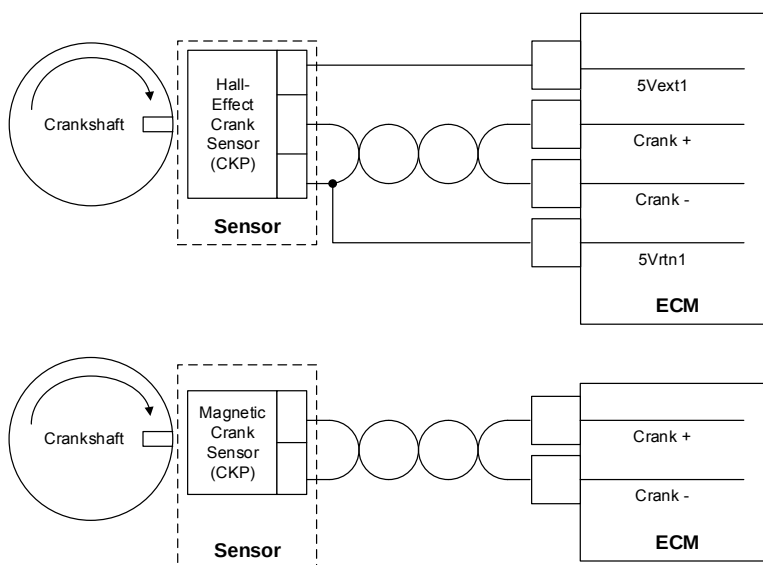
Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?	TBD* (*Application-Specific – see calibration)						
Emissions-related Fault?	YES						
Check Condition:	Key On, Engine Running						
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=	TBD*	% max					
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 306 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 6)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 307 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 7)

DTC	307	SPN	1329	FMI	31
Condition: Cylinder #7 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

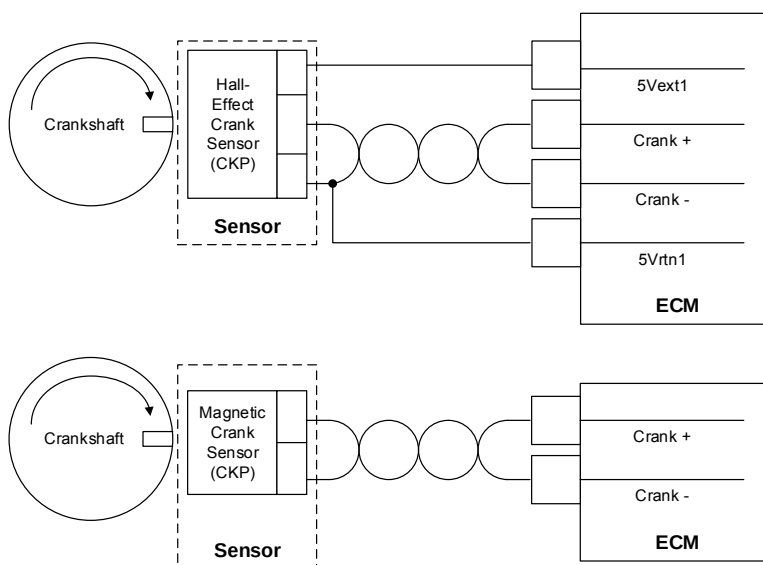
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Running					
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=		TBD*	% max				
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 307 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 7)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 308 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 8)

DTC	308	SPN	1330	FMI	31
Condition: Cylinder #8 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

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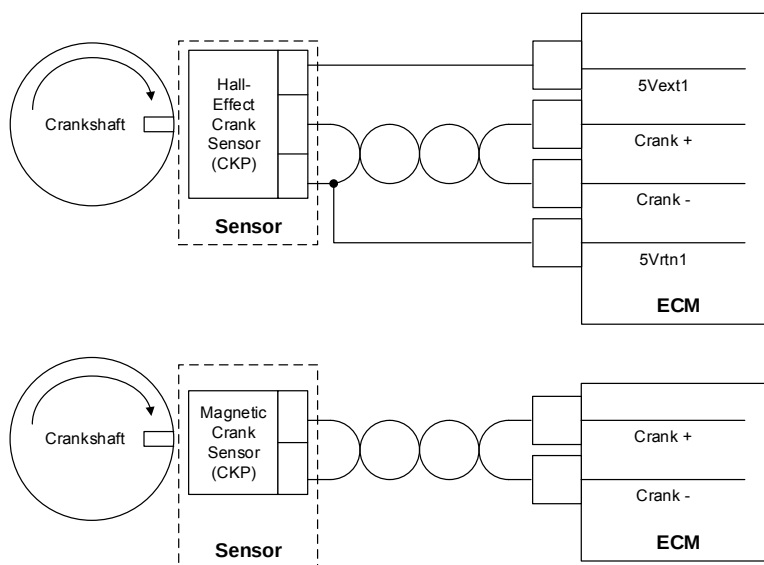
Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?	TBD* (*Application-Specific – see calibration)						
Emissions-related Fault?	YES						
Check Condition:	Key On, Engine Running						
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=	TBD*	% max					
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 308 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 8)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 309 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 9)

DTC	309	SPN	1331	FMI	31
Condition: Cylinder #9 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

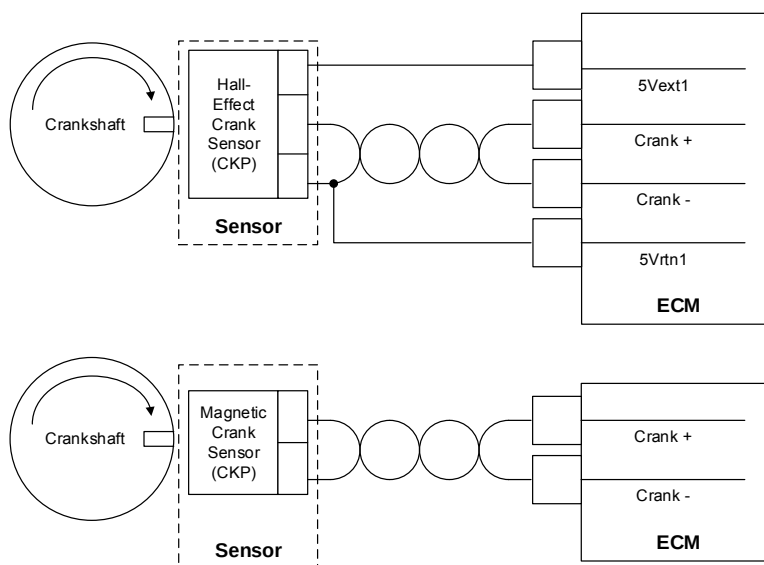
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Running					
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=		TBD*	% max				
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 309 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 9)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 310 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 10)

DTC	310	SPN	1332	FMI	31
Condition: Cylinder #10 Misfire Detected-Emissions/Catalyst Damaging					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence or misfire. Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.					

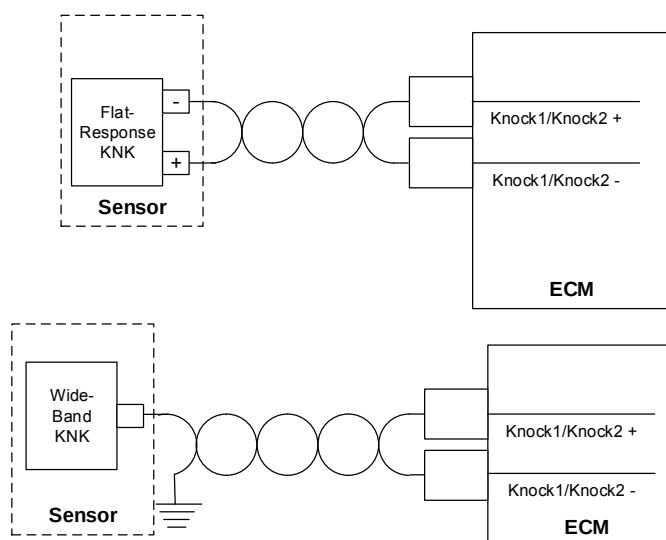
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Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Running					
Fault Set Conditions (as defined in calibration):							
• Identify cylinders misfiring >=		TBD*	% max				
Possible Causes:							
Misfire is typically a result of one or more factors. These factors can include but may not be limited to: 1) a fouled or damaged spark plug(s), 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation, 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge, 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge, 5) low fuel supply pressure resulting in multiple lean cylinders, 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression. Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected. This fault sets if the misfire counter for cylinder #1 exceeds the emissions/catalyst misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

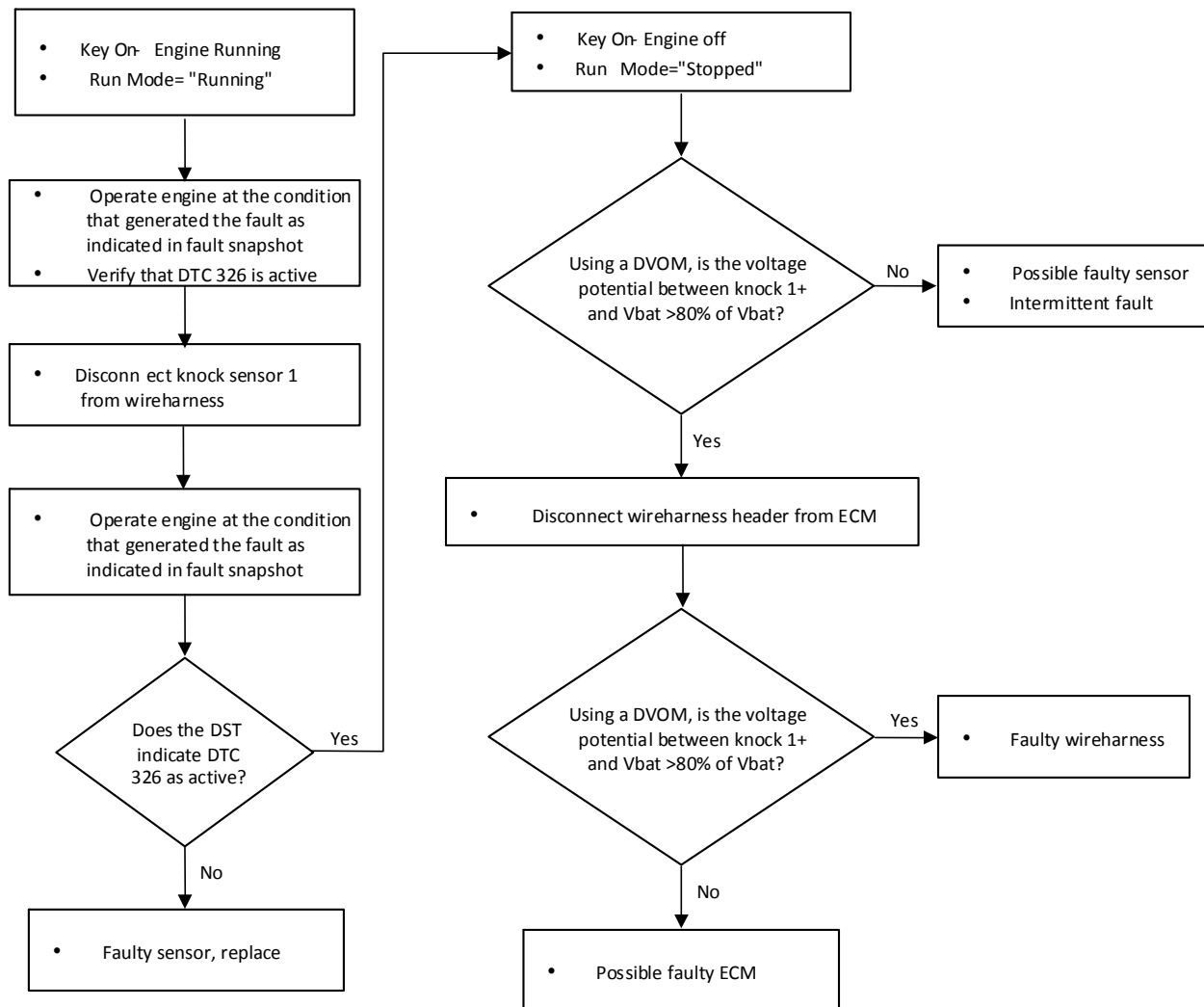
DTC 310 - EMISSIONS/CATALYST DAMAGE MISFIRE DETECTED (CYLINDER 10)**Diagnostic Aids**

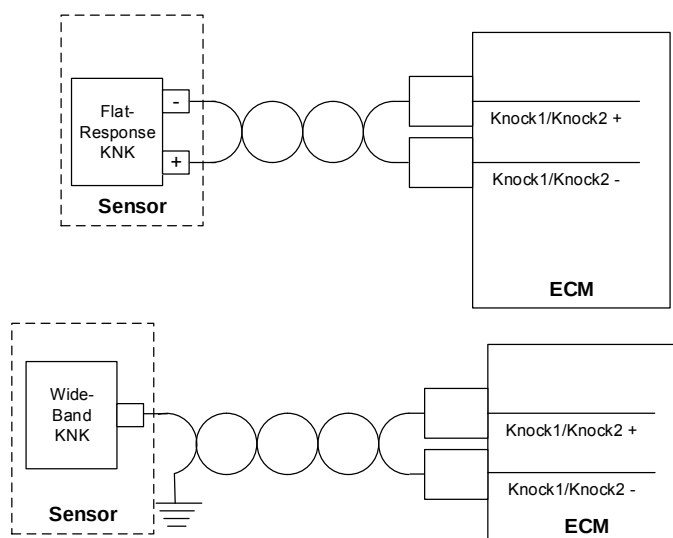
NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power- All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

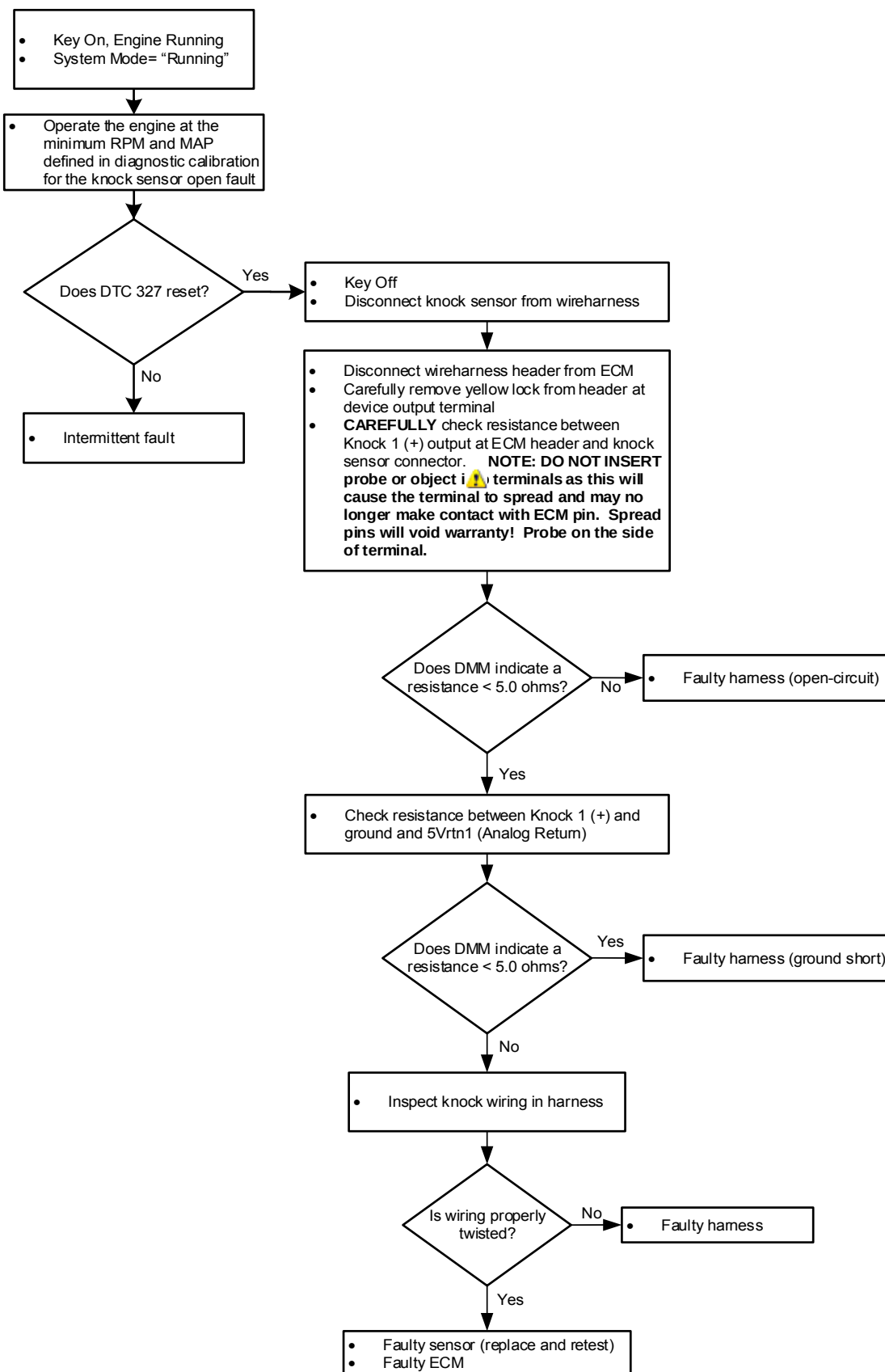
DTC 326 – KNOCK 1 EXCESSIVE OR ERRATIC SIGNAL

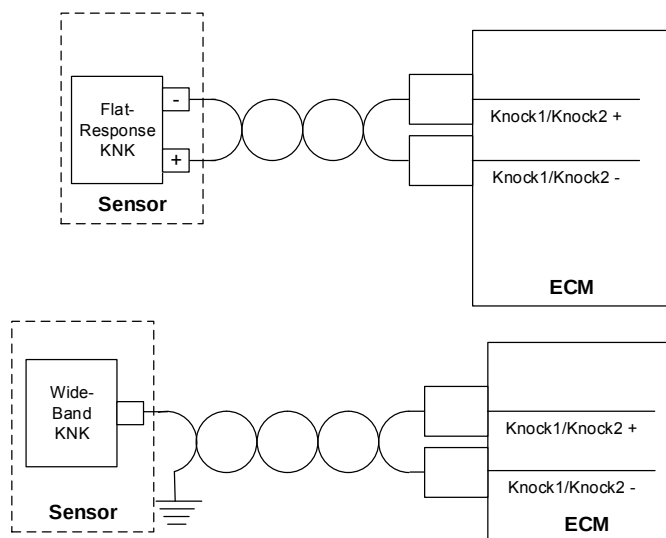
DTC	326	SPN	731	FMI	2		
Hardware: Knock sensor #1							
Hardware Description: The knock sensor is used to detect detonation through mechanical vibration in the engine block and/or cylinder heads and provide feedback for the ignition system to retard spark to reduce knock intensity. In most applications the knock sensor is used to protect the engine from damage that can be caused from detonation or knock based on fixed spark advance. In other applications, the knock sensor is used to optimize spark advance and “learn” between spark tables based on fuel quality.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• KNK1 sensor input >				TBD*	volts		
• and MAP <				TBD*	psia		
• and knock spark retard at minimum							
Possible Causes: This fault sets if the signal from knock sensor 1 is higher than expected for low load operation as defined in calibration. If this fault sets, spark is lowered by the amount defined in calibration for Faulted KNK Retard.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 326 - KNOCK1 EXCESSIVE OR ERRATIC SIGNAL (TROUBLE TREE)

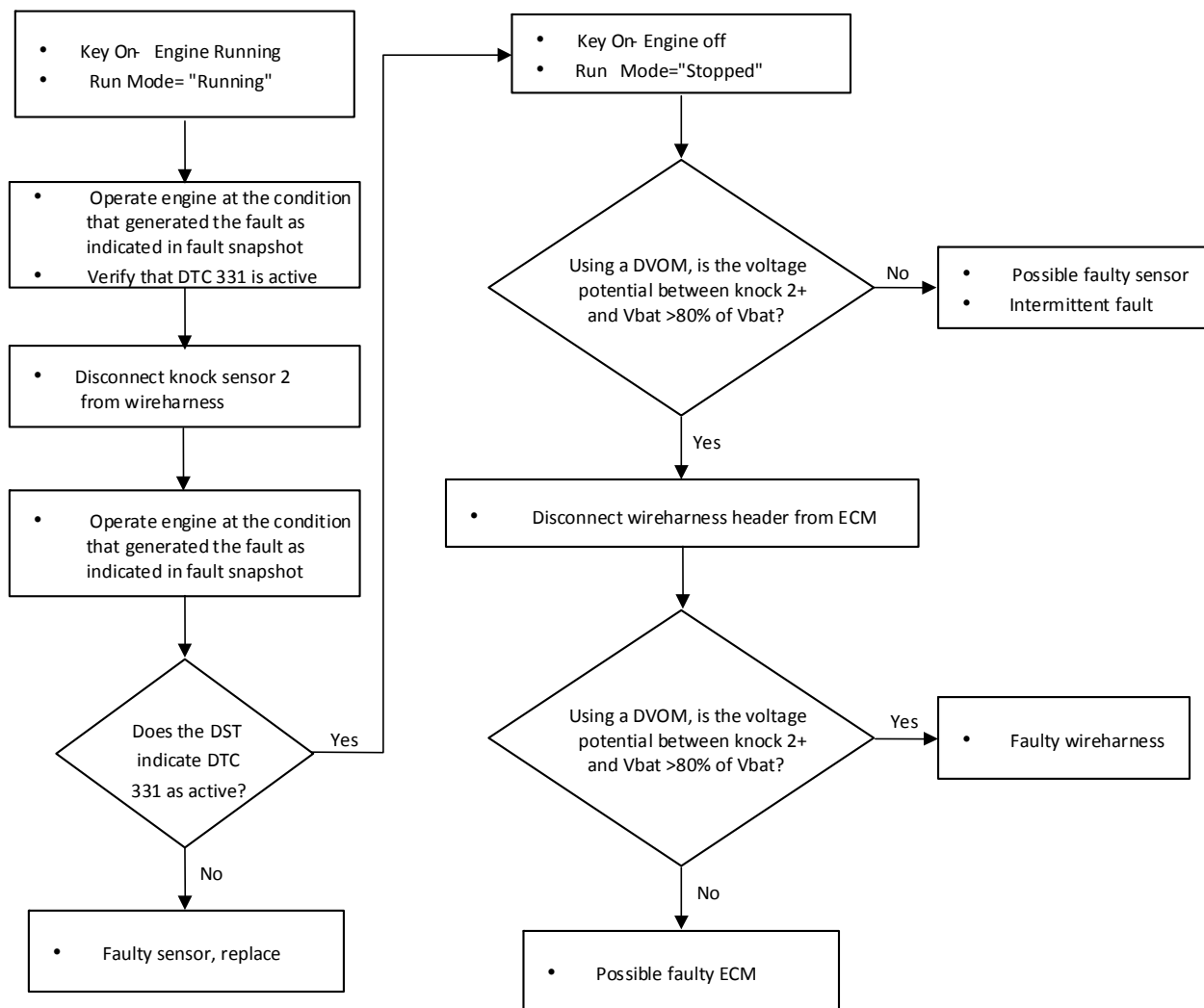
DTC 327 - KNOCK1 SENSOR OPEN OR NOT PRESENT

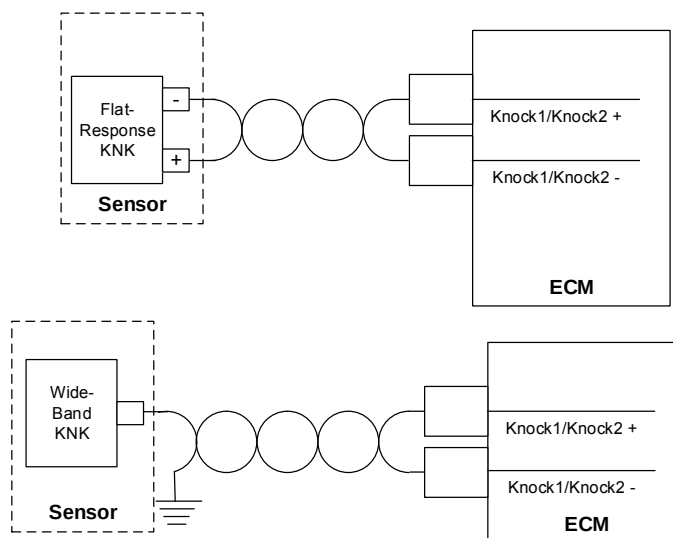
DTC	327	SPN	731	FMI	4		
Hardware: Knock sensor #1							
Hardware Description: The knock sensor is used to detect detonation through mechanical vibration in the engine block and/or cylinder heads and provide feedback for the ignition system to retard spark to reduce knock intensity. In most applications the knock sensor is used to protect the engine from damage that can be caused from detonation or knock based on fixed spark advance. In other applications, the knock sensor is used to optimize spark advance and “learn” between spark tables based on fuel quality.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• KNK1 sensor input <				TBD*	volts		
• and RPM >				TBD*	rpm		
• and MAP >				TBD*	psia		
Possible Causes: This fault sets if the signal from knock sensor 1 is lower than expected for higher speed and load operation as defined in calibration. If this fault sets, spark is lowered by the amount defined in calibration for <i>Faulted KNK Retard</i> .							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 327 - KNOCK1 SENSOR OPEN OR NOT PRESENT (TROUBLE TREE)

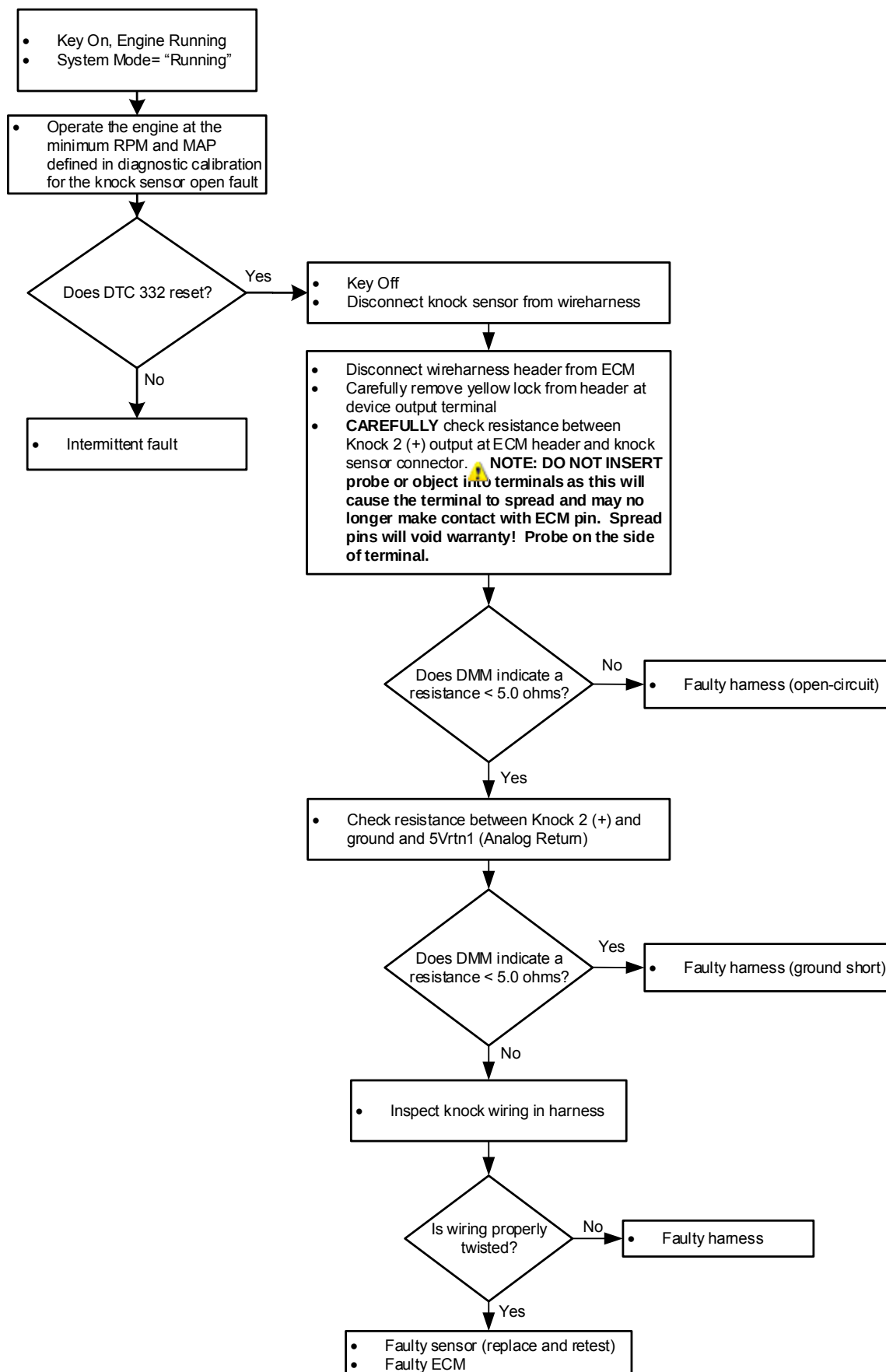
DTC 331 – KNOCK 2 EXCESSIVE OR ERRATIC SIGNAL

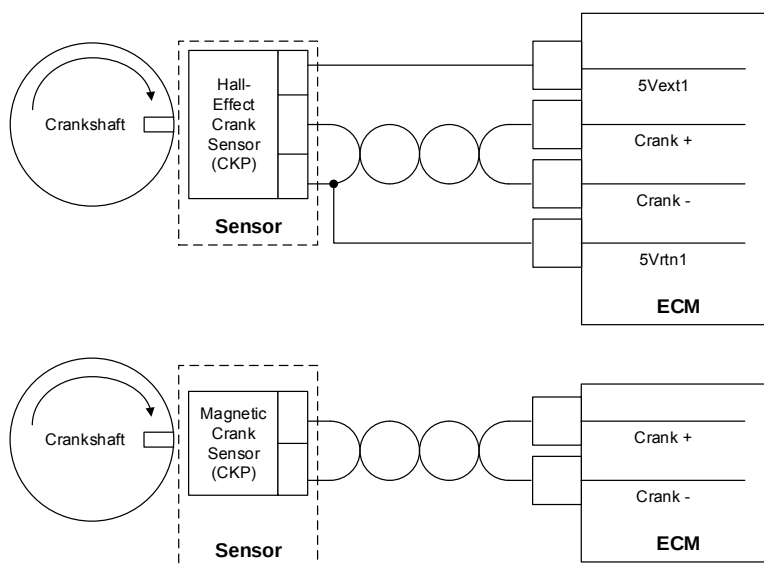
DTC	331	SPN	520197	FMI	2		
Hardware: Knock sensor #2							
Hardware Description: The knock sensor is used to detect detonation through mechanical vibration in the engine block and/or cylinder heads and provide feedback for the ignition system to retard spark to reduce knock intensity. In most applications the knock sensor is used to protect the engine from damage that can be caused from detonation or knock based on fixed spark advance. In other applications, the knock sensor is used to optimize spark advance and “learn” between spark tables based on fuel quality.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• KNK 2 sensor input >				TBD*	volts		
• and MAP <				TBD*	psia		
• and knock spark retard at minimum							
Possible Causes: This fault sets if the signal from knock sensor 2 is higher than expected for low load operation as defined in calibration. If this fault sets, spark is lowered by the amount defined in calibration for Faulted KNK Retard.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 331 – KNOCK 2 EXCESSIVE OR ERRATIC SIGNAL (TROUBLE TREE)

DTC 332 - KNOCK2 SENSOR OPEN OR NOT PRESENT

DTC	332	SPN	520197	FMI	4		
Hardware: Knock sensor #2							
Hardware Description: The knock sensor is used to detect detonation through mechanical vibration in the engine block and/or cylinder heads and provide feedback for the ignition system to retard spark to reduce knock intensity. In most applications the knock sensor is used to protect the engine from damage that can be caused from detonation or knock based on fixed spark advance. In other applications, the knock sensor is used to optimize spark advance and “learn” between spark tables based on fuel quality.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• KNK 2 sensor input <				TBD*	volts		
• and RPM >				TBD*	rpm		
• and MAP >				TBD*	psia		
Possible Causes: This fault sets if the signal from knock sensor 2 is lower than expected for higher speed and load operation as defined in calibration. If this fault sets, spark is lowered by the amount defined in calibration for <i>Faulted KNK Retard</i> .							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 332 – KNOCK2 SENSOR OPEN OR NOT PRESENT (TROUBLE TREE)

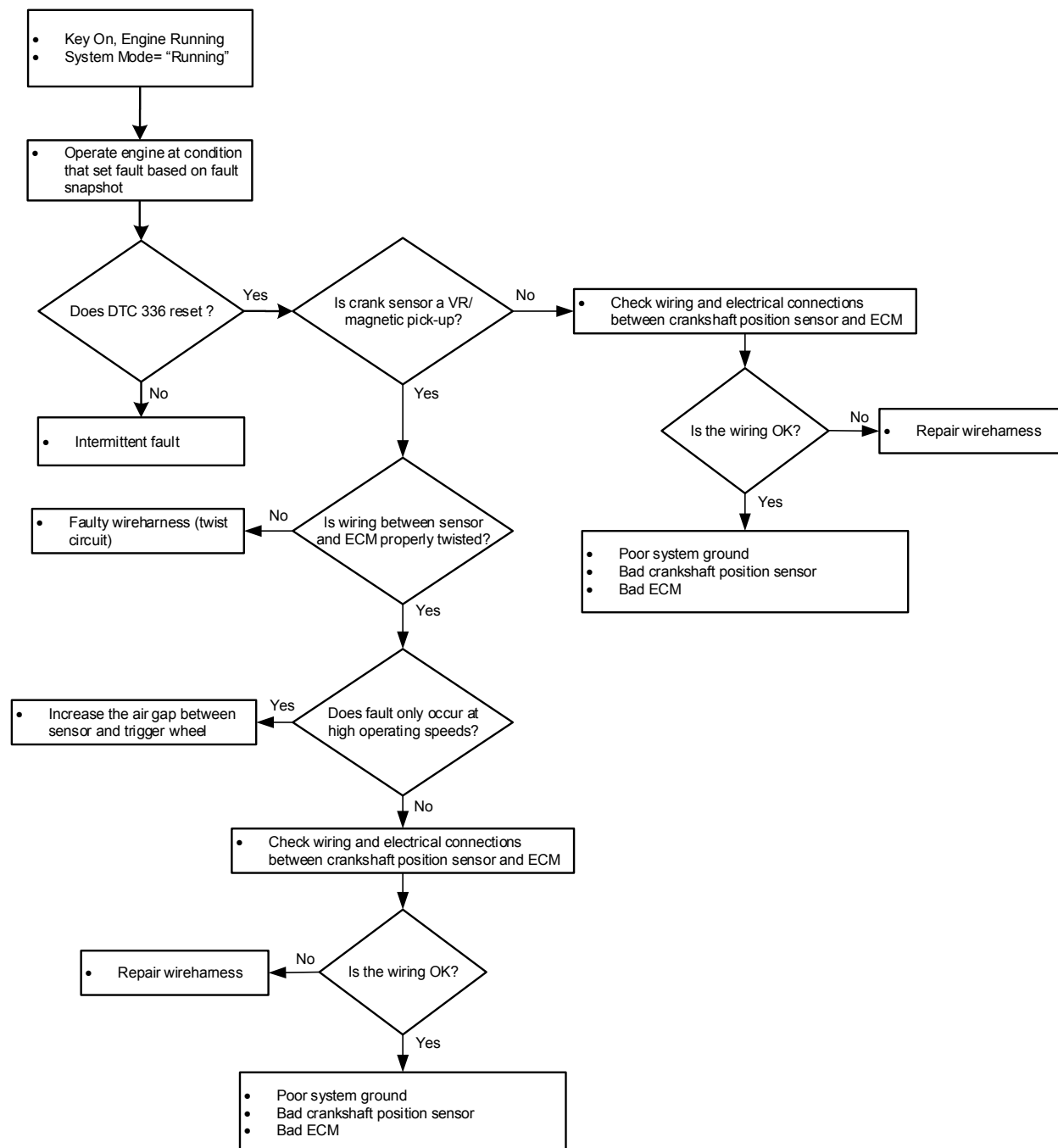
DTC 336 - CRANK INPUT SIGNAL NOISE

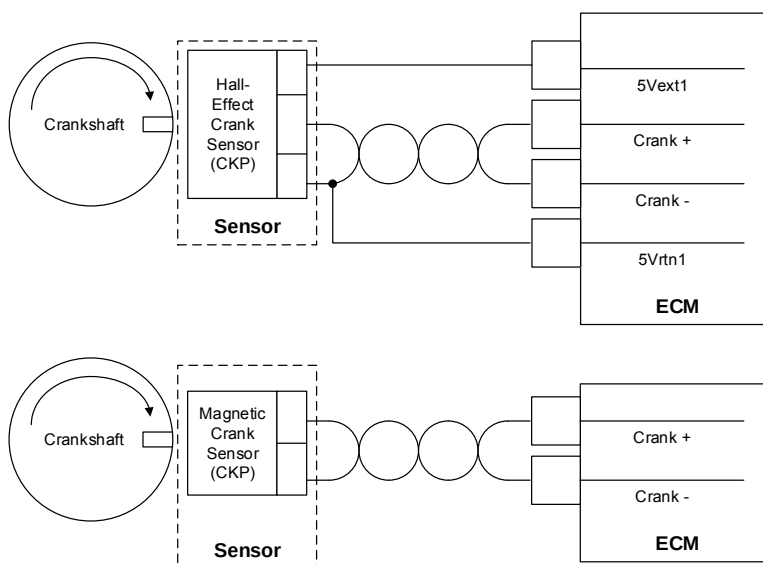
DTC	336	SPN	636	FMI	2
Hardware: Crankshaft Position sensor					
Hardware Description: The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block adjacent to a “coded” trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Number of invalid crank re-syncs				TBD*	re-syncs
• within a time window of <=				TBD*	ms
Possible Causes: The ECM must see a valid crankshaft position signal while running. If no signal is present, the signal amplitude is too high (due to improper air gap with respect to trigger wheel), or an irregular crank pattern is detected causing the ECM to resynchronize x times for y ms or longer as defined in the diagnostic calibration, this fault will set. Irregular crank patterns can be detected by the ECM due to electrical noise, poor machining of trigger wheel, or trigger wheel runout and/or gear lash. Ensure crank circuit used with VR/magnetic pick-up sensors are properly twisted.					

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

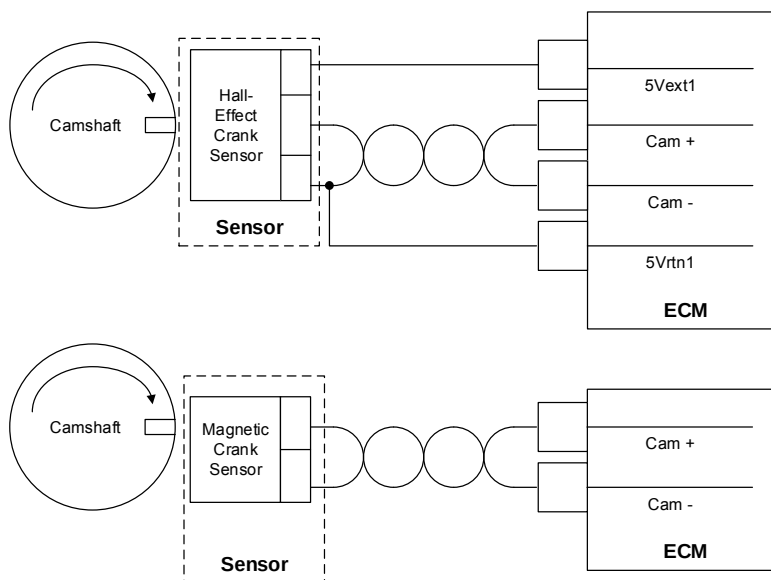
DTC 336 - CRANK INPUT SIGNAL NOISE (TROUBLE TREE)

DTC 337 – LOSS OF CRANKSHAFT SIGNAL

DTC	337	SPN	636	FMI	4		
Hardware: Crankshaft Position sensor							
Hardware Description: The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block adjacent to a “coded” trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• Cam pulses without crank activity >				TBD*	Cam pulses		
Possible Causes: The ECM must see a valid crankshaft position signal while running. If no signal is present while x cam pulses continue the fault will set. The engine typically stalls or dies as a result of this fault condition due to the lack of crankshaft speed input resulting in the inability to control ignition timing.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 337 – LOSS OF CRANKSHAFT SIGNAL (DIAGNOSTIC AIDS)

- ☐ Check that crankshaft position sensor is securely connected to harness
- ☐ Check that crankshaft position sensor is securely installed into engine block
- ☐ Check crankshaft position sensor circuit wiring for open circuit

DTC 341 - CAM INPUT SIGNAL NOISE

DTC	341	SPN	723	FMI	2
Hardware: Crankshaft Position sensor					
Hardware Description: The camshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block or valve train adjacent to a “coded” trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination of the camshaft position is necessary to identify the stroke (or cycle) of the engine to properly activate the fuel injection system and ignition (for coil-on-plug engines) for precise engine control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Number of invalid cam re-syncs			TBD*	re-syncs	
• within a time window of <=			TBD*	ms	
Possible Causes: For a cam synchronized engine, the ECM must see a valid camshaft position signal while running. If no signal is present, the signal amplitude is too high (due to improper air gap with respect to trigger wheel), or an irregular cam pattern is detected causing the ECM to resynchronize x times for y ms or longer as defined in the diagnostic calibration, this fault will set. Irregular cam patterns can be detected by the ECM due to electrical noise, poor machining of trigger wheel, or trigger wheel runout and/or gear lash. Normally the engine will continue to run if equipped with a waste-spark or distributor ignition system.					

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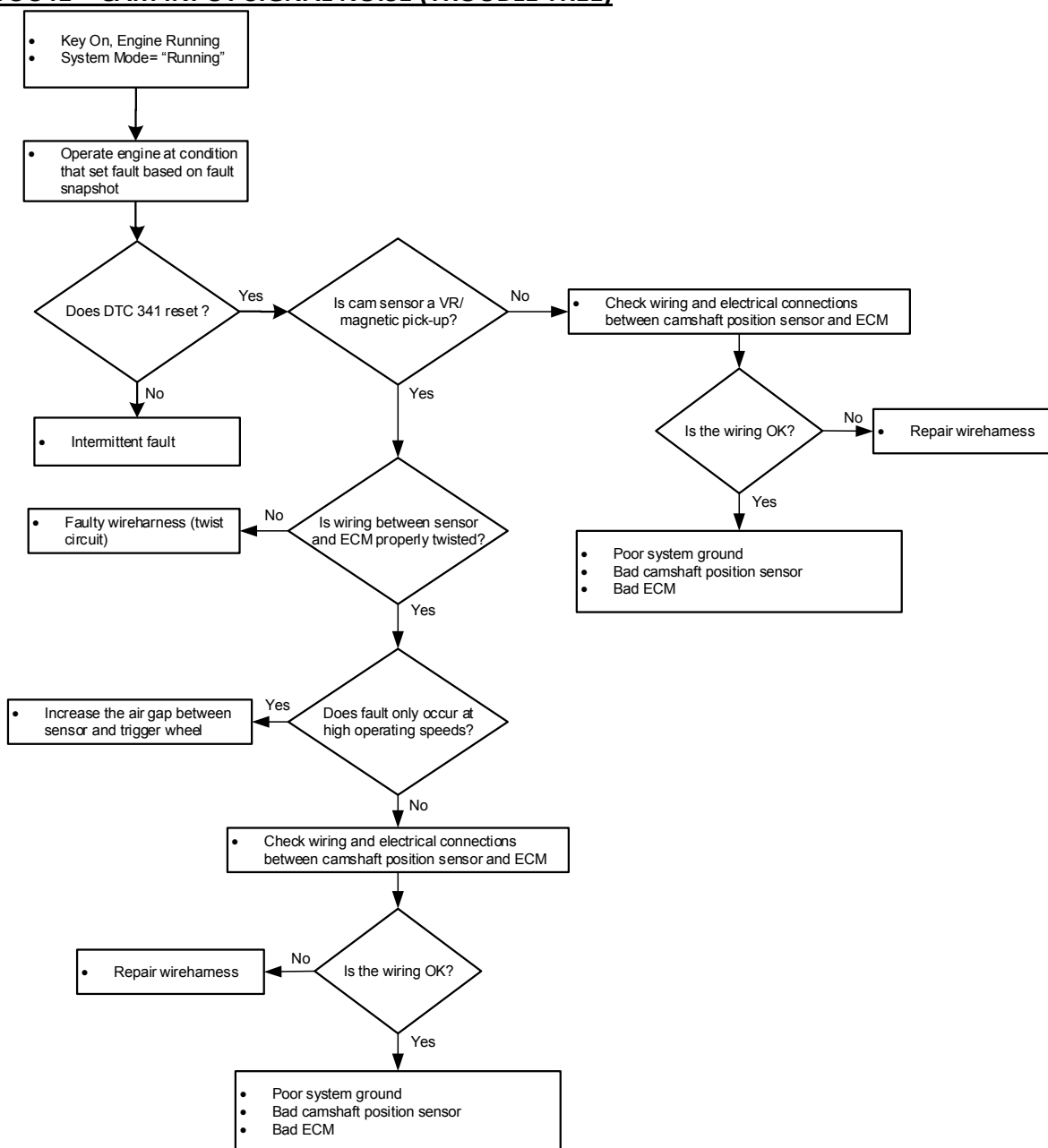
In some instances this fault can cause rough engine operation and can cause the engine to stall or die if equipped with coil-on-plug ignition engines.

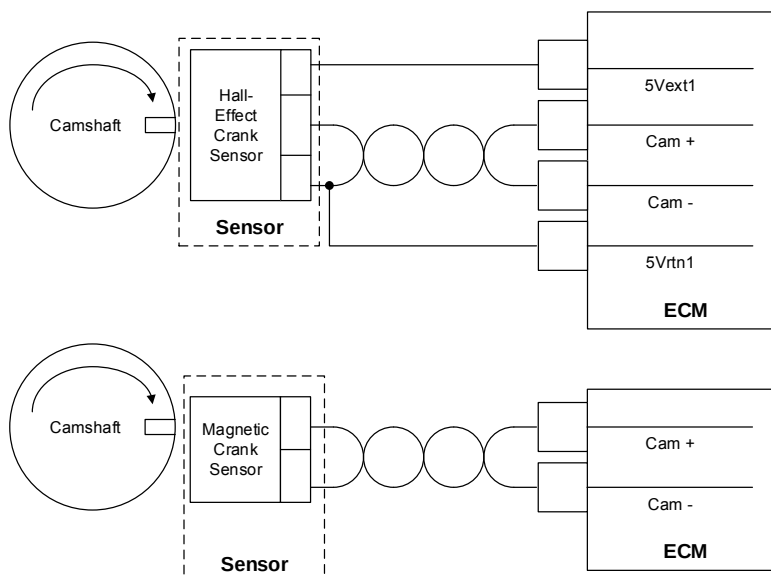
Ensure cam circuit used with VR/magnetic pick-up sensors are properly twisted.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 341 – CAM INPUT SIGNAL NOISE (TROUBLE TREE)



DTC 342 – LOSS OF CAMSHAFT INPUT SIGNAL

DTC	342	SPN	723	FMI	4
Hardware: Camshaft Position sensor					
Hardware Description: The camshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or hall-effect) installed in the engine block or valve train adjacent to a “coded” trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination of the camshaft position is necessary to identify the stroke (or cycle) of the engine to properly activate the fuel injection system and ignition (for coil-on-plug engines) for precise engine control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• No cam pulse in				TBD*	cycles
• and RPM >				TBD*	rpm
Possible Causes: For a cam synchronized engine, the ECM must see a valid camshaft position signal while running. This fault will set if valid crankshaft position data is received for <u>x</u> number of engine cycles while engine speed is greater than <u>y</u> RPM and no camshaft signal is received. Normally the engine will continue to run if equipped with a waste-spark or distributor ignition system. In some instances this fault can cause rough engine operation and can cause the engine to stall or die if equipped with coil-on-plug ignition engines.					

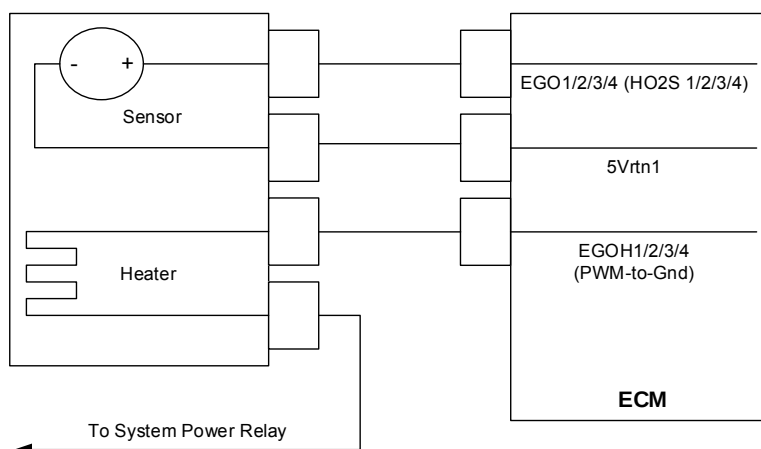
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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

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DTC 342 – LOSS OF CAMSHAFT INPUT SIGNAL (DIAGNOSTIC AIDS)

- ☐ Check that camshaft position sensor is securely connected to harness
- ☐ Check that camshaft position sensor is securely installed into engine block
- ☐ Check camshaft position sensor circuit wiring for open circuit

DTC 420 - CATALYST INACTIVE ON GASOLINE (BANK1)

DTC	420	SPN	3050	FMI	11
Hardware: Bank 1 Catalyst, Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 2-After Catalyst)					
Hardware Description: A catalyst or catalytic converter is a component in the exhaust subsystem used to accelerate/generate chemical reactions within the engine exhaust to convert undesirable gases/pollutants into less harmful gases. In many spark-ignited applications, a three-way catalyst is used to convert hydrocarbons, oxides of nitrogen, and carbon monoxide into nitrogen, water, and carbon dioxide. In addition, many low-emission applications require the use of OBD, which typically require a catalyst monitor to identify whether or not the catalyst is functioning properly. The catalyst monitor diagnostic is typically configured such that exhaust emissions are near compliance-failing levels based on the engines specific regulatory requirement(s). Catalyst monitor techniques typically utilize a HEGO sensor to monitor the amount of oxygen present downstream of the catalyst. This is generally a good indicator of how efficiently the catalyst is using the oxygen entering the catalyst. Some systems also use temperature measurements in the catalyst and compare it to data stored in the ECM for each operating condition to determine if the catalytic reaction is generating the proper amount of heat. The GCP uses a HEGO/HO2S sensor for catalyst monitor. The HEGO/HO2S is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either "CL Active" or "CL + Adapt" control modes.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			

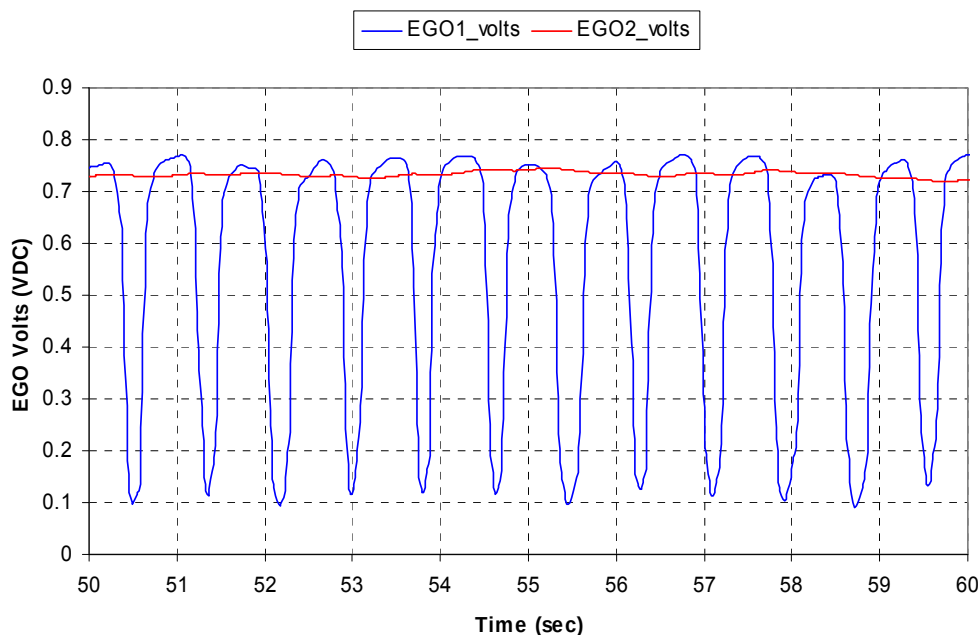
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Fault Set Conditions (as defined in calibration):

• EGO3/4 RMS >	TBD*	phi
• and EGO3/4 RMS > EGO1/2 RMS *	TBD*	%
• and EGO3/4 RMS > CL waveform RMS *	TBD*	%
• and mass flow at ports >=	TBD*	g/sec
• and mass flow at ports <=	TBD*	g/sec
• and CBT - CBT_ss +/-	TBD*	deg F
persistently for	TBD*	sec

Possible Causes:

In theory if the catalyst is operated at a condition that could result in 100 percent conversion efficiency, the catalyst will use all available oxygen present in the exhaust gas to convert the emission pollutants (or reactants) to N₂, CO₂, and H₂O. However, since catalysts generally operate at efficiencies between 85-95% post-catalyst oxygen concentration can be a direct indicator of how efficient the catalyst is. **Error! Reference source not found.** shows an example of a slightly rich biased feed gas or pre-catalyst equivalence ratio versus that of the post-catalyst for a functional catalyst.

**Figure 6: EGO Waveforms (Functional TWC)**

It can be noticed from this figure that the pre-catalyst equivalence ratio, as identified by 'EGO1_volts', is varying due to the CL excursions (perturbation) and that the post-catalyst equivalence ratio, as identified by 'EGO2_volts', is maintained relatively constant rich of stoichiometry. A similar waveform pattern should be expected on properly functioning catalysts.

Error! Reference source not found. shows an example of EGO waveforms for a catalyst with

poor conversion efficiency.

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It can be noticed from this figure that the pre-catalyst equivalence ratio, as identified by 'EGO1_volts', is varying due to the CL excursions (perturbation) and that the post-catalyst equivalence ratio, as identified by 'EGO2_volts', is maintained relatively constant rich of stoichiometry. A similar waveform pattern should be expected on properly functioning catalysts.

Error! Reference source not found. shows an example of EGO waveforms for a catalyst with poor conversion efficiency.

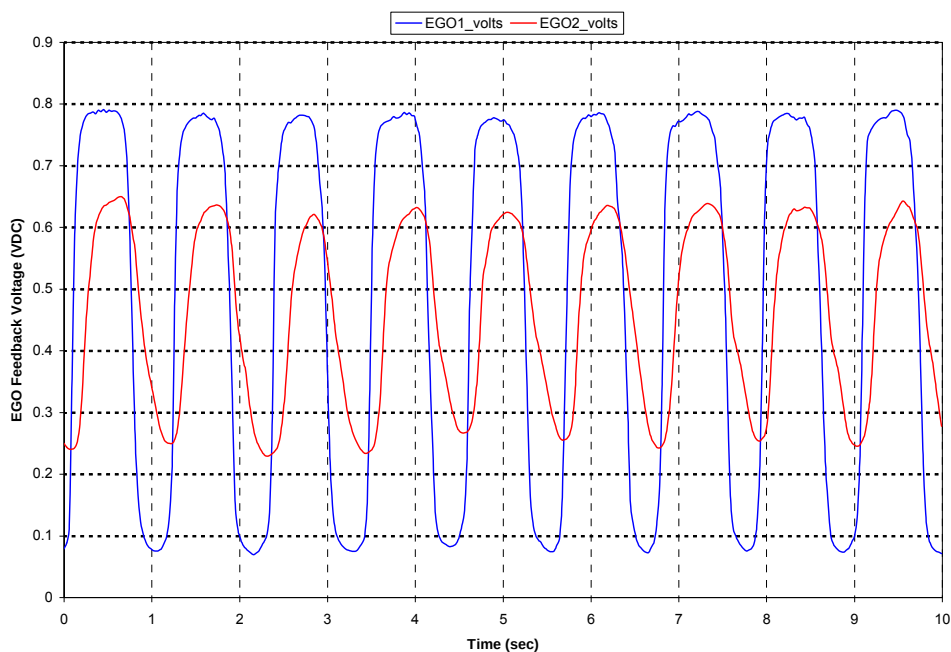


Figure 7: EGO Waveforms (Damaged TWC)

A significant difference between **Error! Reference source not found.** and **Error! Reference source not found.** is that the post-catalyst EGO feedback oscillates with the same frequency as the pre-catalyst EGO feedback and the amplitude is on the order of 60% of that of EGO1. This indicates that a certain amount of oxygen that is entering into the catalyst is passing through the catalyst unconsumed. Catalyst monitor diagnostics are configured such that if the post-catalyst EGO waveform has an amplitude that is directly proportional to the pre-catalyst EGO waveform and who's waveform similarly matches the closed-loop excursion (perturbation) a fault is generated.

Two metric comparisons that are used to identify the health of the catalyst are:

- 1) Post-catalyst EGO root-mean square (RMS) > Pre-catalyst EGO RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).
- 2) Post-catalyst EGO RMS > CL excursion RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).

There are a couple of ways in which the limits for diagnostics can be determined. In both

cases, the system must be tested with an emissions measurement system to determine when the exhaust emissions are nearly failing emissions compliance.

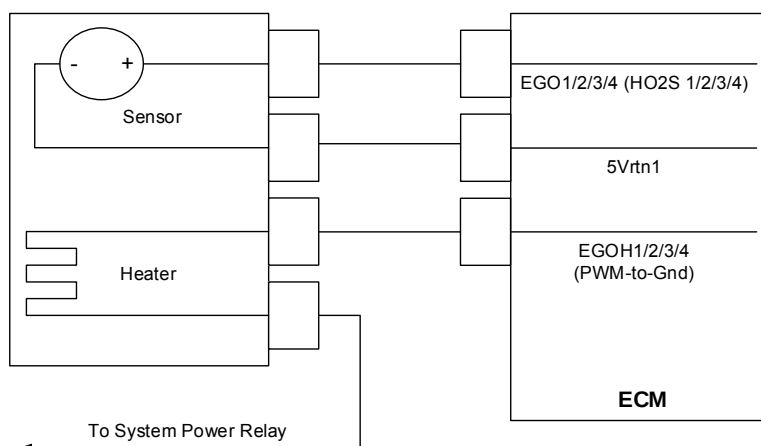
(continued from previous page)

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 420 – CATALYST INACTIVE ON GASOLINE (BANK1) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks upstream and around catalyst and post-catalyst HEGO sensor. Replace gaskets and tighten fasteners if leaks are present.
- ☐ Perform manufacture recommended in-field emissions test.

DTC 430 - CATALYST INACTIVE ON GASOLINE (BANK2)

DTC	430	SPN	3051	FMI	11
Hardware: Bank 2 Catalyst, Heated or Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 2-After Catalyst)					
Hardware Description: A catalyst or catalytic converter is a component in the exhaust subsystem used to accelerate/generate chemical reactions within the engine exhaust to convert undesirable gases/pollutants into less harmful gases. In many spark-ignited applications, a three-way catalyst is used to convert hydrocarbons, oxides of nitrogen, and carbon monoxide into nitrogen, water, and carbon dioxide. In addition, many low-emission applications require the use of OBD, which typically require a catalyst monitor to identify whether or not the catalyst is functioning properly. The catalyst monitor diagnostic is typically configured such that exhaust emissions are near compliance-failing levels based on the engines specific regulatory requirement(s). Catalyst monitor techniques typically utilize a HEGO sensor to monitor the amount of oxygen present downstream of the catalyst. This is generally a good indicator of how efficiently the catalyst is using the oxygen entering the catalyst. Some systems also use temperature measurements in the catalyst and compare it to data stored in the ECM for each operating condition to determine if the catalytic reaction is generating the proper amount of heat. The GCP uses a HEGO/HO2S sensor for catalyst monitor. The HEGO/HO2S is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either "CL Active" or "CL + Adapt" control modes.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			

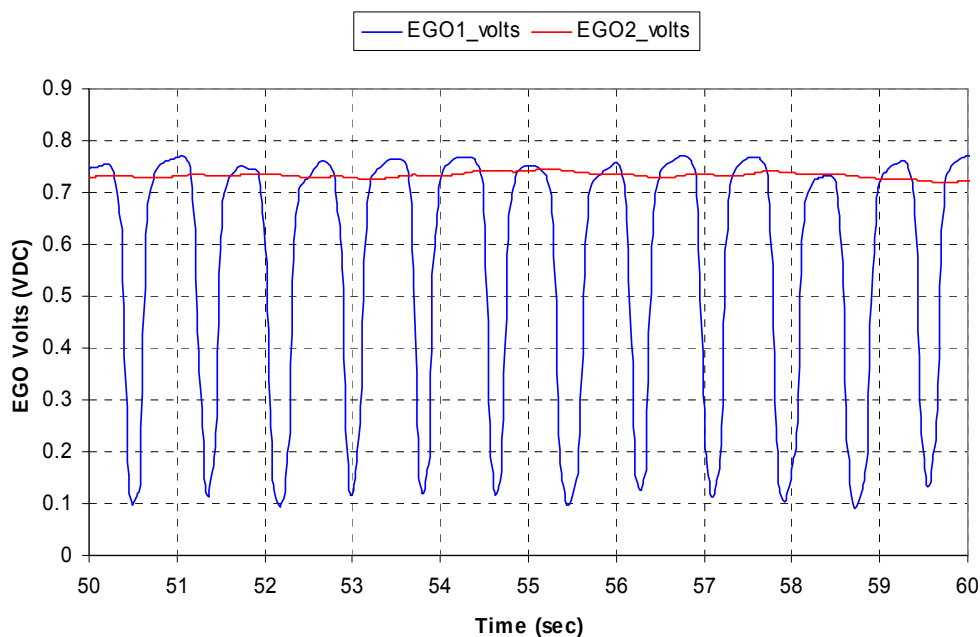
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Fault Set Conditions (as defined in calibration):

• EGO3/4 RMS >	TBD*	phi
• and EGO3/4 RMS > EGO1/2 RMS *	TBD*	%
• and EGO3/4 RMS > CL waveform RMS *	TBD*	%
• and mass flow at ports >=	TBD*	g/sec
• and mass flow at ports <=	TBD*	g/sec
• and CBT - CBT_ss +/-	TBD*	deg F
persistently for	TBD*	sec

Possible Causes:

In theory if the catalyst is operated at a condition that could result in 100 percent conversion efficiency, the catalyst will use all available oxygen present in the exhaust gas to convert the emission pollutants (or reactants) to N₂, CO₂, and H₂O. However, since catalysts generally operate at efficiencies between 85-95% post-catalyst oxygen concentration can be a direct indicator of how efficient the catalyst is. **Error! Reference source not found.** shows an example of a slightly rich biased feed gas or pre-catalyst equivalence ratio versus that of the post-catalyst for a functional catalyst.

**Figure 8: EGO Waveforms (Functional TWC)**

It can be noticed from this figure that the pre-catalyst equivalence ratio, as identified by 'EGO1_volts', is varying due to the CL excursions (perturbation) and that the post-catalyst equivalence ratio, as identified by 'EGO2_volts', is maintained relatively constant rich of stoichiometry. A similar waveform pattern should be expected on properly functioning catalysts.

Error! Reference source not found. shows an example of EGO waveforms for a catalyst with poor conversion efficiency.

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It can be noticed from this figure that the pre-catalyst equivalence ratio, as identified by 'EGO1_volts', is varying due to the CL excursions (perturbation) and that the post-catalyst equivalence ratio, as identified by 'EGO2_volts', is maintained relatively constant rich of stoichiometry. A similar waveform pattern should be expected on properly functioning catalysts.

Error! Reference source not found. shows an example of EGO waveforms for a catalyst with poor conversion efficiency.

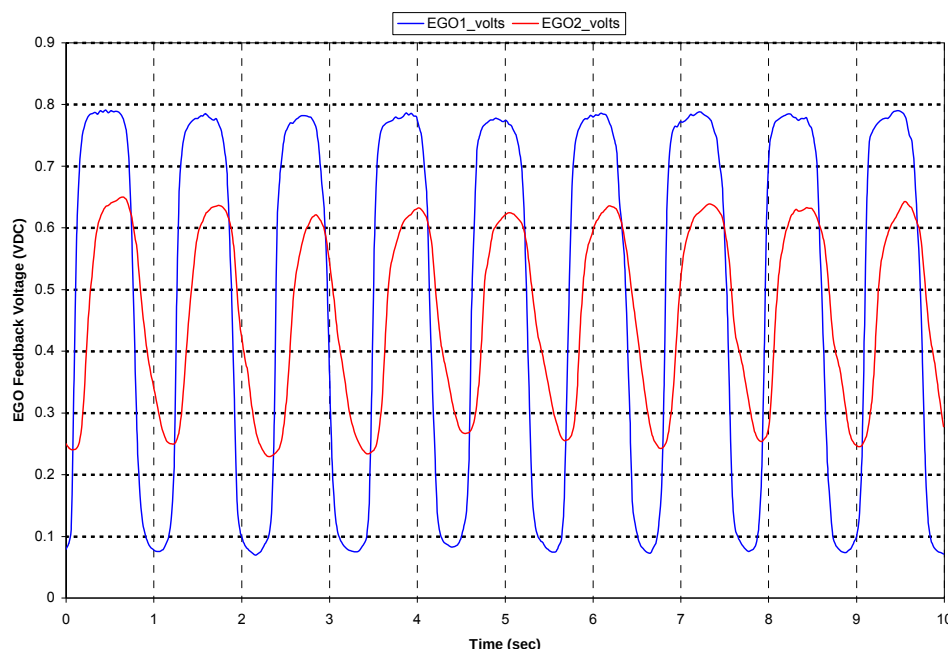


Figure 9: EGO Waveforms (Damaged TWC)

A significant difference between **Error! Reference source not found.** and **Error! Reference source not found.** is that the post-catalyst EGO feedback oscillates with the same frequency as the pre-catalyst EGO feedback and the amplitude is on the order of 60% of that of EGO1. This indicates that a certain amount of oxygen that is entering into the catalyst is passing through the catalyst unconsumed. Catalyst monitor diagnostics are configured such that if the post-catalyst EGO waveform has an amplitude that is directly proportional to the pre-catalyst EGO waveform and who's waveform similarly matches the closed-loop excursion (perturbation) a fault is generated.

Two metric comparisons that are used to identify the health of the catalyst are:

- 1) Post-catalyst EGO root-mean square (RMS) > Pre-catalyst EGO RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).
- 2) Post-catalyst EGO RMS > CL excursion RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).

There are a couple of ways in which the limits for diagnostics can be determined. In both

cases, the system must be tested with an emissions measurement system to determine when the exhaust emissions are nearly failing emissions compliance.

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

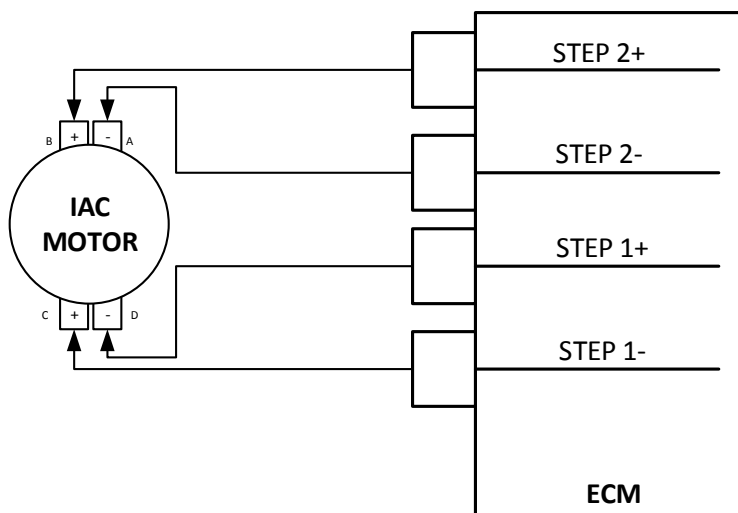
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 430 – CATALYST INACTIVE ON GASOLINE (BANK2) (DIAGNOSTIC AIDS)

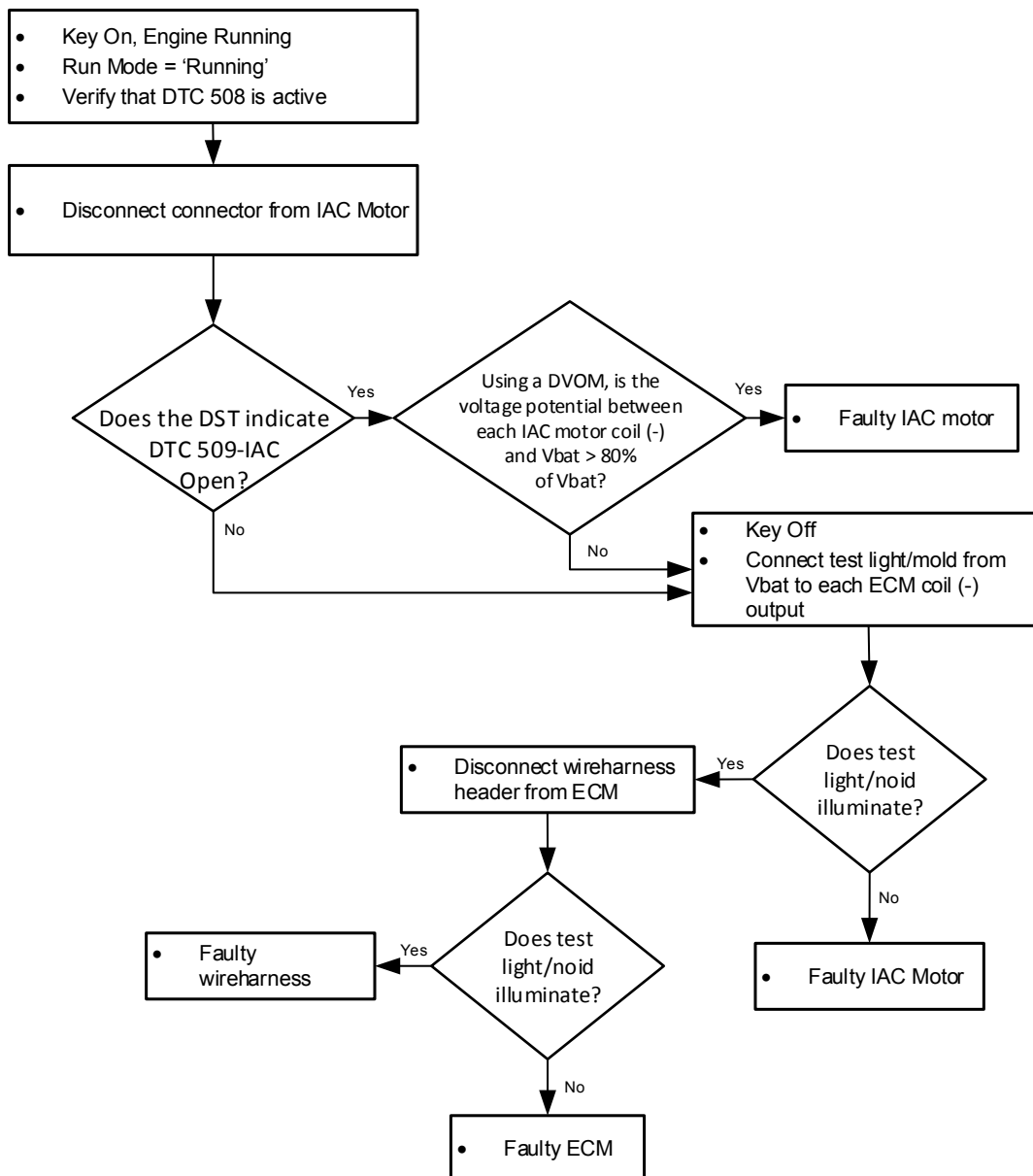
Diagnostic Aids

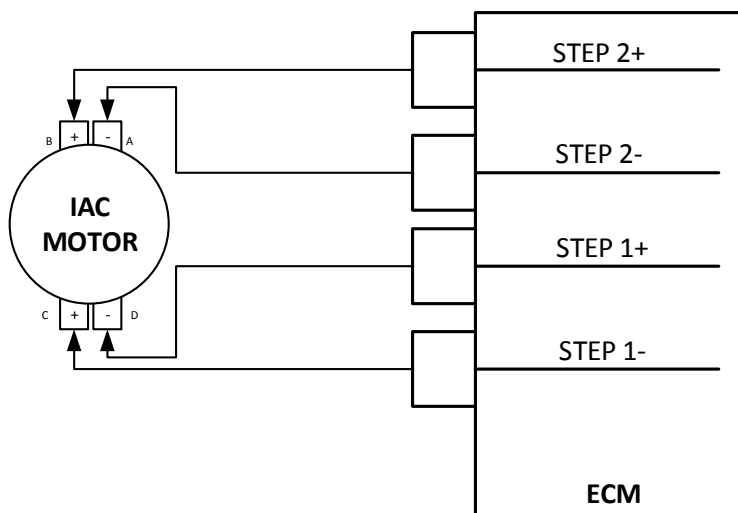
NOTE: If any other DTCs are present, diagnose those first.

- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks upstream and around catalyst and post-catalyst HEGO sensor. Replace gaskets and tighten fasteners if leaks are present.
- ☐ Perform manufacture recommended in-field emissions test.

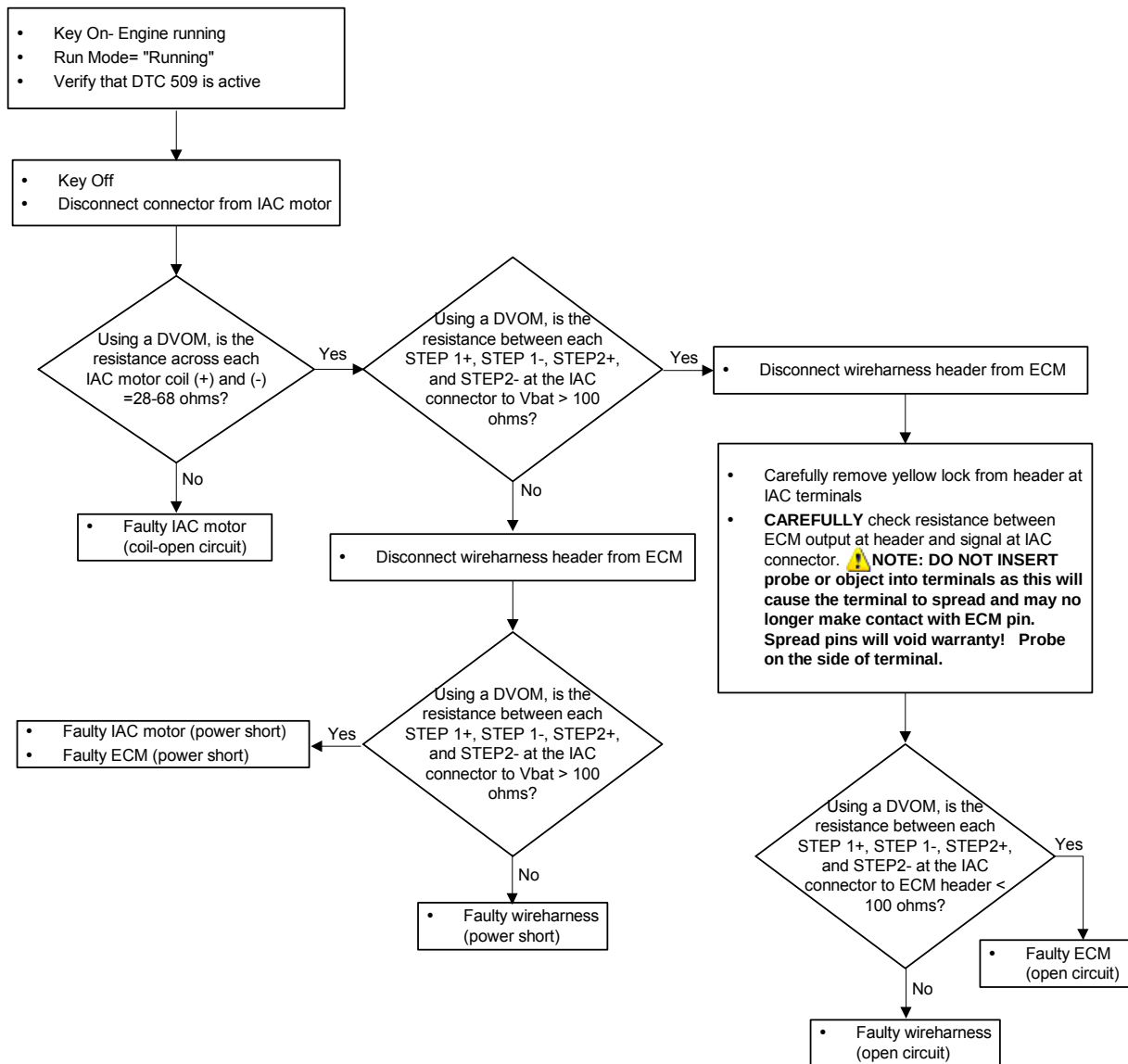
DTC 508 - IAC GROUND SHORT

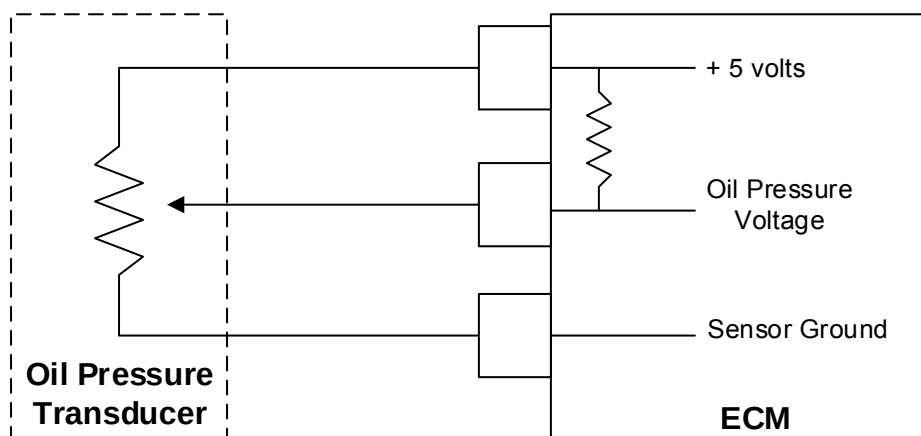
DTC	508	SPN	520201	FMI	6		
Hardware: IAC Motor							
Hardware Description: The IAC motor is a stepper motor that controls/governs the amount of air available to the engine at or near idle in order to regulate the engine torque and speed, reduce emissions, enhance idle quality, and enhance drivability.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration): IAC motor coil open circuit or short to power							
Possible Causes: This fault will set if any pole of the IAC motor coils and/or coil drivers is shorted to ground. The engine may idle roughly while this fault is active.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 508 – IAC GROUND SHORT) (TROUBLE TREE)

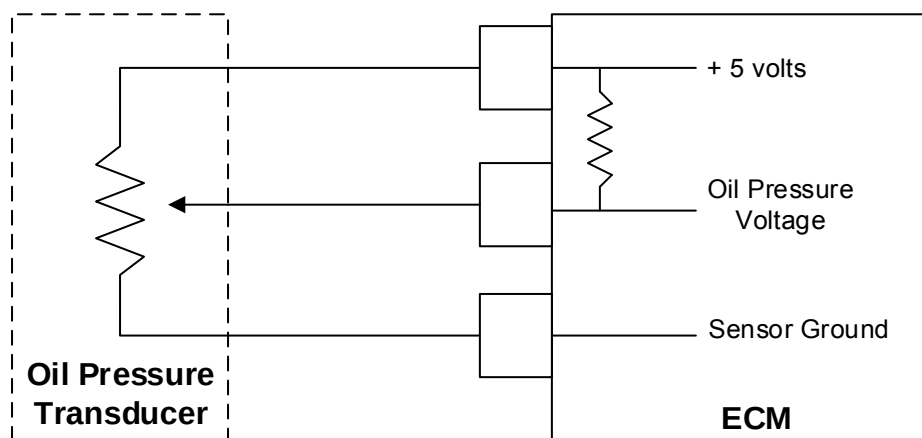
DTC 509 - IAC COIL OPEN/SHORT

DTC	509	SPN	520201	FMI	5		
Hardware: IAC Motor							
Hardware Description: The IAC motor is a stepper motor that controls/governs the amount of air available to the engine at or near idle in order to regulate the engine torque and speed, reduce emissions, enhance idle quality, and enhance drivability.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
IAC motor coil shorted to ground							
Possible Causes: This fault will set if any pole of the IAC motor coils and/or coil drivers is an open circuit or shorted to power. The engine may idle roughly while this fault is active.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

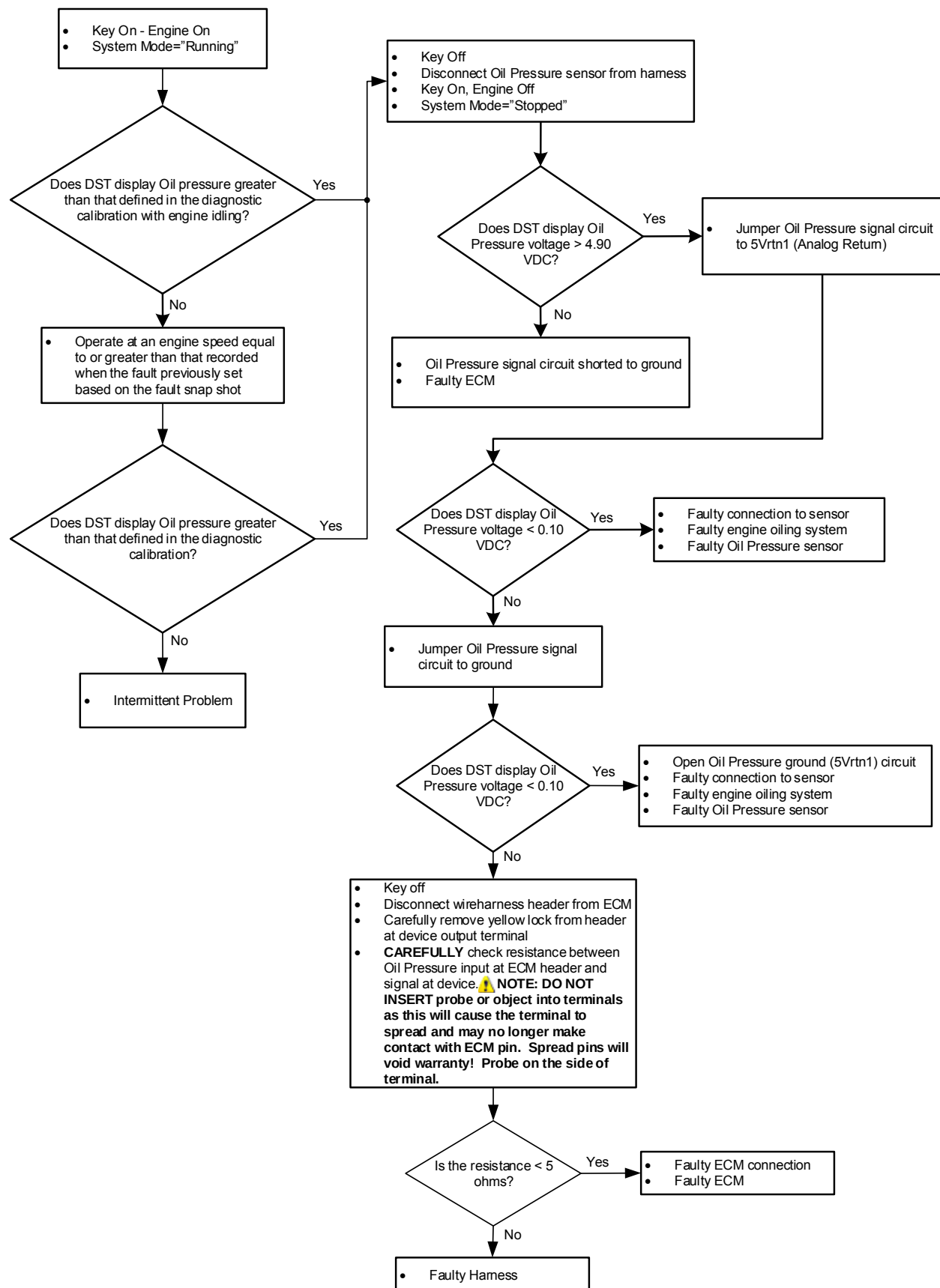
DTC 509 – IAC COIL OPEN/SHORT (TROUBLE TREE)

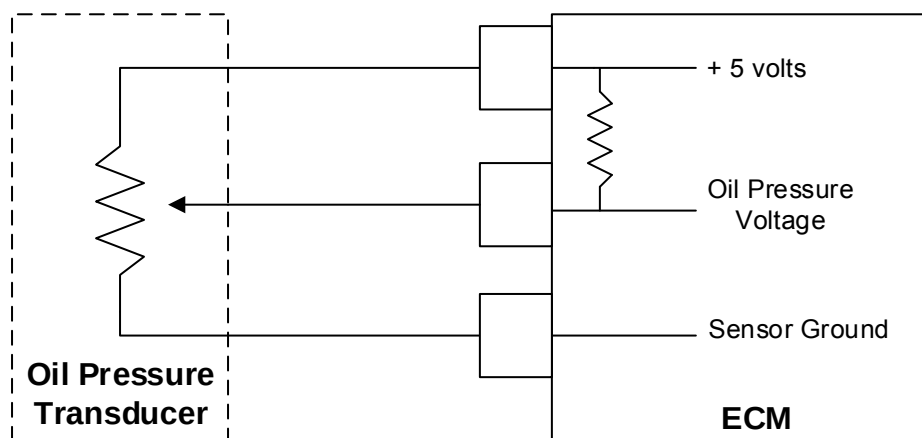
DTC 520 - OIL PRESSURE LOW STAGE 1 (SENDER)**Sensor-Type**

DTC	520	SPN	100	FMI	18		
Measurement: Engine Oil Pressure							
Description: The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine on					
Fault Set Conditions (as defined in calibration):							
<u>For RPM > lower limit AND RPM <=</u>				TBD*	rpm		
• Stage 1: oil pressure <				TBD*	psig		
<u>For RPM >=</u>				TBD*	rpm		
• Stage 1: oil pressure <				TBD*	psig		
Possible Causes: This fault sets if the engine oil pressure is lower than x psia and engine speed greater than y RPM as defined in the diagnostic calibration. Recommend a power derate and/or low rev limit to help prevent possible engine damage and reduce oil pressure.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

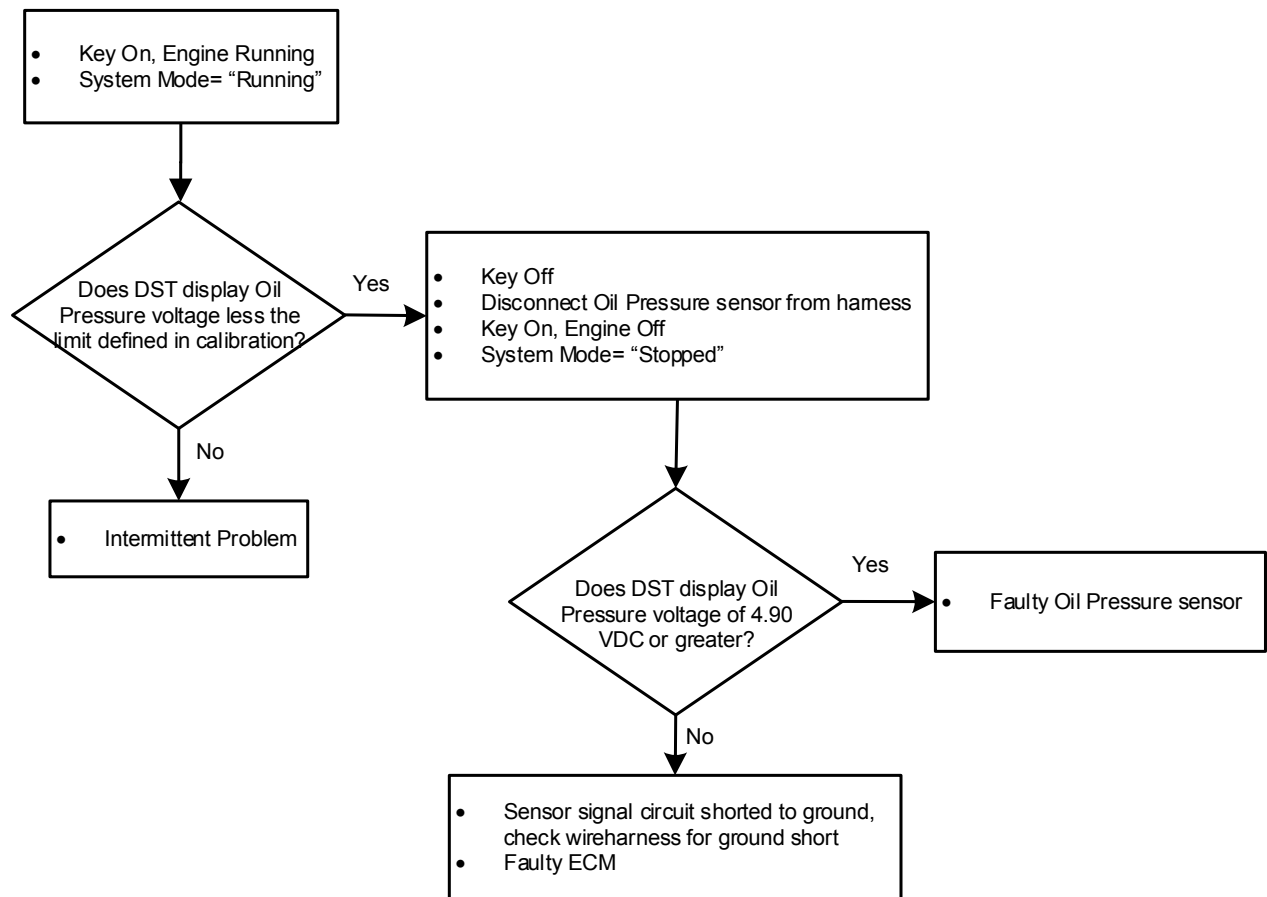
DTC 521 - OIL PRESSURE HIGH (SENDER)**Sensor-Type**

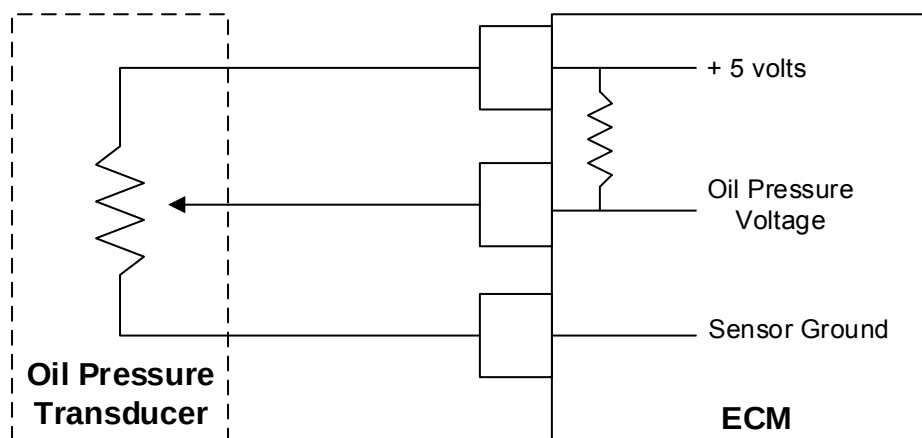
DTC	521	SPN	100	FMI	0		
Measurement: Engine Oil Pressure							
Description: The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine on					
Fault Set Conditions (as defined in calibration):							
• Oil pressure >				TBD*	psig		
• and RPM <				TBD*	rpm		
Possible Causes: This fault sets if the engine oil pressure is higher than x psia and engine speed greater than y RPM as defined in the diagnostic calibration. Recommend a power derate and/or low rev limit to help prevent possible engine damage and reduce oil pressure.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 521 - OIL PRESSURE HIGH (SENDER) (TROUBLE TREE)

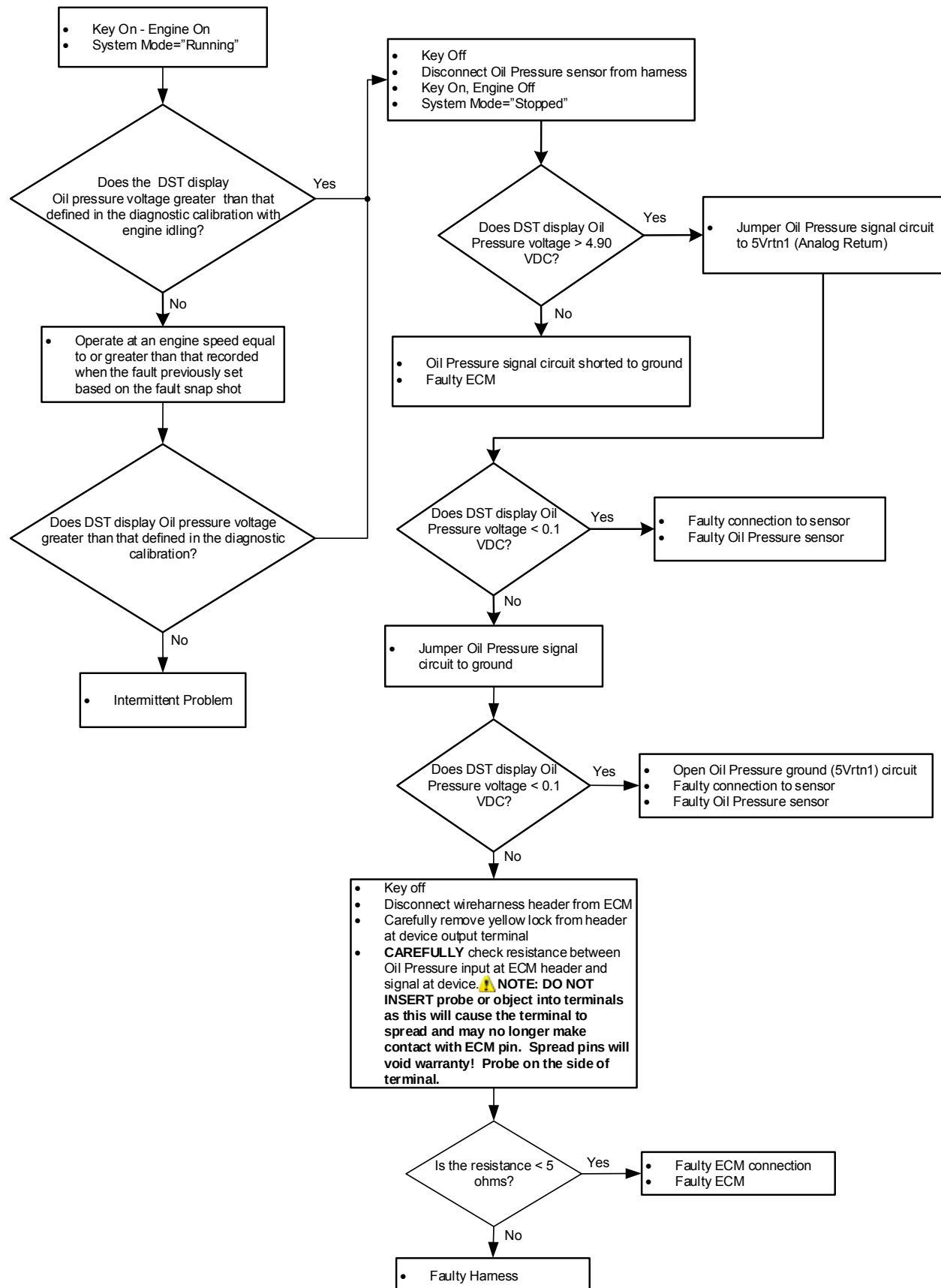
DTC 522 - OIL PRESSURE SENDER LOW VOLTAGE**Sensor-Type**

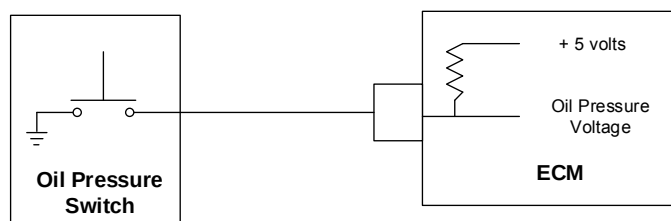
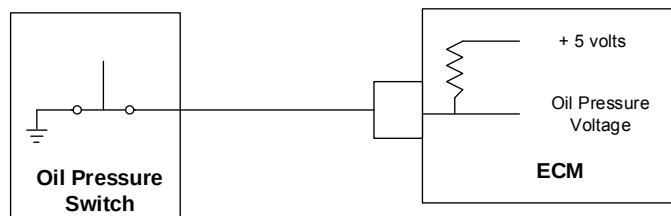
DTC	522	SPN	100	FMI	4		
Measurement: Engine Oil Pressure							
Description: The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine on					
Fault Set Conditions (as defined in calibration):							
• Oil pressure sender voltage <				TBD*	volts		
Possible Causes: This fault sets if the engine oil pressure sender/transducer voltage is lower than defined in the diagnostic calibration. Recommend a power derate and/or low rev limit due to the inability to sense oil pressure and to reduce risk of potential engine damage.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 522 - OIL PRESSURE SENDER LOW VOLTAGE (TROUBLE TREE)

DTC 523 - OIL PRESSURE SENDER HIGH VOLTAGE**Sensor-Type**

DTC	523	SPN	100	FMI	3		
Measurement: Engine Oil Pressure							
Description: The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine on					
Fault Set Conditions (as defined in calibration):							
• Oil pressure sender voltage >				TBD*	volts		
Possible Causes: This fault sets if the engine oil pressure sender/transducer voltage is lower than defined in the diagnostic calibration. Recommend a power derate and/or low rev limit due to the inability to sense oil pressure and to reduce risk of potential engine damage.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 523 - OIL PRESSURE SENDER HIGH VOLTAGE (TROUBLE TREE)

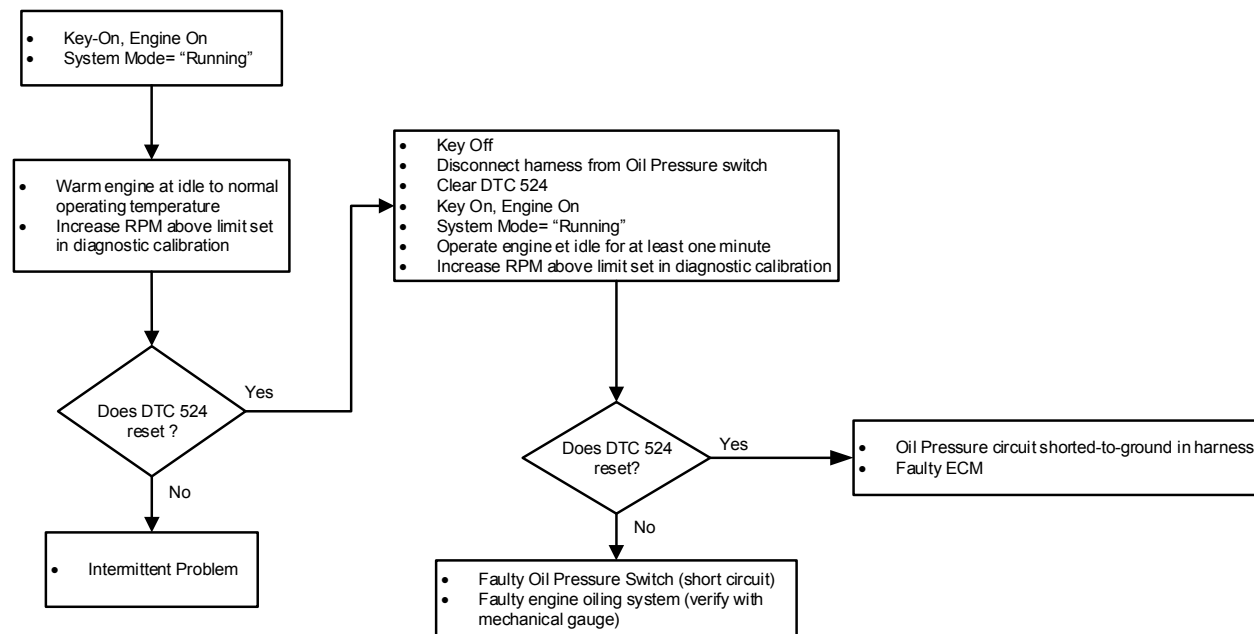
DTC 524 - OIL PRESSURE LOW (SWITCH)**Normally-Open
Switch-Type****Normally-Closed
Switch-Type**

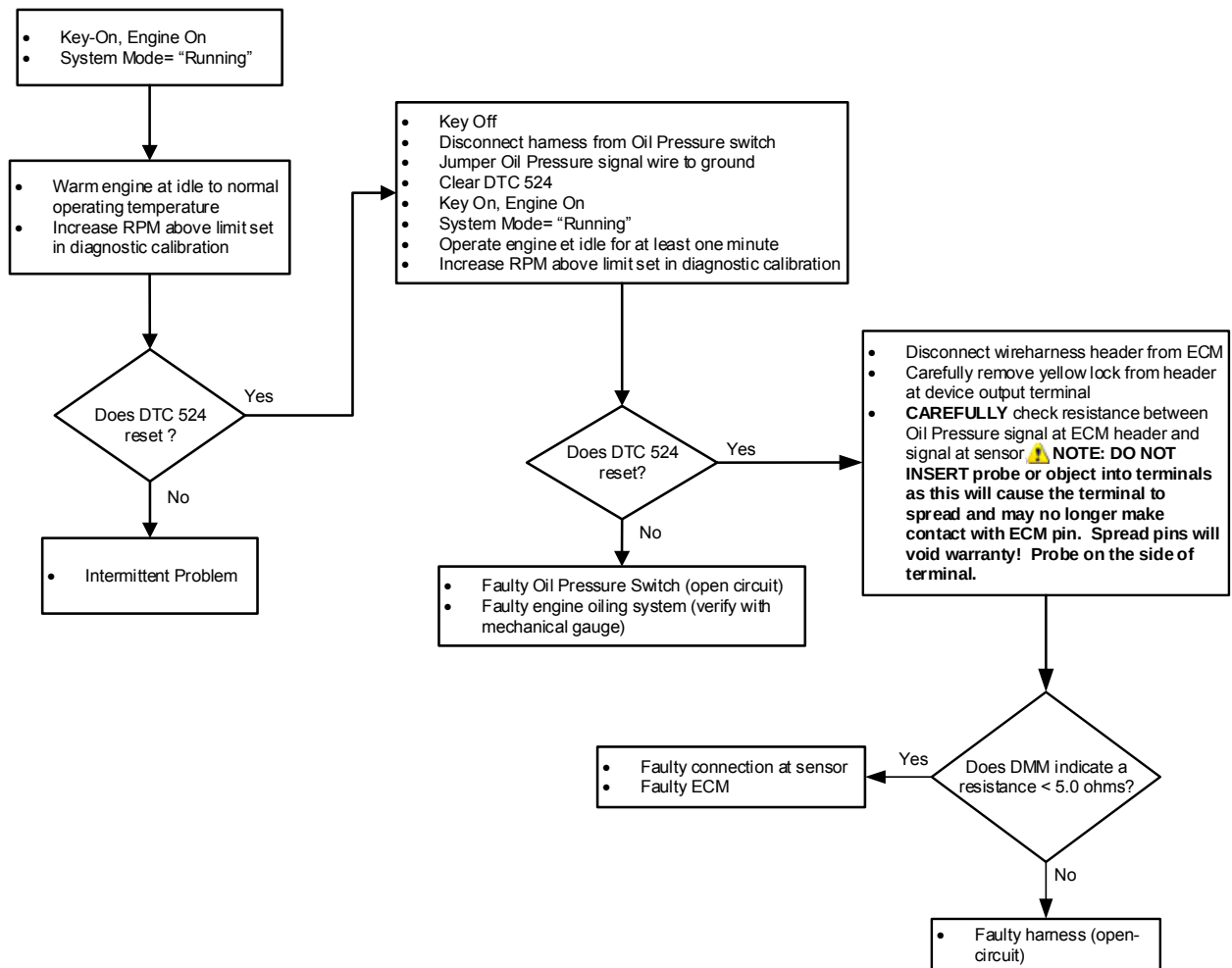
DTC	524	SPN	100	FMI	1
Measurement: Engine Oil Pressure					
Description: The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.					
Fault Enabled in Calibration?		TBD* (Application – Specific)			
Emissions-related Fault?		NO			
Check Condition:		Key on, Engine on			
Fault Set Conditions (as defined in calibration):					
• Oil pressure pulled-up input < (normally closed)				TBD*	volts
• Oil pressure pulled-up input > (normally open)				TBD*	volts
Possible Causes: For systems that use a switch this fault can be configured two different ways. It may use a normally closed switch or a normally open switch. If the switch is normally open, the fault will set if the circuit becomes grounded. If the switch is normally closed, the fault will set if the circuit becomes open. The engine should be configured to de-rate or force idle and/or shut down in the event of this fault to help prevent possible damage.					

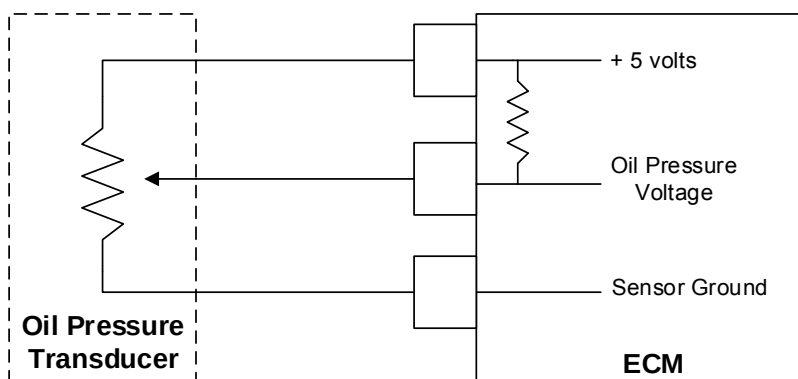
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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

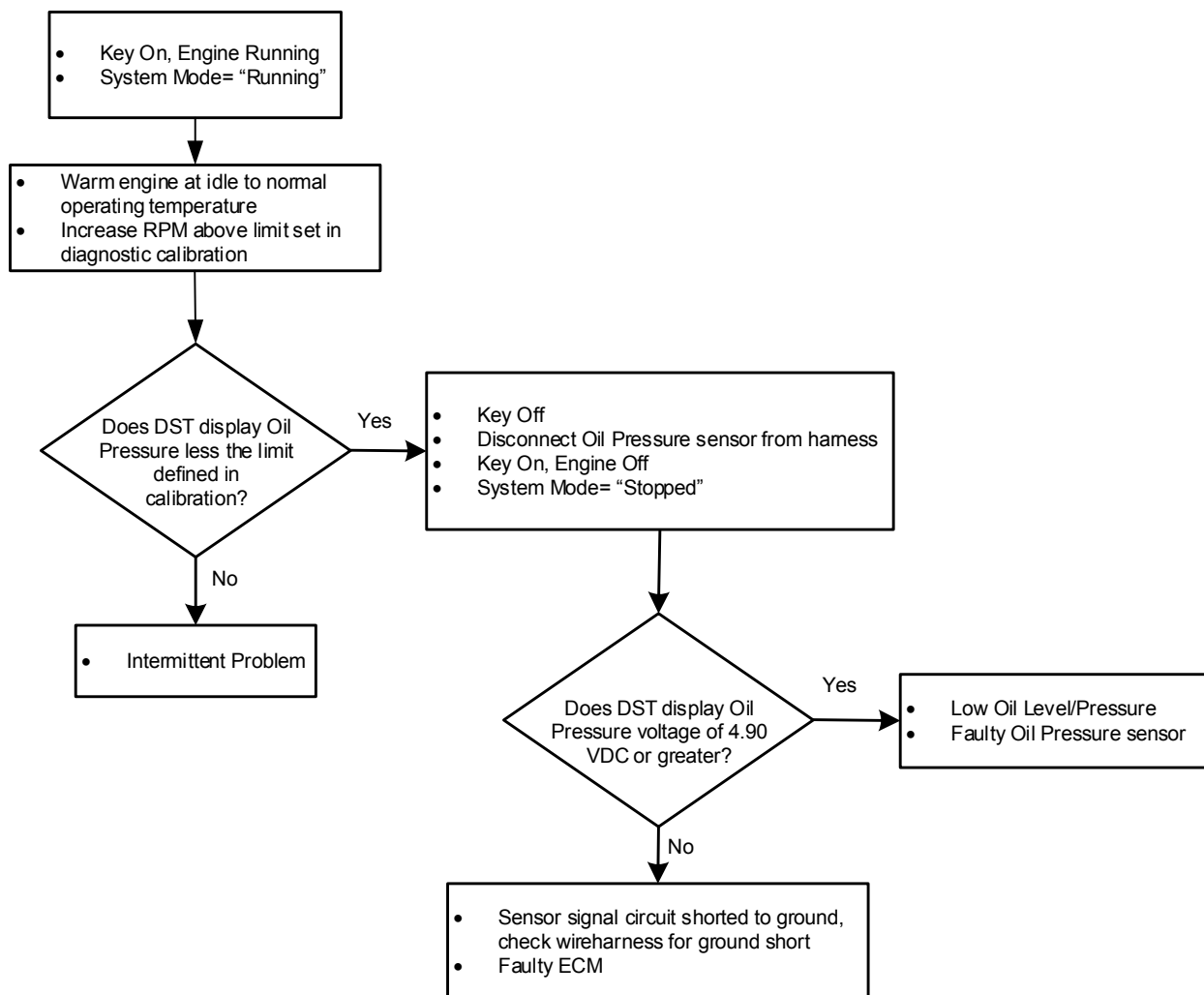
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

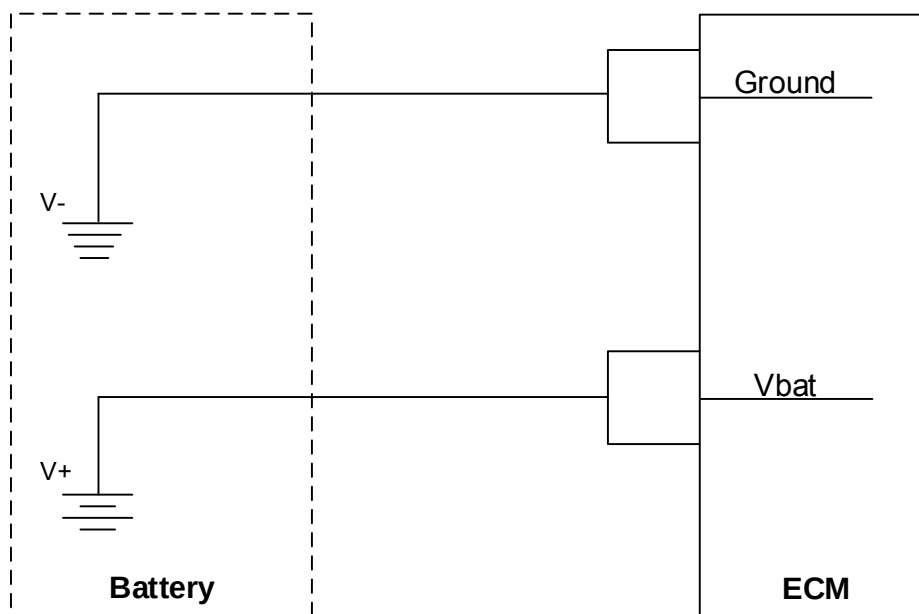
DTC 524 - OIL PRESSURE LOW (NORMALLY-OPEN SWITCH) (TROUBLE TREE)

DTC 524 - OIL PRESSURE LOW (NORMALLY-CLOSED SWITCH) (TROUBLE TREE)

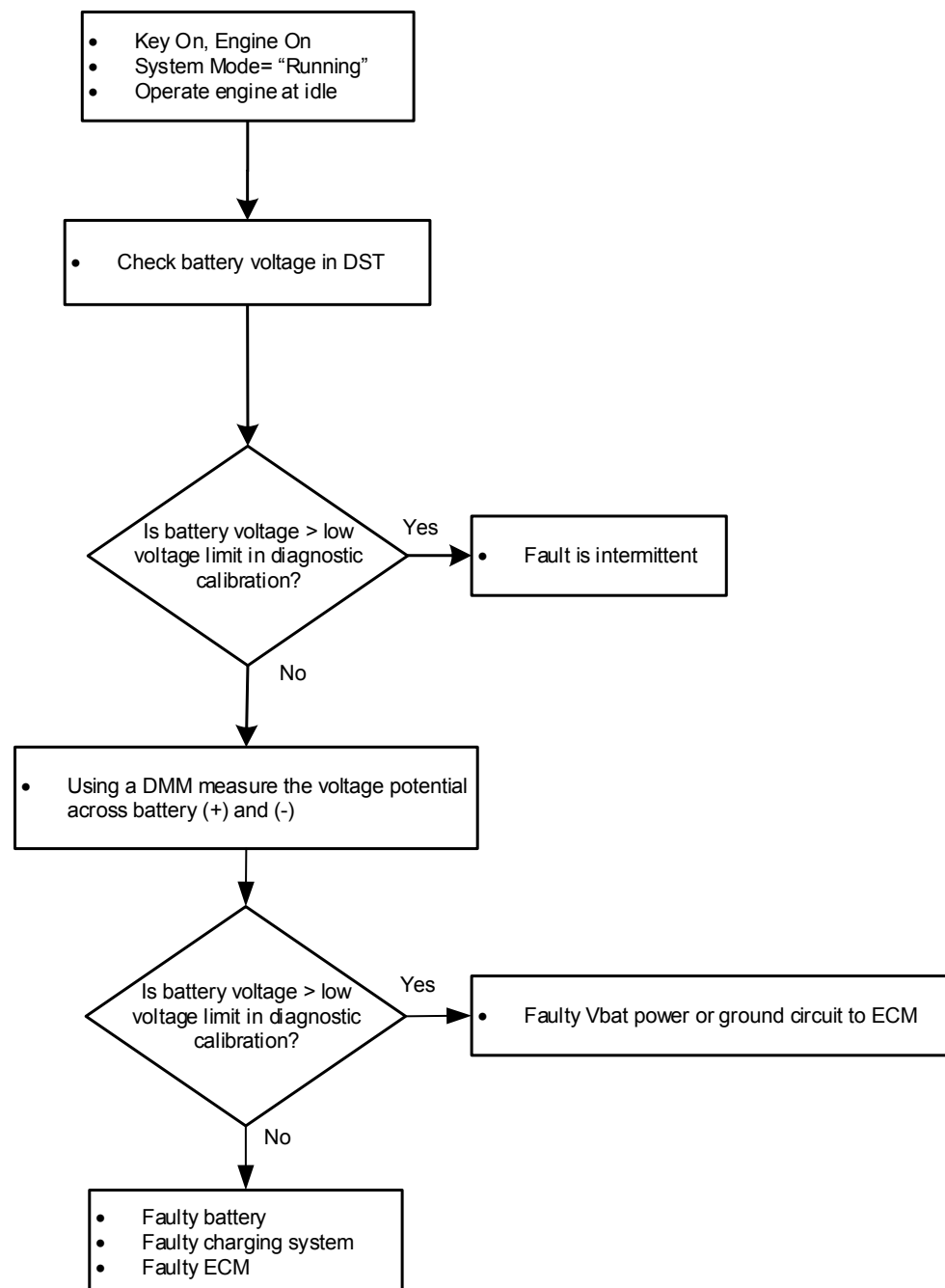
DTC 524 - OIL PRESSURE LOW STAGE 2 (SENDER)**Sensor-Type**

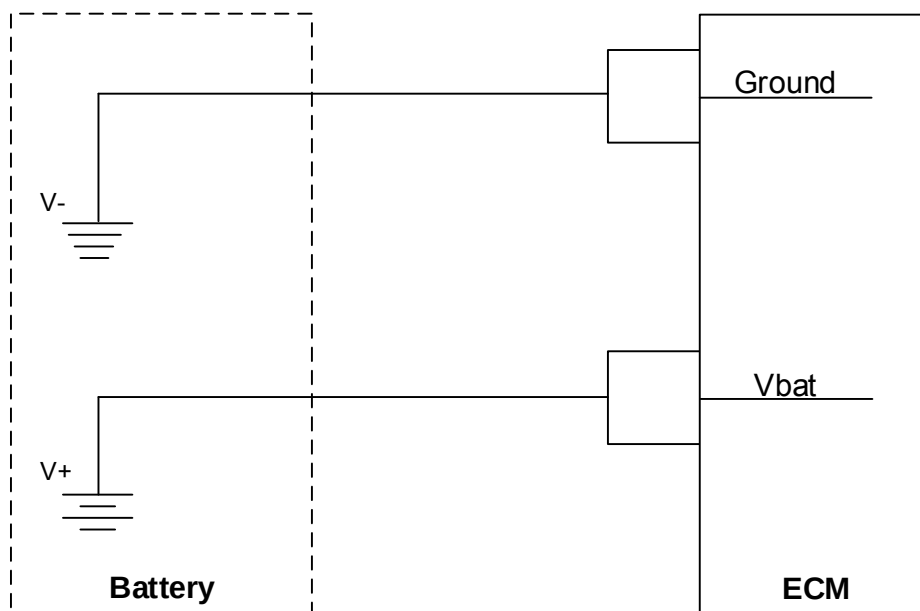
DTC	524	SPN	100	FMI	1		
Measurement: Engine Oil Pressure							
Description: The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine on					
Fault Set Conditions (as defined in calibration):							
<u>For RPM > lower limit AND RPM <=</u>				TBD*	rpm		
• Stage 2: oil pressure <				TBD*	psig		
<u>For RPM >=</u>				TBD*	rpm		
• Stage 2: oil pressure <				TBD*	psig		
Possible Causes: For systems that use a transducer, this fault sets if the engine oil pressure is less than $\bar{x}$ psia and engine speed is greater than $\bar{y}$ RPM after the engine has been running for $\bar{z}$ seconds as defined in the diagnostic calibration. The engine will should be configured to derate or force idle and/or shut down in the event of this fault to help prevent possible damage.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 524 - OIL PRESSURE LOW (SENDER) (TROUBLE TREE)

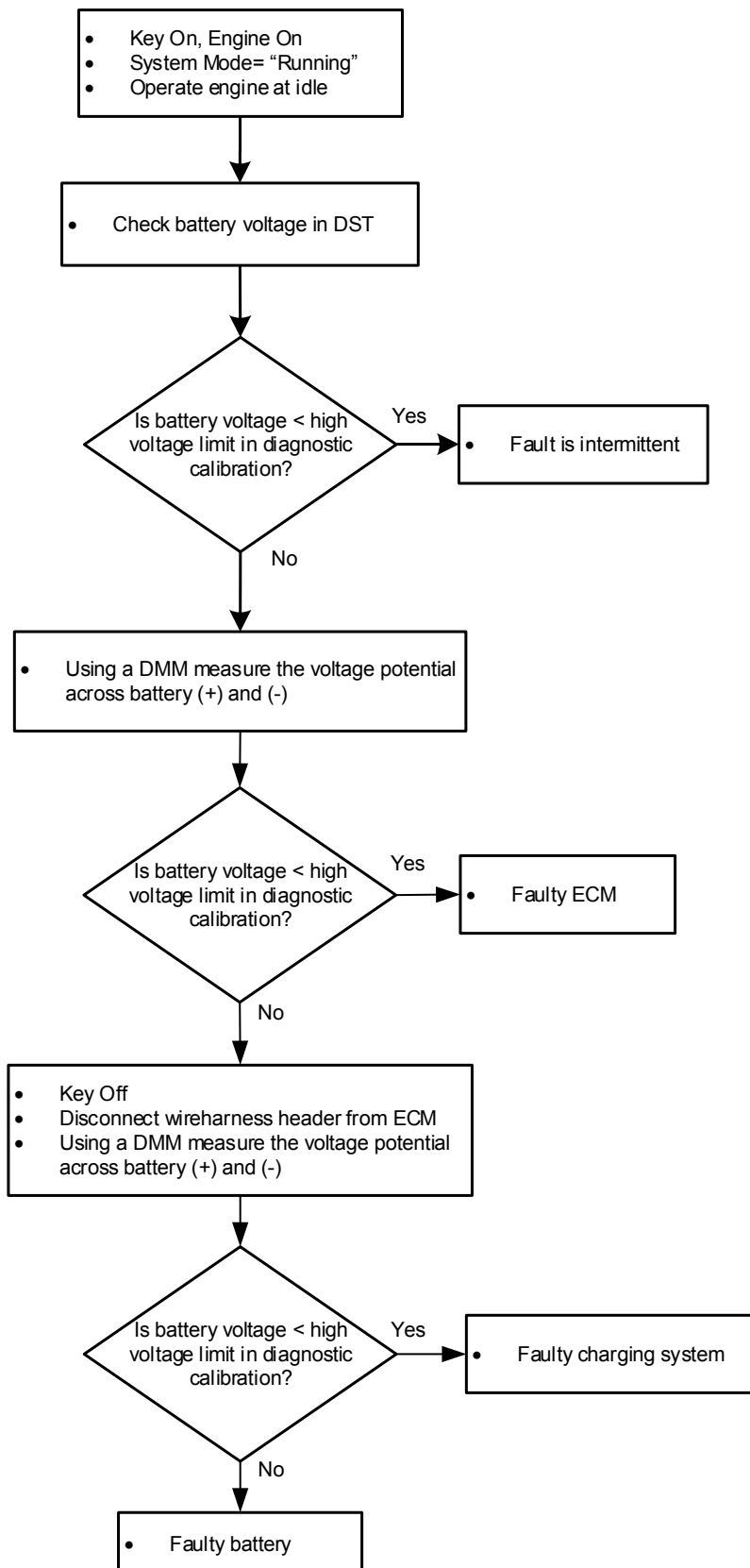
DTC 562 - BATTERY VOLTAGE (VBAT) LOW

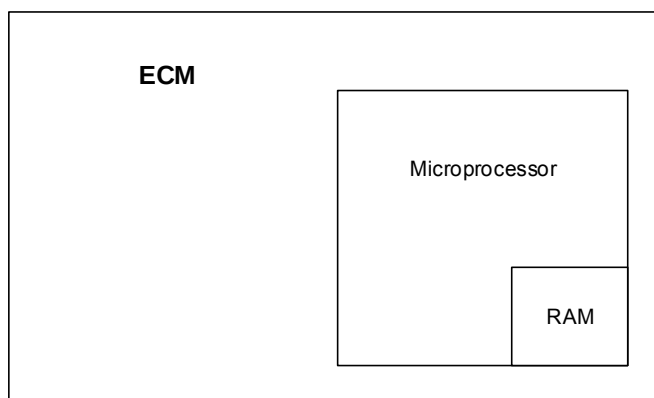
DTC	562	SPN	168	FMI	17		
Measurement: System Voltage to ECM							
Description: The battery voltage powers the ECM and must be within limits to correctly operate injector drivers, ignition coils, throttle, power supplies, and other powered devices that the ECM controls.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine on					
Fault Set Conditions (as defined in calibration):							
• Voltage <				TBD*	volts		
• and RPM >				TBD*	rpm		
Possible Causes: This fault will set if the ECM detects system voltage less than <u>x</u> volts while the engine is operating at <u>y</u> RPM as defined in the diagnostic calibration as the alternator should be charging the system. The adaptive learn is disabled to avoid improper adaptive learning due to the inability to correctly time injector firings.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 562 - BATTERY VOLTAGE (VBAT) LOW (TROUBLE TREE)

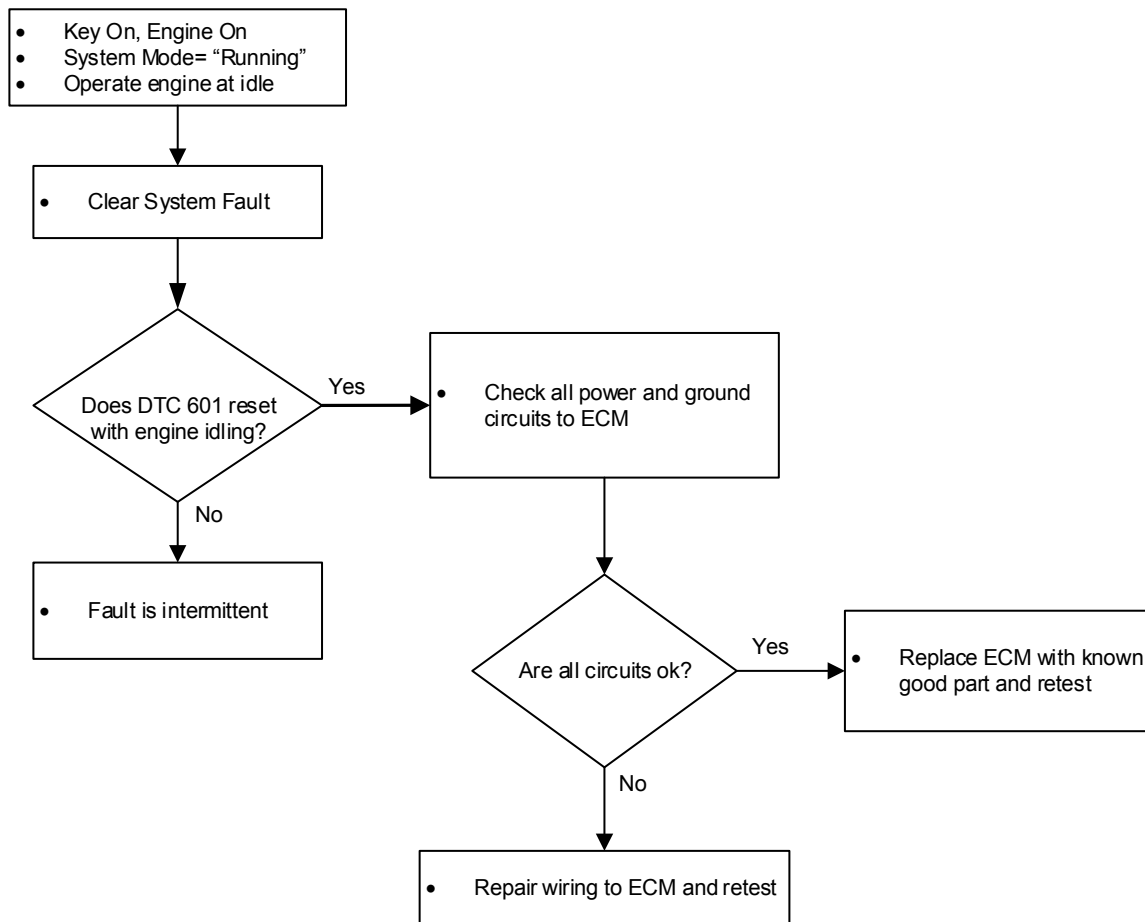
DTC 563 - BATTERY VOLTAGE (VBAT) HIGH

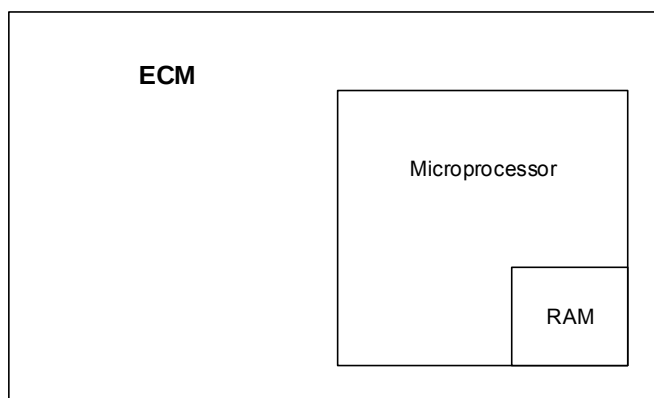
DTC	563	SPN	168	FMI	15		
Measurement: System Voltage to ECM							
Description: The battery voltage powers the ECM and must be within limits to correctly operate injector drivers, ignition coils, throttle, power supplies, and other powered devices that the ECM controls.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on, Engine Cranking or Running					
Fault Set Conditions (as defined in calibration):							
• Voltage >				TBD*	volts		
Possible Causes: This fault will set if the ECM detects system voltage greater than x volts while the engine is running or cranking as defined in the diagnostic calibration. The adaptive learn is disabled to avoid improper adaptive learning.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 563 - BATTERY VOLTAGE (VBAT) HIGH (TROUBLE TREE)

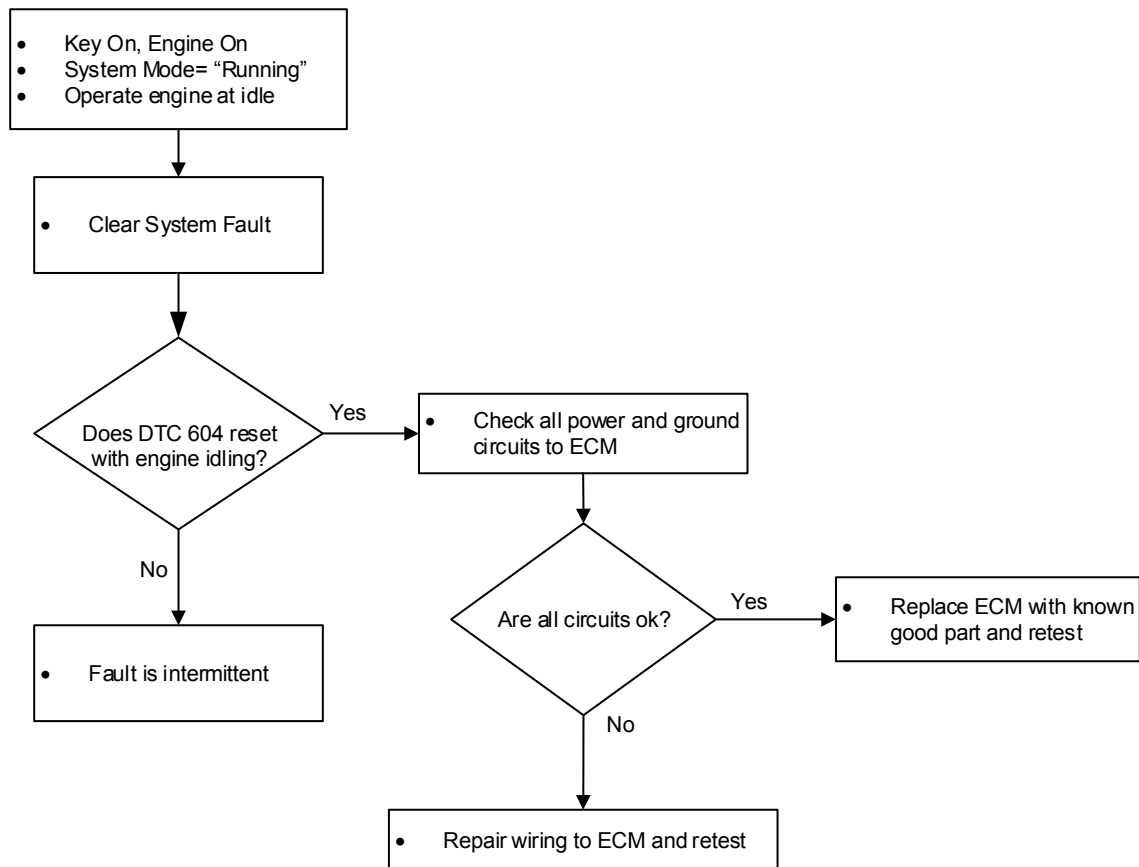
DTC 601 - MICROPROCESSOR FAILURE - FLASH

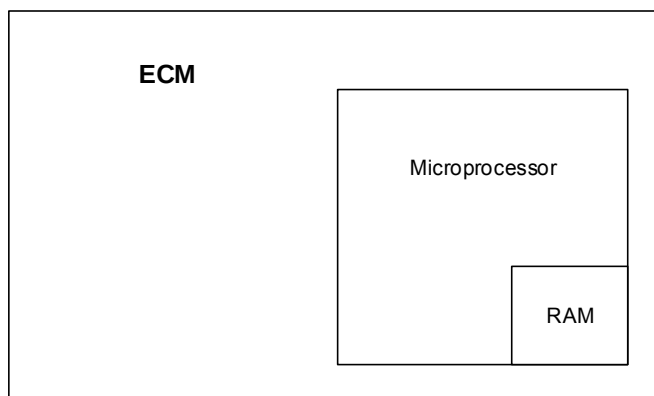
DTC	601	SPN	628	FMI	13		
Hardware: Engine Control Module – Flash Memory							
Description: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on					
Fault Set Conditions (as defined in calibration): Internal microprocessor error							
Possible Causes: If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. A fault of flash memory can occur for any calibration variable set and thus could cause undesirable operation.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 601 - MICROPROCESSOR FAILURE – FLASH (TROUBLE TREE)

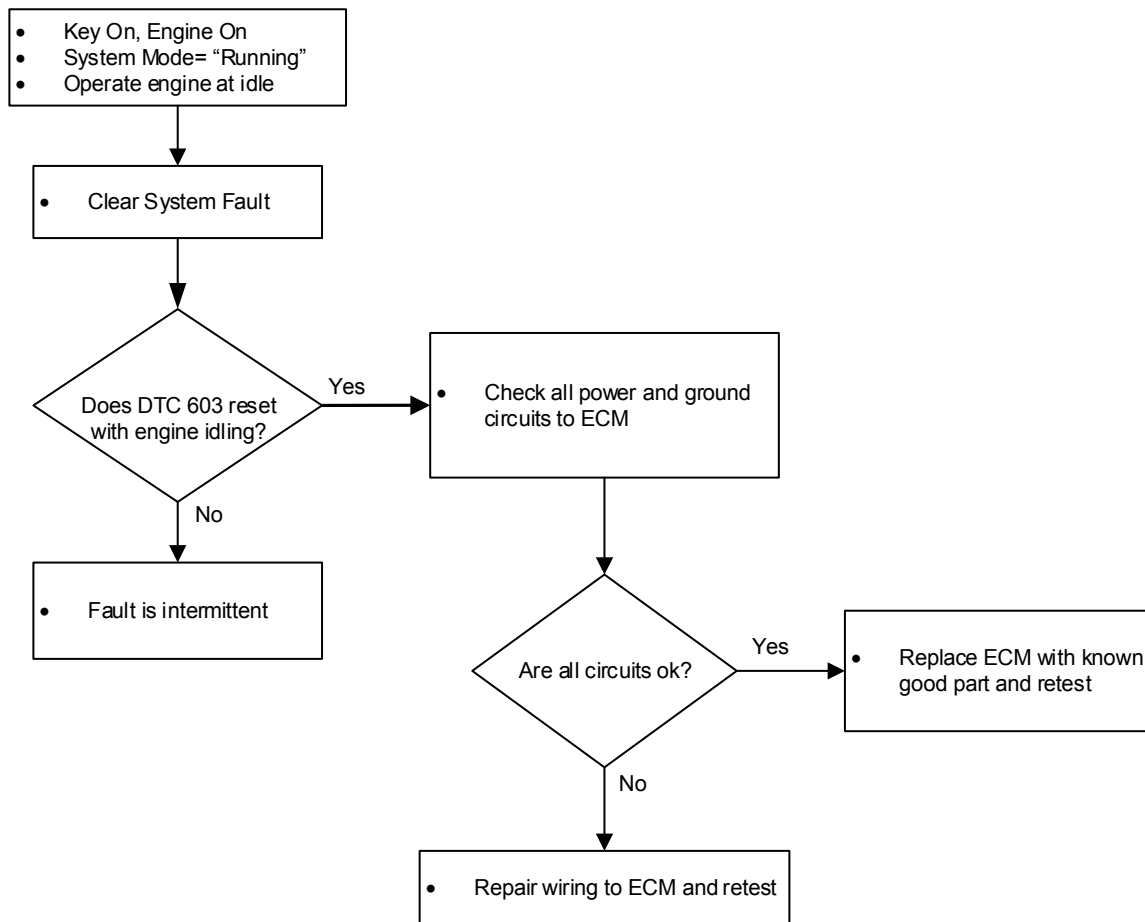
DTC 604 - MICROPROCESSOR FAILURE - RAM

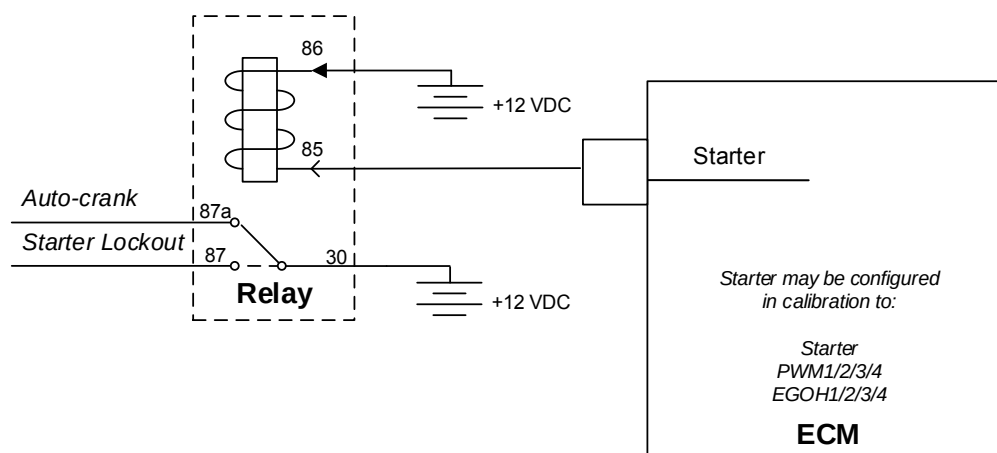
DTC	604	SPN	630	FMI	12		
Hardware: Engine Control Module – Random Access Memory							
Description: Random Access Memory is located within the microprocessor and can be read from or written to at any time. Data stored in RAM include DTCs (when fault configuration is set to “Battery Power Retained”), adaptive fuel learn tables, octane adaptation table, misfire adaption tables, and closed loop fuel multipliers. The ECM has checks that must be satisfied each time an instruction is executed.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on					
Fault Set Conditions (as defined in calibration): Internal microprocessor error							
Possible Causes: This fault will set if the ECM detects a problem accessing or writing information to RAM and should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. If this fault sets, the ECM will reset itself and log the code. This fault should be erased by a technician after diagnostics are performed. The fault should be configured to never forget and will not self-erase.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 604 - MICROPROCESSOR FAILURE – RAM (TROUBLE TREE)

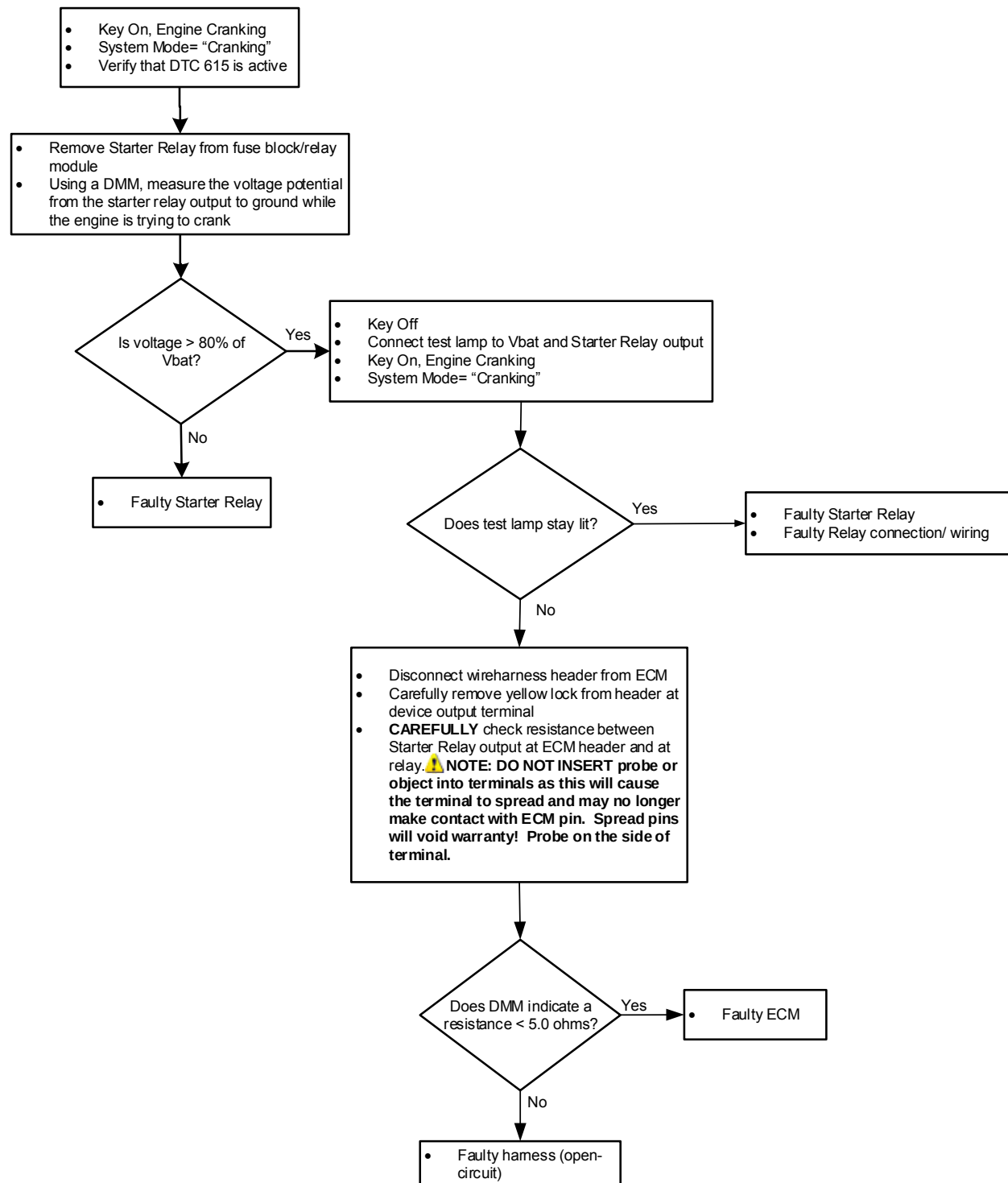
DTC 606 - MICROPROCESSOR FAILURE - COP

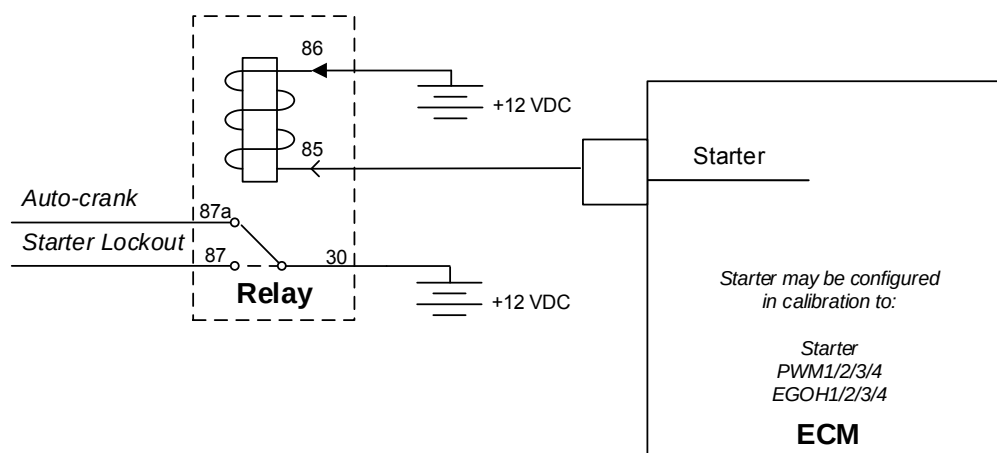
DTC	606	SPN	629	FMI	31		
Hardware: Engine Control Module							
Description: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key on					
Fault Set Conditions (as defined in calibration): Internal microprocessor error							
Possible Causes: If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 606 - MICROPROCESSOR FAILURE – COP (TROUBLE TREE)

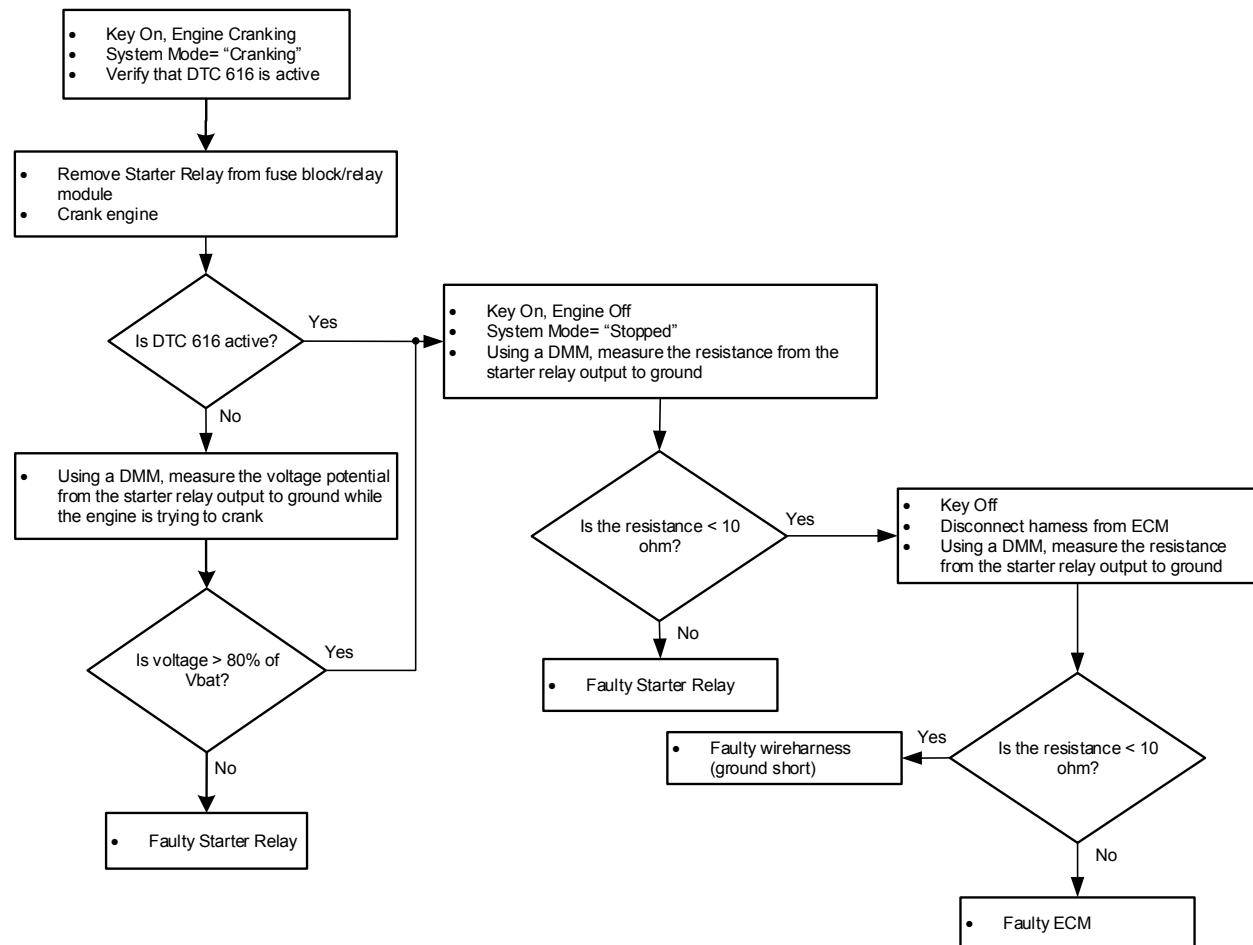
DTC 615 - START RELAY COIL OPEN

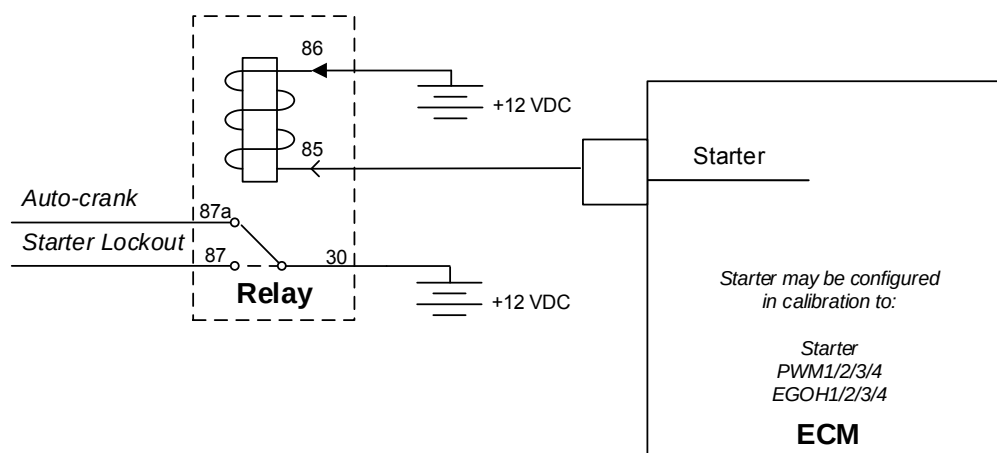
DTC	615	SPN	1321	FMI	5		
Hardware: Starter Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Cranking					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback <				TBD*	% Vbat		
OR							
• high-side feedback >					volts		
• and short-to-power fault inactive							
Possible Causes: This fault sets if the output for the starter relay is detected as an open circuit. If this fault is active the starter motor will not receive power and will not engage.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 615 - START RELAY COIL OPEN (TROUBLE TREE)

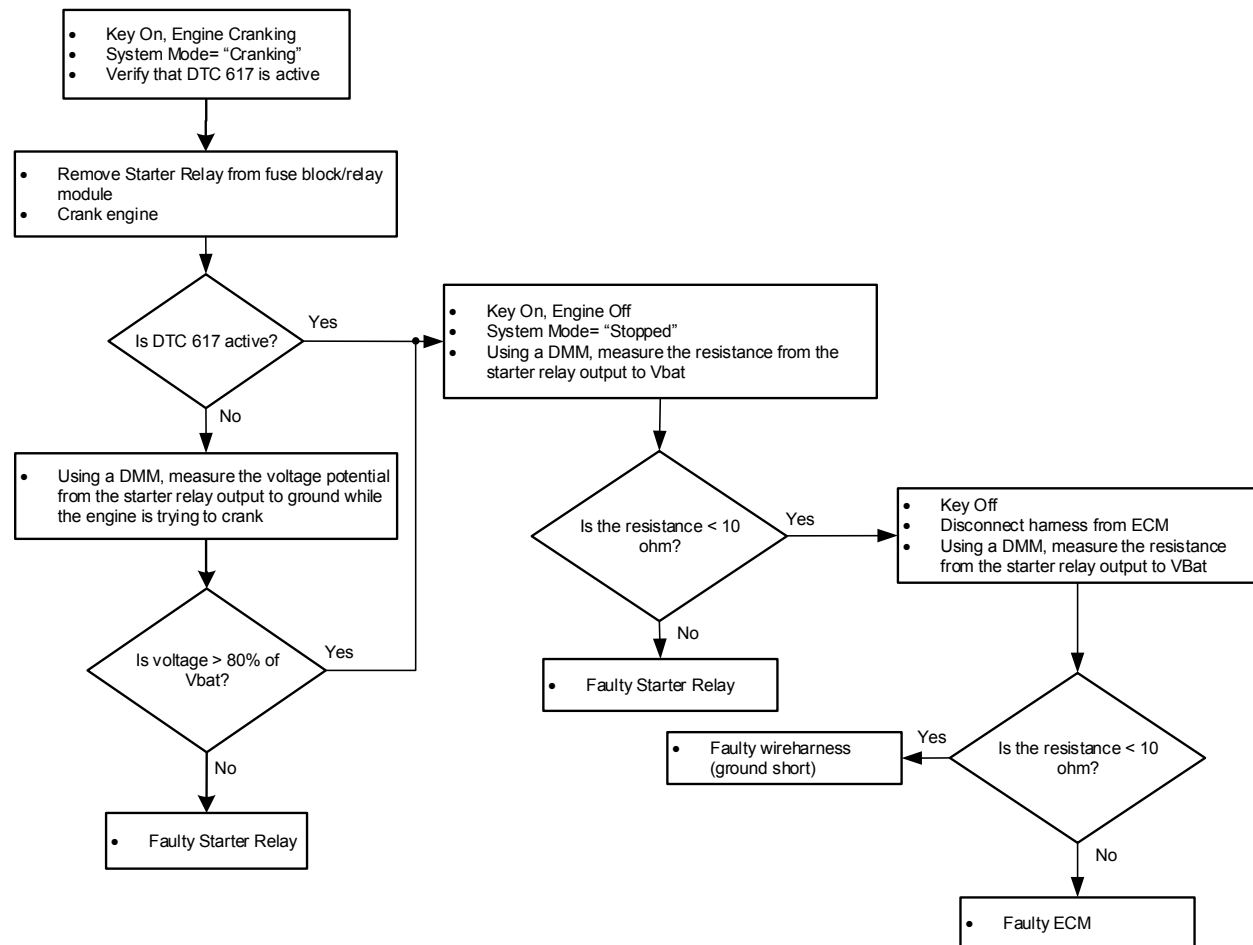
DTC 616 - START RELAY CONTROL GROUND SHORT

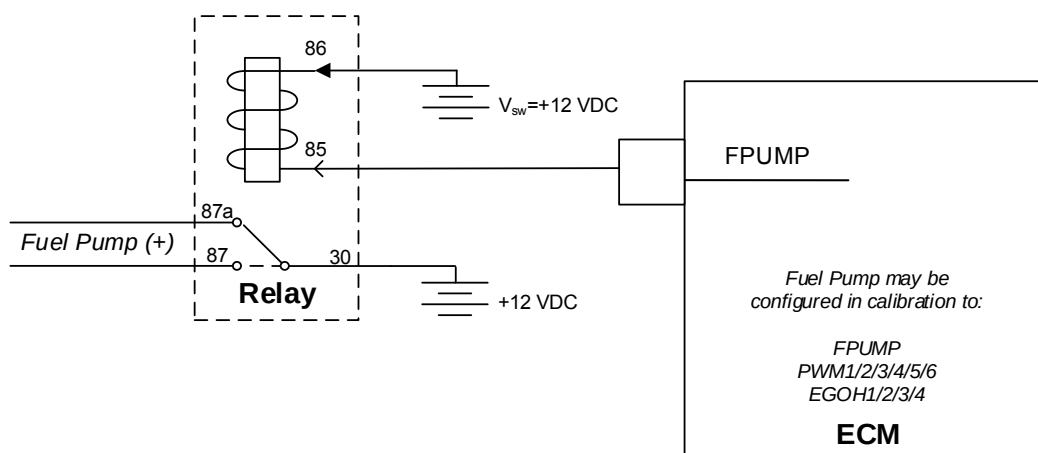
DTC	616	SPN	1321	FMI	4		
Hardware: Starter Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Cranking					
Fault Set Conditions (as defined in calibration):							
• Low-side diagnostics non-adjustable							
OR							
• high-side feedback <				TBD*	% Vbat		
Possible Causes: This fault sets if the output for the starter relay is detected as an open circuit. If this fault is active the starter motor will not receive power and will not engage.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 616 - START RELAY CONTROL GROUND SHORT (TROUBLE TREE)

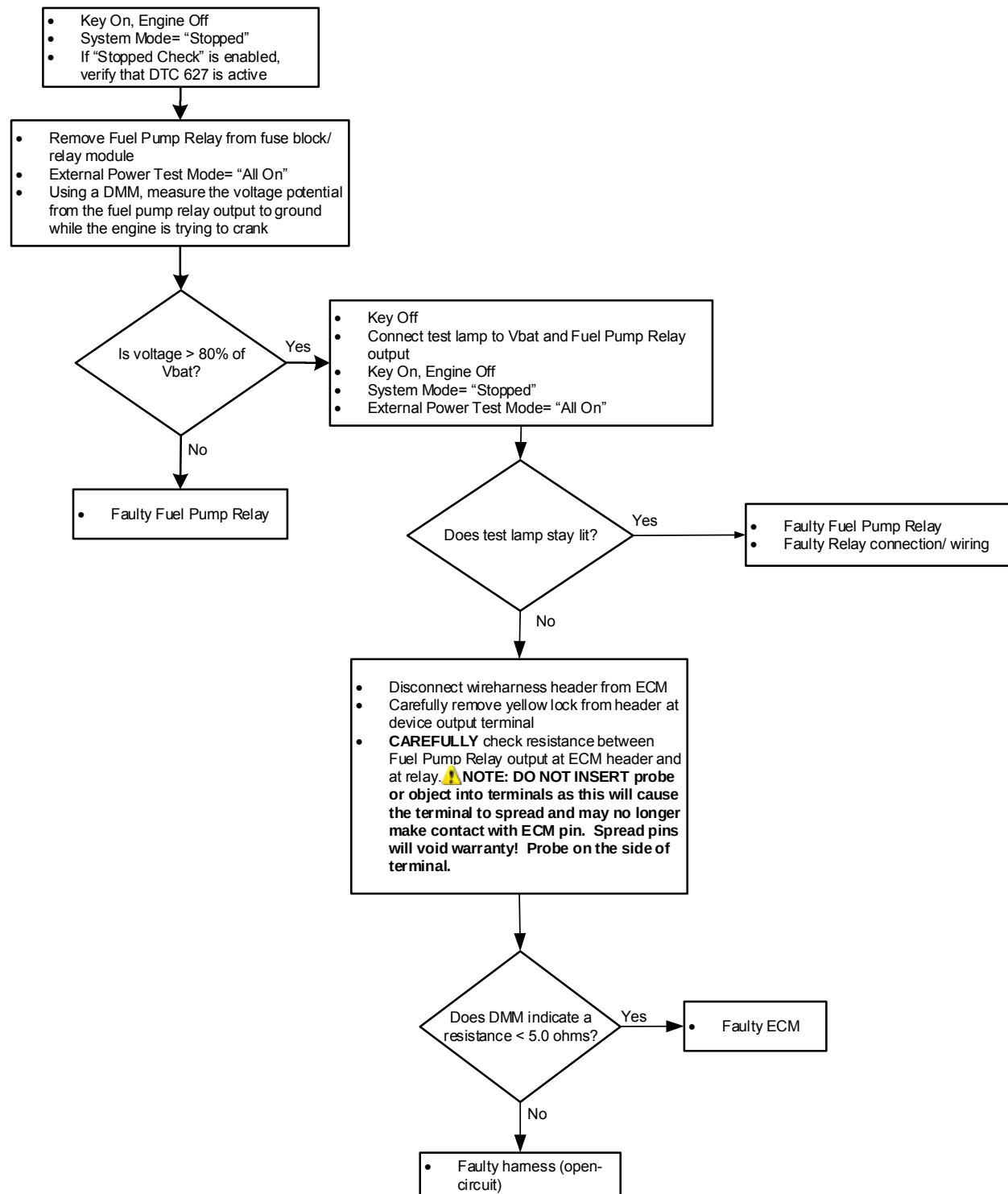
DTC 617 - START RELAY COIL SHORT TO POWER

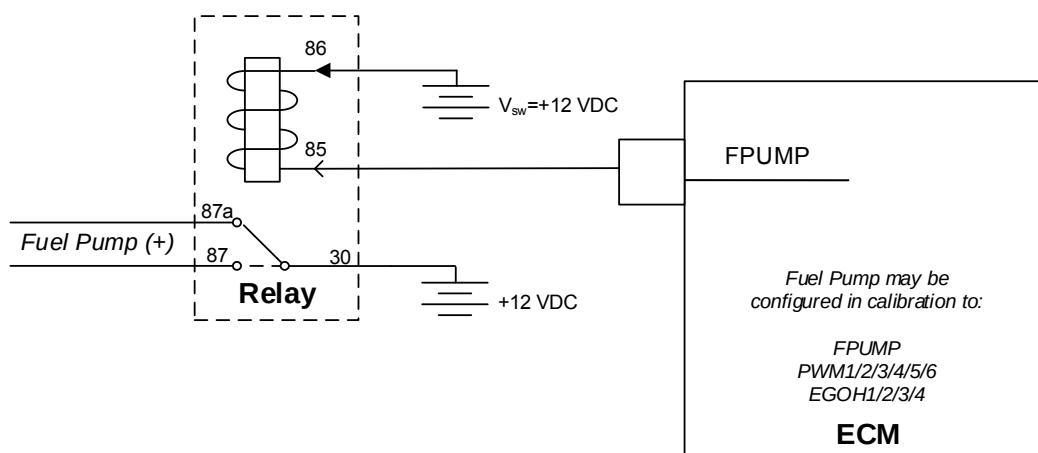
DTC	617	SPN	1321	FMI	3		
Hardware: Starter Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Cranking					
Fault Set Conditions (as defined in calibration):							
• Output feedback >				TBD*	% Vbat		
Possible Causes: This fault sets if the output for the starter relay is detected as shorted to power. If this fault is active the starter motor will not receive power and will not engage.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 617 - START RELAY COIL SHORT TO POWER (TROUBLE TREE)

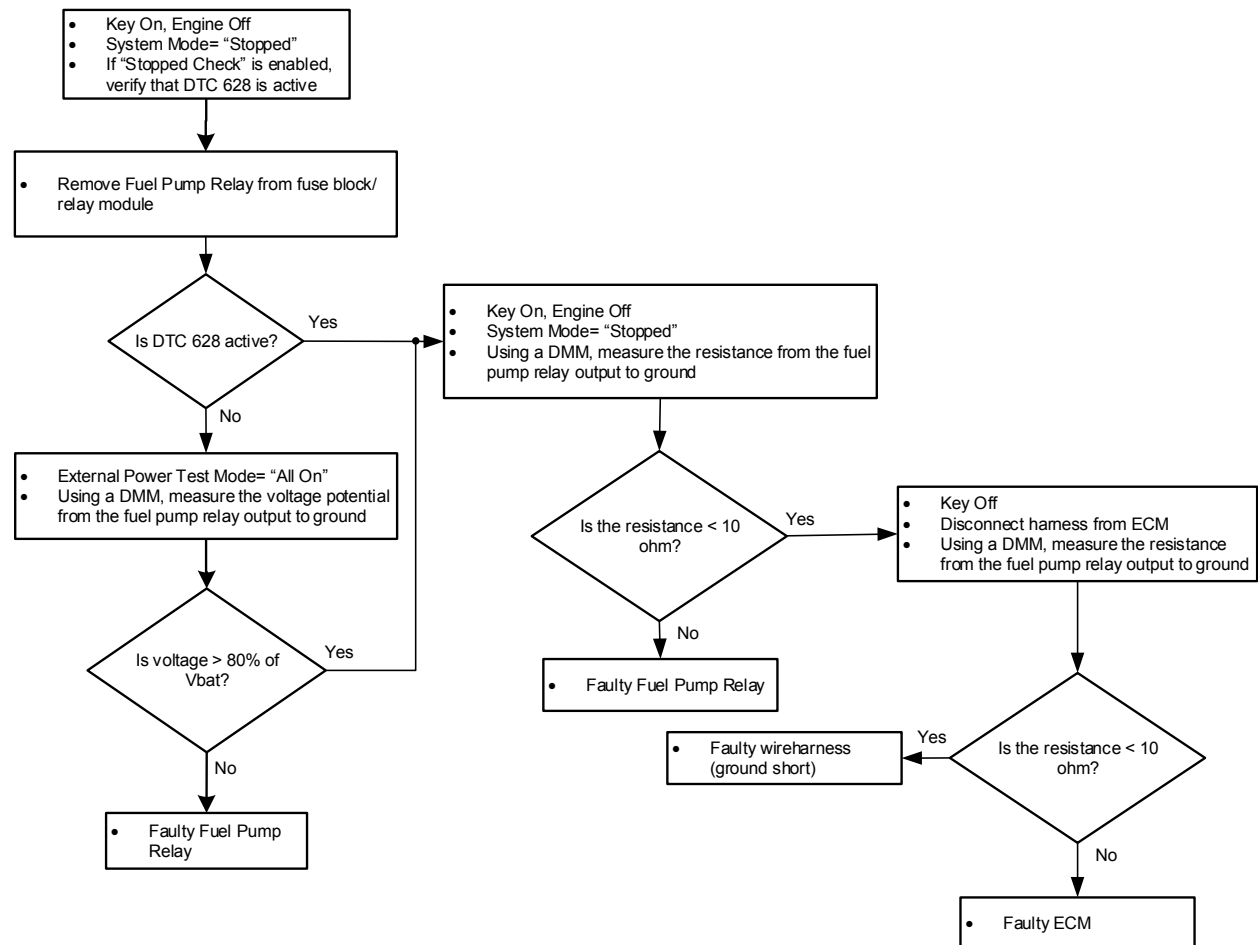
DTC 627 – FUEL PUMP RELAY COIL OPEN

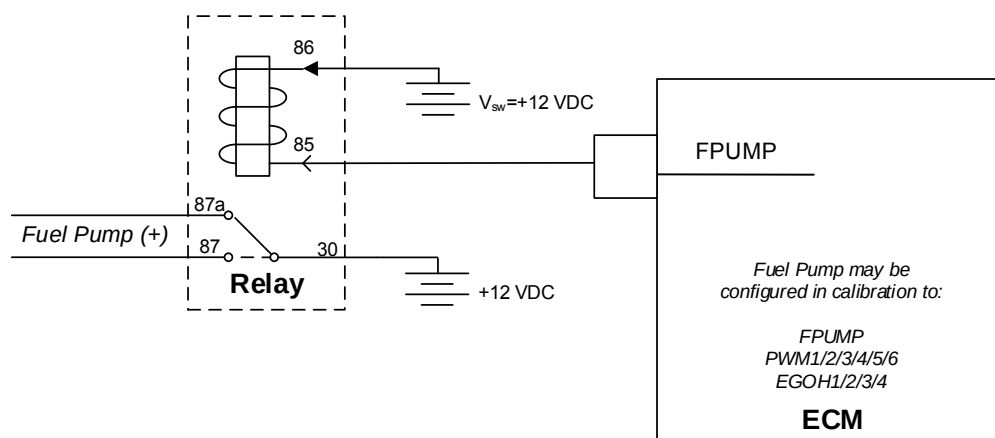
DTC	627	SPN	1348	FMI	5		
Hardware: Fuel Pump Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off					
Fault Set Conditions (as defined in calibration):							
Low-side diagnostics non-adjustable							
OR high-side feedback >				TBD*	volts		
and short-to-power fault inactive							
Possible Causes: This fault sets if the output for the fuel pump relay is detected as an open circuit. If this fault is active the fuel pump will not receive power and the engine will not run on gasoline.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 627 – FUEL PUMP RELAY COIL OPEN (TROUBLE TREE)

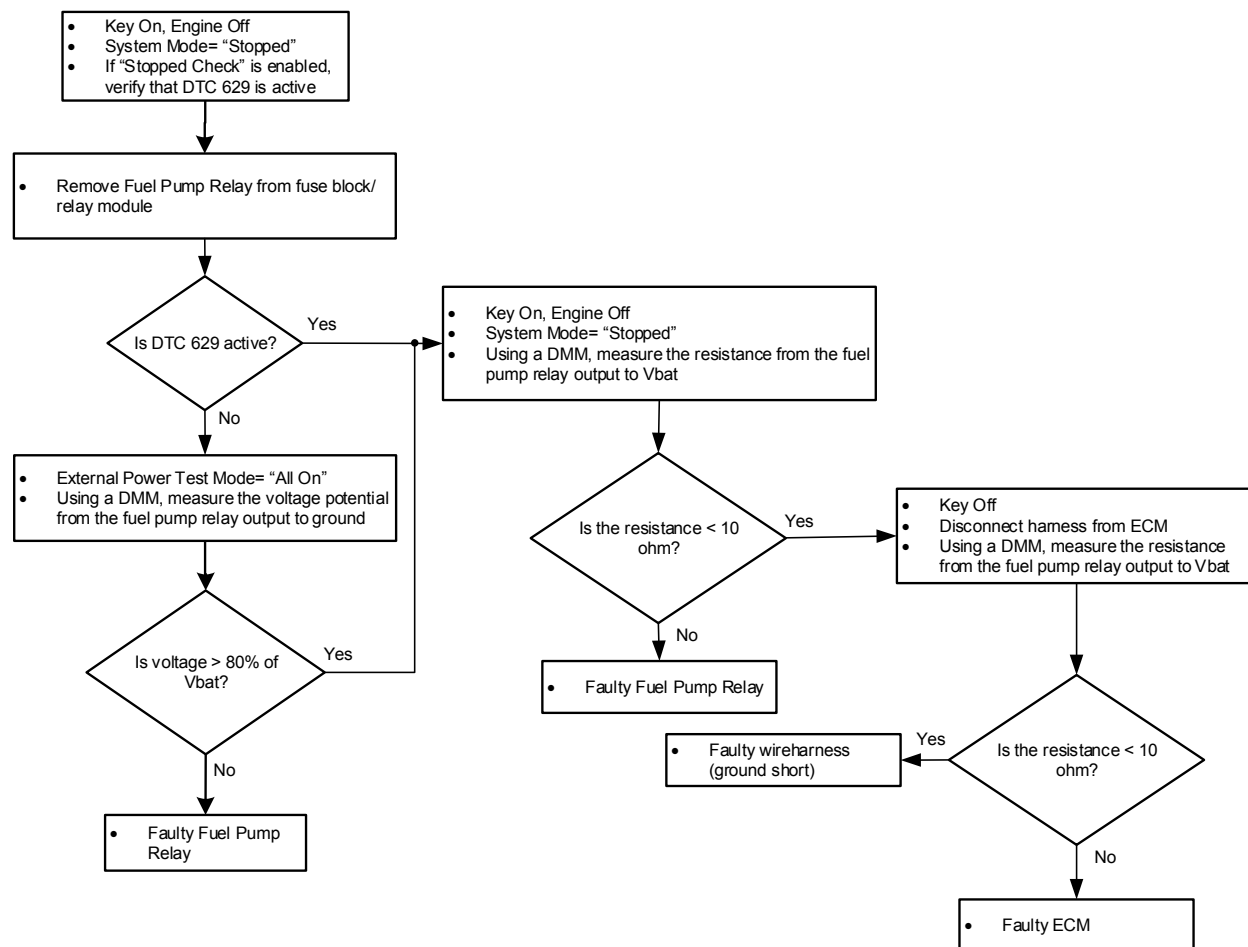
DTC 628 – FUEL PUMP RELAY CONTROL GROUND SHORT

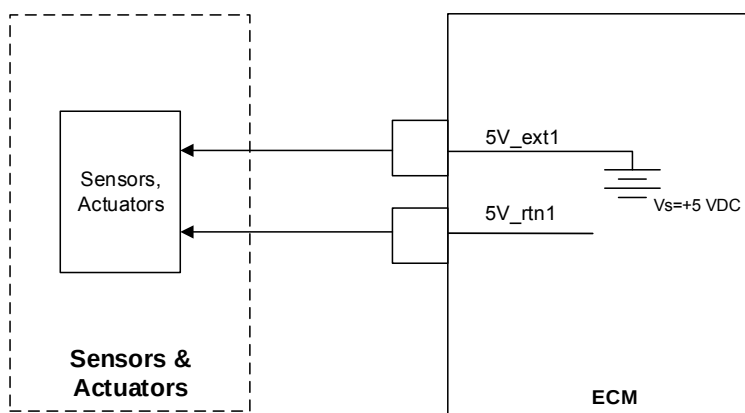
DTC	628	SPN	1348	FMI	4		
Hardware: Fuel Pump Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off					
Fault Set Conditions (as defined in calibration):							
Low-side diagnostics non-adjustable							
OR high-side feedback >				TBD*	volts		
and short-to-power fault inactive							
Possible Causes: This fault sets if the output for the fuel pump relay is detected as being shorted to ground. If this fault is active and the high-side of the fuel pump relay is supplied, the fuel pump will run until the relay or high-side power is removed.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 628 – FPUMP RELAY CONTROL GROUND SHORT (TROUBLE TREE)

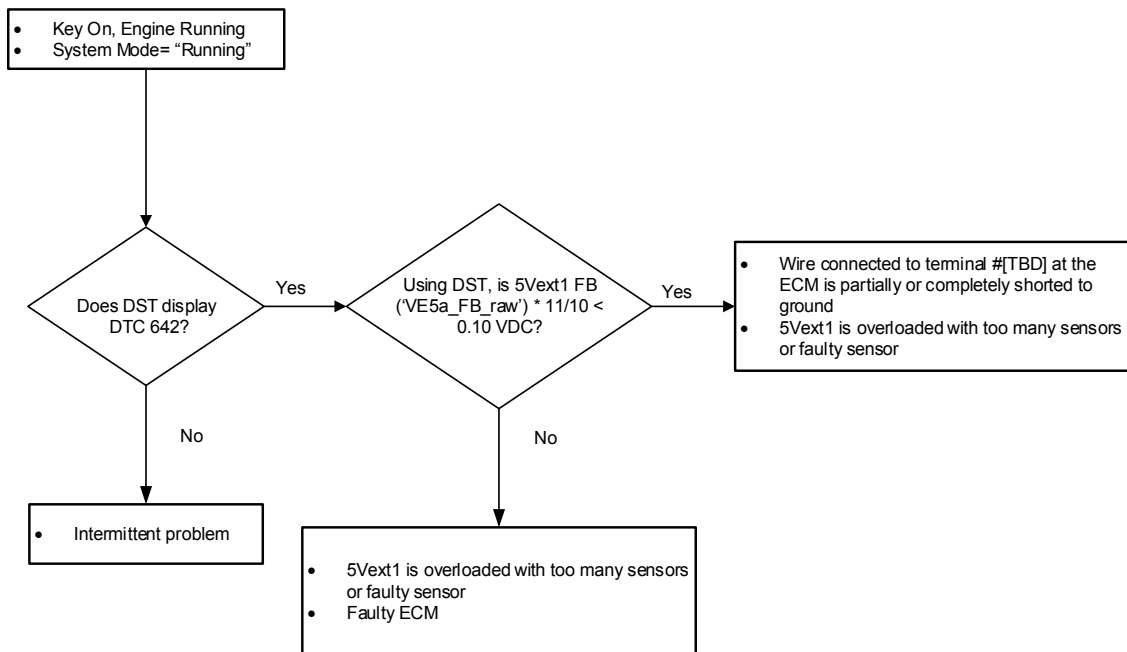
DTC 629 - FPUMP RELAY COIL SHORT TO POWER

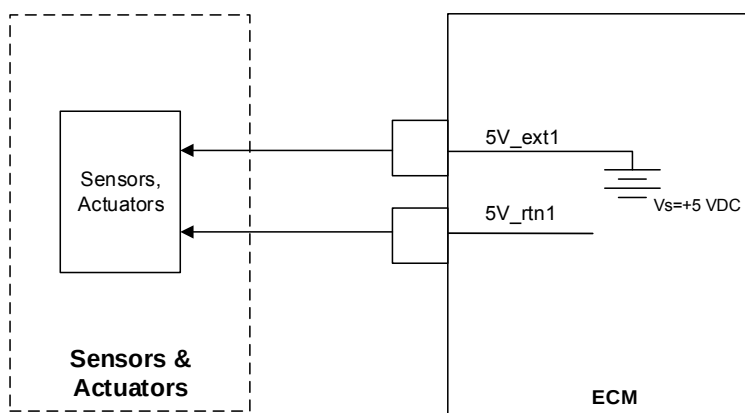
DTC	629	SPN	1348	FMI	3		
Hardware: Fuel Pump Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off					
Fault Set Conditions (as defined in calibration):							
- Low-side diagnostics non-adjustable - OR high-side feedback >							
				TBD*	% Vbat		
Possible Causes: This fault sets if the output for the fuel pump relay is detected as shorted to power. If this fault is active the fuel pump will not receive power and will not run.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 629 - FPUMP RELAY COIL SHORT TO POWER (TROUBLE TREE)

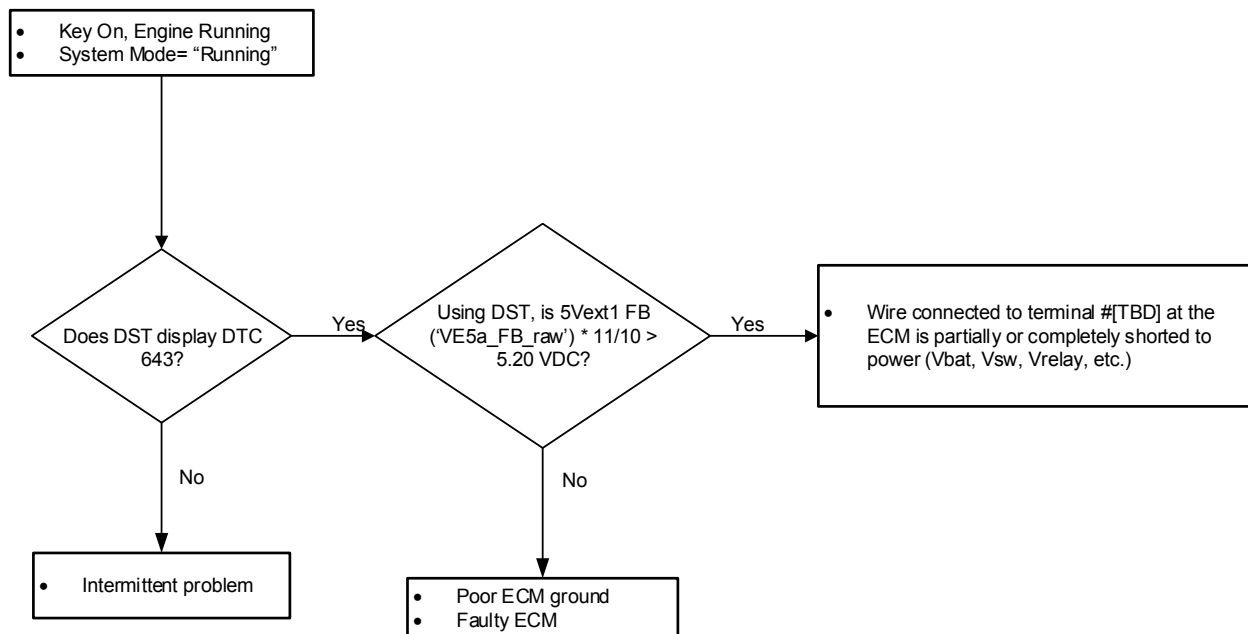
DTC 642 - SENSOR SUPPLY VOLTAGE 1 LOW (5VEXT1)

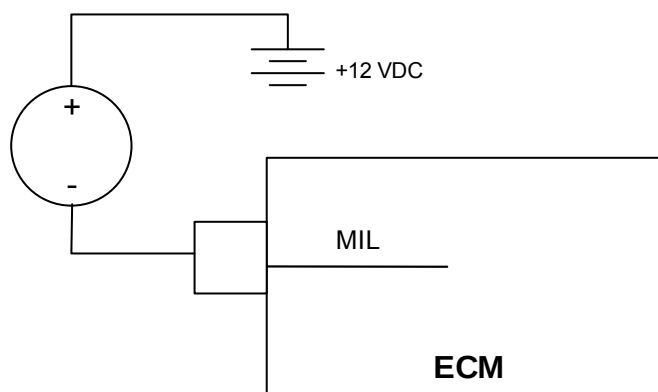
DTC	642	SPN	1079	FMI	4		
Hardware: External Sensor Supply Voltage Regulator							
Description: The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors’ feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off and Running					
Fault Set Conditions (as defined in calibration):							
• 5VE1 <				TBD*	volts		
Possible Causes: This fault will set if the internally measured voltage feedback of the regulator output is lower than the low voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 642 - SENSOR SUPPLY VOLTAGE 1 LOW (5VEXT1) (TROUBLE TREE)

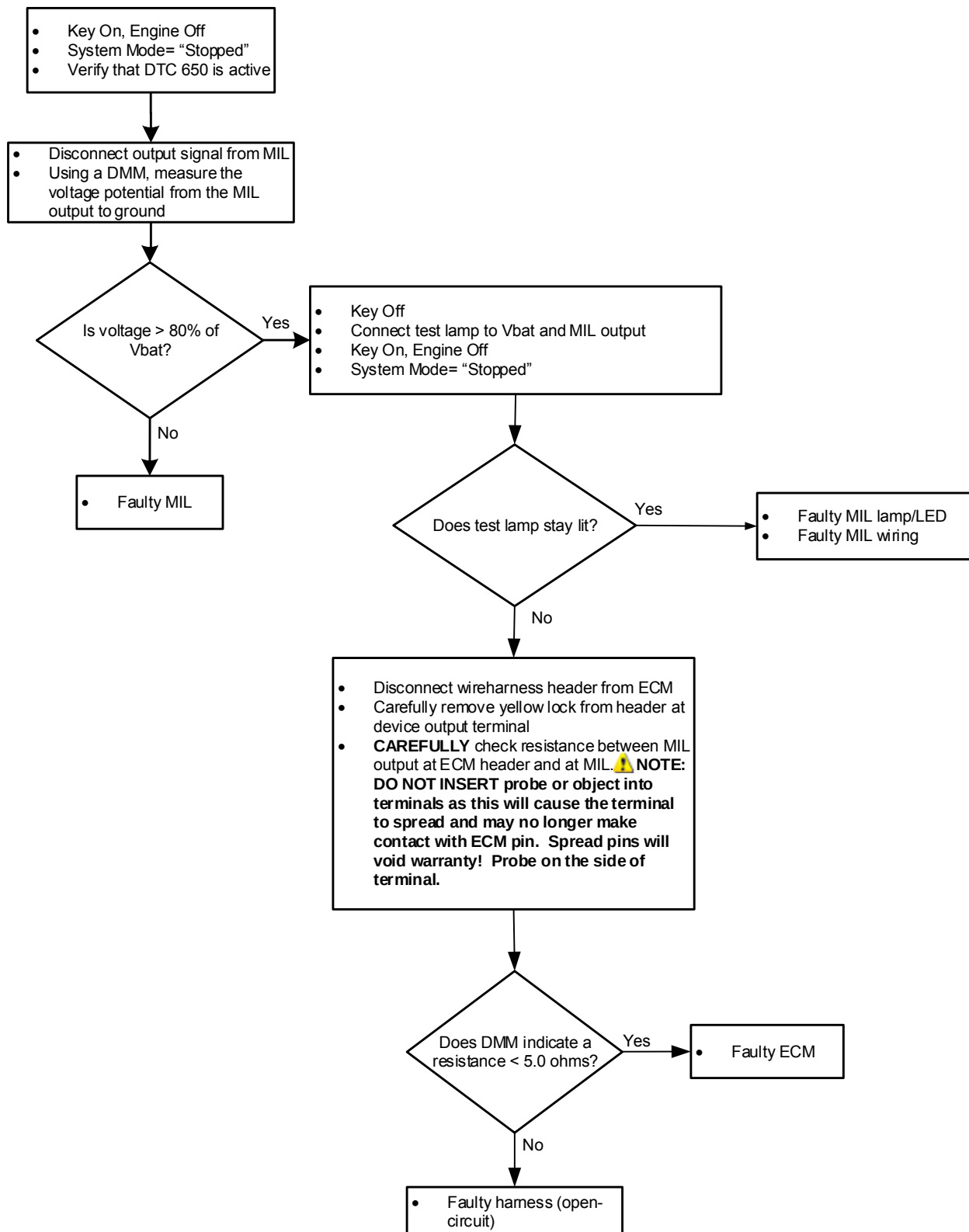
DTC 643 - SENSOR SUPPLY VOLTAGE 1 HIGH (5VEXT1)

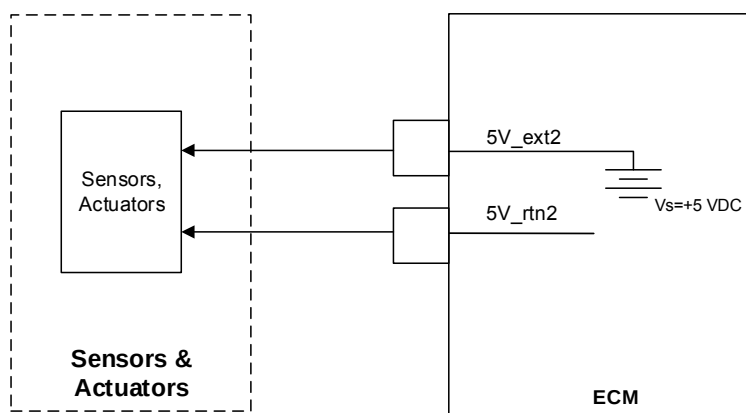
DTC	643	SPN	1079	FMI	3		
Hardware: External Sensor Supply Voltage Regulator							
Description: The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors’ feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off and Running					
Fault Set Conditions (as defined in calibration):							
• 5VE1 >				TBD*	volts		
Possible Causes: This fault will set if the internally measured voltage feedback of the regulator output is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 643- SENSOR SUPPLY VOLTAGE 1 HIGH (5VEXT1) (TROUBLE TREE)

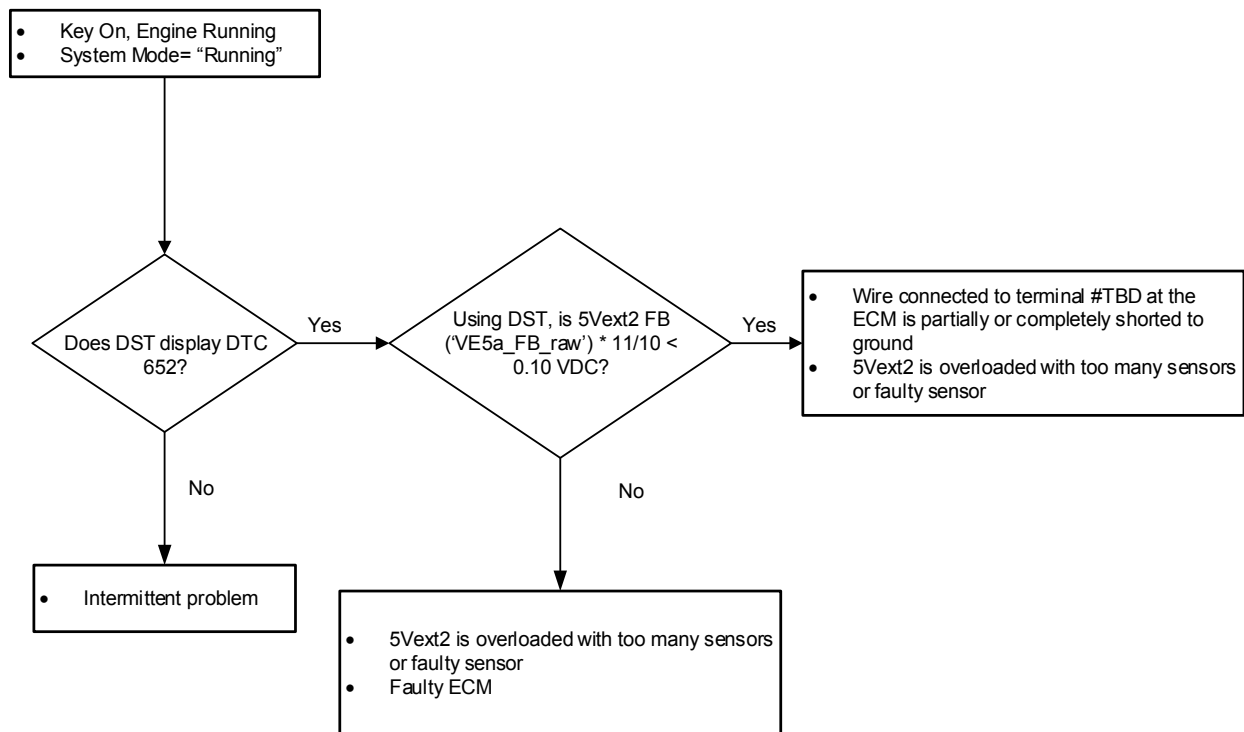
DTC 650 - MIL OPEN

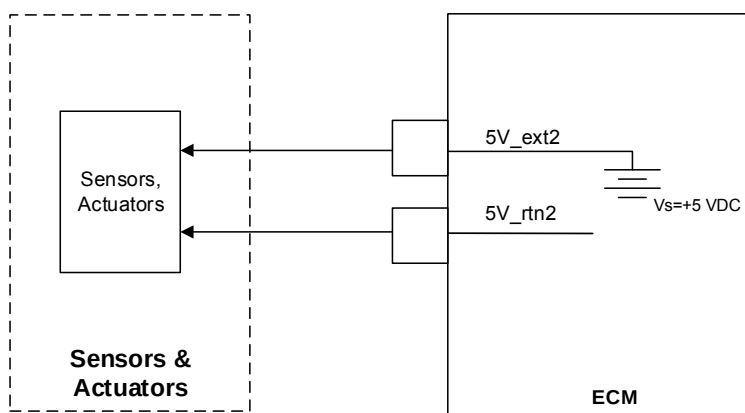
DTC	650	SPN	1213	FMI	5		
Hardware: MIL							
Description: This ECM output is used to provide a low-side switch to a MIL that is used to indicate that an emission related fault has been set.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off or Running					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback <				TBD*	% VBat		
Possible Causes: This fault will set if the ECM detects that there is no load connected to the MIL output.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 650 - MIL OPEN (TROUBLE TREE)

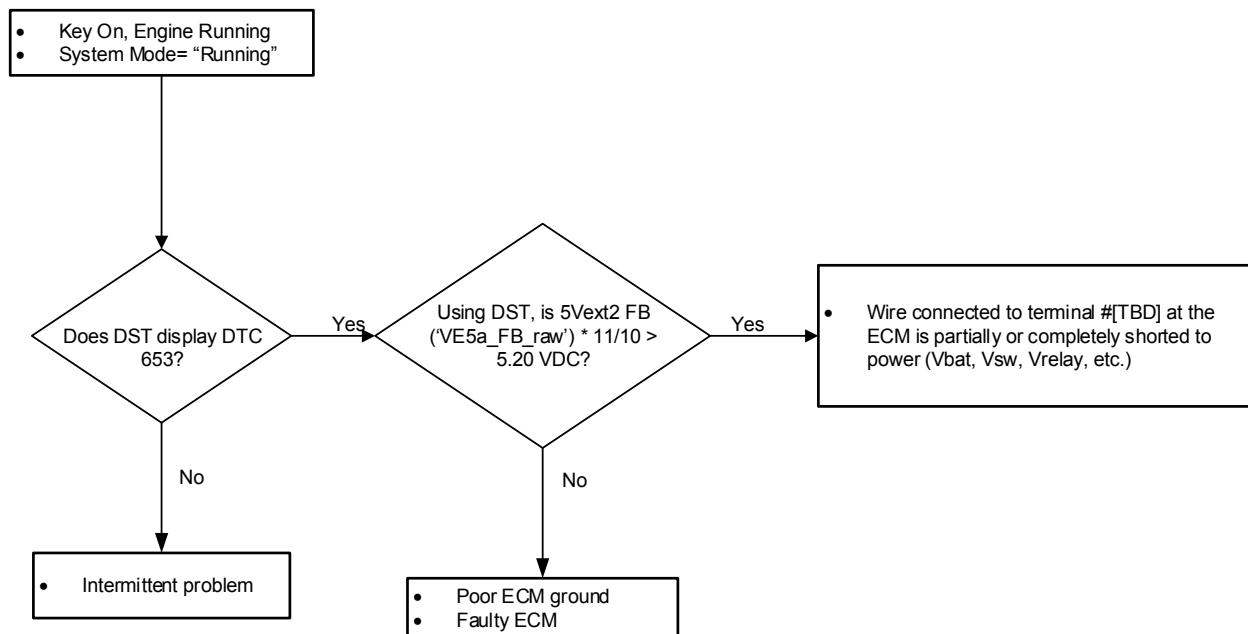
DTC 652 - SENSOR SUPPLY VOLTAGE 2 LOW (5VEXT2)

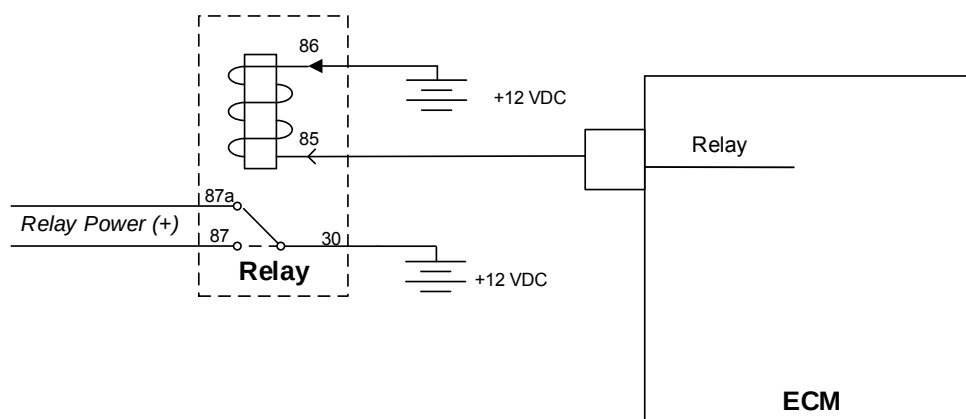
DTC	652	SPN	1080	FMI	4		
Hardware: External Sensor Supply Voltage Regulator							
Description: The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors’ feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off and Running					
Fault Set Conditions (as defined in calibration):							
• 5VE2 <				TBD*	volts		
Possible Causes: This fault will set if the internally measured voltage feedback of the regulator output is lower than the low voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 652 - SENSOR SUPPLY VOLTAGE 2 LOW (5VEXT2) (TROUBLE TREE)

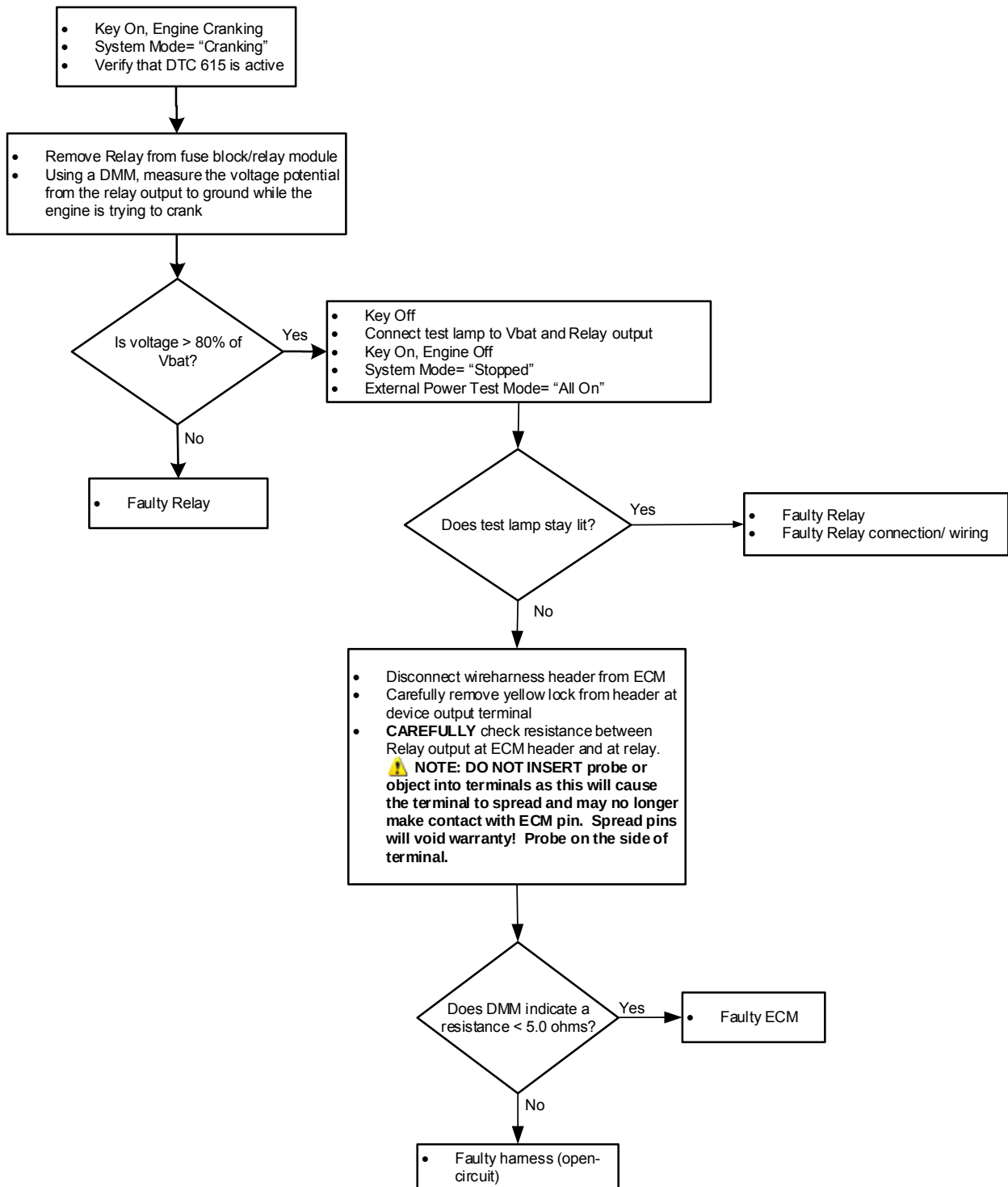
DTC 653 – SENSOR SUPPLY VOLTAGE 2 HIGH (5VEXT2)

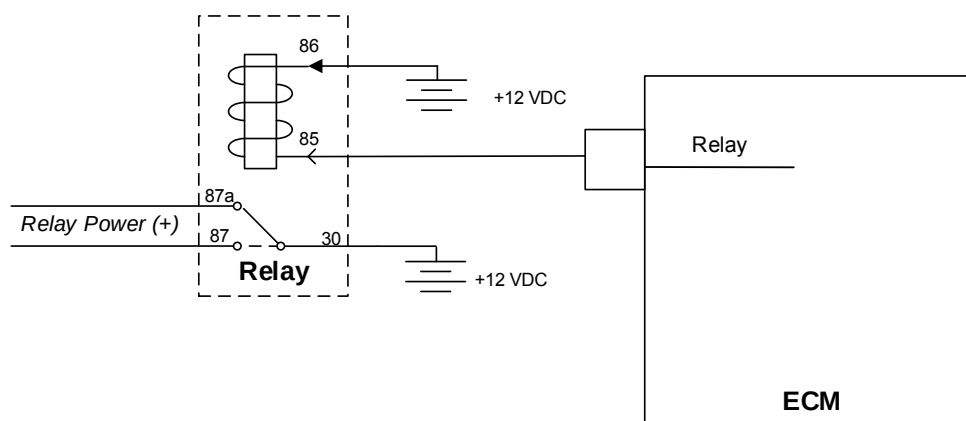
DTC	653	SPN	1080	FMI	3		
Hardware: External Sensor Supply Voltage Regulator							
Description: The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors' feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off and Running					
Fault Set Conditions (as defined in calibration):							
• 5VE2 >				TBD*	volts		
Possible Causes: This fault will set if the internally measured voltage feedback of the regulator output is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 653- SENSOR SUPPLY VOLTAGE 2 HIGH (5VEXT2) (TROUBLE TREE)

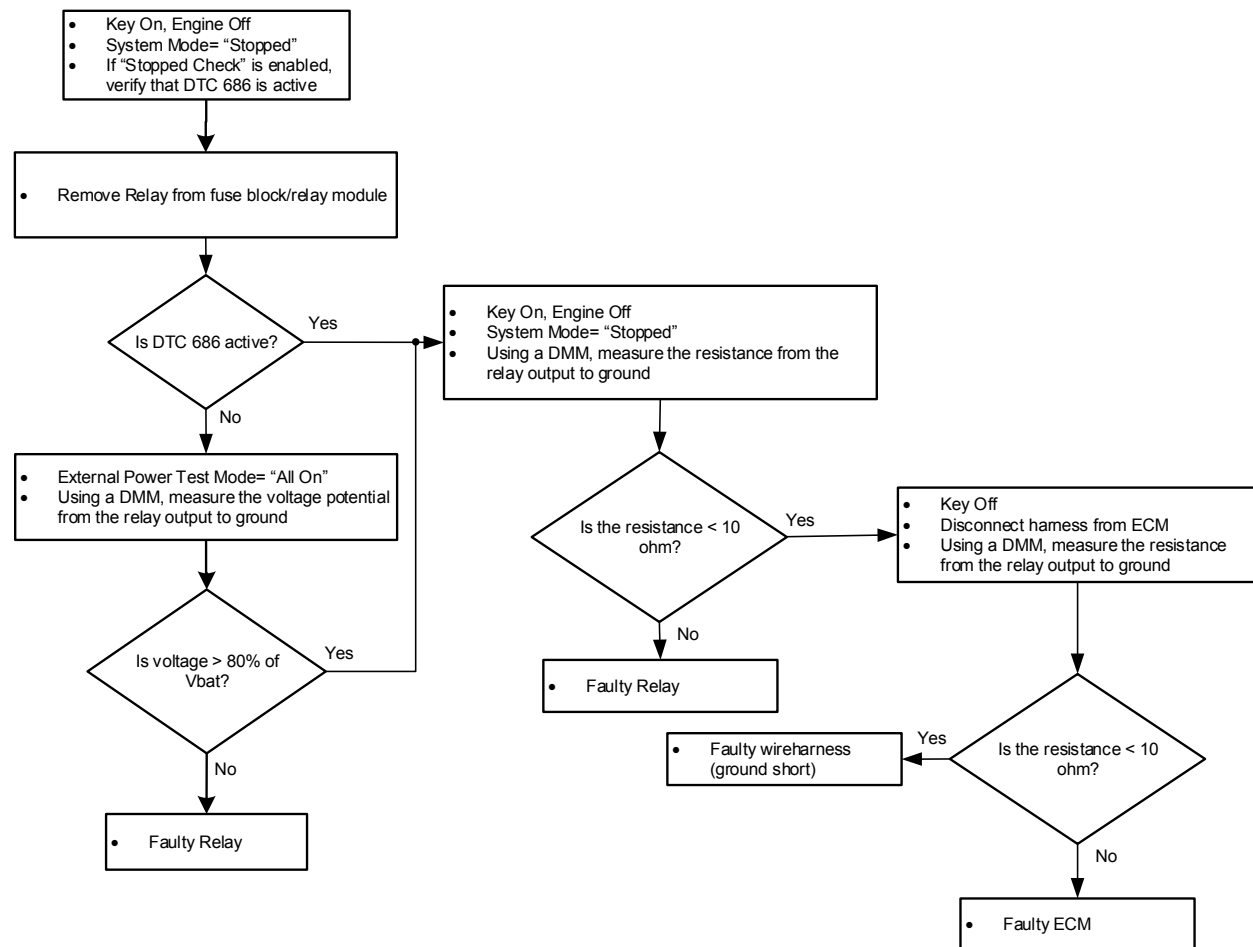
DTC 685 - RELAY COIL OPEN

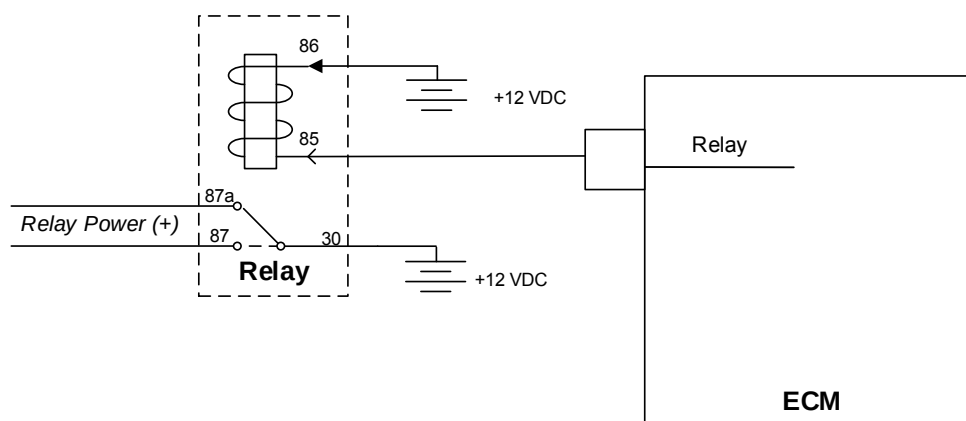
DTC	685	SPN	1485	FMI	5		
Hardware: Power Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback <				TBD*	% Vbat		
Possible Causes: This fault sets if the output for the power relay is detected as an open circuit. If this fault is active the relay-powered device(s)(O ₂ sensor(s), ignition coil(s), injector(s) or similar) will not receive power and the engine likely will not run.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 685 - RELAY COIL OPEN (TROUBLE TREE)

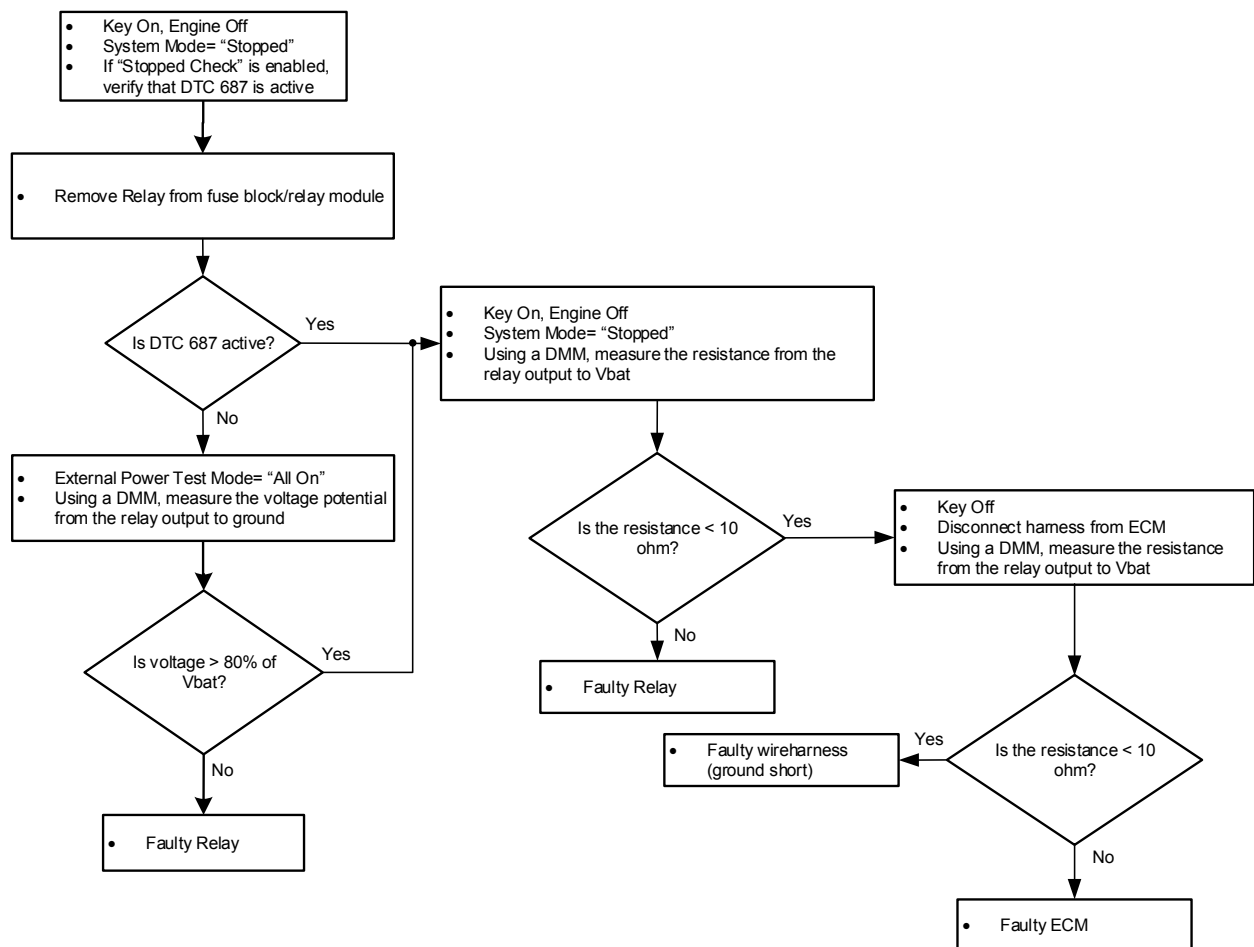
DTC 686 - RELAY CONTROL GROUND SHORT

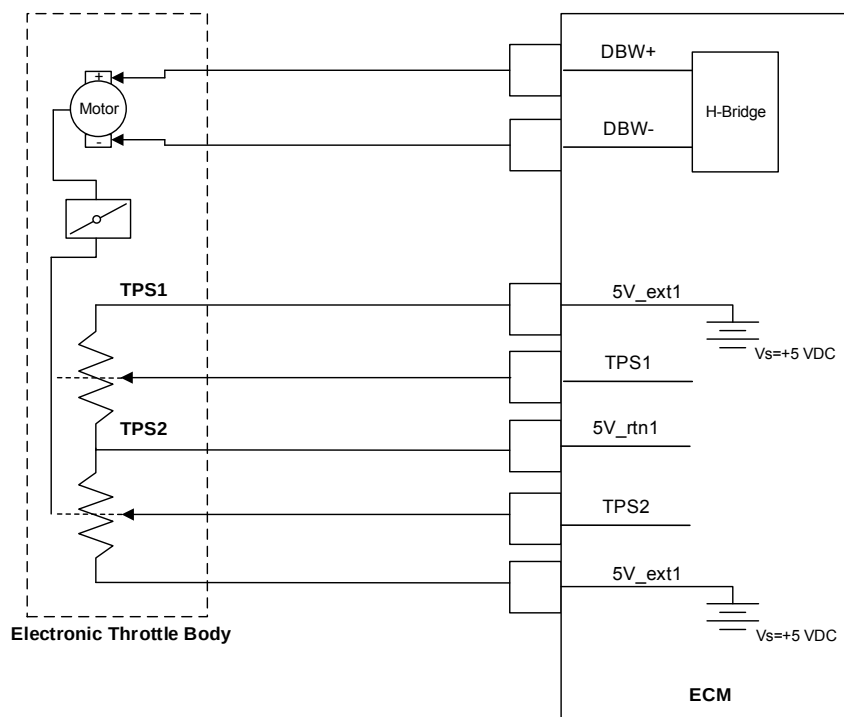
DTC	686	SPN	1485	FMI	4		
Hardware: Power Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback <				TBD*	% Vbat		
Possible Causes: This fault sets if the output for the relay is detected as being shorted to ground. If this fault is active and the high-side of the relay is supplied, the relay-powered device(s)(O ₂ sensor(s), ignition coil(s), injector(s) or similar) will run until the relay or high-side power is removed.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 686 - RELAY COIL GROUND SHORT (TROUBLE TREE)

DTC 687 - RELAY COIL SHORT TO POWER

DTC	687	SPN	1485	FMI	3		
Hardware: Power Relay							
Description: The ECM has auxiliary low-side drivers that can turn on warning devices or ground electromagnetic relay coils to control power to devices connected to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine Off					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback >				TBD*	% Vbat		
Possible Causes: This fault sets if the output for the relay is detected as shorted to power. If this fault is active the relay-powered device(s)(O ₂ sensor(s), ignition coil(s), injector(s) or similar) will not receive power and will not run.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 687 - RELAY COIL SHORT TO POWER (TROUBLE TREE)

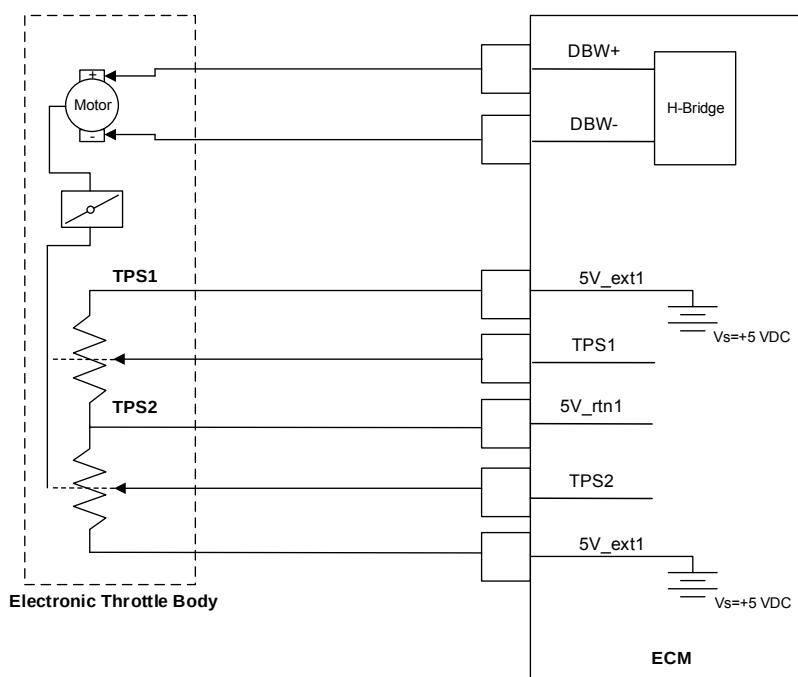
DTC 1111- RPM ABOVE FUEL REV LIMIT LEVEL

DTC	1111	SPN	515	FMI	16		
Measurement / Hardware: Fuel Rev Limit- Crankshaft Position Sensor							
Description (includes additional corrective actions): This fault is designed to help prevent engine or equipment damage and will disable fuel injectors or gaseous fuel actuator to reduce engine speed. The throttle will also be lowered in order to govern the engine to the speed set in the diagnostic calibration for Max Gov Override.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• rpm >				TBD*	rpm		
Possible Causes: This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more. This speed overrides any higher max governor speeds programmed by the user.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1111- RPM ABOVE FUEL REV LIMIT LEVEL (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- ☐ Check mechanical operation of the throttle
- ☐ Check the engine intake for large air leaks downstream of the throttle body

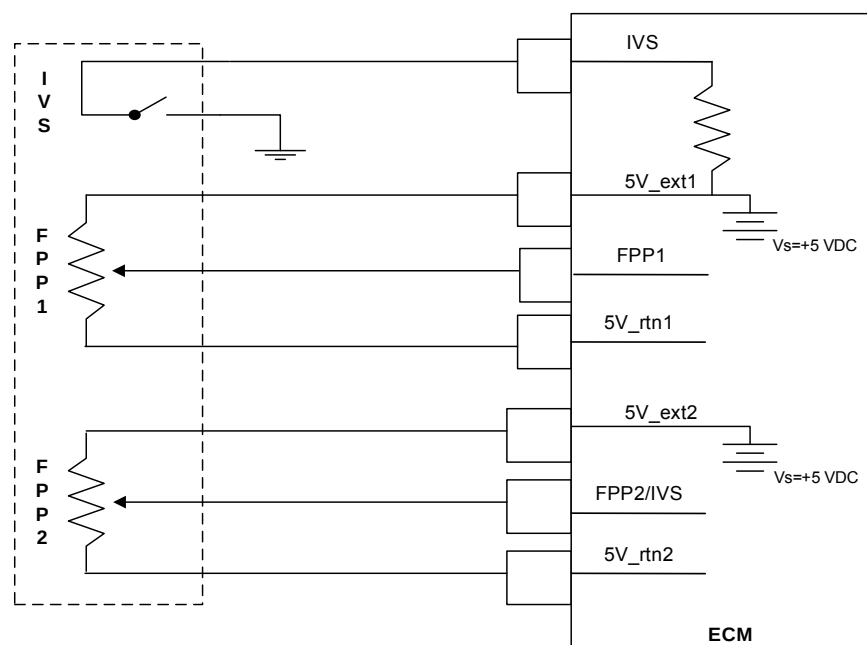
DTC 1112- RPM ABOVE SPARK REV LIMIT LEVEL

DTC	1112	SPN	515	FMI	0		
Measurement / Hardware: Fuel Rev Limit- Crankshaft Position Sensor							
Description (includes additional corrective actions): This fault is designed to help prevent engine or equipment damage and will disable the ignition coils to reduce engine speed. In addition, the throttle will be lowered in order to govern the engine to the speed set in the diagnostic calibration for Max Gov Override and the fuel injectors or gaseous fuel control actuator will be disabled to reduce the engine speed below the speed set in the diagnostic calibration for Fuel Rev Limit.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• rpm >				TBD*	rpm		
Possible Causes: This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more. This speed overrides any higher max governor speeds programmed by the user.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1112- RPM ABOVE SPARKL REV LIMIT LEVEL (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- ☐ Check mechanical operation of the throttle
- ☐ Check the engine intake for large air leaks downstream of the throttle body

DTC 1121 - FPP1/2 SIMULTANEOUS VOLTAGES OUT OF RANGE

DTC	1121	SPN	91	FMI	31
Measurement / Hardware: Electronic foot pedal/throttle control sensor					
Description (includes additional corrective actions): The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			
Fault Set Conditions (as defined in calibration):					
• FPP1 voltage >			TBD*	volts	
OR					
• FPP1 voltage <			TBD*	volts	
--- AND ---					
• FPP2 voltage >			TBD*	volts	
OR					
• FPP2 voltage <			TBD*	volts	

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Possible Causes:

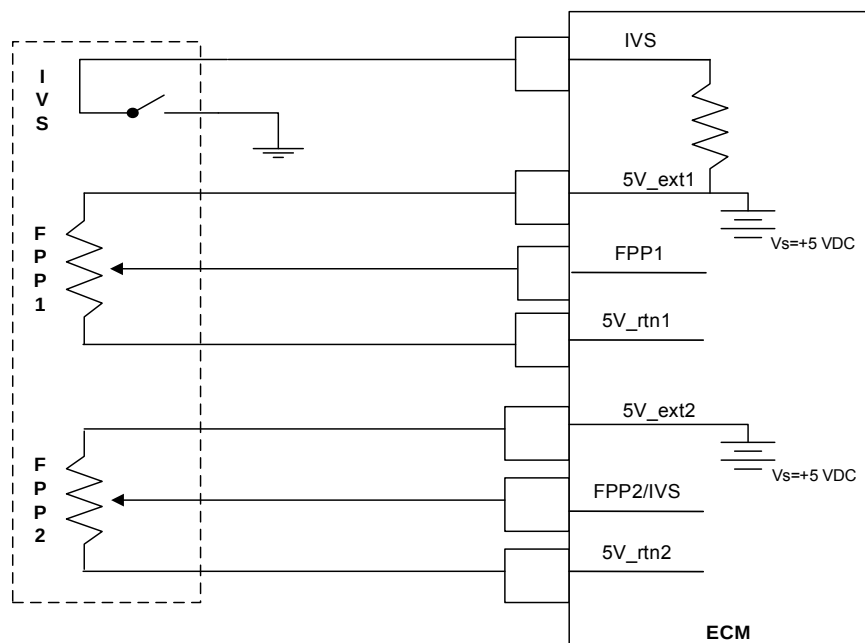
This fault is only applicable with sensors that incorporate dual potentiometer and indicates that FPP1 and FPP2 voltages are out-of-range resulting in a loss of redundancy. As a result, the engine is commanded to a forced idle.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1121 - FPP1/2 SIMULTANEOUS VOLTAGES OUT OF RANGE (DIAGNOSTIC AIDS)**Diagnostic Aids**

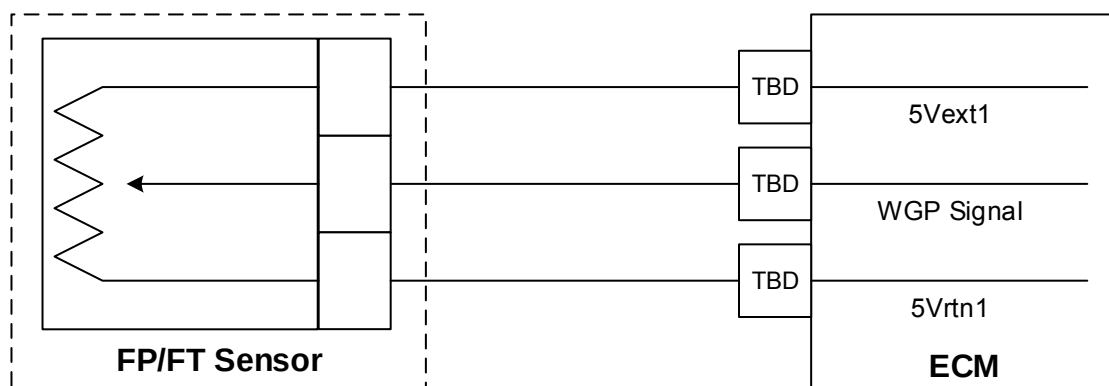
- ☐ Troubleshoot according to *FPP1 voltage out-of-range* following DTC 2122 and 2123 procedures.
- ☐ Troubleshoot according to *FPP2 voltage out-of-range* following DTC 2127 and 2128 procedures.

DTC 1122 - FPP1/2 DO NOT MATCH EACH OTHER OR THE IVS

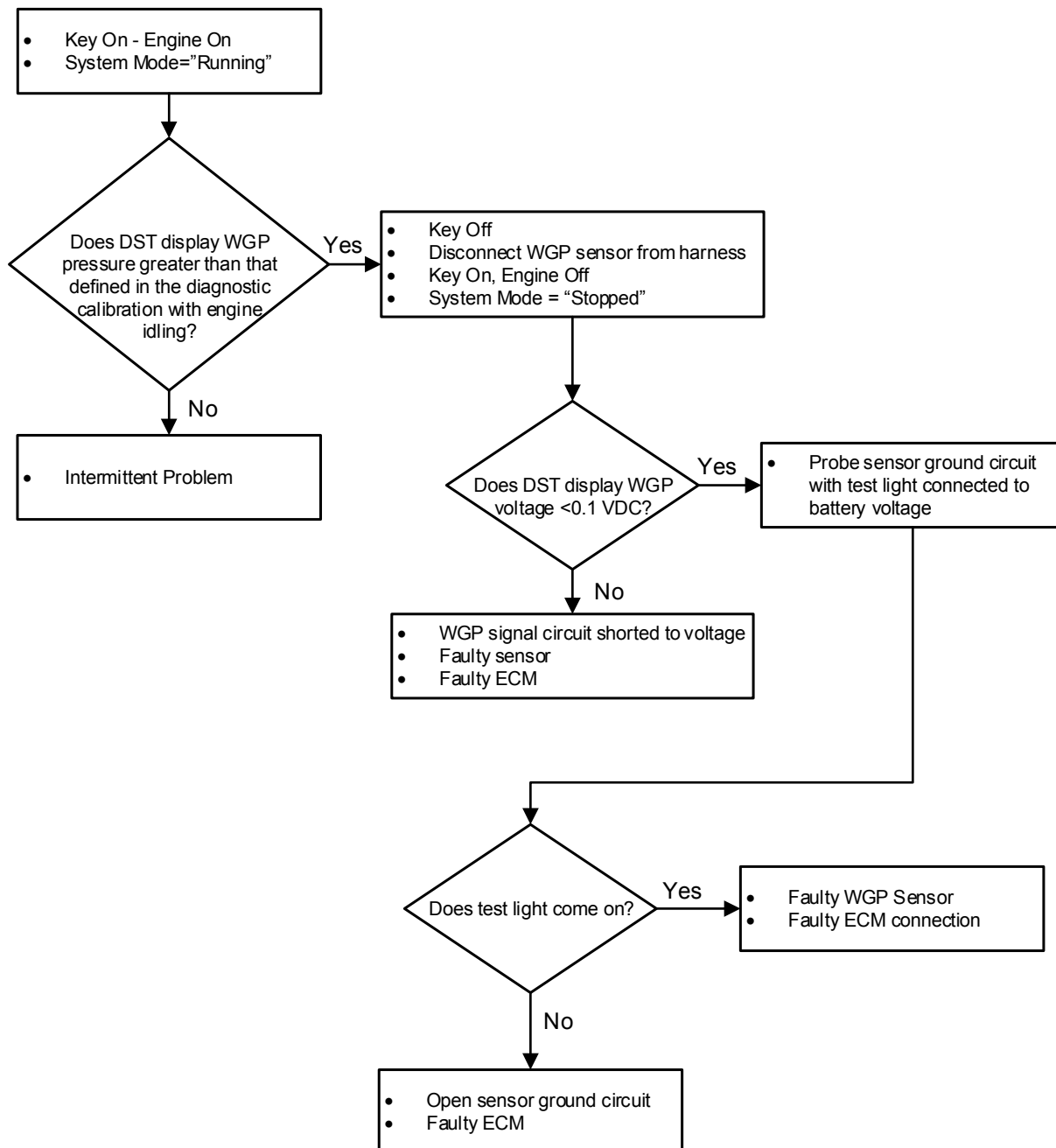
DTC	1122	SPN	520199	FMI	11
Measurement / Hardware: Electronic foot pedal/throttle control sensor					
Description (includes additional corrective actions): The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			

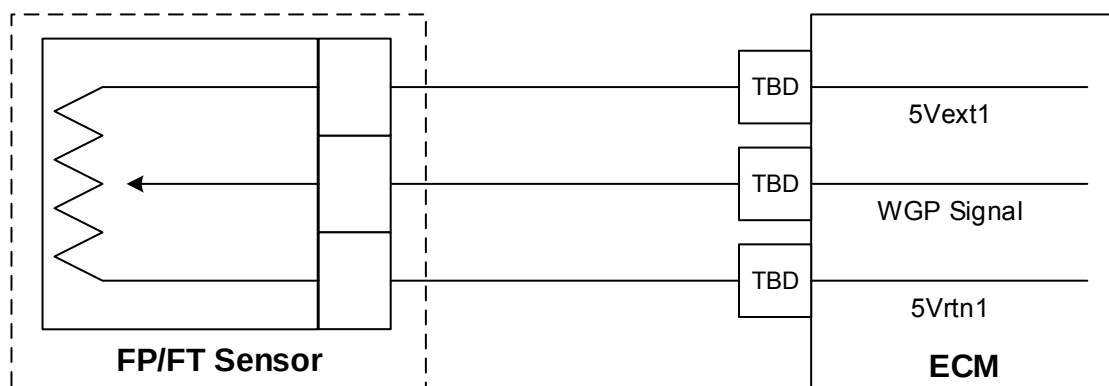
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Fault Set Conditions (as defined in calibration):							
• (FPP1% - FPP2%) >	TBD*	%					
OR							
• (FPP1% - FPP2%) <	TBD*	%					
--- AND ---							
• IVS at-idle when FPP1 >	TBD*	volts					
Or -							
• IVS off-idle when FPP1 <	TBD*	volts					
or IVS off-idle if FPP1 @idle fault	(Enabled)						
and FPP1 < FPP1 learned idle +	TBD*	volts					
--- AND ---							
• IVS at-idle when FPP2 >	TBD*	volts					
Or -							
• IVS off-idle when FPP2 <	TBD*	volts					
or IVS off-idle if FPP2 @idle fault	(Enabled)						
and FPP2 < FPP2 learned idle +	TBD*	volts					
Possible Causes:							
This fault is only applicable for dual potentiometer/single IVS sensors and indicates that FPP1 and FPP2 percentages do not correlate with each other and neither of the two potentiometers correlates with the IVS.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*
Diagnostic Aids							
☐ Troubleshoot according to <i>FPP1 & FPP2 Do Not Match</i> following DTC 2121 and 2126 procedures.							
☐ Troubleshoot according to <i>FPP1 & FPP2 Do Not Match IVS</i> following DTC 2115, 2116, 2139, and 2140 procedures.							

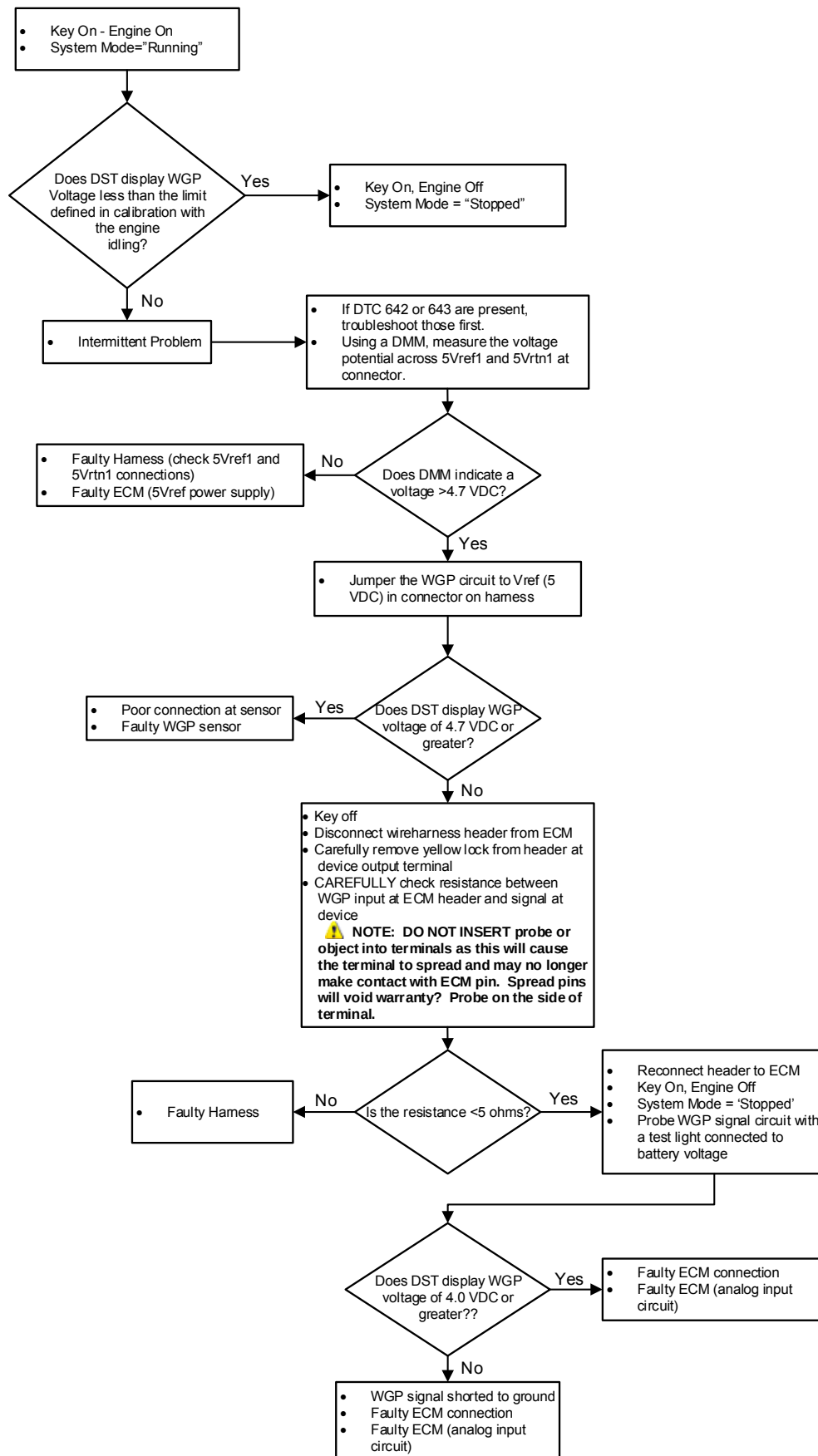
DTC 1131 - WGP HIGH VOLTAGE

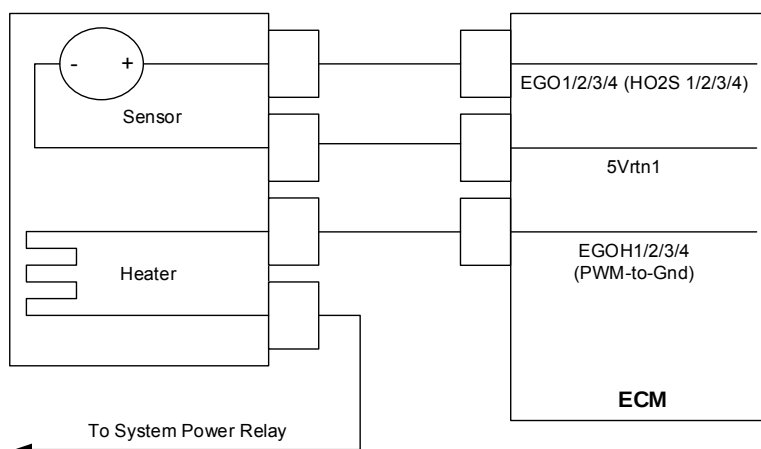
DTC	1131	SPN	1192	FMI	3		
Sensor / Circuit: Wastegate Pressure Sensor							
Description: The Wastegate Pressure sensor is a pressure transducer connected to Boost Control Valve assembly. It is used to measure the pressure of air controlling the wastegate. The pressure reading is used in conjunction with other inputs to determine the amount of air through the wastegate and consequently the level of boost.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Cranking or Running					
Fault Set Conditions (as defined in calibration):							
• WGP voltage >				TBD*	volts		
Possible Causes: This fault will set when the WGP sensor voltage feedback is sensed as higher than the sensor should normally produce. The limit is generally set at 4.7 VDC. In many cases, this condition can be caused by the WGP circuit being shorted to a voltage source or a failure of the sensor. Recommended corrective actions include setting power derate 1, disabling adaptive learn with closed-loop remaining enabled, and outputting a warning to the user. The MIL will be illuminated for the duration of the key on cycle.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1131 - WGP HIGH VOLTAGE (TROUBLE TREE)

DTC 1132 - WGP LOW VOLTAGE

DTC	1131	SPN	1192	FMI	4		
Sensor / Circuit: Wastegate Pressure Sensor							
Description: The Wastegate Pressure sensor is a pressure transducer connected to Boost Control Valve assembly. It is used to measure the pressure of air controlling the wastegate. The pressure reading is used in conjunction with other inputs to determine the amount of air through the wastegate and consequently the level of boost.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine Cranking or Running					
Fault Set Conditions (as defined in calibration):							
• WGP voltage >				TBD*	volts		
Possible Causes: This fault will set when the WGP sensor voltage feedback is sensed as lower than the sensor should normally produce as set in the diagnostic calibration. The limit is generally set at 0.20 VDC. In many cases, this condition is caused by the WGP sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the WGP circuit in the wire harness, a loss of sensor reference voltage, or a failure of the sensor. Recommended corrective actions include setting power derate 1, disabling adaptive learn with closed-loop remaining enabled, and outputting a warning to the user. The MIL will be illuminated for the duration of the key-on cycle.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1132 - WGP LOW VOLTAGE (TROUBLE TREE)

DTC 1151 – CLOSED LOOP HIGH (LPG)

DTC	1151	SPN	4236	FMI	0
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

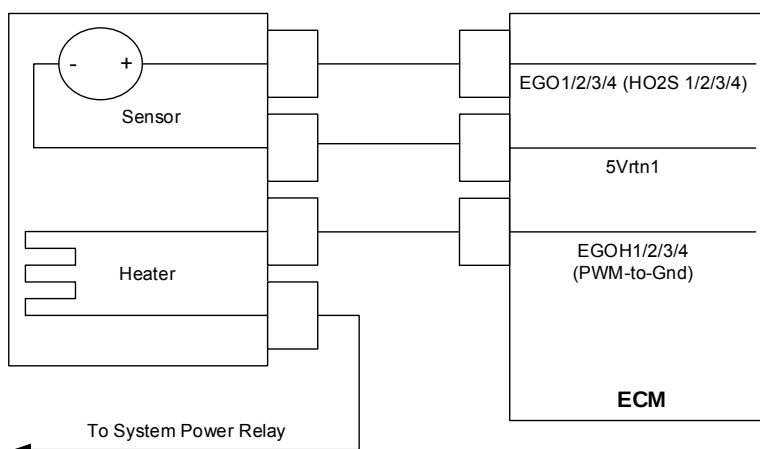
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1152 – CLOSED LOOP LOW (LPG)

DTC	1152	SPN	4236	FMI	1
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

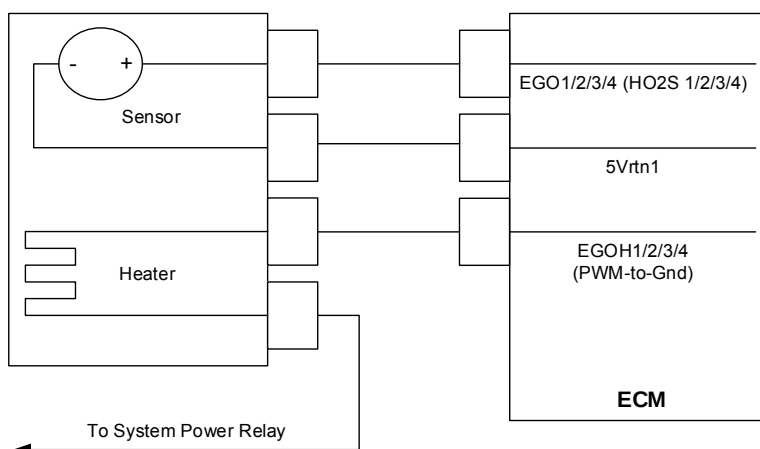
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1153 – CLOSED LOOP HIGH NATURAL GAS

DTC	1153	SPN	4236	FMI	0
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

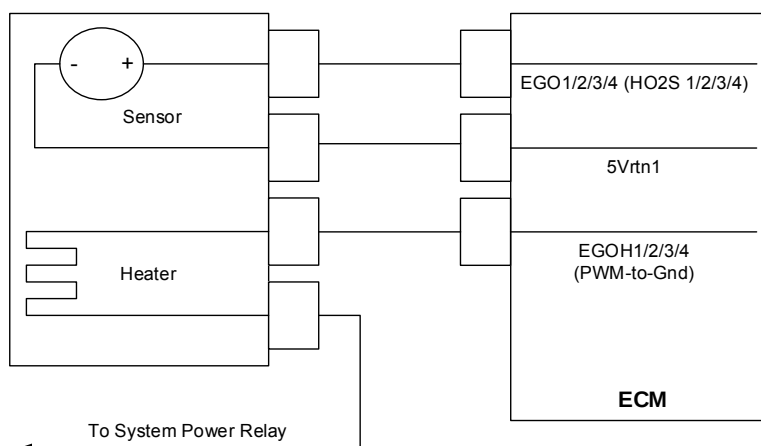
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1154 – CLOSED LOOP LOW NATURAL GAS

DTC	1154	SPN	4236	FMI	1
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Closed Loop multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

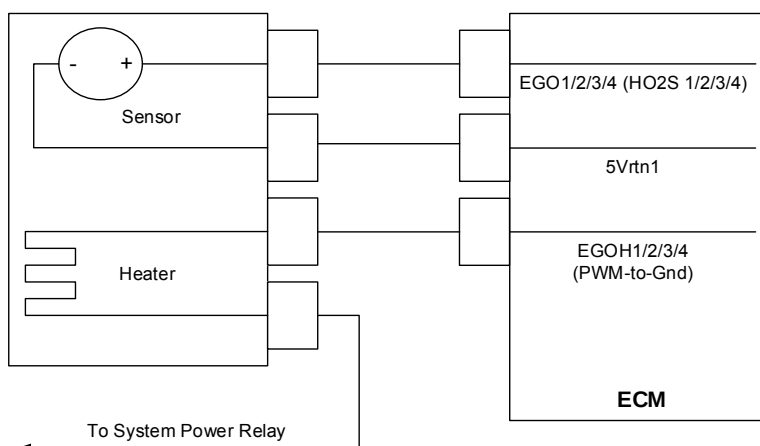
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1155 – CLOSED LOOP HIGH (GASOLINE BANK 1)



DTC	1155	SPN	4236	FMI	0
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the closed loop multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the fuel injection system, 3) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck closed. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

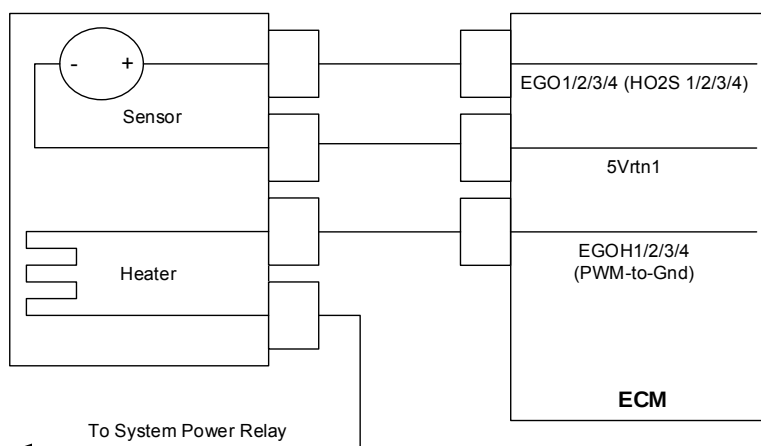
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Injectors - System will be lean if an injector driver or driver circuit fails. The system will also be lean if an injector fails in a closed manner or is dirty.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ Air in Fuel - If the fuel return hose/line is too close to the fuel supply pickup in the fuel tank, air may become entrapped in the pump or supply line causing a lean condition and driveability problems.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including oxygenated fuels.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 1156 – CLOSED LOOP LOW (GASOLINE, BANK 1)



DTC	1156	SPN	4236	FMI	1
Sensor / Circuit:		Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)			
Description:					
The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the closed loop multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the fuel injection system, 2) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck open. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

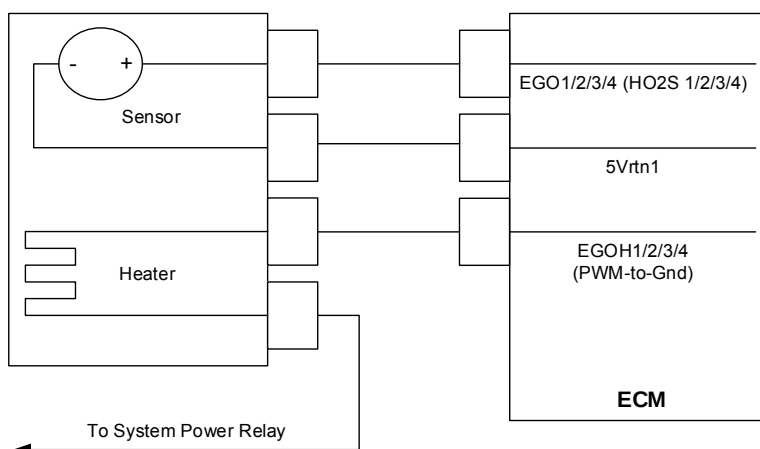
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Injectors - System will be rich if an injector driver or driver circuit fails shorted-to-ground. The system will also be rich if an injector fails in an open.
- ☐ Fuel Pressure - System will be rich if fuel pressure is too high. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 1157 – CLOSED LOOP HIGH (GASOLINE BANK 2)

DTC	1155	SPN	4236	FMI	0
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

Possible Causes:

This fault sets if the closed loop multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the fuel injection system, 3) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck closed. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

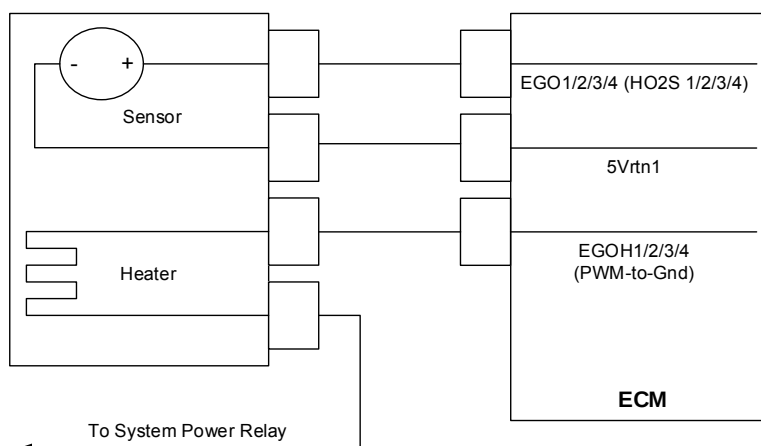
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Injectors - System will be lean if an injector driver or driver circuit fails. The system will also be lean if an injector fails in a closed manner or is dirty.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ Air in Fuel - If the fuel return hose/line is too close to the fuel supply pickup in the fuel tank, air may become entrapped in the pump or supply line causing a lean condition and driveability problems.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including oxygenated fuels.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 1158 – CLOSED LOOP LOW (GASOLINE BANK 2)

DTC	1156	SPN	4236	FMI	1
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the closed loop fuel multiplier is to quickly adjust fuel flow due to variations in fuel composition; engine wear, engine-to-engine build variances, and component degradation prior to adaptive learn fueling correction “learning” the fueling deviation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the closed loop multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the fuel injection system, 2) a non-responsive HEGO/UEGO sensor, and/or 3) an injector that is stuck open. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

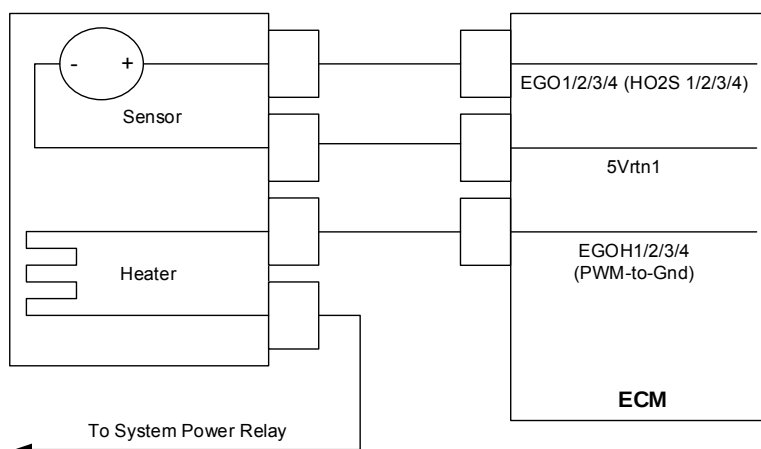
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Injectors - System will be rich if an injector driver or driver circuit fails shorted-to-ground. The system will also be rich if an injector fails in an open.
- ☐ Fuel Pressure - System will be rich if fuel pressure is too high. Check fuel pressure in the fuel rail during key-on, engine off and during normal operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S sensor with a known good part and retest.

DTC 1161 – AADAPTIVE LEARN HIGH (LPG)

DTC	1161	SPN	4237	FMI	0
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• AL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

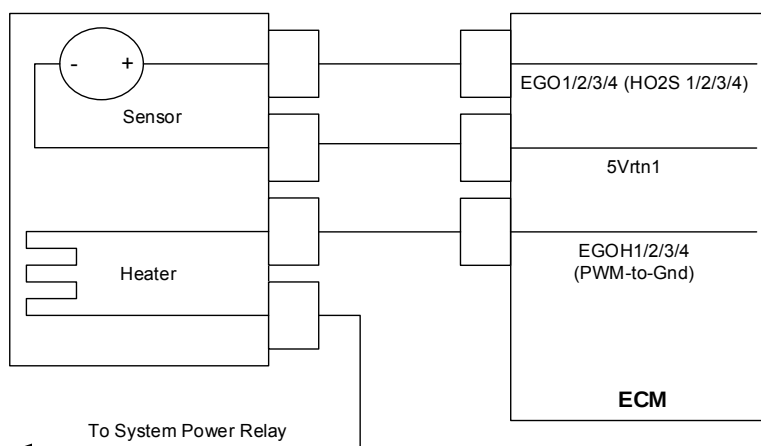
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1162 – ADAPTIVE LEARN LOW (LPG)

DTC	1162	SPN	4237	FMI	1
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

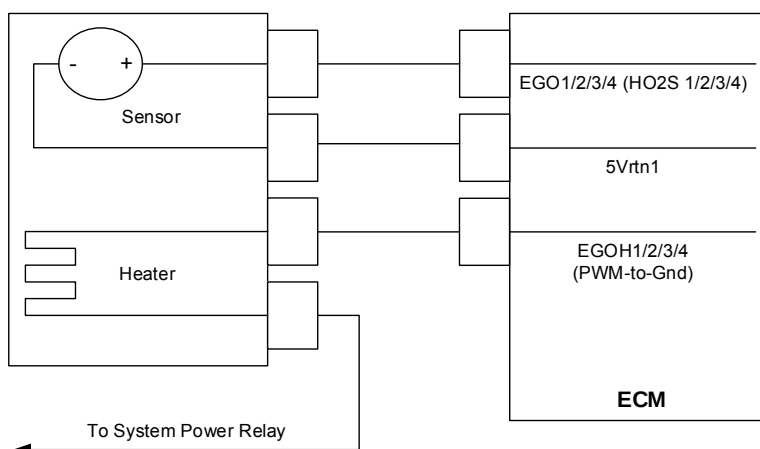
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1163 – ADAPTIVE LEARN HIGH (NATURAL GAS)

DTC	1163	SPN	4237	FMI	0
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• AL_BM >				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the high limit of normal operation indicating that the engine is operating lean (excess oxygen) and requires more fuel than allowed by corrections. Often high positive fueling corrections are a function of one or more of the following conditions: 1) exhaust leaks upstream or near the HEGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive HEGO/UEGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

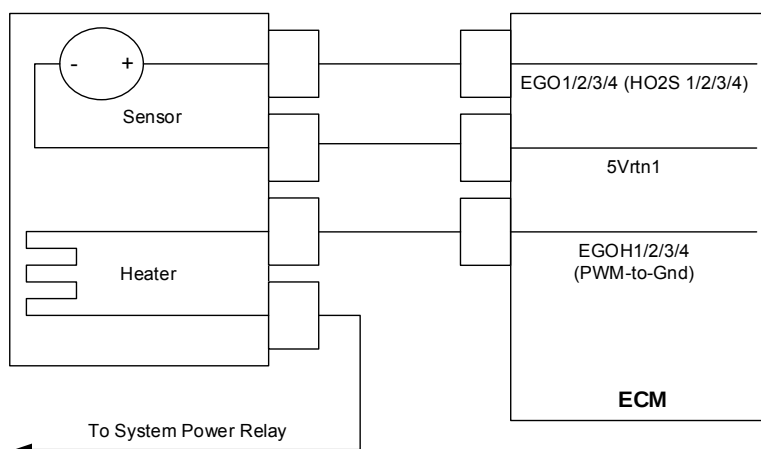
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor sense signal.
- ☐ Vacuum Leaks - Large vacuum leaks and crankcase leaks can cause a lean exhaust condition at light load.
- ☐ Fuel Pressure - System will be lean if fuel pressure is too low. Ensure fuel tank pressure is not too low and that gaseous fuel control actuator/regulator has proper fuel pressure under all operating conditions.
- ☐ Exhaust Leaks - If there is an exhaust leak, outside air can be pulled into the exhaust and past the O2 sensor causing a false lean condition.
- ☐ Fuel Quality - A drastic variation in fuel quality may cause the system to be lean including fuels with high inert gas content.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1164 – ADAPTIVE LEARN LOW (NATURAL GAS)

DTC	1164	SPN	4237	FMI	1
Sensor / Circuit: Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: The HEGO/HO2S sensor is a switching-type sensor around stoichiometry that measures the oxygen content present in the exhaust to determine if the fuel flow to the engine is correct. A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. In either case, if there is a deviation between the expected reading and the actual reading, fuel flow is precisely adjusted for each bank using the Closed Loop multiplier and then “learned” with the Adaptive multiplier. The multipliers only update when the system is in either “CL Active” or “CL + Adapt” control modes. The purpose of the Adaptive Learn fuel multiplier is to adjust fuel flow due to variations in fuel composition, engine wear, engine-to-engine build variances, and component degradation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• CL_BM <				TBD*	%
• and RPM >=				TBD*	rpm
• and RPM <=				TBD*	rpm
• and MAP >=				TBD*	psia
• and MAP <=				TBD*	psia

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Possible Causes:

This fault sets if the Adaptive multiplier exceeds the low limit of normal operation indicating that the engine is operating rich (excess fuel) and requires less fuel than allowed by corrections. Often high negative fueling corrections are a function of one or more of the following conditions: 1) high fuel supply pressure to the gaseous fuel control or faulty pressure regulator and/or 2) a non-responsive HEGO/UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

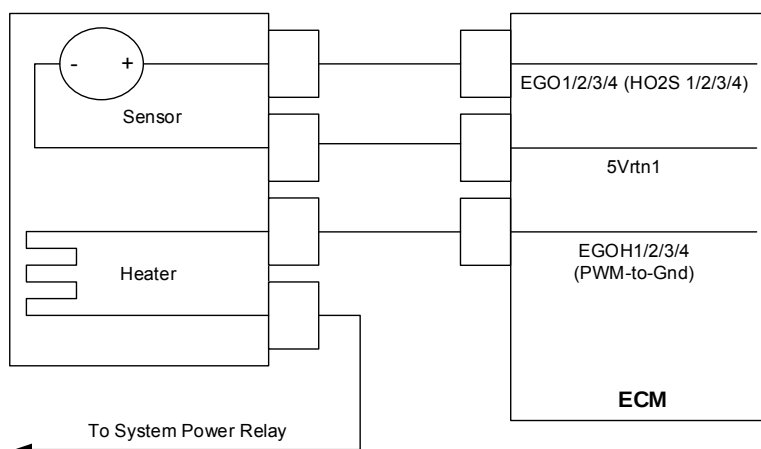
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oxygen Sensor Wire - Sensor may be mispositioned contacting the exhaust. Check for short to ground between harness and sensor and on sensor harness
- ☐ Fuel Pressure - System will be rich if fuel delivery pressure is too high to gaseous control system. Check fuel pressure at the control actuator/valve under all operating conditions.
- ☐ System Grounding - ECM and engine must be grounded to the battery with very little resistance allowing for proper current flow. Faulty grounds can cause current supply issues resulting in many undesired problems.
- ☐ If all tests are OK, replace the HO2S or UEGO sensor with a known good part and retest.

DTC 1165 – CATALYST INACTIVE ON LPG

DTC	1165	SPN	3050	FMI	11
Sensor / Circuit: Bank 1 Catalyst, Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 2-After Catalyst)					
Description: A catalyst or catalytic converter is a component in the exhaust subsystem used to accelerate/generate chemical reactions within the engine exhaust to convert undesirable gases/pollutants into less harmful gases. In many spark-ignited applications, a three-way catalyst is used to convert hydrocarbons, oxides of nitrogen, and carbon monoxide into nitrogen, water, and carbon dioxide. In addition, many low-emission applications require the use of OBD, which typically require a catalyst monitor to identify whether or not the catalyst is functioning properly. The catalyst monitor diagnostic is typically configured such that exhaust emissions are near compliance-failing levels based on the engines specific regulatory requirement(s). Catalyst monitor techniques typically utilize a HEGO sensor to monitor the amount of oxygen present downstream of the catalyst. This is generally a good indicator of how efficiently the catalyst is using the oxygen entering the catalyst. Some systems also use temperature measurements in the catalyst and compare it to data stored in the ECM for each operating condition to determine if the catalytic reaction is generating the proper amount of heat. The GCP uses a HEGO/HO2S sensor for catalyst monitor. The HEGO/HO2S is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either "CL Active" or "CL + Adapt" control modes.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			

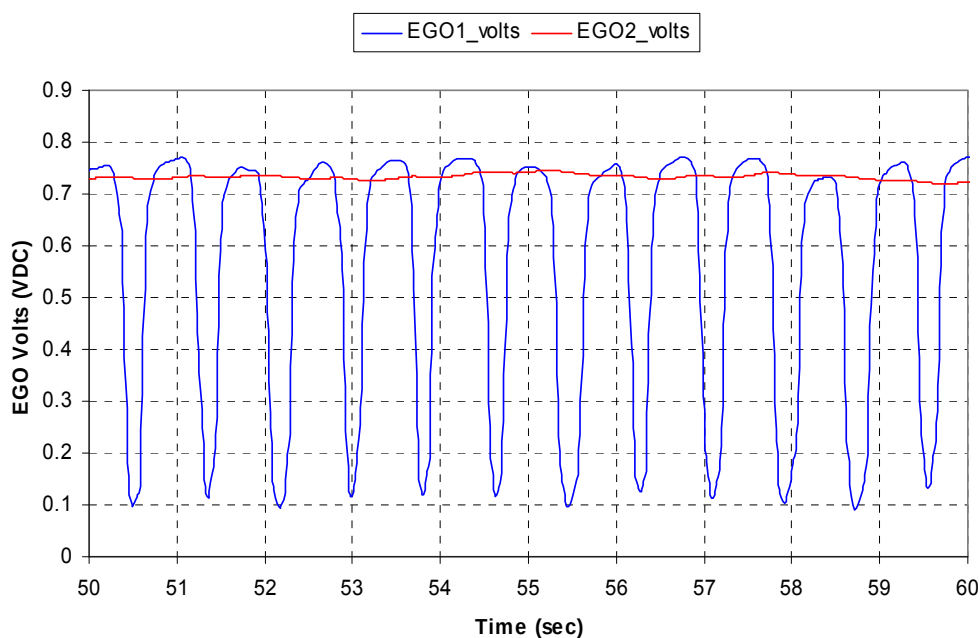
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Fault Set Conditions (as defined in calibration):

• EGO3 RMS >	TBD*	phi
• and EGO3 RMS > EGO1/2 RMS *	TBD*	%
• and EGO3 RMS > CL waveform RMS *	TBD*	%
• and mass flow at ports >=	TBD*	g/sec
• and mass flow at ports <=	TBD*	g/sec
• and CBT - CBT_ss +/-	TBD*	deg F
• persistently for	TBD*	sec

Possible Causes:

In theory if the catalyst is operated at a condition that could result in 100 percent conversion efficiency, the catalyst will use all available oxygen present in the exhaust gas to convert the emission pollutants (or reactants) to N₂, CO₂, and H₂O. However, since catalysts generally operate at efficiencies between 85-95% post-catalyst oxygen concentration can be a direct indicator of how efficient the catalyst is. **Error! Reference source not found.** shows an example of a slightly rich biased feed gas or pre-catalyst equivalence ratio versus that of the post-catalyst for a functional catalyst.

**Figure 10: EGO Waveforms (Functional TWC)**

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It can be noticed from this figure that the pre-catalyst equivalence ratio, as identified by 'EGO1_volts', is varying due to the CL excursions (perturbation) and that the post-catalyst equivalence ratio, as identified by 'EGO2_volts', is maintained relatively constant rich of stoichiometry. A similar waveform pattern should be expected on properly functioning catalysts.

Error! Reference source not found. shows an example of EGO waveforms for a catalyst with poor conversion efficiency.

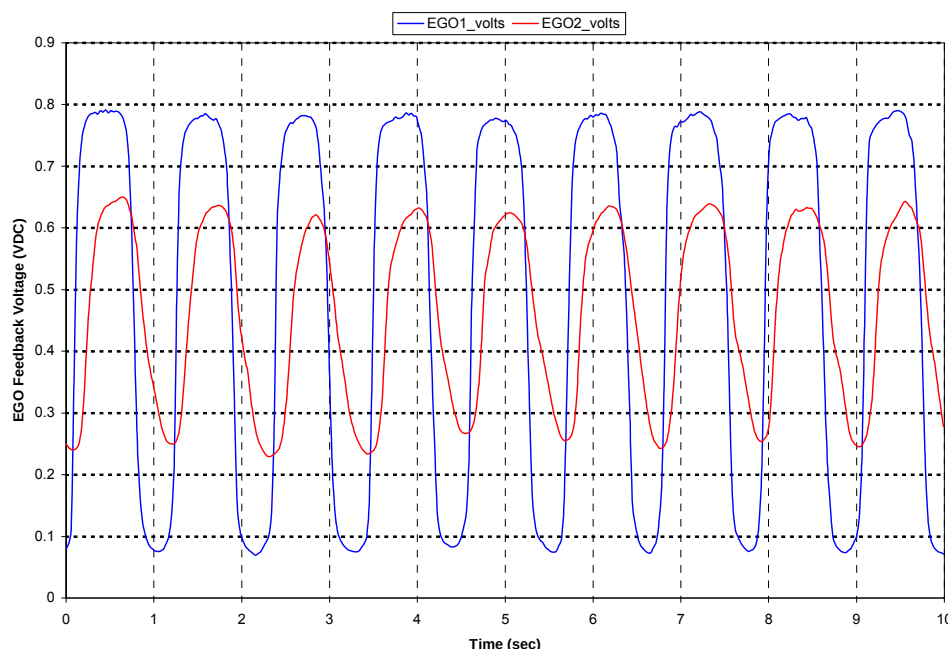


Figure 11: EGO Waveforms (Damaged TWC)

A significant difference between **Error! Reference source not found.** and **Error! Reference source not found.** is that the post-catalyst EGO feedback oscillates with the same frequency as the pre-catalyst EGO feedback and the amplitude is on the order of 60% of that of EGO1. This indicates that a certain amount of oxygen that is entering into the catalyst is passing through the catalyst unconsumed. Catalyst monitor diagnostics are configured such that if the post-catalyst EGO waveform has an amplitude that is directly proportional to the pre-catalyst EGO waveform and who's waveform similarly matches the closed-loop excursion (perturbation) a fault is generated.

Two metric comparisons that are used to identify the health of the catalyst are:

- 1) Post-catalyst EGO root-mean square (RMS) > Pre-catalyst EGO RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).
- 2) Post-catalyst EGO RMS > CL excursion RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).

There are a couple of ways in which the limits for diagnostics can be determined. In both cases, the system must be tested with an emissions measurement system to determine when

the exhaust emissions are nearly failing emissions compliance.

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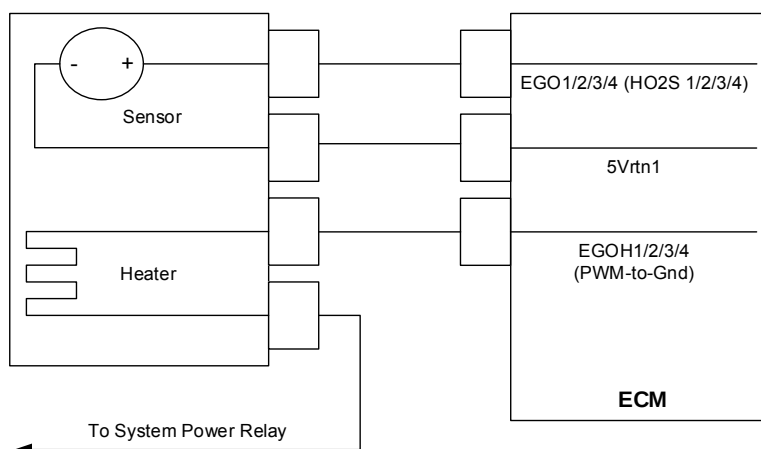
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks upstream and around catalyst and post-catalyst HEGO sensor. Replace gaskets and tighten fasteners if leaks are present.
- ☐ Perform manufacture recommended in-field emissions test.

DTC 1166 – CATALYST INACTIVE ON NATURAL GAS

DTC	1166	SPN	3050	FMI	11
Sensor / Circuit: Bank 1 Catalyst, Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 2-After Catalyst)					
Description: A catalyst or catalytic converter is a component in the exhaust subsystem used to accelerate/generate chemical reactions within the engine exhaust to convert undesirable gases/pollutants into less harmful gases. In many spark-ignited applications, a three-way catalyst is used to convert hydrocarbons, oxides of nitrogen, and carbon monoxide into nitrogen, water, and carbon dioxide. In addition, many low-emission applications require the use of OBD, which typically require a catalyst monitor to identify whether or not the catalyst is functioning properly. The catalyst monitor diagnostic is typically configured such that exhaust emissions are near compliance-failing levels based on the engines specific regulatory requirement(s). Catalyst monitor techniques typically utilize a HEGO sensor to monitor the amount of oxygen present downstream of the catalyst. This is generally a good indicator of how efficiently the catalyst is using the oxygen entering the catalyst. Some systems also use temperature measurements in the catalyst and compare it to data stored in the ECM for each operating condition to determine if the catalytic reaction is generating the proper amount of heat. The GCP uses a HEGO/HO2S sensor for catalyst monitor. The HEGO/HO2S is a switching-type sensor around stoichiometry that measures the oxygen content downstream of the catalyst for two main functions: 1) to compare it to the oxygen content upstream of the catalyst to determine how efficiently the catalyst is using oxygen to determine its effectiveness and 2) trim the commanded equivalence ratio target to maximize the catalyst conversion efficiency. The post-catalyst strategy and diagnostic is only active when the system is in either “CL Active” or “CL + Adapt” control modes.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			

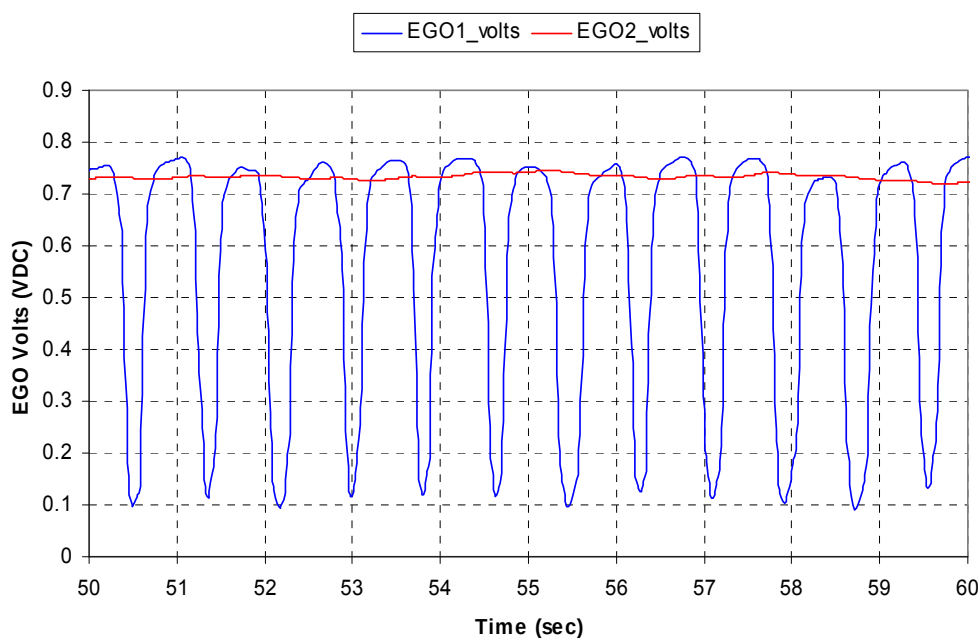
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Fault Set Conditions (as defined in calibration):

• EGO3 RMS >	TBD*	phi
• and EGO3 RMS > EGO1/2 RMS *	TBD*	%
• and EGO3 RMS > CL waveform RMS *	TBD*	%
• and mass flow at ports >=	TBD*	g/sec
• and mass flow at ports <=	TBD*	g/sec
• and CBT - CBT_ss +/-	TBD*	deg F
• persistently for	TBD*	sec

Possible Causes:

In theory if the catalyst is operated at a condition that could result in 100 percent conversion efficiency, the catalyst will use all available oxygen present in the exhaust gas to convert the emission pollutants (or reactants) to N₂, CO₂, and H₂O. However, since catalysts generally operate at efficiencies between 85-95% post-catalyst oxygen concentration can be a direct indicator of how efficient the catalyst is. **Error! Reference source not found.** shows an example of a slightly rich biased feed gas or pre-catalyst equivalence ratio versus that of the post-catalyst for a functional catalyst.

**Figure 12: EGO Waveforms (Functional TWC)**

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It can be noticed from this figure that the pre-catalyst equivalence ratio, as identified by 'EGO1_volts', is varying due to the CL excursions (perturbation) and that the post-catalyst equivalence ratio, as identified by 'EGO2_volts', is maintained relatively constant rich of stoichiometry. A similar waveform pattern should be expected on properly functioning catalysts.

Error! Reference source not found. shows an example of EGO waveforms for a catalyst with poor conversion efficiency.

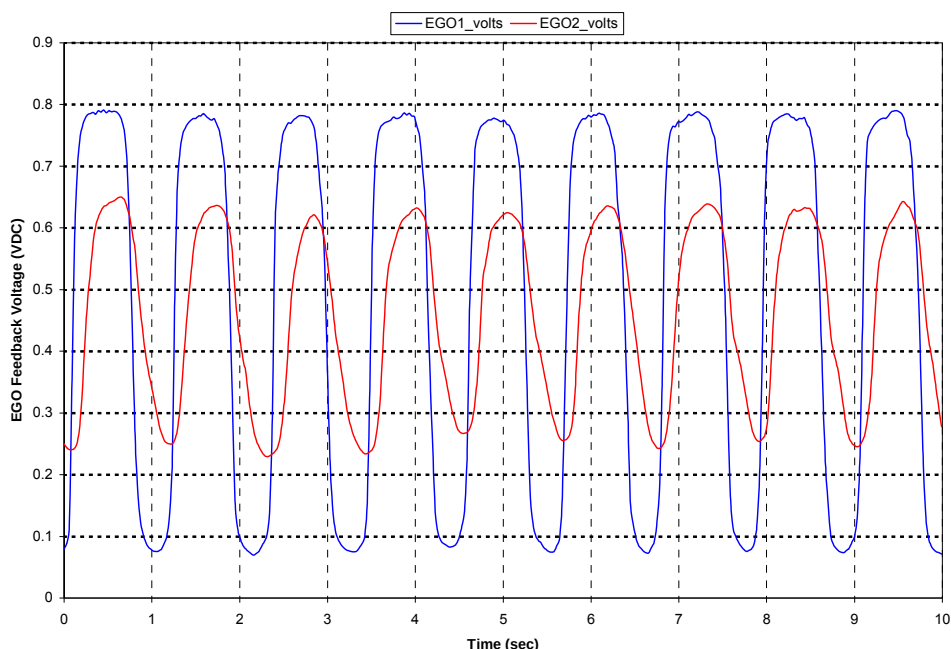


Figure 13: EGO Waveforms (Damaged TWC)

A significant difference between **Error! Reference source not found.** and **Error! Reference source not found.** is that the post-catalyst EGO feedback oscillates with the same frequency as the pre-catalyst EGO feedback and the amplitude is on the order of 60% of that of EGO1. This indicates that a certain amount of oxygen that is entering into the catalyst is passing through the catalyst unconsumed. Catalyst monitor diagnostics are configured such that if the post-catalyst EGO waveform has an amplitude that is directly proportional to the pre-catalyst EGO waveform and who's waveform similarly matches the closed-loop excursion (perturbation) a fault is generated.

Two metric comparisons that are used to identify the health of the catalyst are:

- 1) Post-catalyst EGO root-mean square (RMS) > Pre-catalyst EGO RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).
- 2) Post-catalyst EGO RMS > CL excursion RMS x ??? %, where the ??? % is determined based on emissions compliance testing over the application's certified duty-cycle(s).

There are a couple of ways in which the limits for diagnostics can be determined. In both cases, the system must be tested with an emissions measurement system to determine when

the exhaust emissions are nearly failing emissions compliance.

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks upstream and around catalyst and post-catalyst HEGO sensor. Replace gaskets and tighten fasteners if leaks are present.
- ☐ Perform manufacture recommended in-field emissions test.

DTC 1171 - EPR / CFV REGULATION PRESSURE HIGHER THAN EXPECTED

DTC	1171	SPN	520260	FMI	0
Hardware: EPR (HD EPR) or CFV					
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• EPR (actual-commanded) pressure >				TBD*	in H2O
• or CFV (actual-commanded) pressure >				TBD*	psi

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Possible Causes:

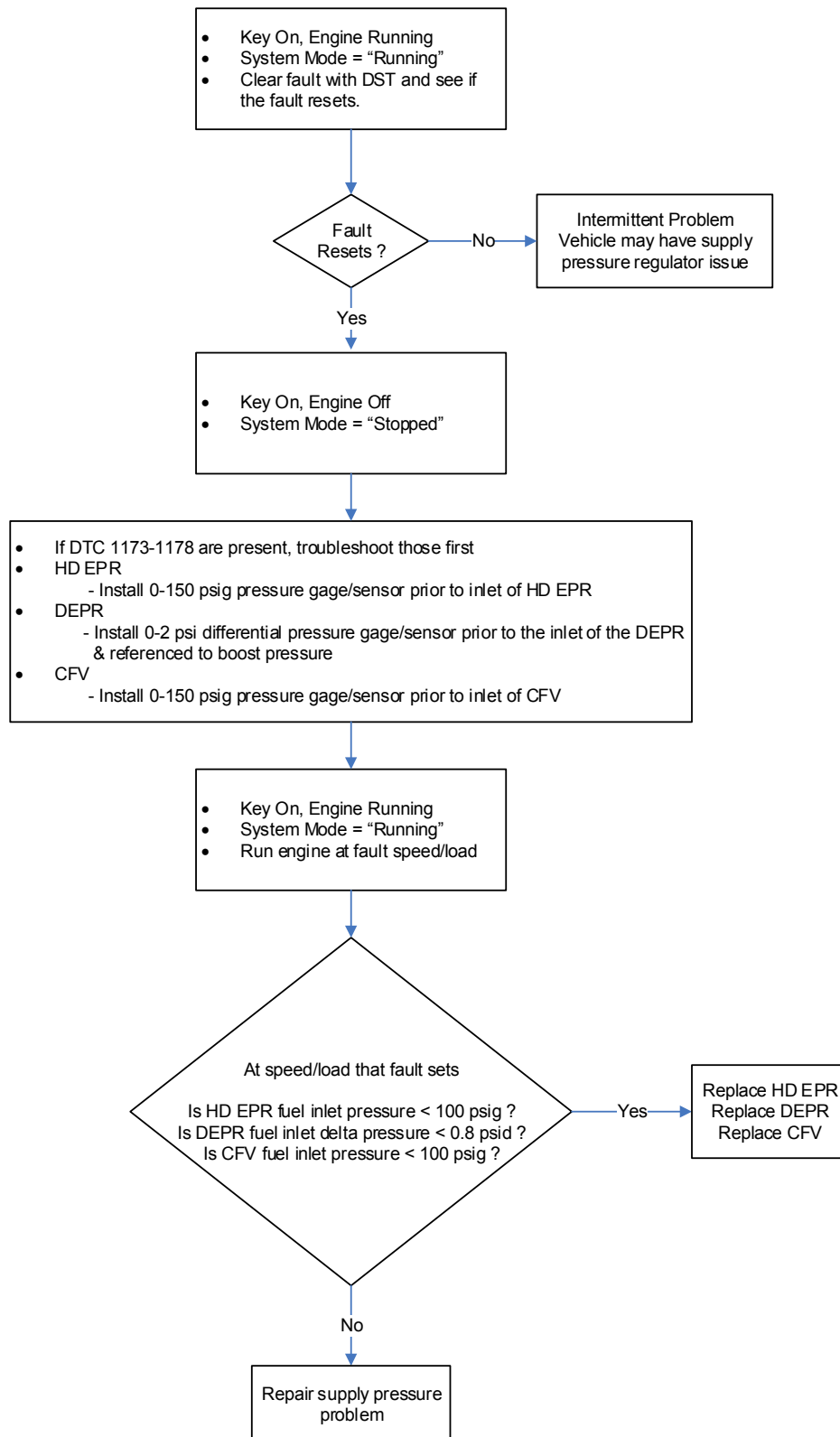
This fault sets if the actual pressure sensed in the EPR/CFV is greater than the commanded pressure by X. Typical values for X are listed below (may vary per specific engine calibration):

- X = + 2.0 in H₂O for EPR (HD EPR or DEPR)
- X = + 10 psi (69 kPa) for CFV

This fault indicates that the device is at its minimum limit of authority and the pressure command cannot be achieved likely due to delivery/supply pressure being higher than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure, and a Power Derate 1 condition is activated to reduce the possibility of engine damage.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1171 - EPR / CFV REGULATION PRESSURE HIGHER THAN EXPECTED (TROUBLE TREE)

DTC 1172 - EPR / CFV REGULATION PRESSURE LOWER THAN EXPECTED

DTC	1172	SPN	520260	FMI	1
Hardware: EPR (HD EPR) or CFV					
Description:					
The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• EPR (actual-commanded) pressure <			TBD*	in H2O	
• or CFV (actual-commanded) pressure <			TBD*	psi	

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Possible Causes:

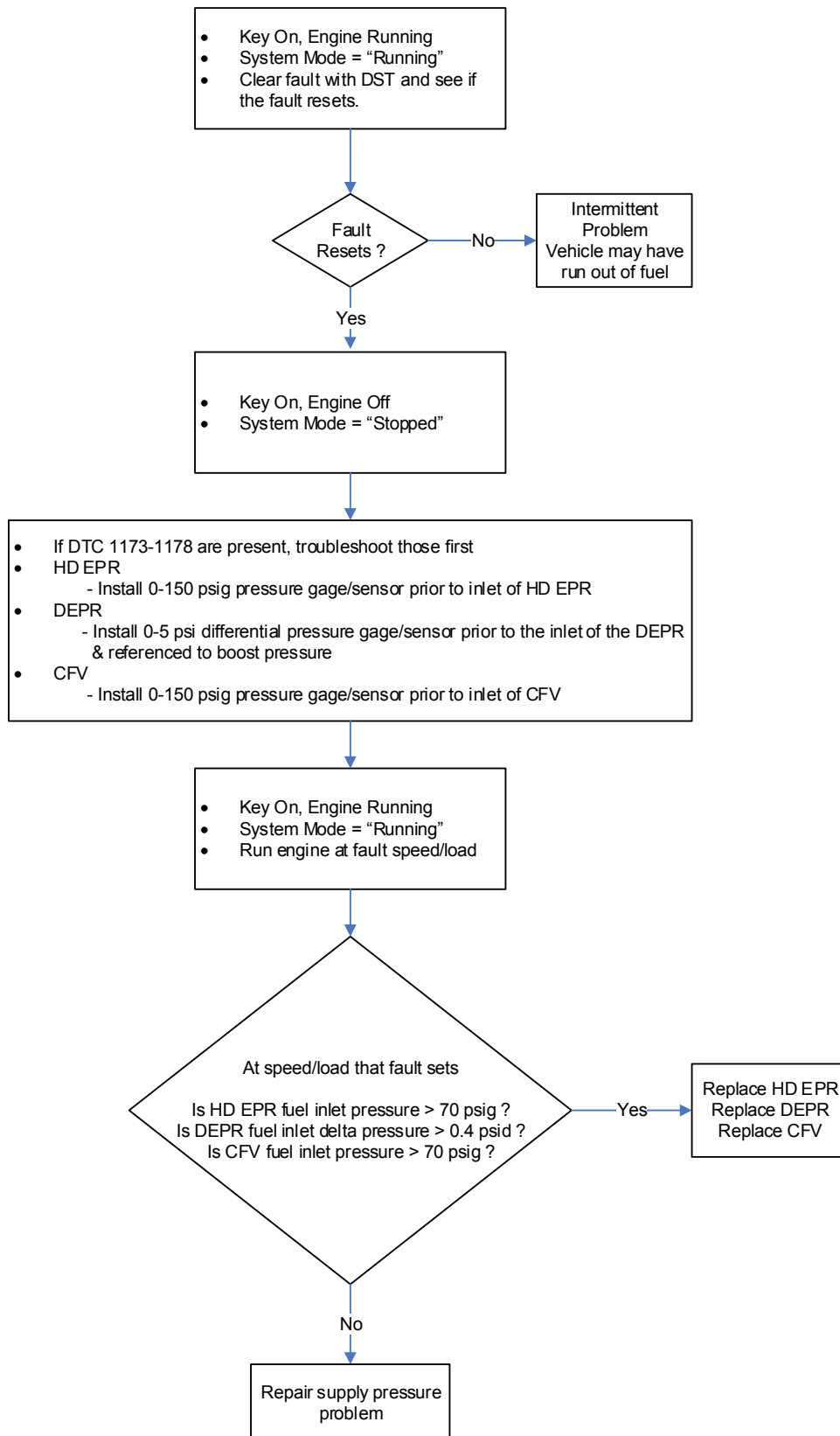
This fault sets if the actual pressure sensed in the EPR/CFV is less than the commanded pressure by X. Typical values for X are listed below (may vary per specific engine calibration):

- X = + 2.0 in H₂O for EPR (HD EPR or DEPR)
- X = + 10 psi (69 kPa) for CFV

This fault indicates that the device is at its minimum limit of authority and the pressure command cannot be achieved likely due to delivery/supply pressure being lower than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure, and a Power Derate 1 condition is activated to reduce the possibility of engine damage.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1172 - EPR / CFV REGULATION PRESSURE LOWER THAN EXPECTED (TROUBLE TREE)

DTC 1173 - EPR / CFV COMM LOST

DTC	1173	SPN	520260	FMI	31
Hardware: EPR (HD EPR) or CFV					
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2 nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• No EPR / CFV packets received within				TBD*	ms

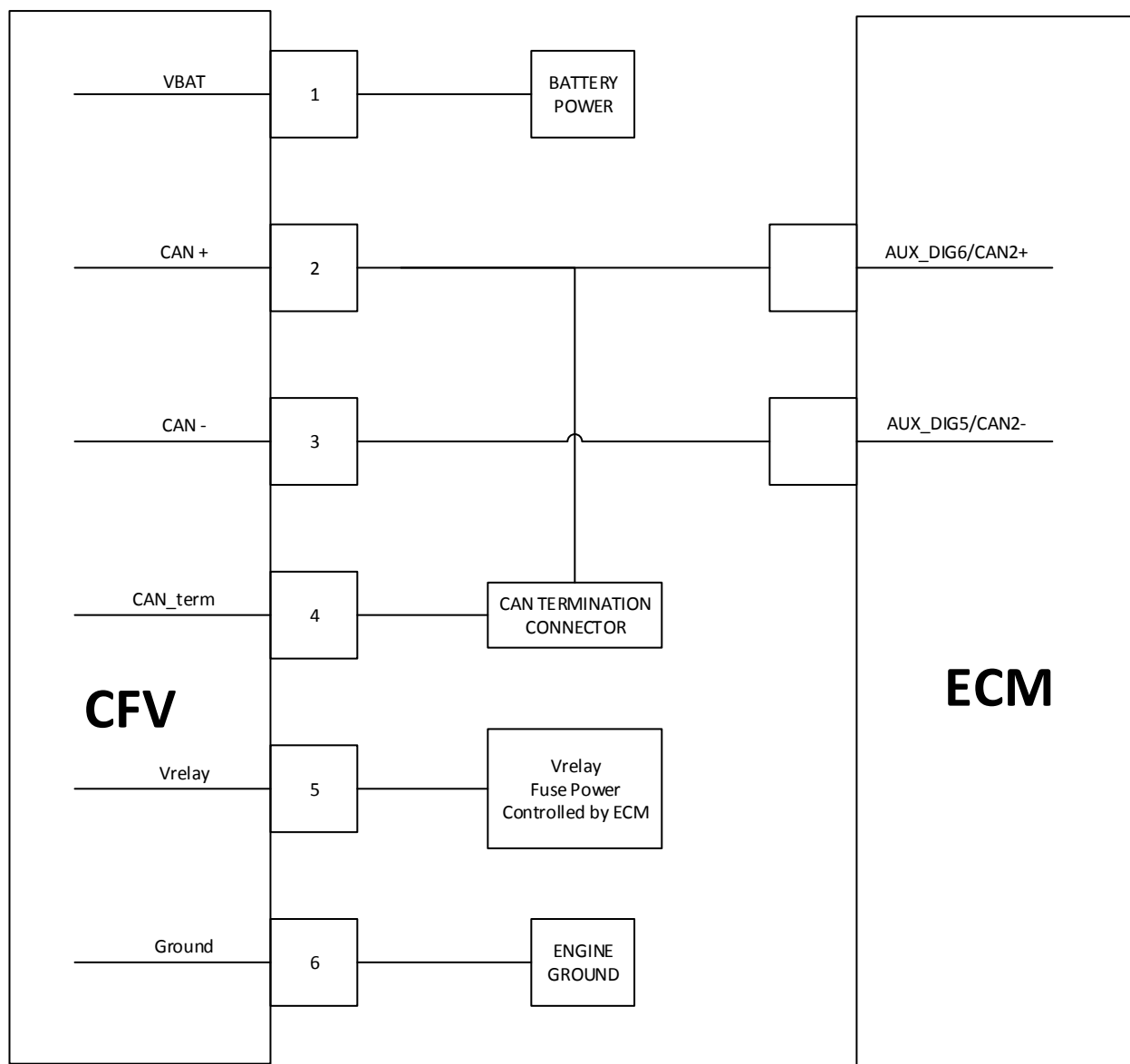
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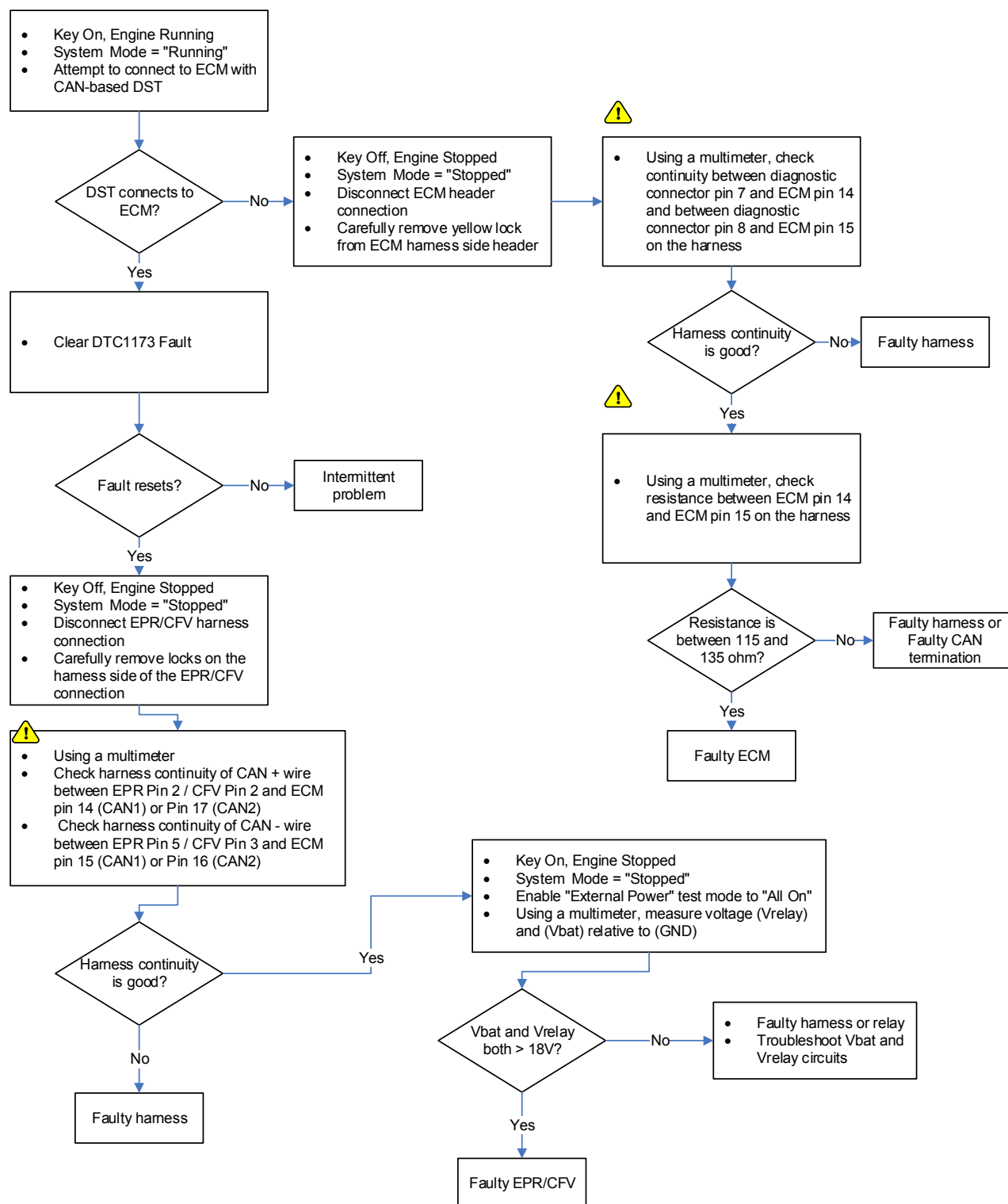
Possible Causes:

This fault sets if the ECM loses CAN communication with the EPR/CFV. This fault indicates that the ECM is no longer receiving CAN packets from the EPR/CFV which also results in the EPR/CFV not receiving communication from the ECM. This is often a result of a power loss at the EPR/CFV or improper CAN termination or wiring. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table, closed-loop is disabled, and a Power Derate 1 condition is activated to reduce the possibility of engine damage. The MIL is illuminated for the duration of the key on cycle.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1173 - EPR / CFV COMM LOST (SCHEMATIC)

DTC 1173 - EPR / CFV COMM LOST (TROUBLE TREE)

NOTE: Do not insert probe or object into terminals as this will cause the terminal to spread and it may no longer make electrical contact with its mate. Spread pins will void warranty. Probe instead on side of terminal.

DTC 1174 - EPR / CFV VOLTAGE SUPPLY HIGH

DTC	1174	SPN	520260	FMI	3		
Hardware: EPR (HD EPR) or CFV							
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• Voltage supply to EPR/CFV is >				TBD*	VDC		
Possible Causes: This fault sets if the supply voltage to the EPR/CFV exceeds 33.0 VDC for greater than 3 seconds. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table. The MIL will be illuminated for the duration of the key on cycle.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1175 - EPR / CFV VOLTAGE SUPPLY LOW

DTC	1175	SPN	520260	FMI	4		
Hardware: EPR (HD EPR) or CFV							
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• Voltage supply to EPR/CFV is <				TBD*	VDC		
• and RPM >				TBD*	rpm		
Possible Causes: This fault sets if the supply voltage to the EPR/CFV is below 18.0 VDC for > 5 seconds while engine RPM > 1000. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table. The MIL will be illuminated for the duration of the key on cycle.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1176 - EPR / CFV INTERNAL ACTUATOR FAULT DETECTION

DTC	1176	SPN	520260	FMI	12
Hardware: EPR (HD EPR) or CFV					
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Internal Actuator Fault detected					

(continued from previous page)

Possible Causes:

This fault sets if the EPR/CFV detects an internal actuator fault. The fault is transmitted from the EPR/CFV to the ECM via CAN. If the fault is active, Adaptive Learn is disabled to prevent improper learning and updating of the table. The MIL is illuminated for the duration of the key on cycle.

If the EPR/CFV does not trigger either 1171, 1172, or either of the CFV Flow fault code(s), there is no issue with the EPR/CFV. If one or more of these faults are triggered, refer to the appropriate section for diagnostic information.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1177 - EPR / CFV INTERNAL CIRCUITRY FAULT DETECTION

DTC	1177	SPN	520260	FMI	12
Hardware: EPR (HD EPR) or CFV					
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Internal circuitry fault detected					

(continued from previous page)

Possible Causes:

This fault sets if the EPR/CFV detects an internal circuitry fault. The fault is transmitted from the EPR/CFV to the ECM via CAN. If the fault is active, Adaptive Learn is disabled to prevent improper learning and updating of the table. The MIL is illuminated for the duration of the key on cycle.

If the EPR/CFV does not trigger either 1171, 1172, or either of the CFV Flow fault code(s), there is no issue with the EPR/CFV. If one or more of these faults are triggered, refer to the appropriate section for diagnostic information.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

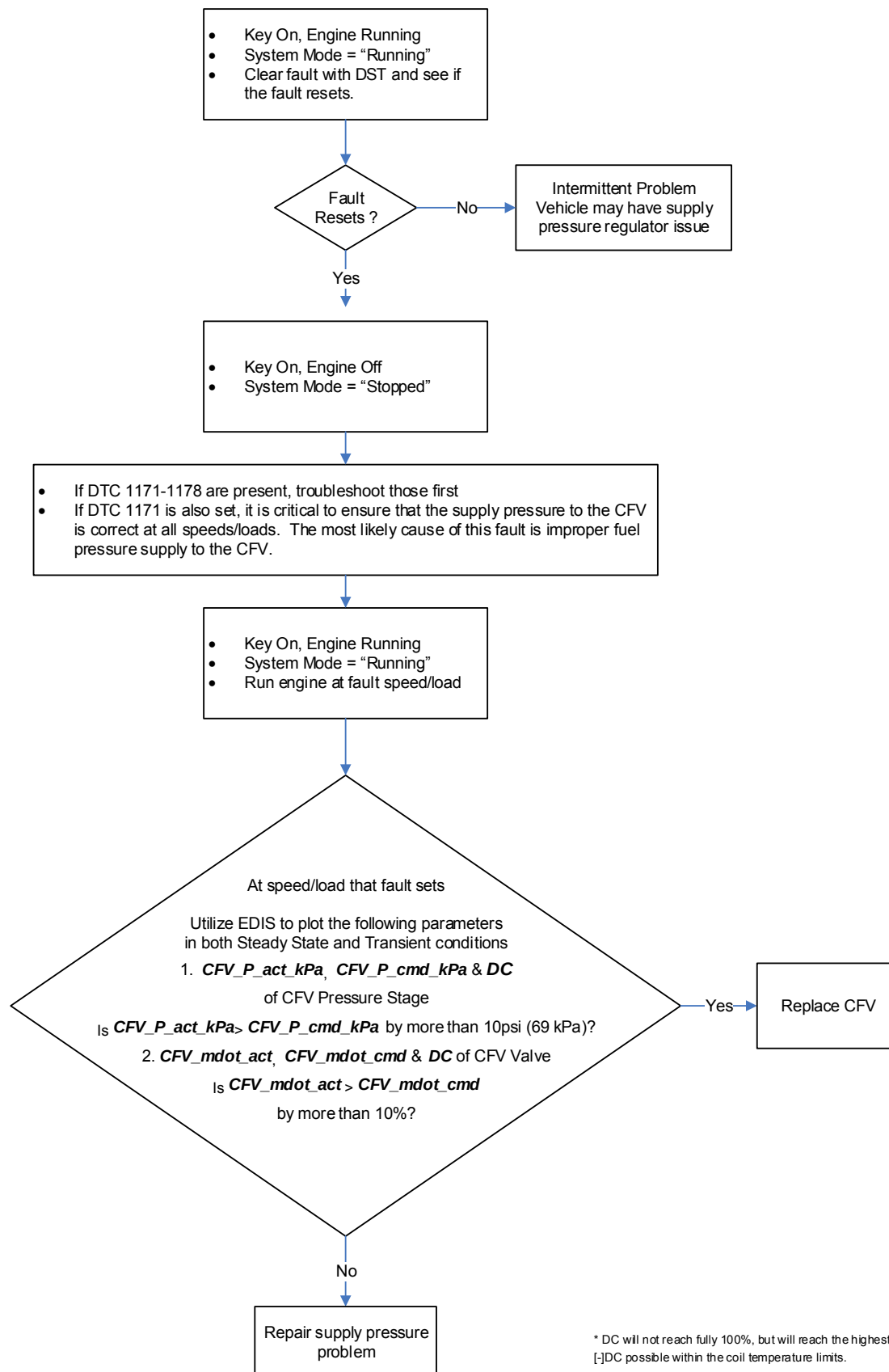
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1178 - EPR / CFV INTERNAL COMM FAULT DETECTION

DTC	1178	SPN	520260	FMI	12		
Hardware: EPR (HD EPR) or CFV							
Description: The EPR is the second generation of EControls’ Electronic Pressure Regulator found in many industrial and heavy-duty applications. The 2nd generation EPR is a “smart” actuator integrated with the primary stage regulator designed to control gaseous fuel pressure in the secondary stage regulator. The EPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The EPR allows for fast and accurate gaseous fuel control to provide a combustible mixture to the engine. The third generation of EControls’ Electronic Pressure Regulator is the DEPR. The DEPR is a “smart” actuator that is fed supply pressure through a DSR (Dual Stage Regulator). The DSR is fully mechanical. The DEPR receives fuel pressure commands from the ECM and quickly and precisely modulates fuel pressure to the gaseous fuel mixer. The DEPR allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator and a precision Continuous Flow Valve. The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates both the fuel pressure and metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
Internal comm fault detected							
Possible Causes: This fault sets if the EPR/CFV detects a loss of CAN communication with the ECM. The ECM is configured to illuminate the MIL, disable closed loop fueling correction and adaptive fueling correction, and initiate a Power Derate 1 condition to prevent possible damage to the engine.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

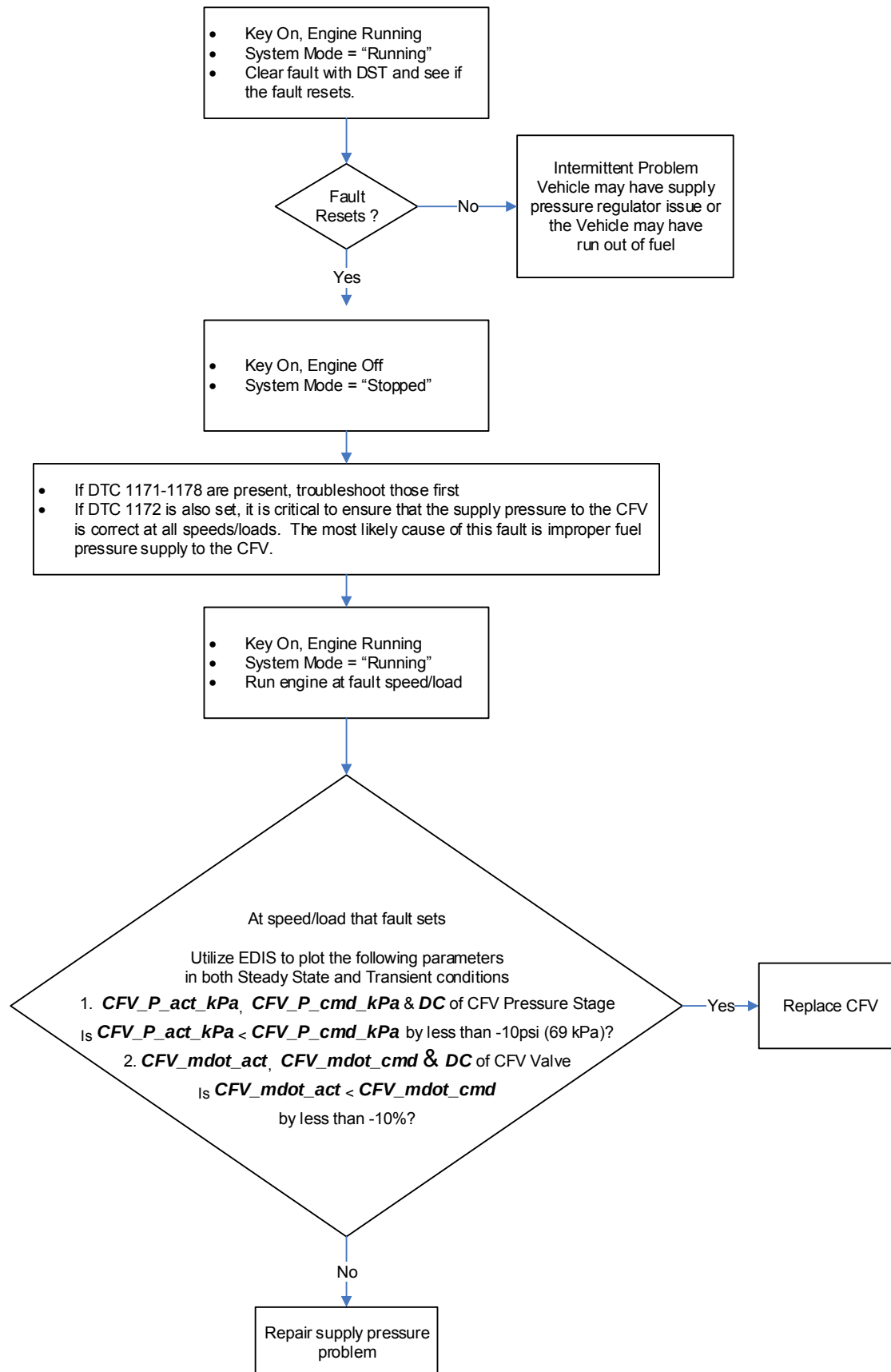
DTC 1179 - CFV FLOW HIGHER THAN COMMANDED

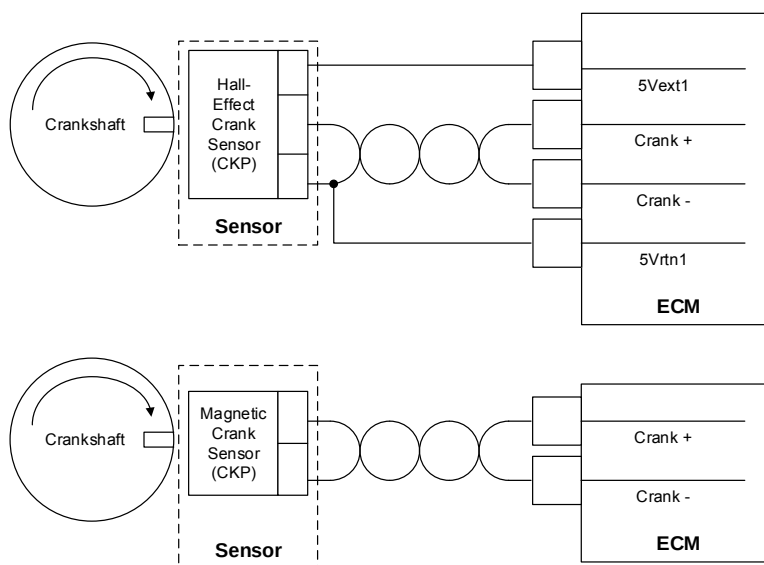
DTC	1179	SPN	520260	FMI	15		
Hardware: CFV							
Description: The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator (1st Stage) and a precision Continuous Flow Valve (2nd Stage). The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates the 1st Stage to control the fuel pressure and the 2nd Stage to control the metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• (actual flow - commanded flow) >				TBD*	%		
Possible Causes: This fault sets if the actual mass flow of the CFV is greater than the commanded mass flow by greater than X%, where typically, X = +10% of $\dot{m}_{cmd}$ (refer to engine specific calibration). This fault indicates that the device is at its minimum limit of authority on one or both actuators and the CFV is unable to achieve the mass flow commanded by the ECM. This is most likely caused by the delivery/supply pressure to the CFV being higher than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1179 CFV FLOW HIGHER THAN COMMANDED (TROUBLE TREE)

DTC 1180 - CFV FLOW LOWER THAN COMMANDED

DTC	1180	SPN	520260	FMI	17		
Hardware: CFV							
Description: The fourth generation of EControls’ gaseous fuel control valve is the CFV. The CFV contains both a high-pressure Electronic Pressure Regulator (1st Stage) and a precision Continuous Flow Valve (2nd Stage). The inlet pressure to the CFV is typically 85 psig (586 kPa). The CFV receives mass flow commands from the ECM and quickly and precisely modulates the 1st Stage to control the fuel pressure and the 2nd Stage to control the metering valve to achieve the desired mass flow. The CFV allows for very fast and very accurate gaseous fuel control to provide a combustible mixture to the engine.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Engine Running					
Fault Set Conditions (as defined in calibration):							
• (actual flow - commanded flow) <				TBD*	%		
Possible Causes: This fault sets if the actual mass flow of the CFV is less than the commanded mass flow by less than X%, where typically, X = -10% of $\dot{m}_{cmd}$ (refer to engine specific calibration). This fault indicates that the device is at its maximum limit of authority on one or both actuators and the CFV is unable to achieve the mass flow commanded by the ECM. This is most likely caused by the delivery/supply pressure to the CFV being lower than expected. Adaptive fueling correction is disabled to avoid improper learning of the fuel correction table due to improper fuel supply pressure.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1180 CFV FLOW LOWER THAN COMMANDED (TROUBLE TREE)

DTC 1311 - MISFIRE DETECTED (CYLINDER 1)

DTC	1311	SPN	1323	FMI	11
Sensor / Circuit: Cylinder #1 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

(continued from previous page)

Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #1 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

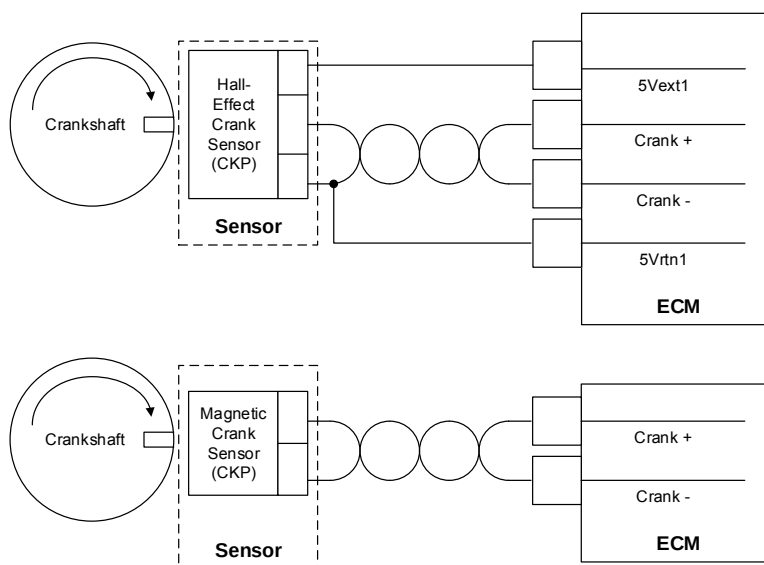
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1311 - MISFIRE DETECTED (CYLINDER 1) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1312 - MISFIRE DETECTED (CYLINDER 2)

DTC	1312	SPN	1324	FMI	11
Sensor / Circuit: Cylinder #2 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #2 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

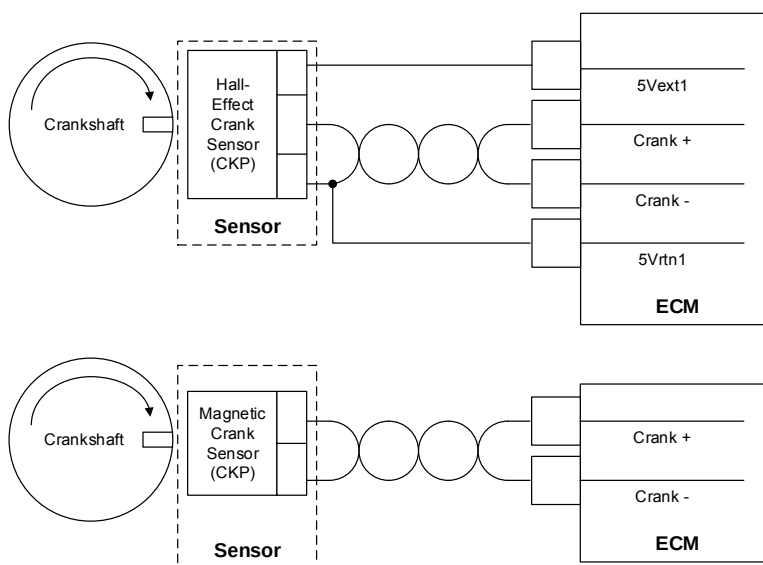
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1312 - MISFIRE DETECTED (CYLINDER 2) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1313 - MISFIRE DETECTED (CYLINDER 3)

DTC	1313	SPN	1325	FMI	11
Sensor / Circuit: Cylinder #3 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #3 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

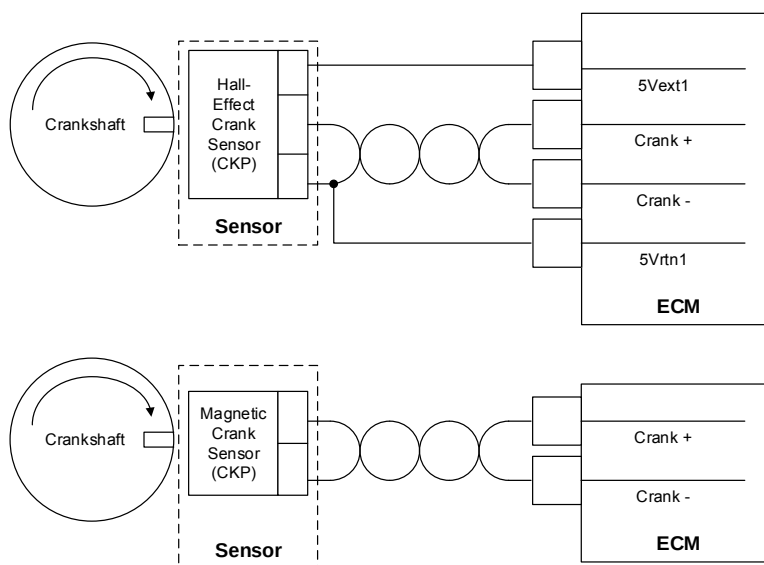
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1313 - MISFIRE DETECTED (CYLINDER 3) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1314 - MISFIRE DETECTED (CYLINDER 4)

DTC	1314	SPN	1326	FMI	11
Sensor / Circuit: Cylinder #4 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #4 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

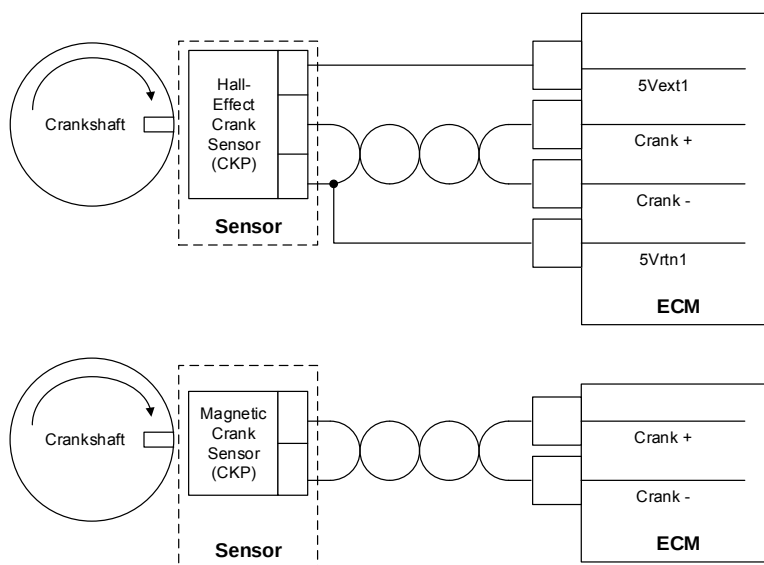
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1314 - MISFIRE DETECTED (CYLINDER 4) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1315 - MISFIRE DETECTED (CYLINDER 5)

DTC	1315	SPN	1327	FMI	11
Sensor / Circuit: Cylinder #5 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #5 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

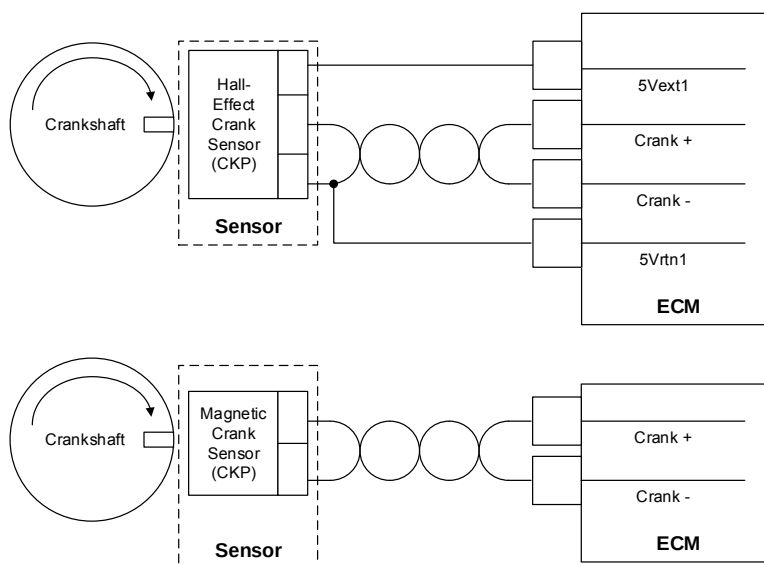
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1315 - MISFIRE DETECTED (CYLINDER 5) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1316 - MISFIRE DETECTED (CYLINDER 6)

DTC	1316	SPN	1328	FMI	11
Sensor / Circuit: Cylinder #6 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #6 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

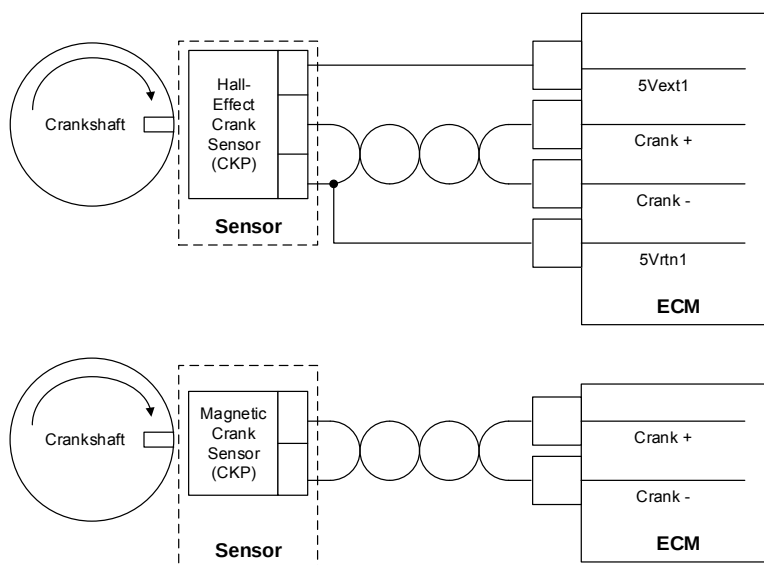
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1316 - MISFIRE DETECTED (CYLINDER 6) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1317 - MISFIRE DETECTED (CYLINDER 7)

DTC	1317	SPN	1329	FMI	11
Sensor / Circuit: Cylinder #7 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #7 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

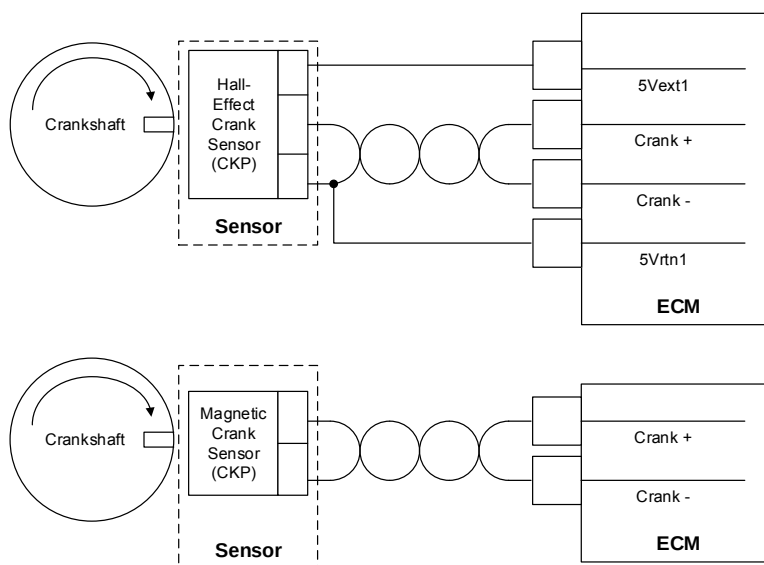
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1317 - MISFIRE DETECTED (CYLINDER 7) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1318 - MISFIRE DETECTED (CYLINDER 8)

DTC	1318	SPN	1330	FMI	11
Sensor / Circuit: Cylinder #8 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #8 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

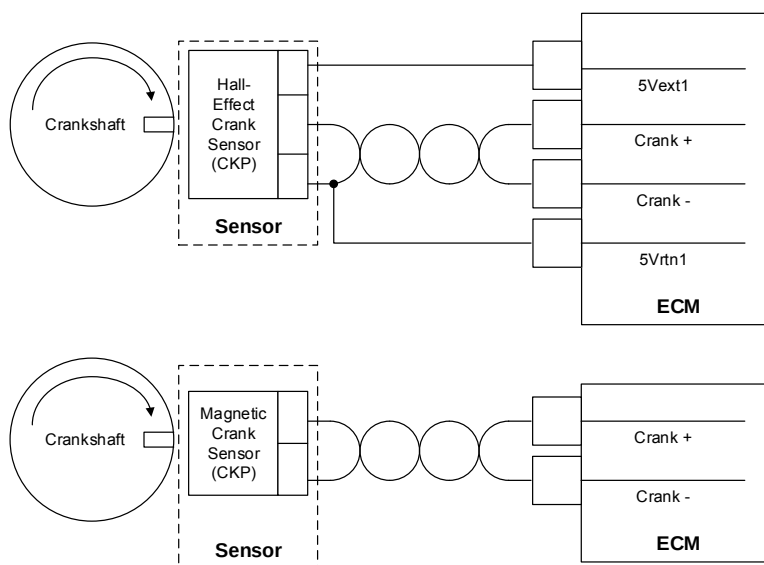
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1318 - MISFIRE DETECTED (CYLINDER 8) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1319 - MISFIRE DETECTED (CYLINDER 9)

DTC	1319	SPN	1331	FMI	11
Sensor / Circuit: Cylinder #9 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #9 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

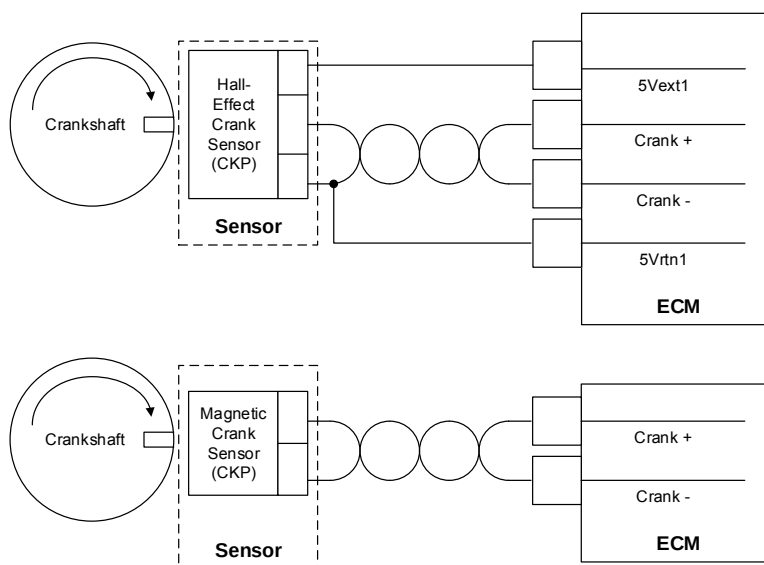
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1319 - MISFIRE DETECTED (CYLINDER 9) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1320 - MISFIRE DETECTED (CYLINDER 10)

DTC	1320	SPN	1332	FMI	11
Sensor / Circuit: Cylinder #10 Misfire Detected-Driveability/Performance					
Description: The ECM is capable of detecting combustion misfire for certain crank-cam software modules. The ECM continuously monitors changes in crankshaft angular velocity, comparing acceleration rates on a cycle-to-cycle basis and determining if a given cylinder's rate of change is abnormal compared to other cylinders. This method of detection is better known as Instant Crank Angle Velocity (ICAV). Misfire is of concern for four main reasons: 1) damage can occur to aftertreatment systems due to the presence of unburned fuel and oxygen causing chemical reactions resulting in extremely high temperatures causing irreversible damage to catalytic coatings and/or substrates, 2) exhaust emissions increase during misfiring, 3) the engine's driveability suffers due to inconsistent operation, and 4) fuel economy suffers due to the need for higher power operating conditions to achieve the same brake torque. The GCP has two stages of misfire faults 1) emissions/catalyst damaging misfire detected and 2) driveability or general misfire detected. Emissions/catalyst misfire is generally thought of as a per "bank" fault as multiple cylinders misfiring on the same bank cumulatively add unburned fuel and oxygen to that bank's aftertreatment device(s). The catalyst/emissions fault is configured to set based on one or both of the following conditions: 1) Aftertreatment temperatures experienced during this level of misfire are high enough to cause permanent damage to emission control components 2) Emissions are higher than allowed by legislation due to the presence of misfire.					

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Therefore, if two cylinders misfire on the same bank together they both may set the misfire fault even if neither cylinder individually exceeds the catalyst/misfire threshold.

Typically the driveability level is calibrated to set prior to the emissions/catalyst level if a two stage fault is desired. This fault would set to notify the user of a problem prior to it causing damage to the exhaust aftertreatment system.

Fault Enabled in Calibration?

TBD* (*Application-Specific – see calibration)

Emissions-related Fault?

YES

Check Condition:

Key On, Engine Running

Fault Set Conditions (as defined in calibration):

- Cylinder #10 misfiring >=

TBD*

% max

Possible Causes:

Misfire is typically a result of one or more factors. These factors can include but may not be limited to:

- 1) a fouled or damaged spark plug(s),
- 2) a damaged or defective ignition coil(s) or coil wire(s) resulting in weak spark generation,
- 3) a plugged or contaminated injector(s) that intermittently sticks closed resulting in a lean cylinder charge,
- 4) an injector(s) that is stuck open causing an uncontrolled rich cylinder charge,
- 5) low fuel supply pressure resulting in multiple lean cylinders,
- 6) low cylinder compression due to a failed or worn piston ring(s) or non-seating valve(s) can result in a low cylinder pressure charge that may not be ignited, and
- 7) an exhaust leak in close proximity to an exhaust valve permitting uncontrolled amounts of oxygen to be drawn into a cylinder generating an excessively lean charge either directly resulting in misfire or possibly causing excessive combustion temperatures resulting in burned valves and loss of compression.

Misfire can be difficult to correct as it may be a function of one or more of the conditions mentioned above and may require checking and/or changing several components for each cylinder or cylinders affected.

This fault sets if the misfire counter for cylinder #1 exceeds the driveability misfire limit set in the misfire diagnostic calibration and is based on a percentage of misfire over a certain number of engine cycles.

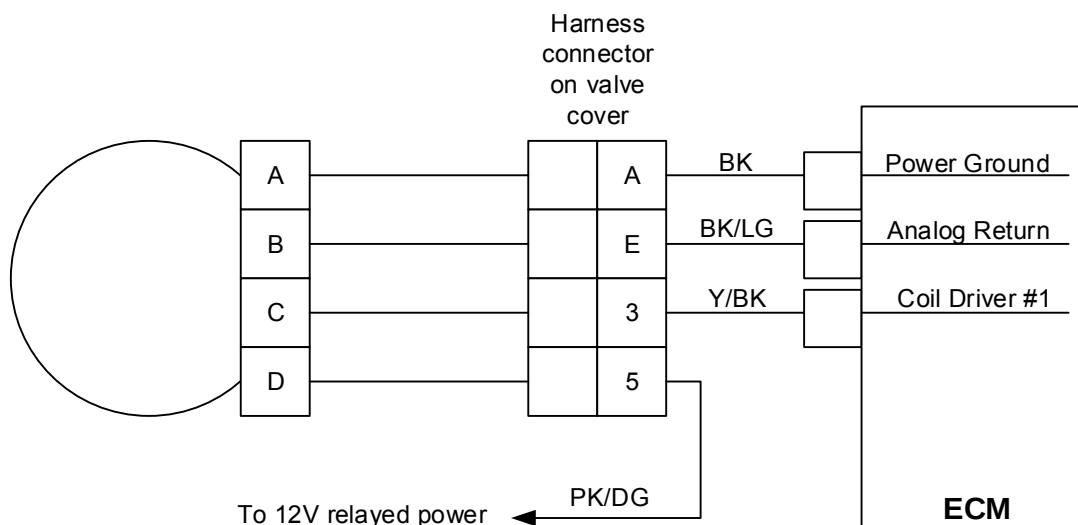
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1320 - MISFIRE DETECTED (CYLINDER 10) (DIAGNOSTIC AIDS)**Diagnostic Aids**

NOTE: If any other DTCs are present, diagnose those first.

- ☐ Oil Level- Many engines have valve trains that utilize lifters that are hydraulically actuated and require specific levels of oil to maintain proper pressure for lifter actuation. If the engine has improper oil, insufficient oil level, or has too much oil the hydraulic lifters may not function as intended causing changes in valve lift and timing. As a result, incomplete combustion may occur as a result of oil problems. Check engine oil level and oil type according to manufacture maintenance procedures.
- ☐ Fuel Level- Misfire can occur due to intermittent or prolonged loss of fuel pressure due to a lack of fuel supply. If misfire counts or faults set and a fuel pressure fault is not recorded, question the operator(s) about the possibility of running out of fuel before replacing components.
- ☐ Ignition System- Wear or damage to ignition system components (spark plugs, spark plug wires, distributor or ignition coils) can result in weak or misplaced spark causing partial combustion and thus partial misfire.
 - o Spark Plug(s) – Check for fouled or damaged spark plugs. Replace and regap according to manufacture recommended procedure(s).
 - o Spark Plug Wire(s) – Check that spark plug wire is properly connected to ignition coil and spark plug. If equipped, ensure that spark plug terminal nut is tight to plug and that there is not substantial wear on nut. Check for cracks in insulation of spark plug wire or boot. Replace spark plug wire(s) if deemed necessary according to manufacture recommended procedure(s).
 - o Distributor modules- Check distributor for oxidized or corroded spark distribution conductors including the distributor rotor and distributor cap poles.
- ☐ Fuel Pressure – Check fuel rail pressure at key-on/engine-off or with External Power-All On test running. Monitor fuel rail pressure when key is turned off to determine if fuel pressure bleeds down too quickly. Run an injector fire test on a couple of injectors to monitor the pressure drop in the rail for each injector. If an injector appears to flow inconsistent compared to others, replace and retest.
- ☐ Cylinder Check – Run a compression test and cylinder leak test on suspected cylinder(s) to check mechanical integrity of piston rings and valve seats.
- ☐ Exhaust Leak – Pressurize exhaust system with 1-2 psig of air and check for pressure leaks around exhaust manifold gasket and pre-catalyst EGO sensor. Replace gasket(s) and tighten fasteners according to manufacture recommended procedure(s).

DTC 1351 – DTC 1360 – SPARK PLUG OR COIL FAILURE (CYLINDERS 1-10)

DTC	1351	SPN	520260	FMI	17		
Sensor/Circuit: Ignition/Spark Coil, cylinders 1-10 (Dumb-coil ONLY)							
Description: Coil driver #1 (correlates to DTC 1351) fires either the 1st cylinder in the firing order or the 1st cylinder in the block order depending on the configuration of the ‘Injector/Spark Diagnostic Numbering’ scheme as set in calibration. Drivers 2-10 (correlating to DTCs 1352-1360) follow in-kind.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration): Ignition/Spark drive circuitry (internal to the ECM) is overheating							
Possible Causes: This fault will set if the ECM detects that the spark/ignition drive circuitry within the ECM is over-heating. Once over-heating is detected and this fault is active, the ECM will kill spark on the affected channel until x seconds after the drive circuit cools or until the key switch is cycled depending upon the selection made in the diagnostic calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1351 – DTC 1360 – SPARK PLUG OR COIL FAILURE (CYLINDERS 1-10)

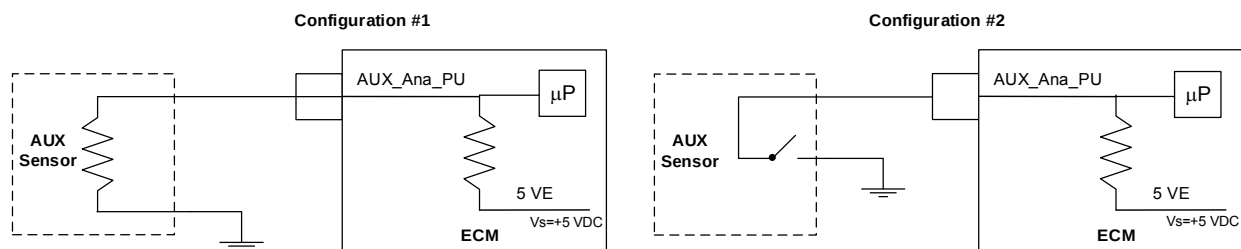
(continued from previous page)

Typical causes of this fault include:

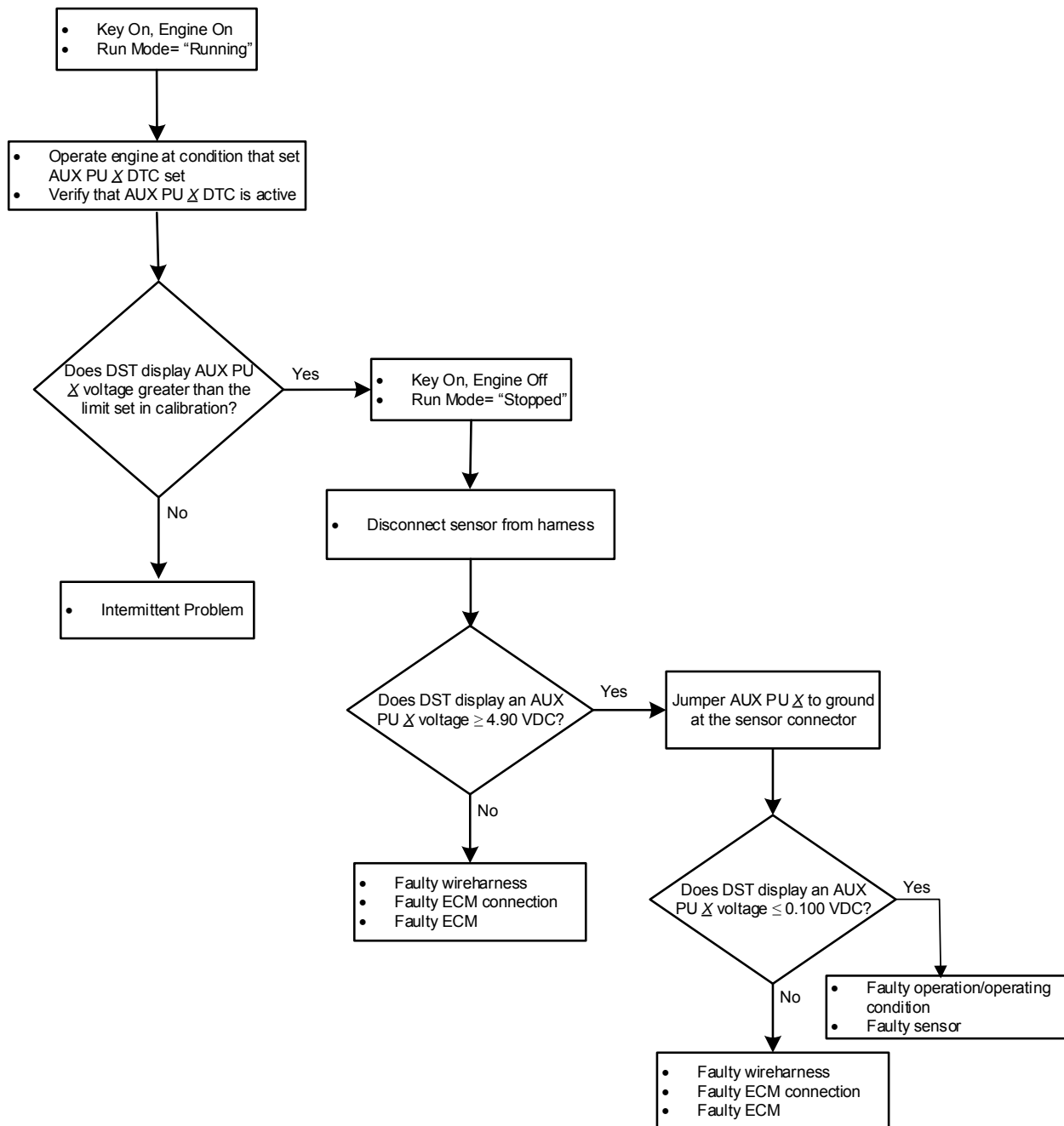
- shorted coil
- poor quality coil
- coil loose from spark plug
- plug gap too large (all inductive energy goes back on driver)
- dwell time is set too long in the diagnostic calibration
- ambient temp too high

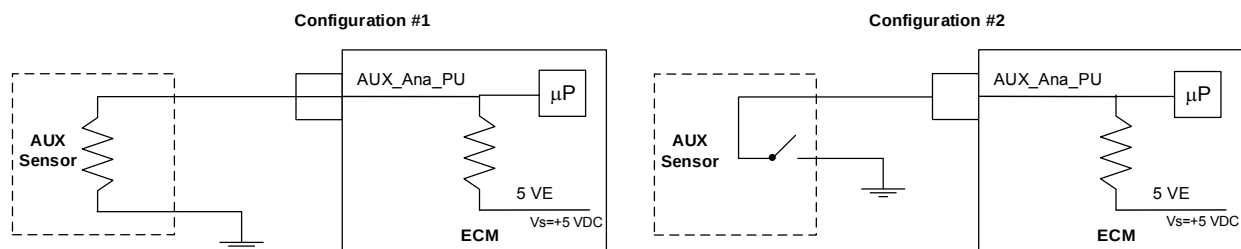
Diagnostic Aids:

- ☐ Check plug gap on the cylinder associated with the fault.
- ☐ Check for loose connections at the coil and spark plugs. Look for evidence of charring or arcing around spark plugs.
- ☐ Check coil resistance and verify that it is within specifications. Look for a short internal to the coil.
- ☐ Ensure the use of high quality coils without a history of internal arcing or other failures.
- ☐ Verify that ambient conditions are not exceeding 85C on a continuous basis or 125C for short intervals. If so, verify that this fault stops occurring when ambient temperatures lower.
- ☐ Verify the dwell time set in the diagnostic calibration is not set too long and that adaptive dwell is enabled.

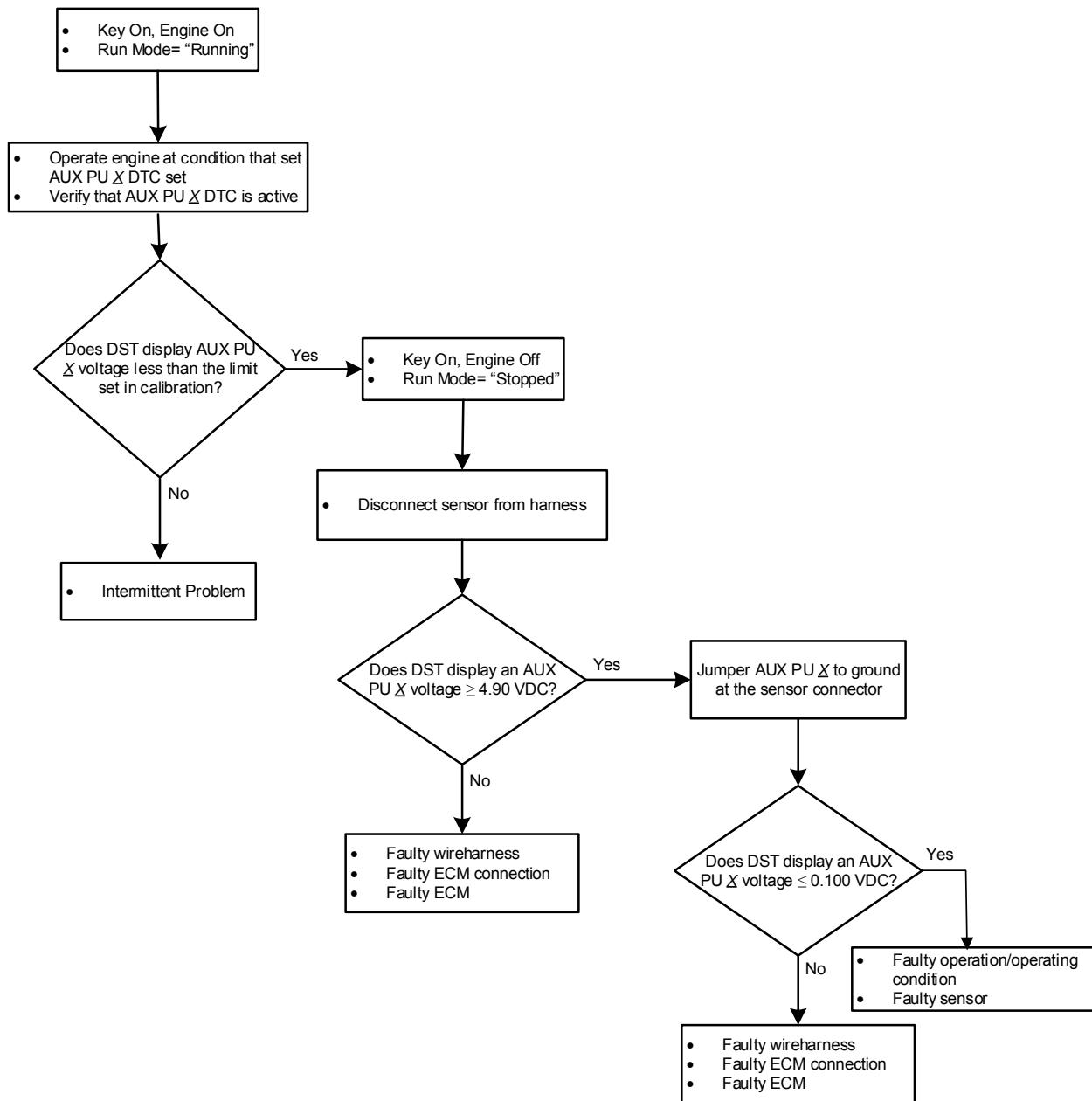
DTC 1511 - AUX ANALOG PULL-UP 1 HIGH VOLTAGE FAULT

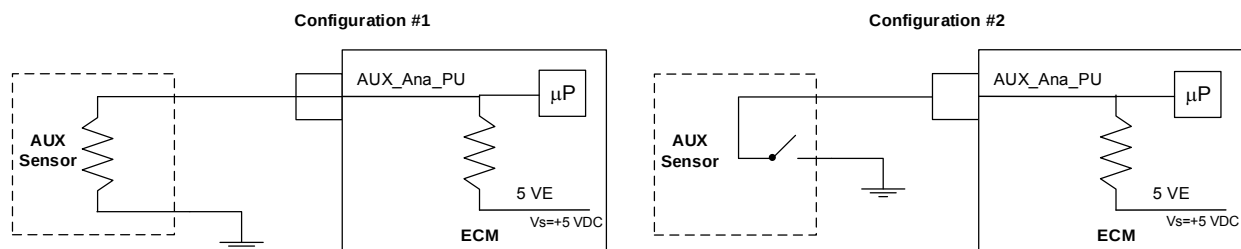
DTC	1511	SPN	701	FMI	3		
Sensor/Circuit: Configuration #1: Auxiliary Sensor (proportional voltage type), Configuration #2: Auxiliary Sensor (switch-type)							
Description: The auxiliary analog input circuit is customer specific and can be used to perform an action based on a sensor that switches to ground or a sensor that outputs a proportional voltage. Typical uses of the auxiliary circuit includes switches that activate particular software strategies, switches that act as vehicle safeties to trigger derate or shutdown conditions, or auxiliary senders used to drive gauges. The circuit internal to the ECM is connected in parallel with the regulated 5 VDC power supply so that when no load is connected to the circuit the feedback voltage is equal to 5 VDC.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU1 >				TBD*	volts		
Possible Causes: This fault is active when the voltage feedback from the sensor is above the limit defined in calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1511 - AUX ANALOG PULL-UP 1 HIGH VOLTAGE FAULT (TROUBLE TREE)

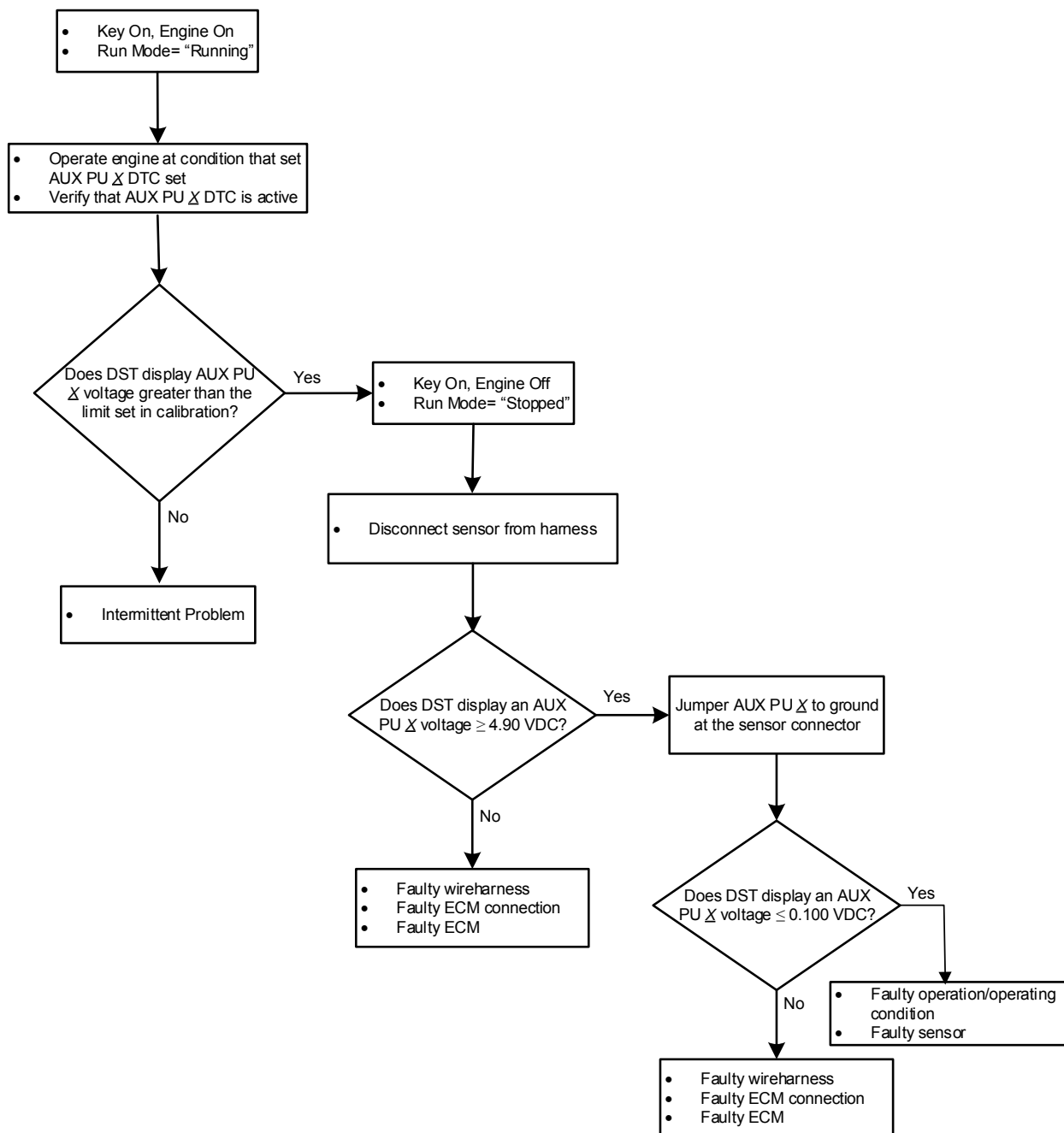
DTC 1512 - AUX ANALOG PULL-UP 1 LOW VOLTAGE FAULT

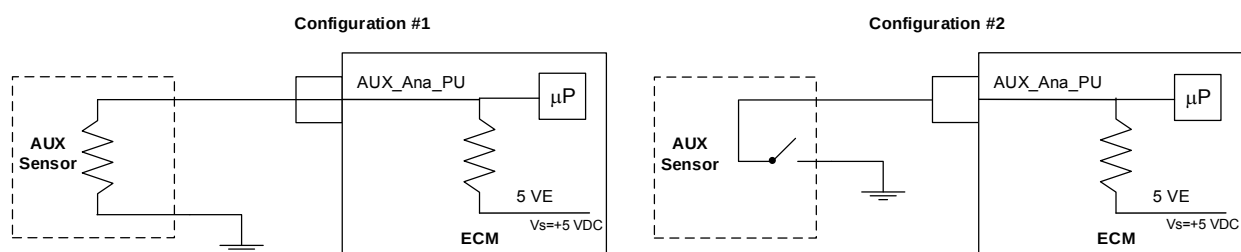
DTC	1512	SPN	701	FMI	4		
Sensor/Circuit: Configuration #1: Auxiliary Sensor (proportional voltage type), Configuration #2: Auxiliary Sensor (switch-type)							
Description: The auxiliary analog input circuit is customer specific and can be used to perform an action based on a sensor that switches to ground or a sensor that outputs a proportional voltage. Typical uses of the auxiliary circuit includes switches that activate particular software strategies, switches that act as vehicle safeties to trigger derate or shutdown conditions, or auxiliary senders used to drive gauges. The circuit internal to the ECM is connected in parallel with the regulated 5 VDC power supply so that when no load is connected to the circuit the feedback voltage is equal to 5 VDC.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU1 <				TBD*	volts		
Possible Causes: This fault is active when the voltage feedback from the sensor is below the limit defined in calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1512 - AUX ANALOG PULL-UP 1 LOW VOLTAGE FAULT (TROUBLE TREE)

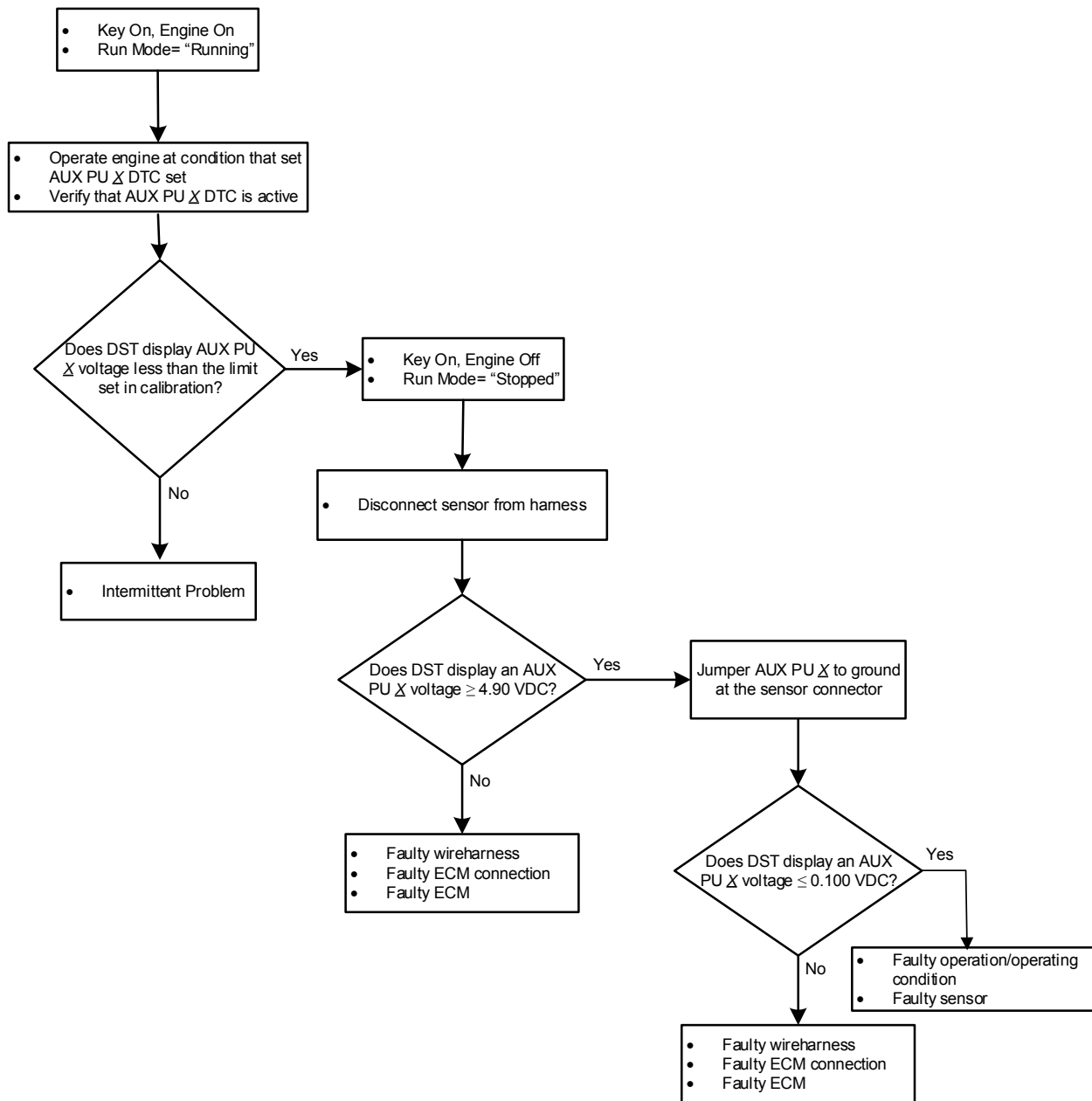
DTC 1513 - AUX ANALOG PULL-UP 2 HIGH VOLTAGE FAULT

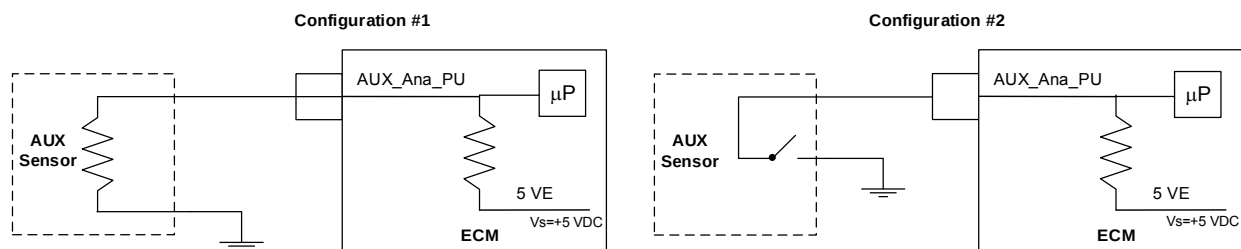
DTC	1513	SPN	702	FMI	3		
Sensor/Circuit: Configuration #1: Auxiliary Sensor (proportional voltage type), Configuration #2: Auxiliary Sensor (switch-type)							
Description: The auxiliary analog input circuit is customer specific and can be used to perform an action based on a sensor that switches to ground or a sensor that outputs a proportional voltage. Typical uses of the auxiliary circuit includes switches that activate particular software strategies, switches that act as vehicle safeties to trigger derate or shutdown conditions, or auxiliary senders used to drive gauges. The circuit internal to the ECM is connected in parallel with the regulated 5 VDC power supply so that when no load is connected to the circuit the feedback voltage is equal to 5 VDC.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU2 >				TBD*	volts		
Possible Causes: This fault is active when the voltage feedback from the sensor is above the limit defined in calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1513 - AUX ANALOG PULL-UP 2 HIGH VOLTAGE FAULT (TROUBLE TREE)

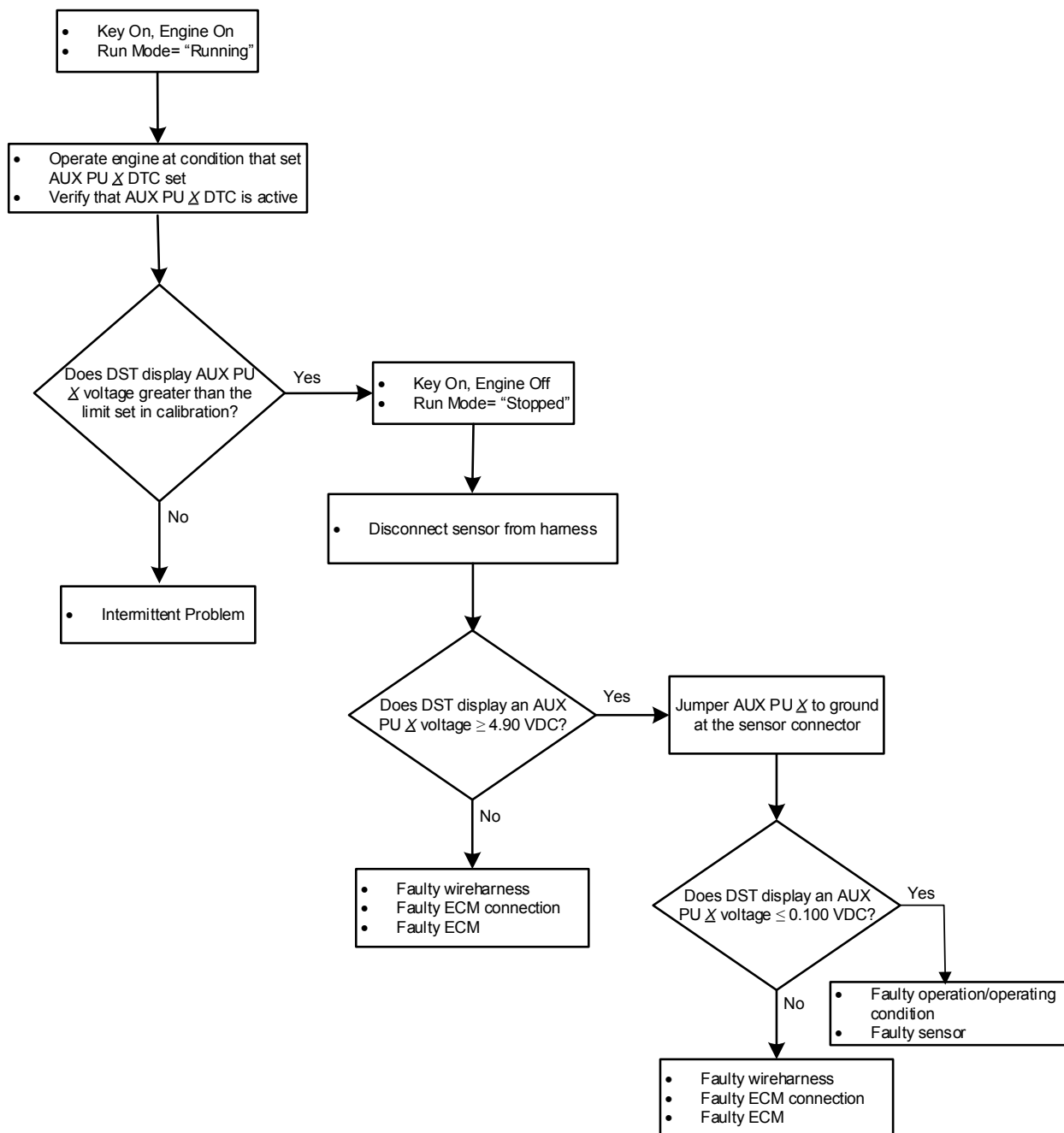
DTC 1514 - AUX ANALOG PULL-UP 2 LOW VOLTAGE FAULT

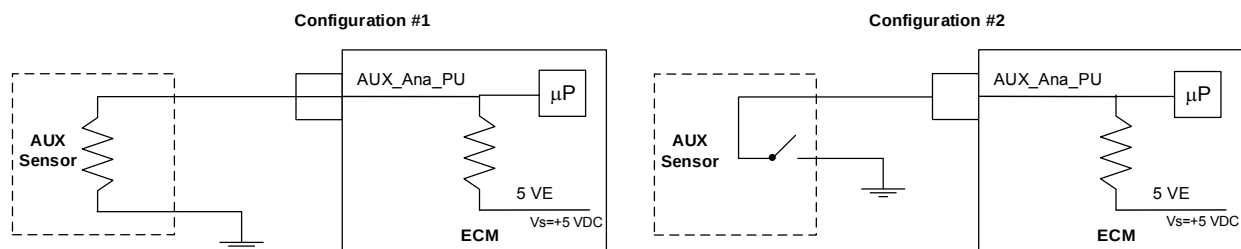
DTC	1514	SPN	702	FMI	4		
Sensor/Circuit: Configuration #1: Auxiliary Sensor (proportional voltage type), Configuration #2: Auxiliary Sensor (switch-type)							
Description: The auxiliary analog input circuit is customer specific and can be used to perform an action based on a sensor that switches to ground or a sensor that outputs a proportional voltage. Typical uses of the auxiliary circuit includes switches that activate particular software strategies, switches that act as vehicle safeties to trigger derate or shutdown conditions, or auxiliary senders used to drive gauges. The circuit internal to the ECM is connected in parallel with the regulated 5 VDC power supply so that when no load is connected to the circuit the feedback voltage is equal to 5 VDC.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU2 <				TBD*	volts		
Possible Causes: This fault is active when the voltage feedback from the sensor is below the limit defined in calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1514 - AUX ANALOG PULL-UP 2 LOW VOLTAGE FAULT (TROUBLE TREE)

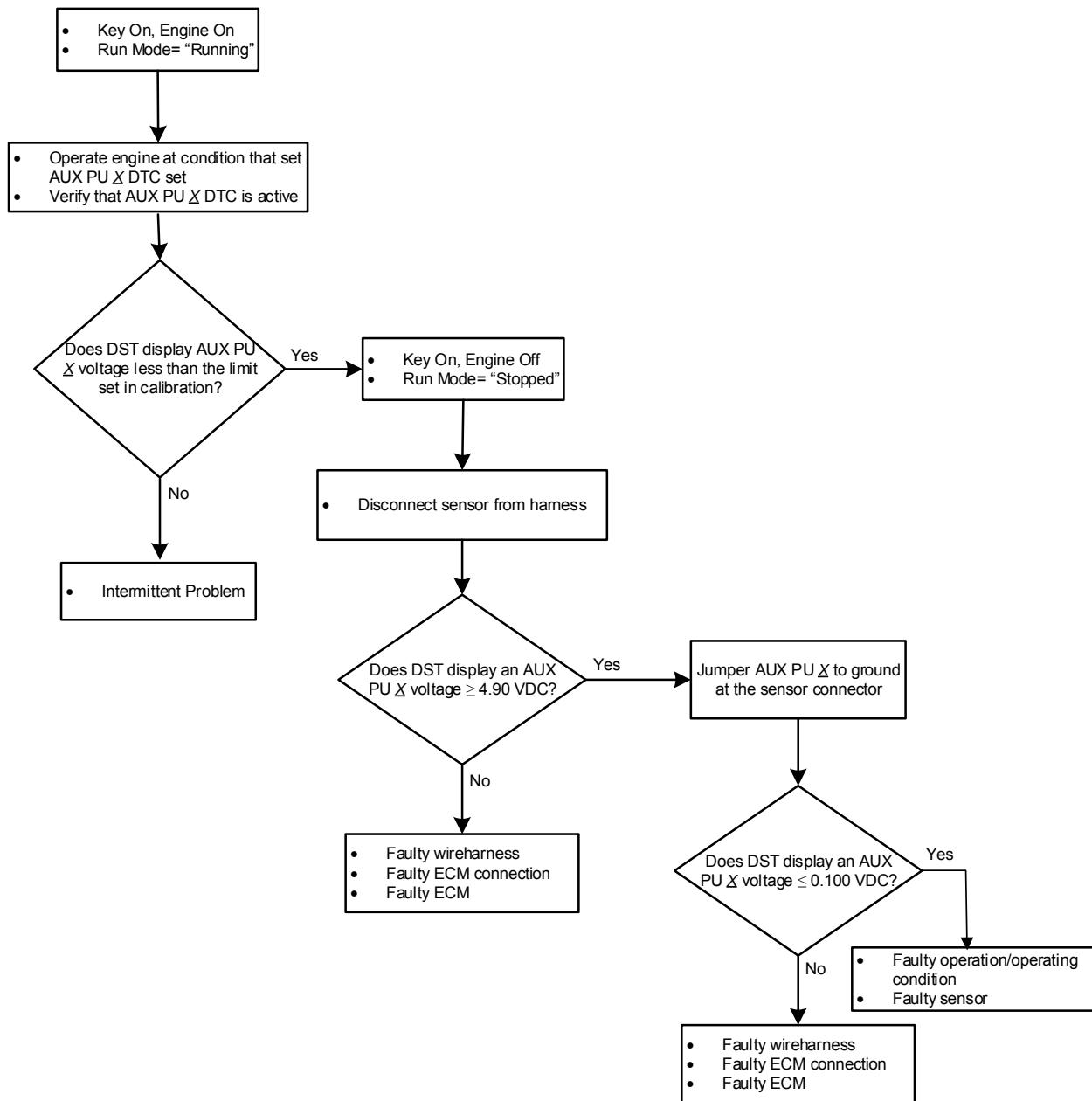
DTC 1517- AUX ANALOG PULL-UP 3 HIGH VOLTAGE FAULT

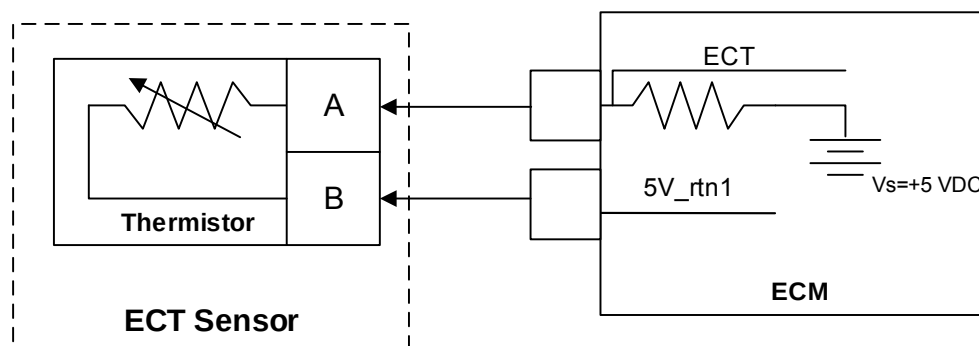
DTC	1517	SPN	703	FMI	3		
Sensor/Circuit: Configuration #1: Auxiliary Sensor (proportional voltage type), Configuration #2: Auxiliary Sensor (switch-type)							
Description: The auxiliary analog input circuit is customer specific and can be used to perform an action based on a sensor that switches to ground or a sensor that outputs a proportional voltage. Typical uses of the auxiliary circuit includes switches that activate particular software strategies, switches that act as vehicle safeties to trigger derate or shutdown conditions, or auxiliary senders used to drive gauges. The circuit internal to the ECM is connected in parallel with the regulated 5 VDC power supply so that when no load is connected to the circuit the feedback voltage is equal to 5 VDC.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU3 >				TBD*	volts		
Possible Causes: This fault is active when the voltage feedback from the sensor is above the limit defined in calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1517 - AUX ANALOG PULL-UP 3 HIGH VOLTAGE FAULT (TROUBLE TREE)

DTC 1518- AUX ANALOG PULL UP 3 LOW VOLTAGE FAULT

DTC	1516	SPN	703	FMI	4		
Sensor/Circuit: Configuration #1: Auxiliary Sensor (proportional voltage type), Configuration #2: Auxiliary Sensor (switch-type)							
Description: The auxiliary analog input circuit is customer specific and can be used to perform an action based on a sensor that switches to ground or a sensor that outputs a proportional voltage. Typical uses of the auxiliary circuit includes switches that activate particular software strategies, switches that act as vehicle safeties to trigger derate or shutdown conditions, or auxiliary senders used to drive gauges. The circuit internal to the ECM is connected in parallel with the regulated 5 VDC power supply so that when no load is connected to the circuit the feedback voltage is equal to 5 VDC.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU3 <				TBD*	volts		
Possible Causes: This fault is active when the voltage feedback from the sensor is below the limit defined in calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

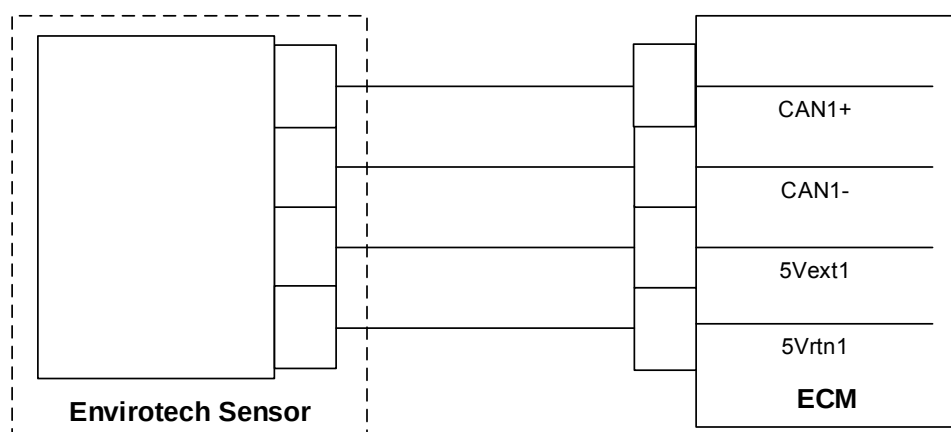
DTC 1516 - AUX ANALOG PULL-UP 3 LOW VOLTAGE FAULT (TROUBLE TREE)

DTC 1521 - CHT HIGHER THAN EXPECTED STAGE 1

DTC	1521	SPN	110	FMI	16		
Sensor/Circuit: Cylinder Head Temperature Sensor							
Description: The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• CHT >				TBD*	deg F		
• and RPM >				TBD*	rpm		
• and run-time >				TBD*	seconds		
Possible Causes: This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1521- CHT Higher Than Expected Stage 1 (Diagnostic Aids)

- ☐ If the “ECT High Voltage” fault is also present, follow the troubleshooting procedures for that fault as it may have caused “ECT Higher Than Expected 1.”
- ☐ If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:
 - o Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
 - o Ensure that there is no trapped air in the cooling path
 - o Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - o Check that the fan is operating properly
 - o Check that the thermostat is not stuck closed
- ☐ If the cooling system utilizes a water-to-water heat exchanger:
 - o Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
 - o Ensure that there is no trapped air in the cooling path
 - o Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - o Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
 - o Check that the thermostat is not stuck closed
 - o Check that the raw water pump/impeller is tact and that it is not restricted

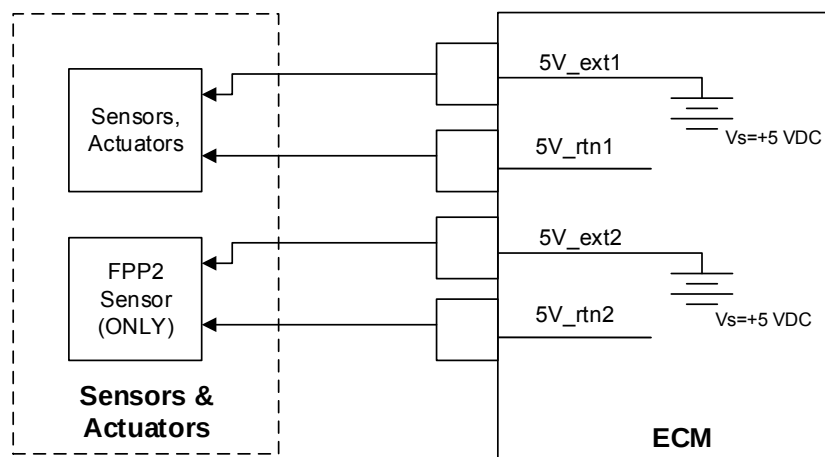
DTC 1601 - ENVIROTECH RECEIPT LOST

DTC	1601	SPN	4490	FMI	18		
Sensor/Circuit: Envirotech Sensor							
Description: The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. The Envirotech sensor measures environmental information (barometric pressure, humidity) and reports this data to ECM via the CAN network.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Off and/or Running					
Fault Set Conditions (as defined in calibration):							
• ECM does not receive Envirotech data for a calibrated period of time							
Possible Causes: This fault will set if CAN communication is enabled and the ECM transceiver is expecting to see Envirotech sensor data and does not receive data for > X + Y seconds. X is the initial trigger period (typically 2.2 seconds) and Y is the additional calibrated latch time for this diagnostic. Potential issues related to missing or erroneous data from Envirotech sensor include increased knock propensity (related to inaccurate or unknown humidity levels), and turbo overspeed at altitude (related to inaccurate or unknown barometric pressure).							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

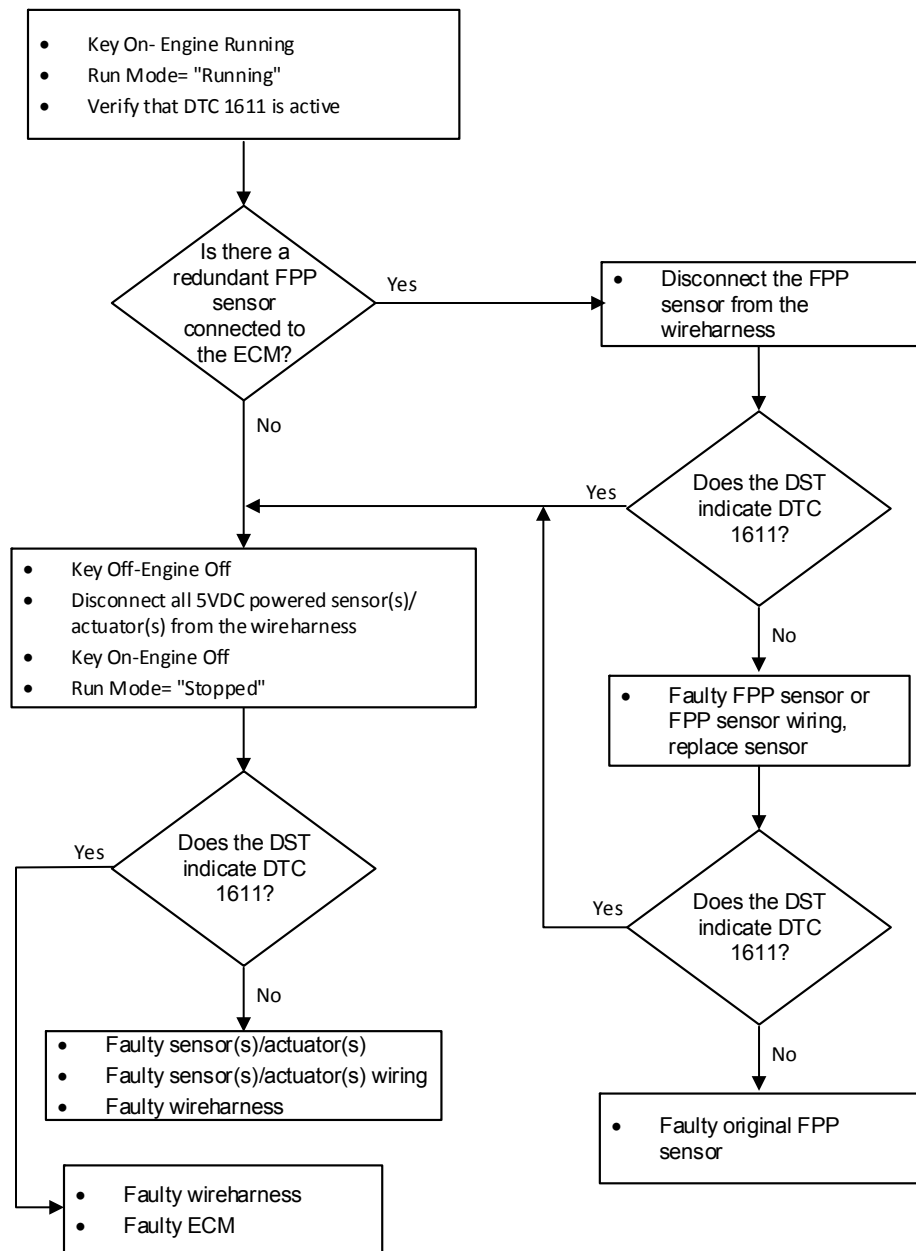
DTC 1601 – Envirotech Receipt Lost (Diagnostic Aids:

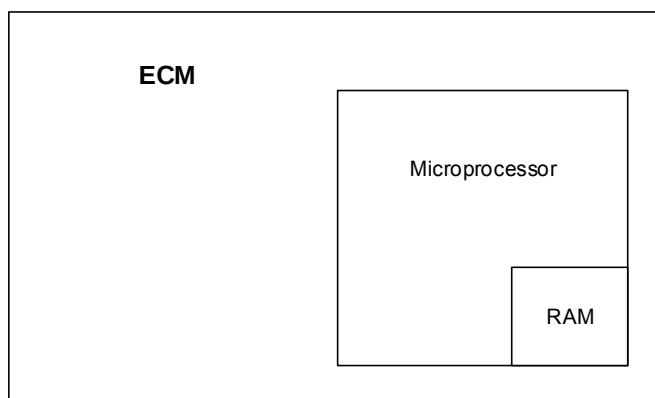
- ☐ Verify that the Envirotech sensor is powered and properly grounded
- ☐ Verify that the CAN1 network is properly terminated
- ☐ Check CAN1 wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- ☐ Check CAN1 (+) and (-) wires for short circuits

DTC 1611 - SENSOR SUPPLY VOLTAGE (5VEXT 1/2) SIMULTANEOUS OUT-OF-RANGE

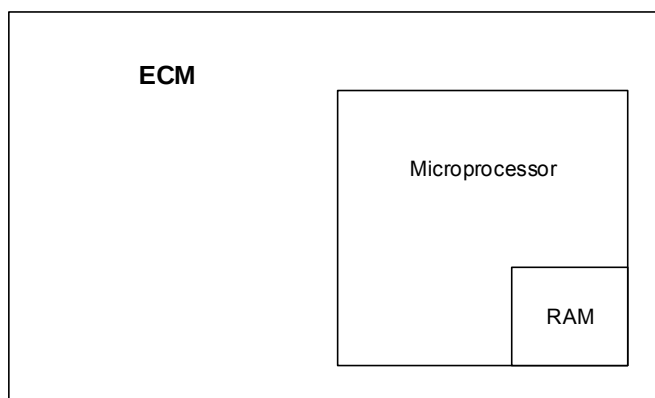


DTC	1611	SPN	1079	FMI	31		
Sensor/Circuit: Powered sensors/actuators and FPP2							
Description: 5V_ext1 is a regulated 5 VDC output that supplies power to sensors and actuators. This power is generally supplied, but is not limited to hall-effects, potentiometers, switches, and pressure transducers. 5V_ext2 is a low-current 5 VDC power supply intended solely for powering a second potentiometer used for electronic throttle control in configurations where high redundancy is required. High accuracy of the power supplies are required in order to ensure proper signal scaling. Both power supplies have a feedback voltage that is monitored by the ECM to determine if the output is overloaded, shorted, or otherwise out of specification.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Engine On					
Fault Set Conditions (as defined in calibration):							
• AUX analog PU3 >				TBD*	volts		
Possible Causes: This fault indicates that both power supply feedback voltages are out-of-range as defined in the calibration. In configurations where the crank and/or camshaft position sensors are powered hall-effect sensors, the engine may stall due to loss of synchronization.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

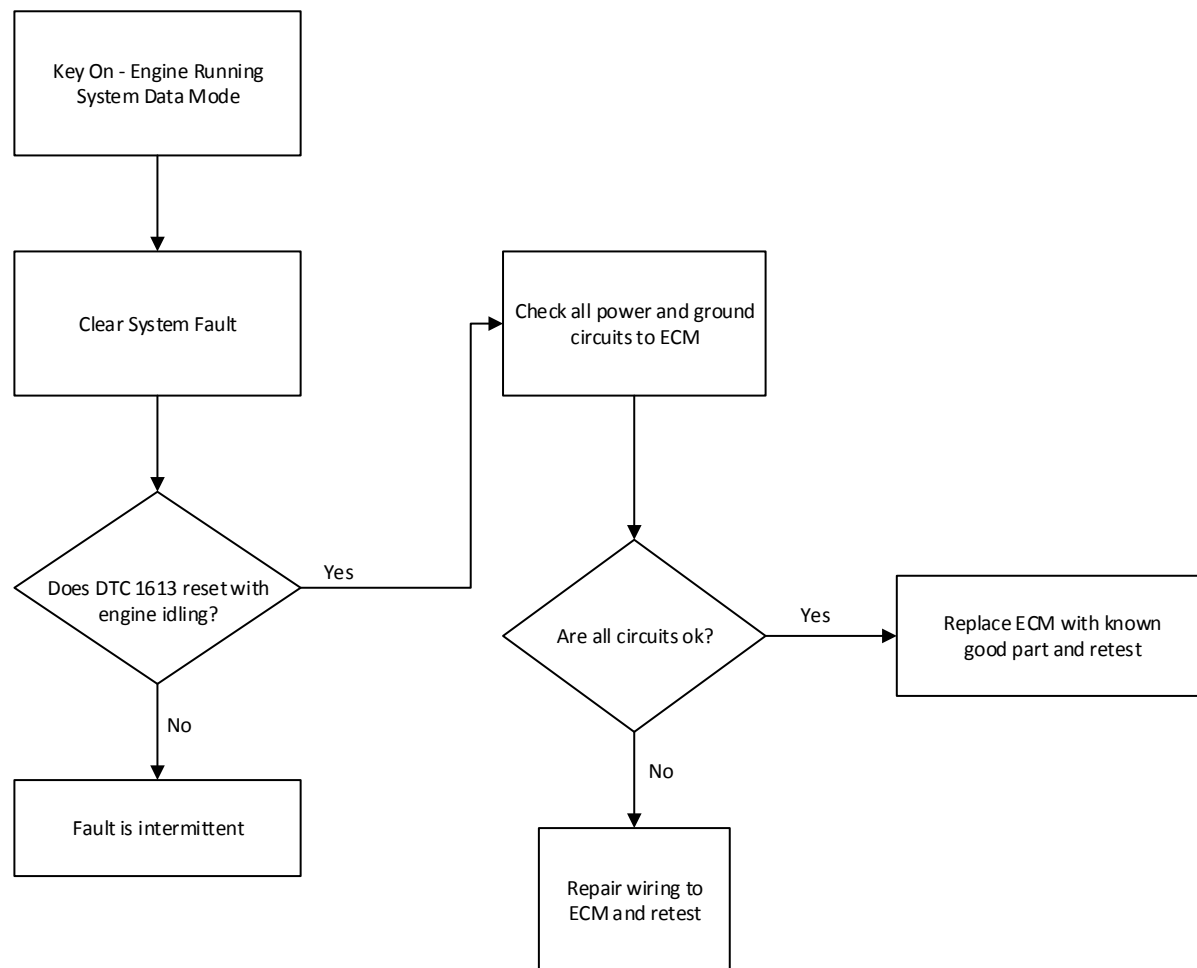
**DTC 1611 - SENSOR SUPPLY VOLTAGE (5VEXT 1/2) SIMULTANEOUS OUT-OF-RANGE
(TROUBLE TREE)**

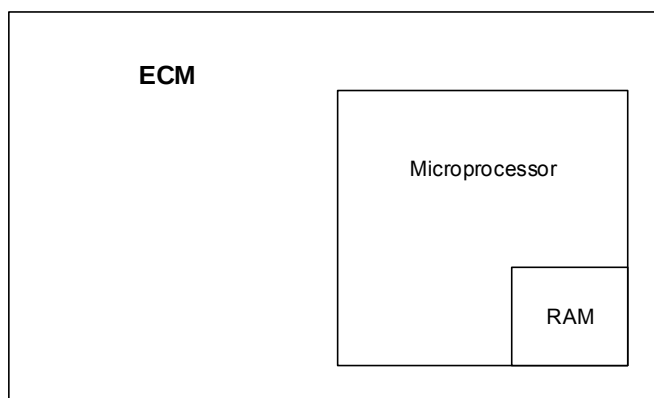
DTC 1612 - MICROPROCESSOR FAILURE - RTI 1

DTC	1612	SPN	629	FMI	31		
Sensor/Circuit: Engine Control Module							
Description: The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration):							
Internal microprocessor error							
Possible Causes: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*
Diagnostic Aids: Replace ECM with known good unit and retest.							

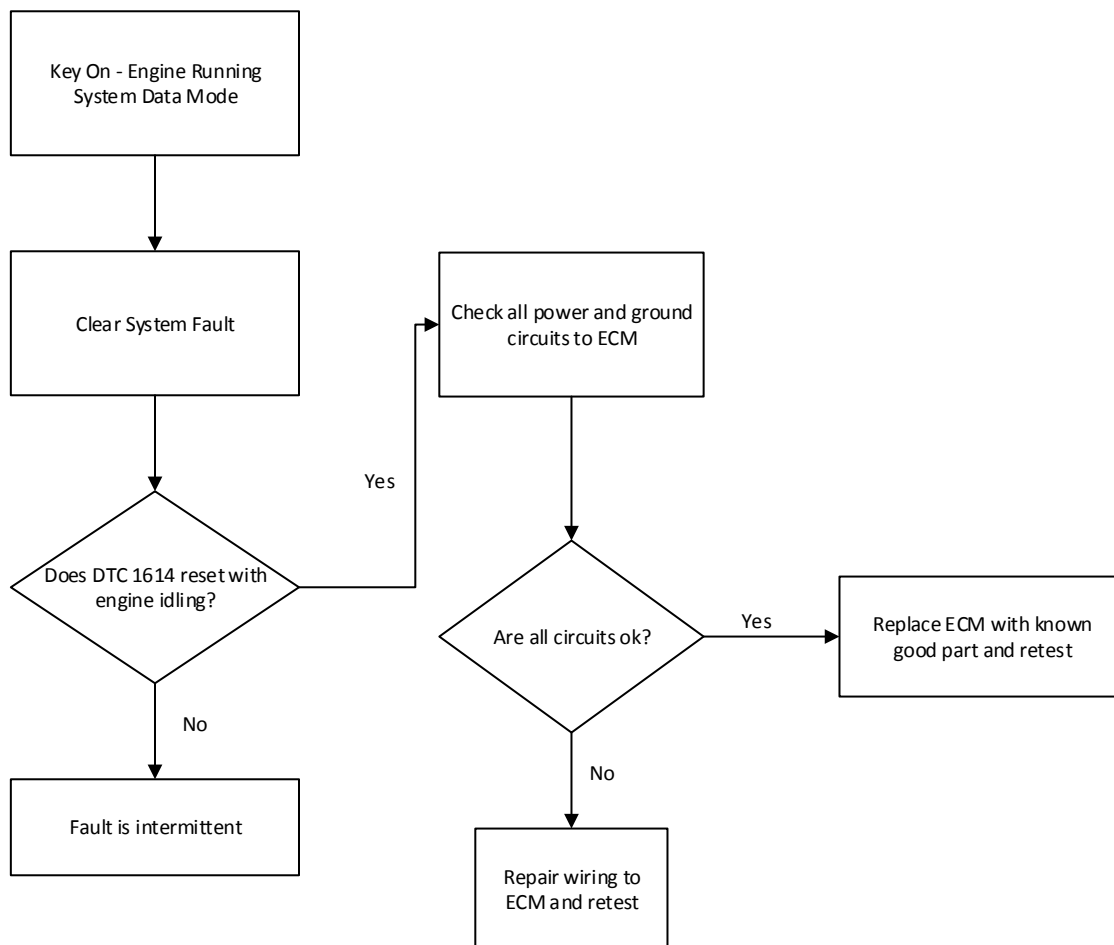
DTC 1613 - MICROPROCESSOR FAILURE - RTI 2

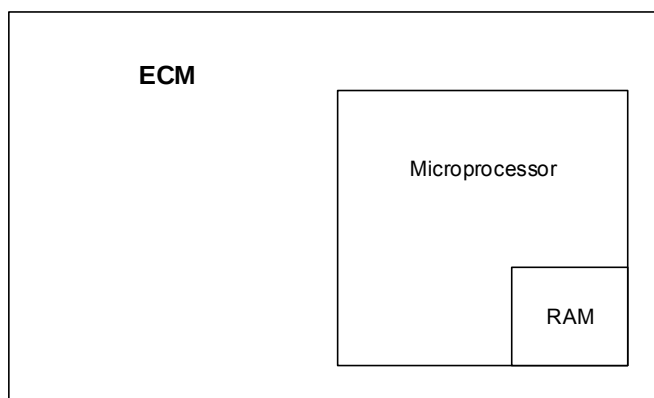
DTC	1613	SPN	629	FMI	31		
Sensor/Circuit: Engine Control Module							
Description: The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration):							
Internal microprocessor error							
Possible Causes: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1613 - MICROPROCESSOR FAILURE - RTI 2 (TROUBLE TREE)

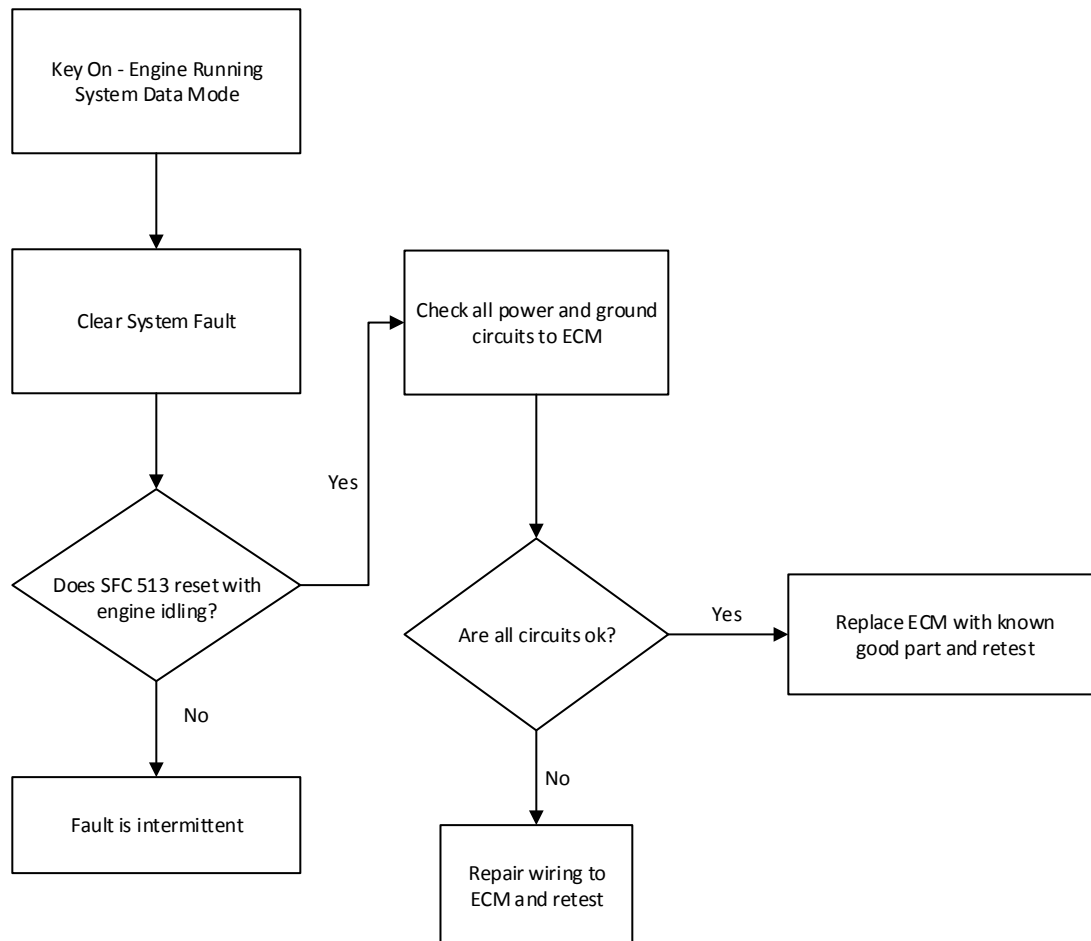
DTC 1614 - MICROPROCESSOR FAILURE - RTI 3

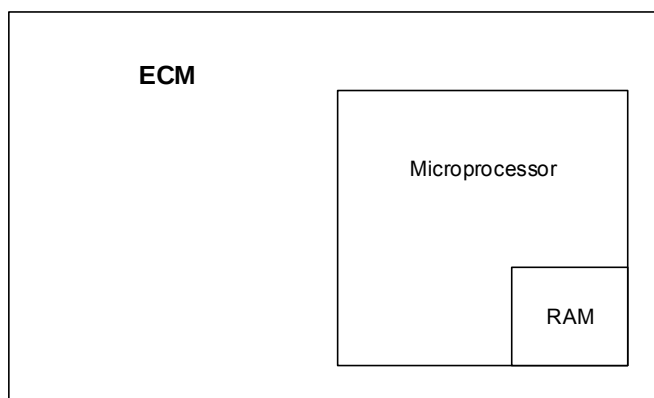
DTC	1614	SPN	629	FMI	31		
Sensor/Circuit: Engine Control Module							
Description: The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration): Internal microprocessor error							
Possible Causes: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1614 - MICROPROCESSOR FAILURE - RTI 3 (TROUBLE TREE)

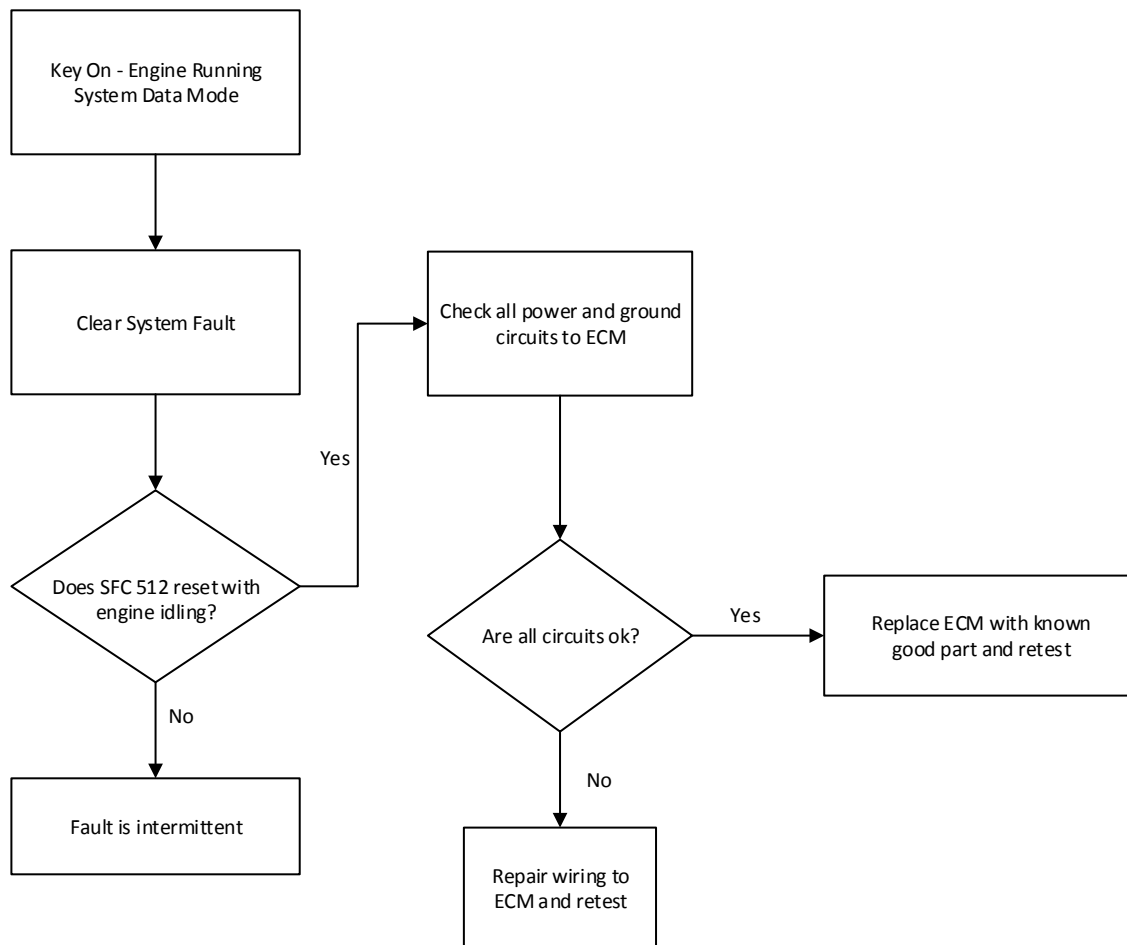
DTC 1615- MICROPROCESSOR FAILURE - A/D

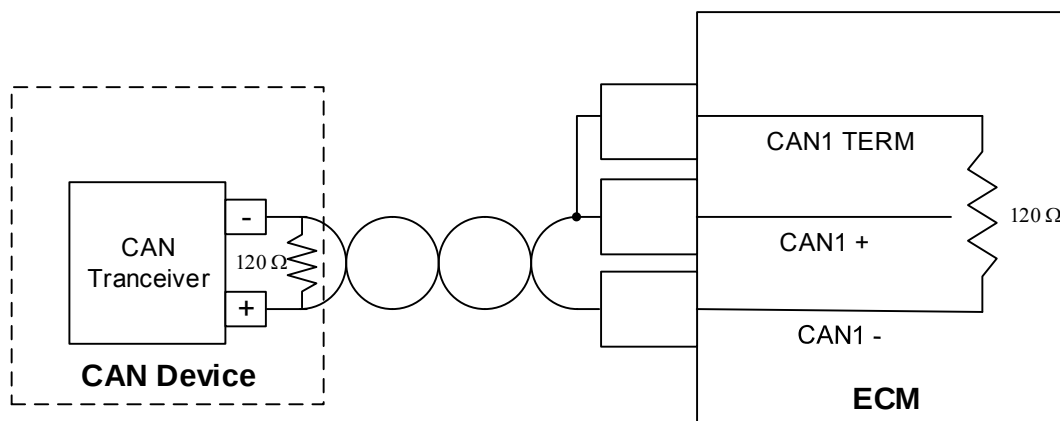
DTC	1615	SPN	629	FMI	31		
Sensor/Circuit: Engine Control Module							
Description: The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration): Internal microprocessor error							
Possible Causes: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1615 - MICROPROCESSOR FAILURE – A/D (TROUBLE TREE)

DTC 1616 – MICROPROCESSOR FAILURE – INTERRUPT

DTC	1616	SPN	629	FMI	31		
Sensor/Circuit: Engine Control Module							
Description: The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration): Internal microprocessor error							
Possible Causes: The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

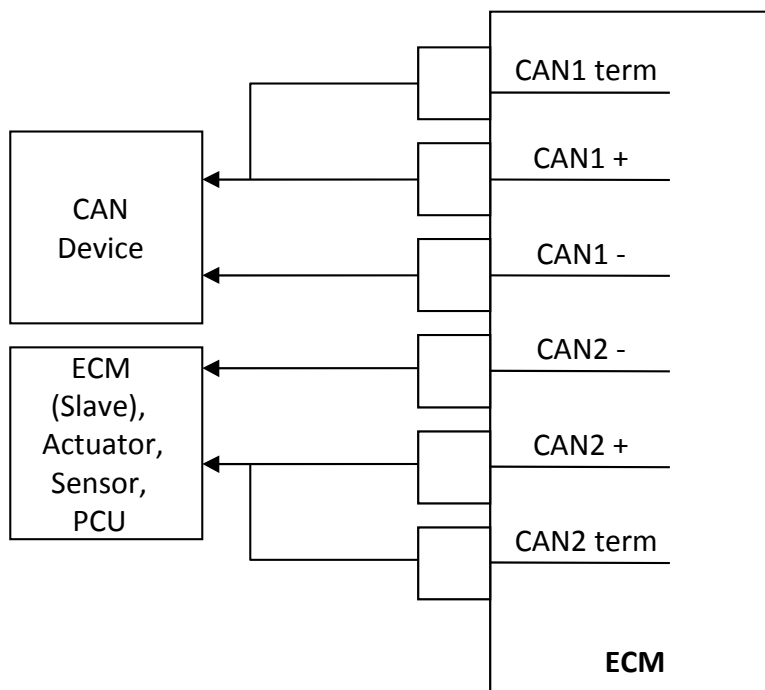
DTC 1616 - MICROPROCESSOR FAILURE – INTERRUPT (TROUBLE TREE)

DTC 1626 – CAN1 J1939 TRANSMIT (TX) FAULT

DTC	1626	SPN	639	FMI	12		
Sensor/Circuit: Controller Area Network							
Description: The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators (EPR), smart sensors (Envirotech), dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES (If EPR-Equipped)					
Check Condition:		Key On, Engine Off and/or Running					
Fault Set Conditions (as defined in calibration):							
• Tx error counter >				TBD*	failures		
Possible Causes: This fault will set if CAN communication is enabled and the ECM transceiver broadcasts a number of packets (as defined in the diagnostic calibration, must be set to less than 125 failures) to the network that are not received.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1626 – CAN1 J1939 TRANSMIT (TX) FAULT (Diagnostic Aides):

- ☐ Verify that all CAN devices are powered and are properly grounded
- ☐ Verify that the CAN1 network is properly terminated
- ☐ Check CAN1 wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- ☐ Check CAN1 (+) and (-) wires for short circuits

DTC 1628 - CAN1 ADDRESS CONFLICT FAILURE

DTC	1626	SPN	639	FMI	12
Sensor/Circuit: CAN Device(s)					
Description: The controller area network serves as a communication portal between intelligent devices. These devices may be but are not limited to other engine ECMs (slave), diagnostic tools, “smart” gauges, “smart” sensors, powertrain control units, vehicle controllers, actuators, etc. The network permits several devices to communicate with each other receiving and broadcasting commands as programmed. This type of network allows devices to be added to an entire system through only two conductors and permits all other devices to broadcast and receive commands to and from the device when properly commanded. CAN1 is used for general network communication including gauge display, scan tool communication, and other general 3rd party traffic. CAN2 is reserved solely for engine control (engine synchronization, throttle control, vehicle controller commands, etc.) and is limited to EControls Inc. approved devices only.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine on			
Fault Set Conditions (as defined in calibration):					
• Address conflict counter >				TBD*	failures

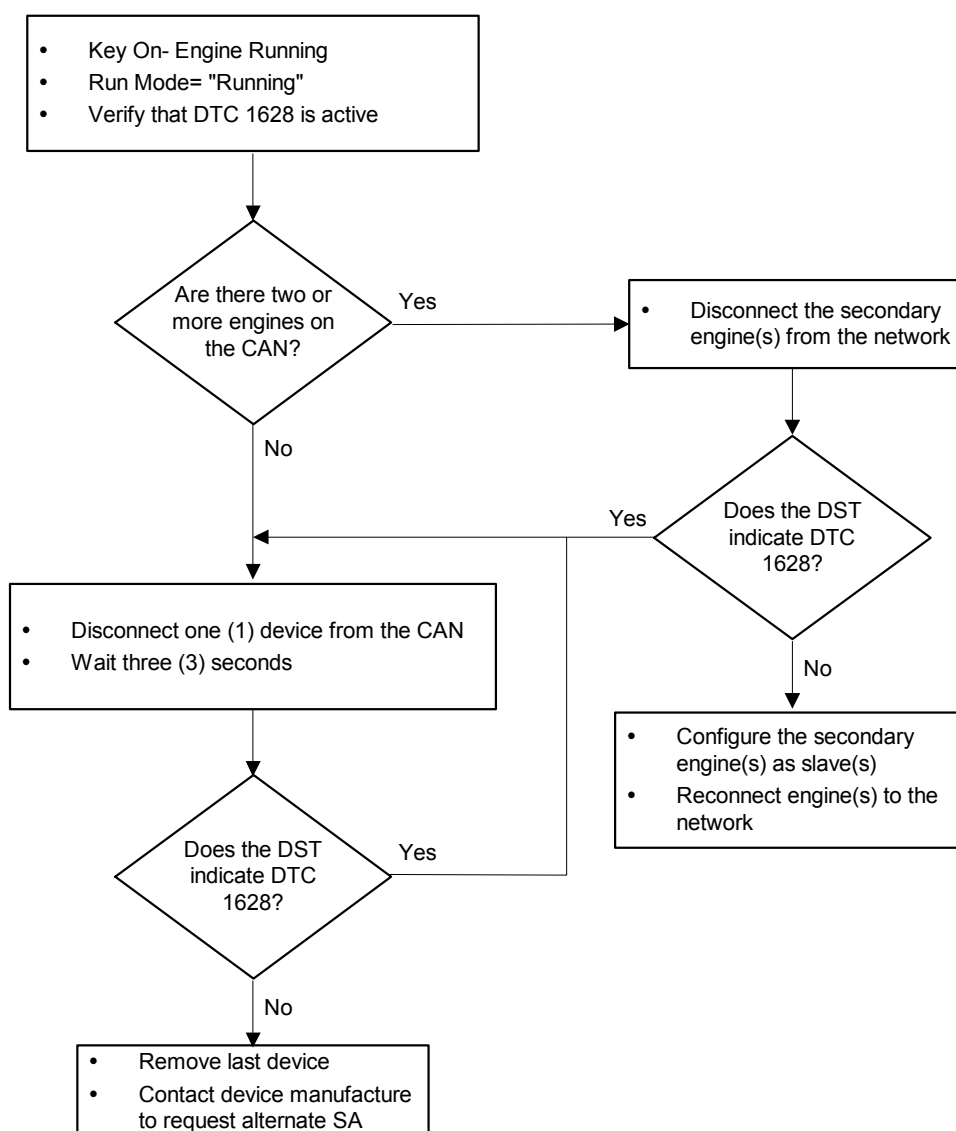
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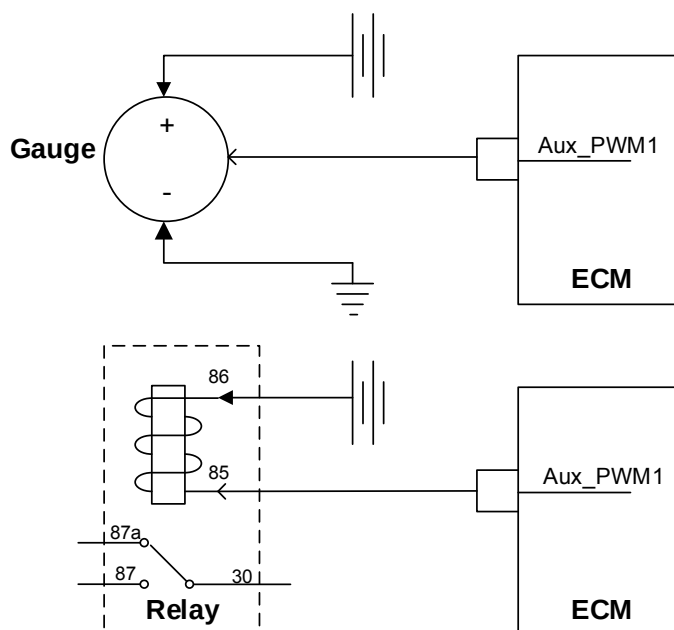
Possible Causes:

This fault indicates that there are two (2) or more devices on the network that use the same source address.

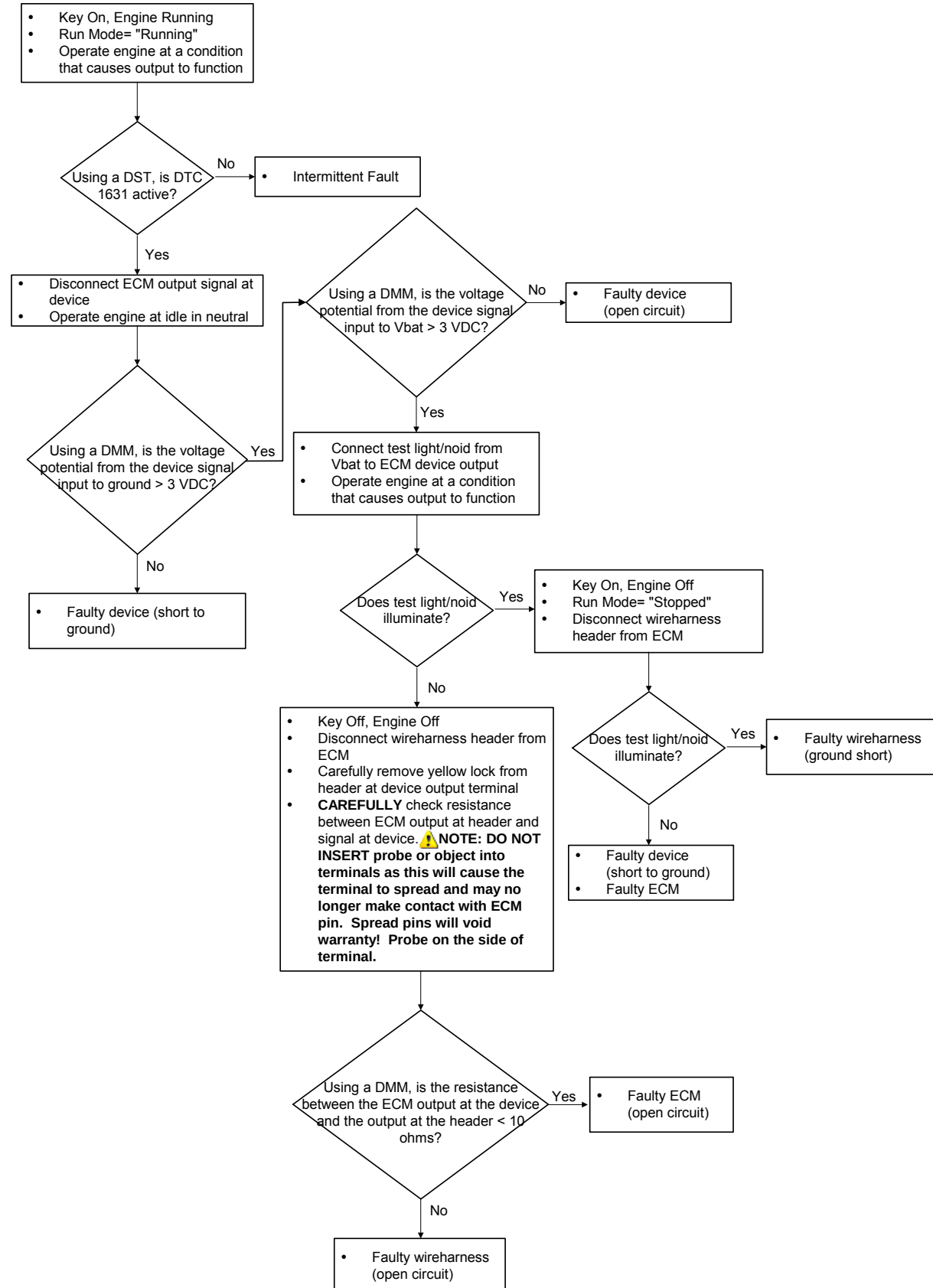
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1628 - CAN1 ADDRESS CONFLICT FAILURE (TROUBLE TREE)

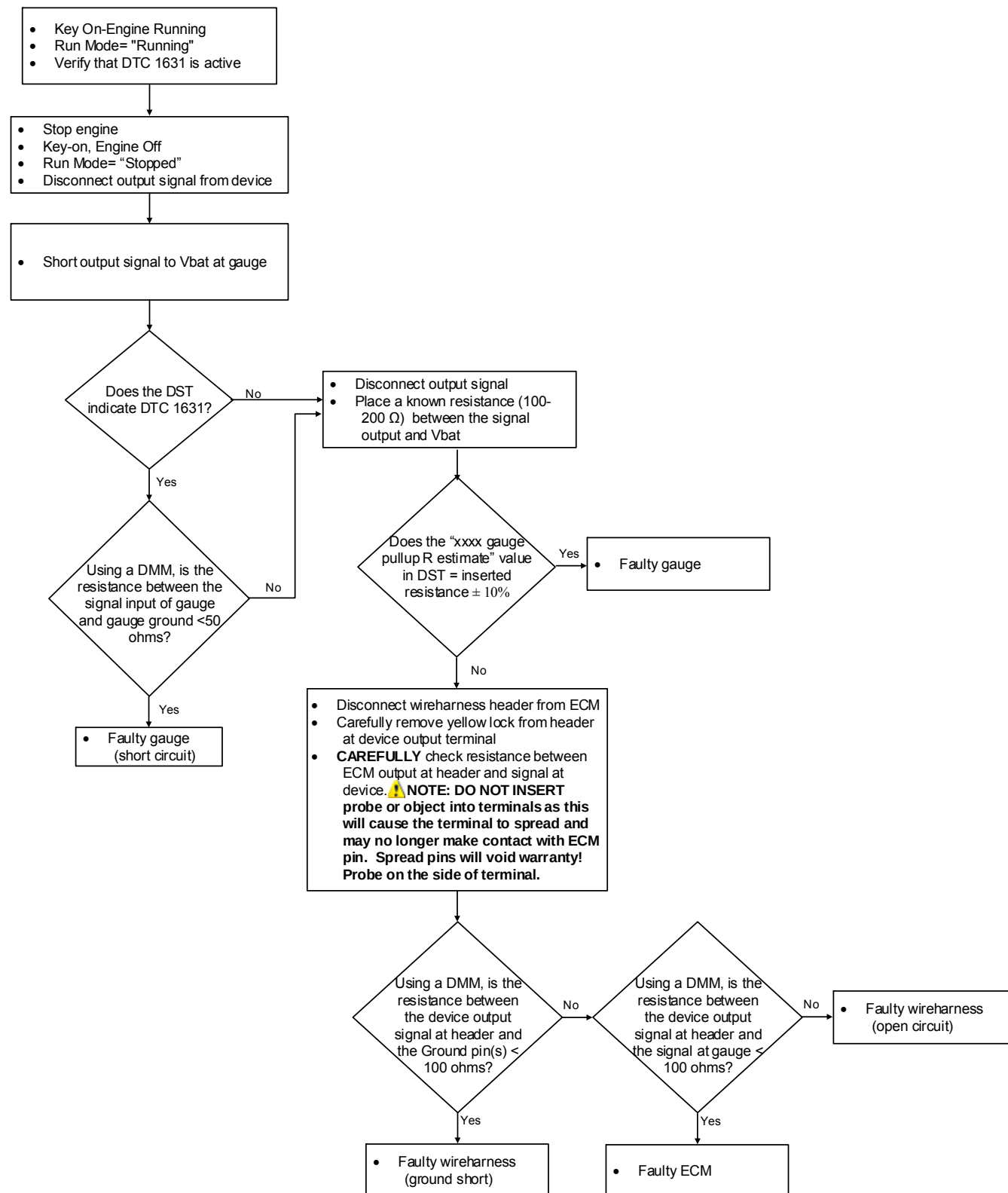
DTC 1631 - PWM1 OPEN / GROUND SHORT

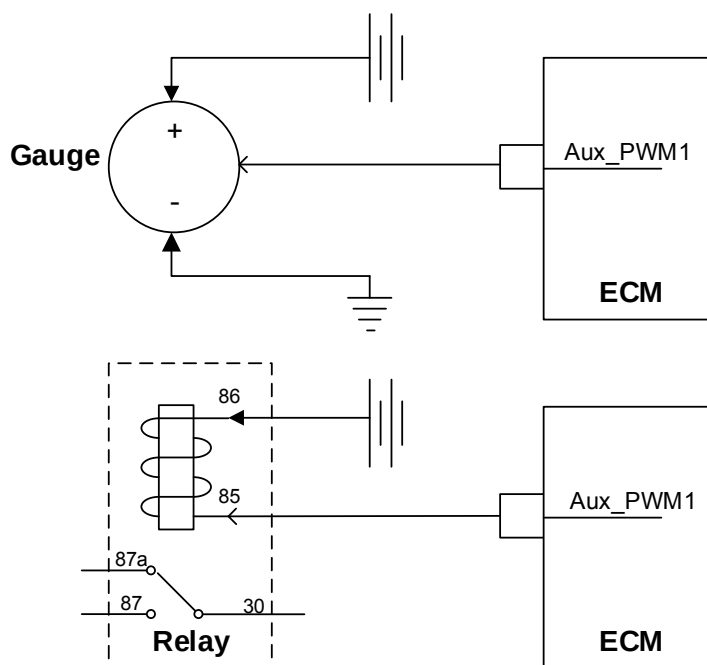
DTC	1631	SPN	697	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM1 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 1 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM1 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1631 - PWM1 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1631 - PWM1 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1632 - PWM1 SHORT TO POWER

DTC	1632	SPN	697	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM1 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 1 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 1 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

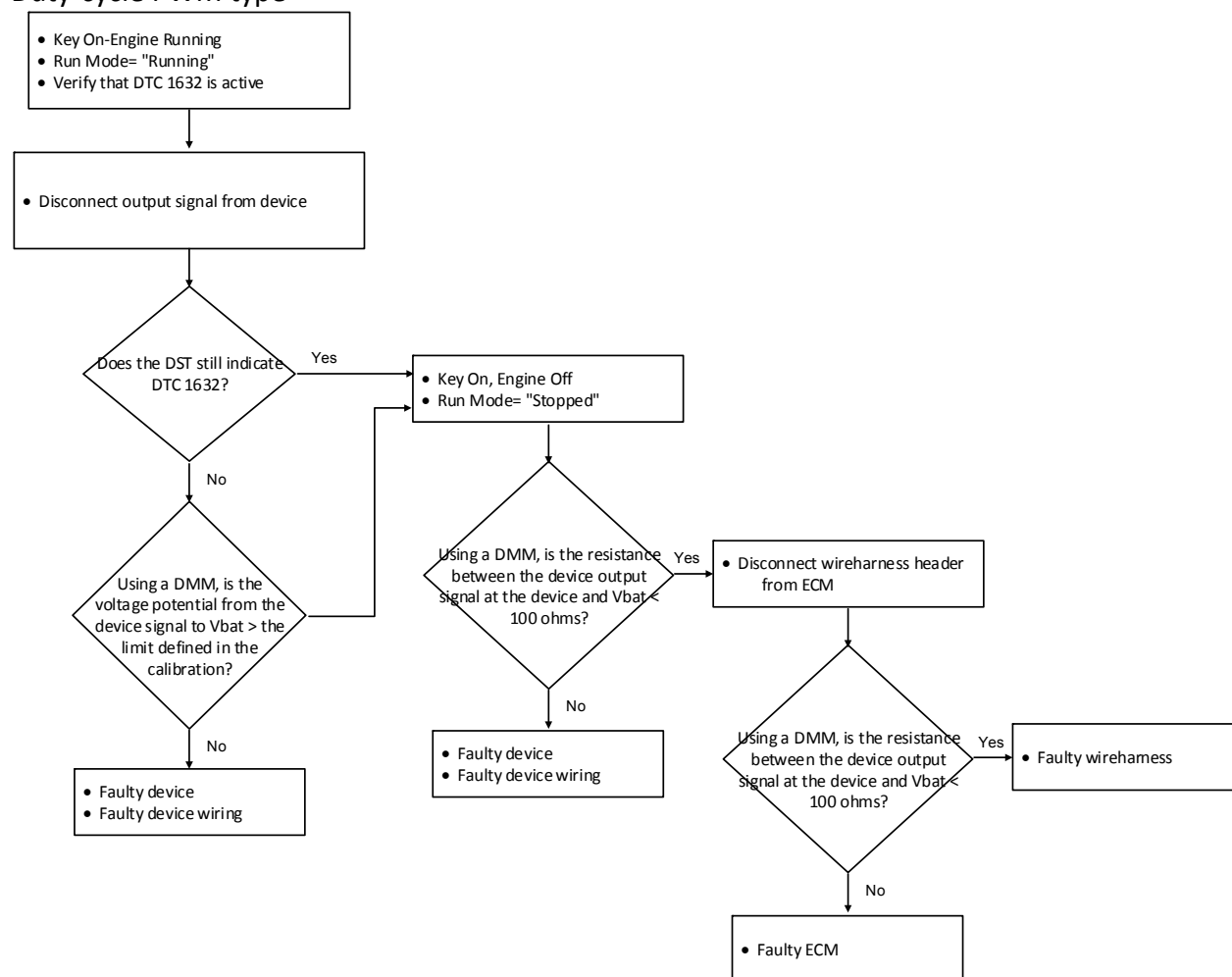
AUX PWM1 output shorted to power

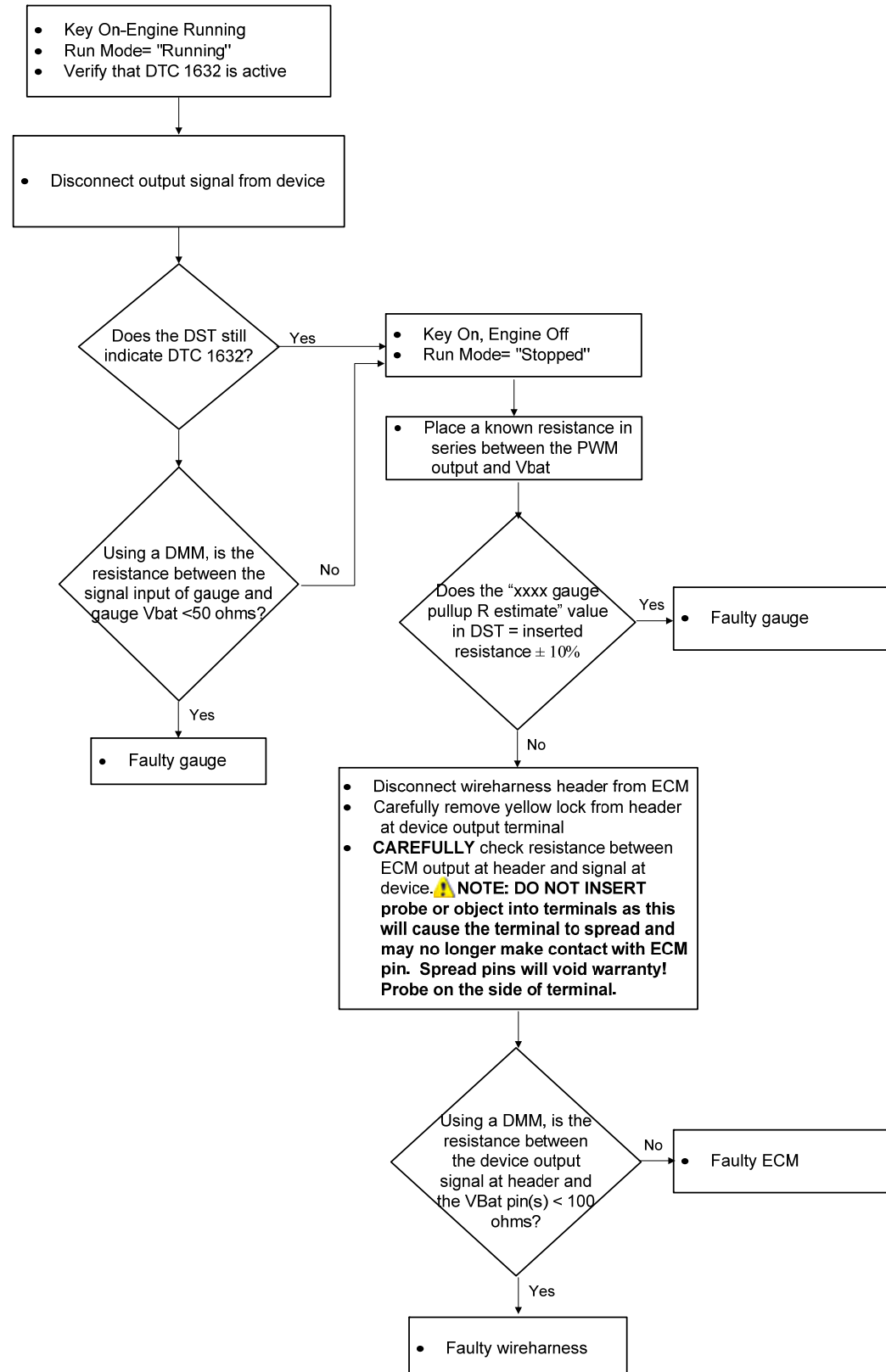
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

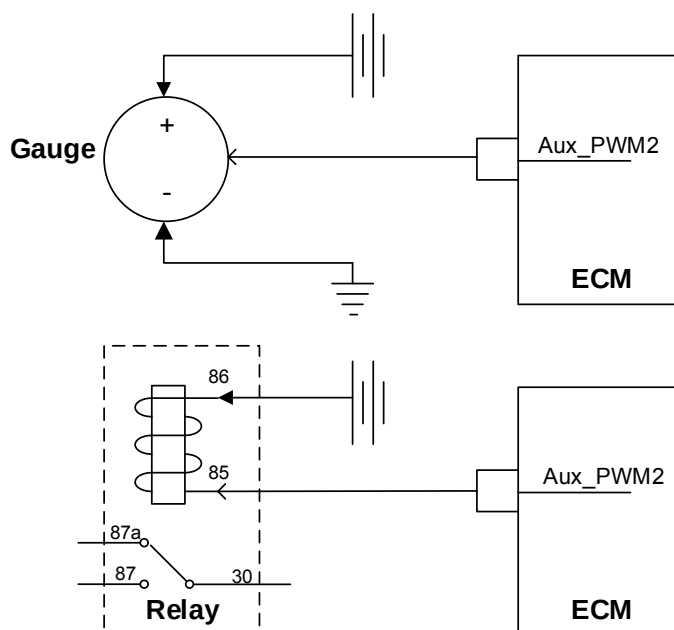
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1632 – PWM1 SHORT TO POWER (TROUBLE TREE)

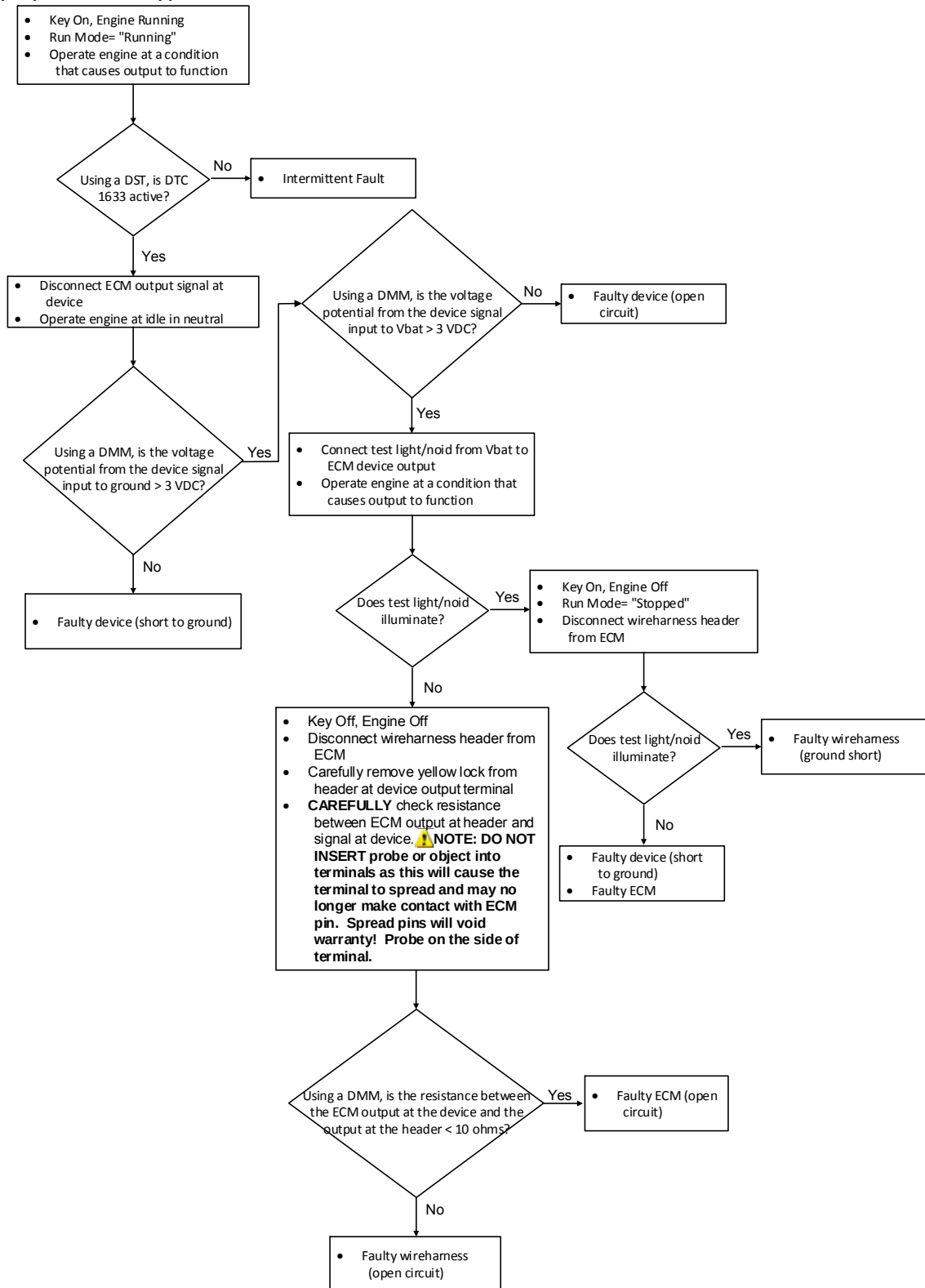
Duty-cycle PWM type



DTC 1632 – PWM1 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

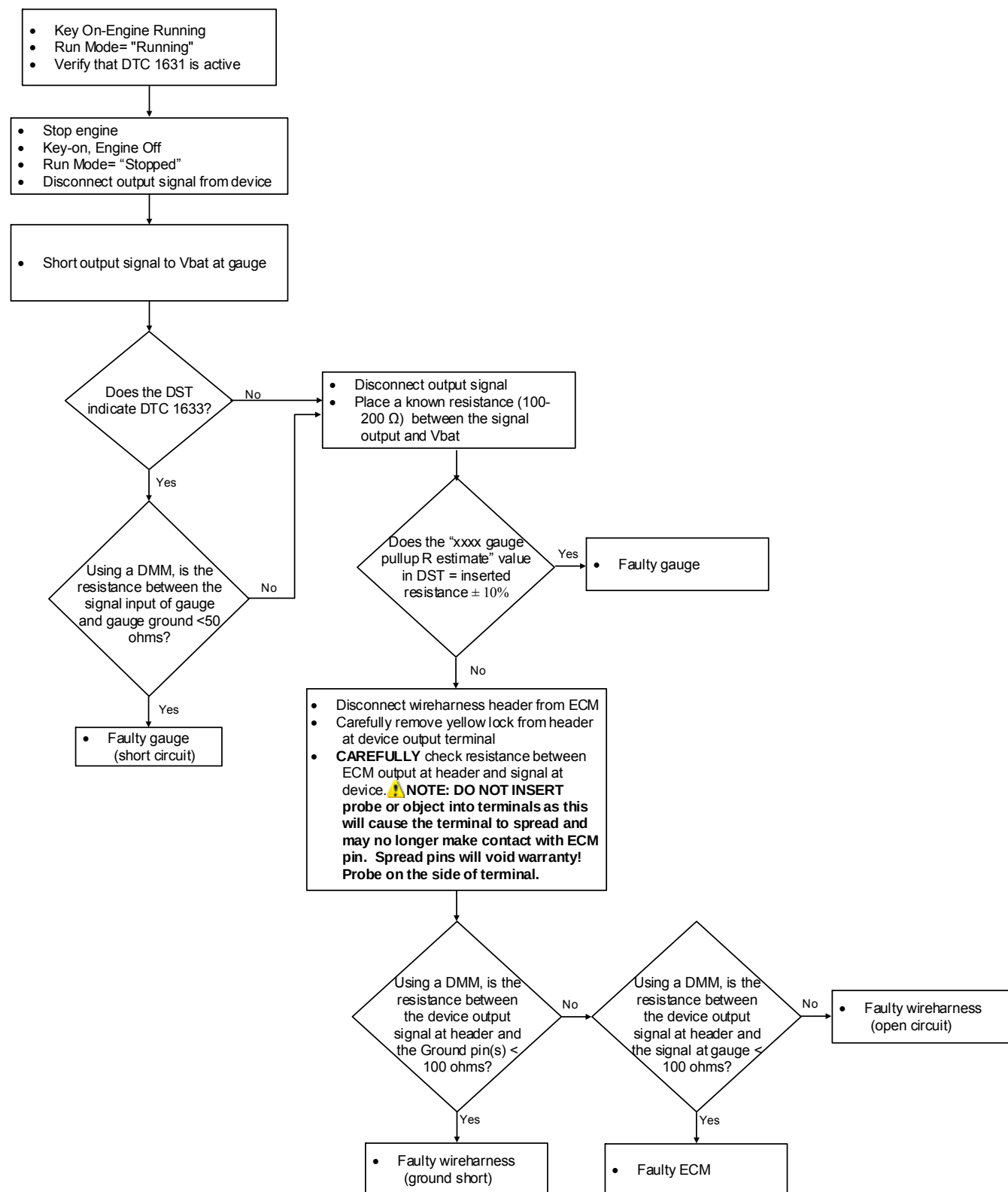
DTC 1633 - PWM2 OPEN / GROUND SHORT

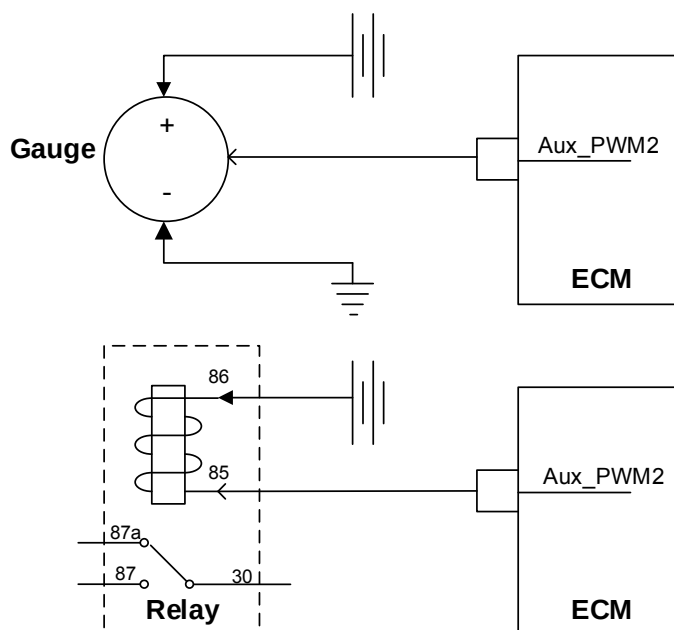
DTC	1633	SPN	698	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM2 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 2 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM2 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1633 – PWM2 OPEN / GROUND SHORT (TROUBLE TREE)**Duty Cycle PWM Type**

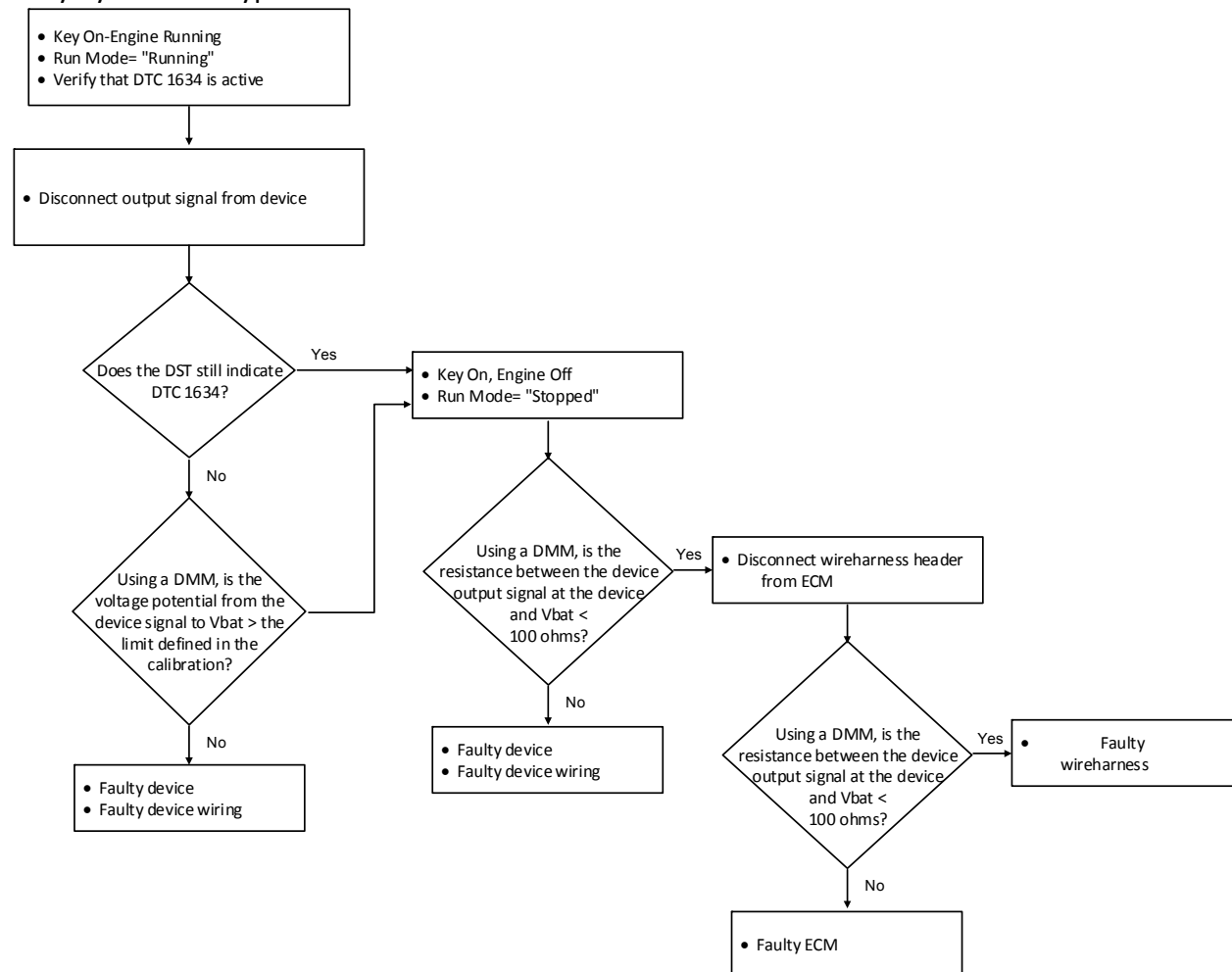
DTC 1633 – PWM2 OPEN / GROUND SHORT (TROUBLE TREE)

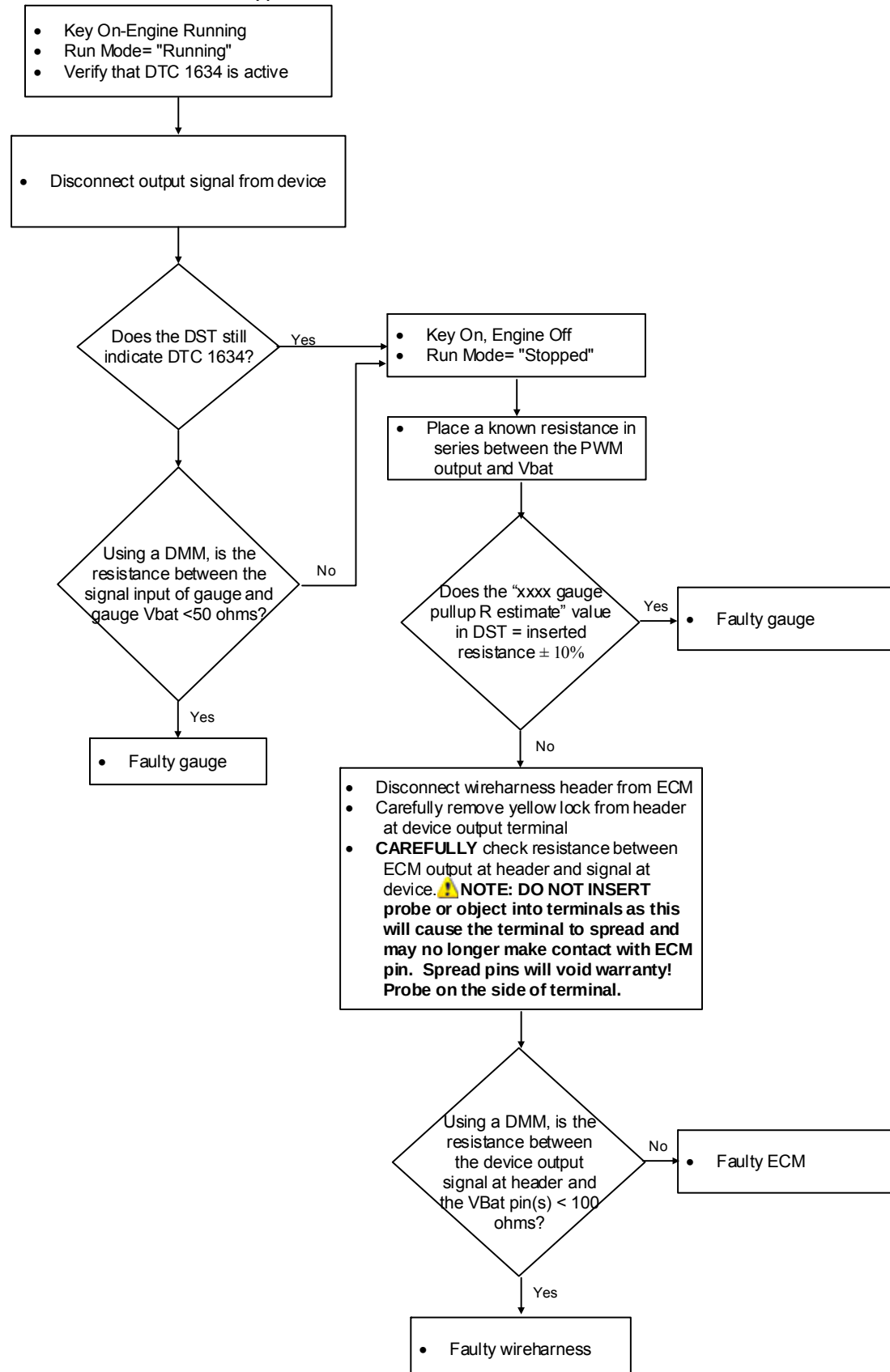
Resistance Simulation type

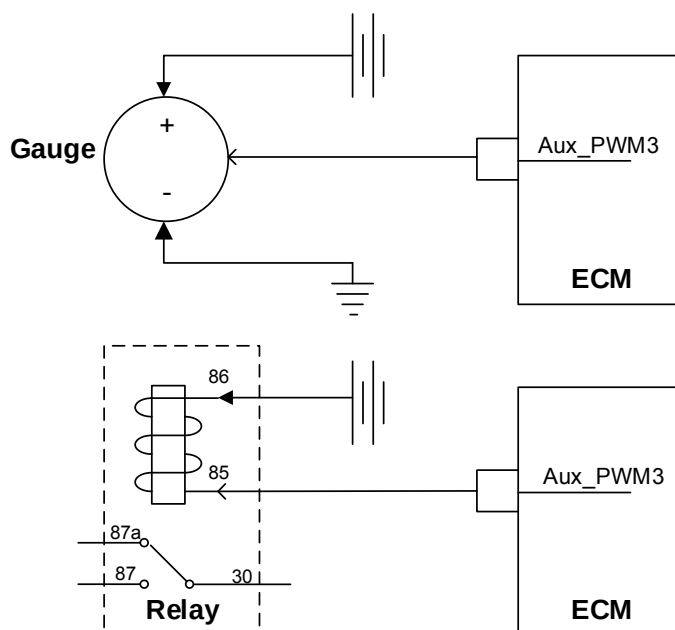


DTC 1634 – PWM2 SHORT TO POWER

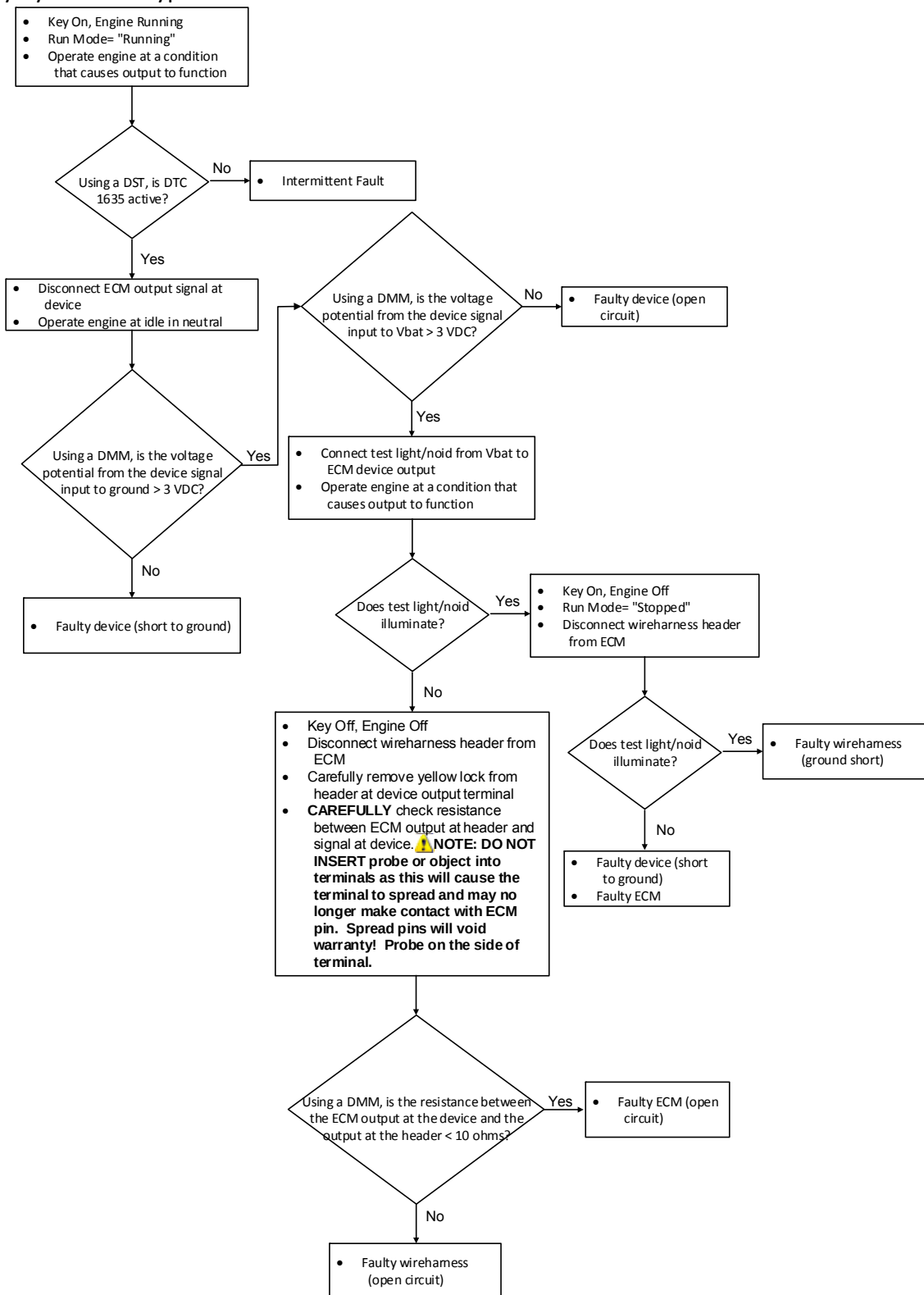
DTC	1634	SPN	698	FMI	3		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM2 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 1 low-side feedback >				TBD*	% Vbat		
• and PWM duty-cycle >				TBD*	%		
Possible Causes: AUX PWM2 output shorted to power							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1634 – PWM2 SHORT TO POWER (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1634 – PWM2 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

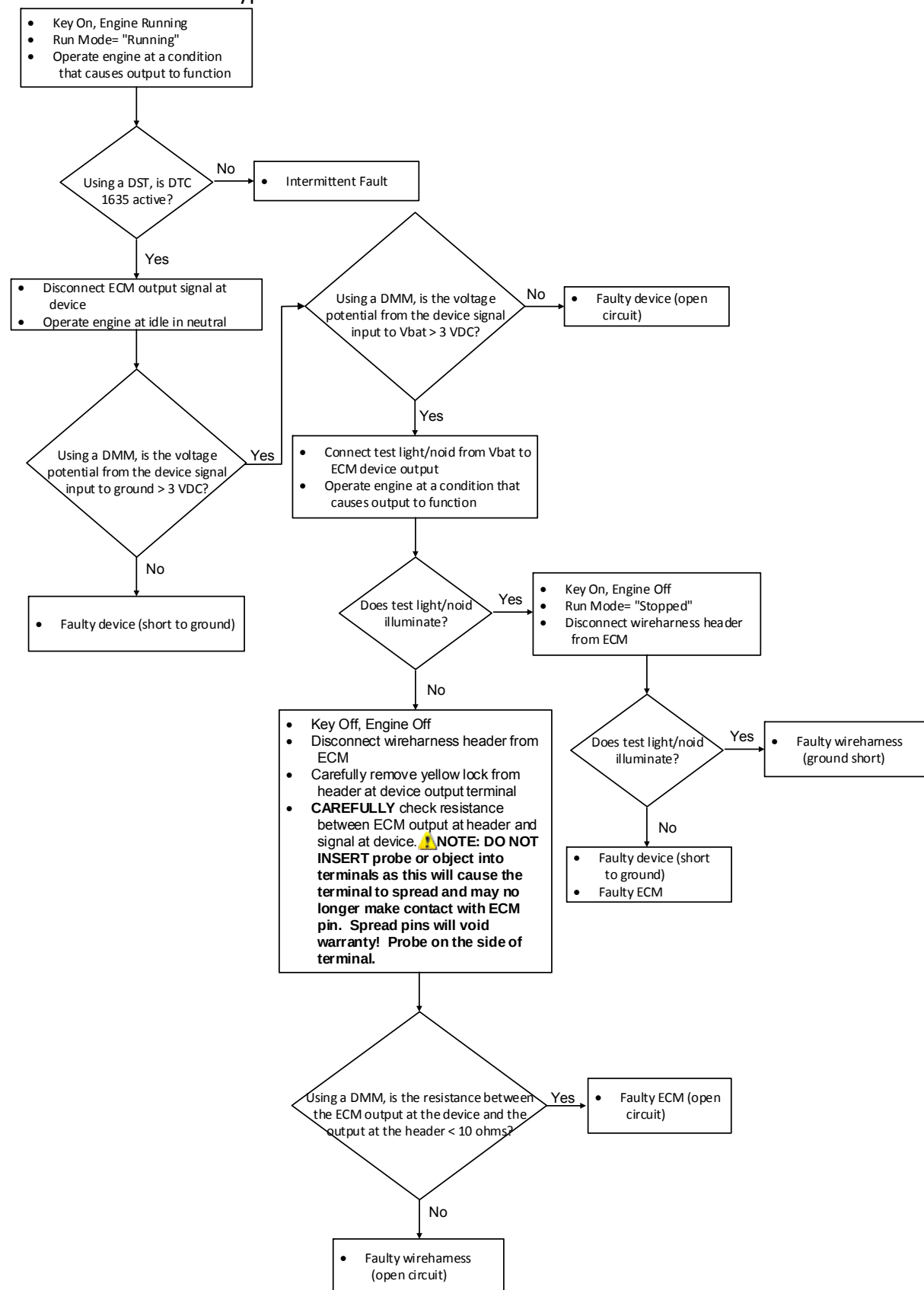
DTC 1635 – PWM3 OPEN / GROUND SHORT

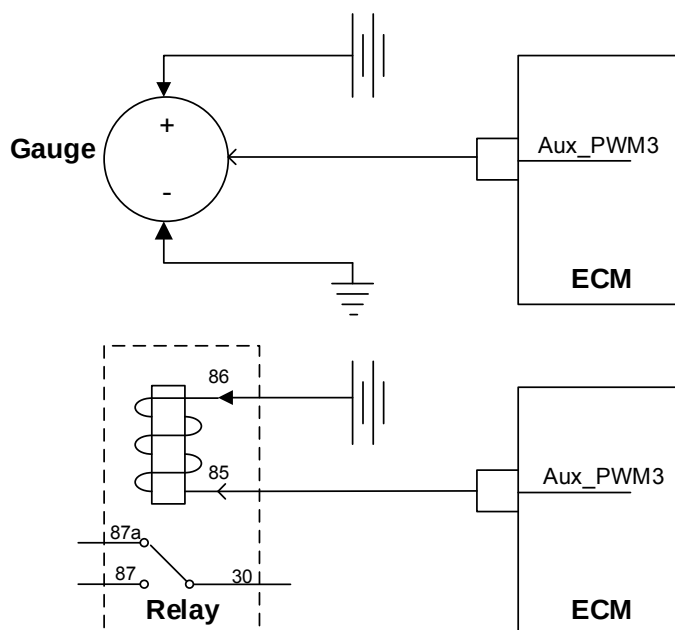
DTC	1635	SPN	699	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM3 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 3 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM3 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1635 – PWM3 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1635 – PWM3 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type

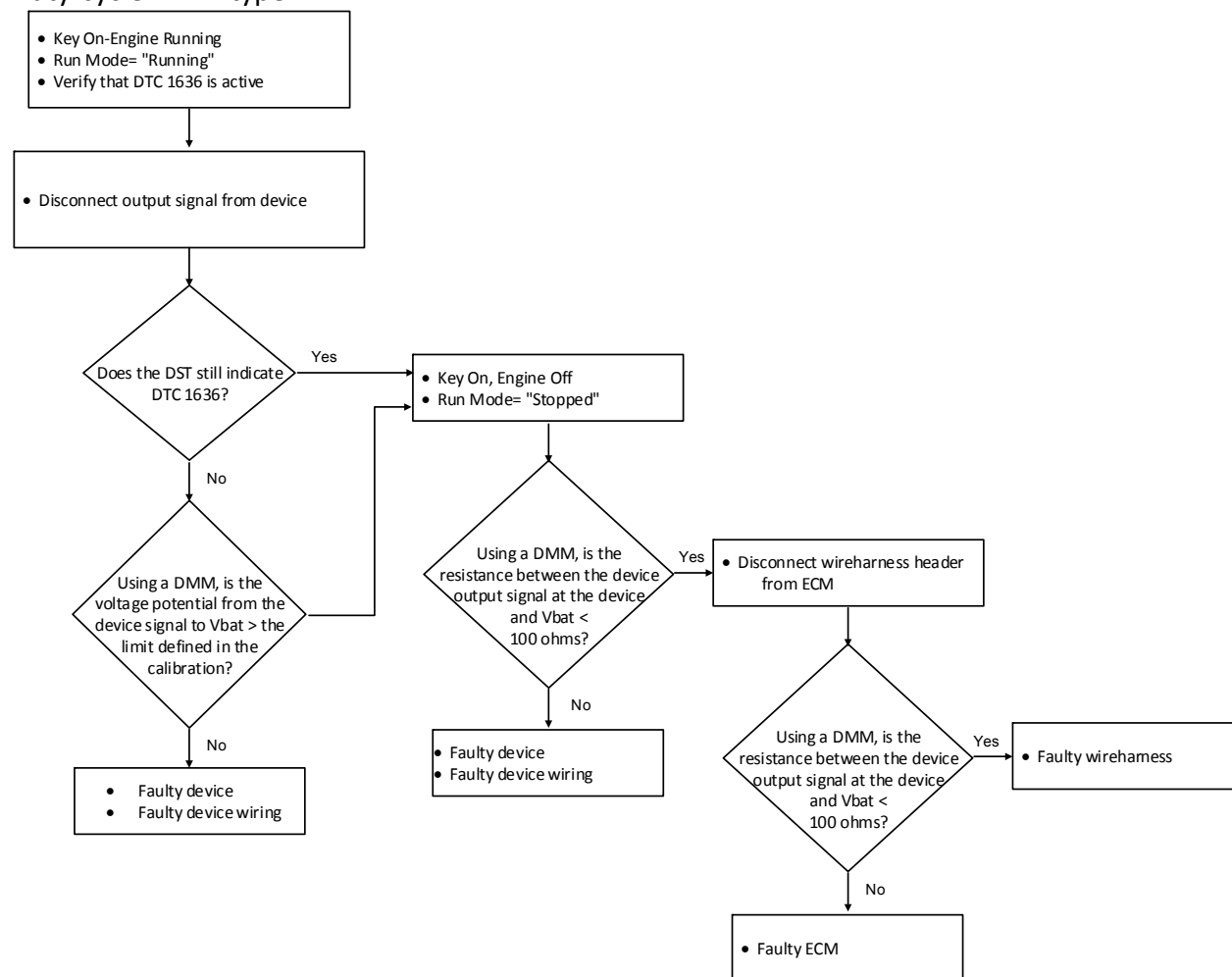


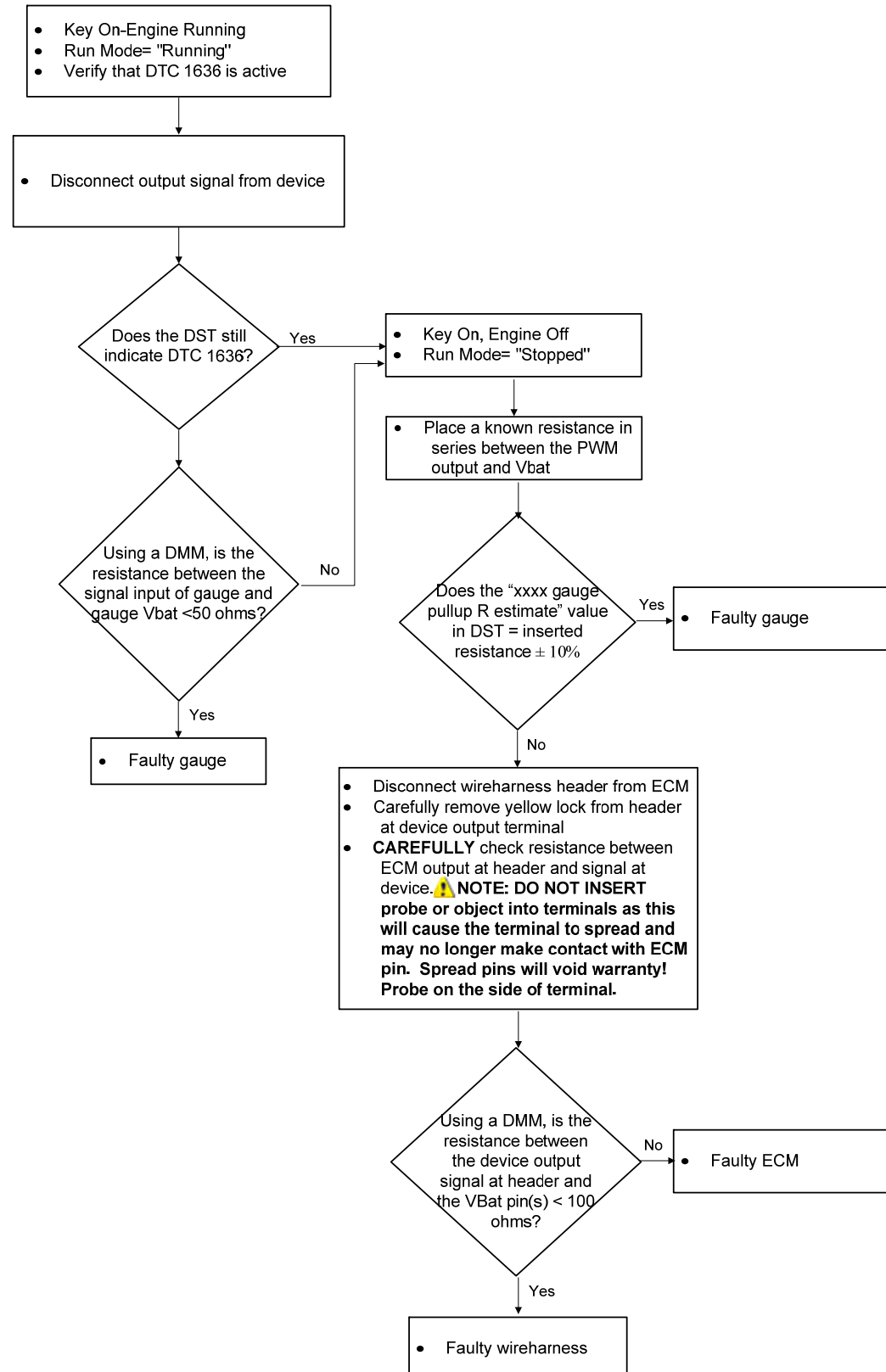
DTC 1636 - PWM3 SHORT TO POWER

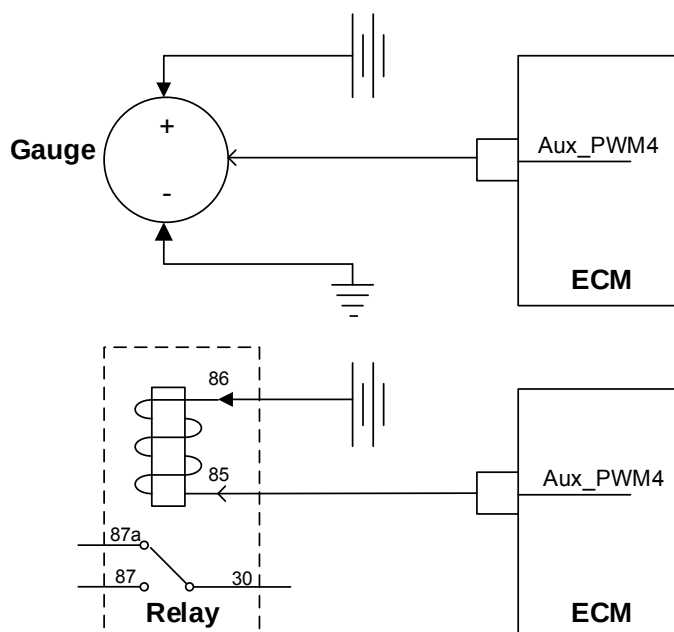
DTC	1636	SPN	699	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM3 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 3 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 3 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	
Possible Causes: AUX PWM3 output shorted to power					

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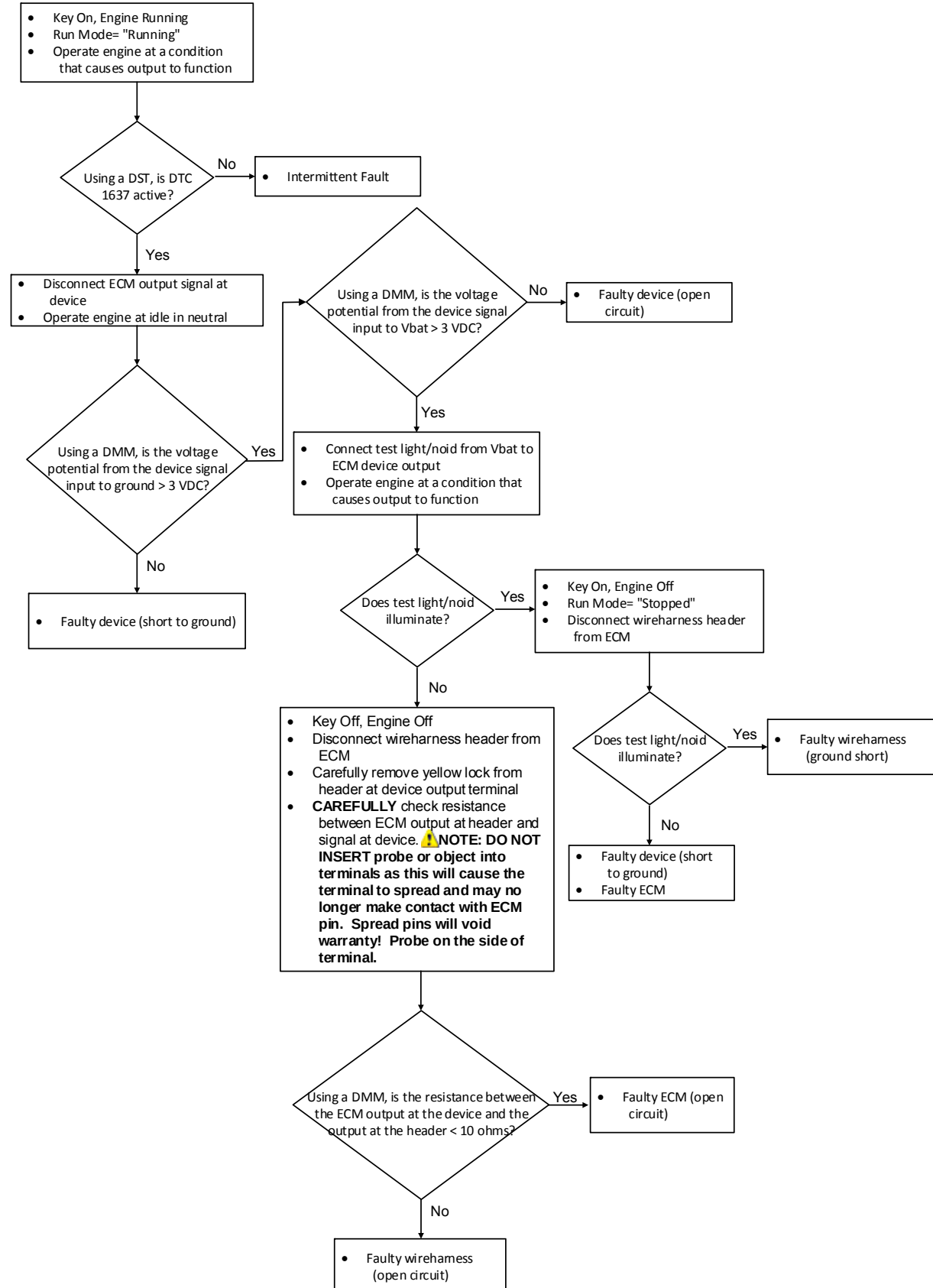
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1636 – PWM3 SHORT TO POWER (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1636 – PWM3 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation Type**

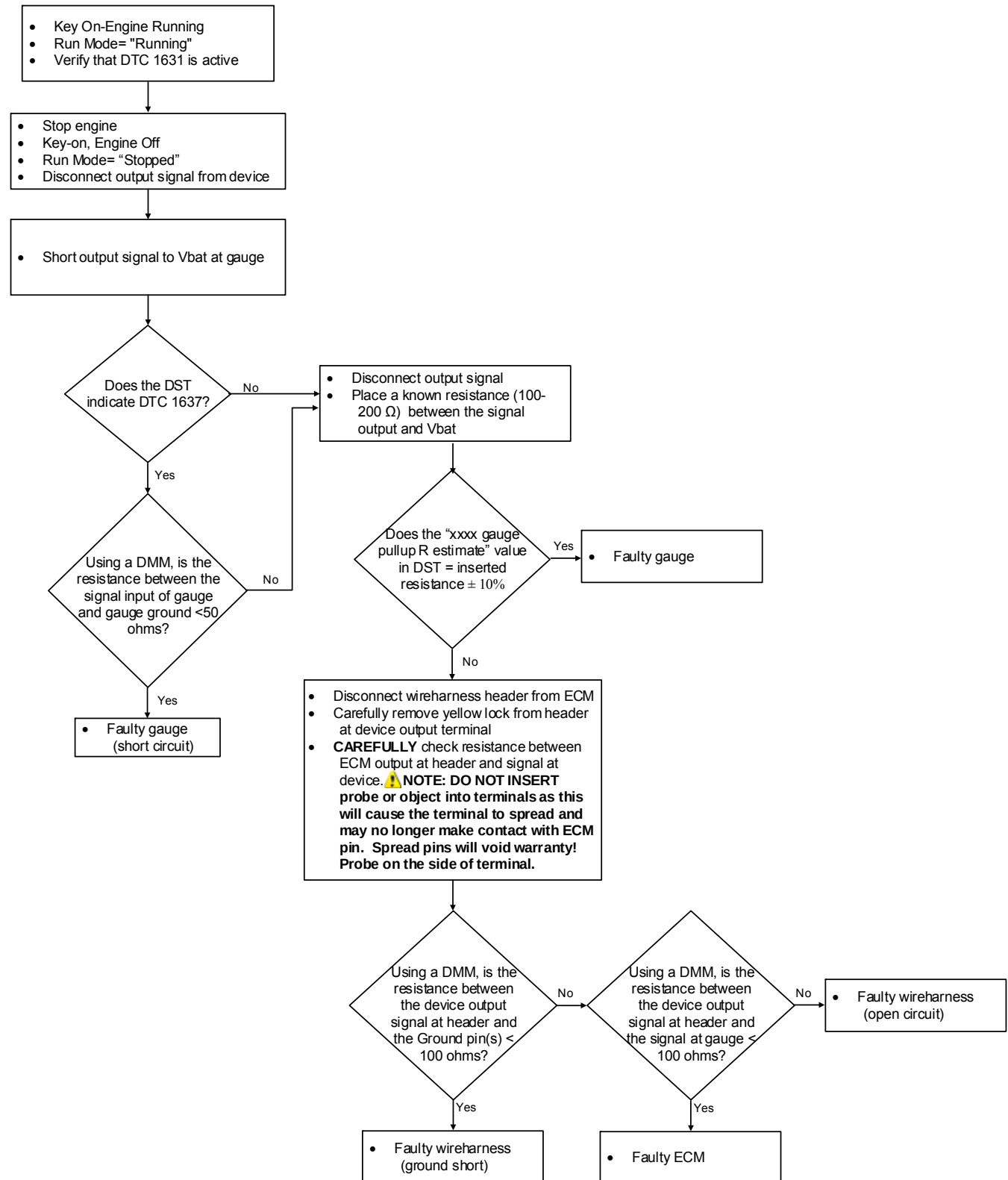
DTC 1637 - PWM4 OPEN / GROUND SHORT

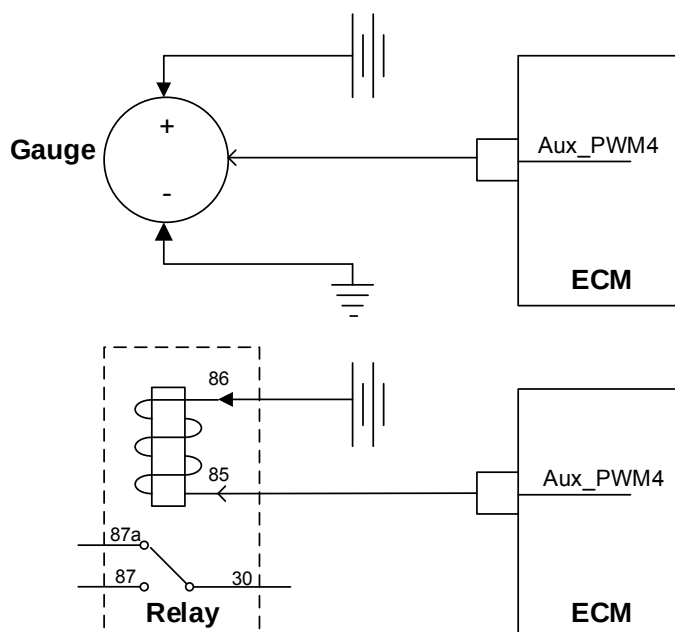
DTC	1637	SPN	700	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM4 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 4 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM4 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1637 – PWM4 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

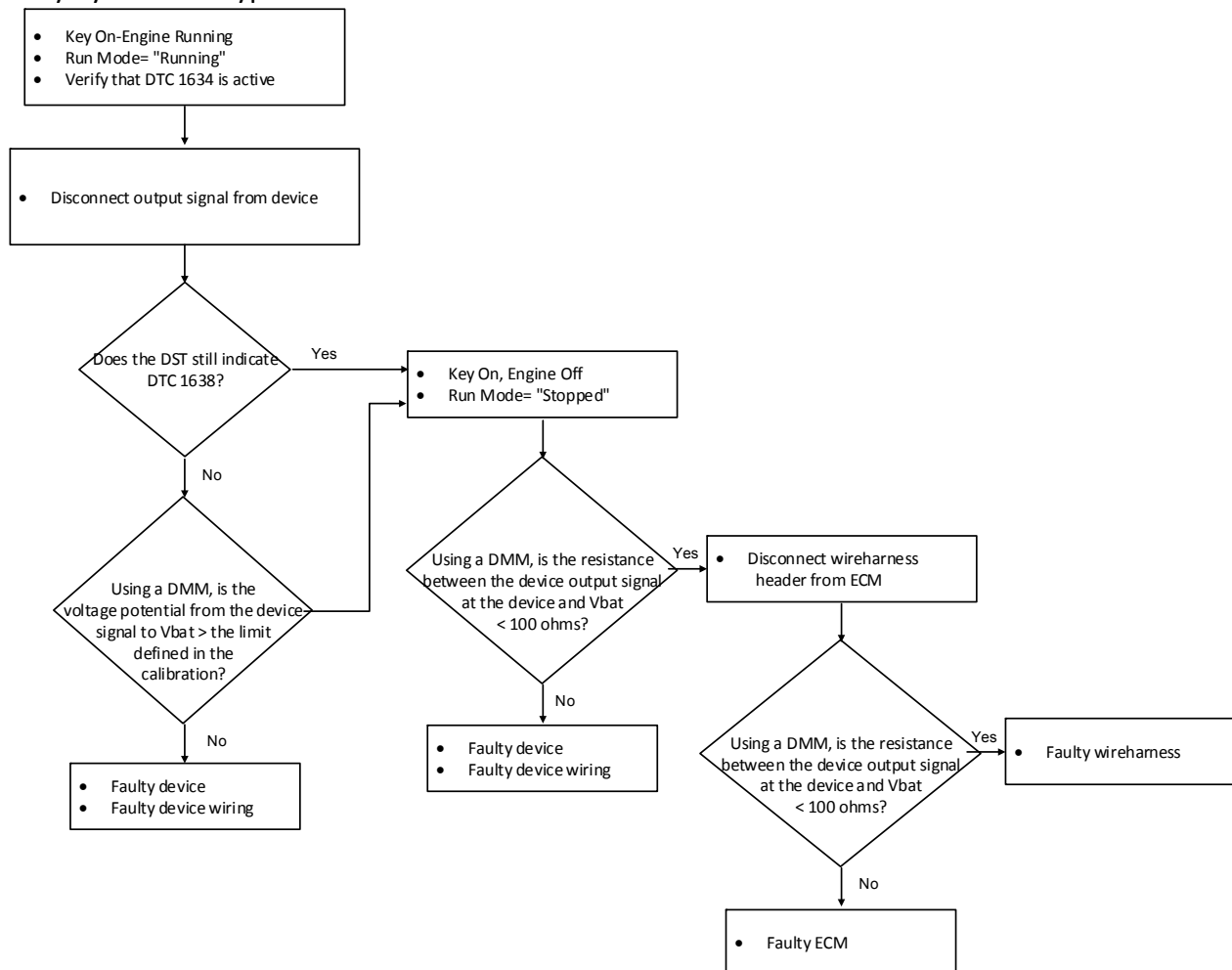
DTC 1637 – PWM4 OPEN / GROUND SHORT (TROUBLE TREE)

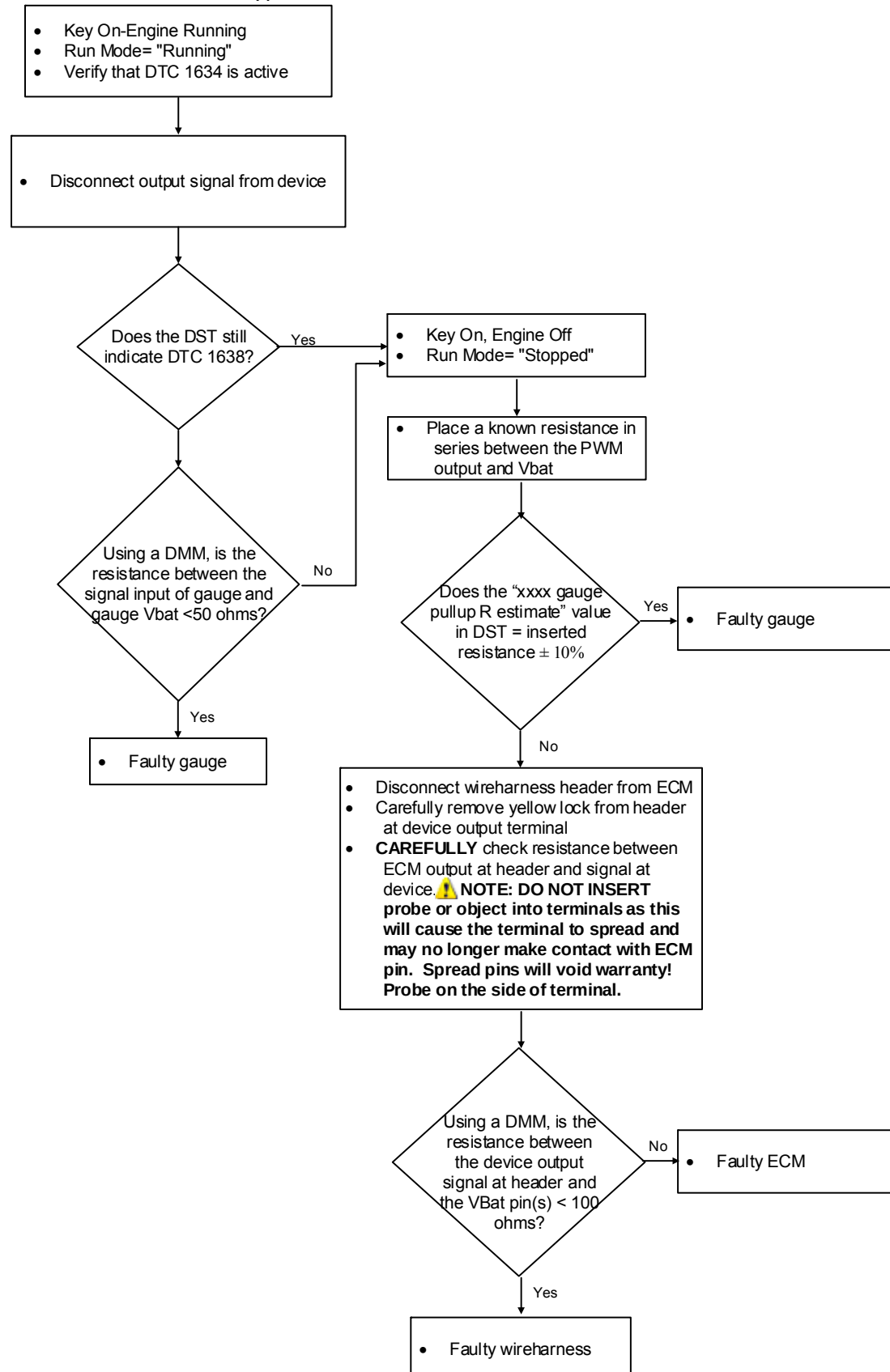
Resistance Simulation type

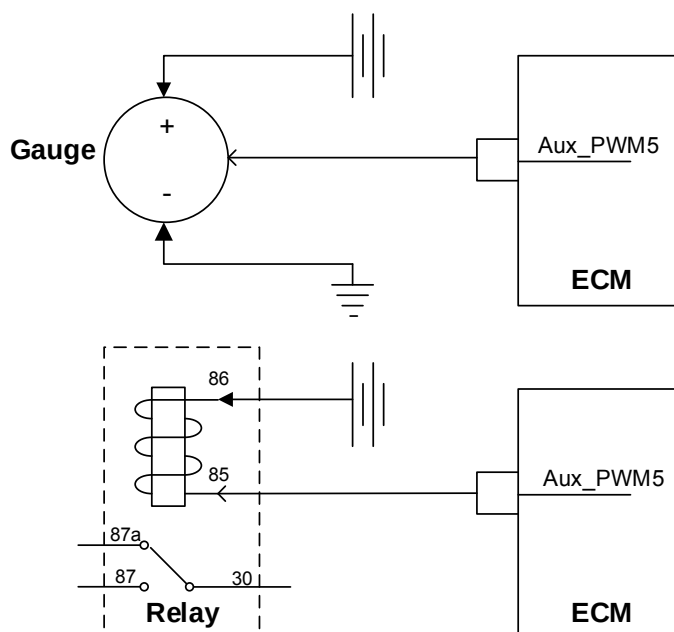


DTC 1638 - PWM4 SHORT TO POWER

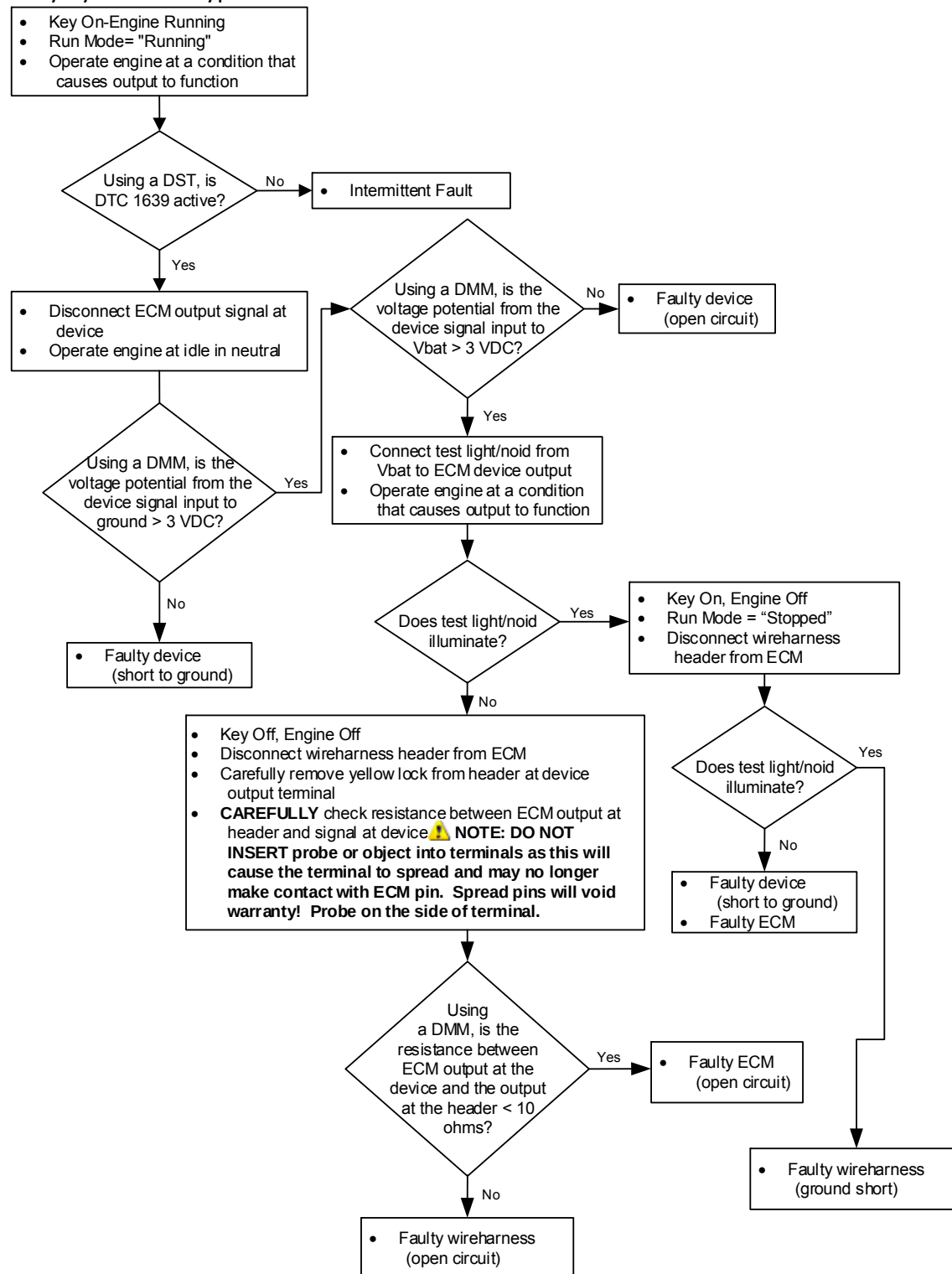
DTC	1638	SPN	700	FMI	3		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM4 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 4 low-side feedback >				TBD*	% Vbat		
• and PWM duty-cycle >				TBD*	%		
Possible Causes: AUX PWM4 output shorted to power							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

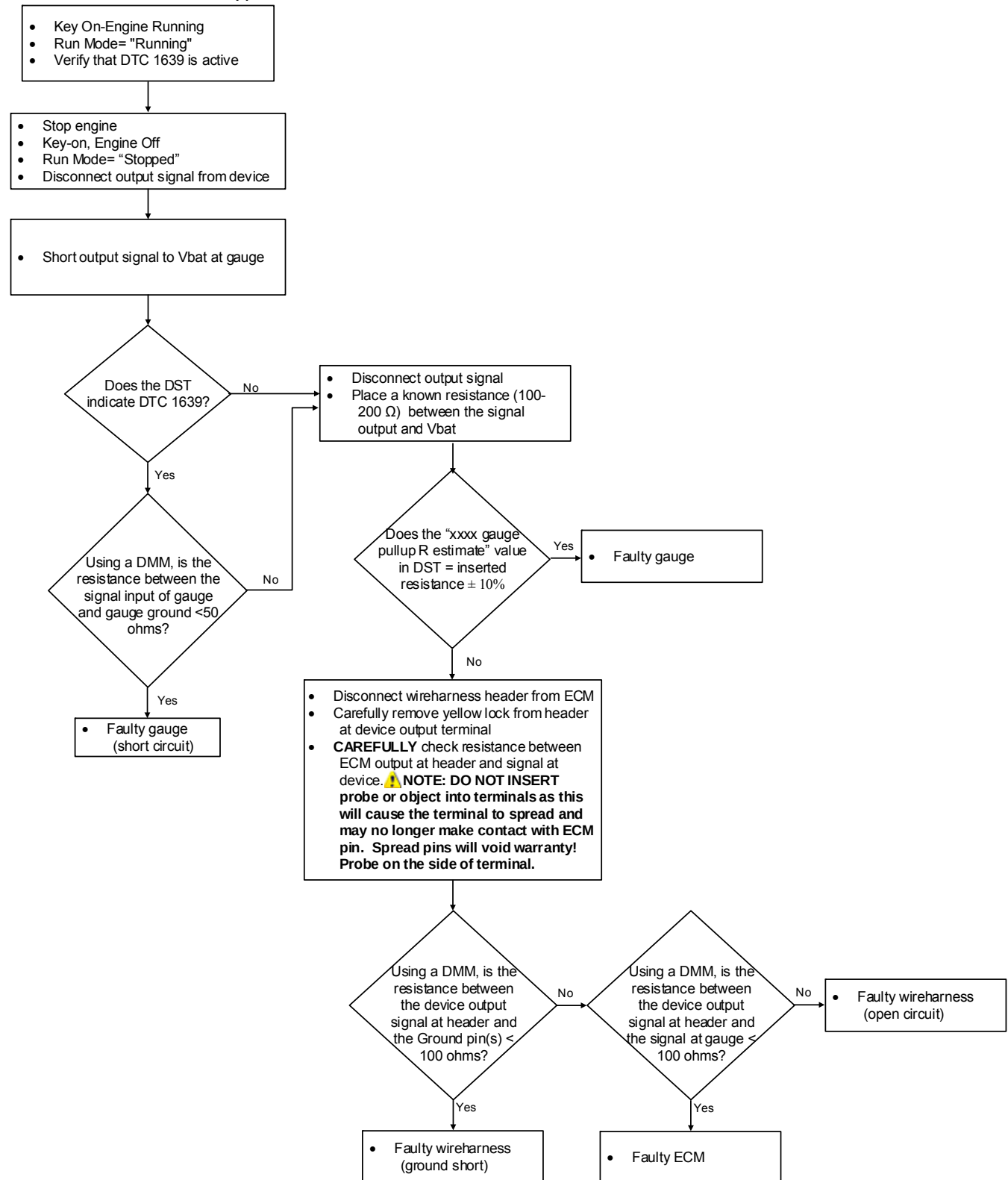
DTC 1634 – PWM2 SHORT TO POWER (TROUBLE TREE)**Duty-cycle PWM type**

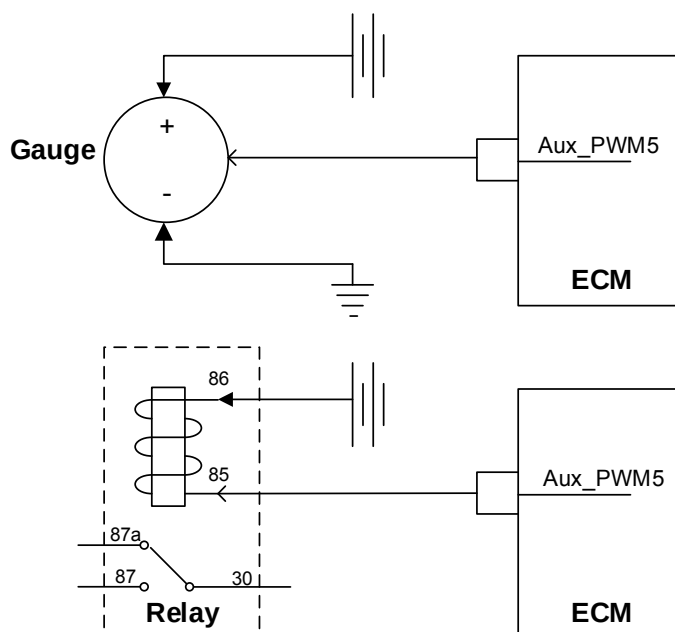
DTC 1638 – PWM4 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

DTC 1639 - PWM5 OPEN / GROUND SHORT

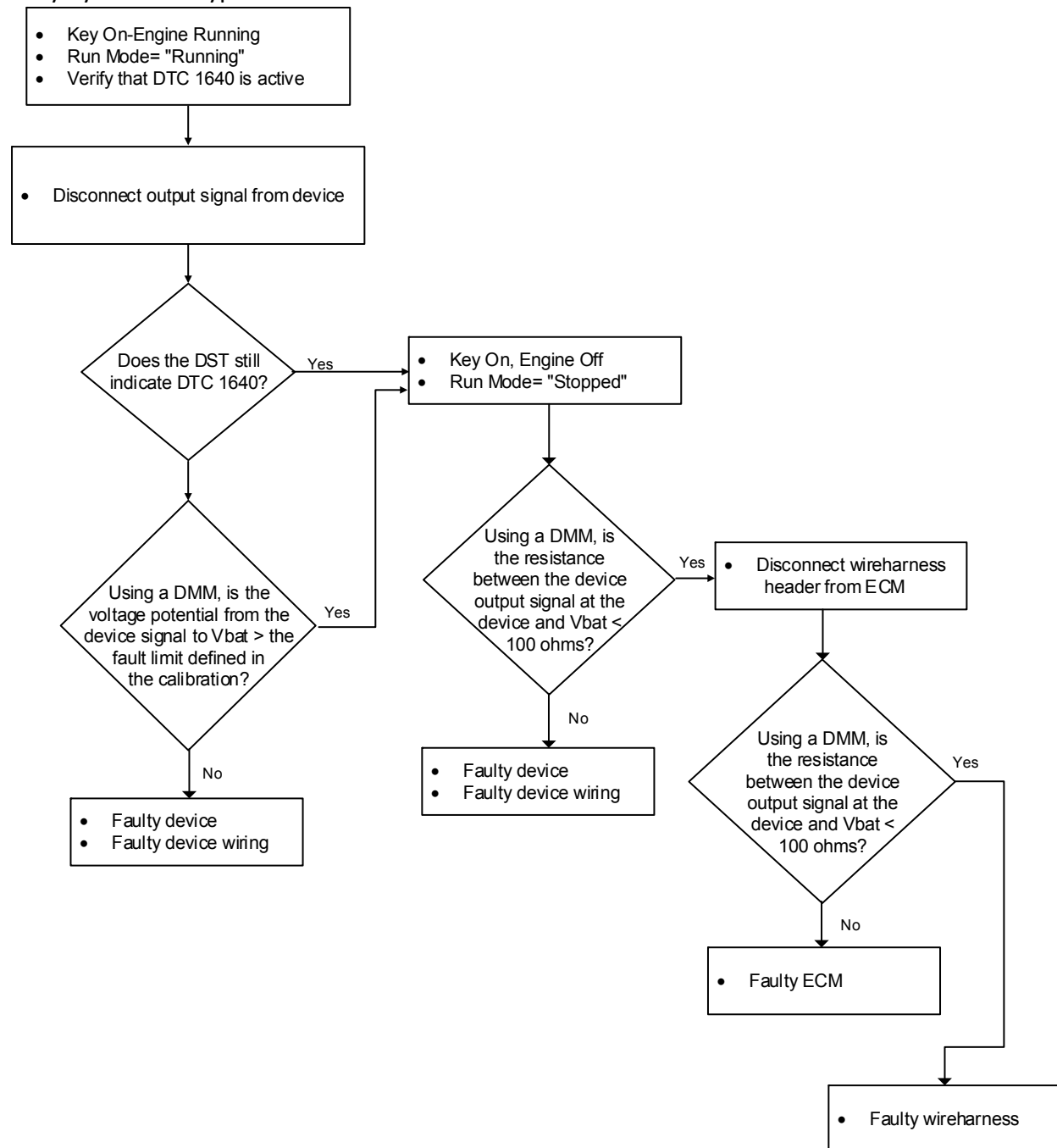
DTC	1639	SPN	924	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM5 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 5 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM5 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

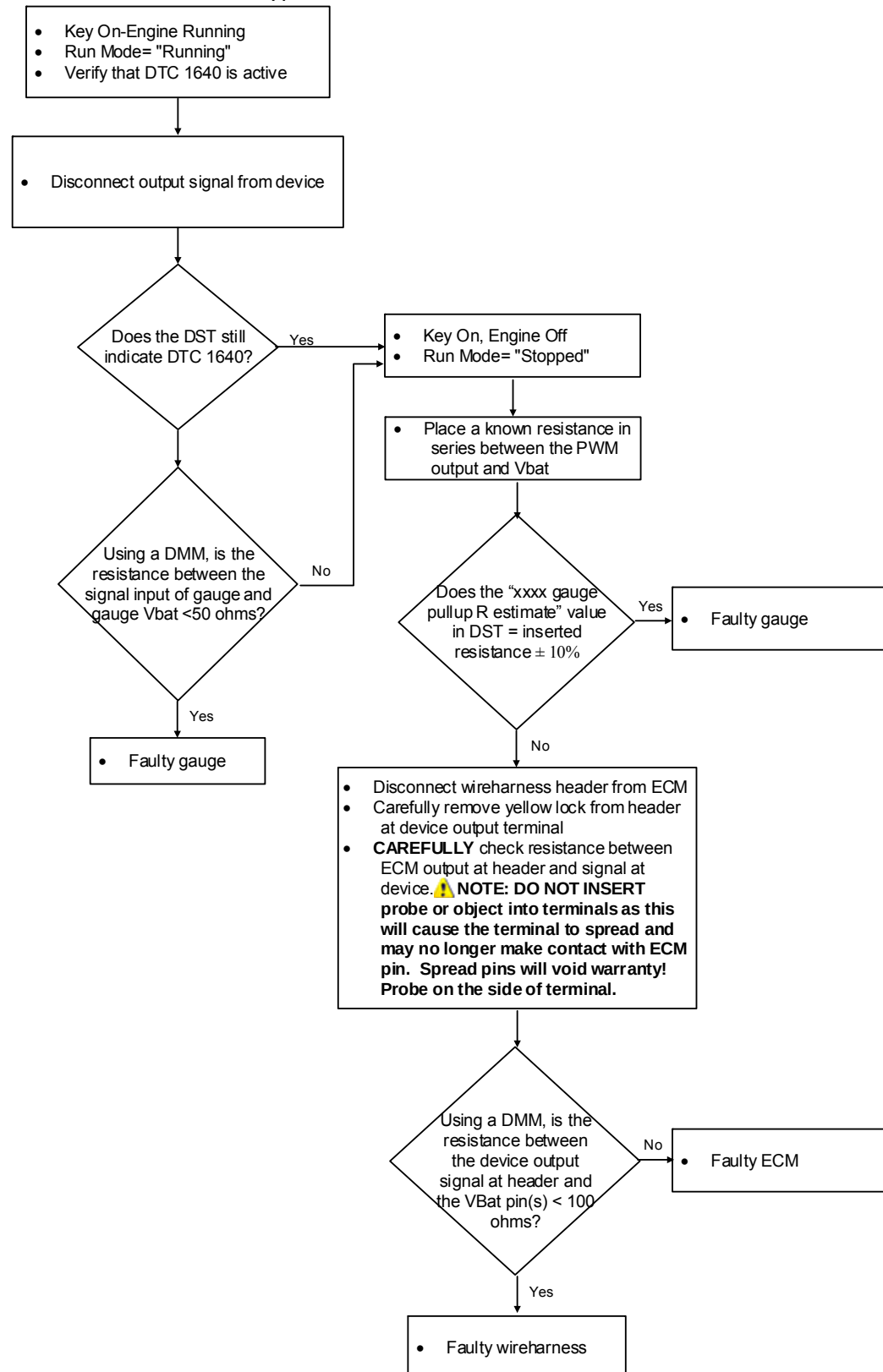
DTC 1639 – PWM5 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

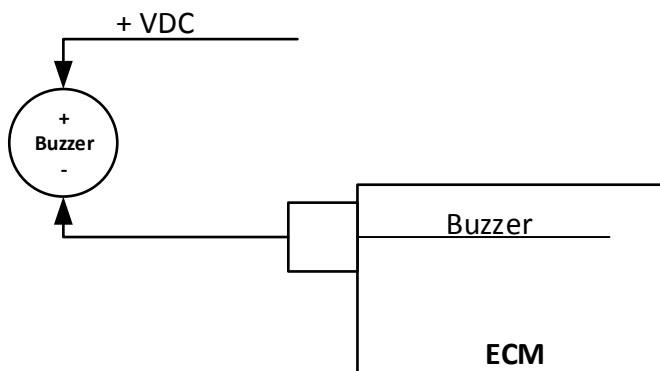
DTC 1639 – PWM5 OPEN / GROUND SHORT (TROUBLE TREE)**Resistance Simulation type**

DTC 1640 - PWM5 SHORT TO POWER

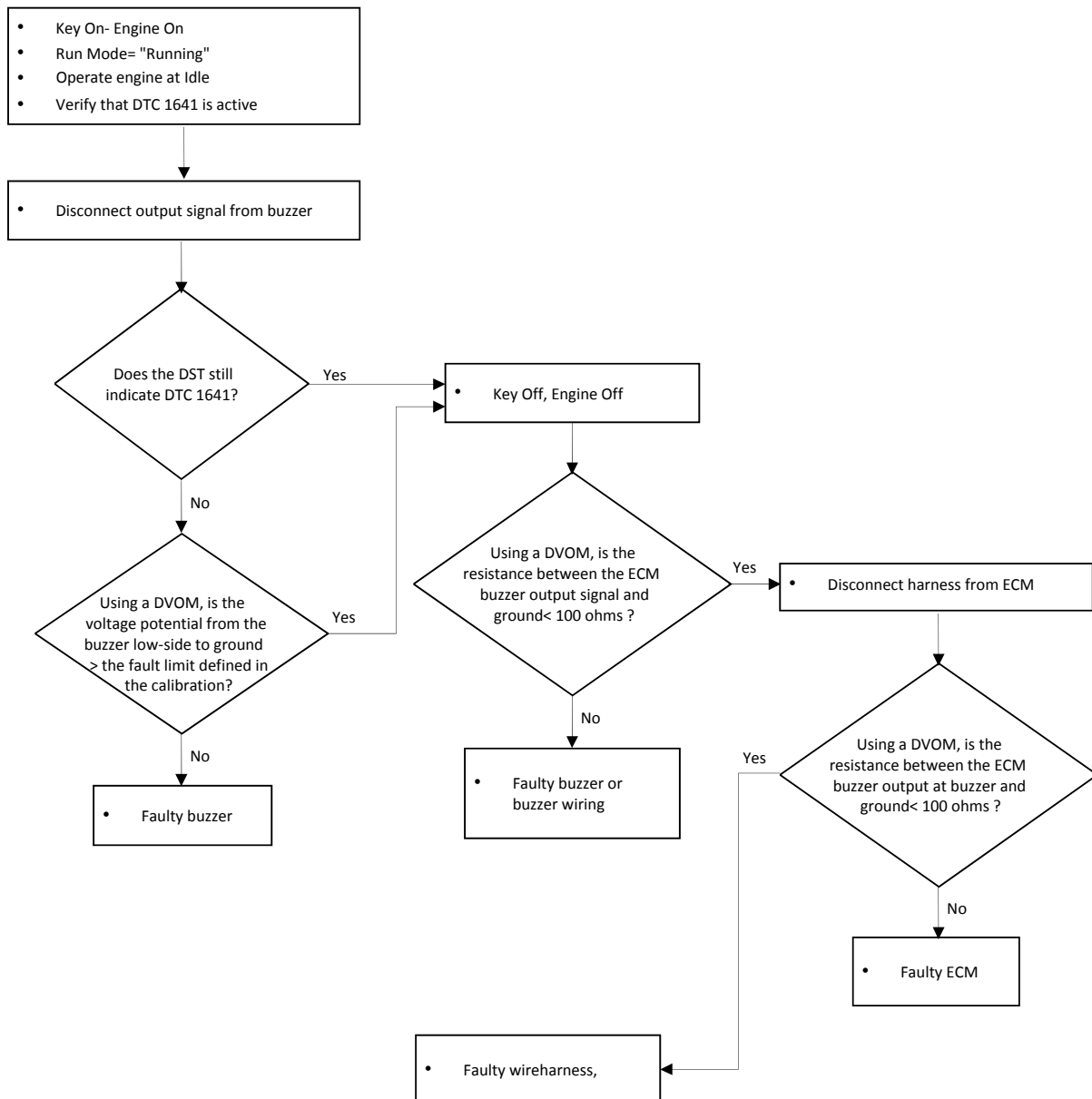
DTC	1640	SPN	924	FMI	3		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM5 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 5 low-side feedback >				TBD*	% Vbat		
• and PWM duty-cycle >				TBD*	%		
Possible Causes: AUX PWM5 output shorted to power							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

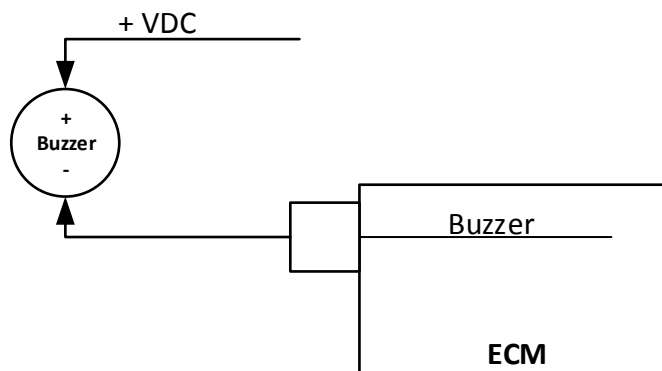
DTC 1640 – PWM5 SHORT TO POWER (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1640 – PWM5 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation Type**

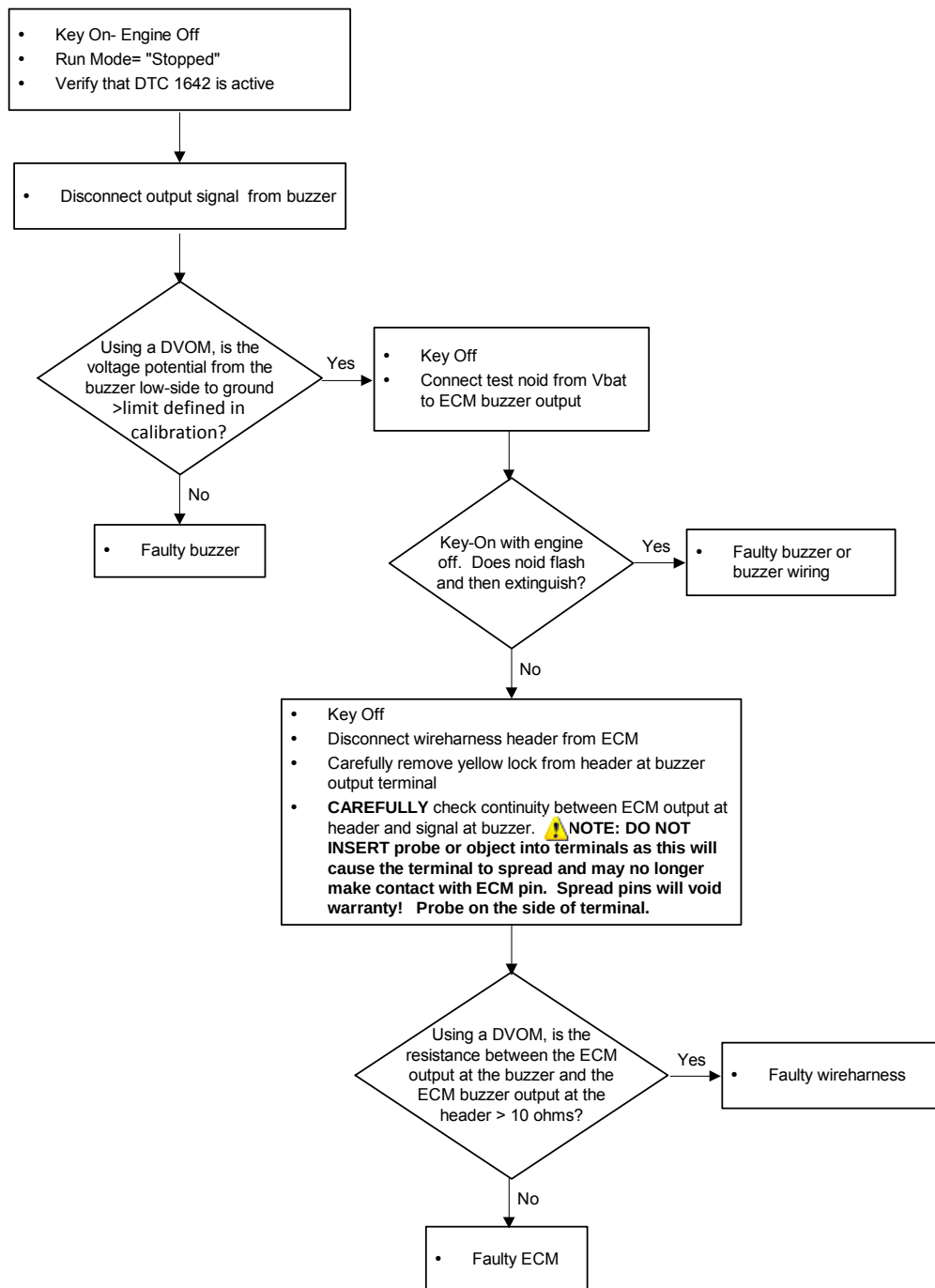
DTC 1641 - BUZZER CONTROL GROUND SHORT

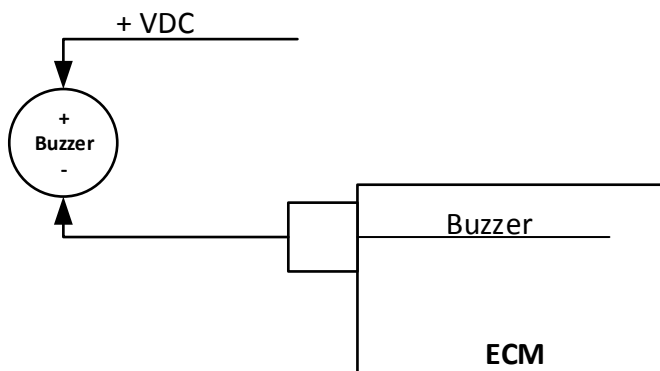
DTC	1641	SPN	920	FMI	4		
Sensor/Circuit: Buzzer/Secondary warning device							
Description: This ECM output is used to provide a low-side switch to a secondary warning device such as an audible buzzer or secondary warning lamp.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration): ECM buzzer output shorted to ground							
Possible Causes: ECM buzzer output shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1641 – BUZZER CONTROL GROUND SHORT (TROUBLE TREE)

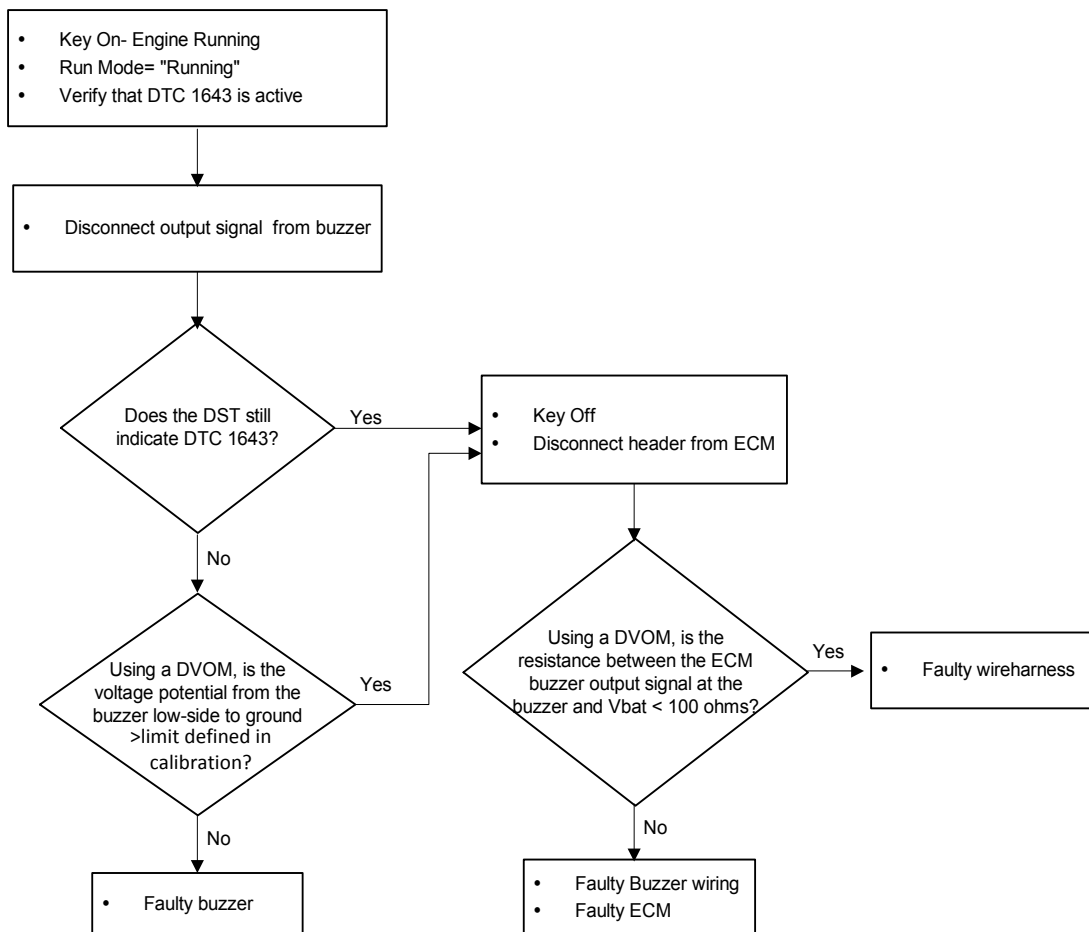
DTC 1642 - BUZZER OPEN

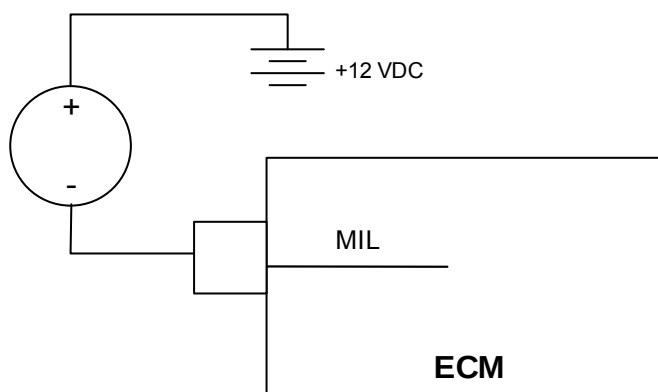
DTC	1642	SPN	920	FMI	5		
Sensor/Circuit: Buzzer/Secondary warning device							
Description: This ECM output is used to provide a low-side switch to a secondary warning device such as an audible buzzer or secondary warning lamp.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback <				TBD*	% Vbat		
Possible Causes: ECM buzzer output open circuit							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1642 – BUZZER OPEN (TROUBLE TREE)

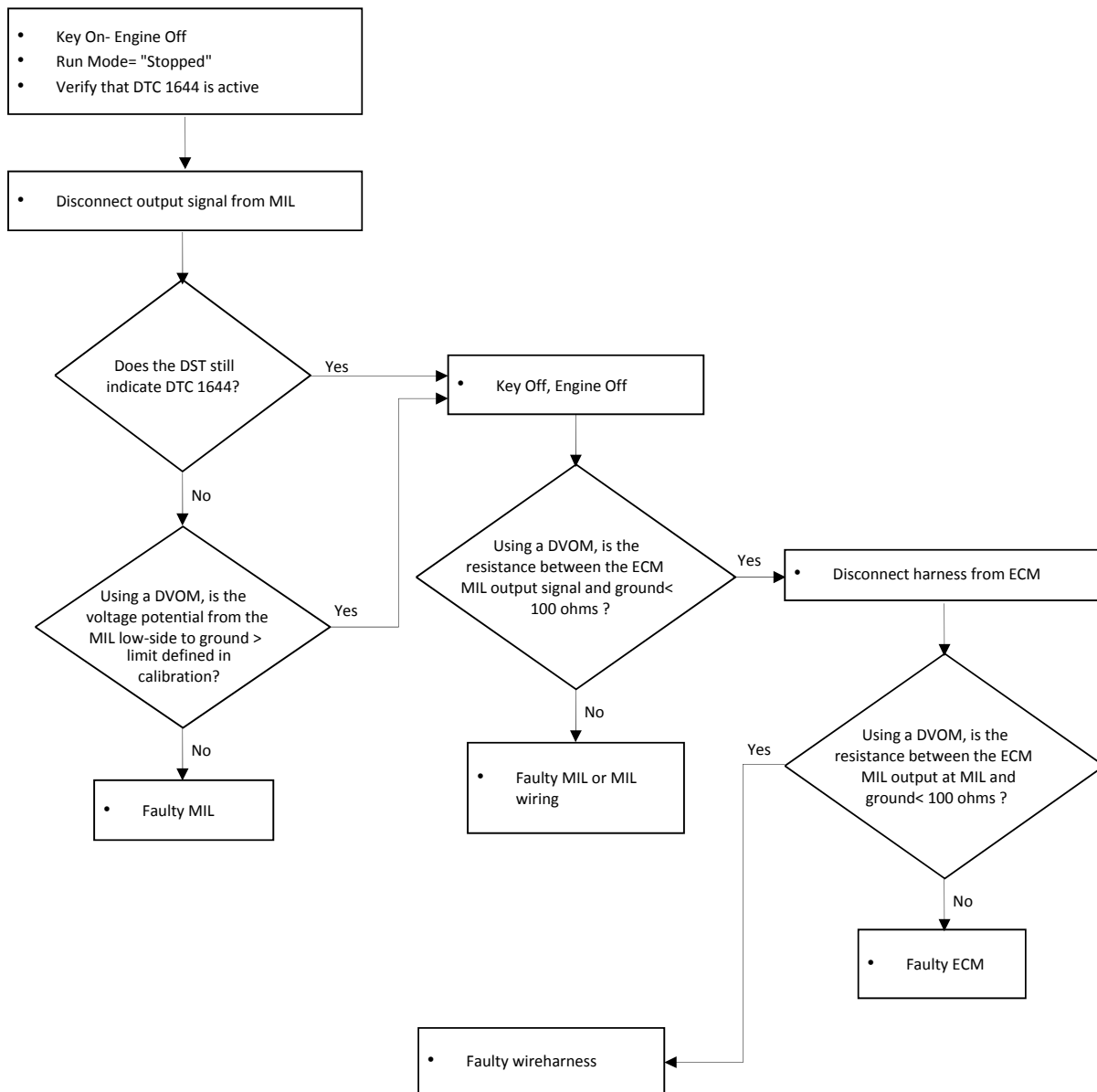
DTC 1643 - BUZZER CONTROL SHORT TO POWER

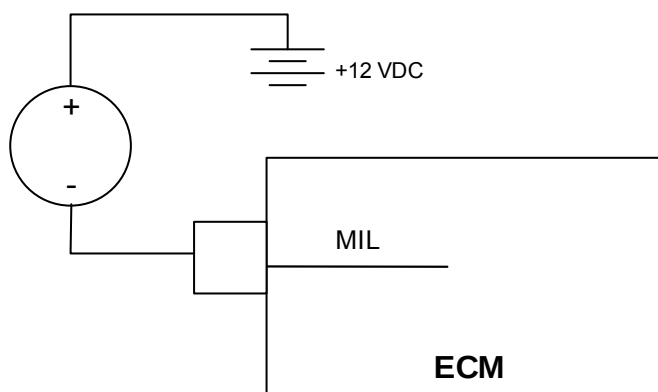
DTC	1643	SPN	920	FMI	3		
Sensor/Circuit: Buzzer/Secondary warning device							
Description: This ECM output is used to provide a low-side switch to a secondary warning device such as an audible buzzer or secondary warning lamp.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback >				TBD*	% Vbat		
Possible Causes: ECM buzzer output shorted to power							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1643 – BUZZER CONTROL SHORT TO POWER (TROUBLE TREE)

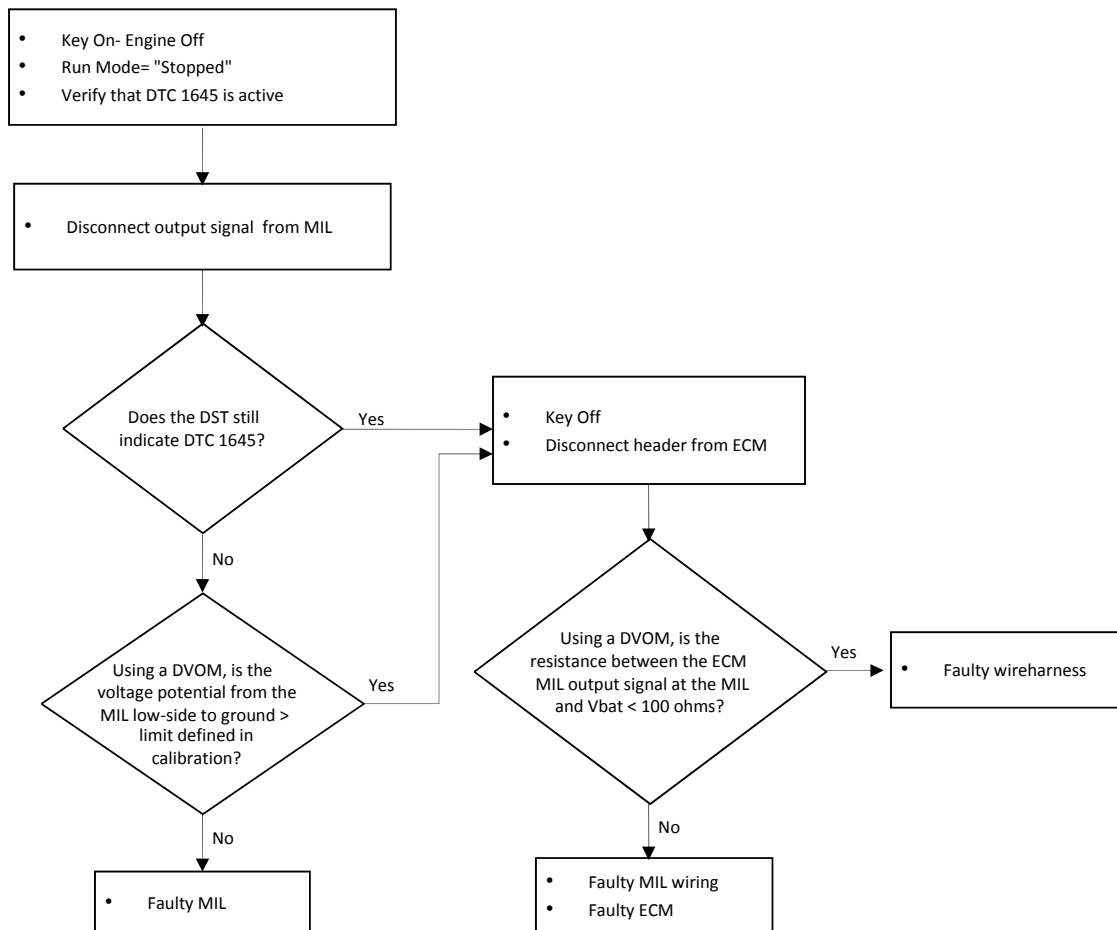
DTC 1644 - MIL CONTROL GROUND SHORT

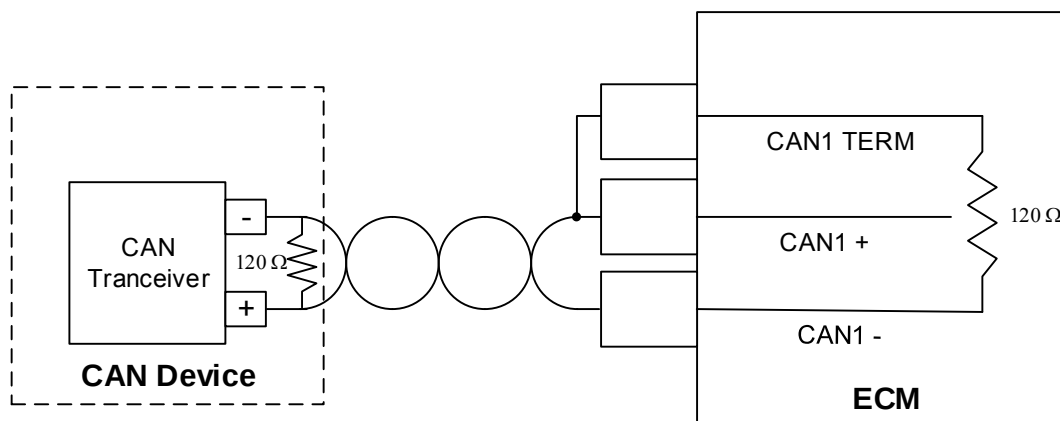
DTC	1644	SPN	1213	FMI	4		
Sensor/Circuit: MIL							
Description: This ECM output is used to provide a low-side switch to a MIL that is used to indicate that an emission related fault has been set.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
Ground short of MIL output							
Possible Causes: This fault will set if the ECM detects that there is a ground short of the MIL output.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1644 - MIL CONTROL GROUND SHORT (TROUBLE TREE)

DTC 1645 - MIL CONTROL SHORT TO POWER

DTC	1645	SPN	1213	FMI	3		
Sensor/Circuit: MIL							
Description: This ECM output is used to provide a low-side switch to a MIL that is used to indicate that an emission related fault has been set.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback >				TBD*	% Vbat		
Possible Causes: This fault will set if the ECM detects that the ECM MIL output shorted to power							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1645 - MIL CONTROL SHORT TO POWER (TROUBLE TREE)

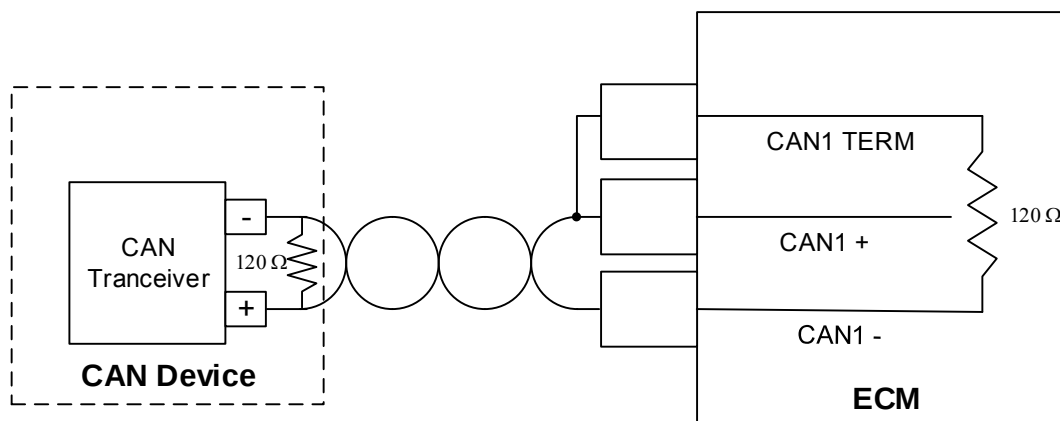
DTC 1646 – CAN2 J1939 TRANSMIT (TX) FAULT

DTC	1646	SPN	1231	FMI	12		
Sensor/Circuit: Controller Area Network							
Description: The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators (EPR/CFV), smart sensors (Envirotech), dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES (If EPR-Equipped)					
Check Condition:		Key On, Engine Off and/or Running					
Fault Set Conditions (as defined in calibration):							
• Tx error counter >				TBD*	failures		
Possible Causes: This fault will set if CAN communication is enabled and the ECM transceiver broadcasts a number of packets (as defined in the diagnostic calibration, must be set to less than 125 failures) to the network that are not received.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

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DTC 1646 – CAN2 J1939 TRANSMIT (TX) FAULT (Diagnostic Aides):

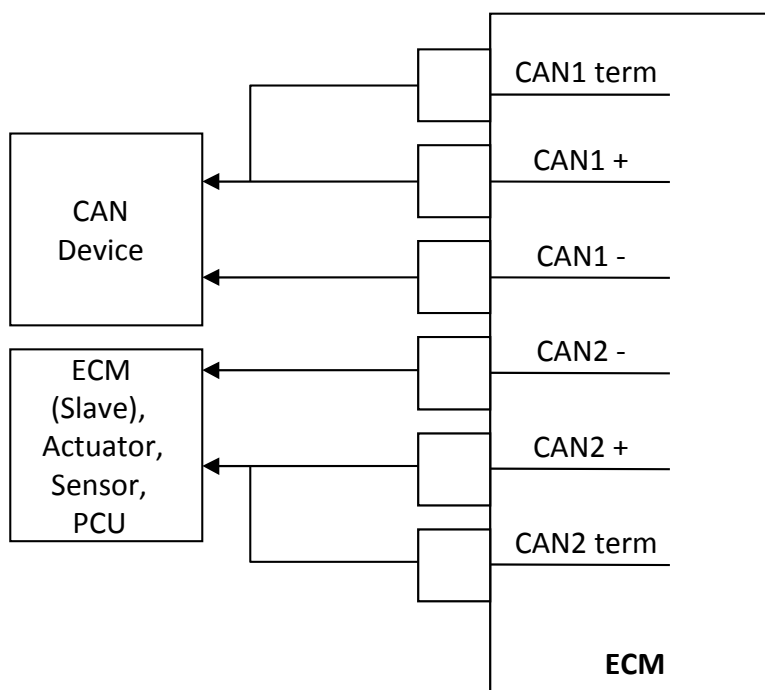
- ☐ Verify that all CAN devices are powered and are properly grounded
- ☐ Verify that the CAN2 network is properly terminated
- ☐ Check CAN2 wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- ☐ Check CAN2 (+) and (-) wires for short circuits

DTC 1647 – CAN2 J1939 TRANSMIT (TX) FAULT

DTC	1647	SPN	1235	FMI	12		
Sensor/Circuit: Controller Area Network							
Description: The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators (EPR/CFV), smart sensors (Envirotech), dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES (If EPR-Equipped)					
Check Condition:		Key On, Engine Off and/or Running					
Fault Set Conditions (as defined in calibration):							
• Tx error counter >				TBD*	failures		
Possible Causes: This fault will set if CAN communication is enabled and the ECM transceiver broadcasts a number of packets (as defined in the diagnostic calibration, must be set to less than 125 failures) to the network that are not received.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1646 – CAN3 J1939 TRANSMIT (TX) FAULT (Diagnostic Aides):

- ☐ Verify that all CAN devices are powered and are properly grounded
- ☐ Verify that the CAN3 network is properly terminated
- ☐ Check CAN3 wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- ☐ Check CAN3 (+) and (-) wires for short circuits

DTC 1650 - CAN2 ADDRESS CONFLICT FAILURE

DTC	1650	SPN	1231	FMI	13
Sensor/Circuit: CAN Device(s)					
Description: The controller area network serves as a communication portal between intelligent devices. These devices may be but are not limited to other engine ECMs (slave), diagnostic tools, “smart” gauges, “smart” sensors, powertrain control units, vehicle controllers, actuators, etc. The network permits several devices to communicate with each other receiving and broadcasting commands as programmed. This type of network allows devices to be added to an entire system through only two conductors and permits all other devices to broadcast and receive commands to and from the device when properly commanded. CAN1 is used for general network communication including gauge display, scan tool communication, and other general 3rd party traffic. CAN2 and CAN3 are reserved solely for engine control (engine synchronization, throttle control, vehicle controller commands, etc.) and are limited to EControls Inc. approved devices only.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine on			
Fault Set Conditions (as defined in calibration):					
• Address conflict counter >				TBD*	failures

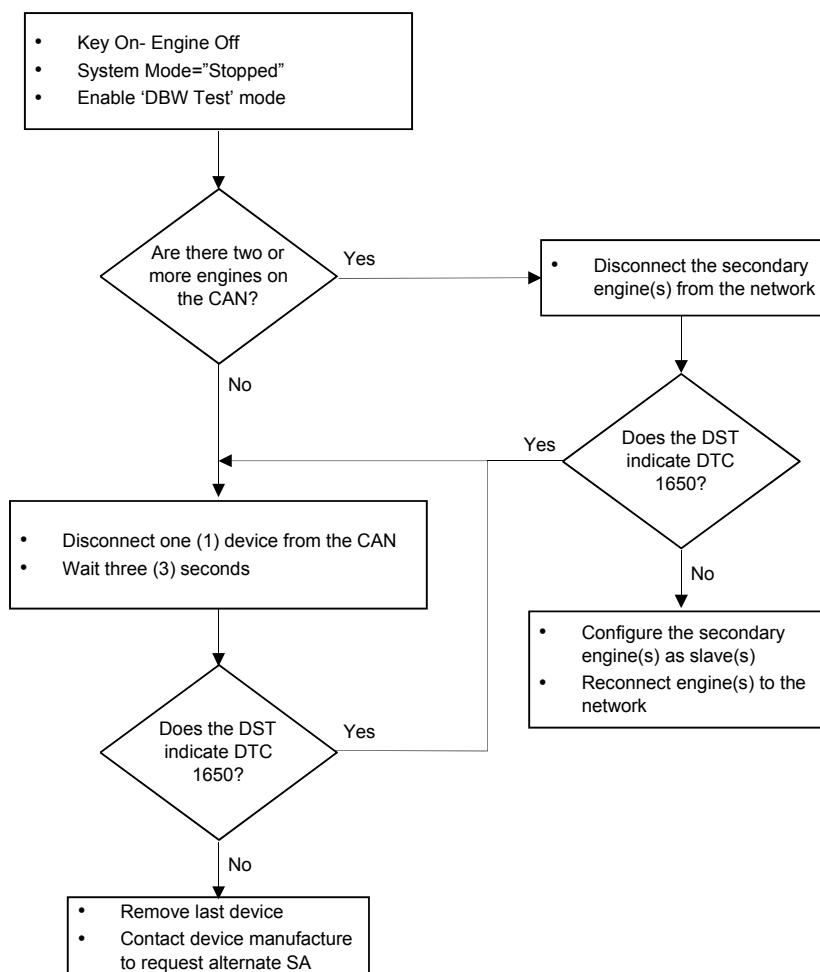
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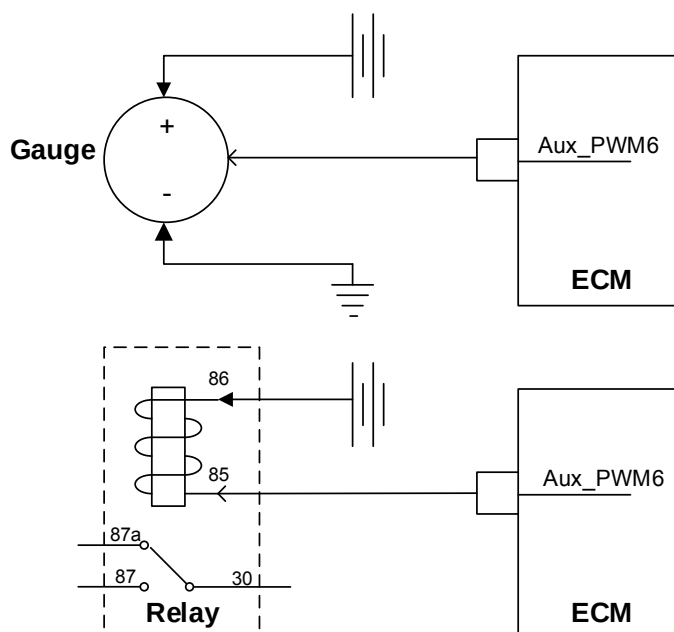
Possible Causes:

This fault indicates that there are two (2) or more devices on the network that use the same source address.

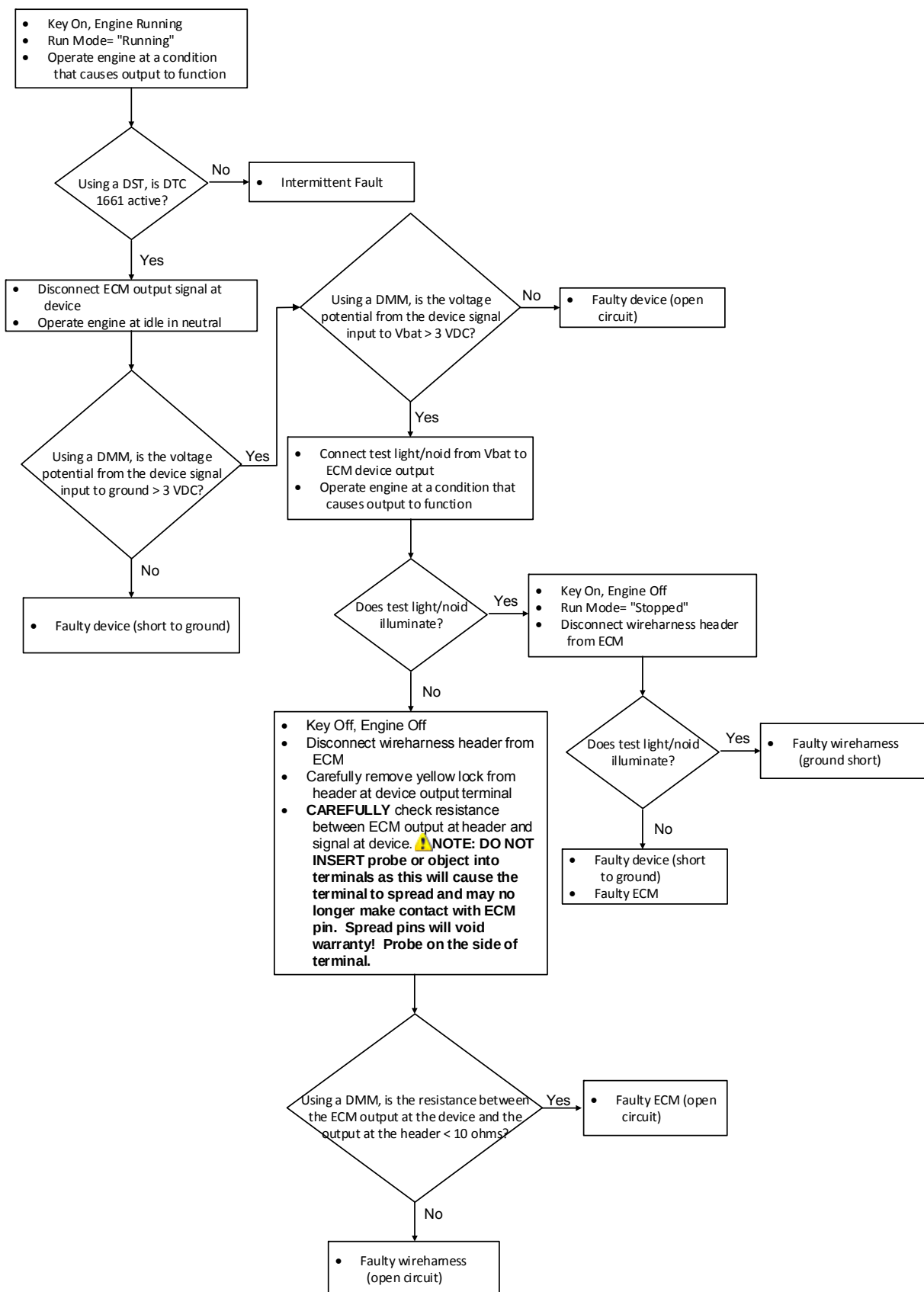
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1650 – CAN2 ADDRESS CONFLICT FAILURE (TROUBLE TREE)

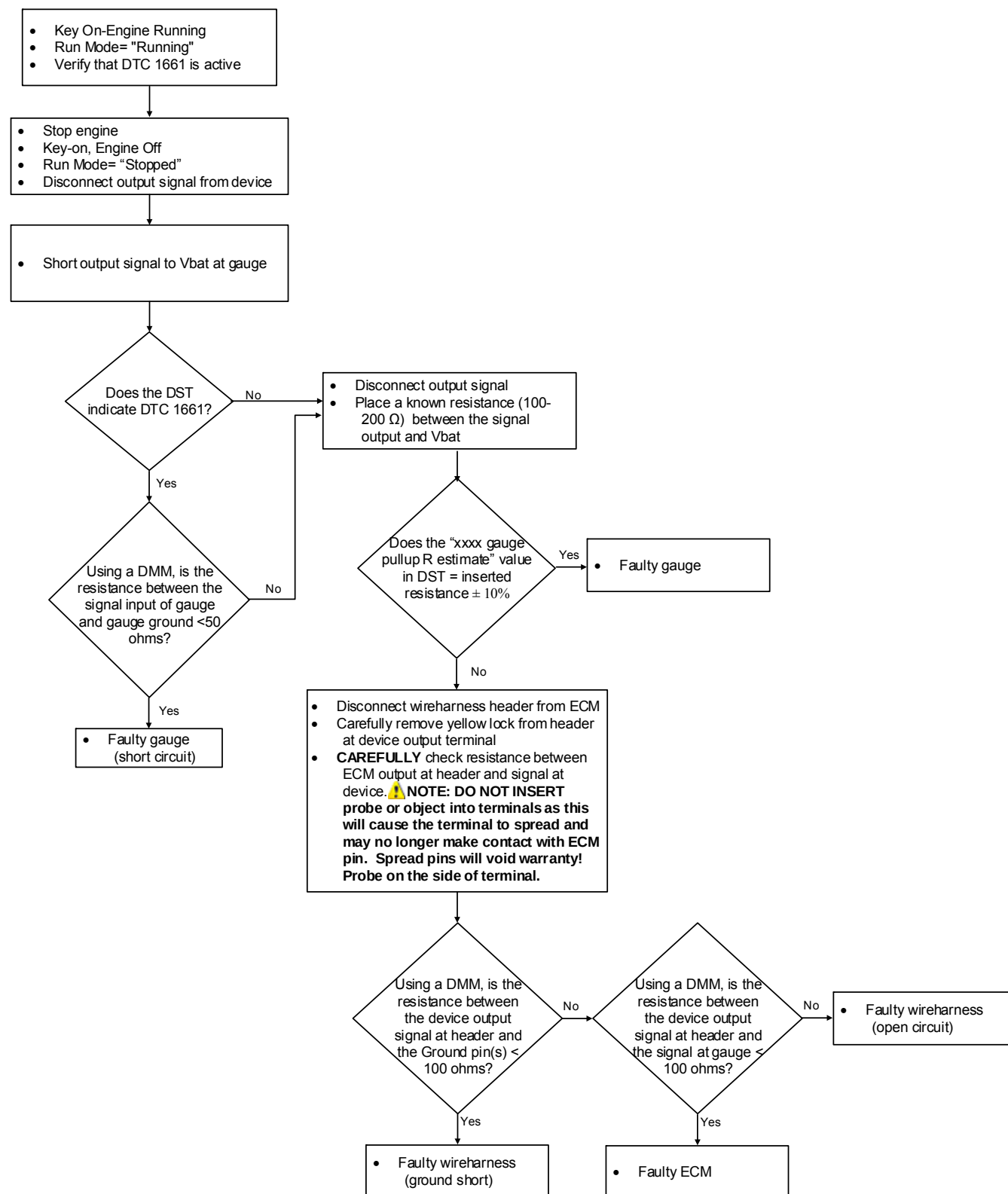
DTC 1661 - PWM6 OPEN / GROUND SHORT

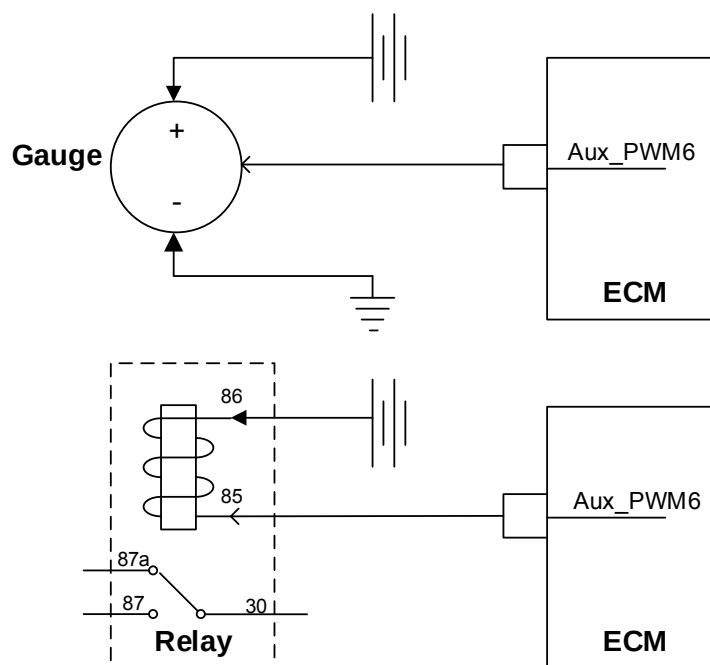
DTC	1661	SPN	925	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM6 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 6 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM6 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1661 – PWM6 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1661 – PWM6 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1662 - PWM6 SHORT TO POWER

DTC	1662	SPN	925	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM6 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 6 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 6 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

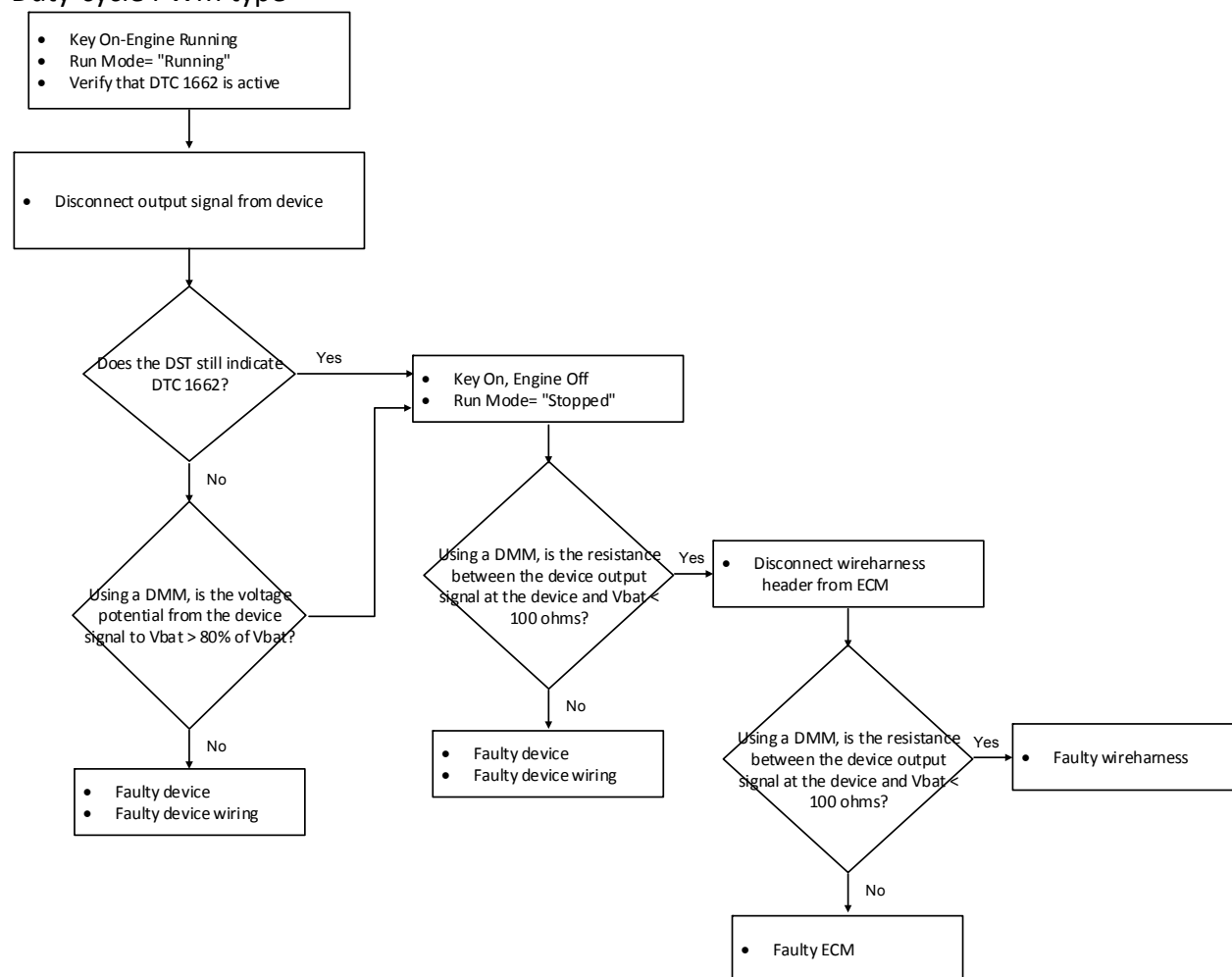
AUX PWM6 output shorted to power

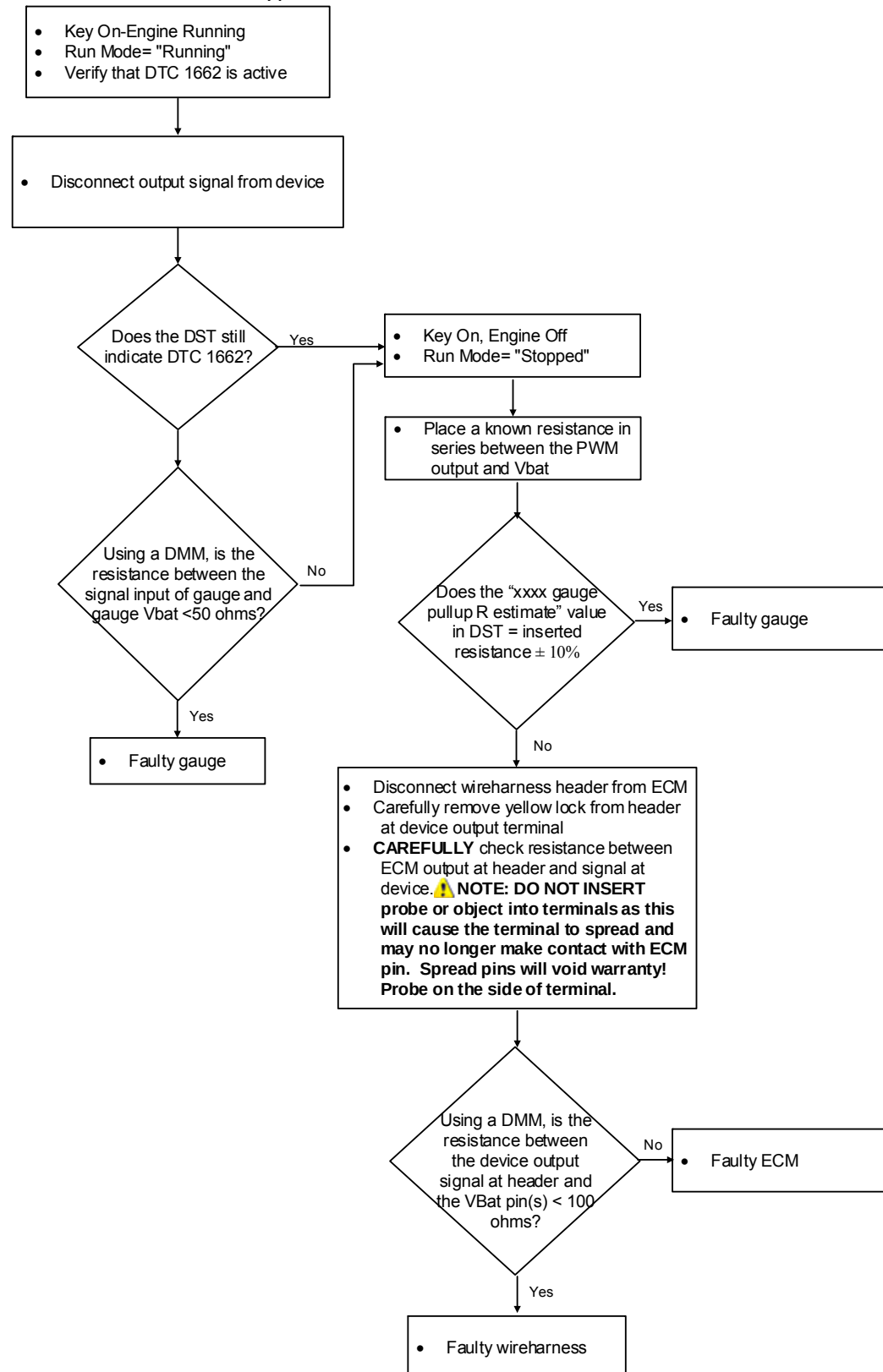
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

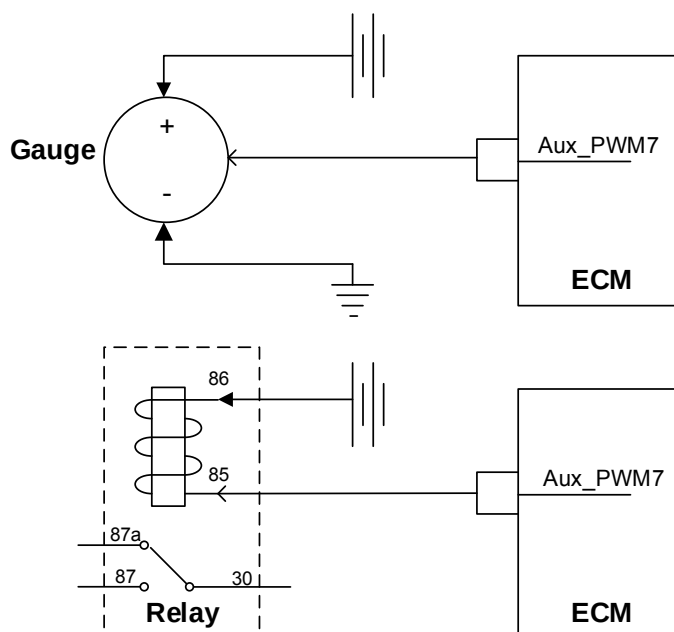
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1662 – PWM6 SHORT TO POWER (TROUBLE TREE)

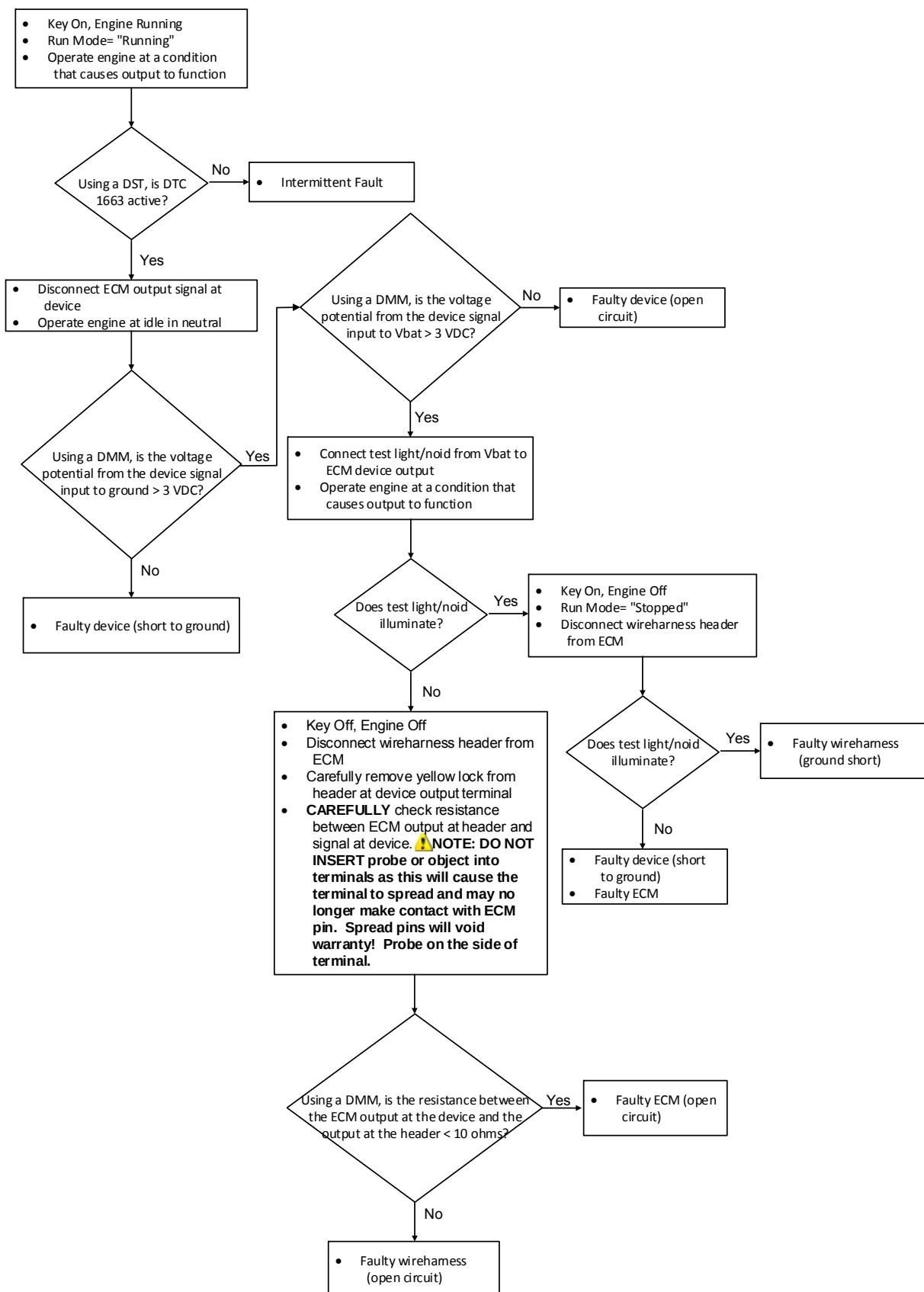
Duty-cycle PWM type



DTC 1662 – PWM6 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

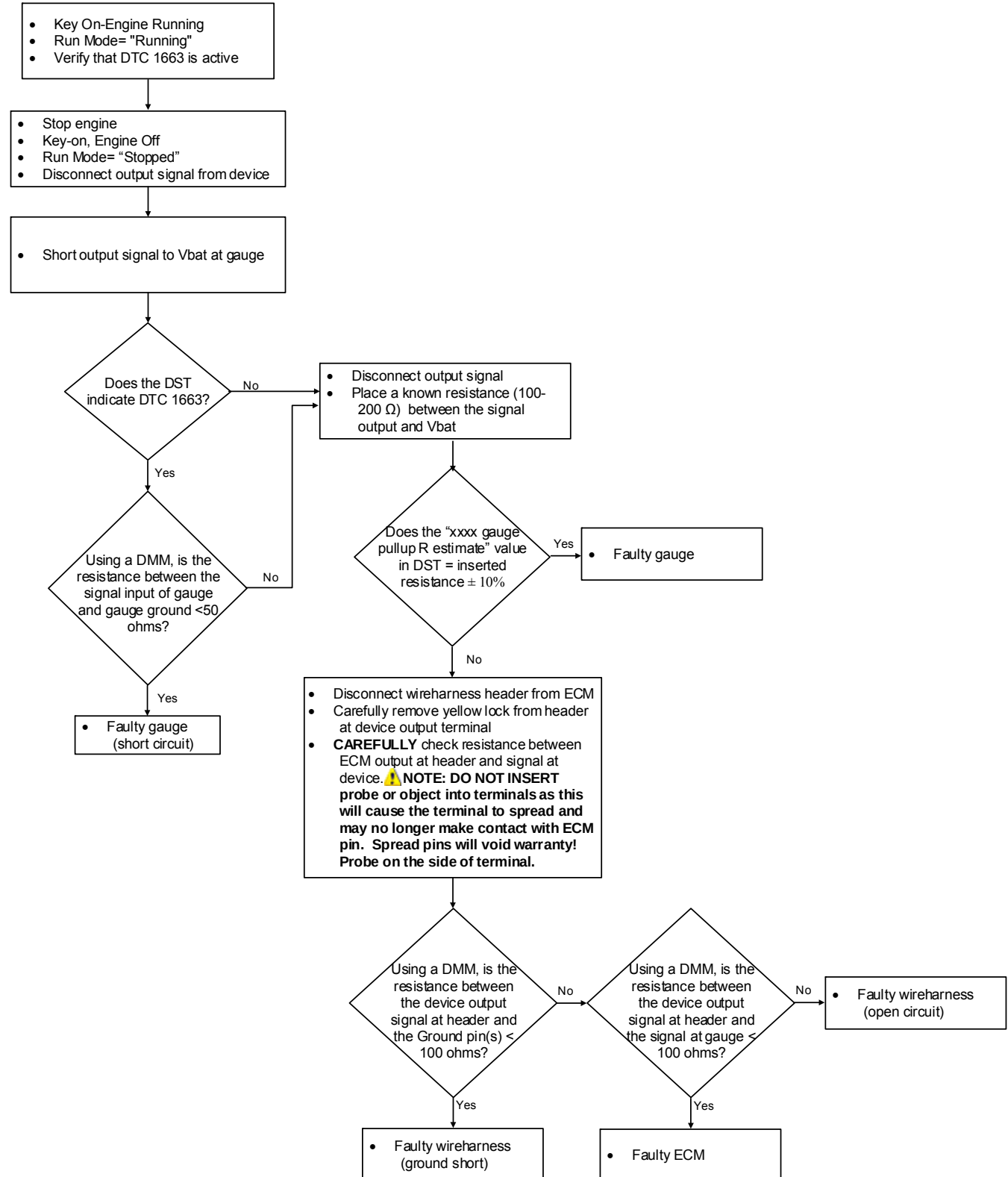
DTC 1663 - PWM7 OPEN / GROUND SHORT

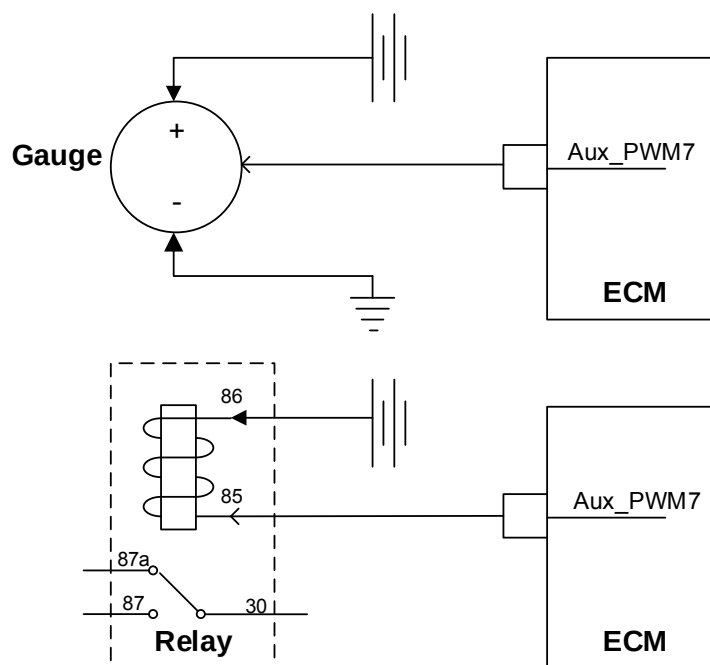
DTC	1663	SPN	926	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM7 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 7 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM7 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1663 – PWM7 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1663 – PWM7 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1664 - PWM7 SHORT TO POWER

DTC	1664	SPN	926	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM7 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 7 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 7 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

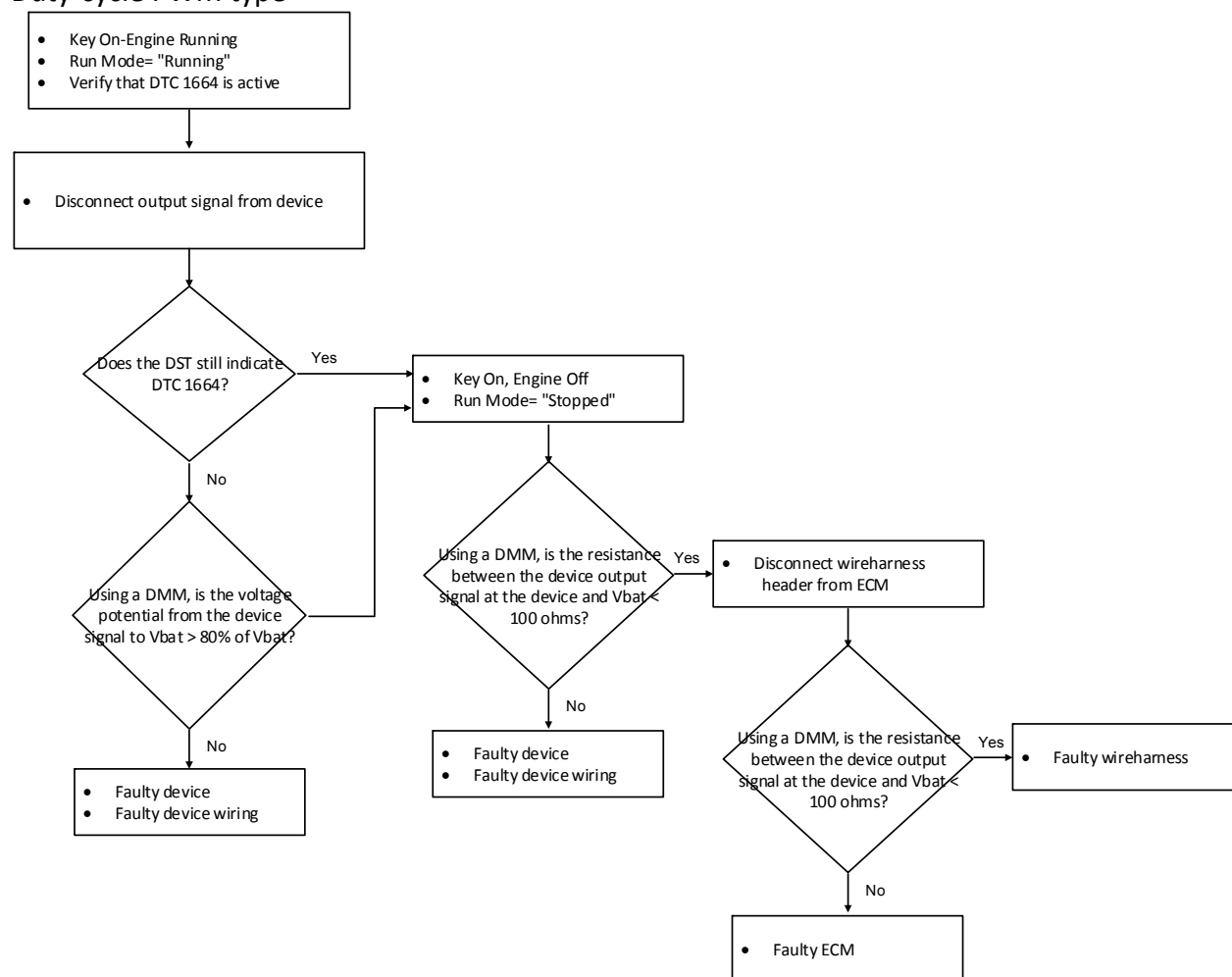
AUX PWM7 output shorted to power

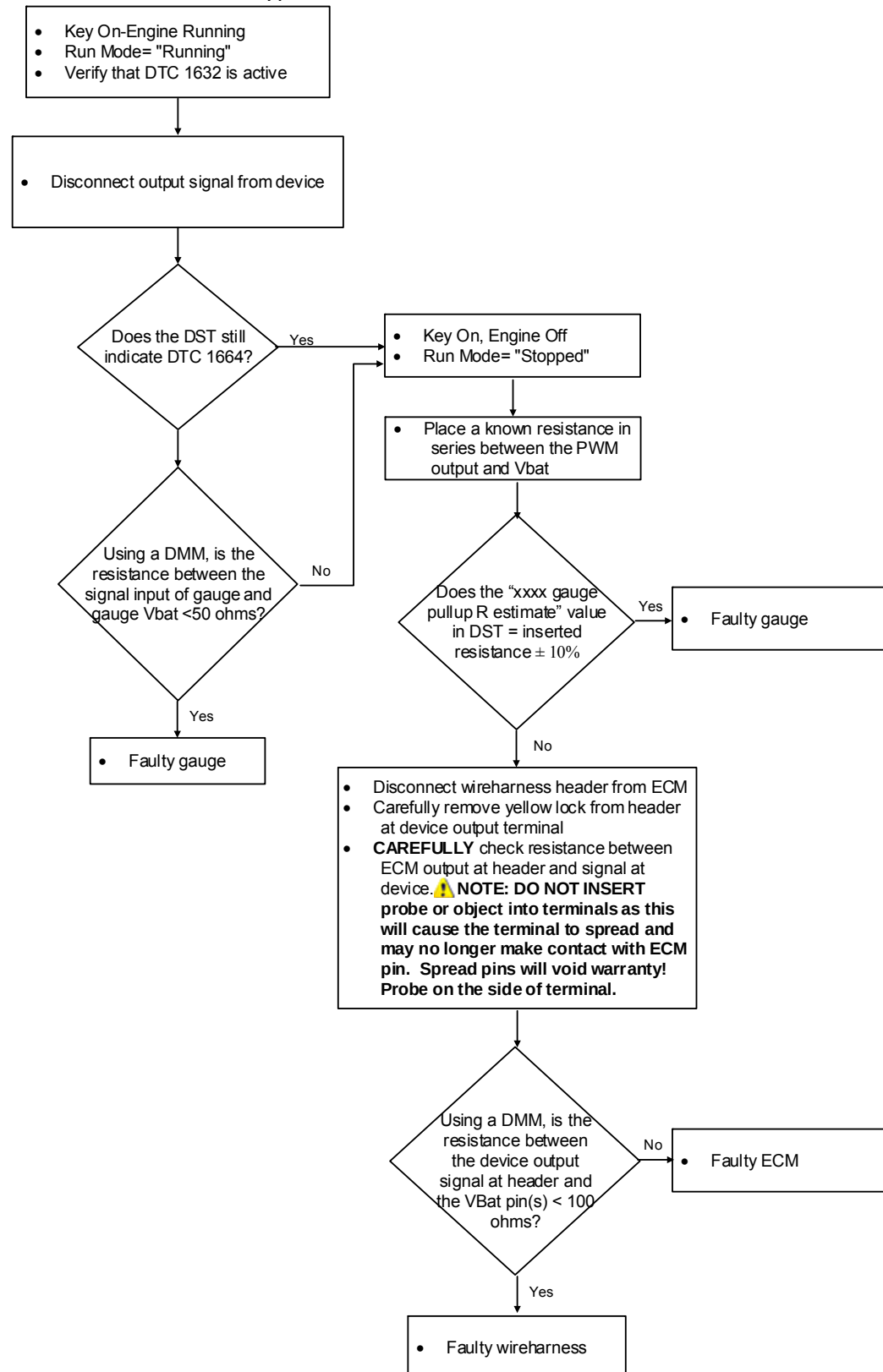
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

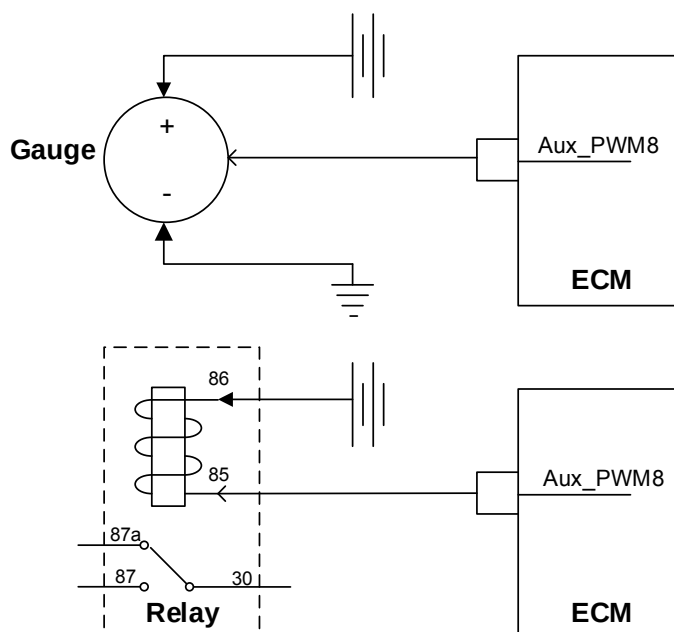
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1664 – PWM7 SHORT TO POWER (TROUBLE TREE)

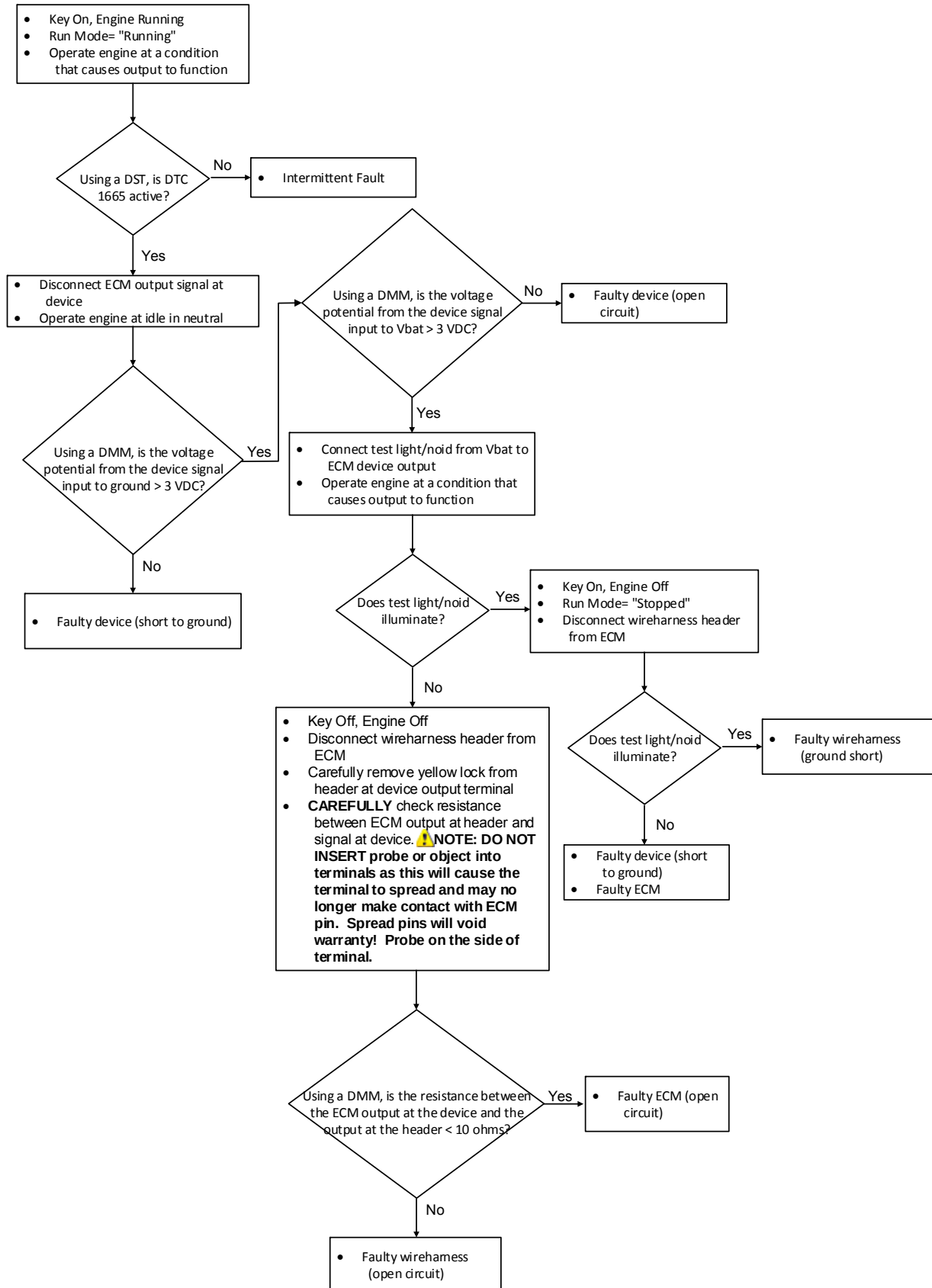
Duty-cycle PWM type



DTC 1664 – PWM7 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

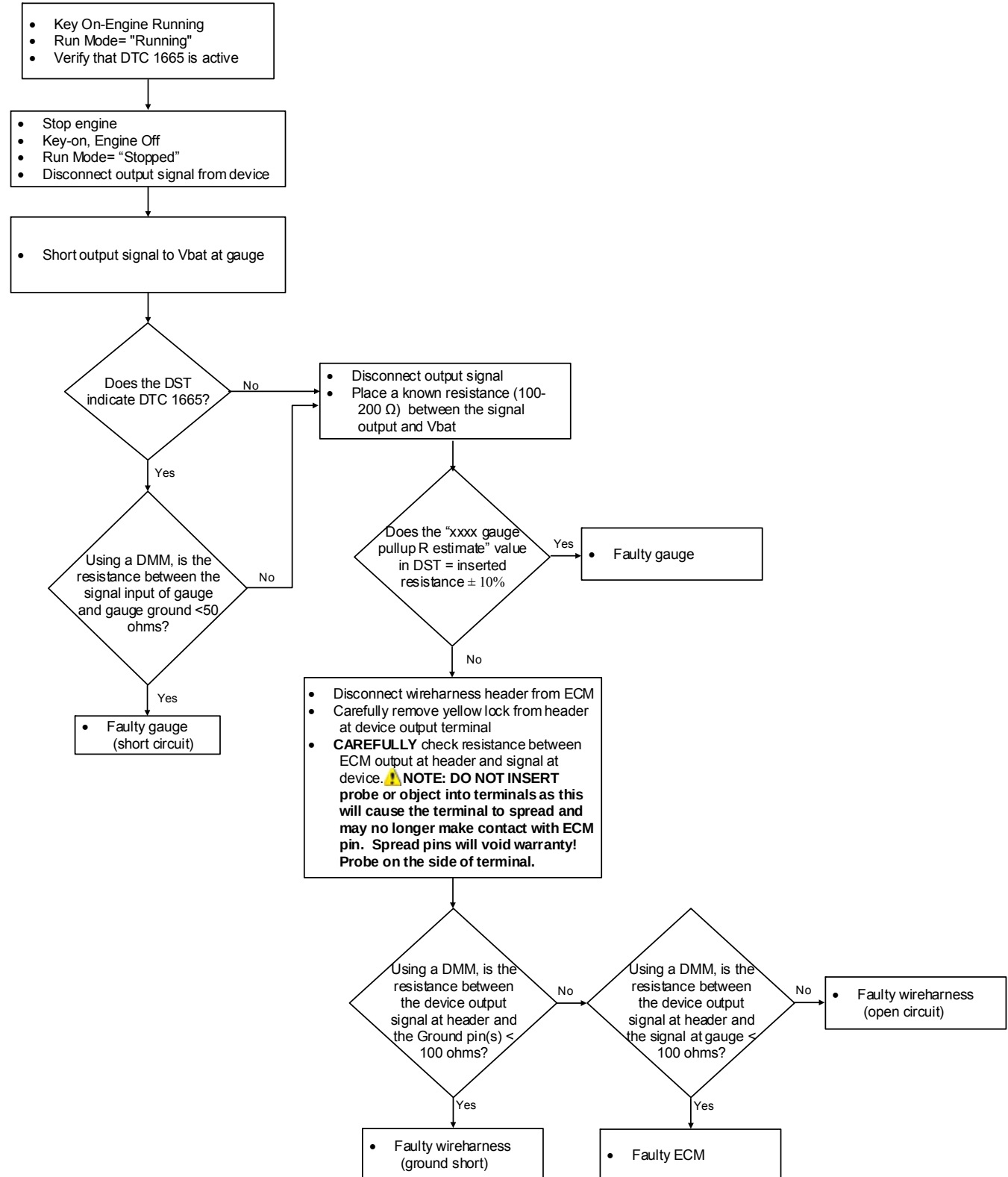
DTC 1665 - PWM8 OPEN / GROUND SHORT

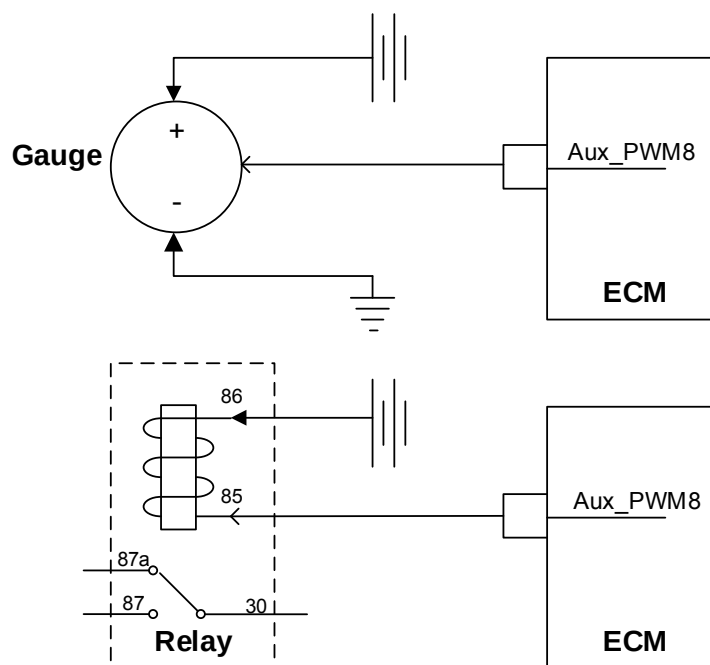
DTC	1665	SPN	2646	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM8 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 8 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM8 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1665 – PWM8 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1665 – PWM8 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1666 - PWM8 SHORT TO POWER

DTC	1666	SPN	2646	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM8 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 1 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 1 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

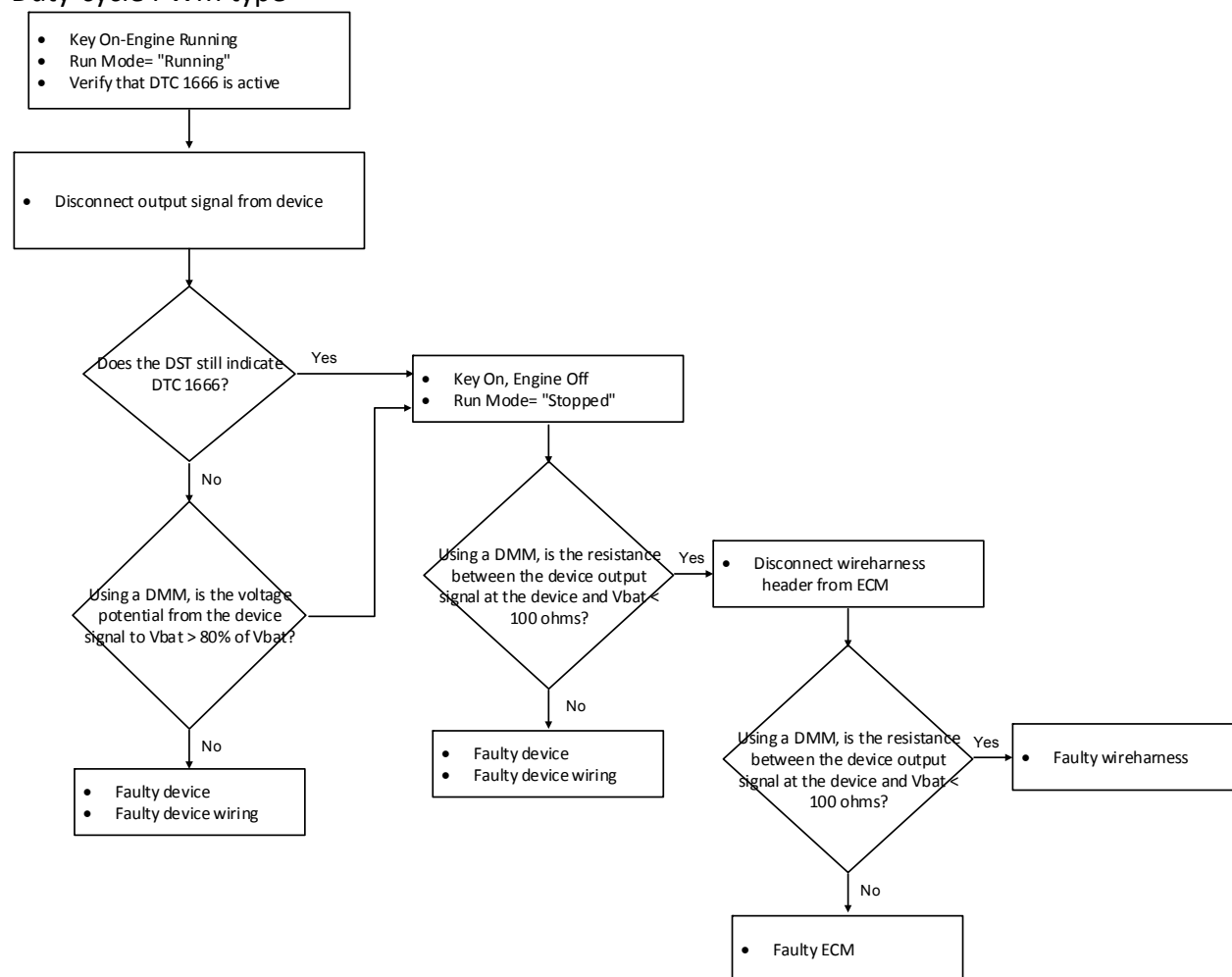
AUX PWM8 output shorted to power

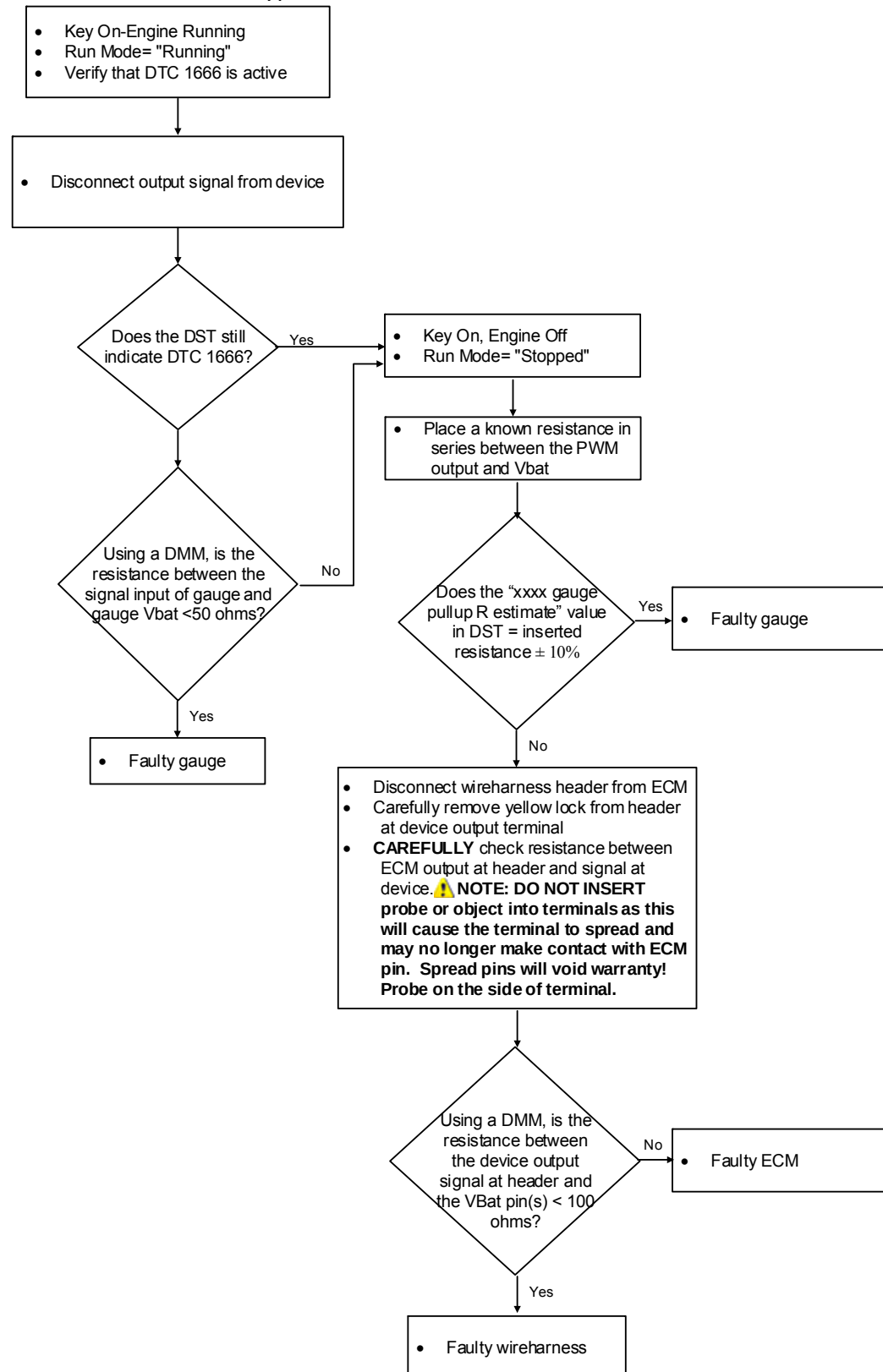
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

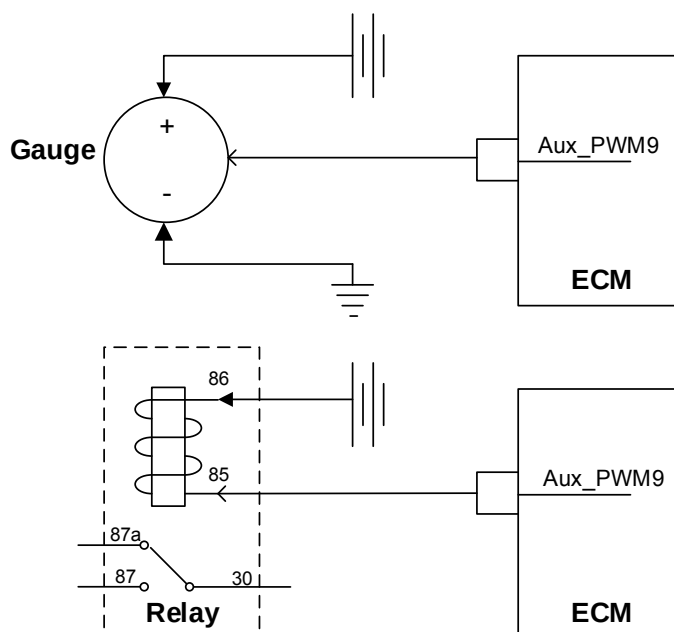
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1666 – PWM8 SHORT TO POWER (TROUBLE TREE)

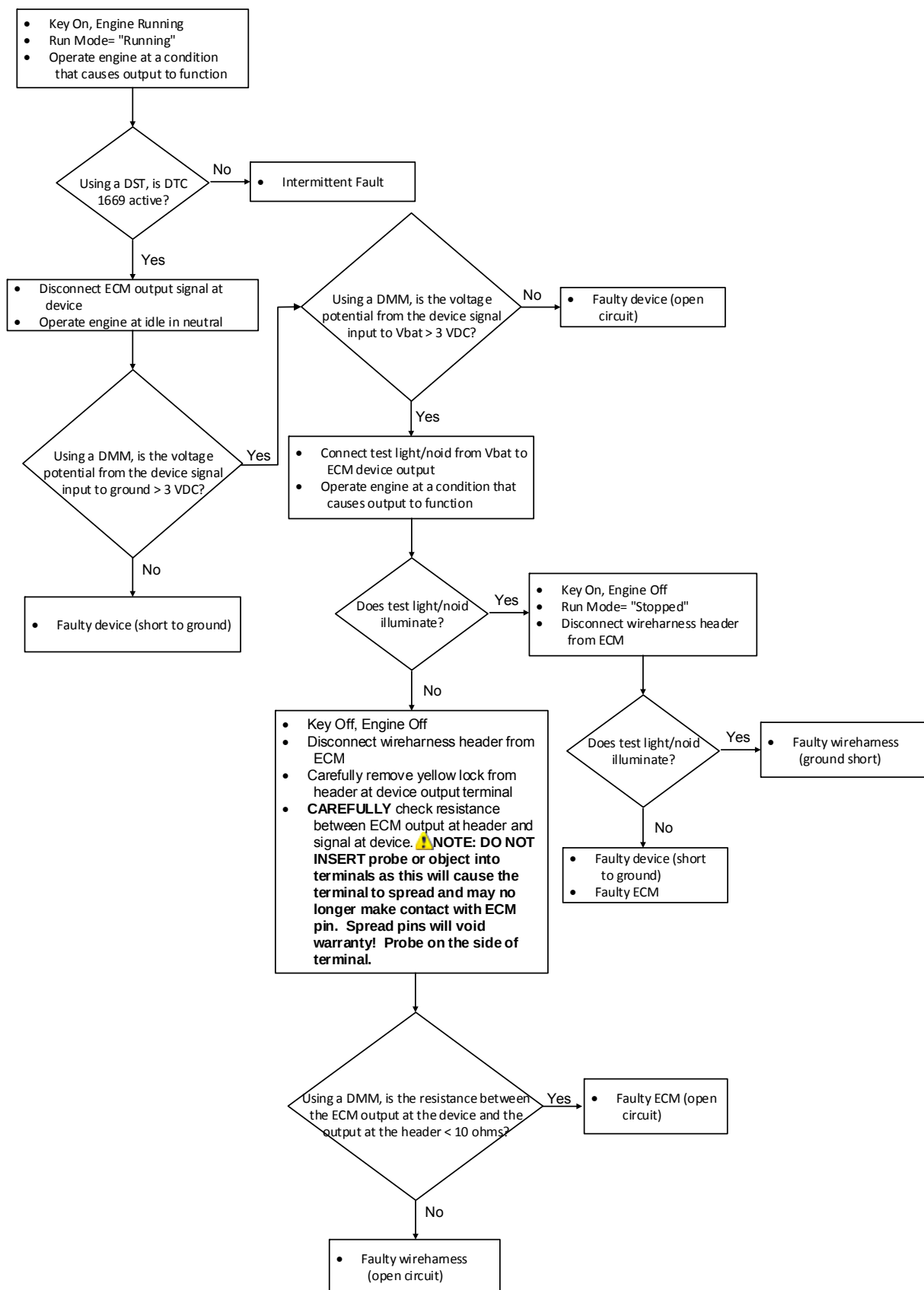
Duty-cycle PWM type



DTC 1666 – PWM8 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

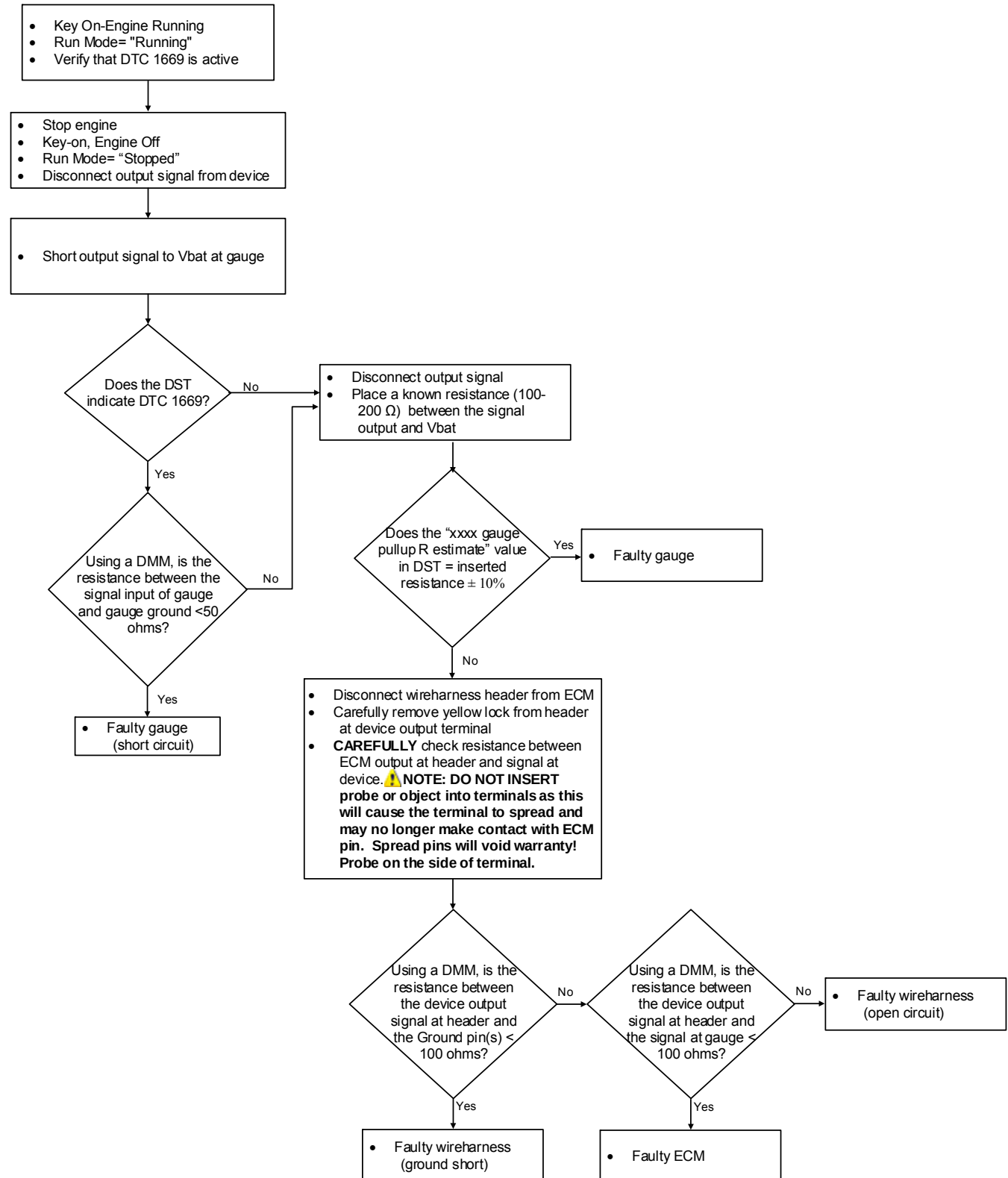
DTC 1669 - PWM9 OPEN / GROUND SHORT

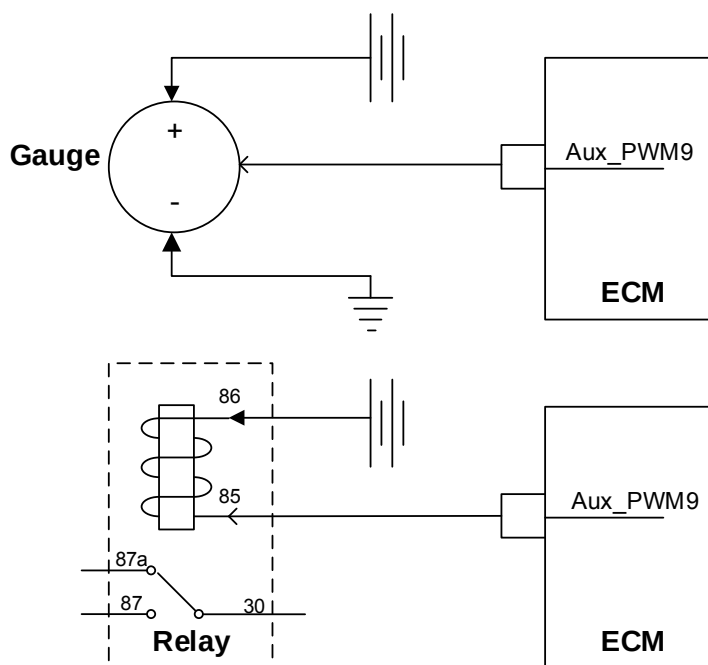
DTC	1669	SPN	2647	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM9 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 9 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM9 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1669 – PWM9 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1669 - PWM1 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1670 - PWM9 SHORT TO POWER

DTC	1670	SPN	2647	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM9 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 9 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 9 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

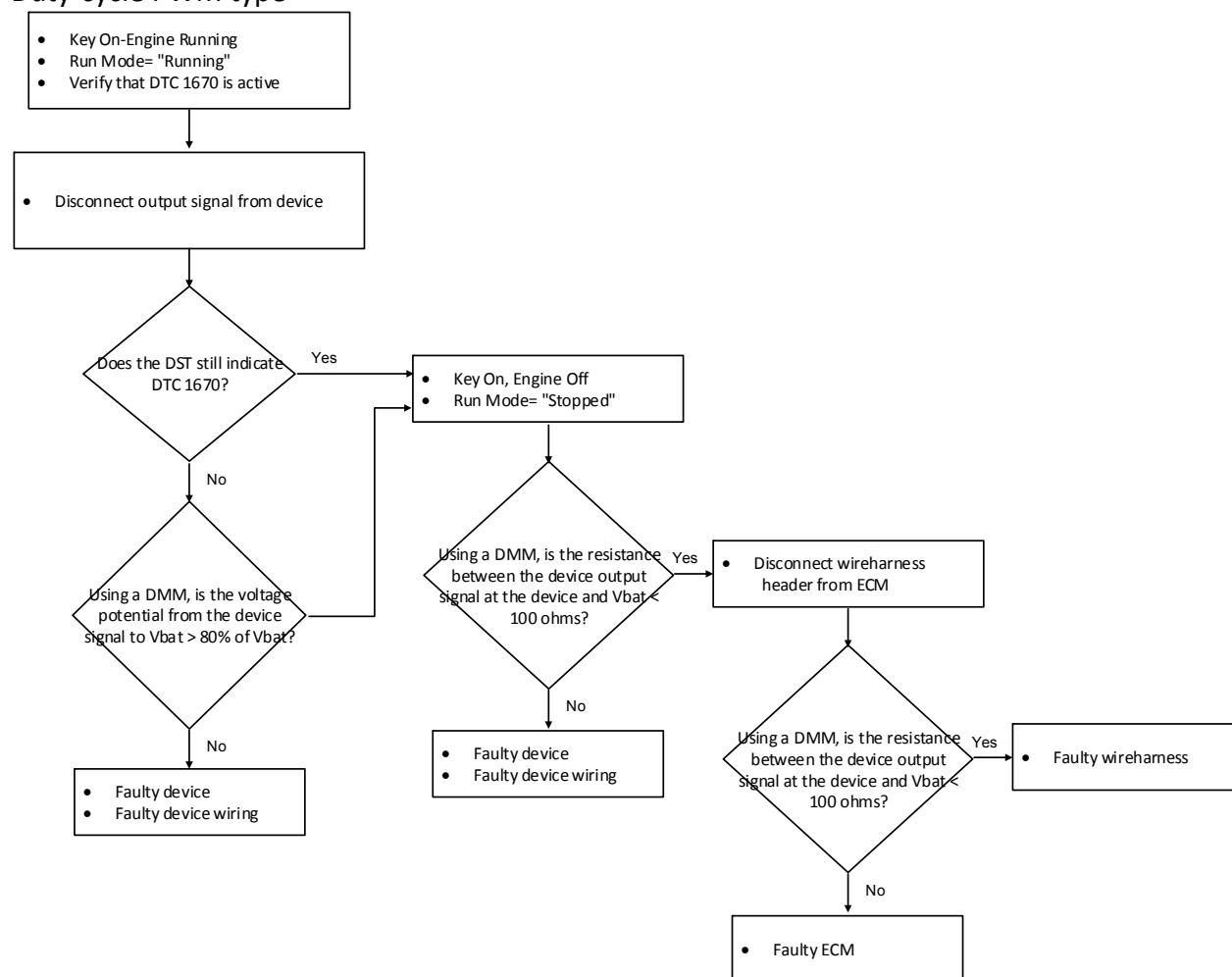
AUX PWM9 output shorted to power

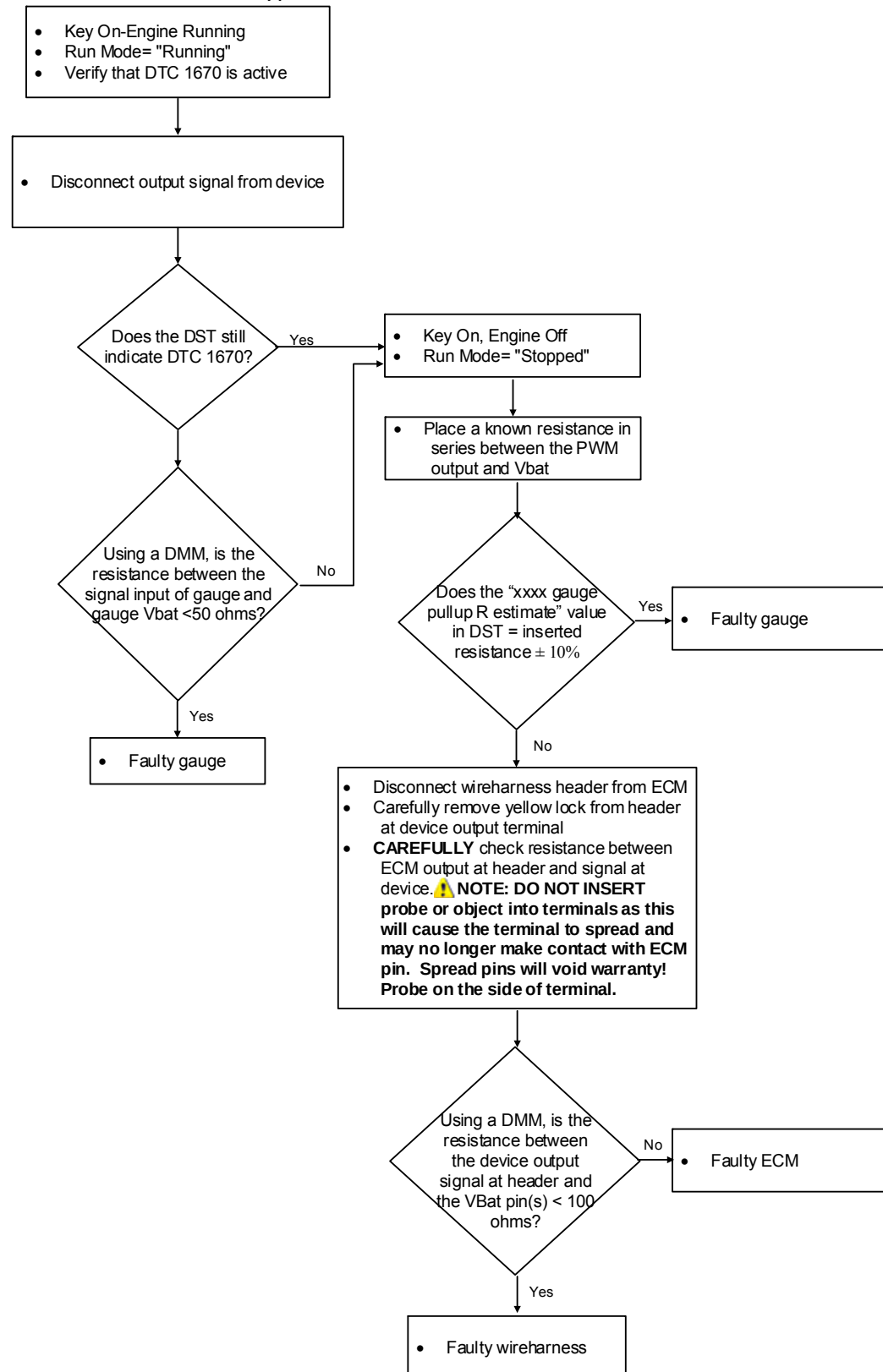
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

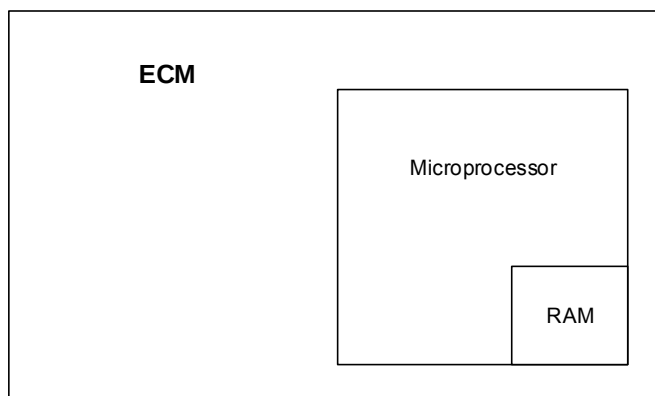
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1670 – PWM9 SHORT TO POWER (TROUBLE TREE)

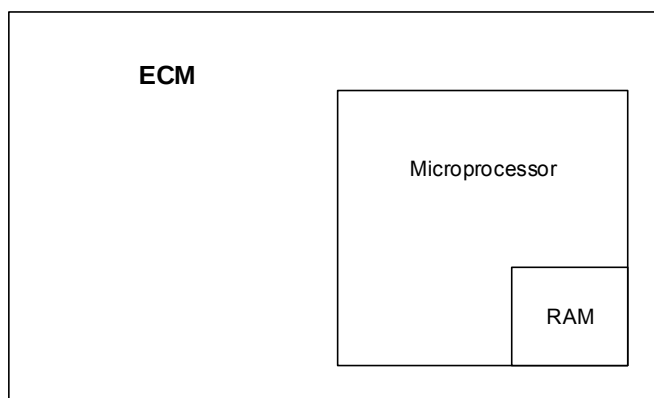
Duty-cycle PWM type



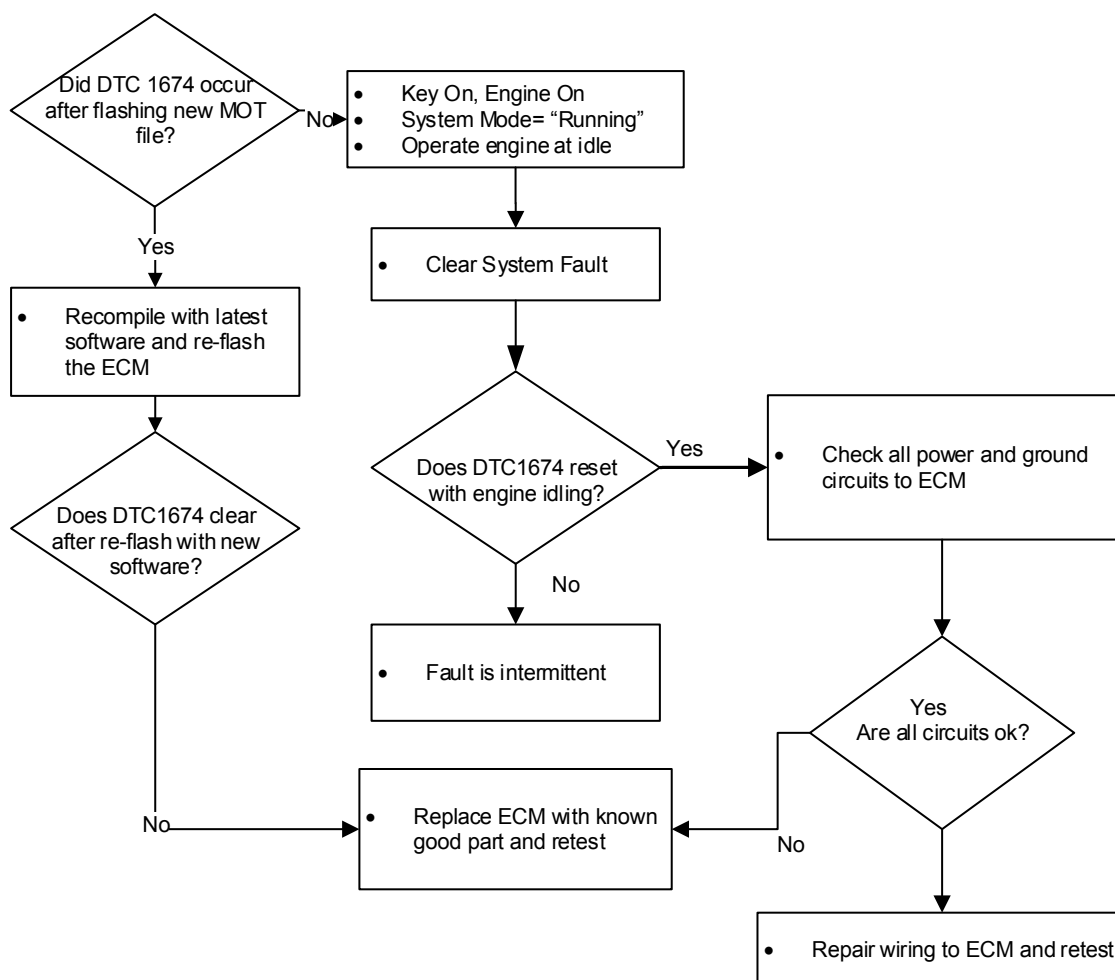
DTC 1670 – PWM9 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

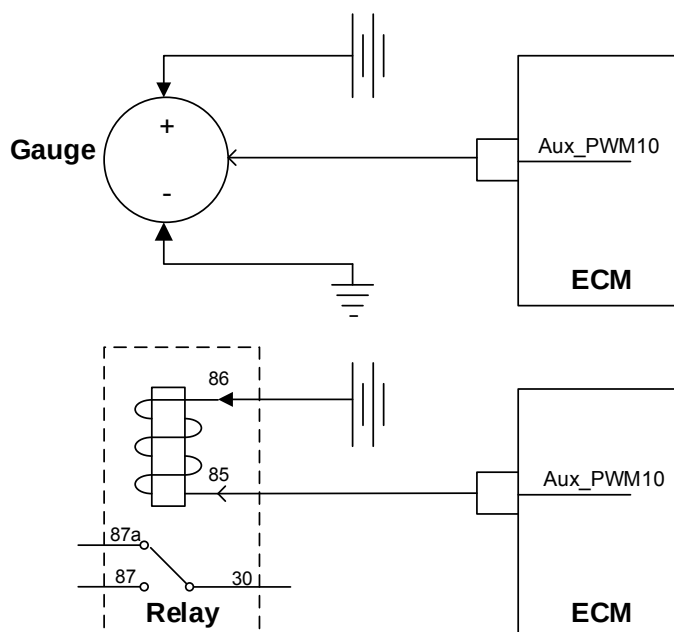
DTC 1673 - CALIBRATION CONFIGURATION ERROR

DTC	1673	SPN	1634	FMI	13		
Sensor/Circuit: Calibration Configuration Error							
Description: The ECM checks certain safety-related calibration variables for acceptable values or ranges. During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared. Adaptive Learn will be disabled for the duration of the key on cycle to prevent improper learning and updating of the table. The MIL will be illuminated for the duration of the key on cycle. Additionally, the fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration): Specific calibration variable checks do not return expected results							
Possible Causes: Specific calibration variable checks do not return expected results							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

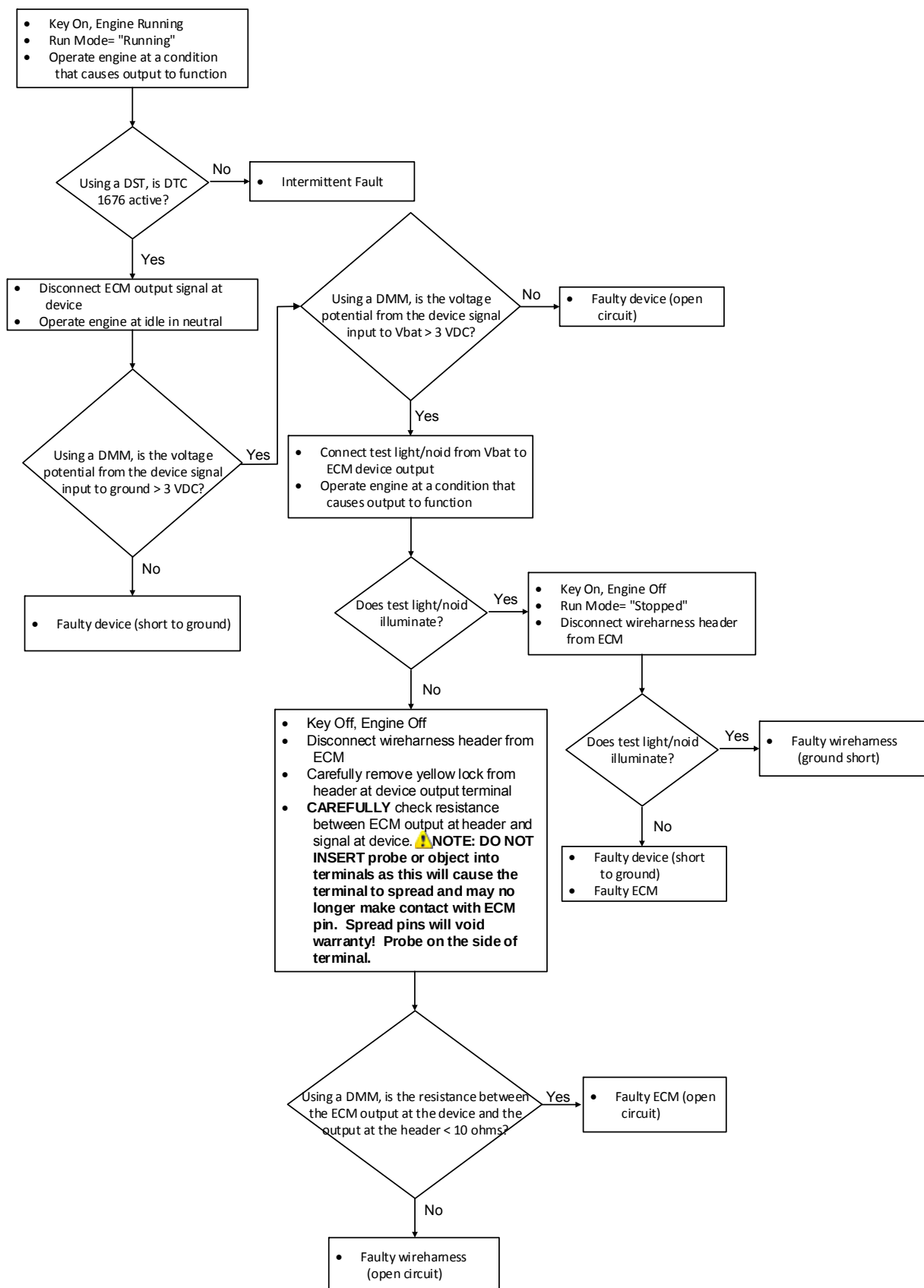
DTC 1674 - HARDWARE ID FAILURE

DTC	1674	SPN	1634	FMI	2		
Sensor/Circuit: Engine Control Module- Hardware ID Failure							
Description: The ECM checks the MOT file against hardware ID tags that indicate the current ECM hardware revisions level. If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration): MOT file is too old for ECM hardware revision level.							
Possible Causes: This fault will set when programming the ECM with a MOT file that is too old for the given hardware revision level.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1674 - HARDWARE ID FAILURE (TROUBLE TREE)

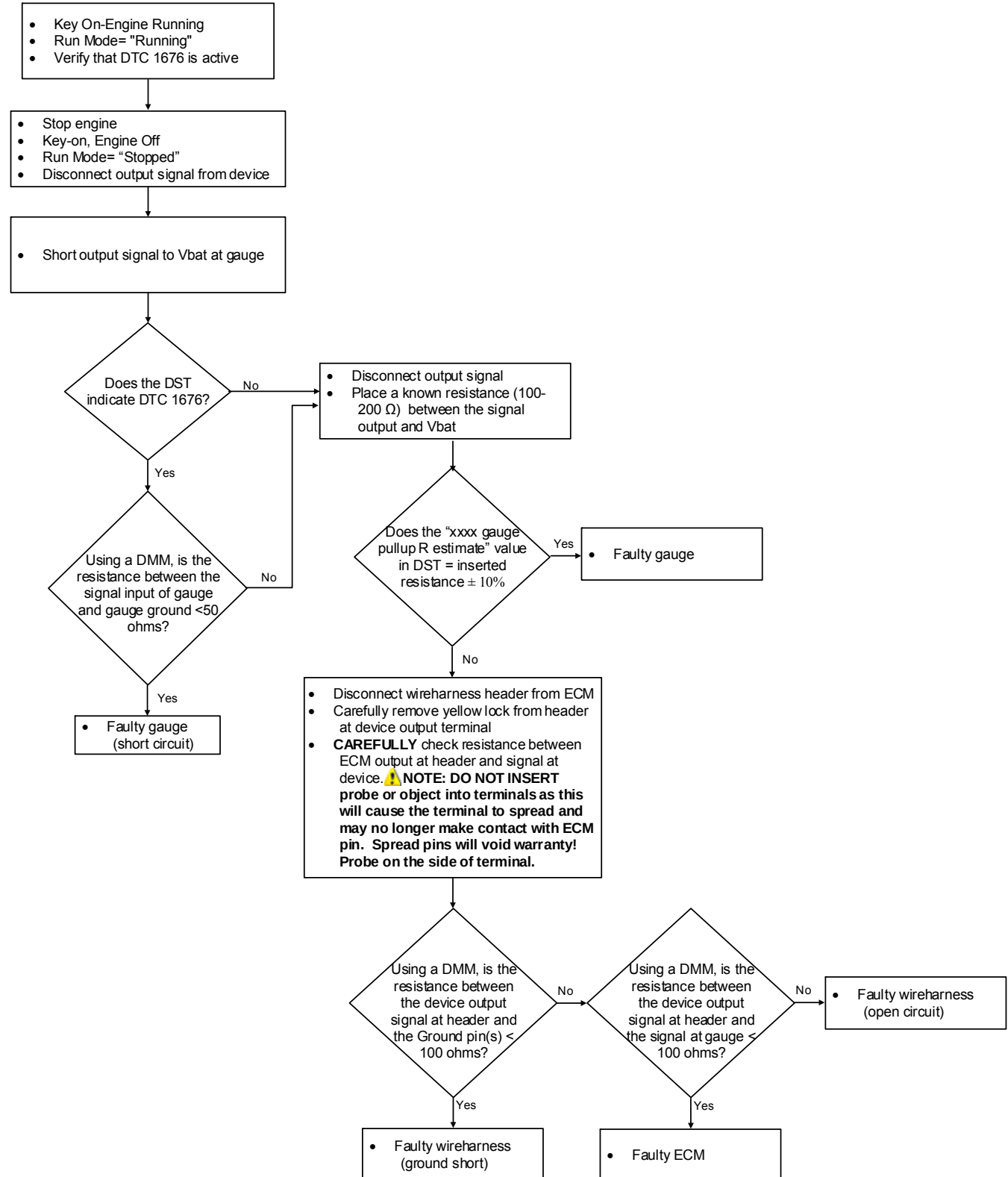
DTC 1676 - PWM10 OPEN / GROUND SHORT

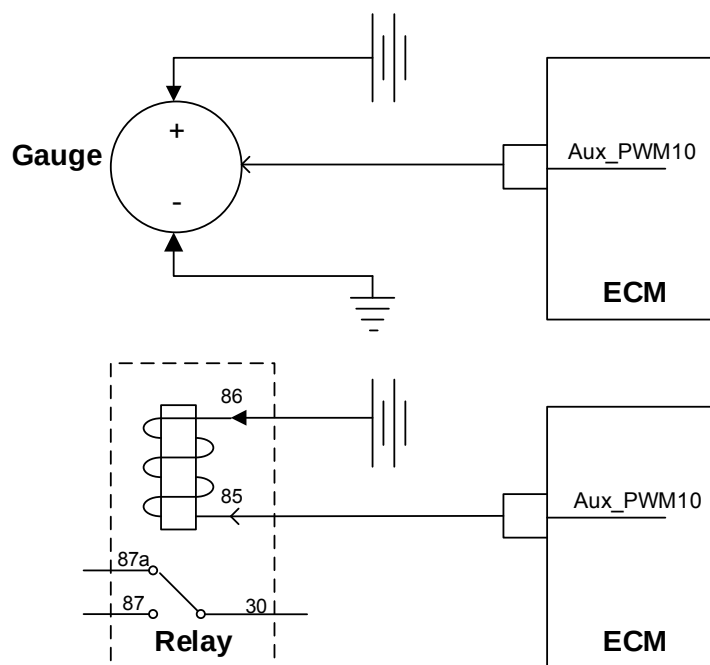
DTC	1676	SPN	2648	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM10 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 10 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM10 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1676 - PWM10 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1676 - PWM10 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1677 - PWM10 SHORT TO POWER

DTC	1677	SPN	2648	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM10 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 10 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 10 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

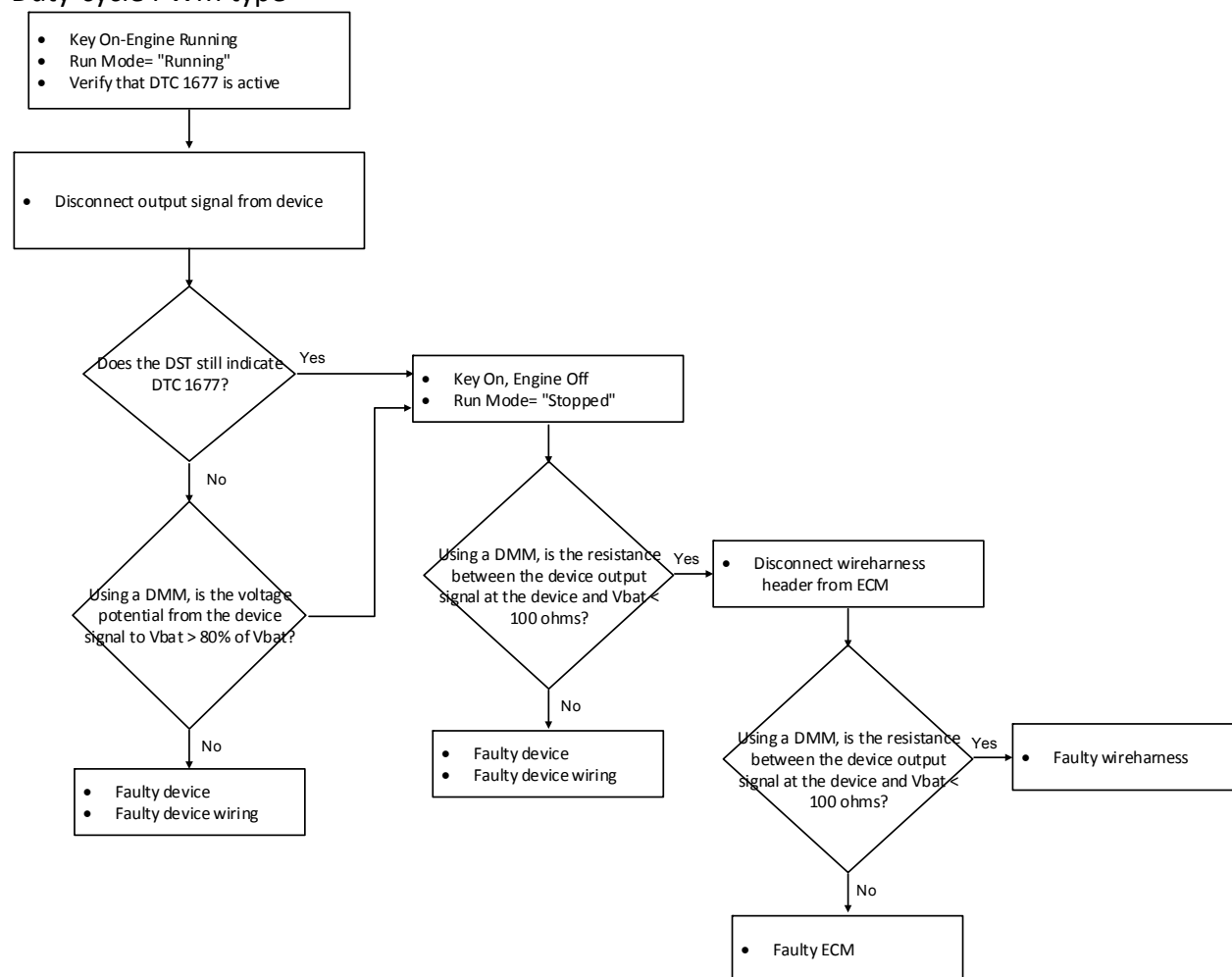
AUX PWM10 output shorted to power

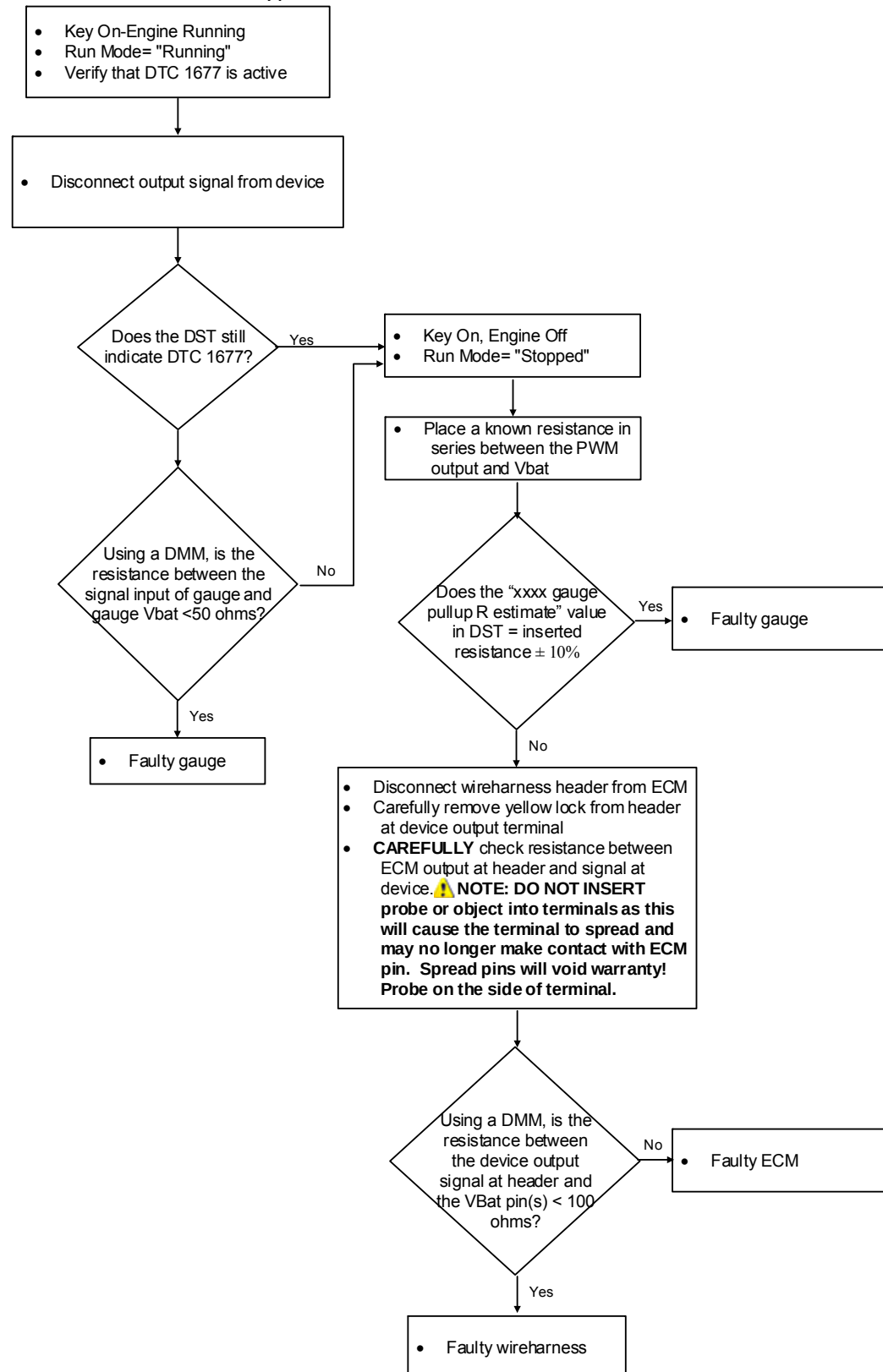
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

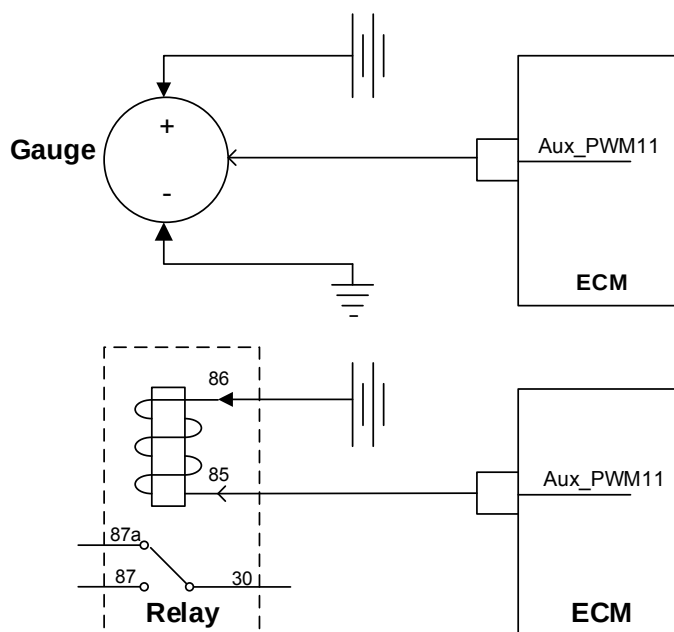
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1677 – PWM10 SHORT TO POWER (TROUBLE TREE)

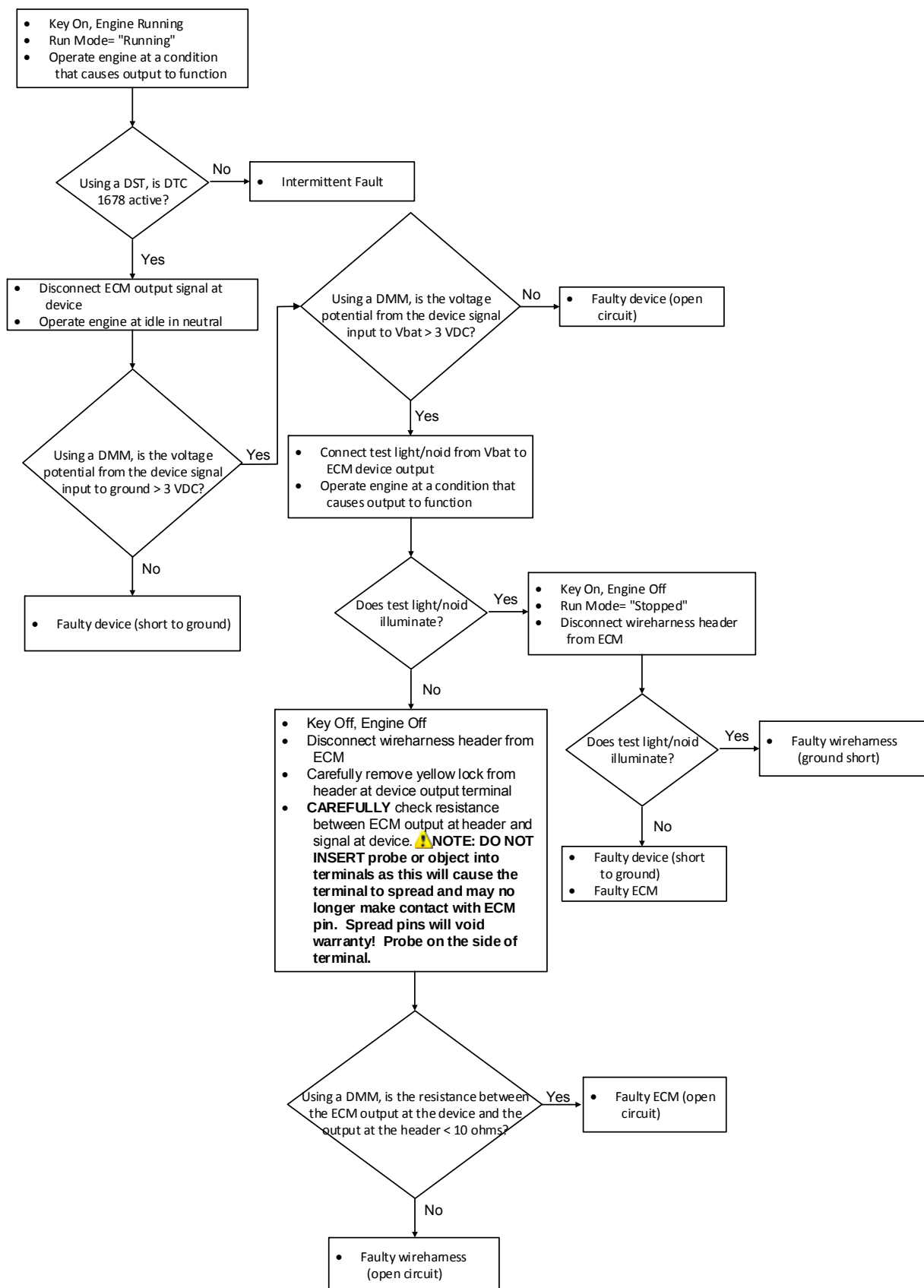
Duty-cycle PWM type



DTC 1677 – PWM10 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

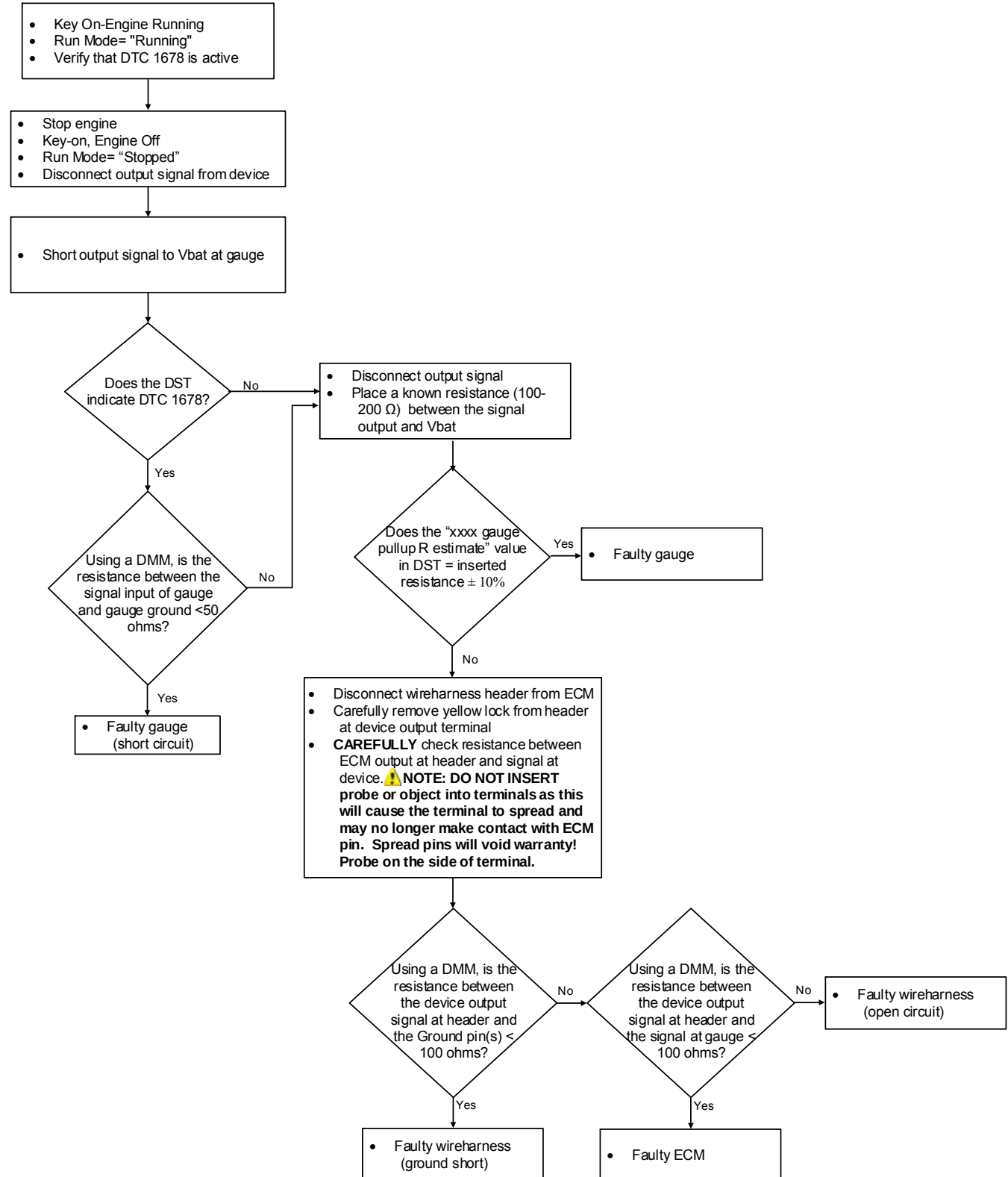
DTC 1678 - PWM11 OPEN / GROUND SHORT

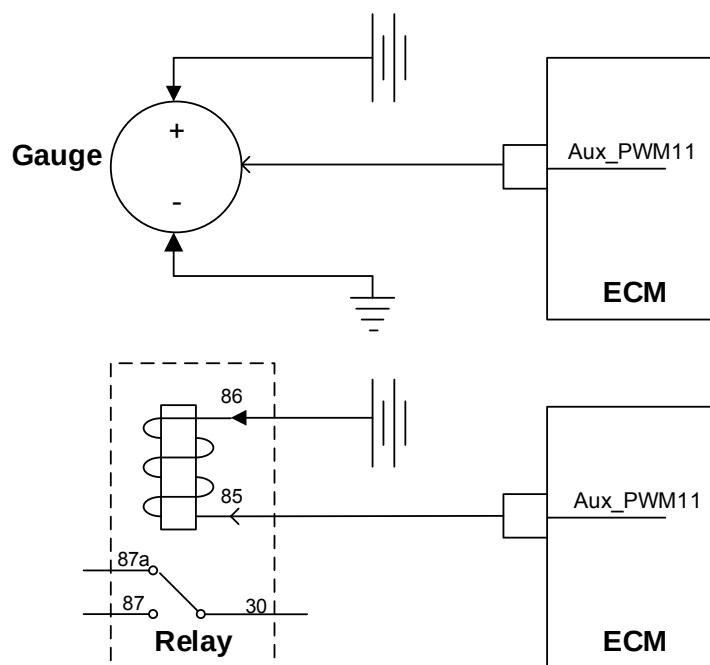
DTC	1678	SPN	2649	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM11 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 11 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM11 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1678 - PWM11 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1678 - PWM11 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1679 - PWM11 SHORT TO POWER

DTC	1679	SPN	2649	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM11 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 11 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 11 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

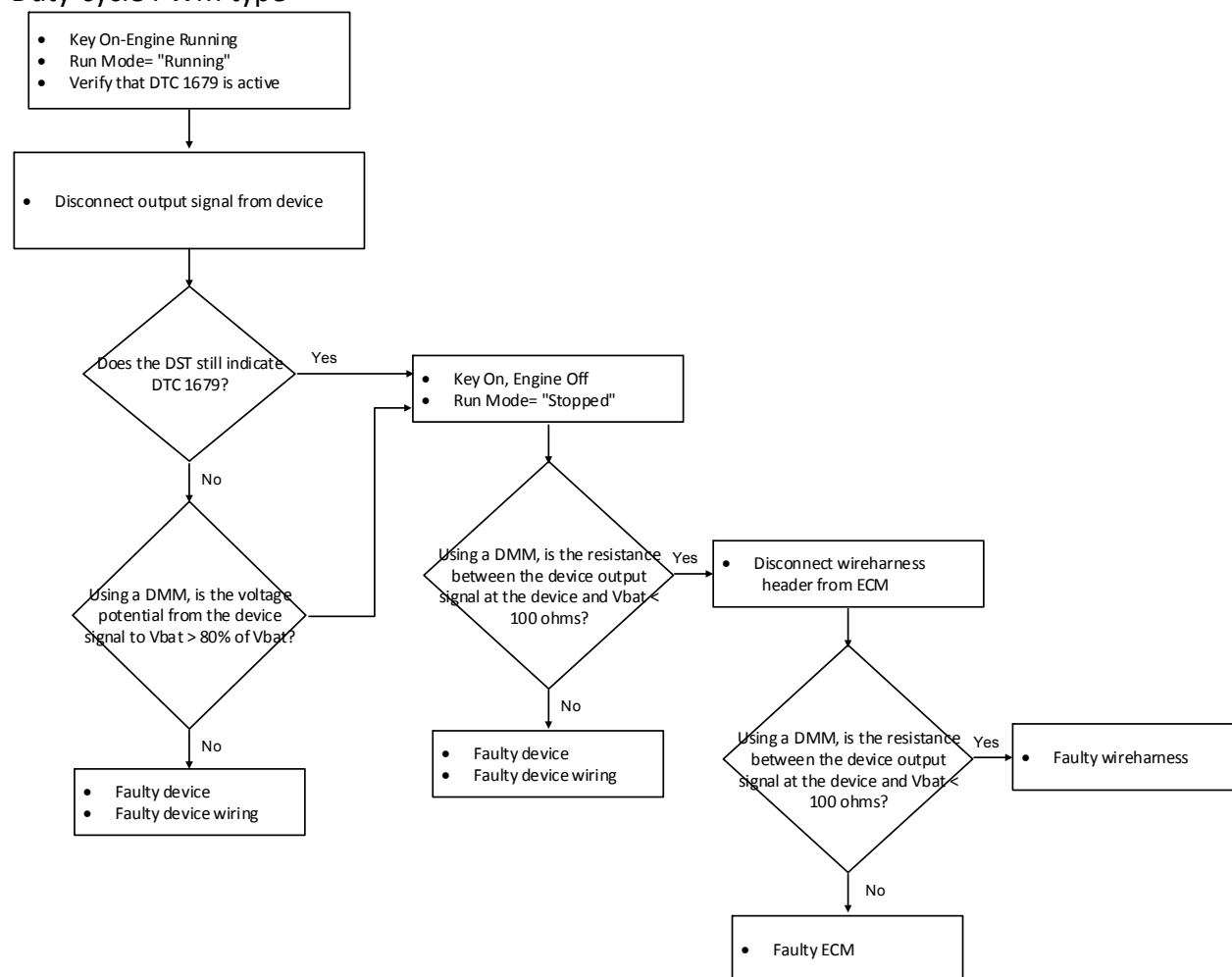
AUX PWM11 output shorted to power

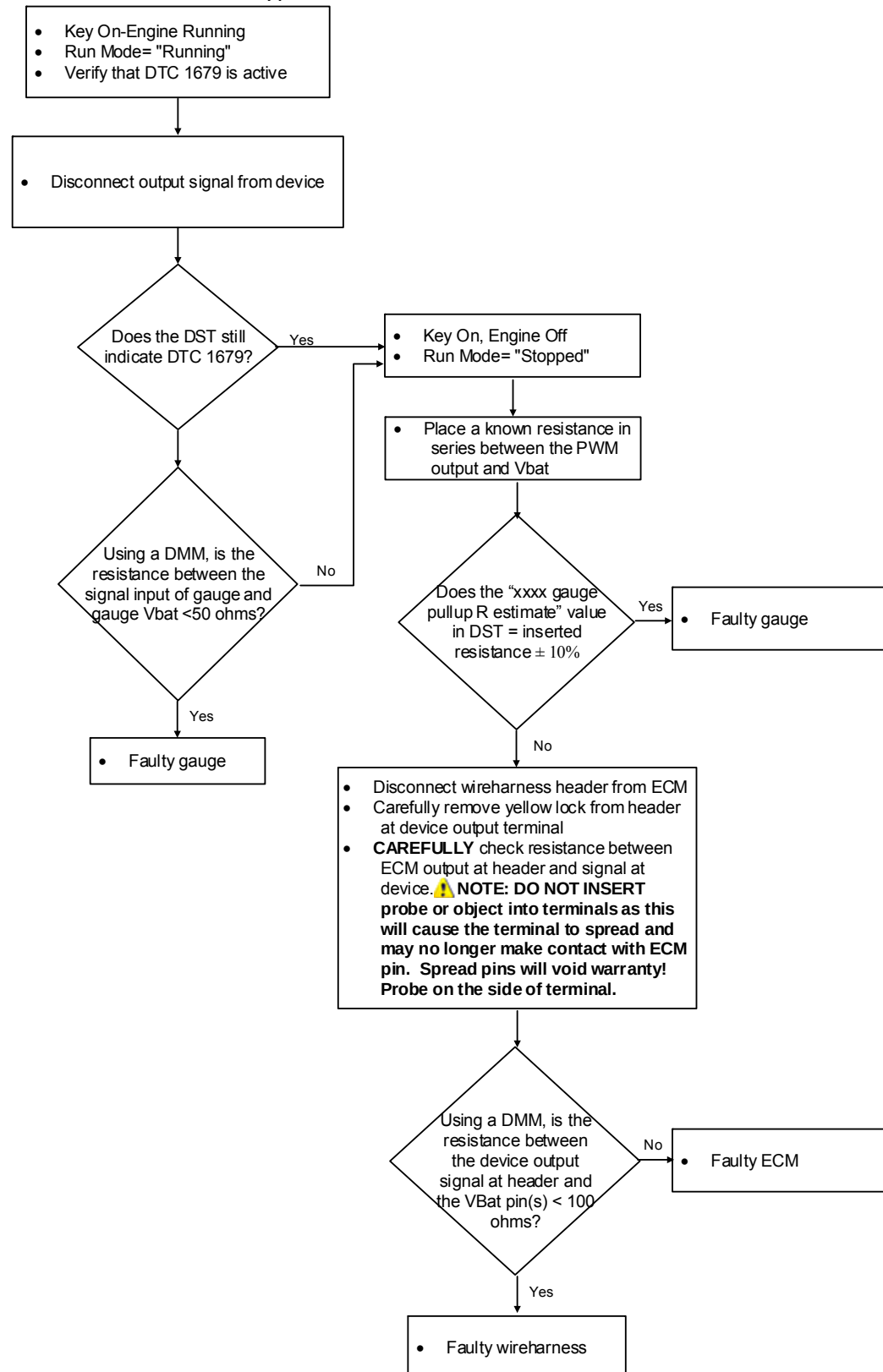
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

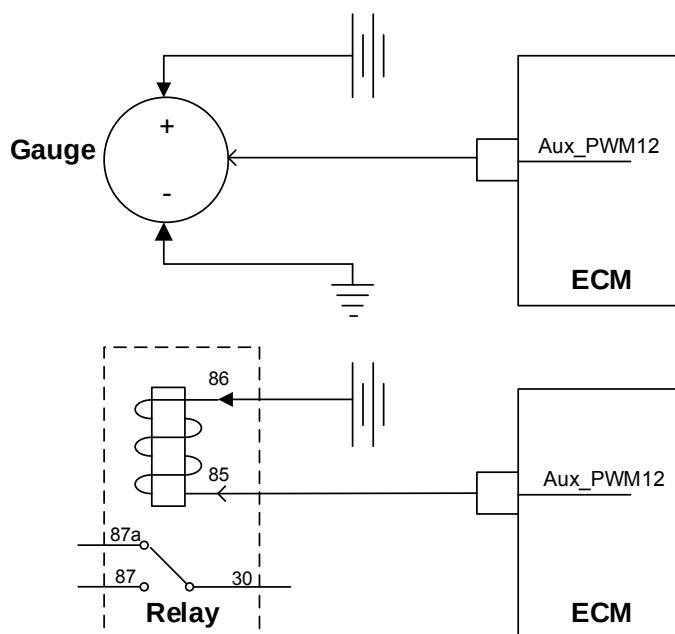
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1679 – PWM11 SHORT TO POWER (TROUBLE TREE)

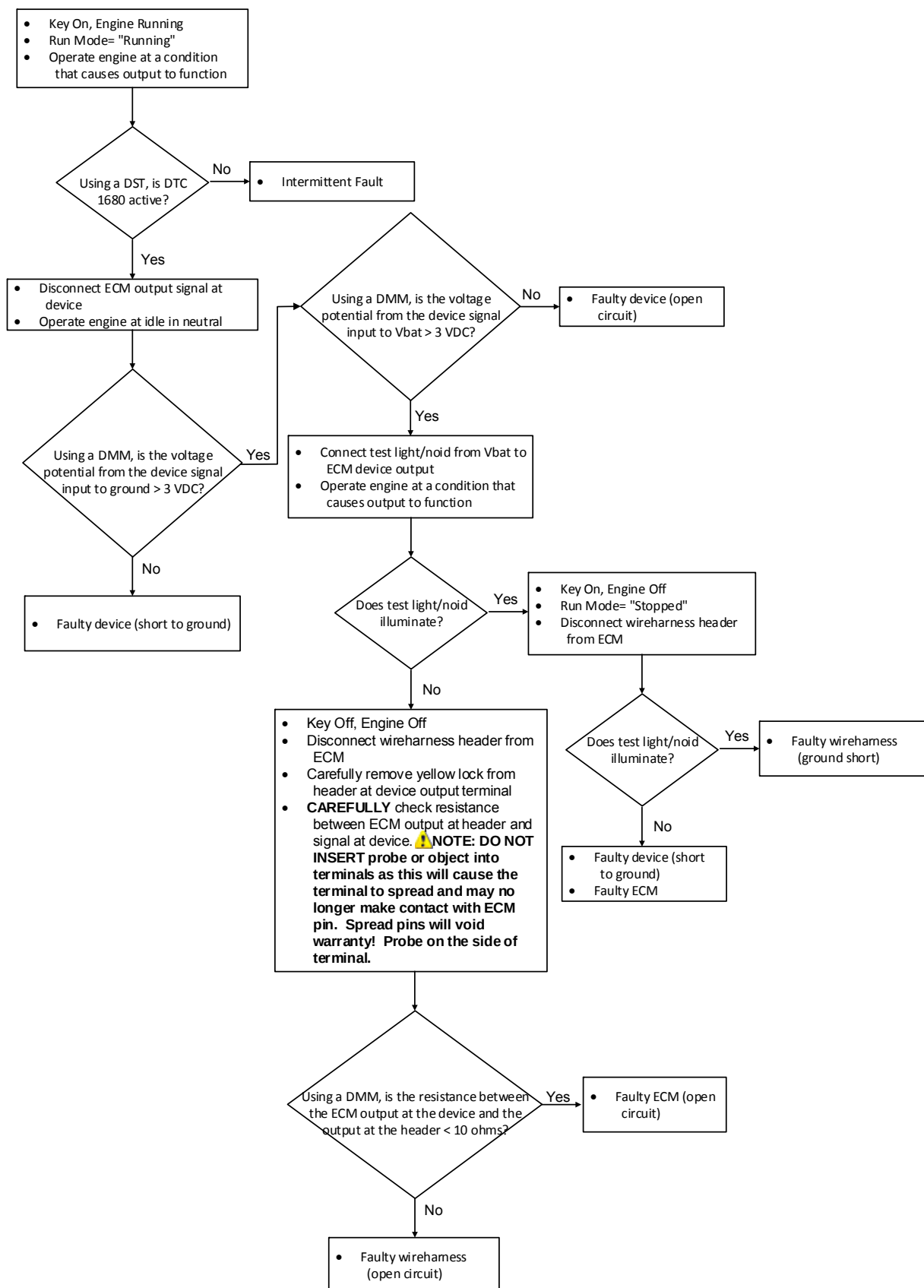
Duty-cycle PWM type



DTC 1679 – PWM11 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

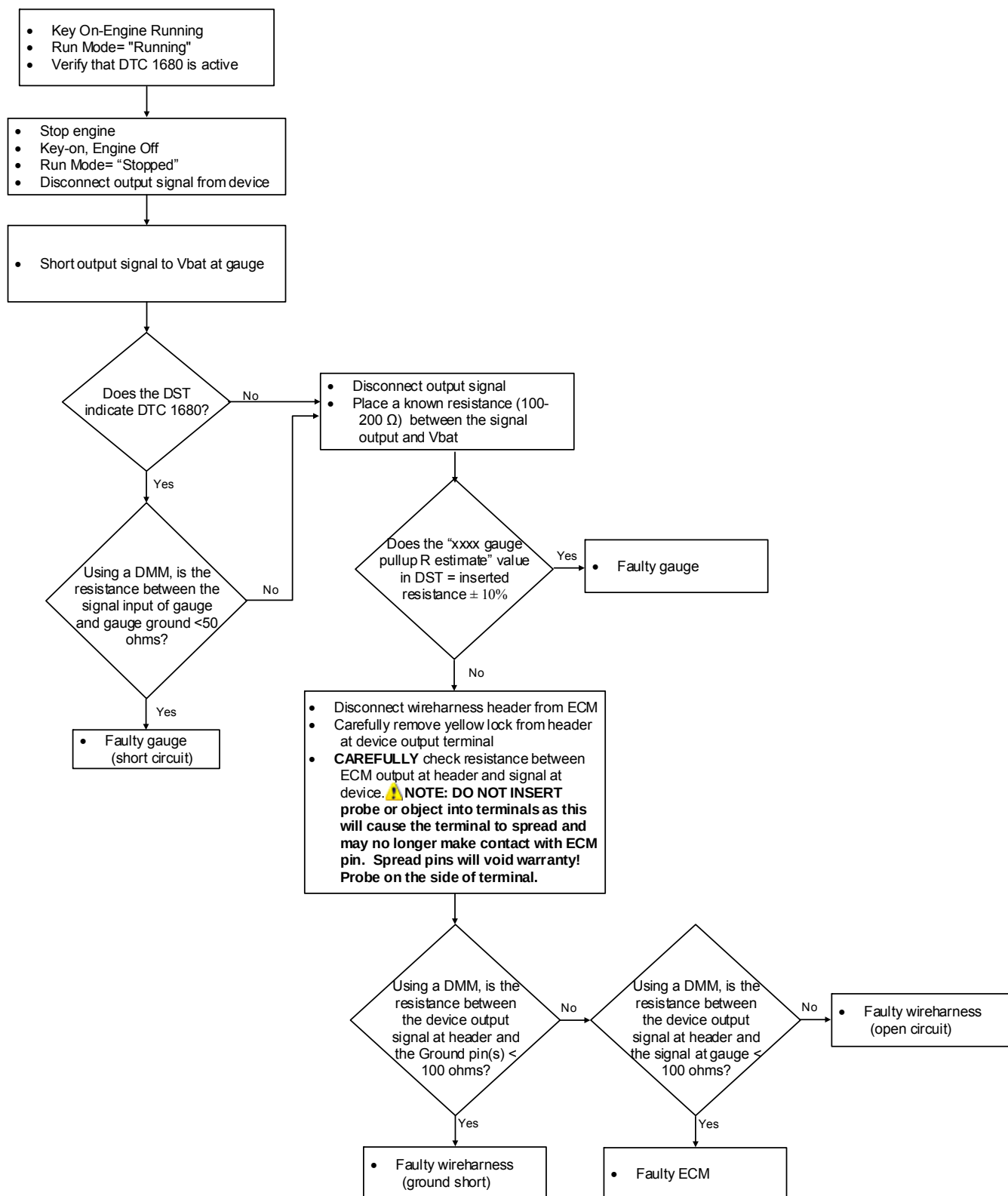
DTC 1680 - PWM12 OPEN / GROUND SHORT

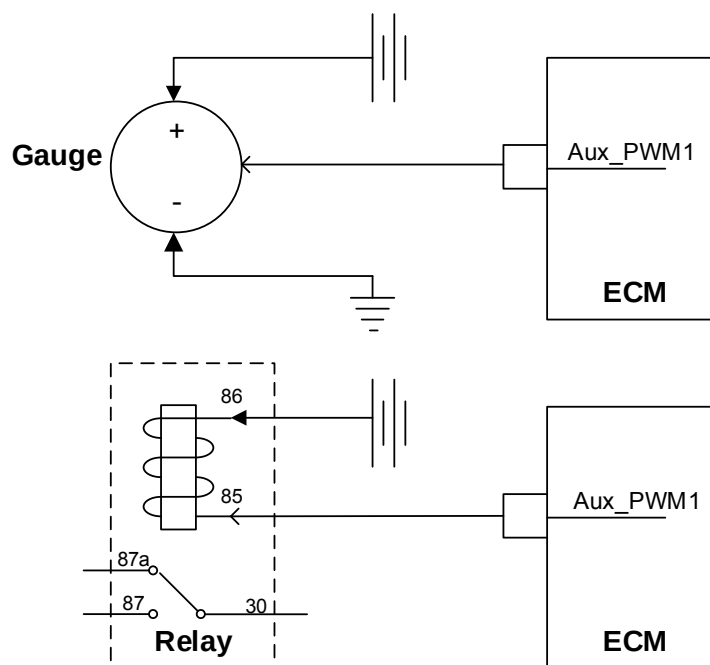
DTC	1680	SPN	2650	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM12 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 12 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM12 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1680 - PWM12 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1680 - PWM12 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1681 - PWM12 SHORT TO POWER

DTC	1681	SPN	2650	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM12 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 12 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 12 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

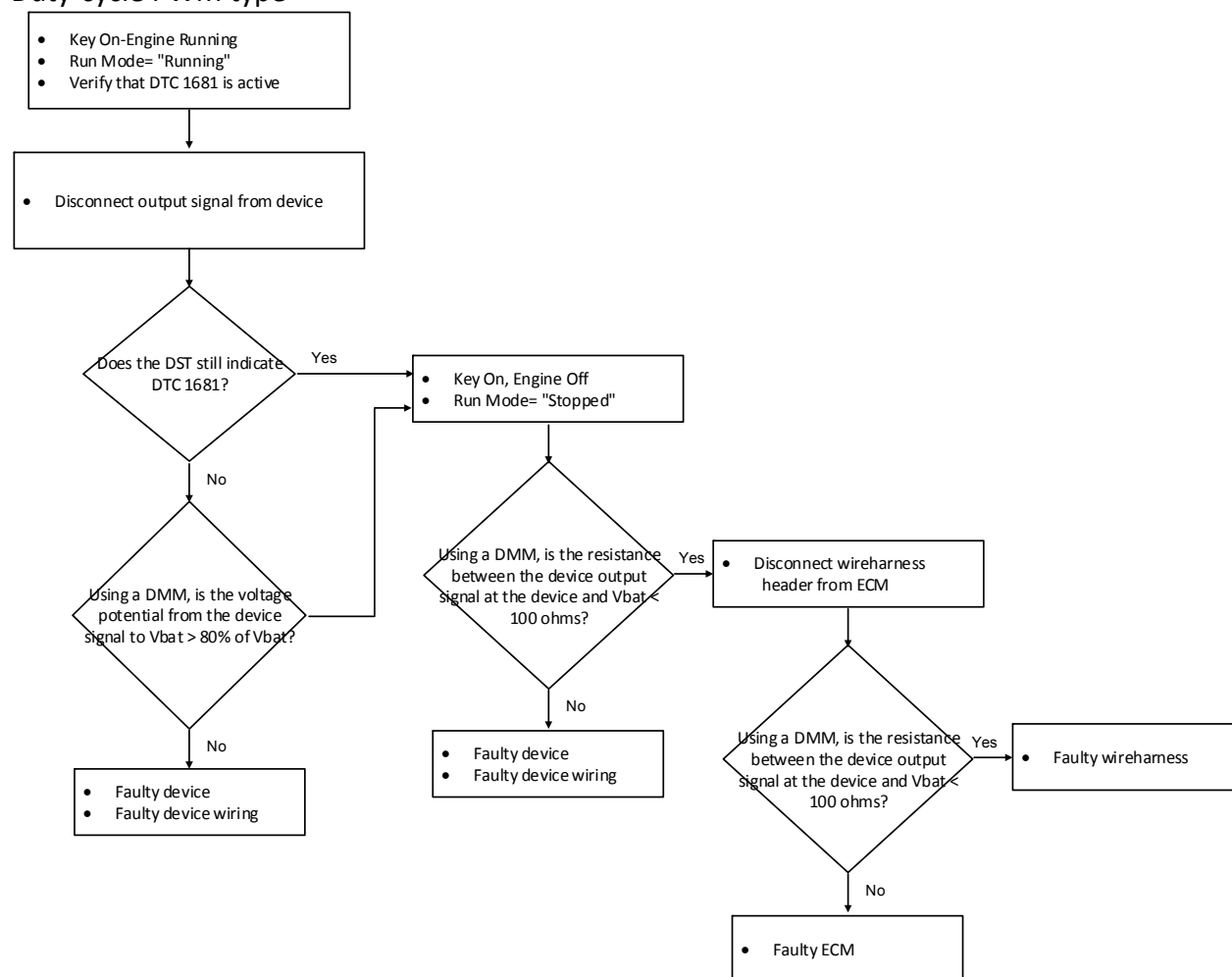
AUX PWM12 output shorted to power

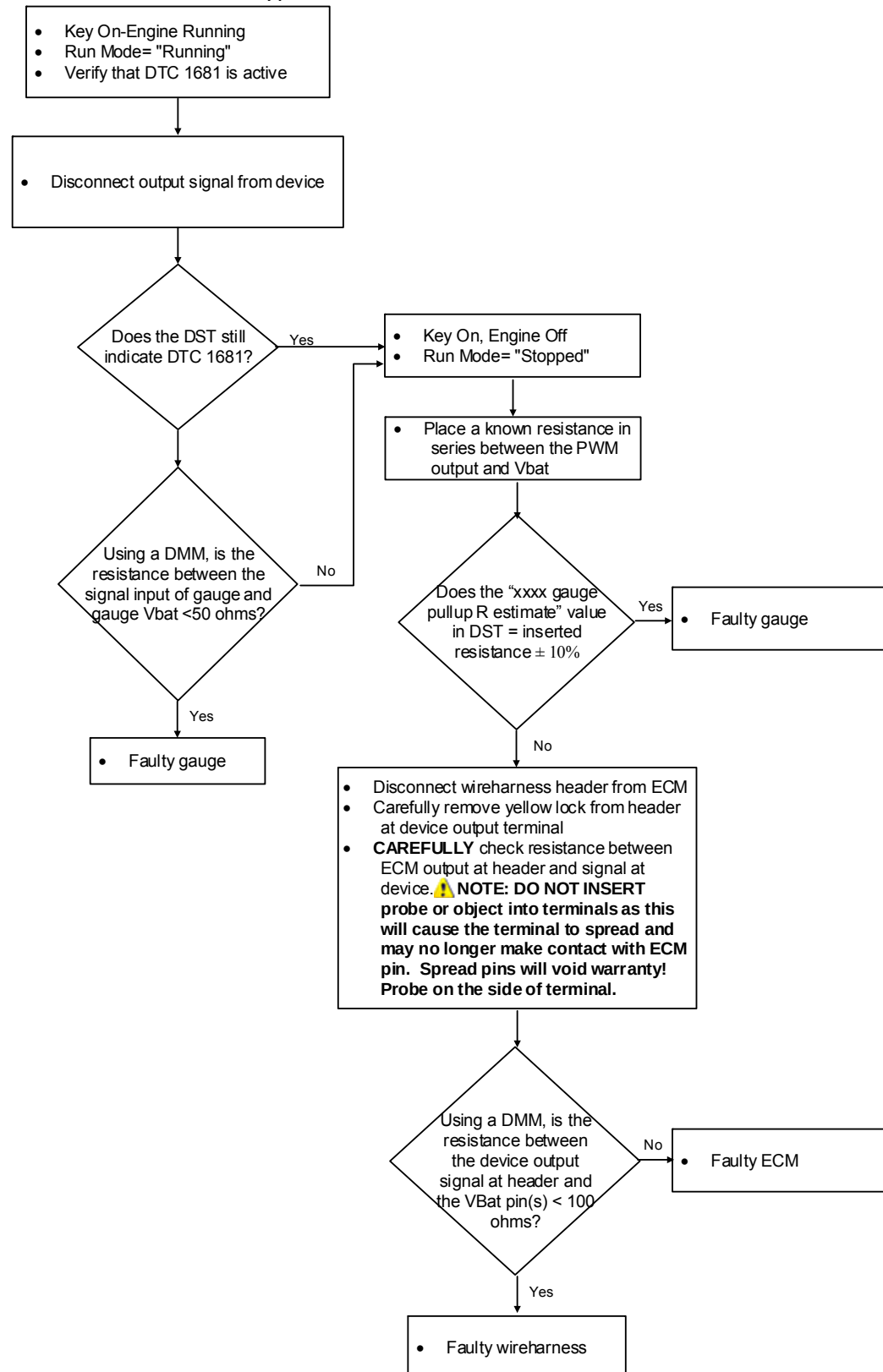
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

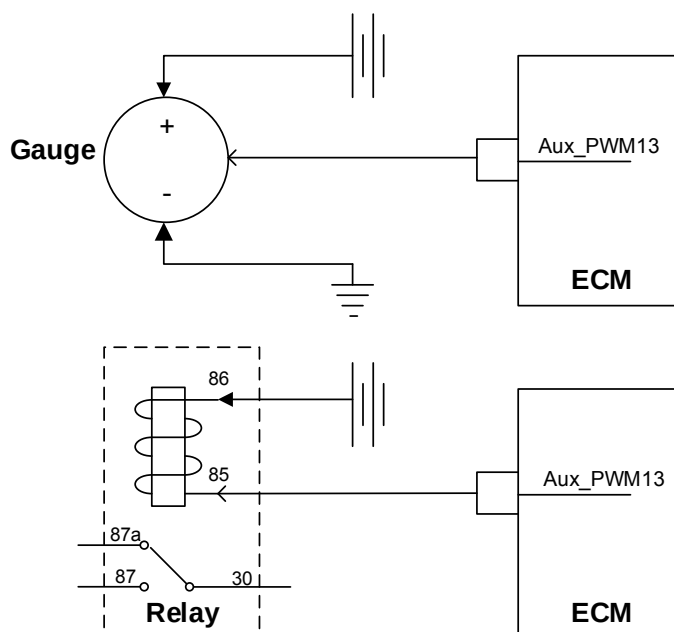
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1681 – PWM12 SHORT TO POWER (TROUBLE TREE)

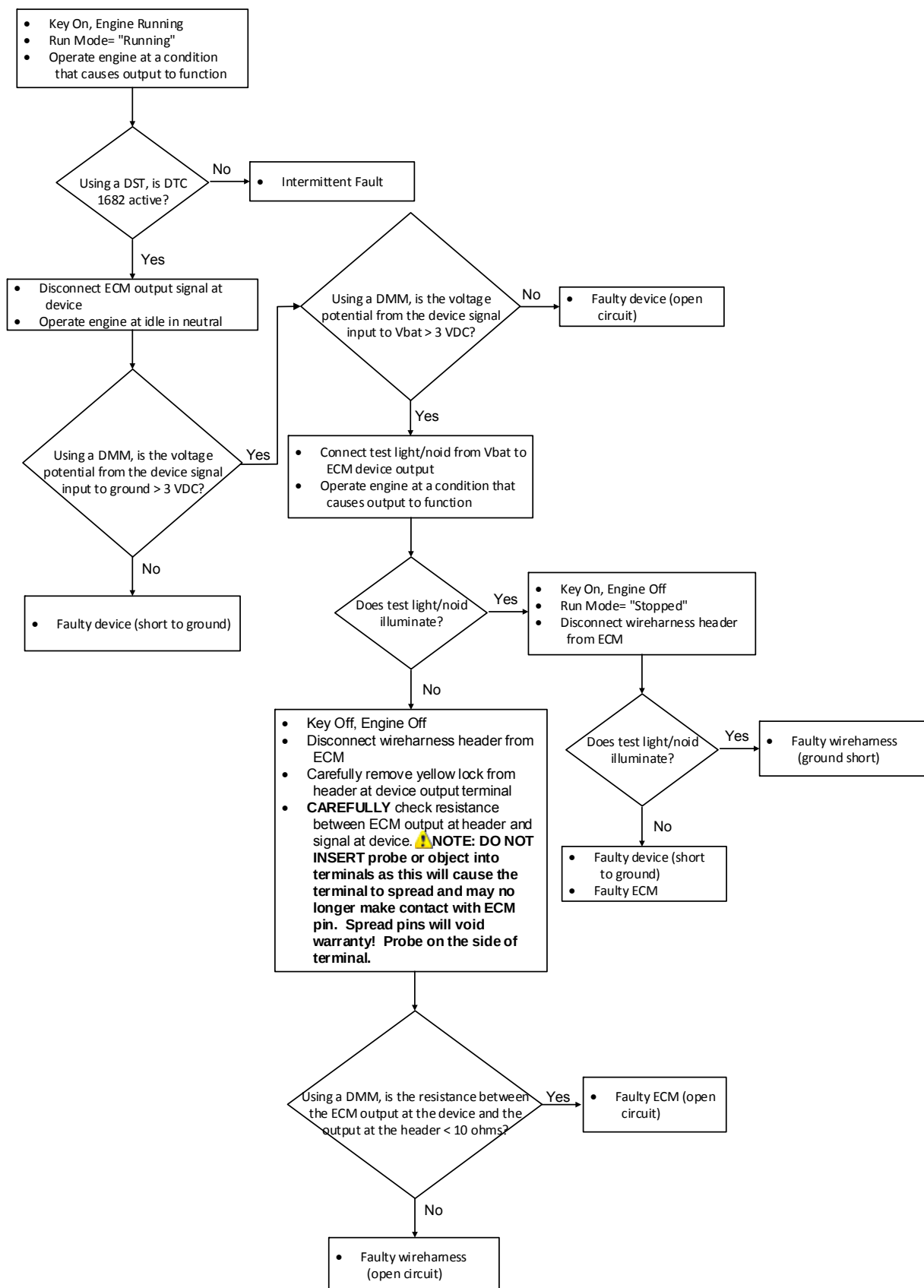
Duty-cycle PWM type



DTC 1681 – PWM12 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

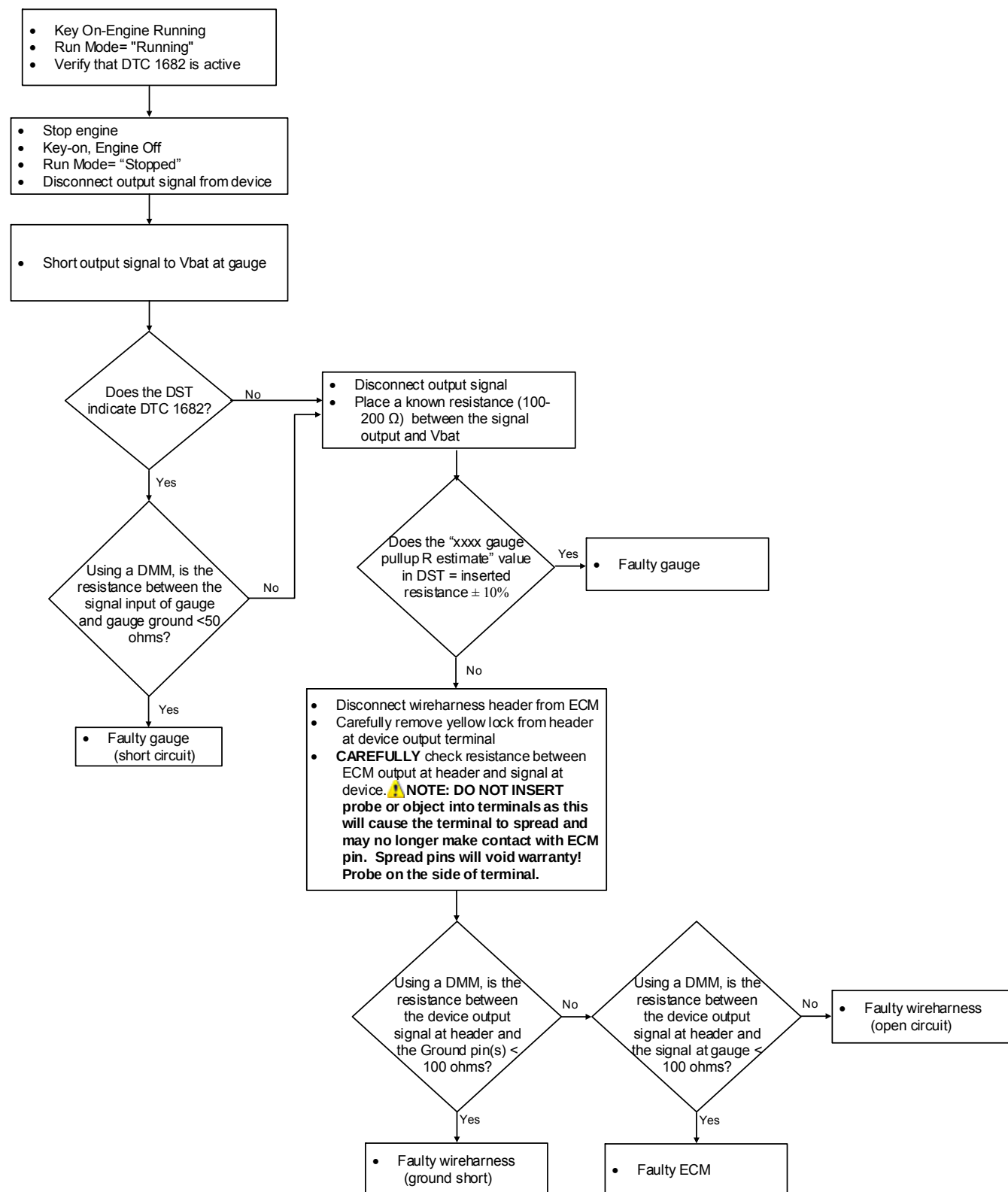
DTC 1682 - PWM13 OPEN / GROUND SHORT

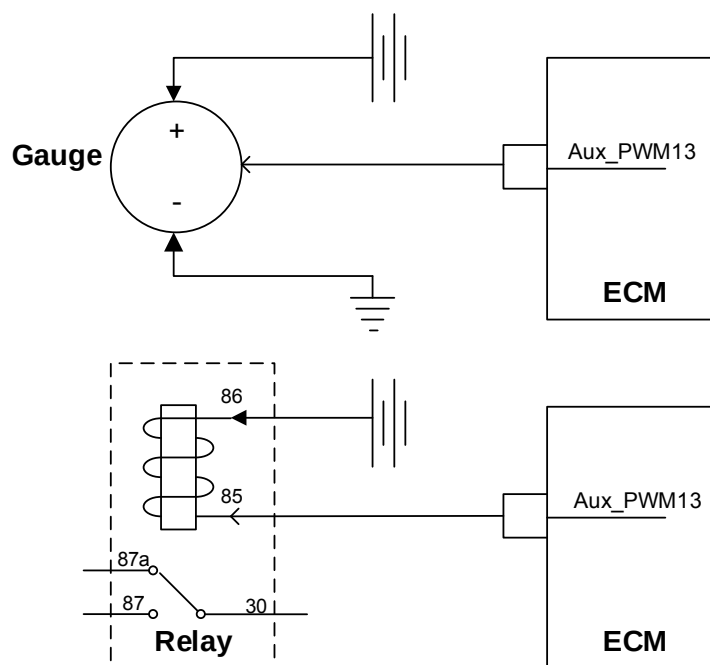
DTC	1682	SPN	2651	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM13 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 13 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM13 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1682 - PWM13 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1682 - PWM13 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1683 - PWM13 SHORT TO POWER

DTC	1683	SPN	2651	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM13 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 13 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 13 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

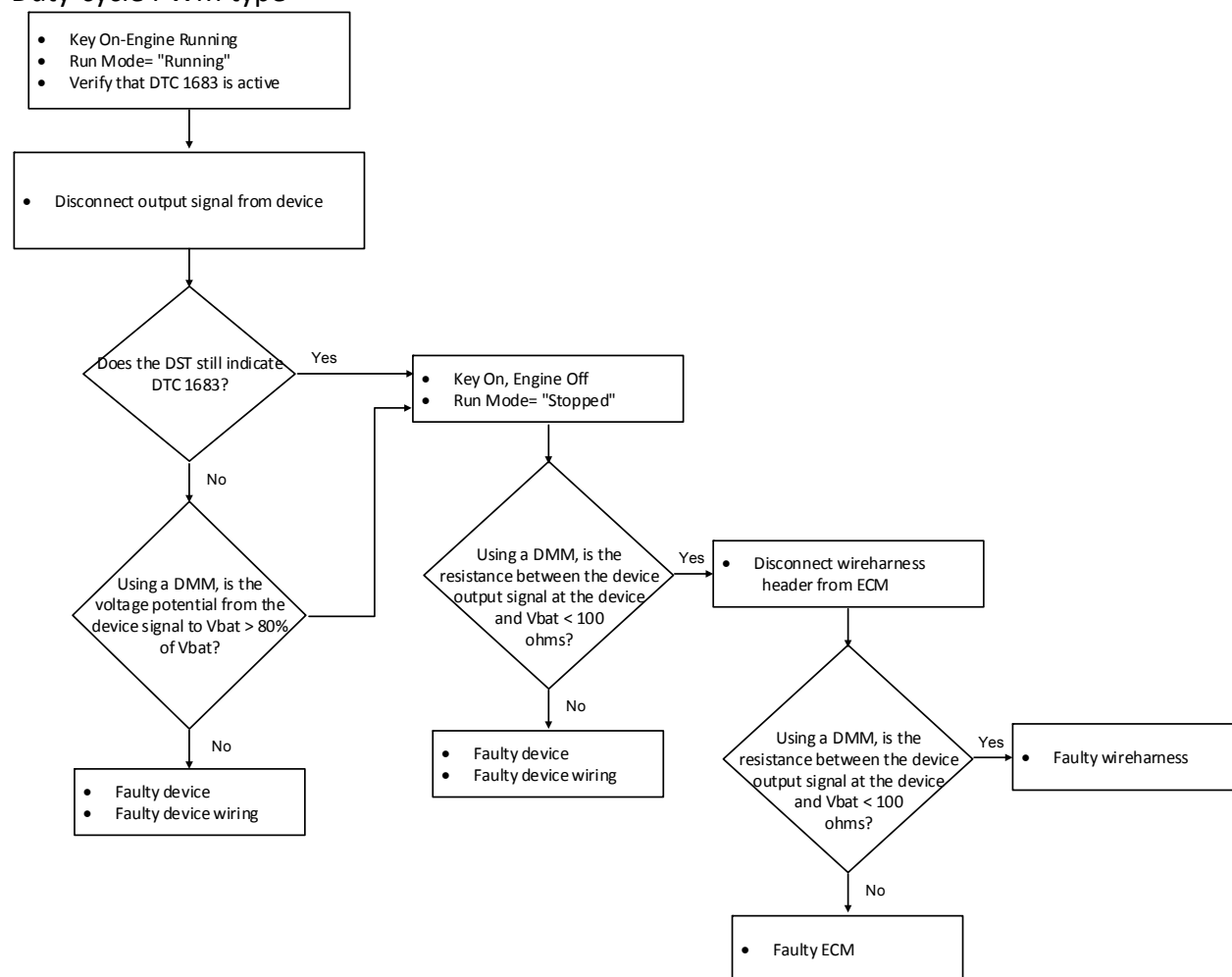
AUX PWM13 output shorted to power

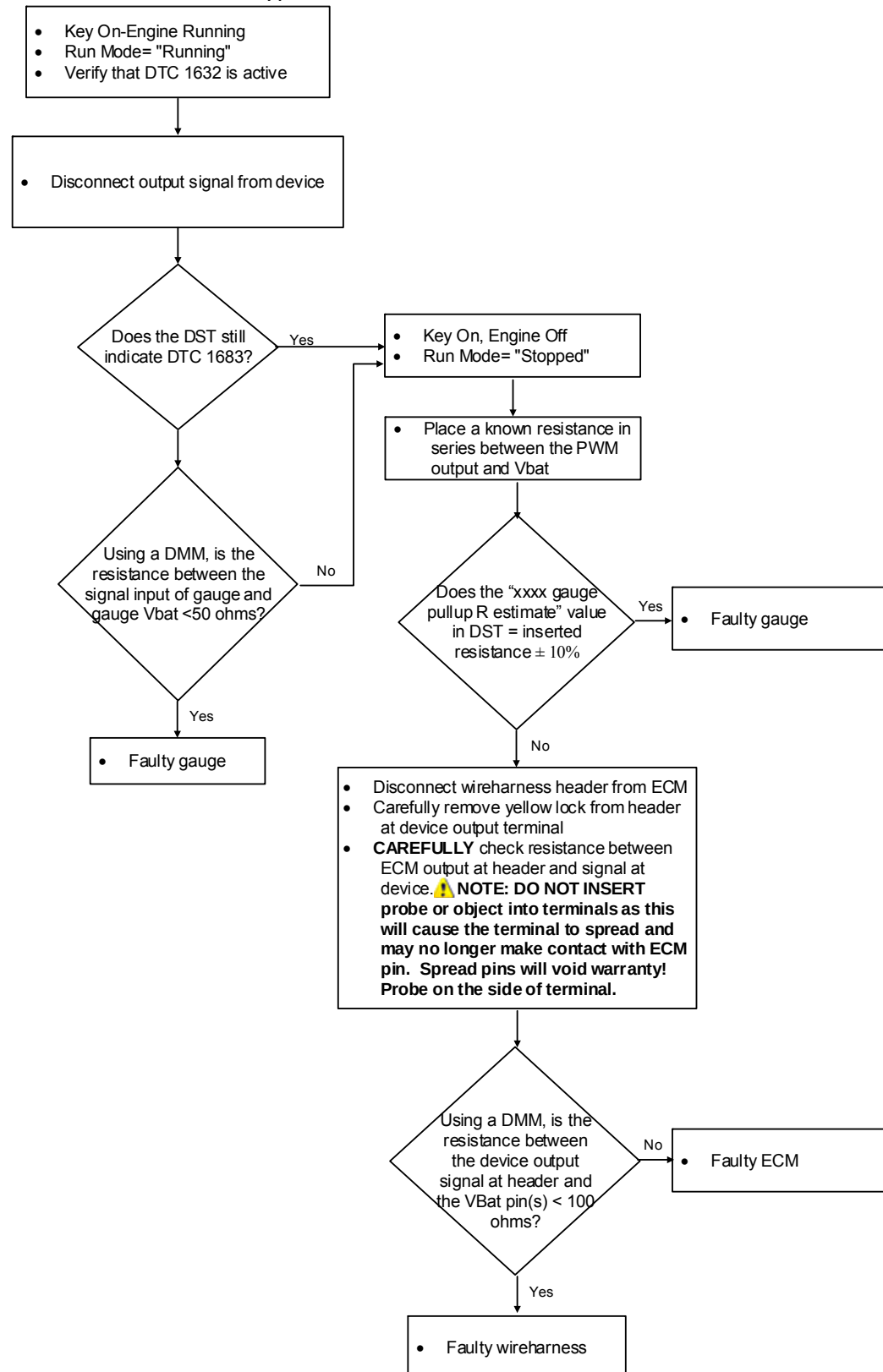
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

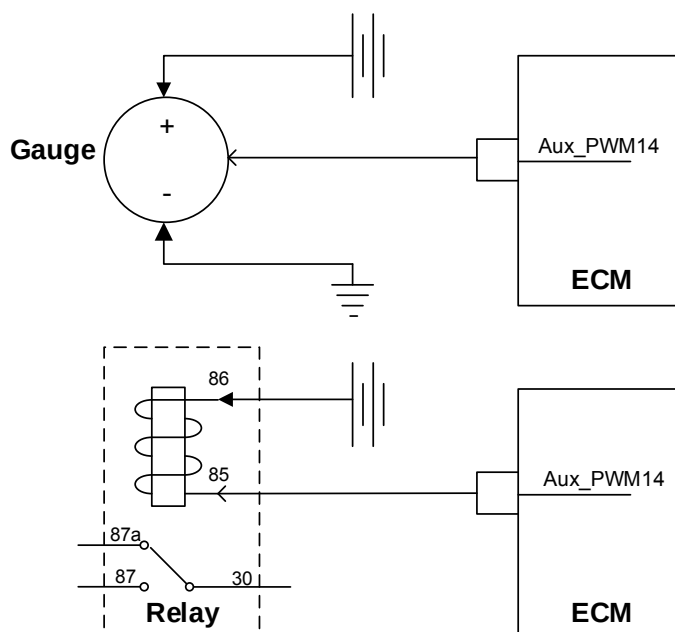
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1683 – PWM13 SHORT TO POWER (TROUBLE TREE)

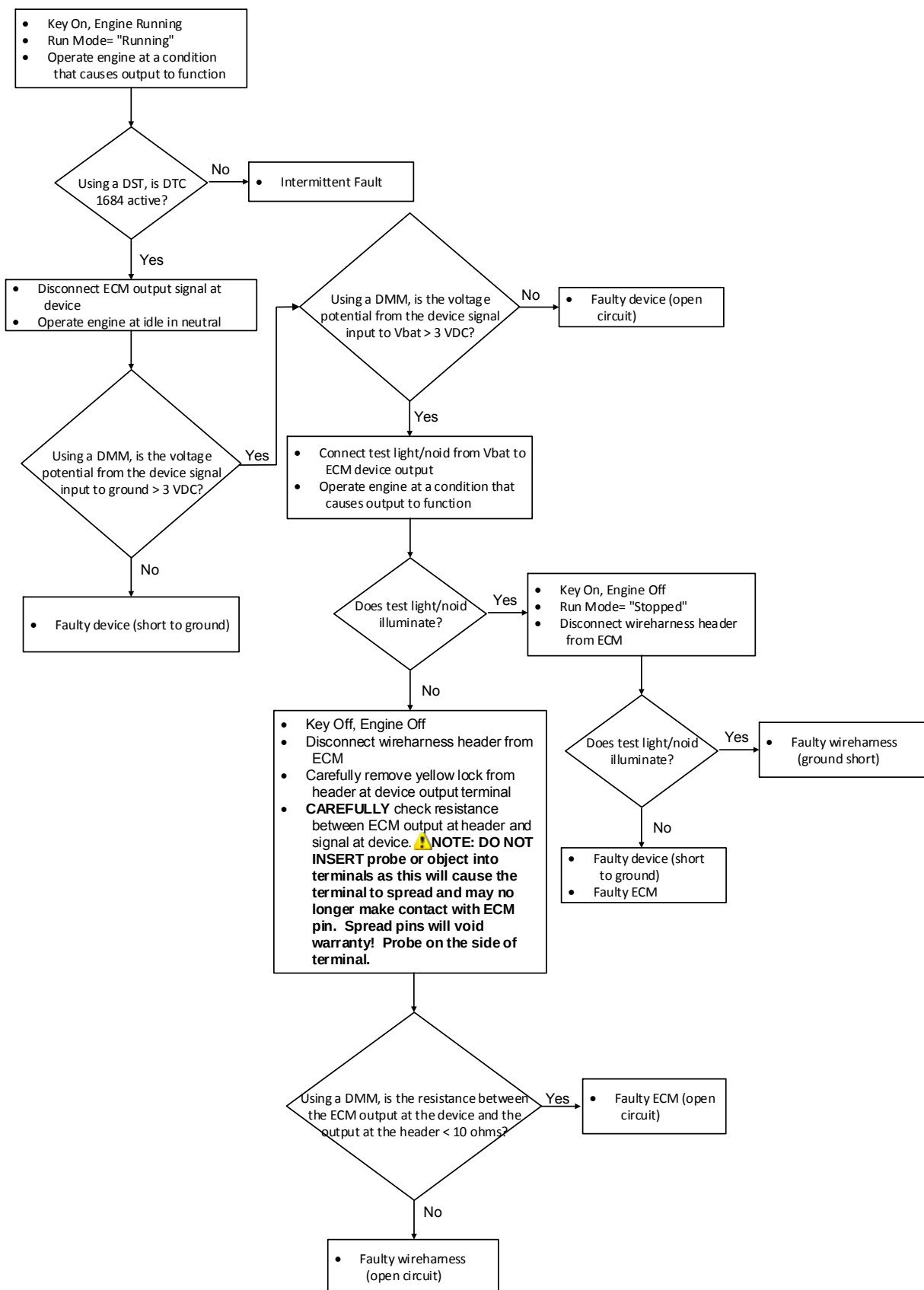
Duty-cycle PWM type



DTC 1683 – PWM13 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

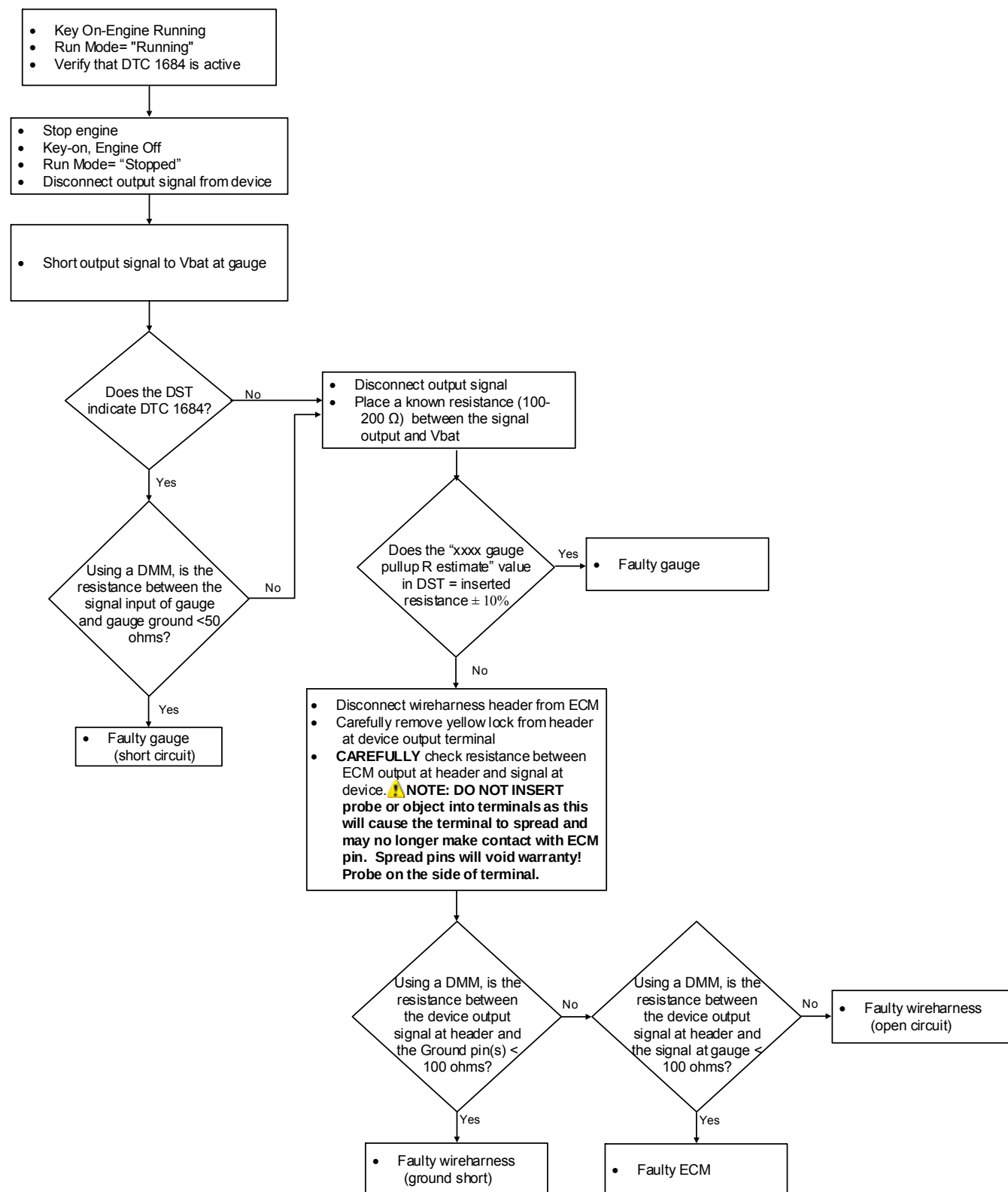
DTC 1684 - PWM14 OPEN / GROUND SHORT

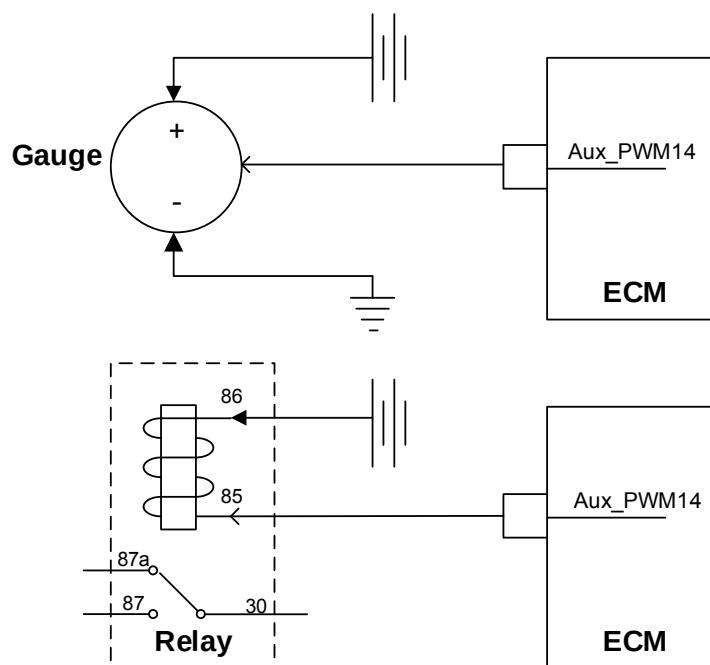
DTC	1684	SPN	2652	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM14 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 14 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM14 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1684 - PWM14 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1684 - PWM14 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1685 - PWM14 SHORT TO POWER

DTC	1685	SPN	2652	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM14 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 14 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 14 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

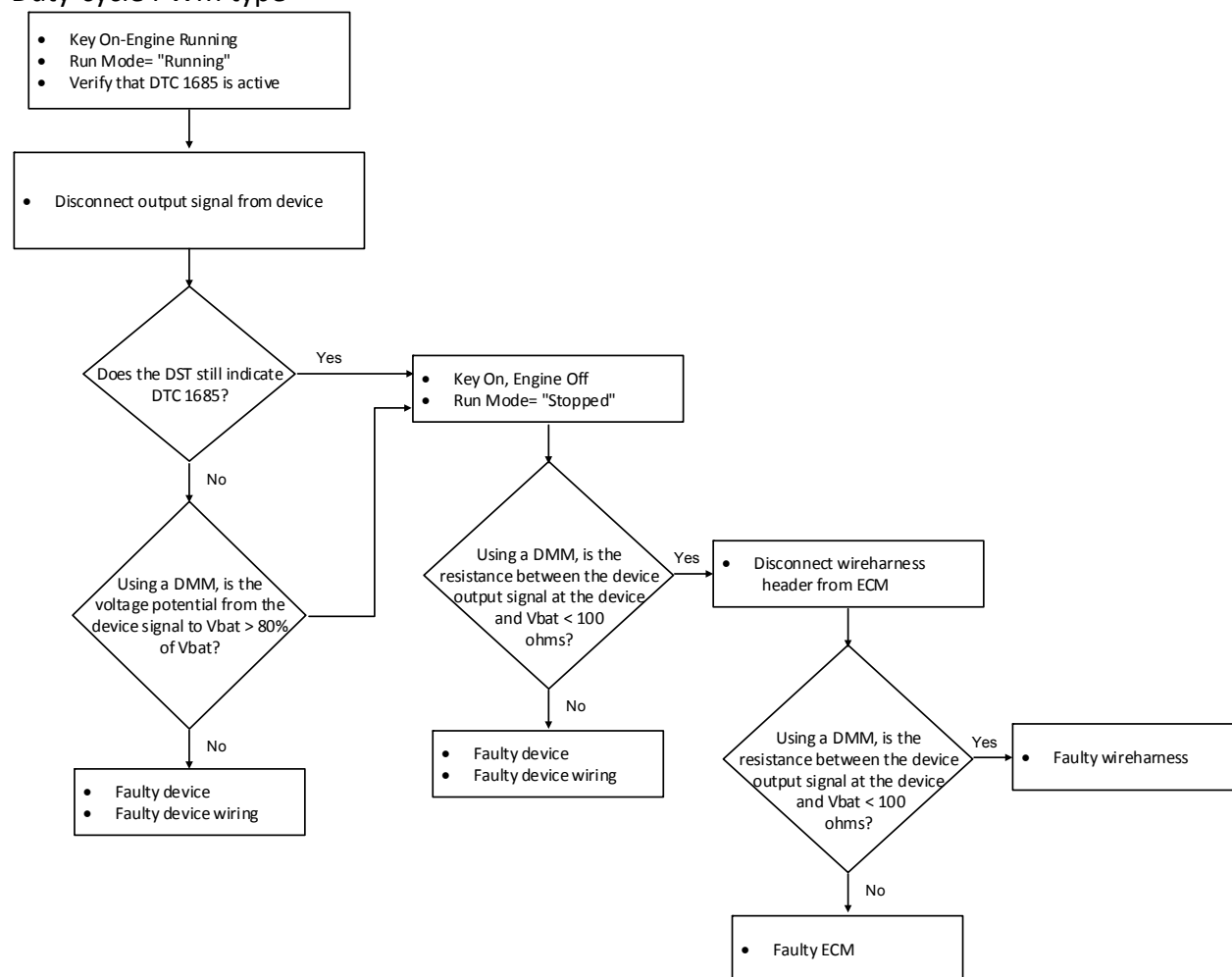
AUX PWM14 output shorted to power

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

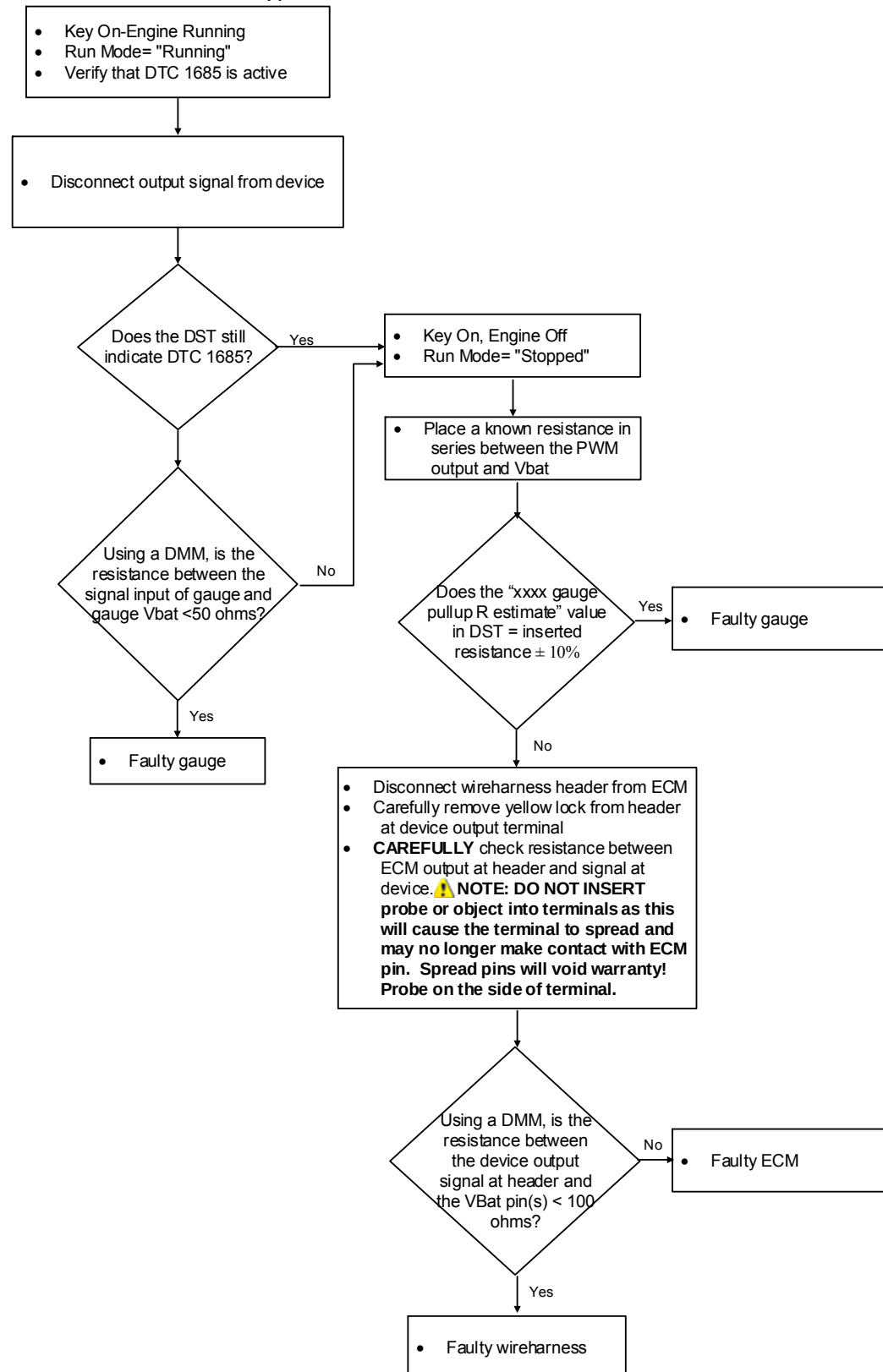
DTC 1685 – PWM14 SHORT TO POWER (TROUBLE TREE)

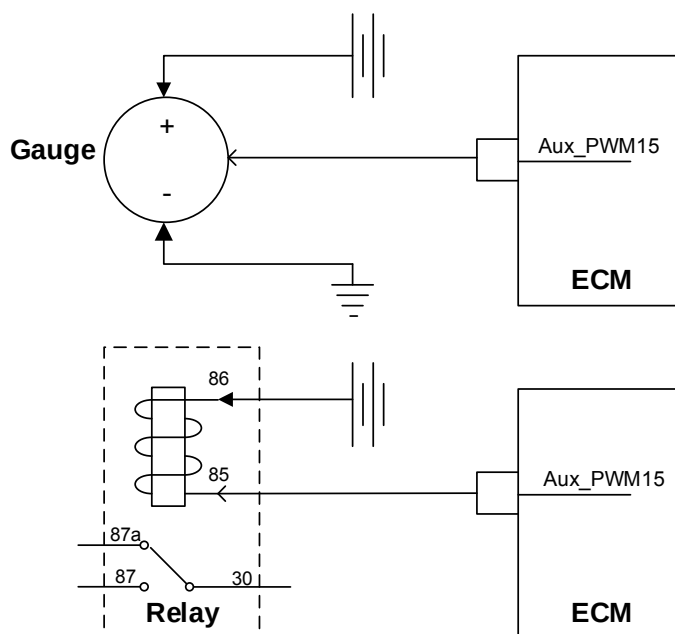
Duty-cycle PWM type



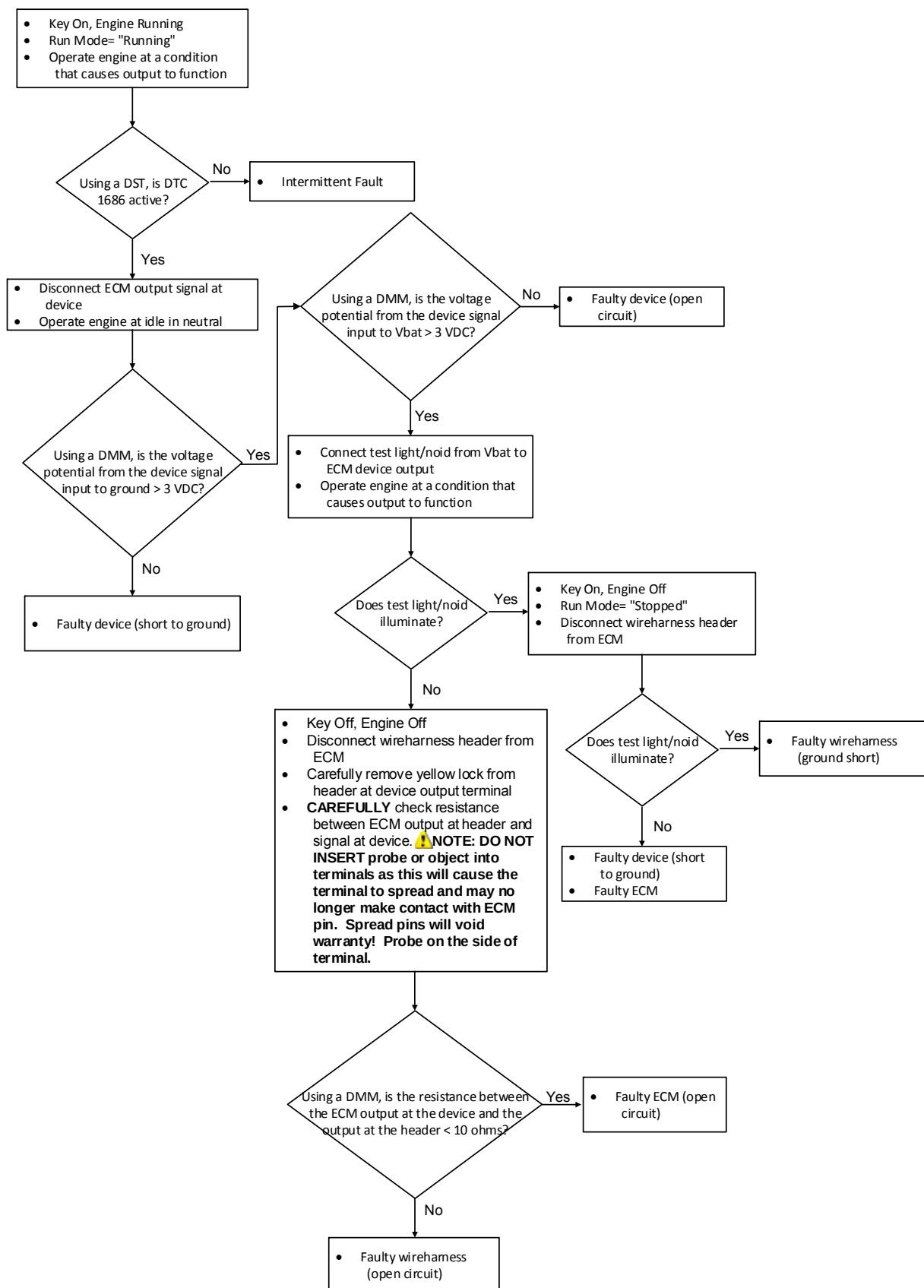
DTC 1685 – PWM14 SHORT TO POWER (TROUBLE TREE)

Resistance Simulation type



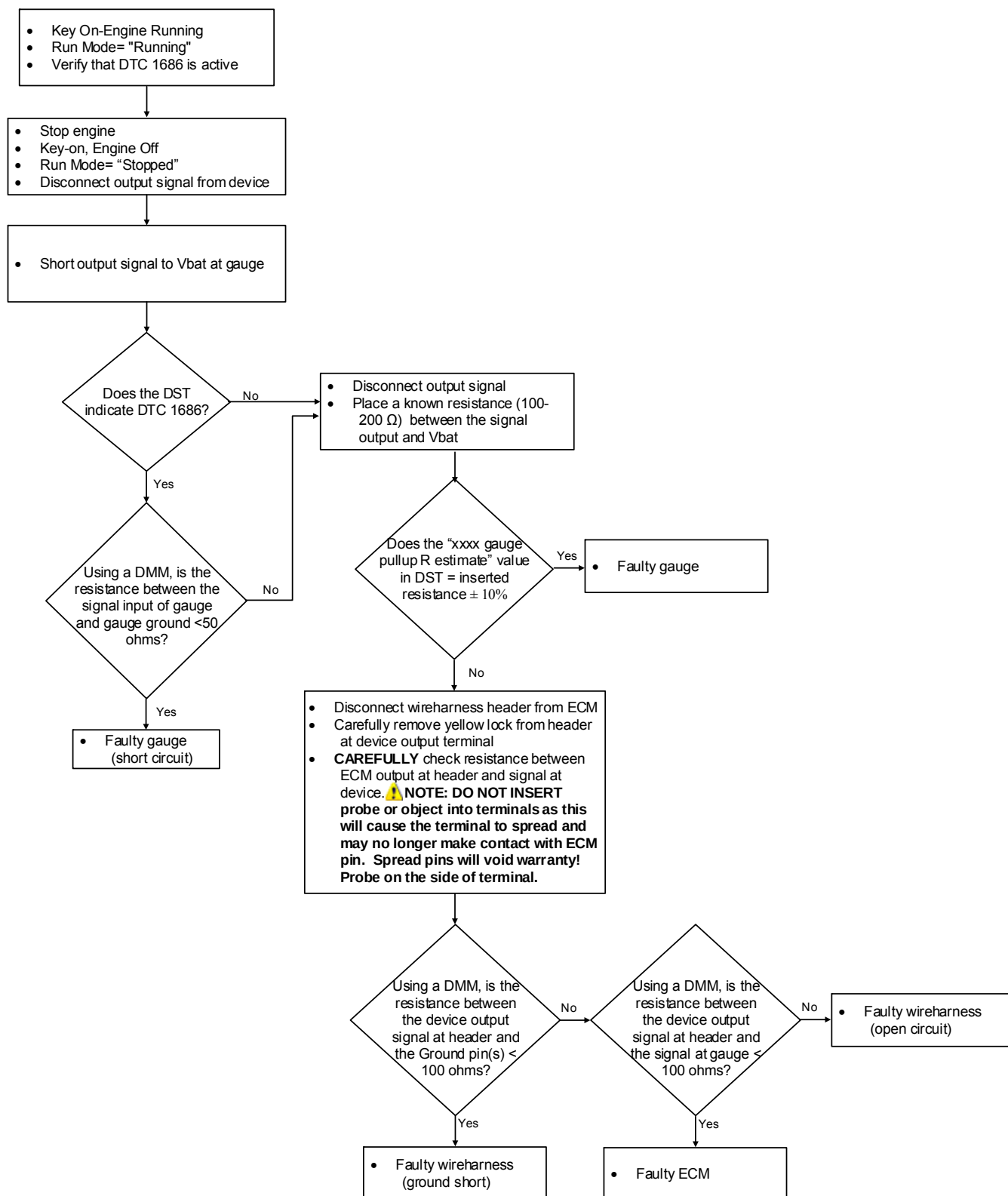
DTC 1686 - PWM15 OPEN / GROUND SHORT

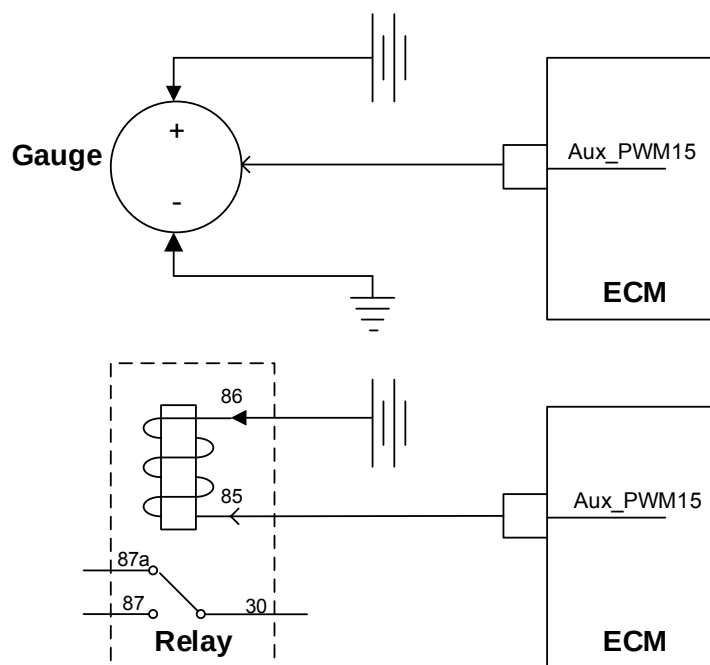
DTC	1686	SPN	2653	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM15 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 15 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM15 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1686 - PWM15 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1686 - PWM15 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1687 - PWM15 SHORT TO POWER

DTC	1687	SPN	2653	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM15 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 15 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 15 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

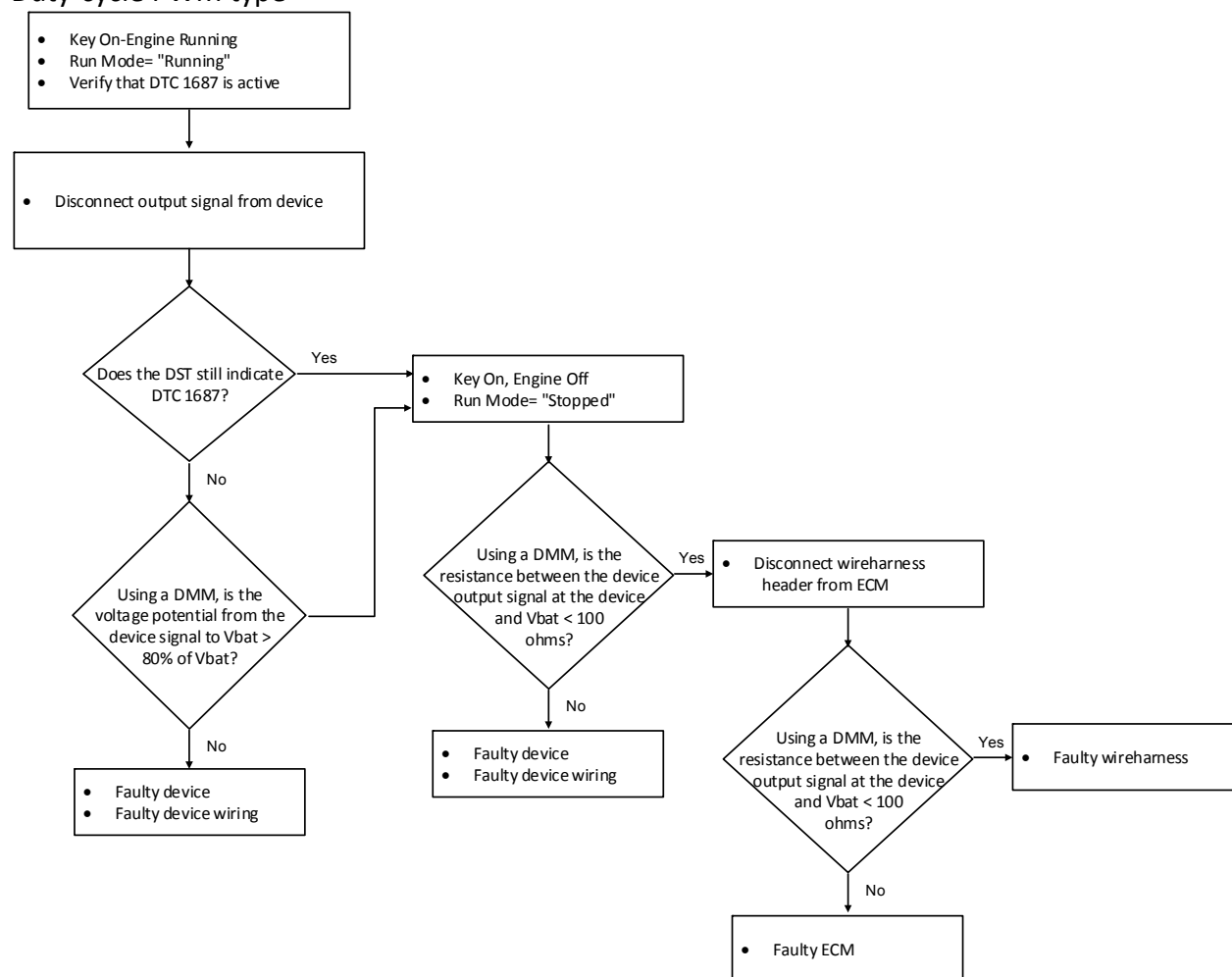
AUX PWM15 output shorted to power

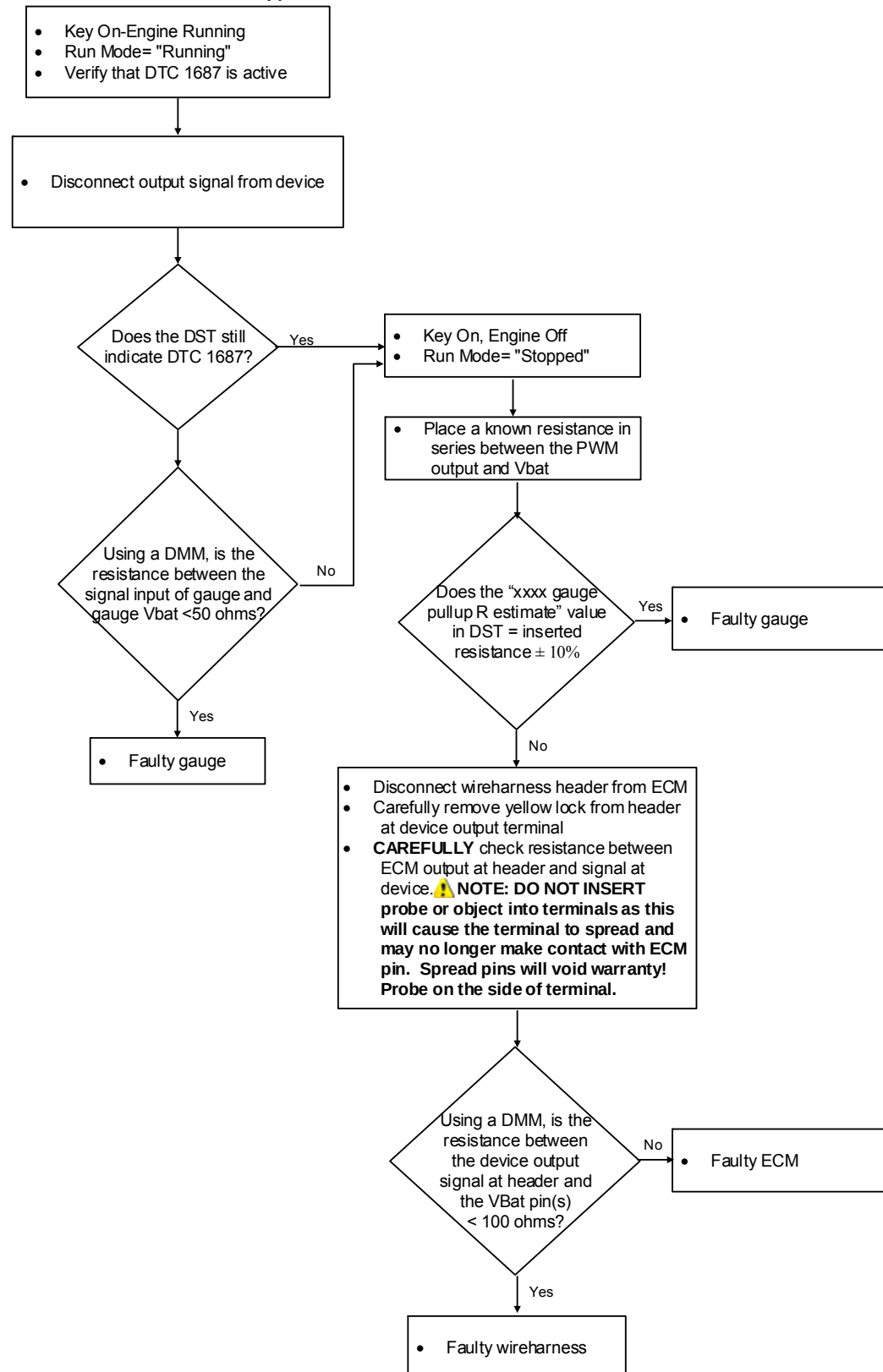
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

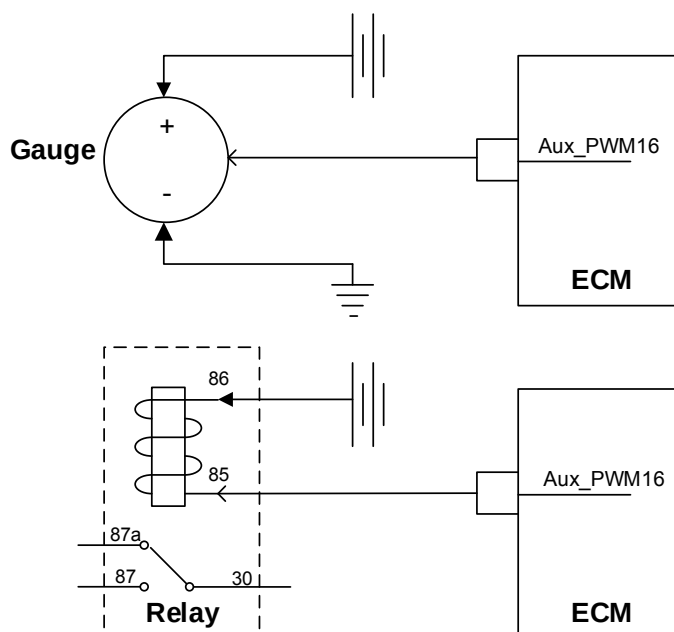
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1687 – PWM15 SHORT TO POWER (TROUBLE TREE)

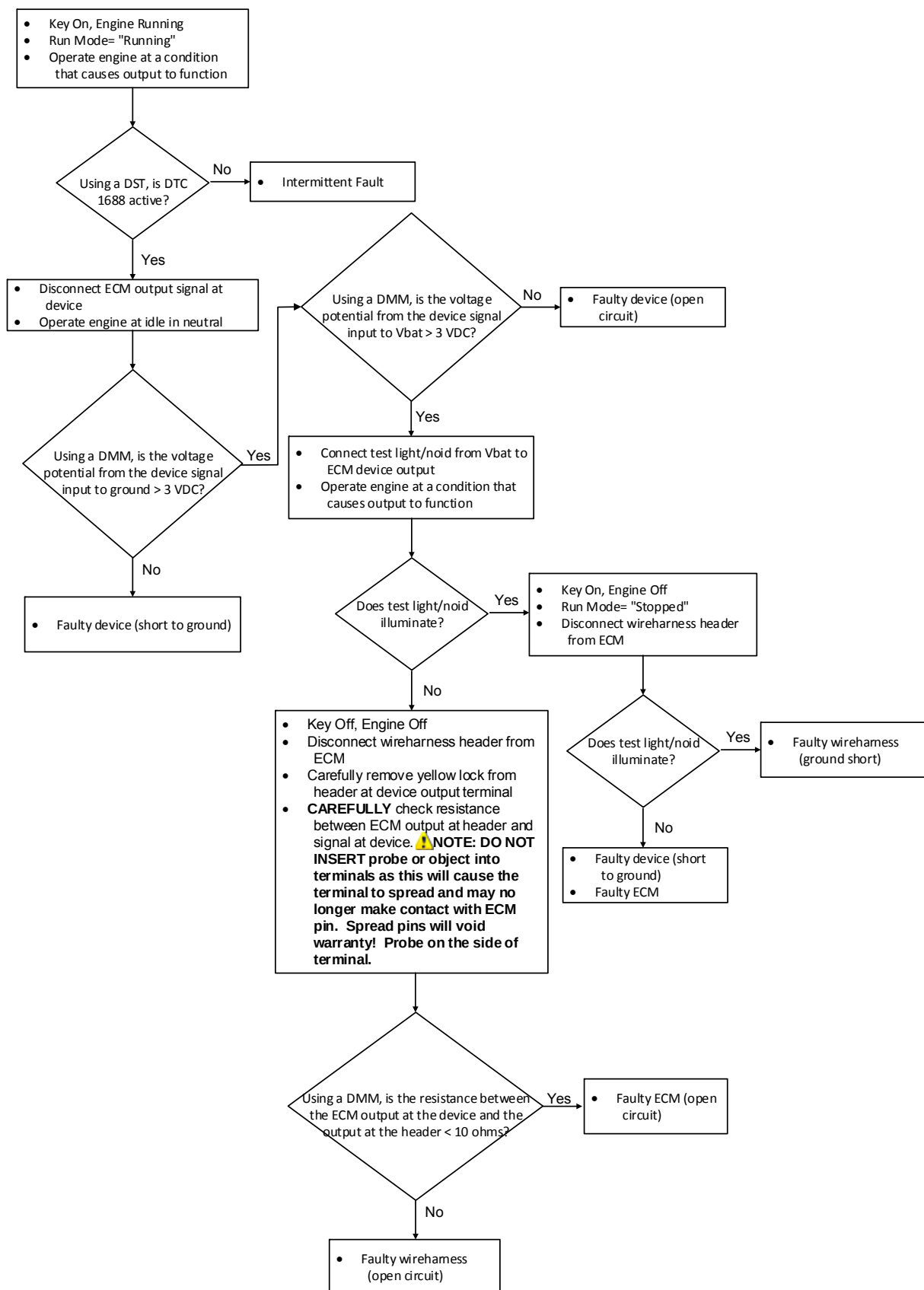
Duty-cycle PWM type



DTC 1687 – PWM15 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

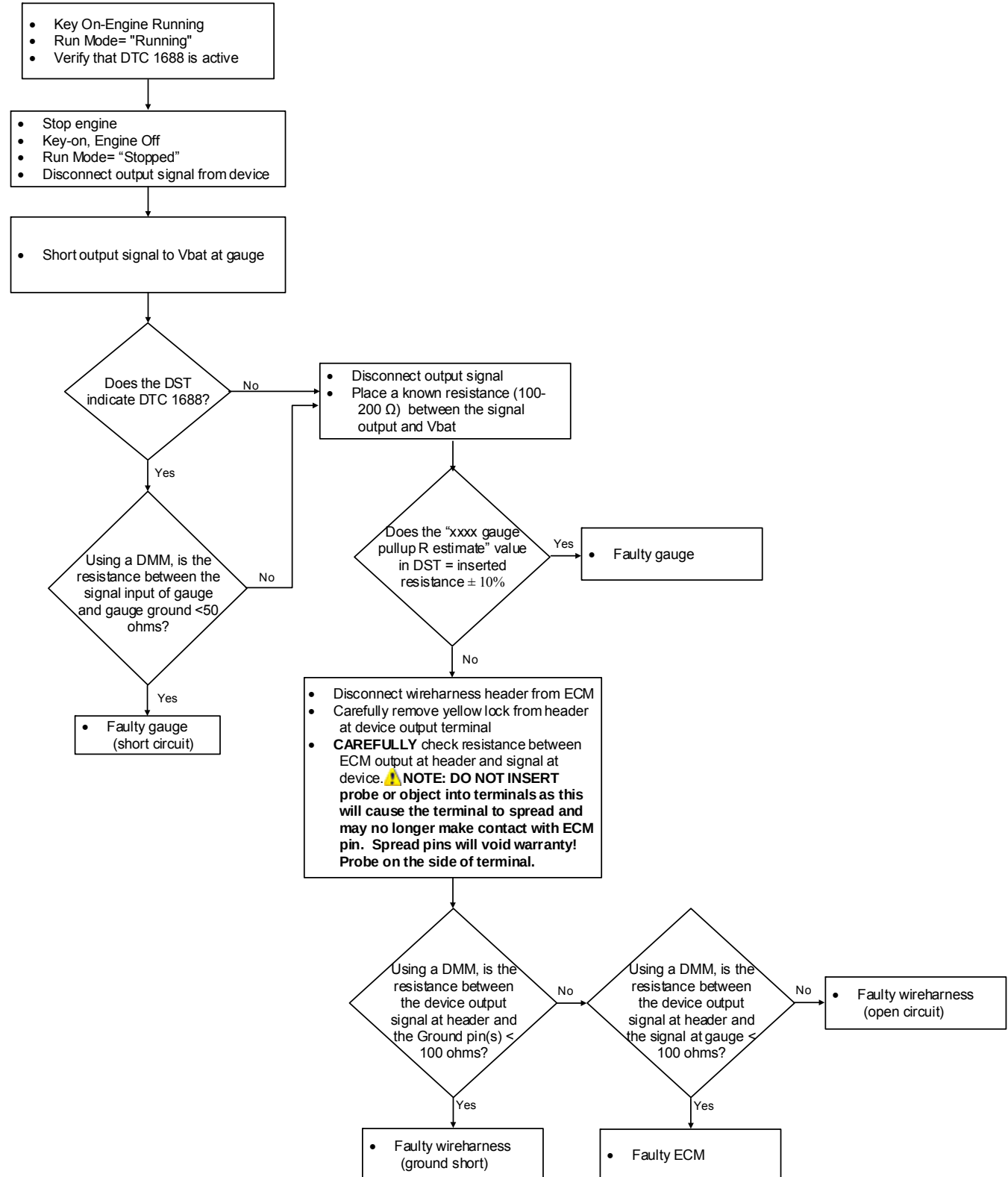
DTC 1688 - PWM16 OPEN / GROUND SHORT

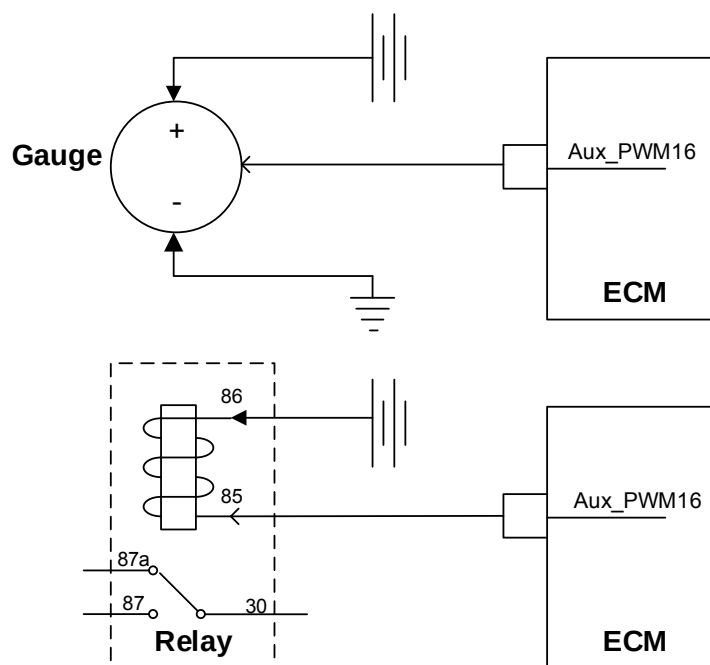
DTC	1688	SPN	2654	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM16 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 16 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM16 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1688 - PWM16 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1688 - PWM16 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1689 - PWM16 SHORT TO POWER

DTC	1689	SPN	2654	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM16 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 16 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 16 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

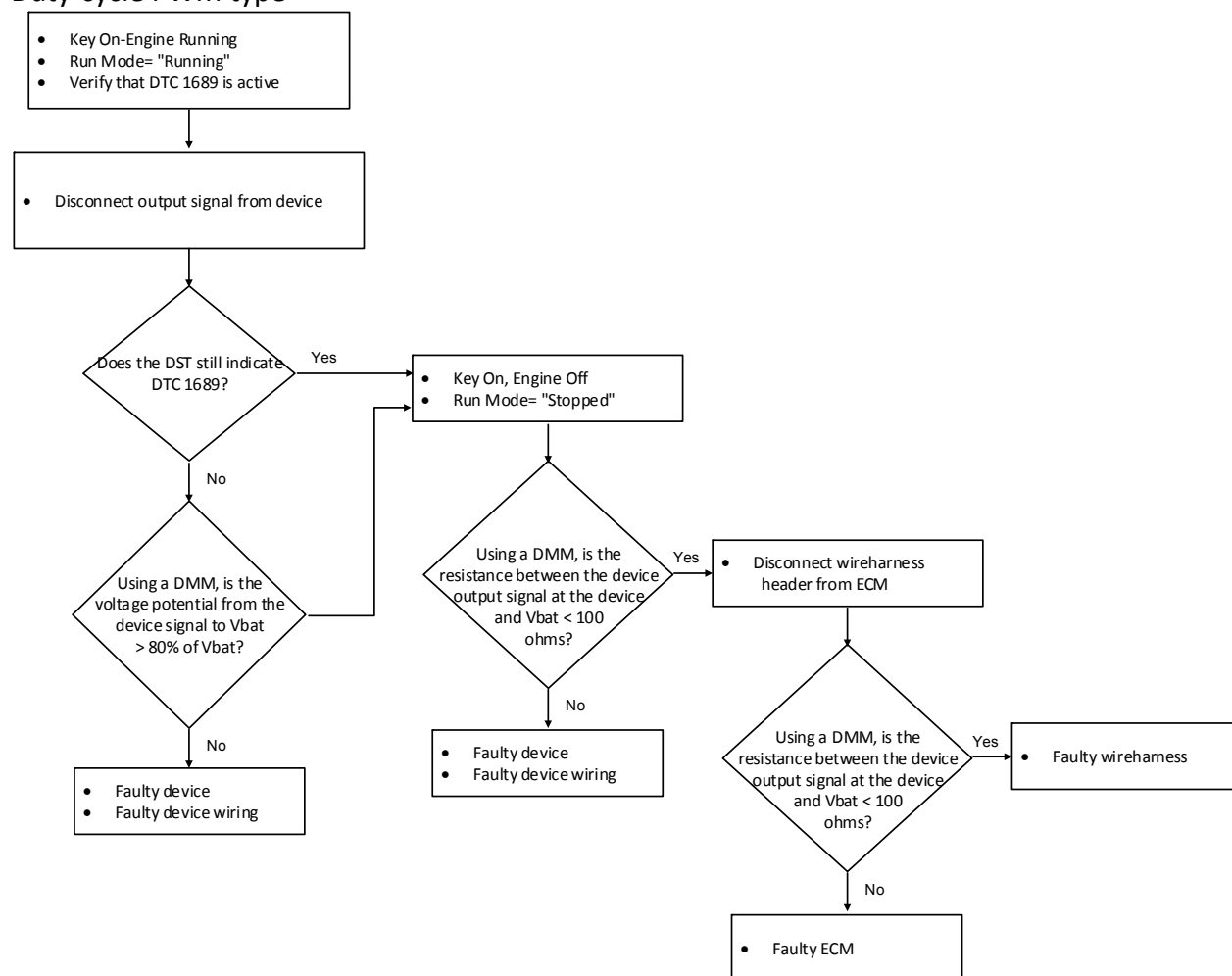
AUX PWM16 output shorted to power

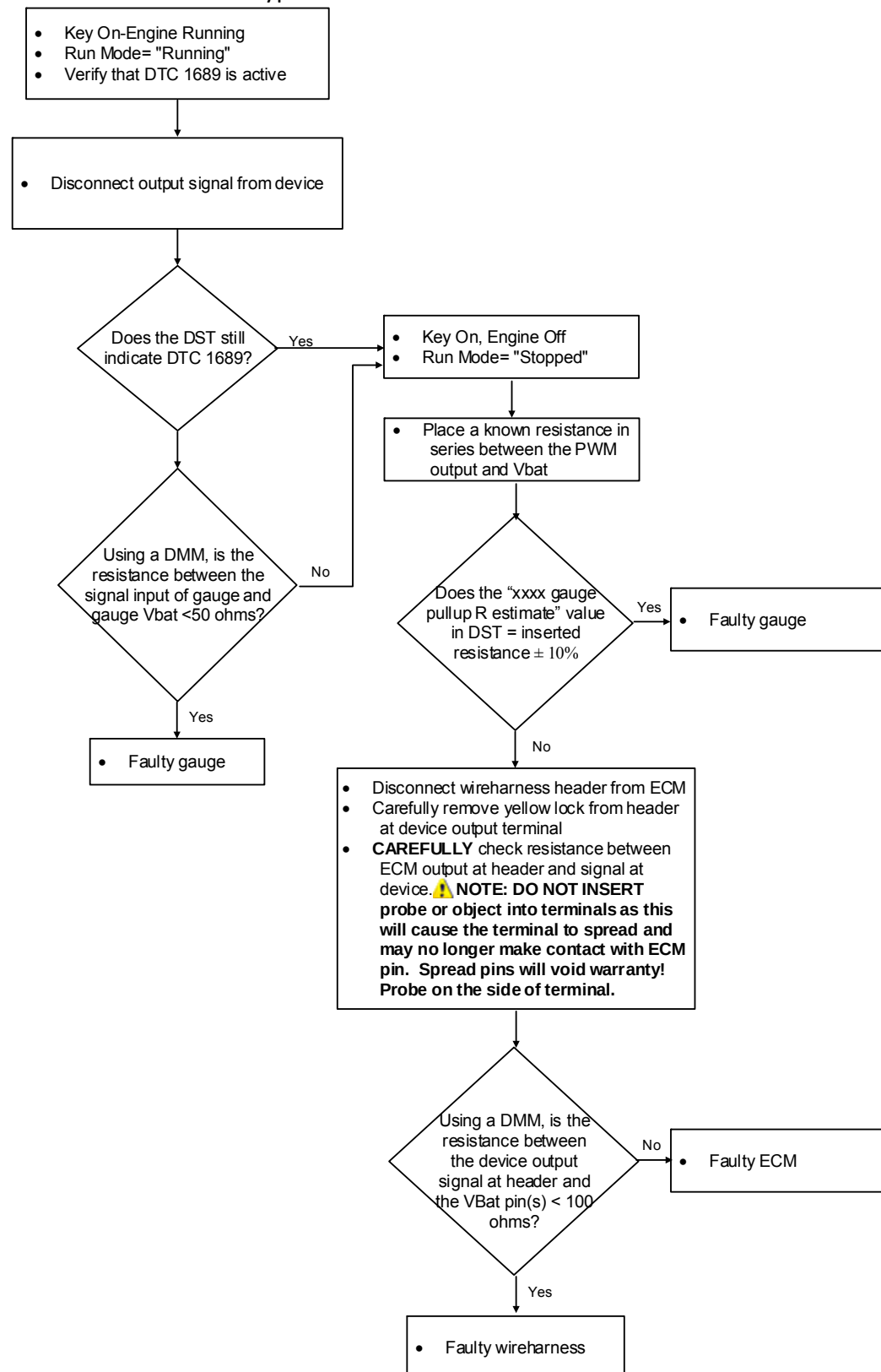
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

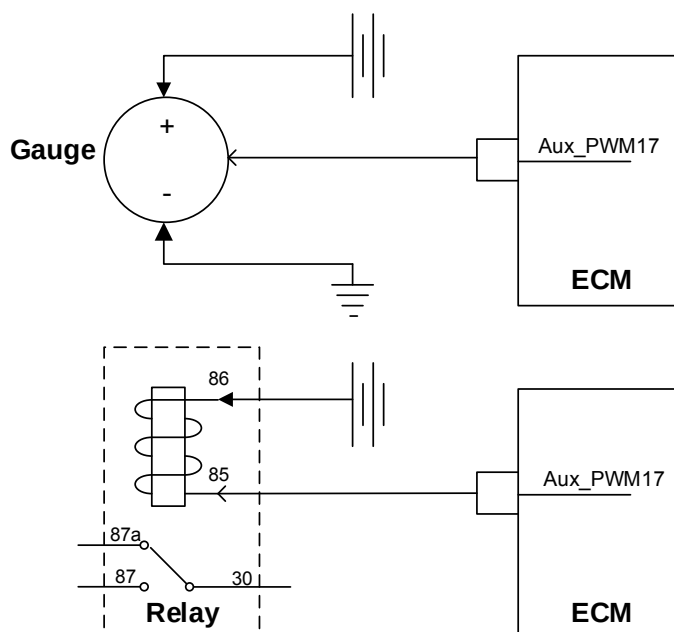
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1689 – PWM16 SHORT TO POWER (TROUBLE TREE)

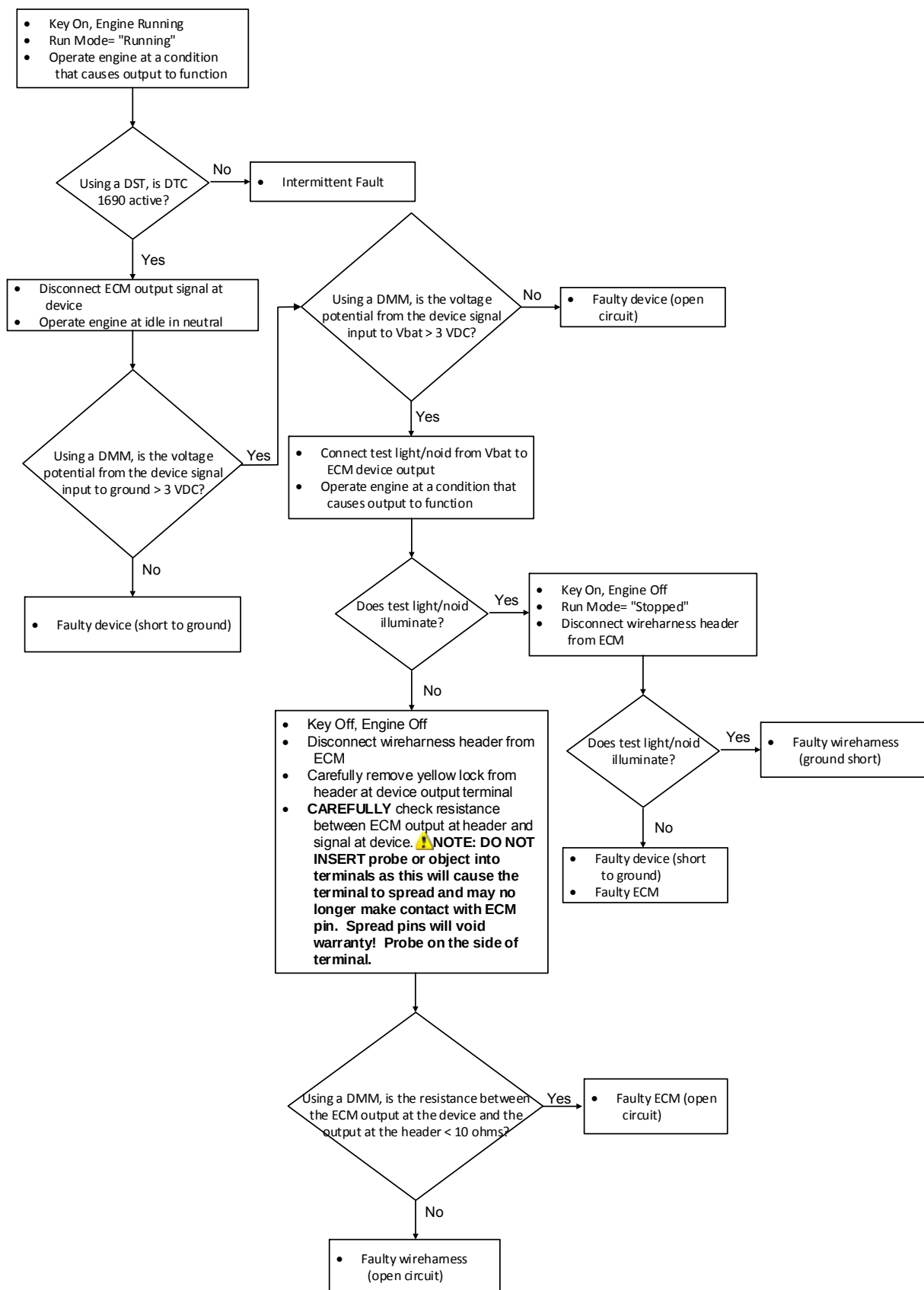
Duty-cycle PWM type



DTC 1689– PWM16 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

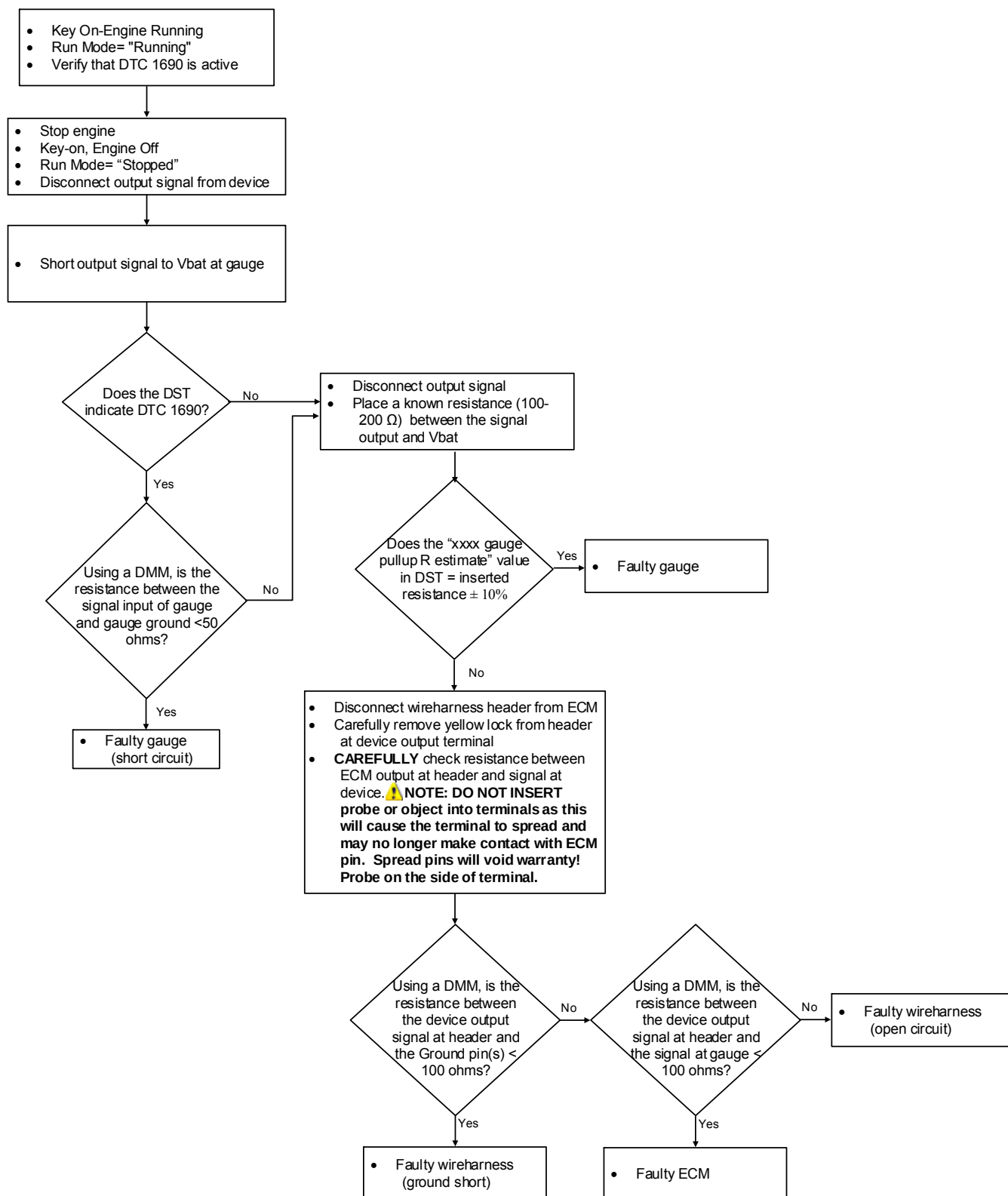
DTC 1690 - PWM17 OPEN / GROUND SHORT

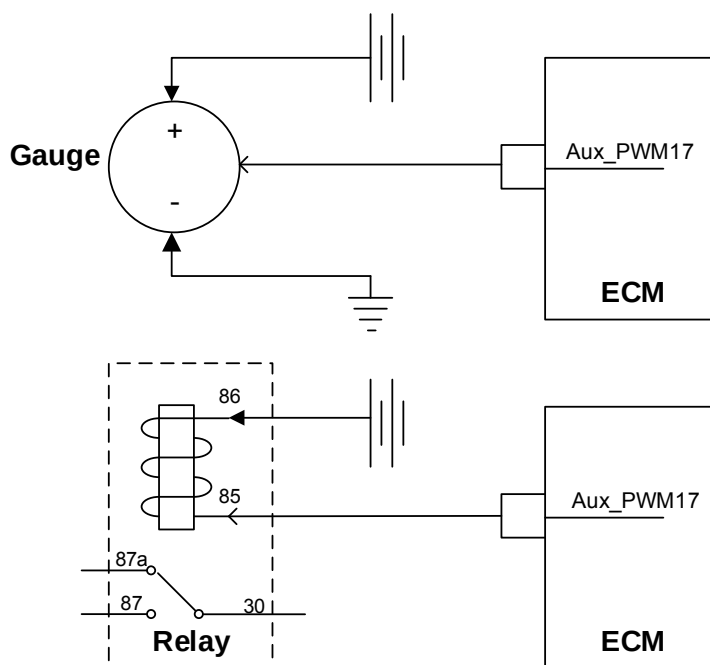
DTC	1690	SPN	2655	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM17 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 17 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM17 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1690 - PWM17 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1690 - PWM17 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1691 - PWM17 SHORT TO POWER

DTC	1691	SPN	2655	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM17 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 17 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 17 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

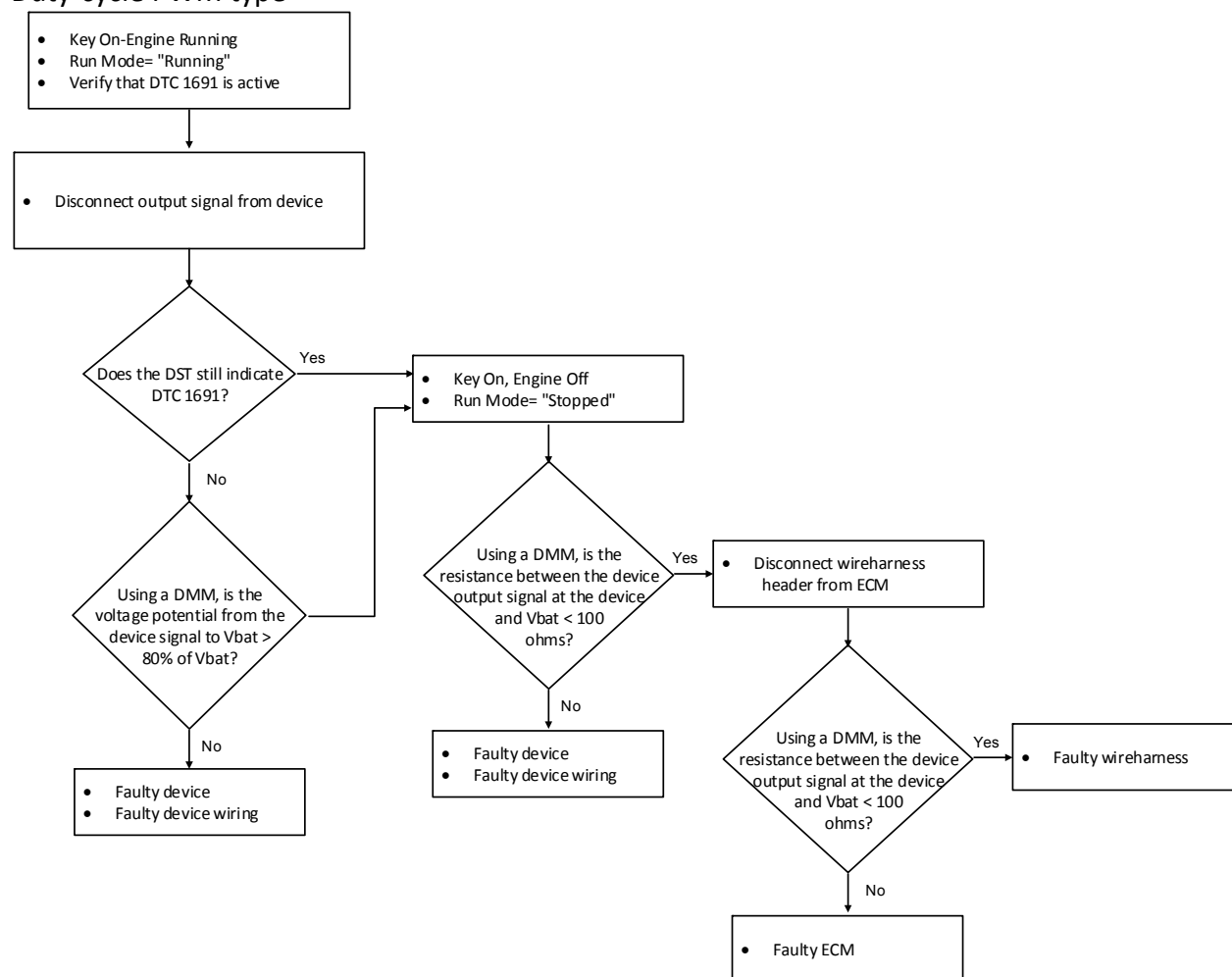
(Continued from previous page)

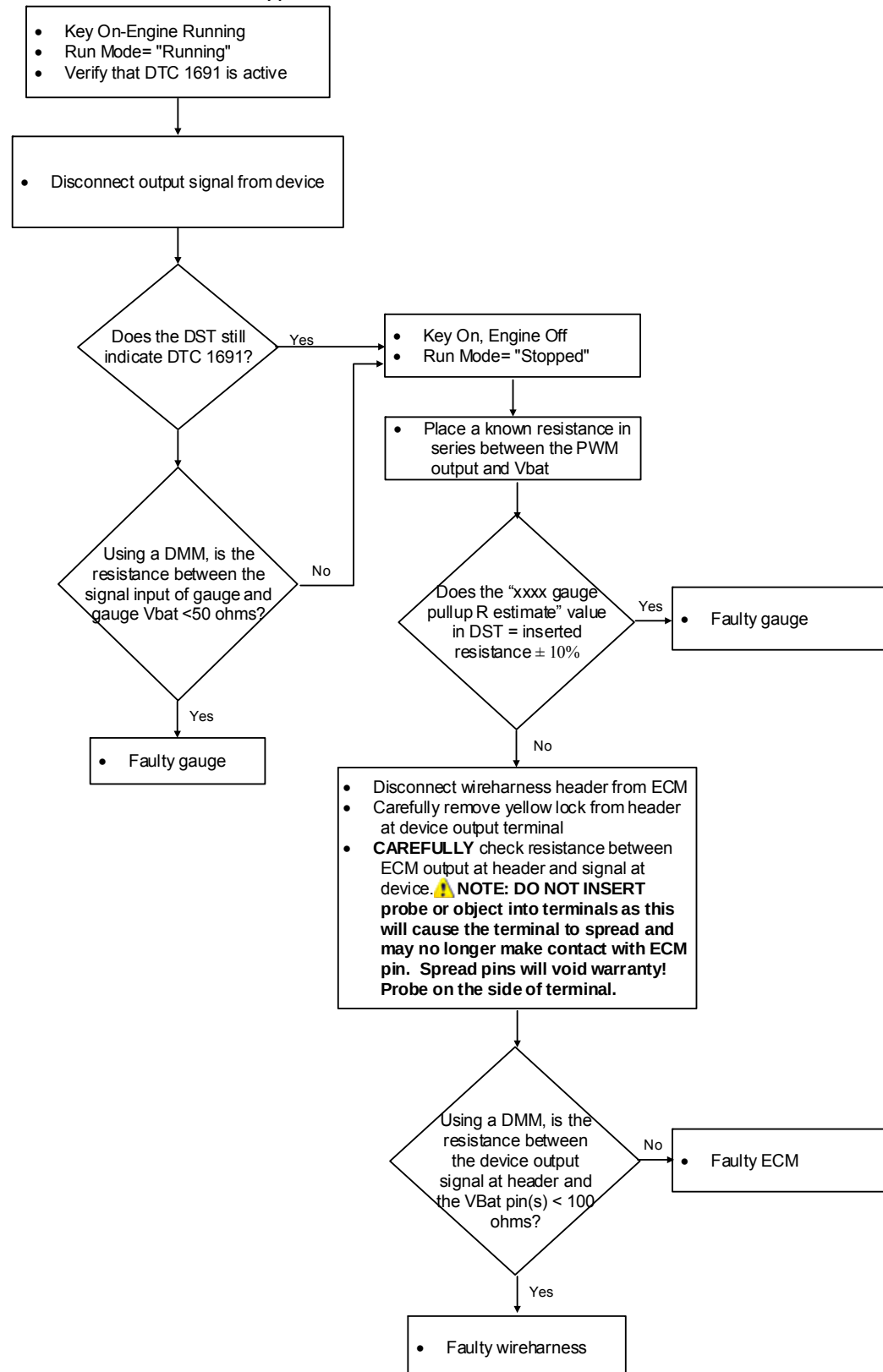
Possible Causes:

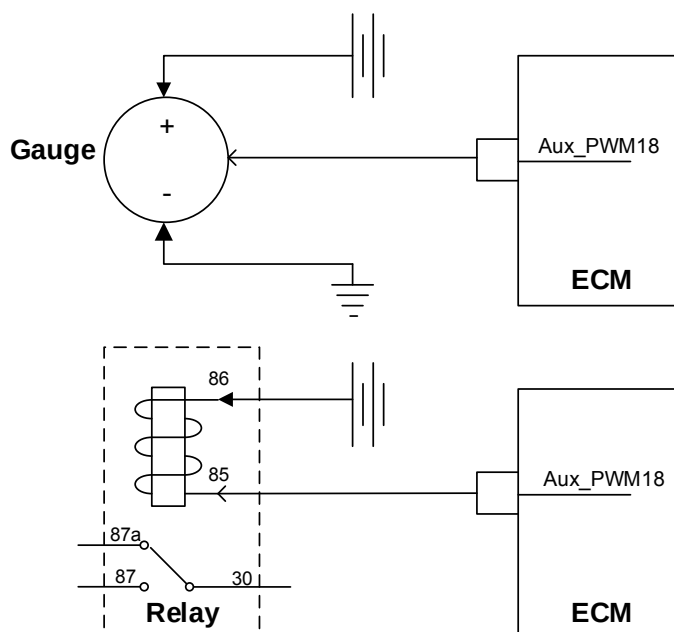
AUX PWM17 output shorted to power

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

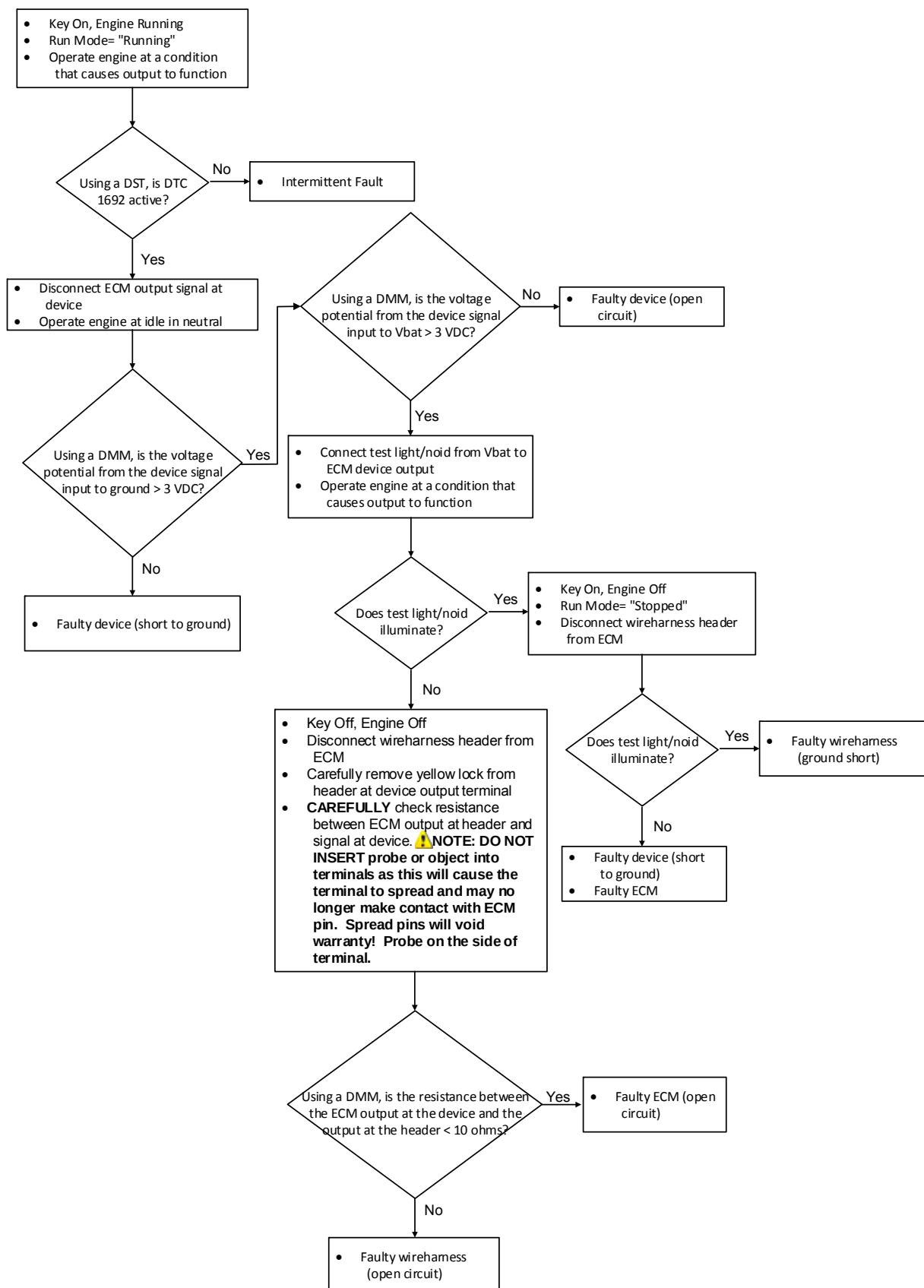
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1691 – PWM17 SHORT TO POWER (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1691 – PWM17 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

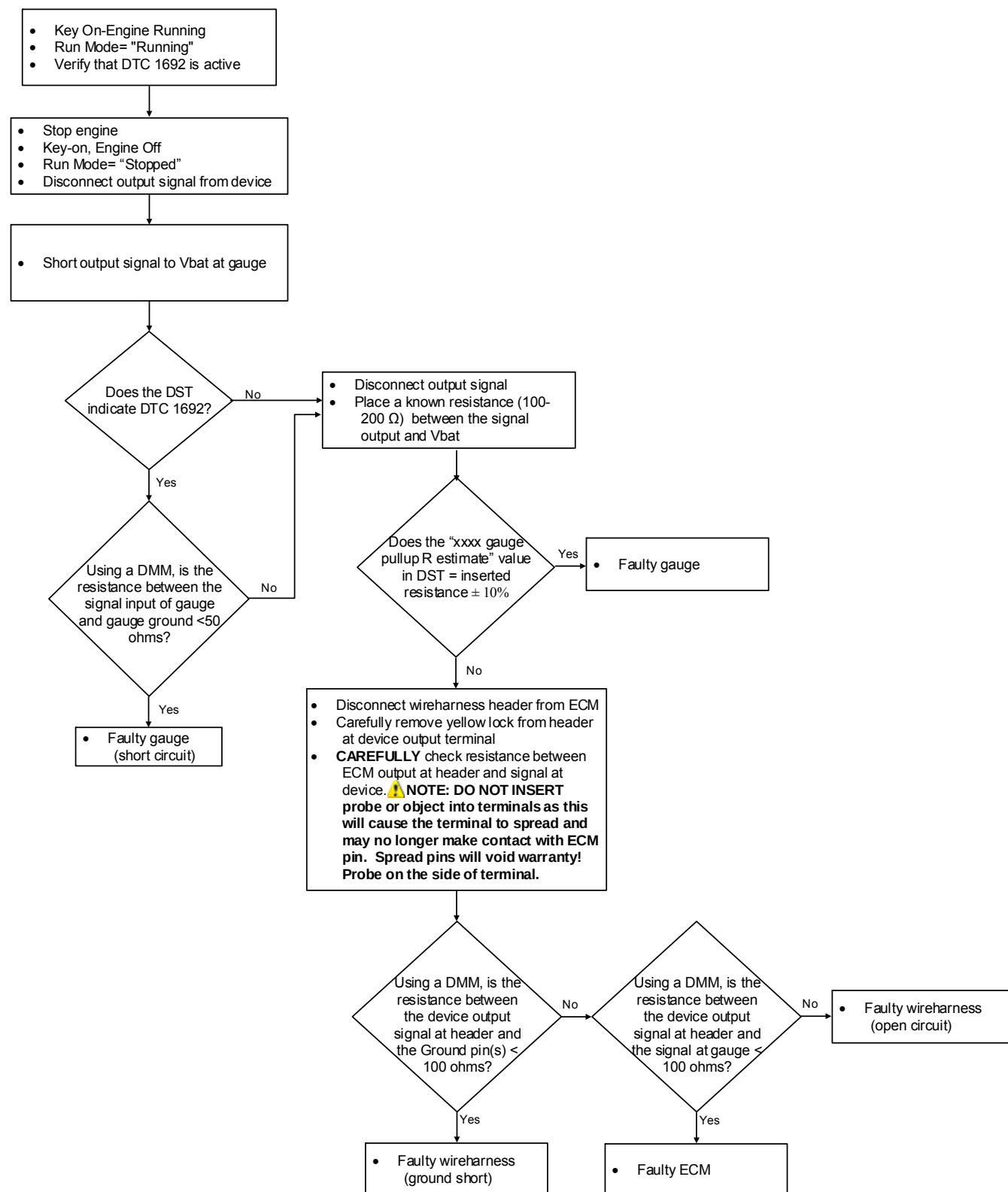
DTC 1692 - PWM18 OPEN / GROUND SHORT

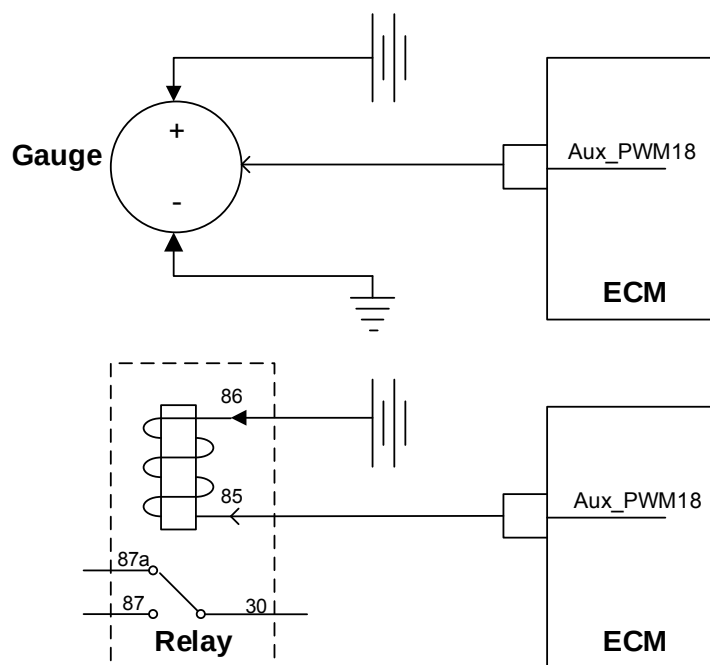
DTC	1692	SPN	2656	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM18 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 18 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM18 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1692 - PWM18 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1692 - PWM18 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1693 - PWM18 SHORT TO POWER

DTC	1693	SPN	2656	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM18 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 18 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 18 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

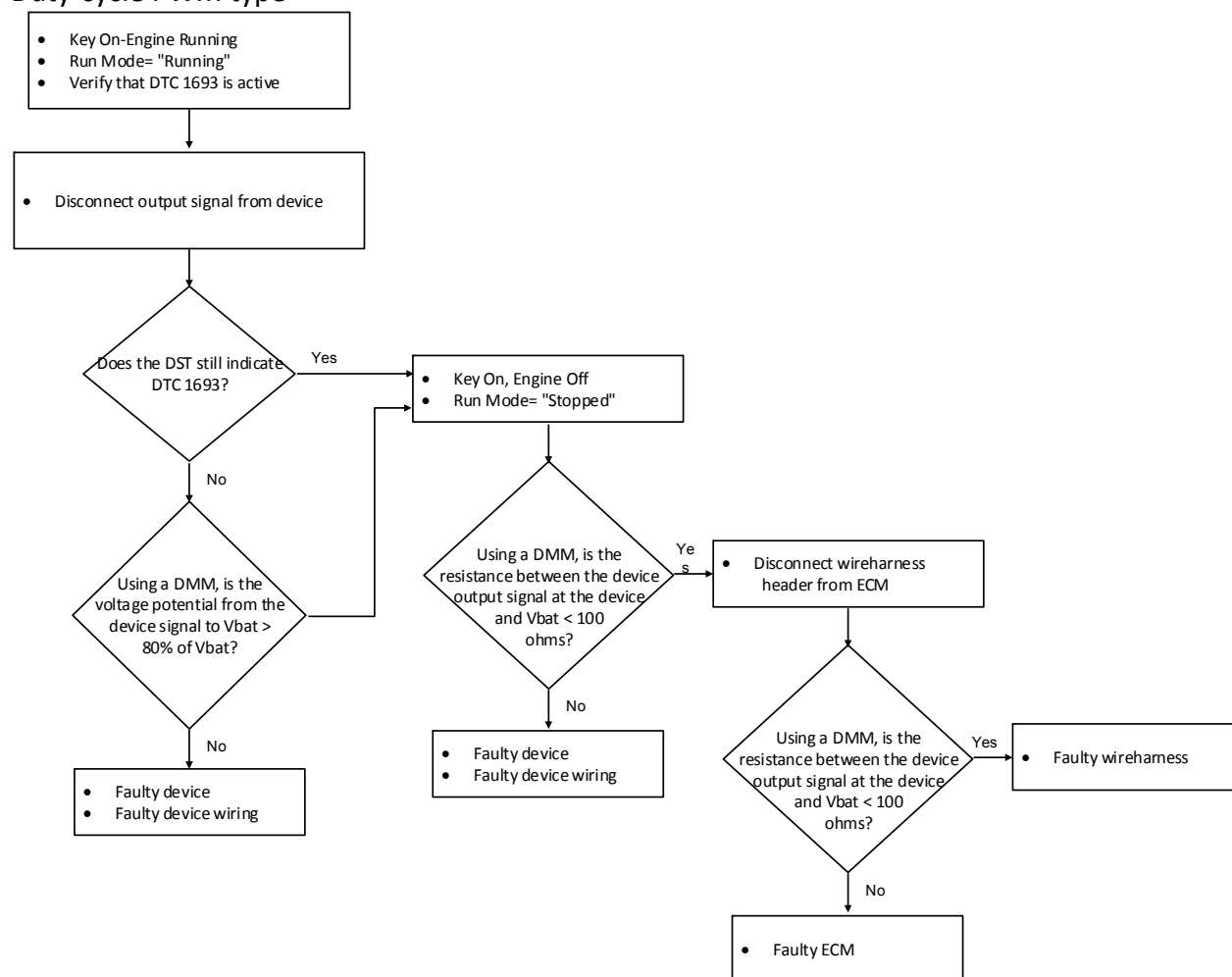
AUX PWM18 output shorted to power

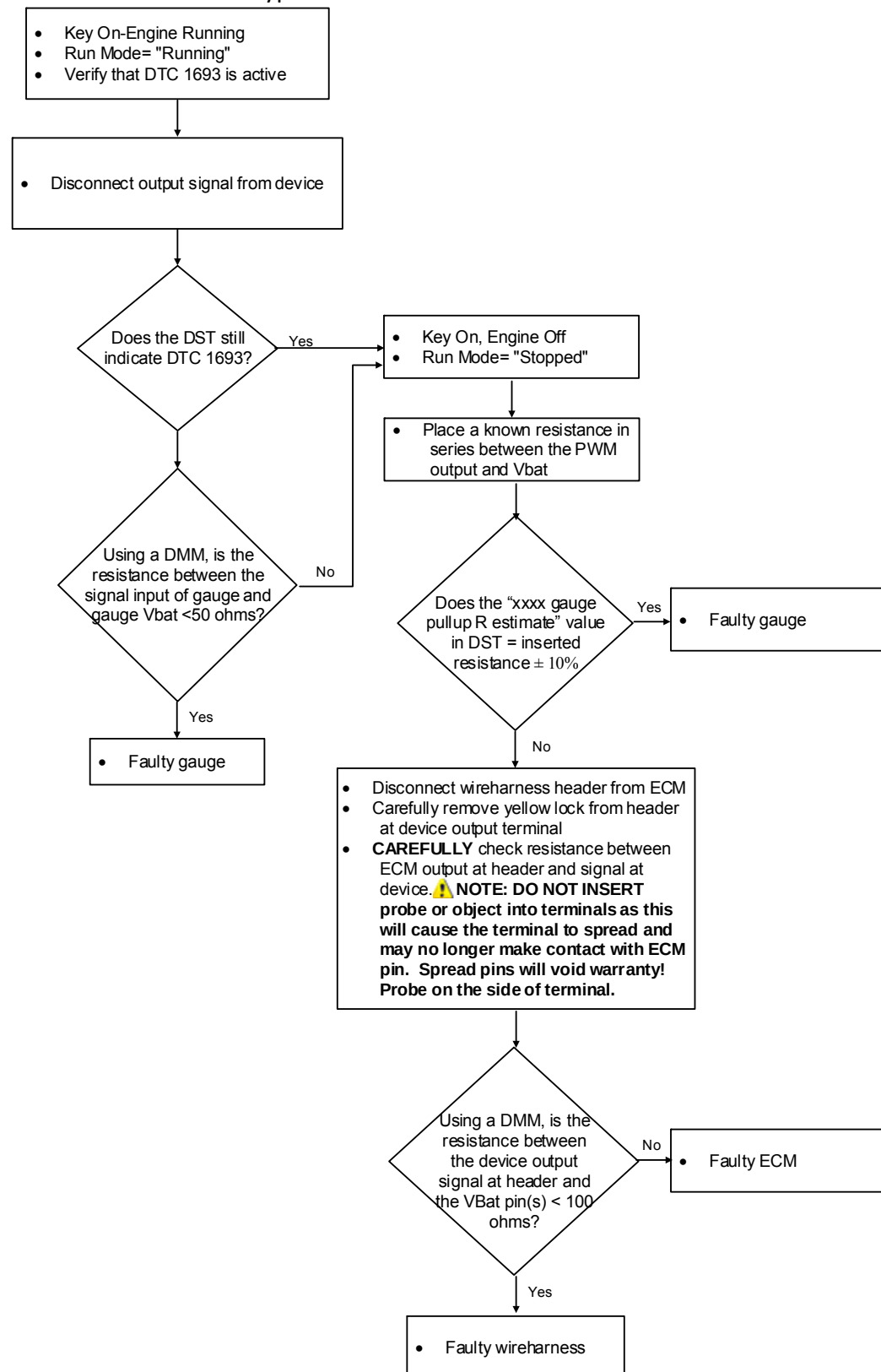
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

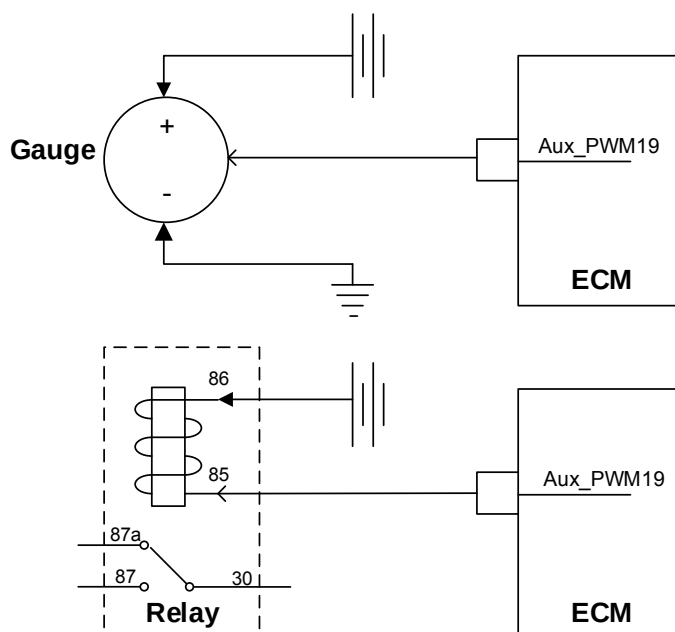
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1693 – PWM18 SHORT TO POWER (TROUBLE TREE)

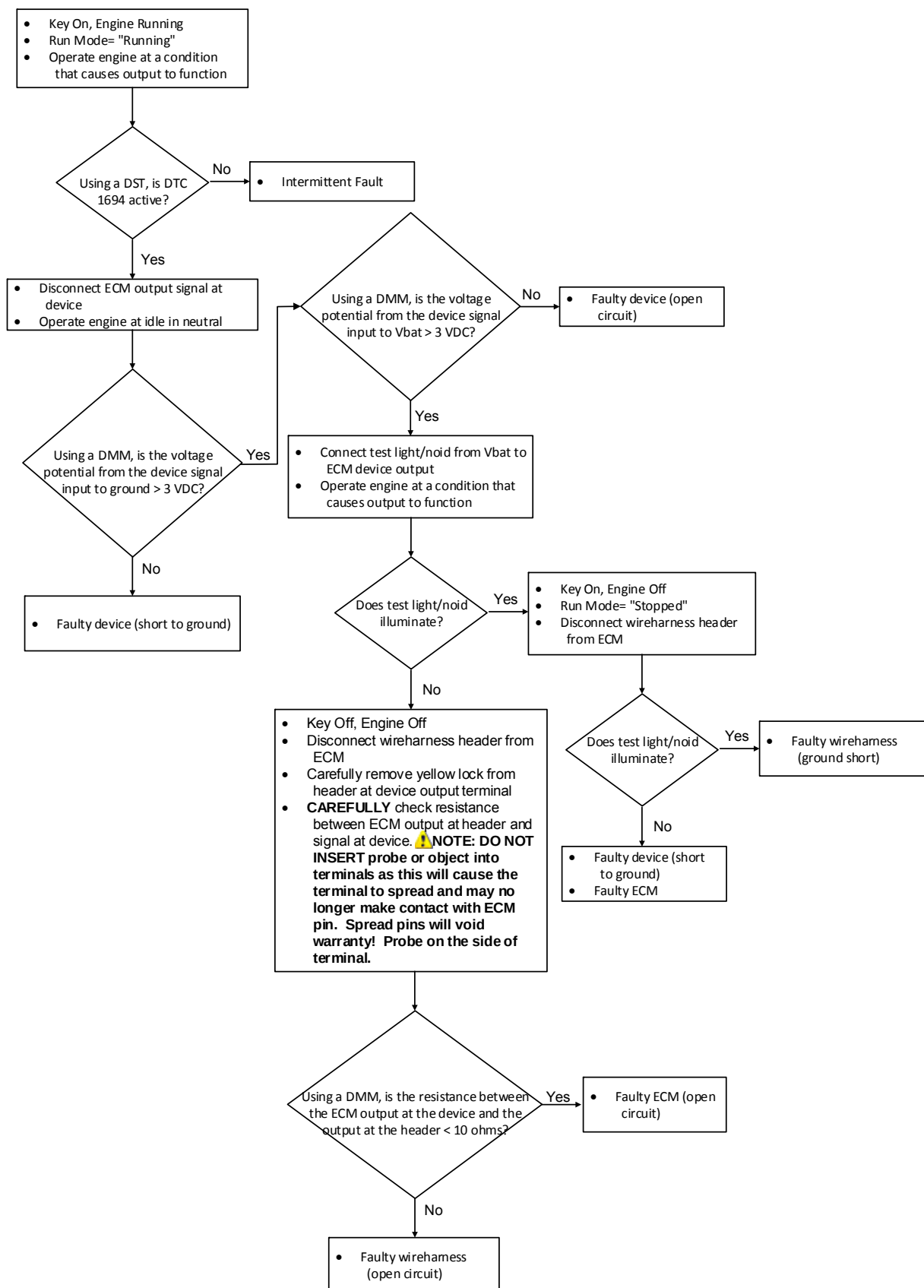
Duty-cycle PWM type



DTC 1693 – PWM18 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

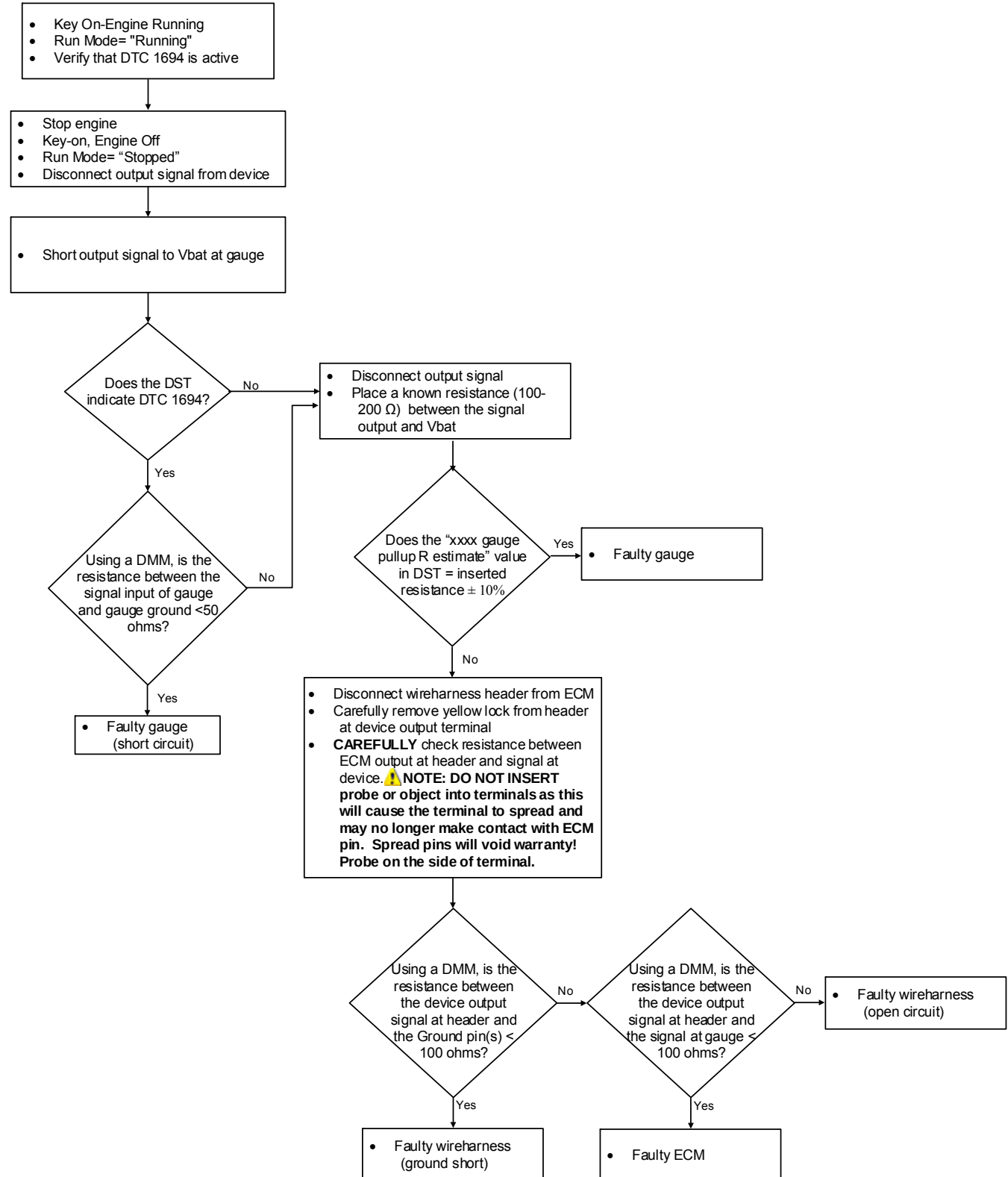
DTC 1694 - PWM19 OPEN / GROUND SHORT

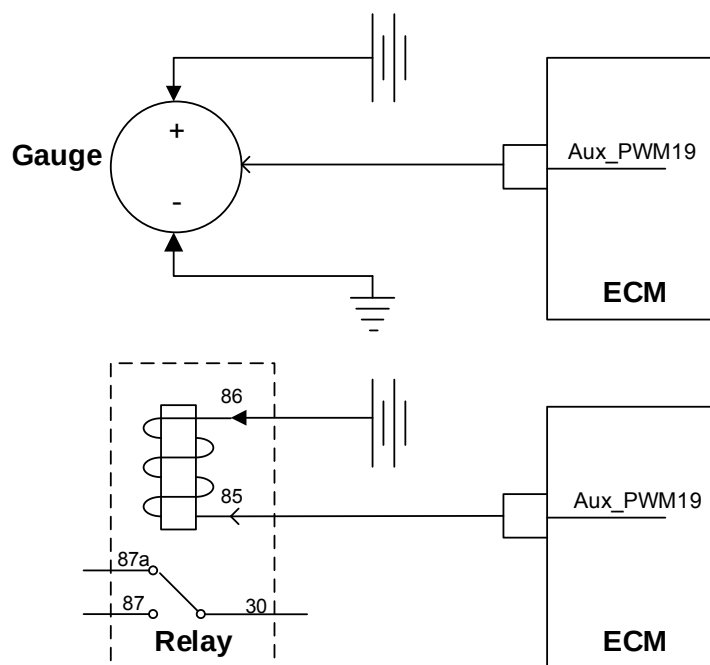
DTC	1694	SPN	2657	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM19 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 19 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM19 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1694 - PWM19 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1694 - PWM19 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1695 - PWM19 SHORT TO POWER

DTC	1695	SPN	2657	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM19 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 19 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 19 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

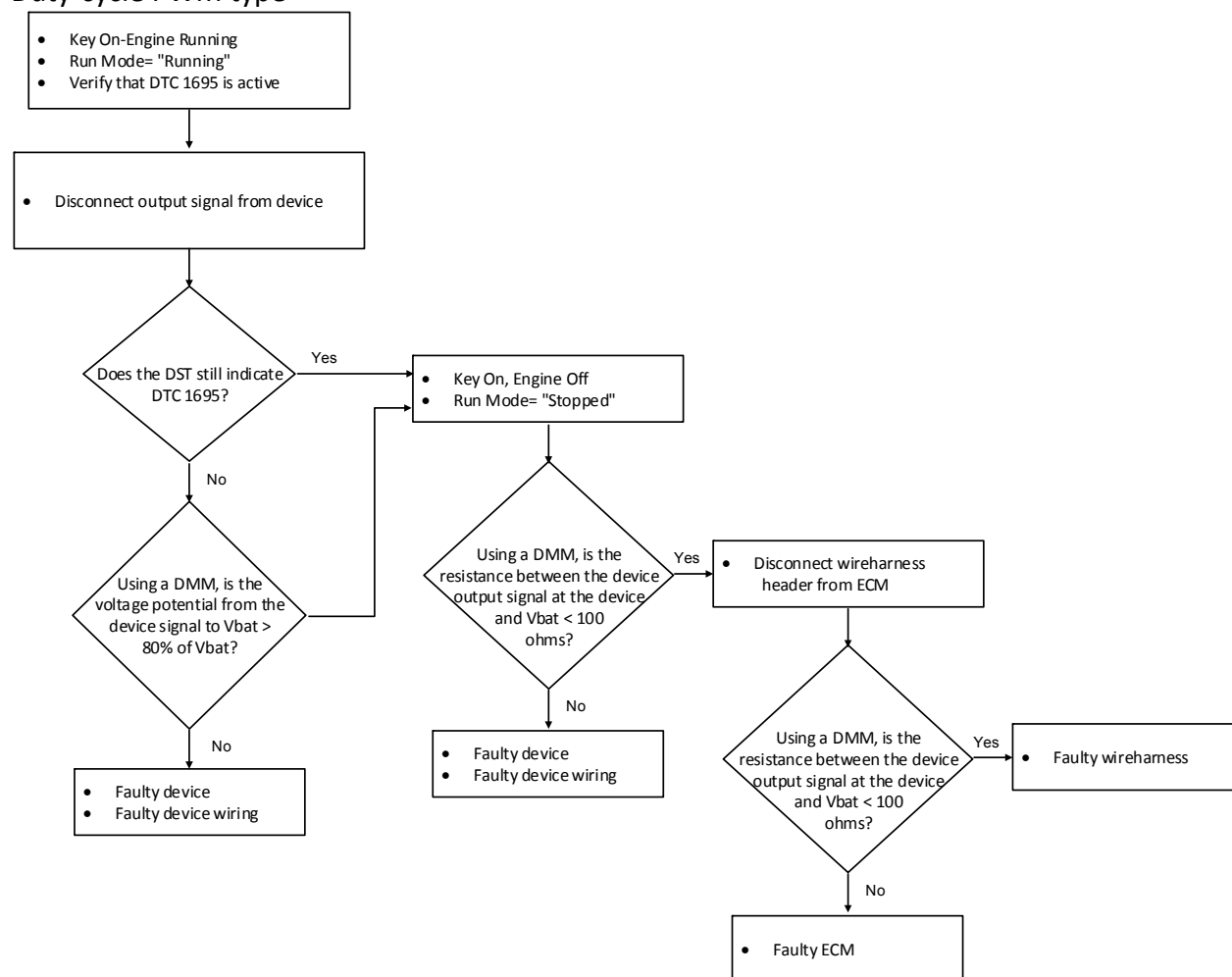
AUX PWM19 output shorted to power

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

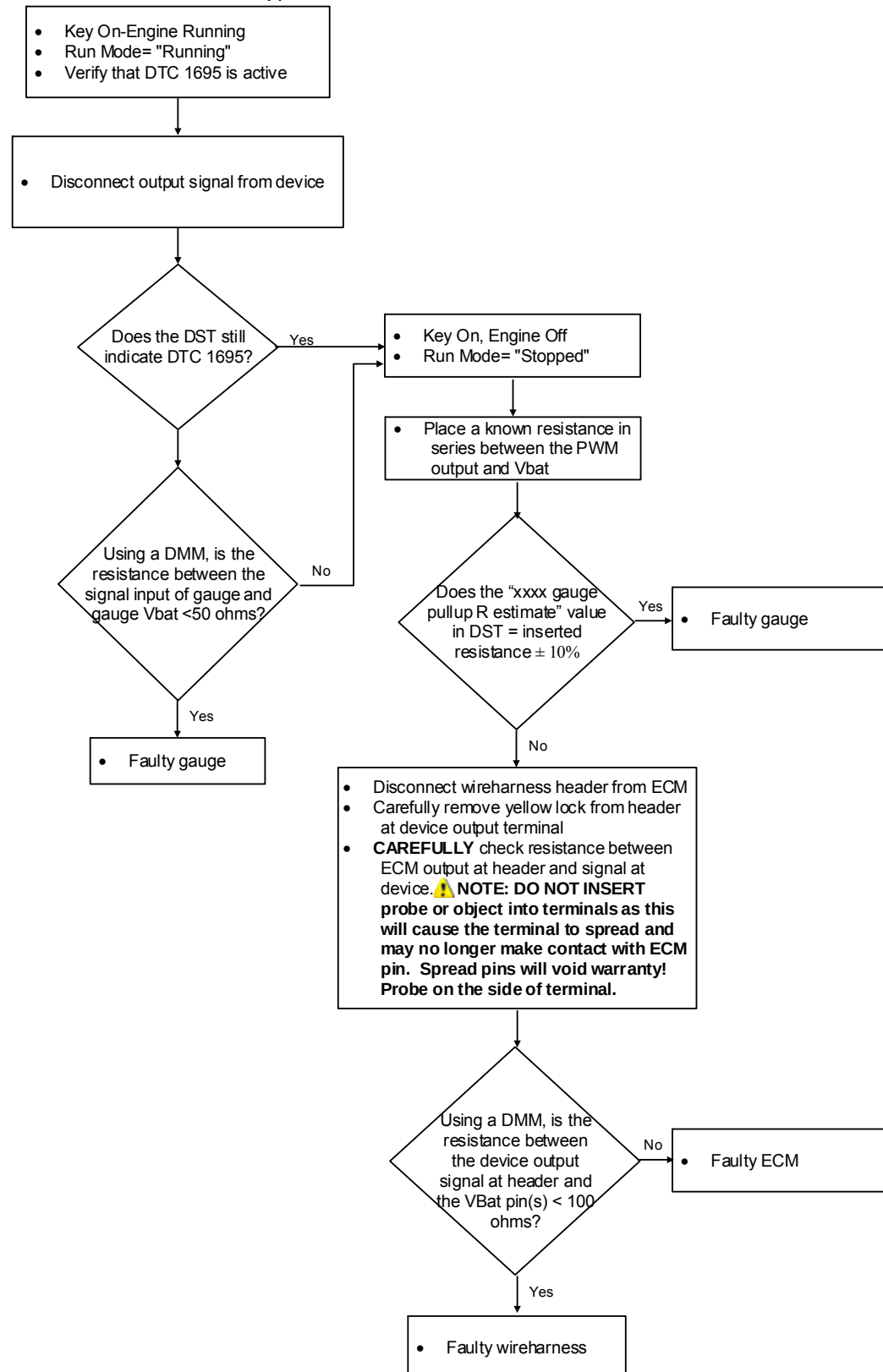
DTC 1695 – PWM19 SHORT TO POWER (TROUBLE TREE)

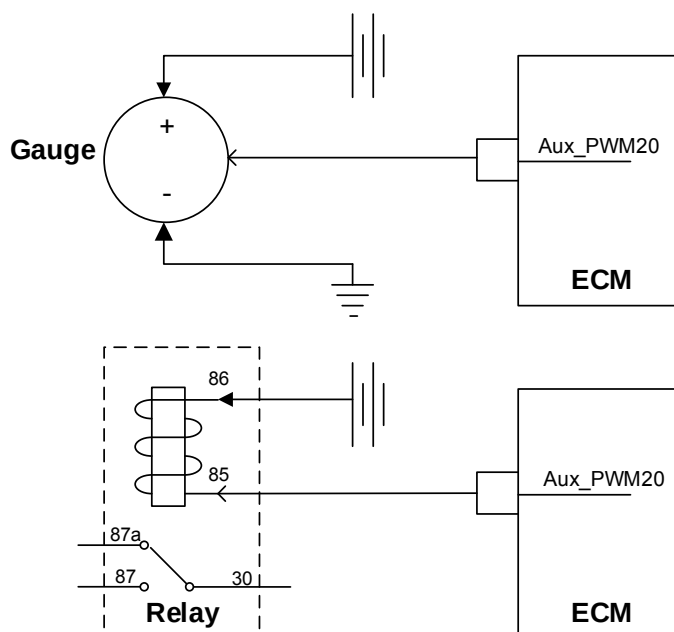
Duty-cycle PWM type



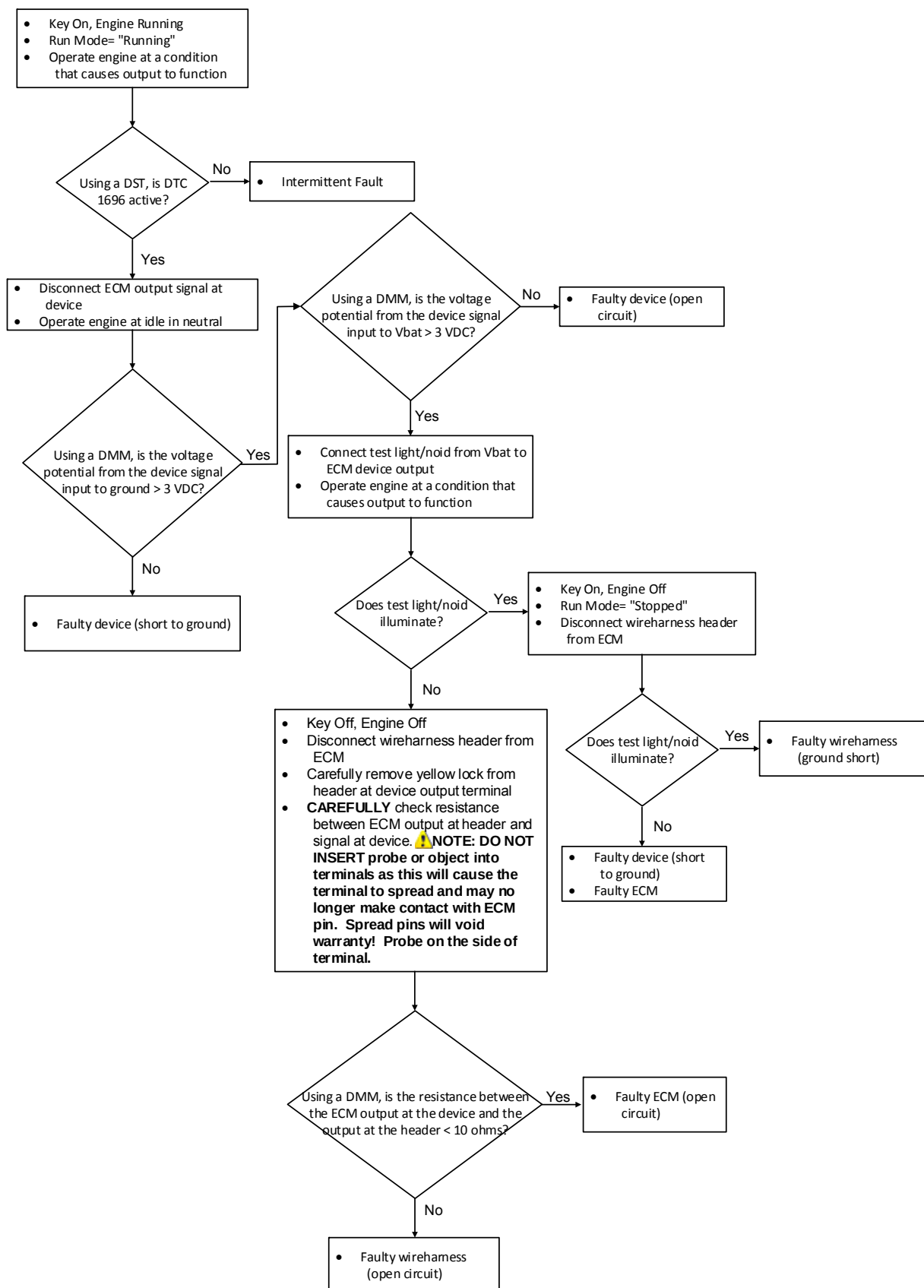
DTC 1695 – PWM19 SHORT TO POWER (TROUBLE TREE)

Resistance Simulation type



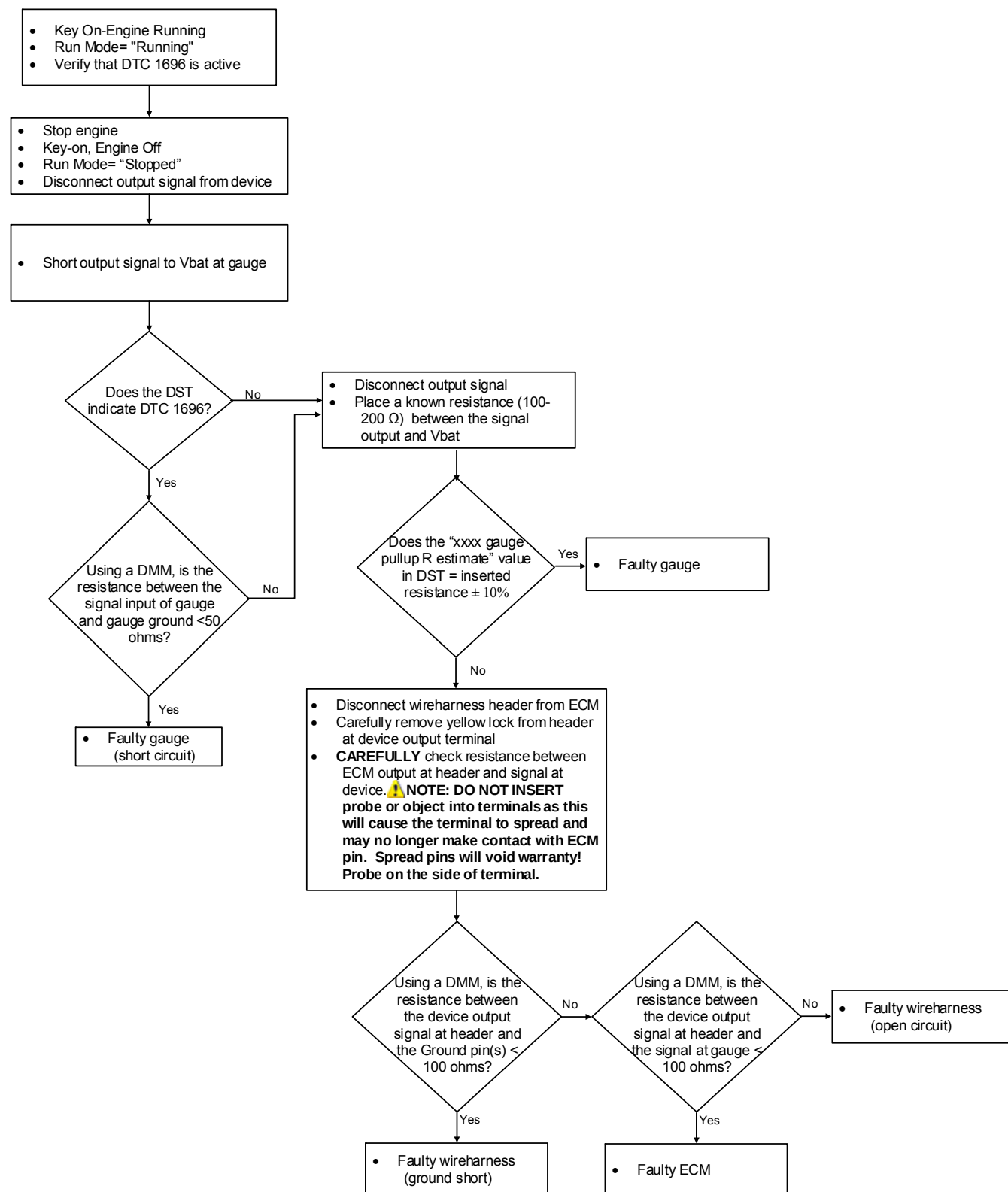
DTC 1696 - PWM20 OPEN / GROUND SHORT

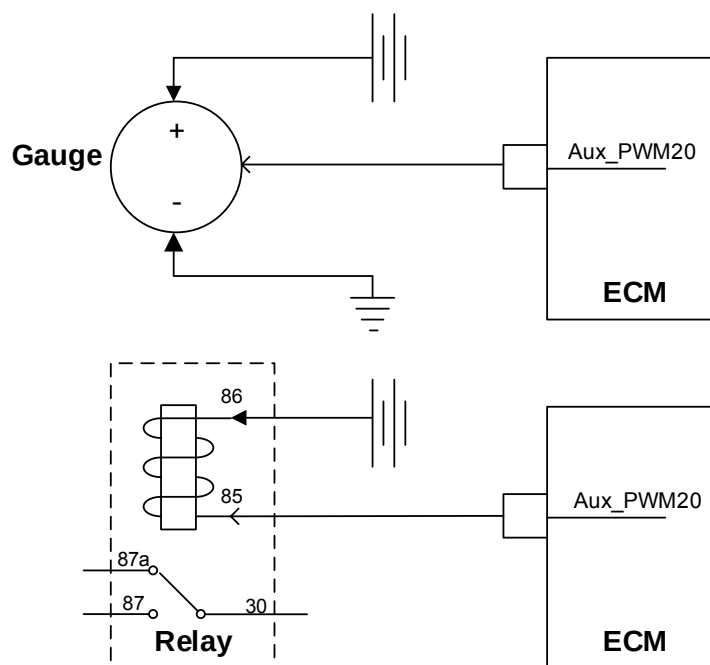
DTC	1696	SPN	2658	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM20 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM20 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM20 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1696 – PWM20 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1696 – PWM20 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1697 - PWM20 SHORT TO POWER

DTC	1697	SPN	2658	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM20 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 20 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 20 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

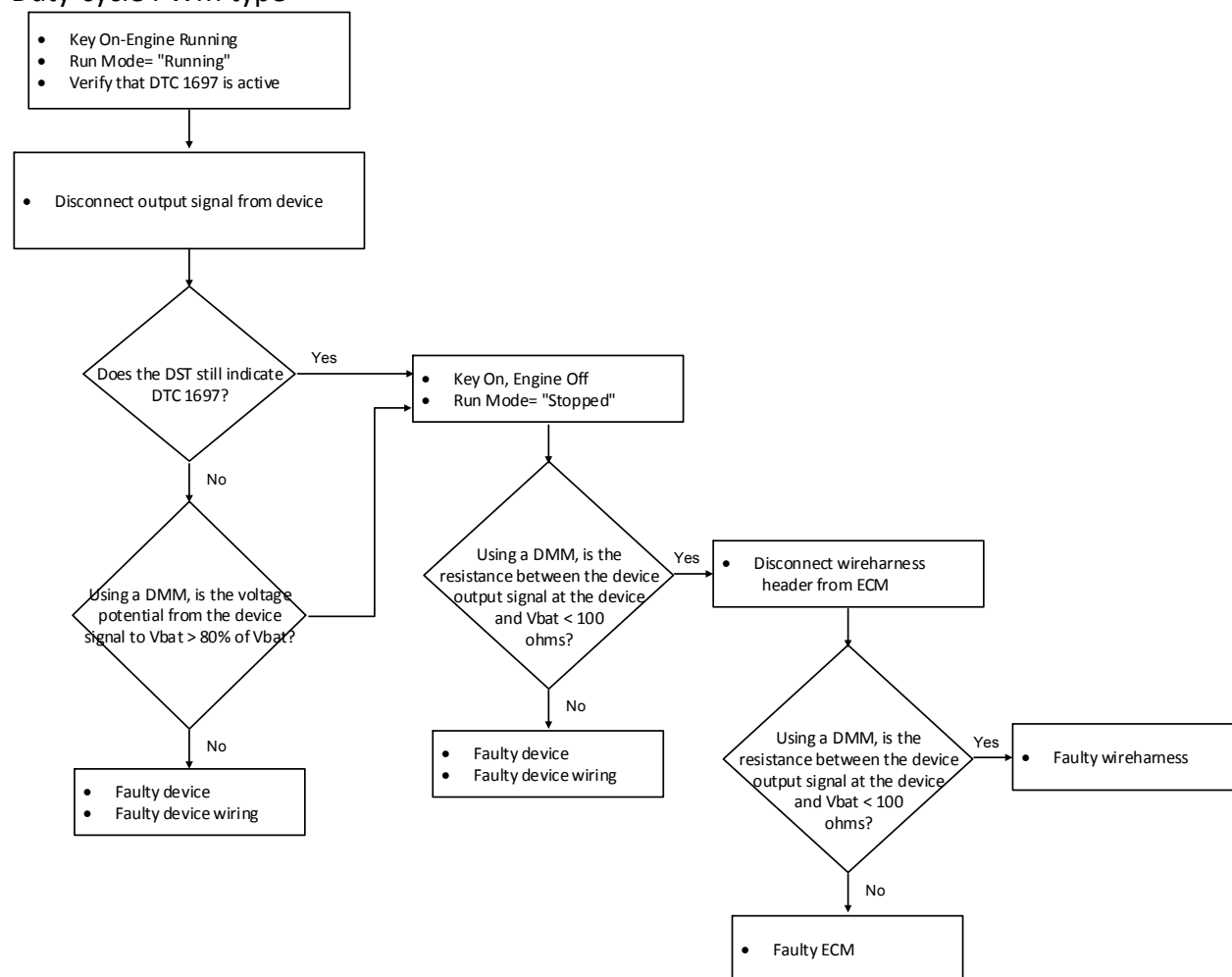
AUX PWM20 output shorted to power

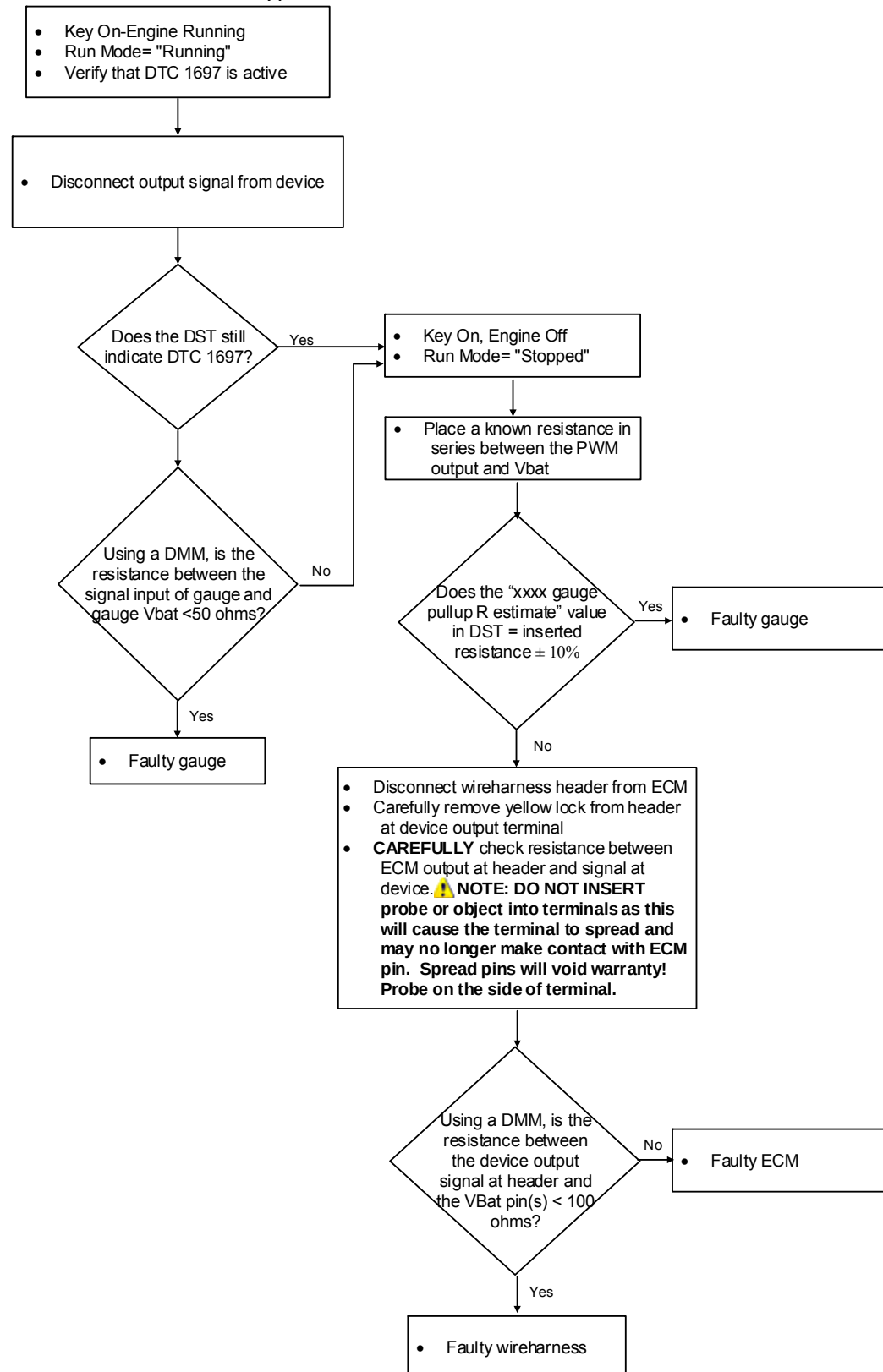
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

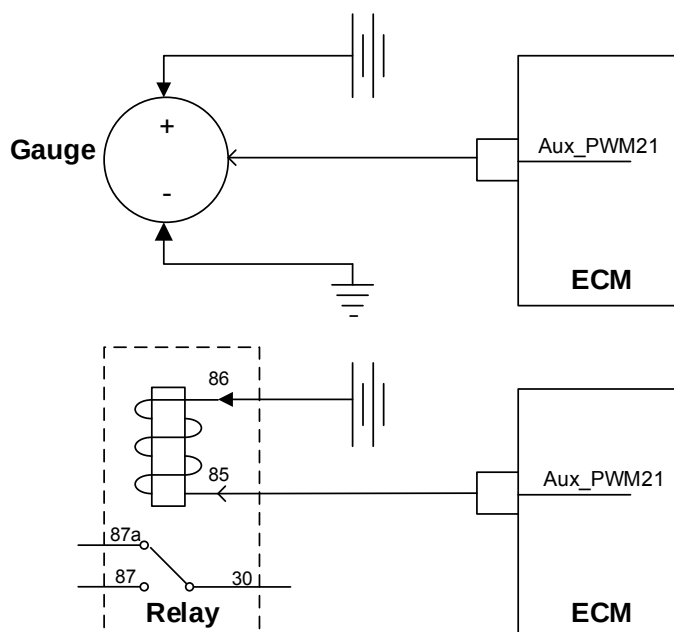
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1697 – PWM20 SHORT TO POWER (TROUBLE TREE)

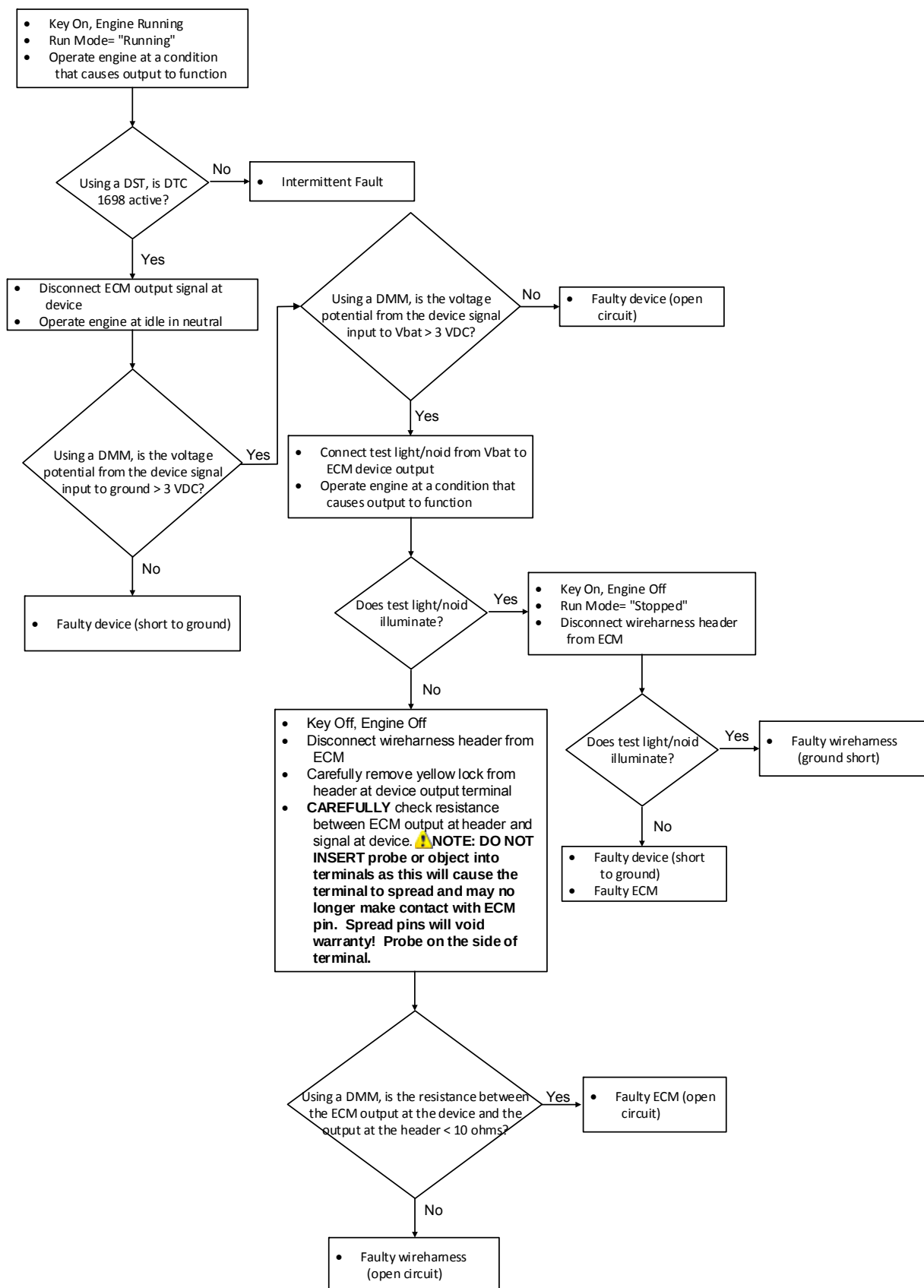
Duty-cycle PWM type

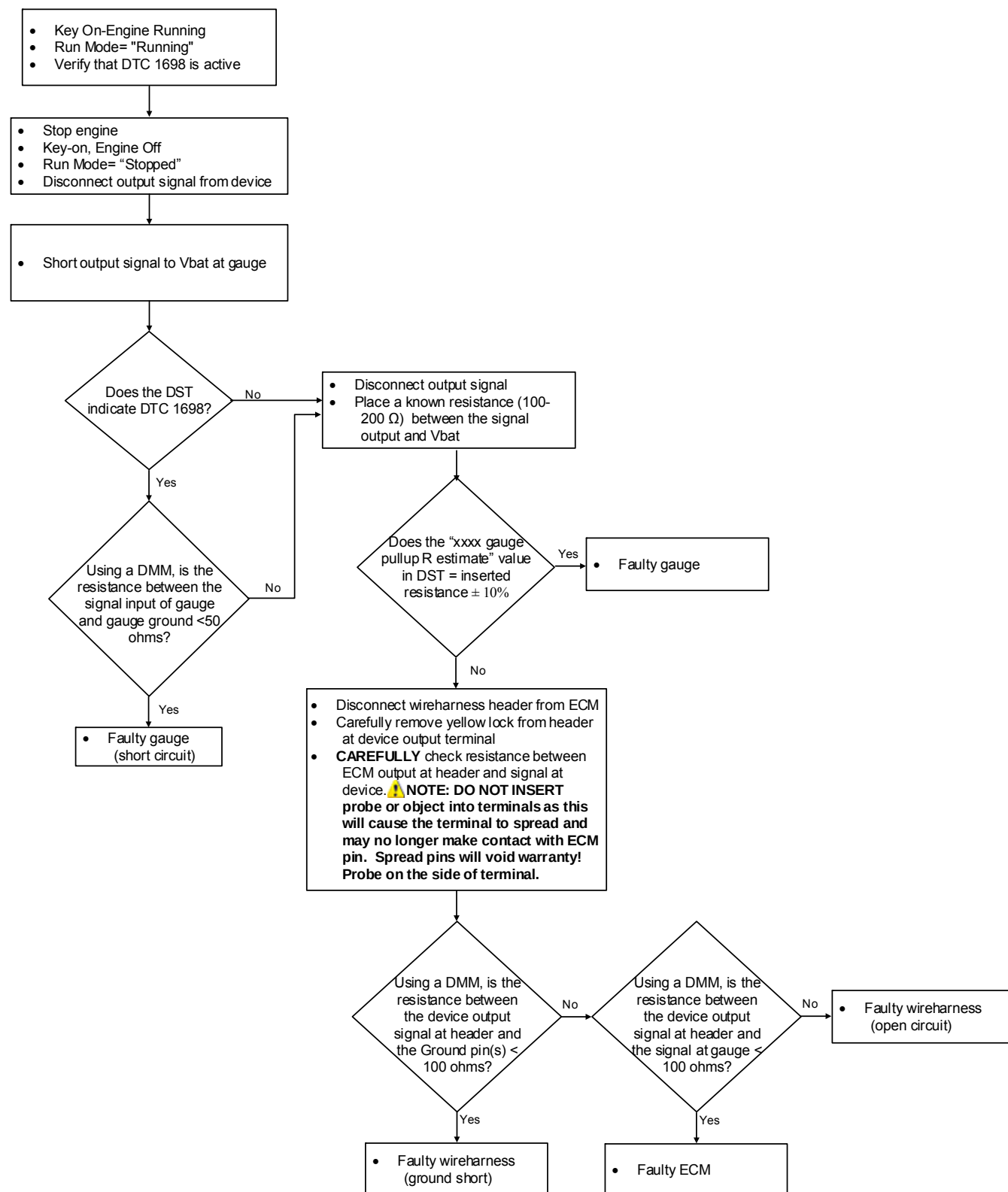


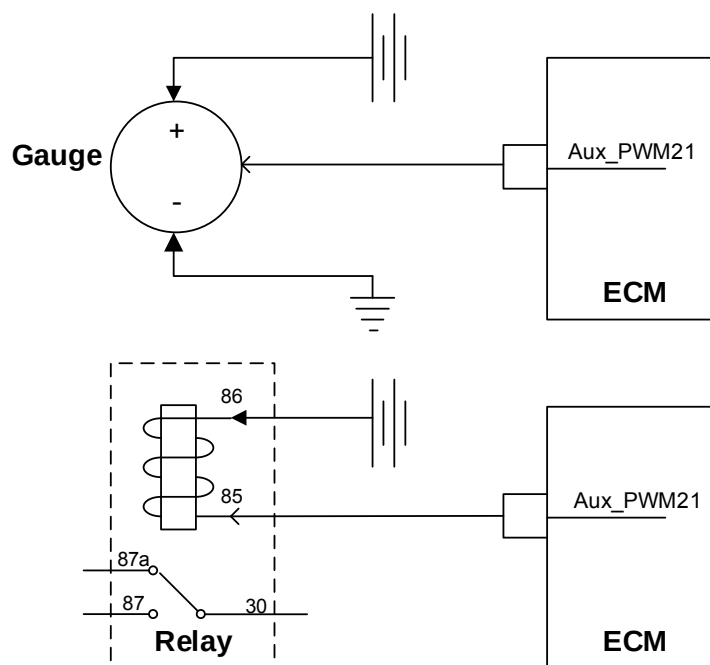
DTC 1697 – PWM20 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

DTC 1698 - PWM21 OPEN / GROUND SHORT

DTC	1698	SPN	2659	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM21 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 21 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM21 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1698 – PWM21 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1698 – PWM21 OPEN / GROUND SHORT (TROUBLE TREE)**Resistance Simulation type**

DTC 1699 - PWM21 SHORT TO POWER

DTC	1699	SPN	2659	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM21 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 21 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 21 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

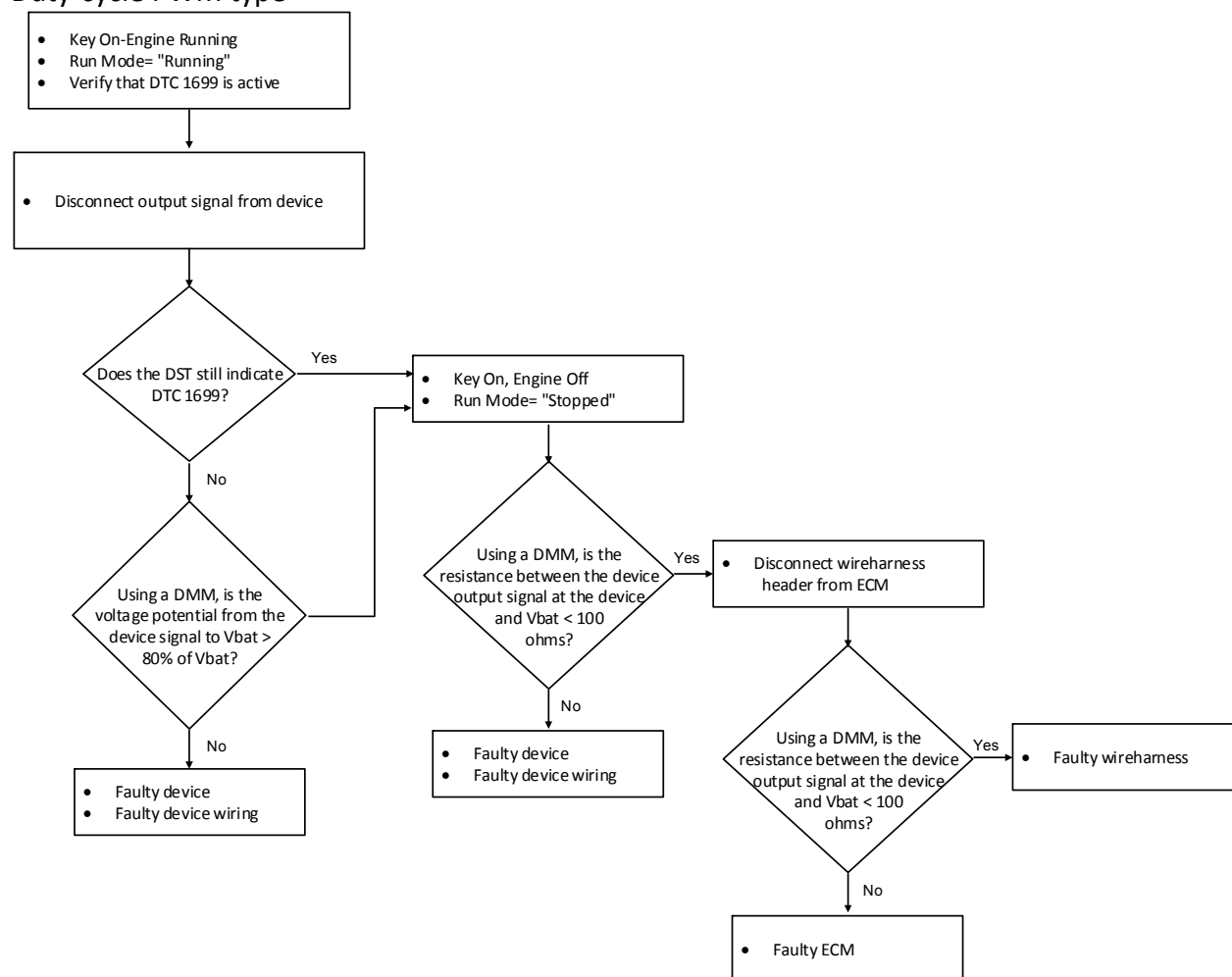
AUX PWM21 output shorted to power

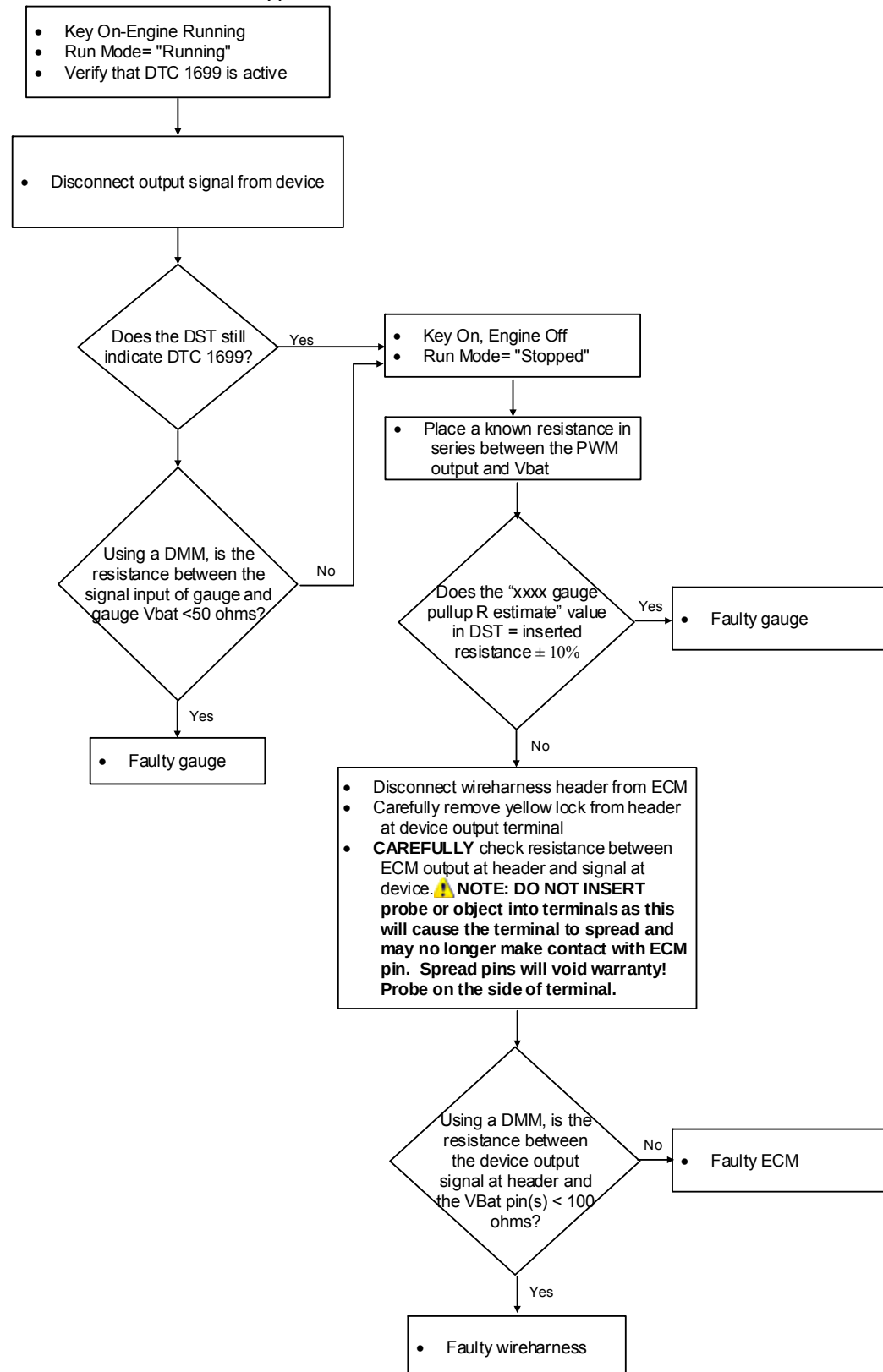
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

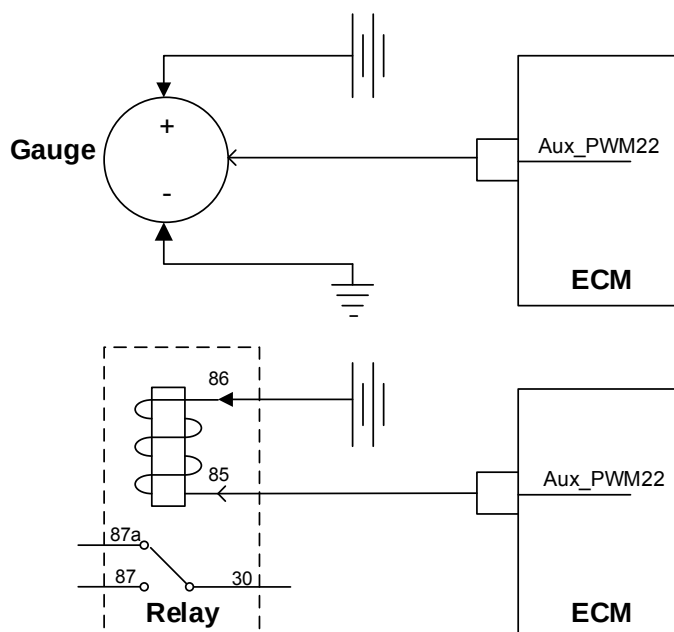
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1699 – PWM21 SHORT TO POWER (TROUBLE TREE)

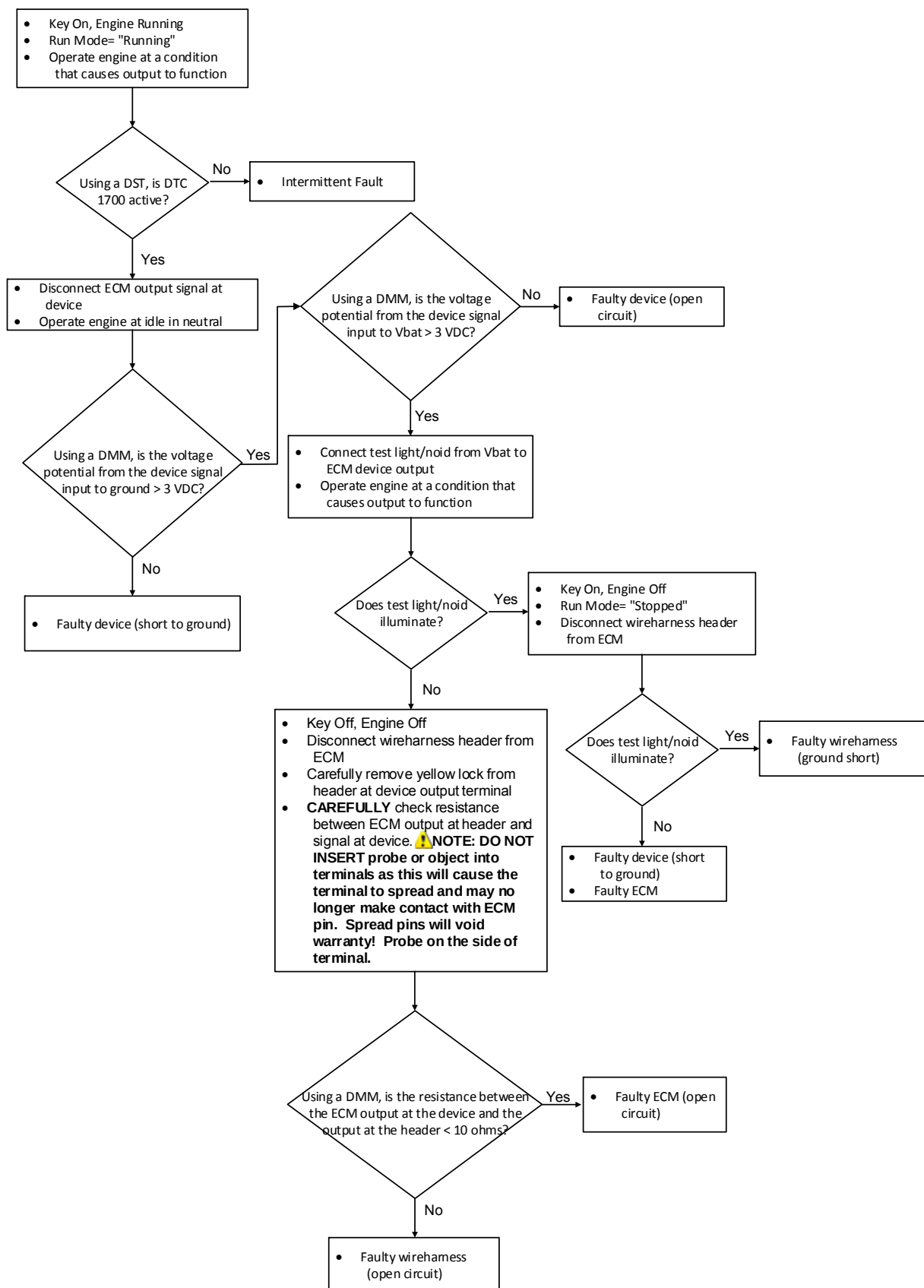
Duty-cycle PWM type



DTC 1699 – PWM21 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

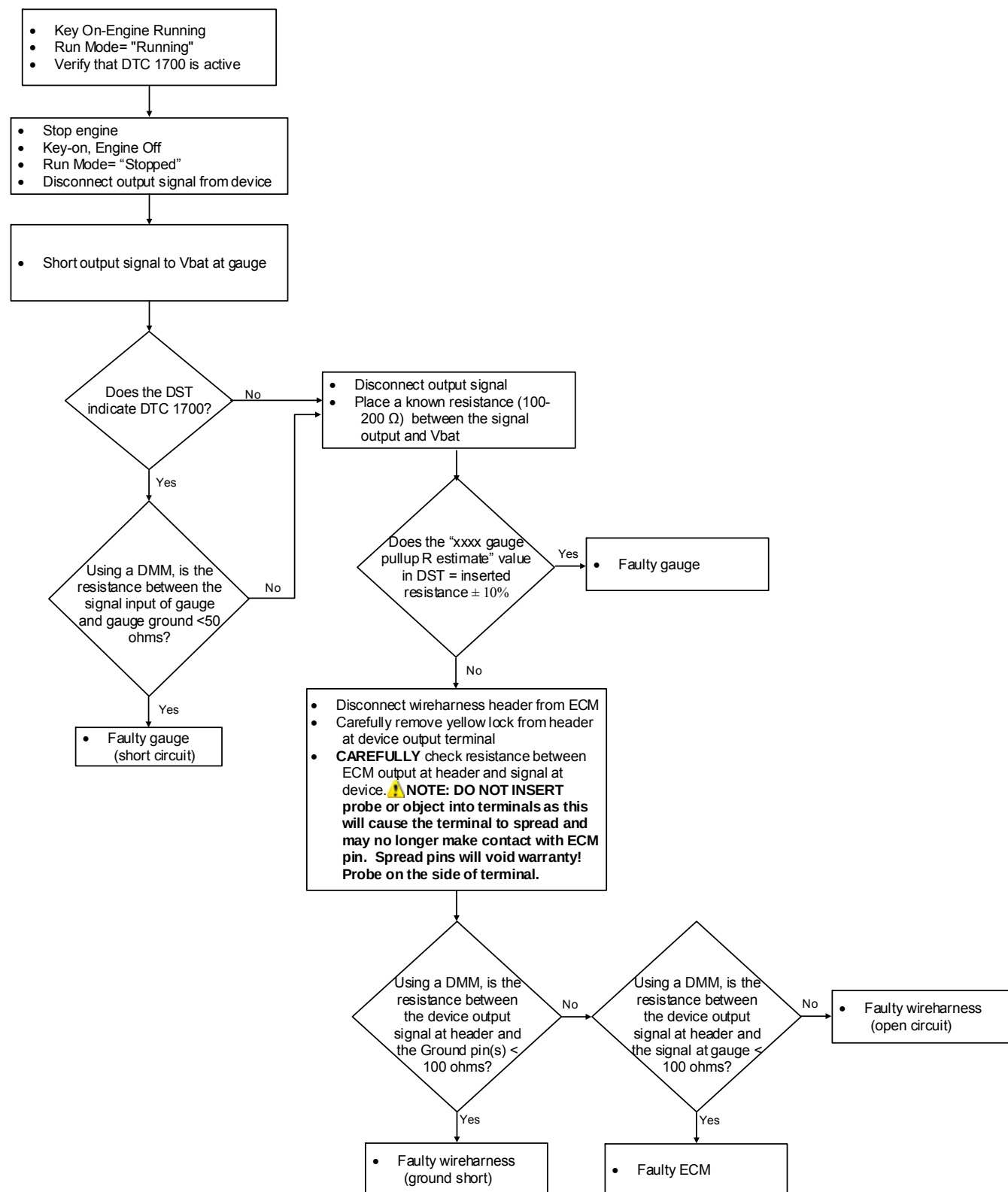
DTC 1700 - PWM22 OPEN / GROUND SHORT

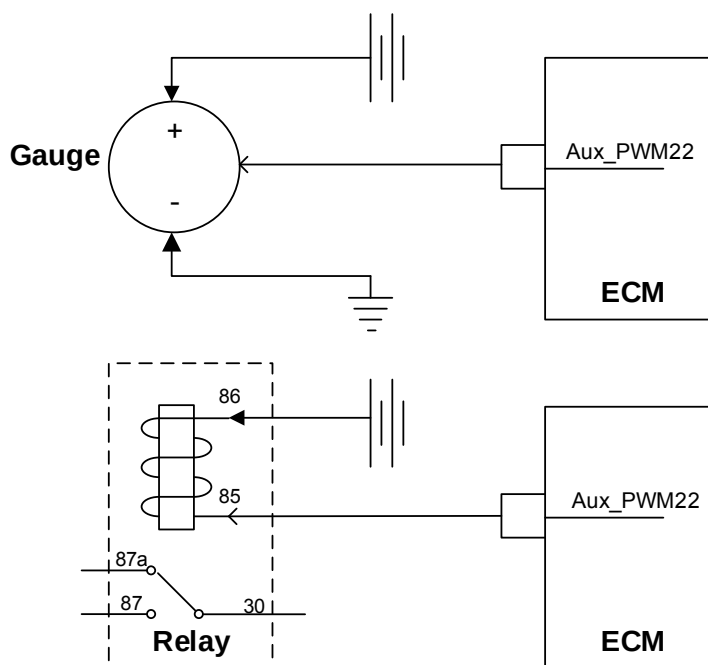
DTC	1700	SPN	2660	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM22 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 22 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM22 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1700 – PWM22 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 16700 – PWM22 OPEN / GROUND SHORT (TROUBLE TREE)

Resistance Simulation type



DTC 1701 - PWM22 SHORT TO POWER

DTC	1701	SPN	2660	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM22 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 22 low-side feedback >				TBD*	% Vbat
• and PWM duty-cycle >				TBD*	%
OR					
• PWM 22 current feedback >				TBD*	mA
• and PWM duty-cycle <				TBD*	%

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Possible Causes:

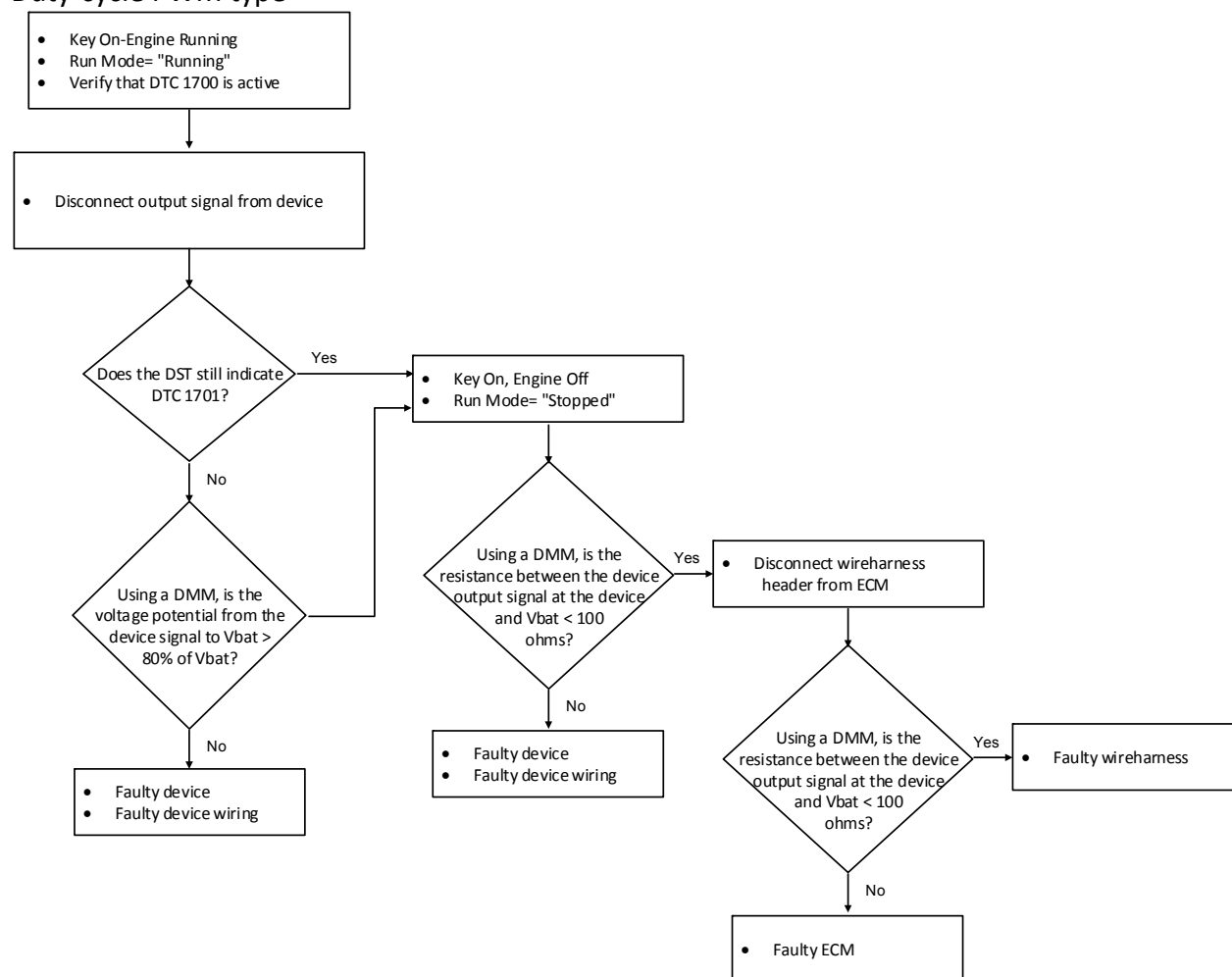
AUX PWM22 output shorted to power

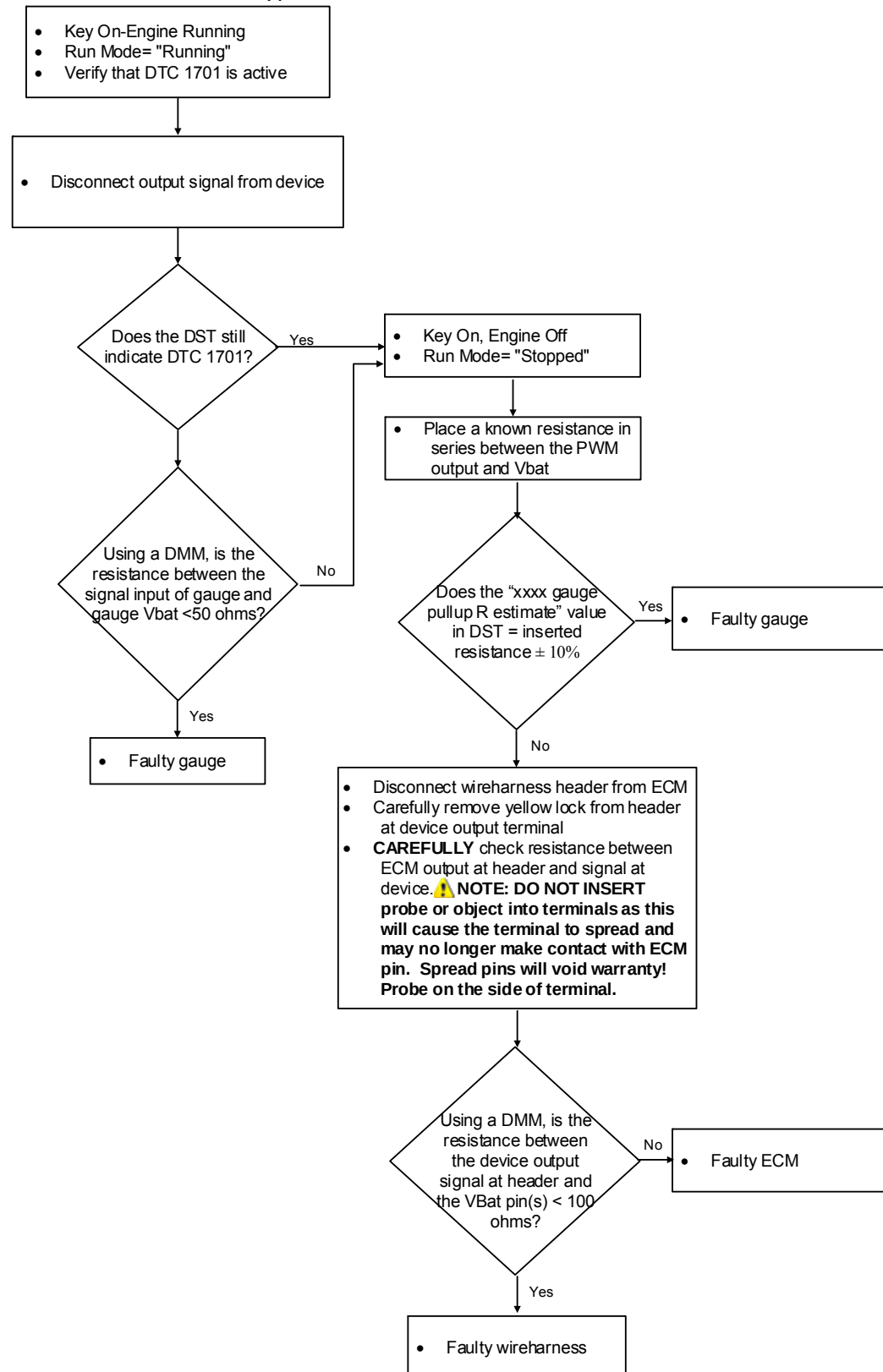
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

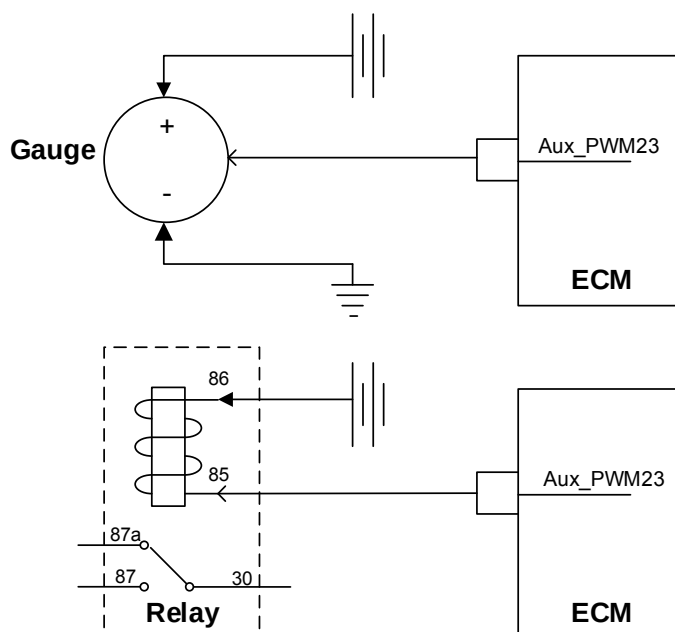
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1701 – PWM22 SHORT TO POWER (TROUBLE TREE)

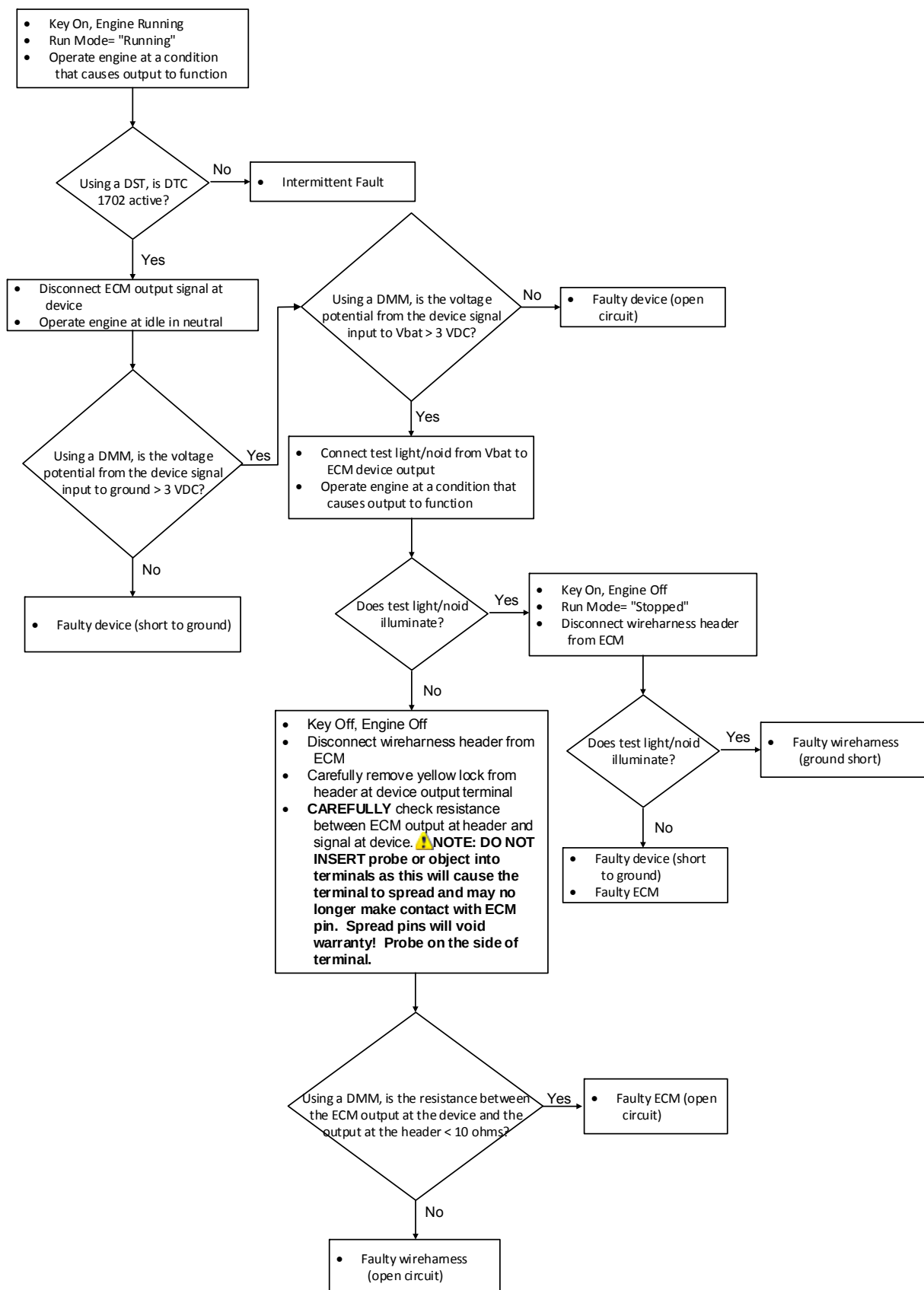
Duty-cycle PWM type

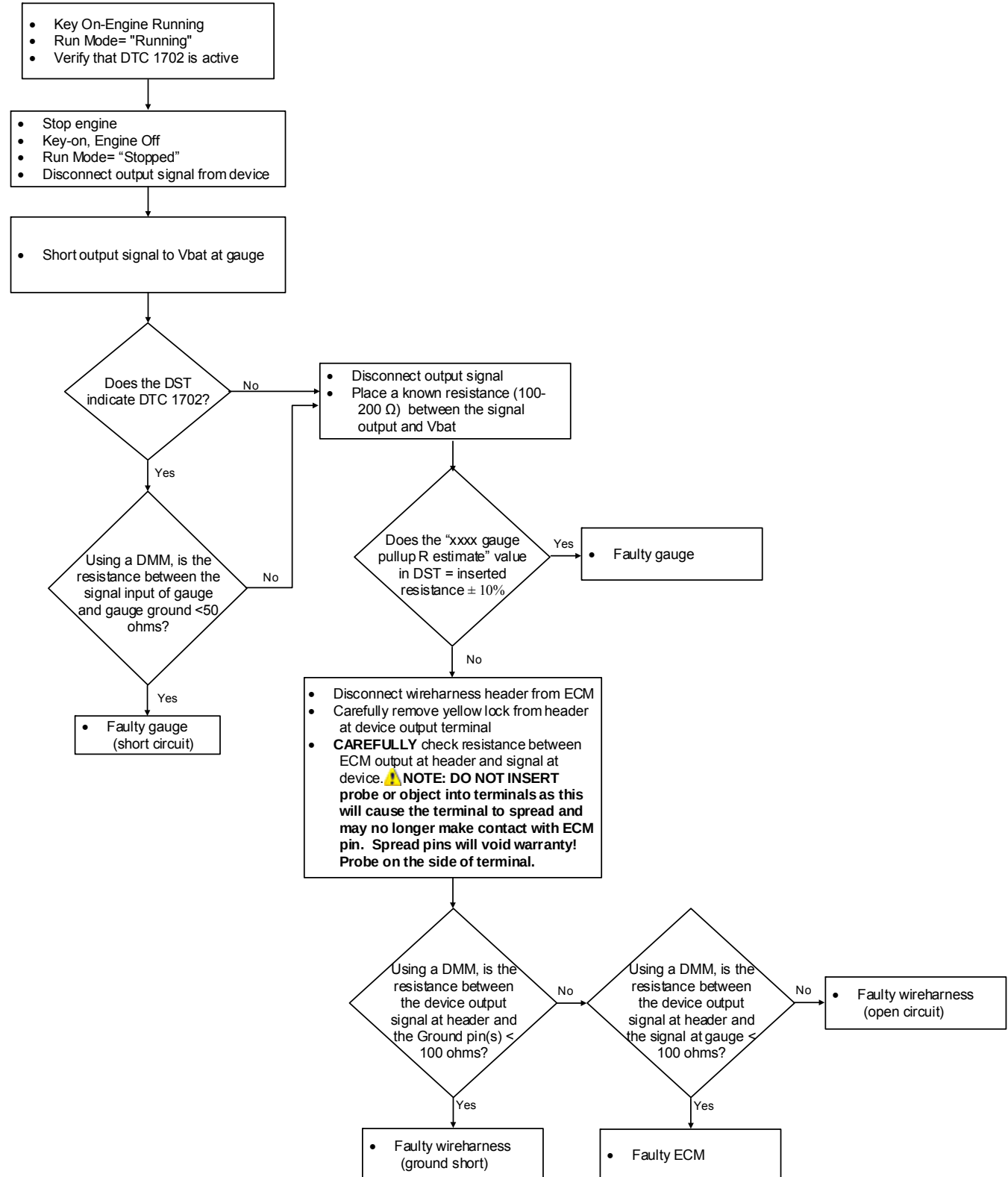


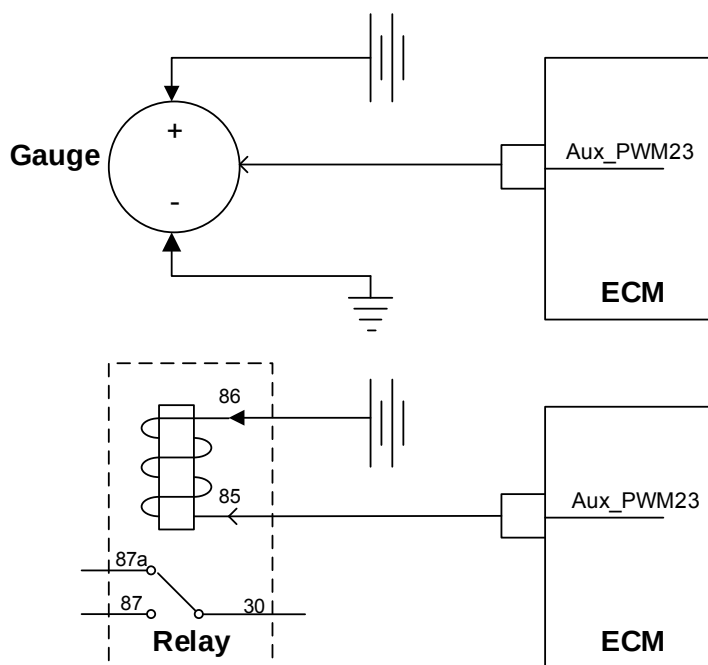
DTC 1701 – PWM22 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

DTC 1702 - PWM23 OPEN / GROUND SHORT

DTC	1702	SPN	2661	FMI	5		
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)							
Description: AUX_PWM23 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key-On, Engine On					
Fault Set Conditions (as defined in calibration):							
• PWM 23 low-side feedback <				TBD*	% Vbat		
• and PWM duty-cycle <				TBD*	%		
Possible Causes: AUX PWM23 output open circuit or shorted to ground							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1702 – PWM23 OPEN / GROUND SHORT (TROUBLE TREE)**Duty-cycle PWM type**

DTC 1702 – PWM23 OPEN / GROUND SHORT (TROUBLE TREE)**Resistance Simulation type**

DTC 1703 - PWM23 SHORT TO POWER

DTC	1703	SPN	2661	FMI	3
Sensor/Circuit: Analog gauge, proportional actuator, on-off device (see examples above)					
Description: AUX_PWM23 is an output that, depending on the ECM HW configuration, may be used to: • Simulate the resistance of a sender to drive an analog gauge (Gauge driver config) • PWM an analog gauge (PWM config) • PWM the low-side of an on-off device (PWM config) • PWM a proportional actuator (PWM config)					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key-On, Engine On			
Fault Set Conditions (as defined in calibration):					
• PWM 23 low-side feedback >			TBD*	% Vbat	
• and PWM duty-cycle >			TBD*	%	
OR					
• PWM 23 current feedback >			TBD*	mA	
• and PWM duty-cycle <			TBD*	%	

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Possible Causes:

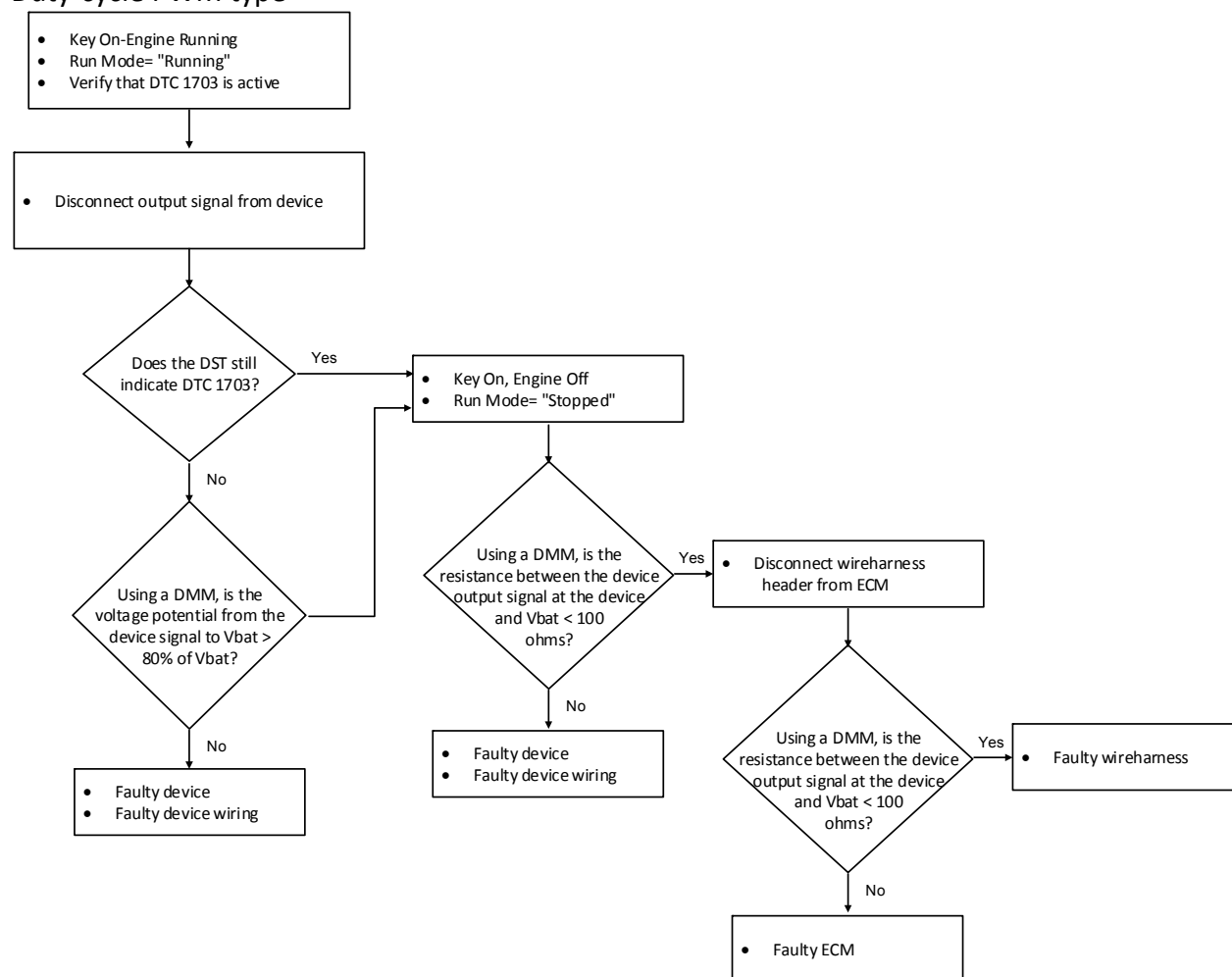
AUX PWM23 output shorted to power

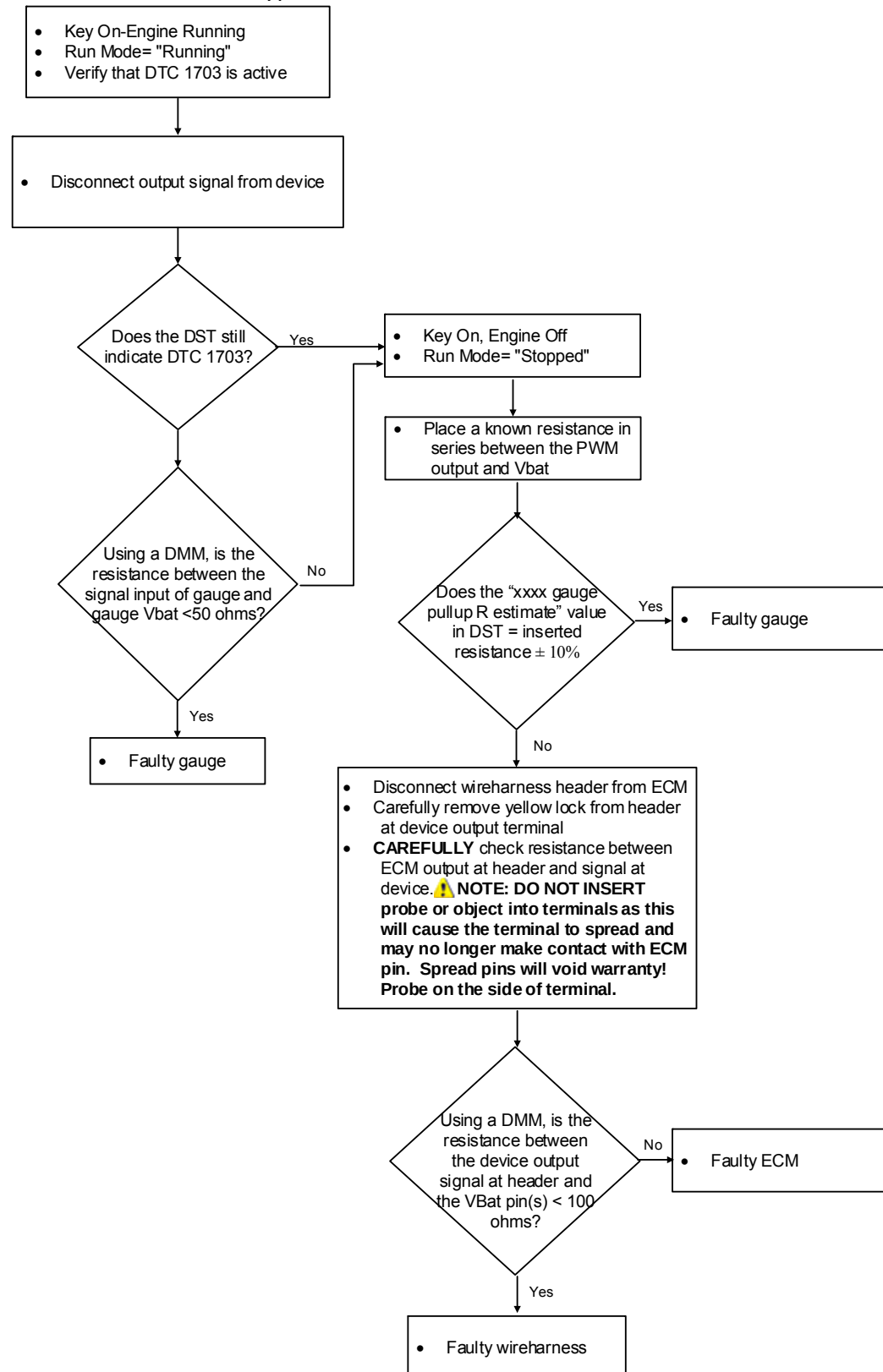
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

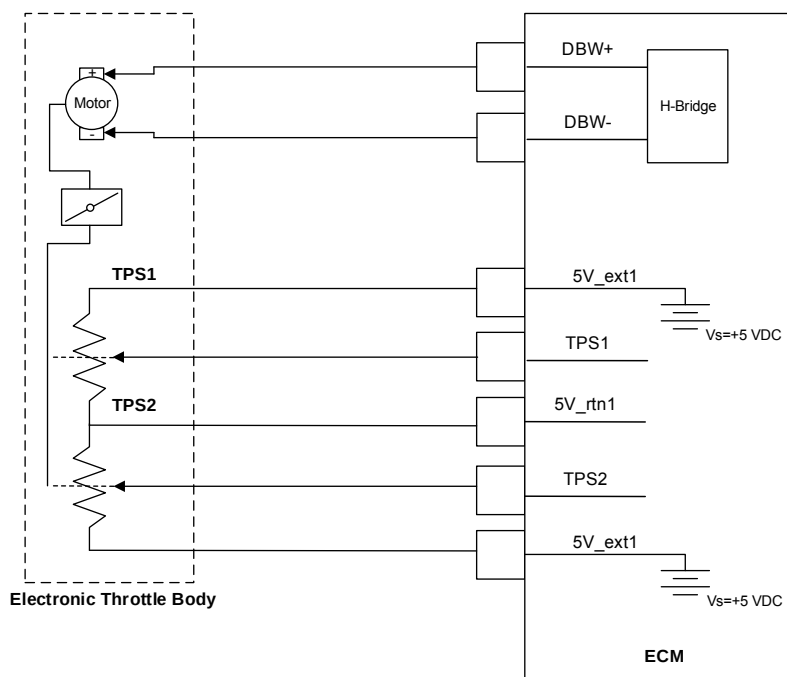
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 1703 – PWM23 SHORT TO POWER (TROUBLE TREE)

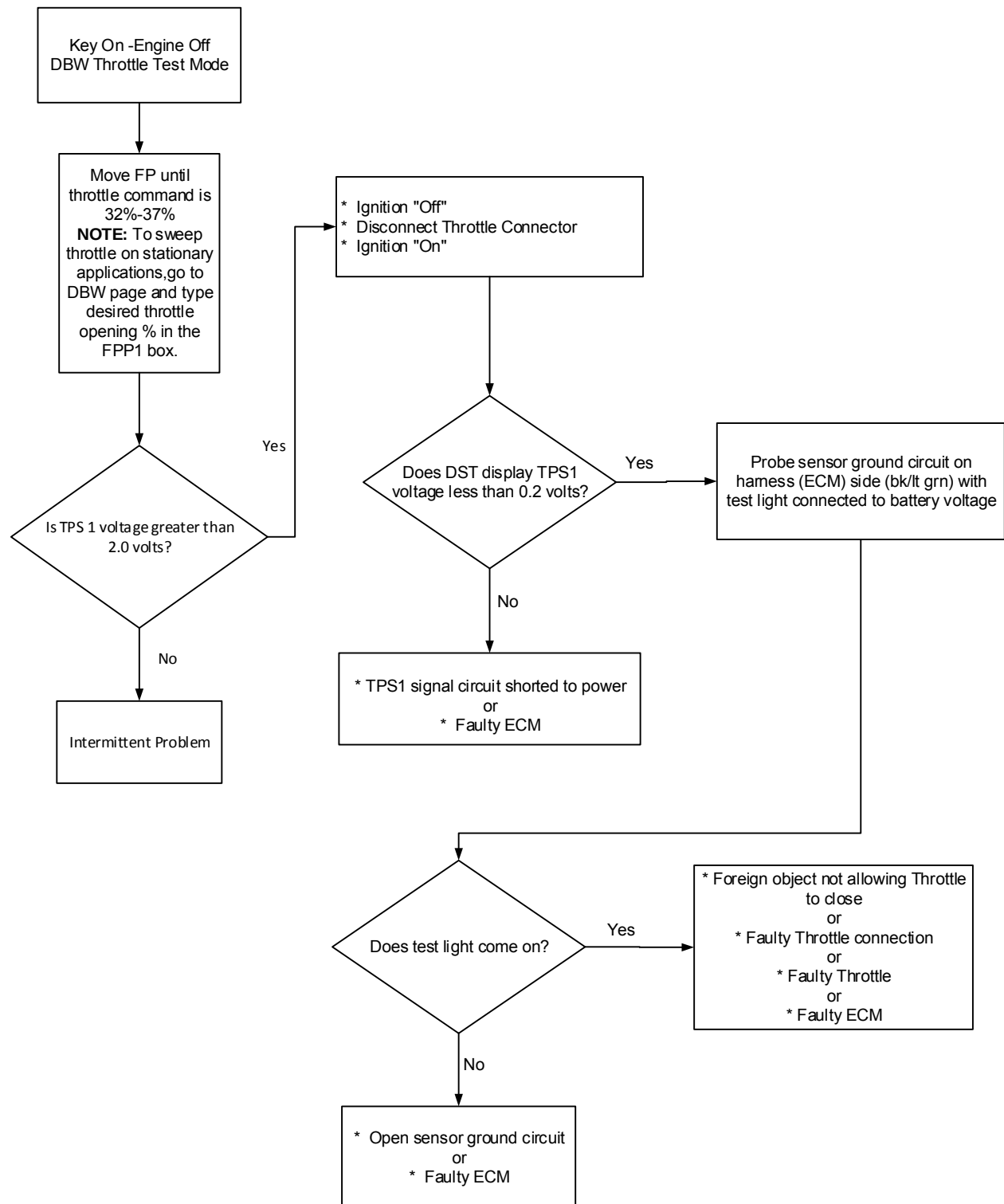
Duty-cycle PWM type

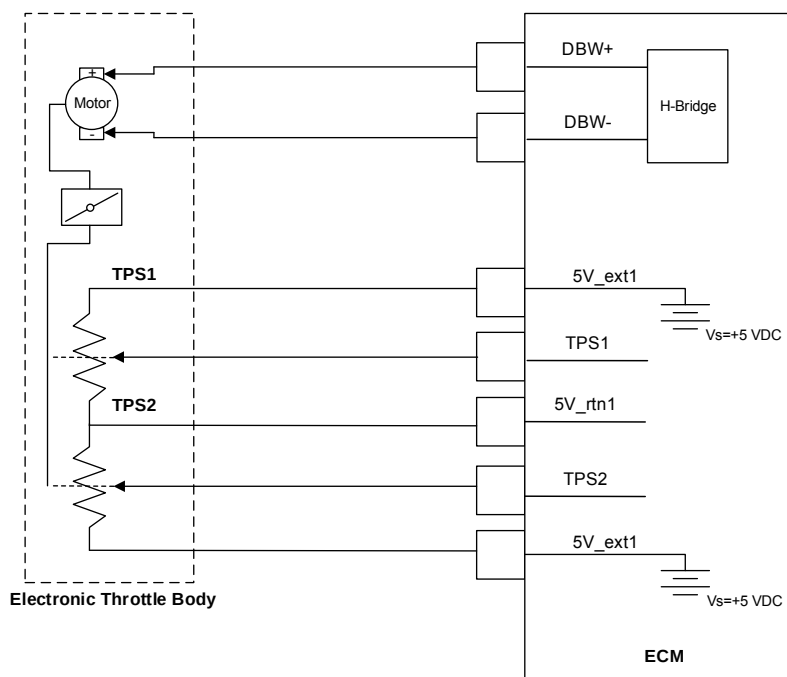


DTC 1703 – PWM23 SHORT TO POWER (TROUBLE TREE)**Resistance Simulation type**

DTC 2111 - UNABLE TO REACH LOWER TPS

DTC	2111	SPN	51	FMI	7		
Sensor/Circuit: Throttle Position Sensor							
Description: There are 2 Throttle Position Sensors located within the throttle which use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read low voltage when closed and TPS2 will read high voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			NO				
Check Condition:			Cranking or Running				
Fault Set Conditions (as defined in calibration):							
Throttle command is 20% less than throttle position for 200ms or longer							
Possible Causes: This fault will set if the throttle command is 20% less than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

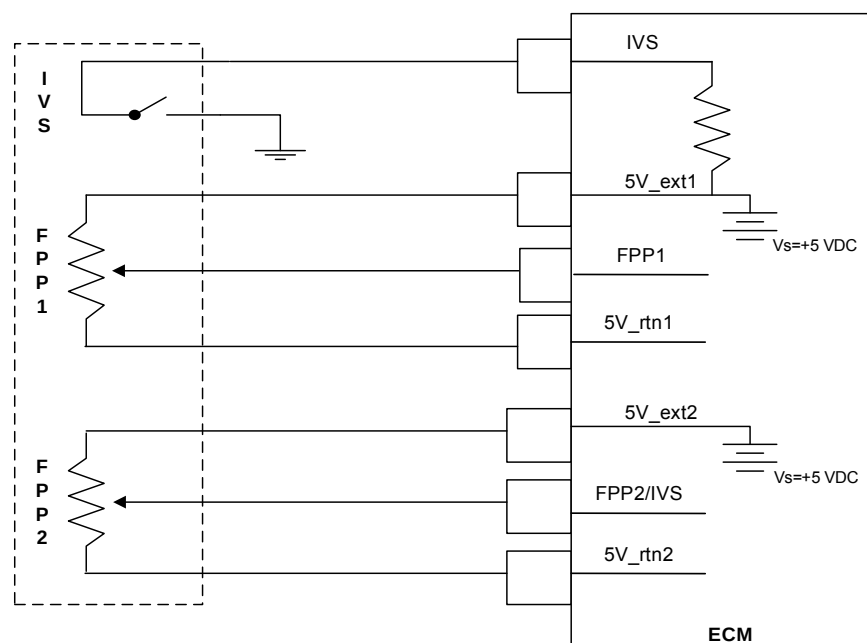
DTC 2111 - UNABLE TO REACH LOWER TPS (TROUBLE TREE)

DTC 2112 - UNABLE TO REACH HIGHER TPS

DTC	2112	SPN	51	FMI	7		
Sensor/Circuit: Throttle Position Sensor							
Description: There are 2 Throttle Position Sensors located within the throttle which use variable resistors to determine signal voltage based on throttle plate position. TPS1 will read low voltage when closed and TPS2 will read high voltage when closed. The TPS1 and TPS2 percentages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position percentages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded.							
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)				
Emissions-related Fault?			NO				
Check Condition:			Cranking or Running				
Fault Set Conditions (as defined in calibration): Throttle command is 20% more than actual throttle position							
Possible Causes: This fault will set if the throttle command is 20% or more than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2112 - UNABLE TO REACH HIGHER TPS (TROUBLE TREE)

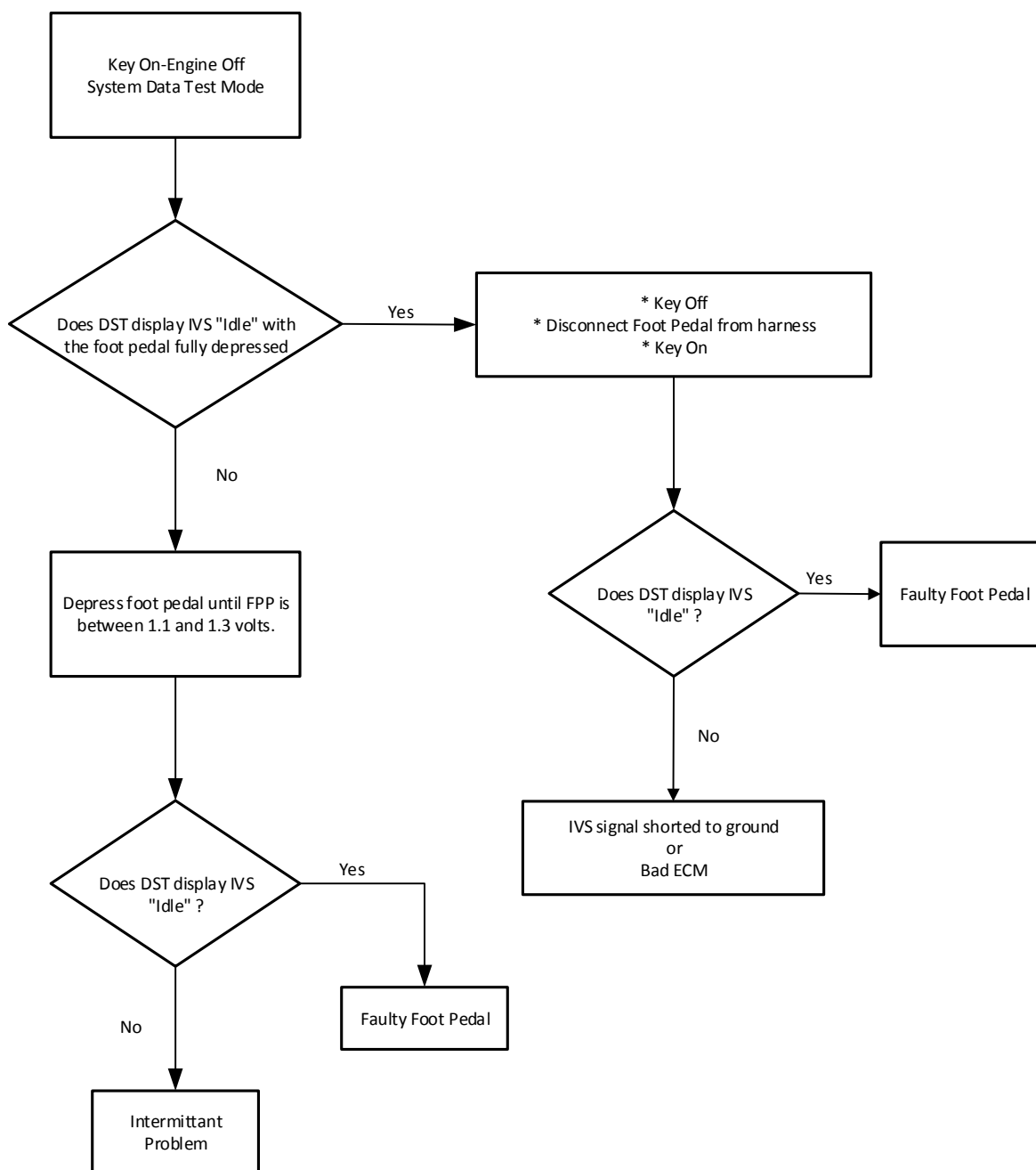
THIS SECTION CURRENTLY IN PROCESS

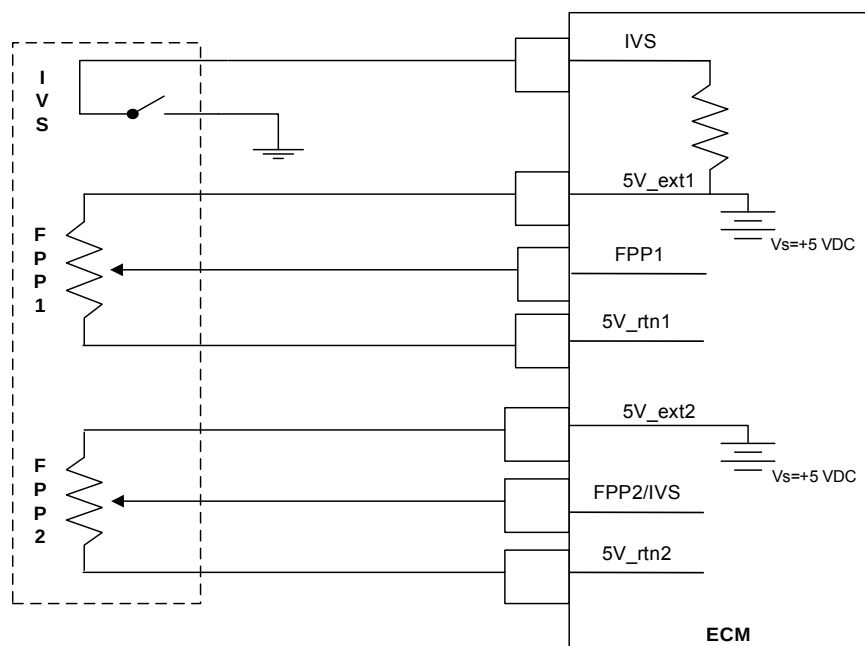
DTC 2115 - FPP1 HIGHER THAN IVS LIMIT

DTC	2115	SPN	91	FMI	0
Sensor/Circuit: Foot Pedal Position/Idle Validation Switch					
Description: The engine load command to the ECM is determined by operator depression of the electronic foot pedal. The ECM monitors the foot pedal position and controls the throttle to maintain the commanded power level. Because a problem with the foot pedal signal can result in a higher or lower power than intended by the operator, the pedal used with this control system incorporates a sensor with an idle validation switch. Checks and cross checks are constantly conducted by the ECM to determine the validity of the signals. The Idle Validation Switch (IVS) is a normally open contact (idle) that grounds (closed contacts) the IVS circuit to the ECM when the pedal is depressed more than the idle position.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Engine Cranking or Running			
Fault Set Conditions (as defined in calibration):					
• IVS at-idle when FPP1 >				TBD*	volts
Possible Causes: This fault will set if the IVS is at idle (open) and the FPP voltage is greater than the fault limit defined in the calibration.					

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2115 – FPP1 HIGHER THAN IVS LIMIT (TROUBLE TREE)

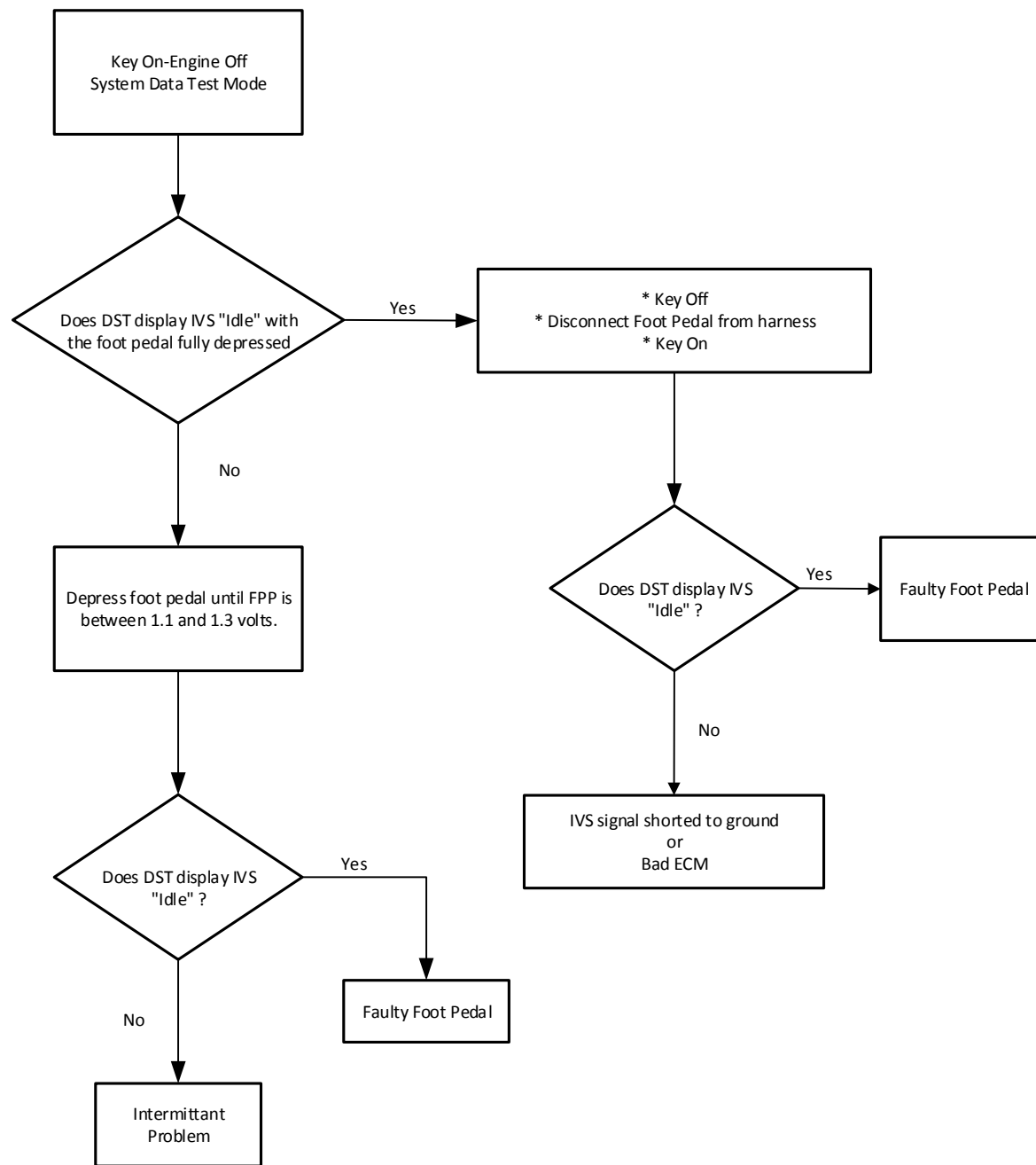
DTC 2116 - FPP2 HIGHER THAN IVS LIMIT

DTC	2116	SPN	29	FMI	0
Sensor/Circuit: Foot Pedal Position/Idle Validation Switch					
Description: The engine load command to the ECM is determined by operator depression of the electronic foot pedal. The ECM monitors the foot pedal position and controls the throttle to maintain the commanded power level. Because a problem with the foot pedal signal can result in a higher or lower power than intended by the operator, the pedal used with this control system incorporates a sensor with an idle validation switch. Checks and cross checks are constantly conducted by the ECM to determine the validity of the signals. The Idle Validation Switch (IVS) is a normally open contact (idle) that grounds (closed contacts) the IVS circuit to the ECM when the pedal is depressed more than the idle position.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Engine Cranking or Running			
Fault Set Conditions (as defined in calibration):					
• IVS at-idle when FPP2 >				TBD*	volts
Possible Causes: This fault will set if the IVS is at idle (open) and the FPP voltage is greater than the fault limit defined in the calibration.					

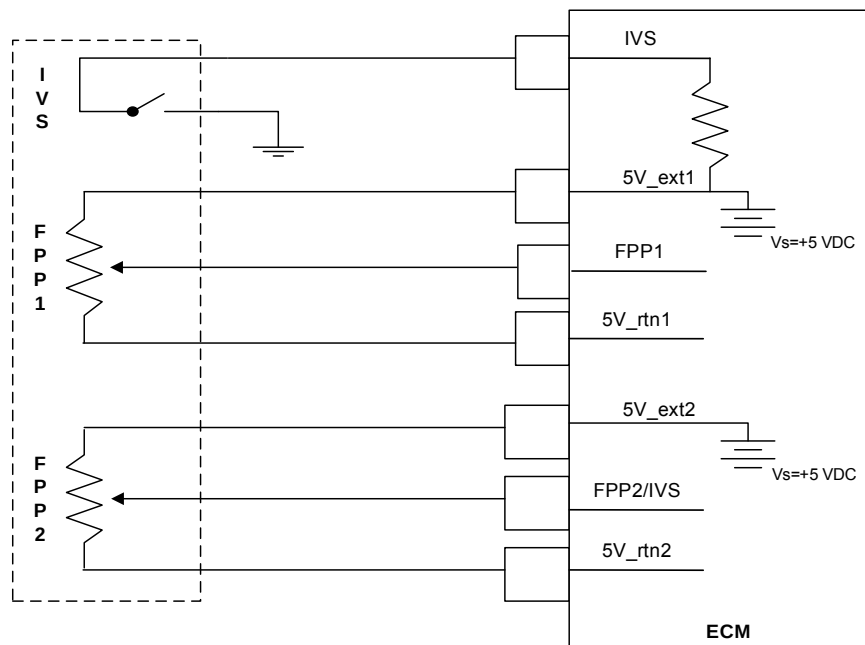
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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2116 – FPP2 HIGHER THAN IVS LIMIT (TROUBLE TREE)

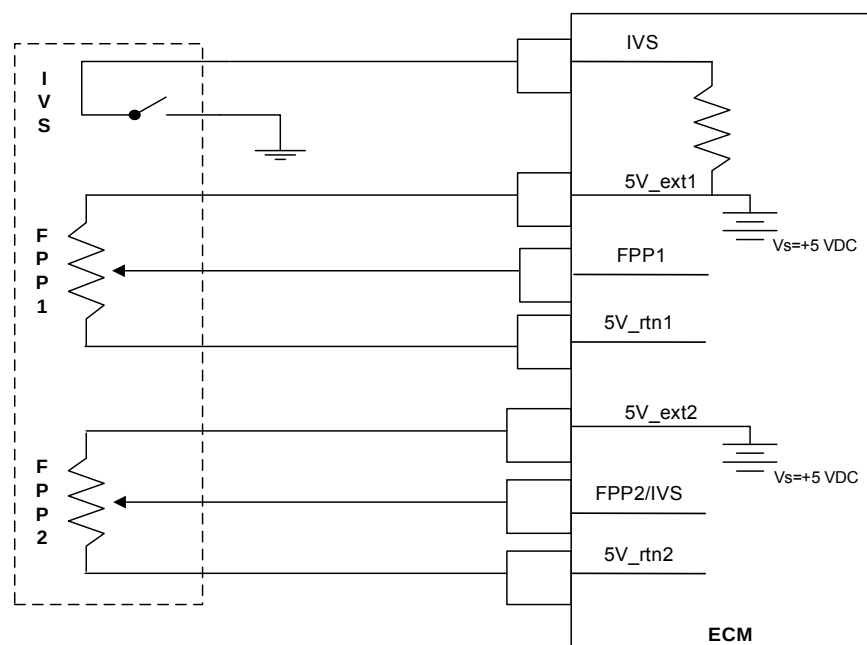
DTC 2120 - FPP1 INVALID VOLTAGE AND FPP2 DISAGREES WITH IVS (REDUNDANCY LOST)



DTC	2120	SPN	520199	FMI	11
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?			TBD* (*Application-Specific – see calibration)		
Emissions-related Fault?			NO		
Check Condition:			Engine Cranking or Running		

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Fault Set Conditions (as defined in calibration):							
• FPP1 voltage >				TBD*	volts		
or FPP1 voltage <				TBD*	volts		
AND							
• IVS at-idle when FPP2 >				TBD*	volts		
- Or -							
• IVS off-idle when FPP2 <				TBD*	volts		
or IVS off-idle if FPP2 @idle fault				(Enabled/Disabled)			
and FPP2 < FPP2 learned idle +				TBD*	volts		
Possible Causes:							
This fault is only applicable with dual potentiometer/single IVS sensors and indicates that FPP1 voltage is out-of-range and FPP2 does not correlate with the IVS state resulting in a loss of redundancy.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*
Diagnostic Aids							
☐ Troubleshoot FPP1 voltage out-of-range following DTC 2122 and 2123 procedures. ☐ Troubleshoot FPP2 disagrees with IVS following DTC 2116 and 2140 procedures.							

DTC 2121 - FPP1 LOWER THAN FPP2

DTC	2121	SPN	91	FMI	18
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			
Fault Set Conditions (as defined in calibration):					
• (FPP1% - FPP2%) <				TBD*	%

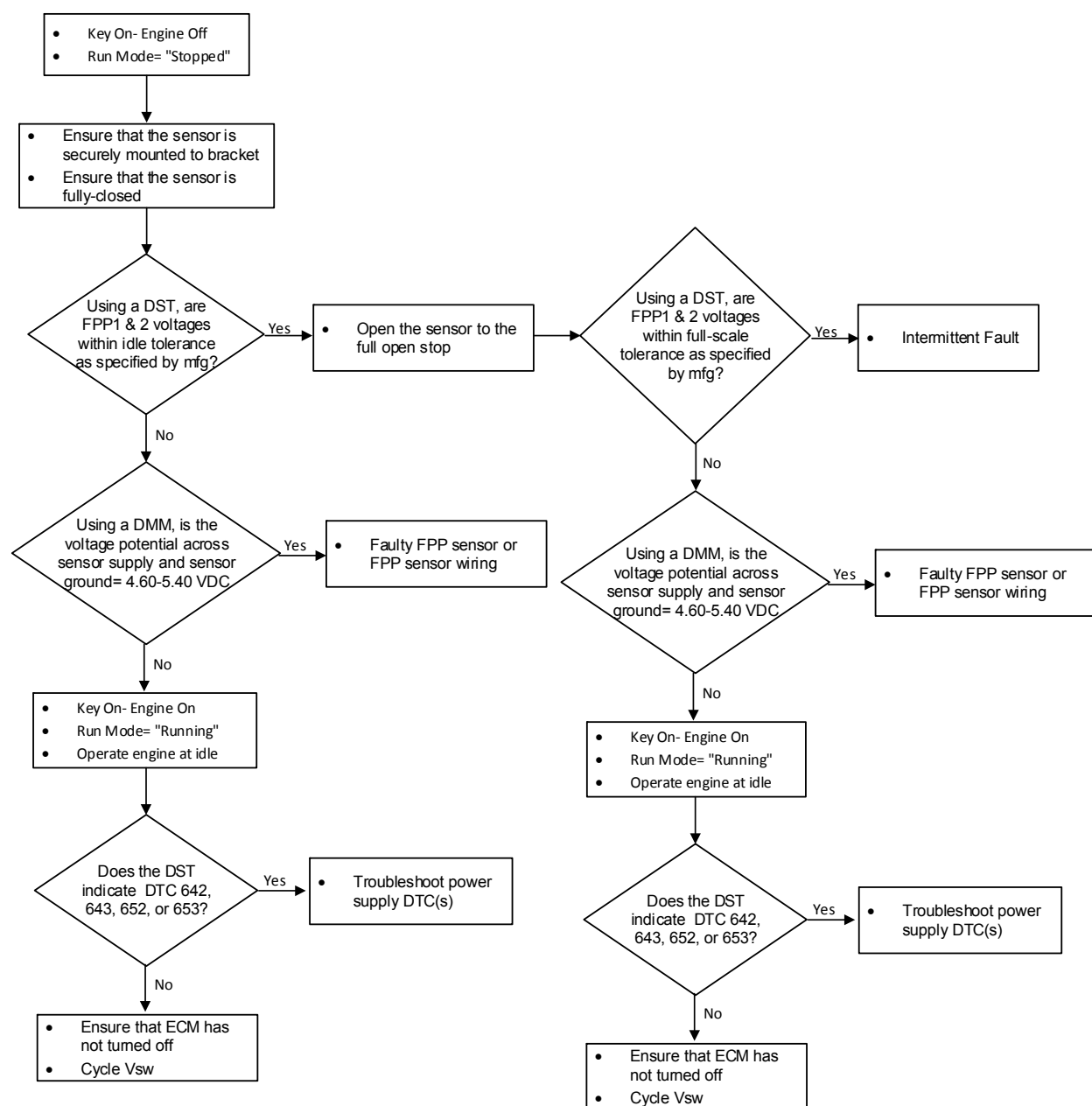
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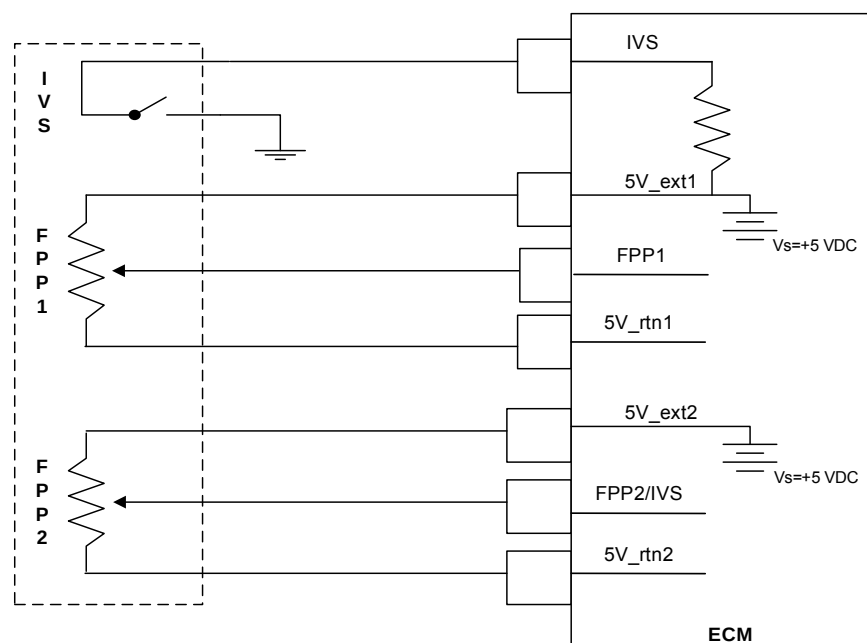
Possible Causes:

This fault indicates that the measured % deflection of sensor 1 is less than sensor 2 by an amount defined in calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2121 - FPP1 LOWER THAN FPP2 (TROUBLE TREE)

DTC 2122 - FPP1 HIGH VOLTAGE

DTC	2122	SPN	91	FMI	3
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer/hall-effect with IVS, two potentiometers/hall-effects, or two potentiometers/hall-effects with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor input(s) to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation. In systems that utilize a mechanical throttle the foot pedal input is used to monitor the position of the mechanical throttle valve in order to activate minimum or maximum governors. In electronic throttle control systems the foot pedal position/throttle control position sensor is used by the engine/equipment operator or system to command either throttle position or a governor speed target proportional to the input in order to achieve desired system behavior.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			
Fault Set Conditions (as defined in calibration):					
• FPP1 voltage >				TBD*	volts

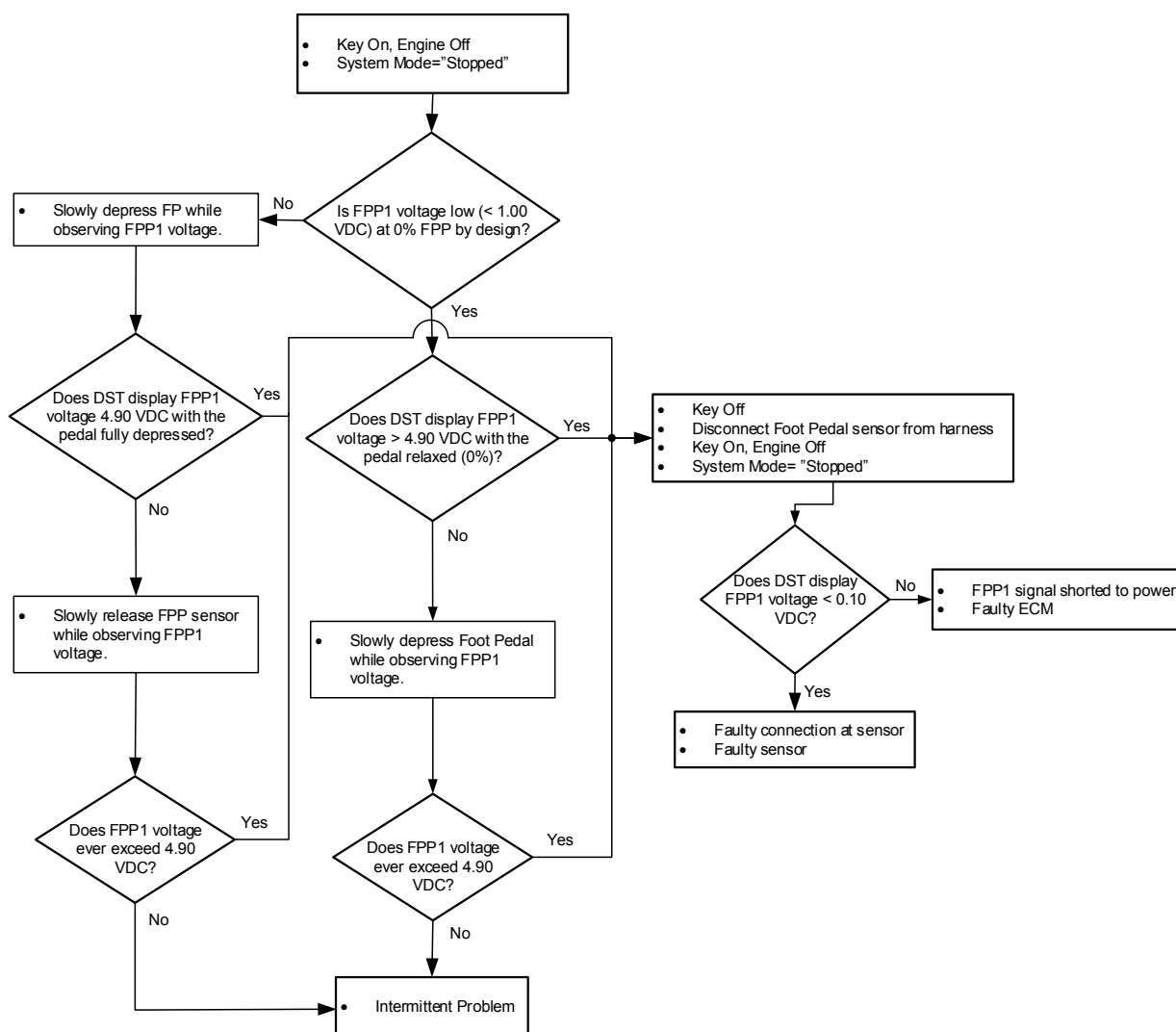
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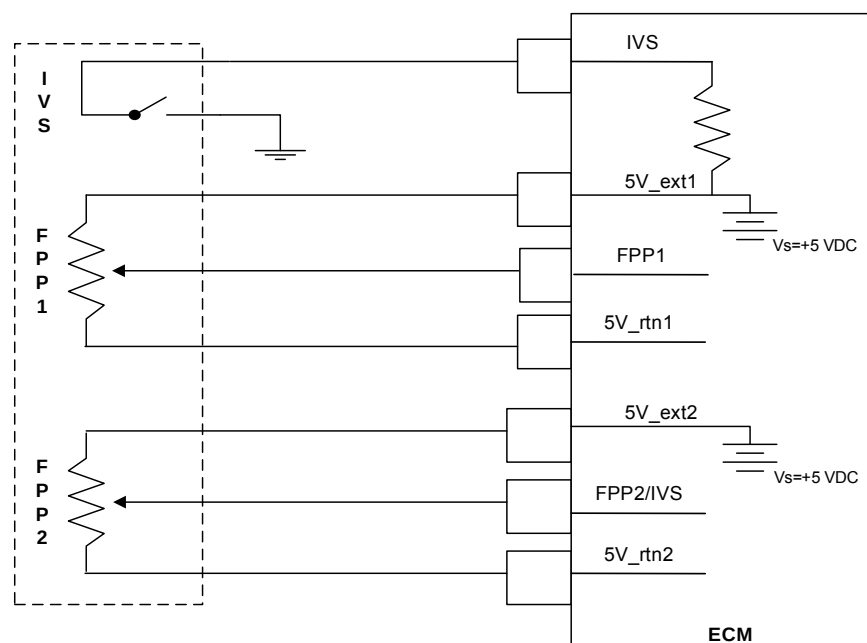
Possible Causes:

This fault will set if FPP1 voltage is higher than the limit defined in the engine calibration at any operating condition. Fully redundant systems (when three sensors are compared) limited operation may result in setting codes without requiring derates, however, single or non-redundant systems (FPP1 w/IVS) must command forced idle or engine shutdowns depending on the type of system.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2122 - FPP1 HIGH VOLTAGE (TROUBLE TREE)

DTC 2123 - FPP1 LOW VOLTAGE

DTC	2123	SPN	91	FMI	4
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer/hall-effect with IVS, two potentiometers/hall-effects, or two potentiometers/hall-effects with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor input(s) to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation. In systems that utilize a mechanical throttle the foot pedal input is used to monitor the position of the mechanical throttle valve in order to activate minimum or maximum governors. In electronic throttle control systems the foot pedal position/throttle control position sensor is used by the engine/equipment operator or system to command either throttle position or a governor speed target proportional to the input in order to achieve desired system behavior.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			
Fault Set Conditions (as defined in calibration):					
• FPP1 voltage <				TBD*	volts

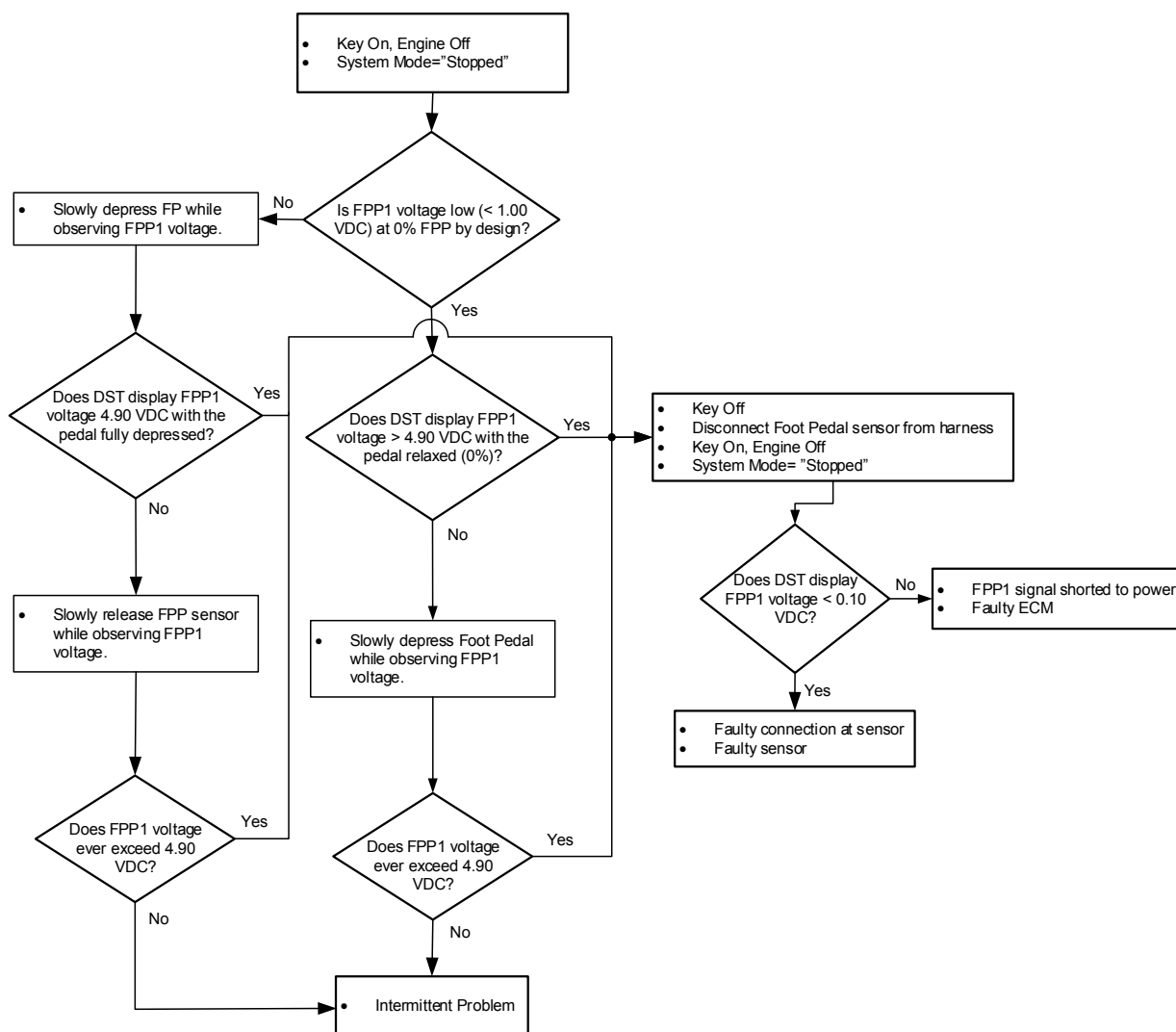
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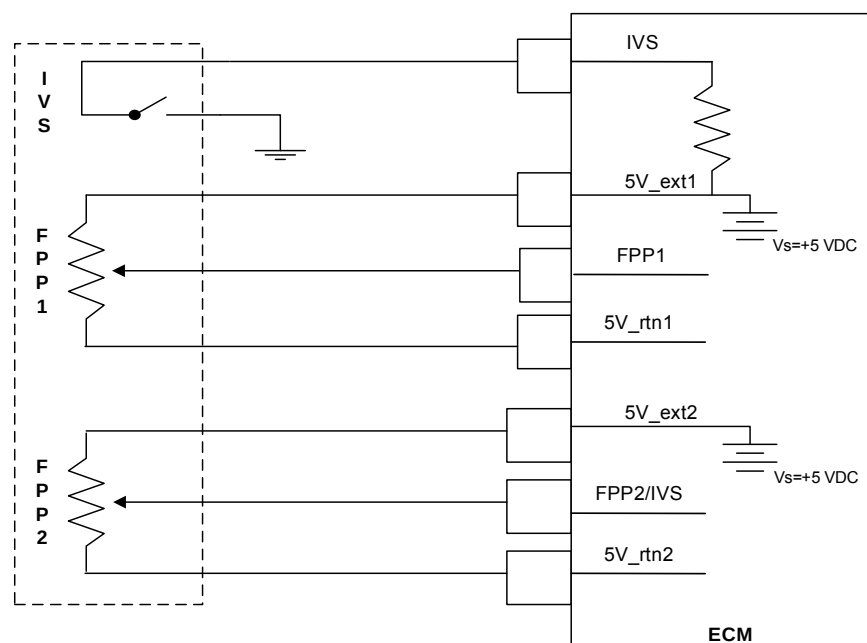
Possible Causes:

This fault will set if FPP1 voltage is lower than the limit defined in the engine calibration at any operating condition. Fully redundant systems (when three sensors are compared) limited operation may result in setting codes without requiring derates, however, single or non-redundant systems (FPP1 w/IVS) must command forced idle or engine shutdowns depending on the type of system.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

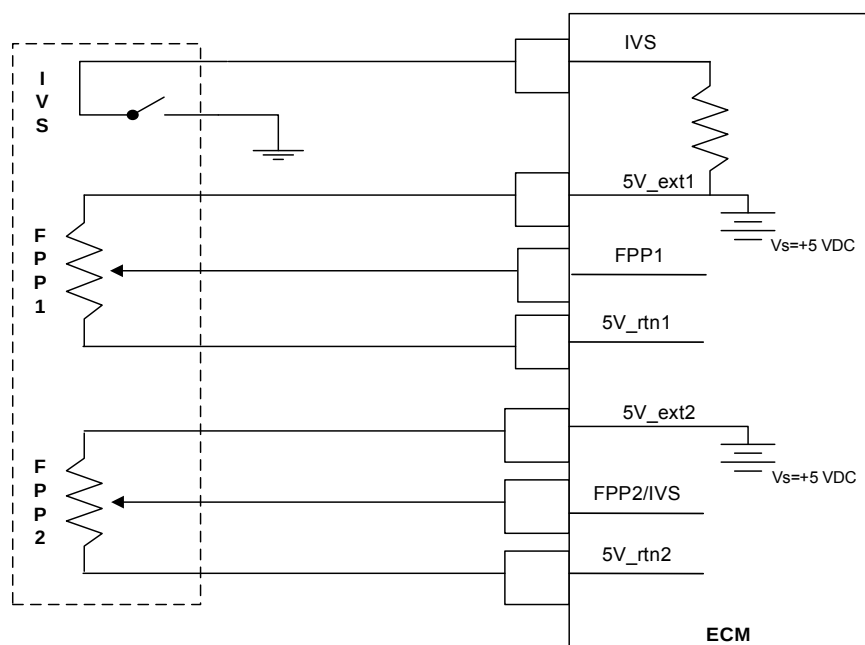
DTC 2123 - FPP1 LOW VOLTAGE (TROUBLE TREE)

DTC 2125 - FPP2 INVALID VOLTAGE AND FPP1 DISAGREES WITH IVS

DTC	2125	SPN	520199	FMI	11
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			

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Fault Set Conditions (as defined in calibration):							
• FPP2 voltage >	TBD*	volts					
or FPP2 voltage <	TBD*	volts					
AND							
• IVS at-idle when FPP1 >	TBD*	volts					
- Or -							
• IVS off-idle when FPP1 <	TBD*	volts					
or IVS off-idle if FPP1 @idle fault	(Enabled/Disabled)						
and FPP1 < FPP1 learned idle +	TBD*	volts					
Possible Causes:							
This fault is only applicable with dual potentiometer/single IVS sensors and indicates that FPP2 voltage is out-of-range and FPP1% does not correlate with the IVS state resulting in a loss of redundancy.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*
Diagnostic Aids:							
☐ Troubleshoot FPP2 voltage out-of-range following DTC 2127 and 2128 procedures.							
☐ Troubleshoot FPP1 disagrees with IVS following DTC 2115 and 2139 procedures.							

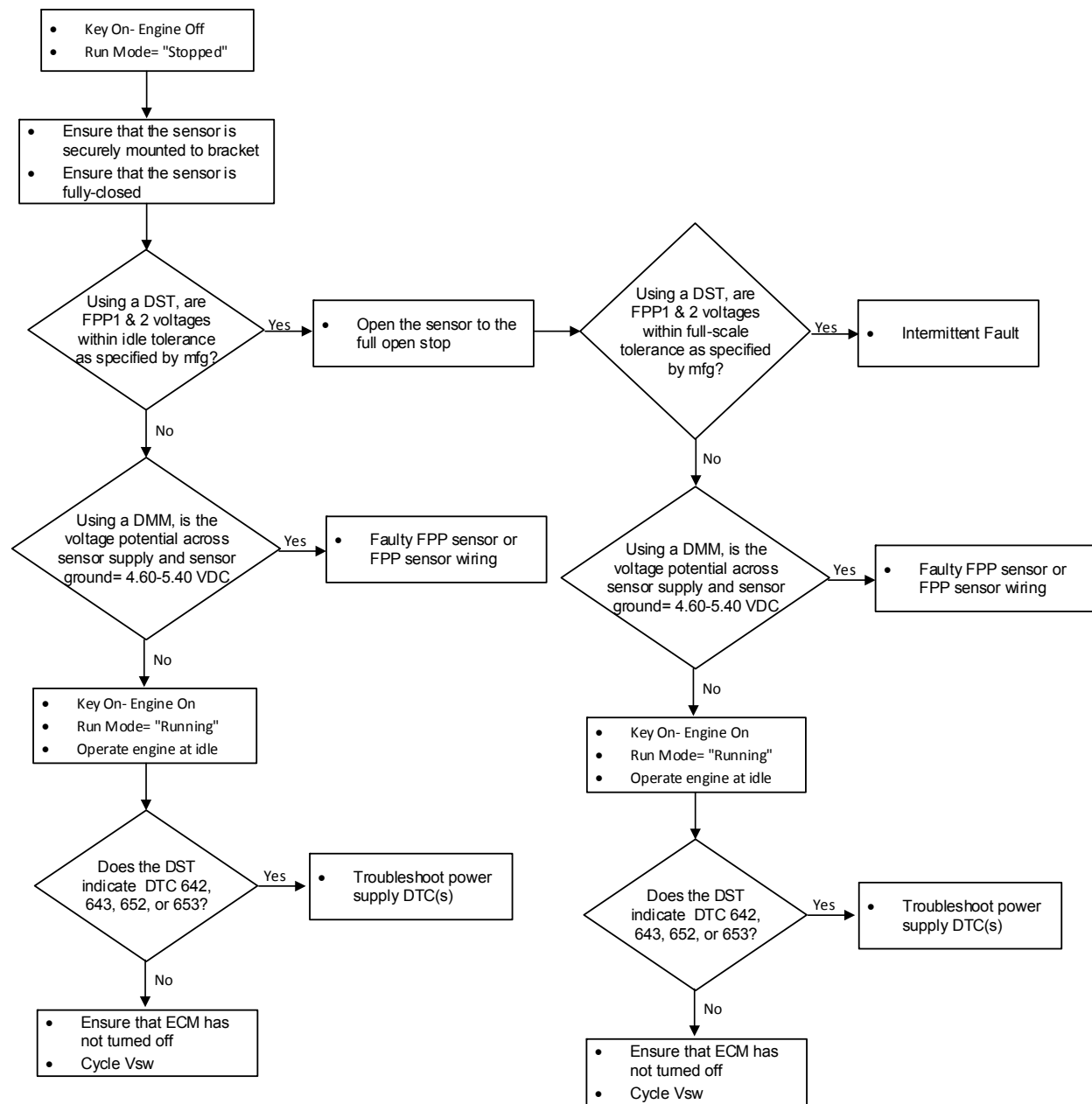
DTC 2126 - FPP1 HIGHER THAN FPP2

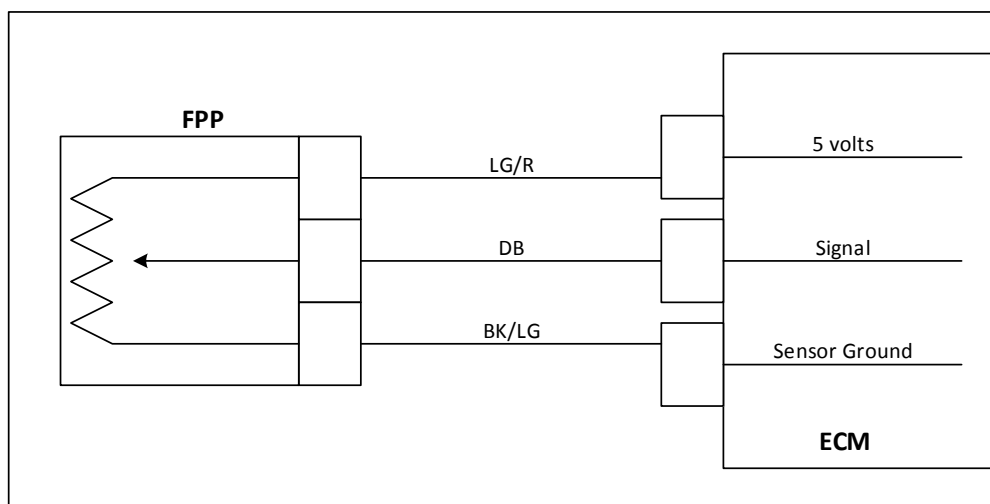
DTC	2126	SPN	91	FMI	16
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine Off			
Fault Set Conditions (as defined in calibration):					
• (FPP1% - FPP2%) >				TBD*	%
Possible Causes: This fault indicates that the measured % deflection of sensor 1 is greater than sensor 2 by an amount defined in calibration.					

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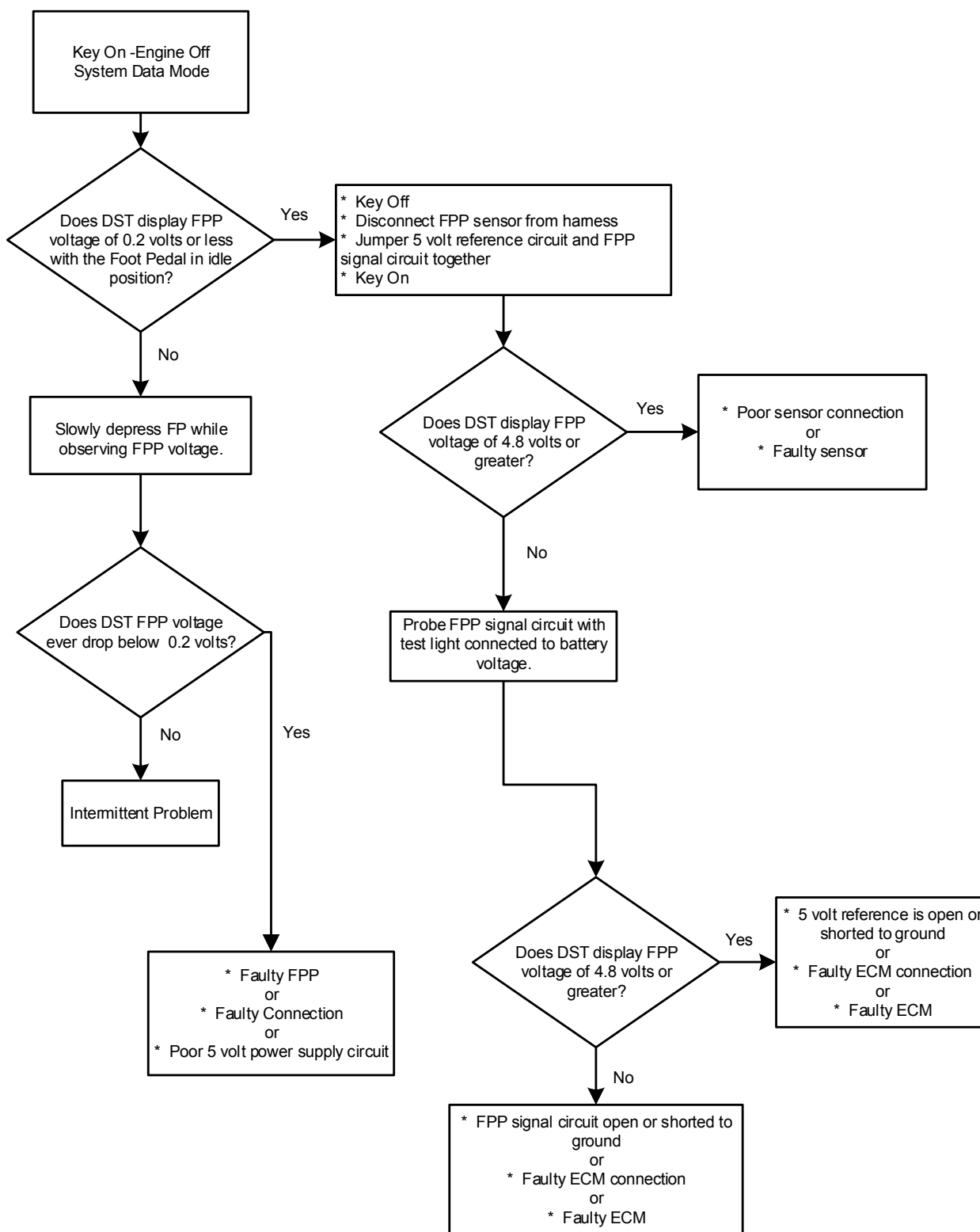
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

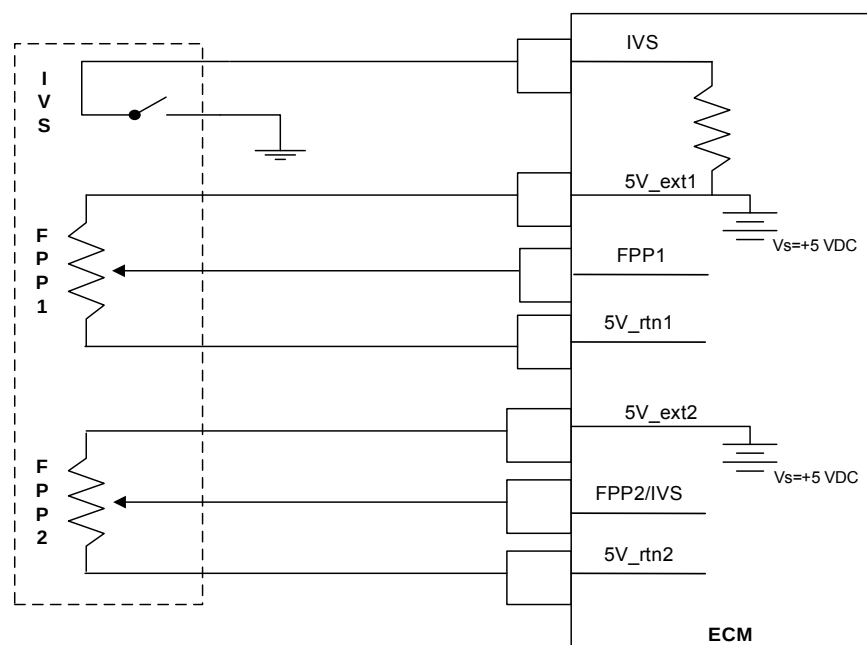
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2126 - FPP1 HIGHER THAN FPP2 (TROUBLE TREE)

DTC 2127 - FPP2 LOW VOLTAGE

DTC	2127	SPN	29	FMI	4		
Sensor/Circuit: Electronic foot pedal/throttle control sensor							
Description: The Foot Pedal Position sensor uses a variable resistor to determine signal voltage based on pedal position. Less depression of pedal results in lower voltage, and greater depression results in higher voltage.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On					
Fault Set Conditions (as defined in calibration):							
• FPP2 voltage >				TBD*	volts		
Possible Causes: This fault will set if voltage is less than 0.2 volts at any operating condition while the key is on. If the voltage is less than 0.2, then FPP is considered to be out of specifications. At this point the ECM does not have a valid signal, and must therefore enforce the low rev limit and Power Derate (level-1).							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

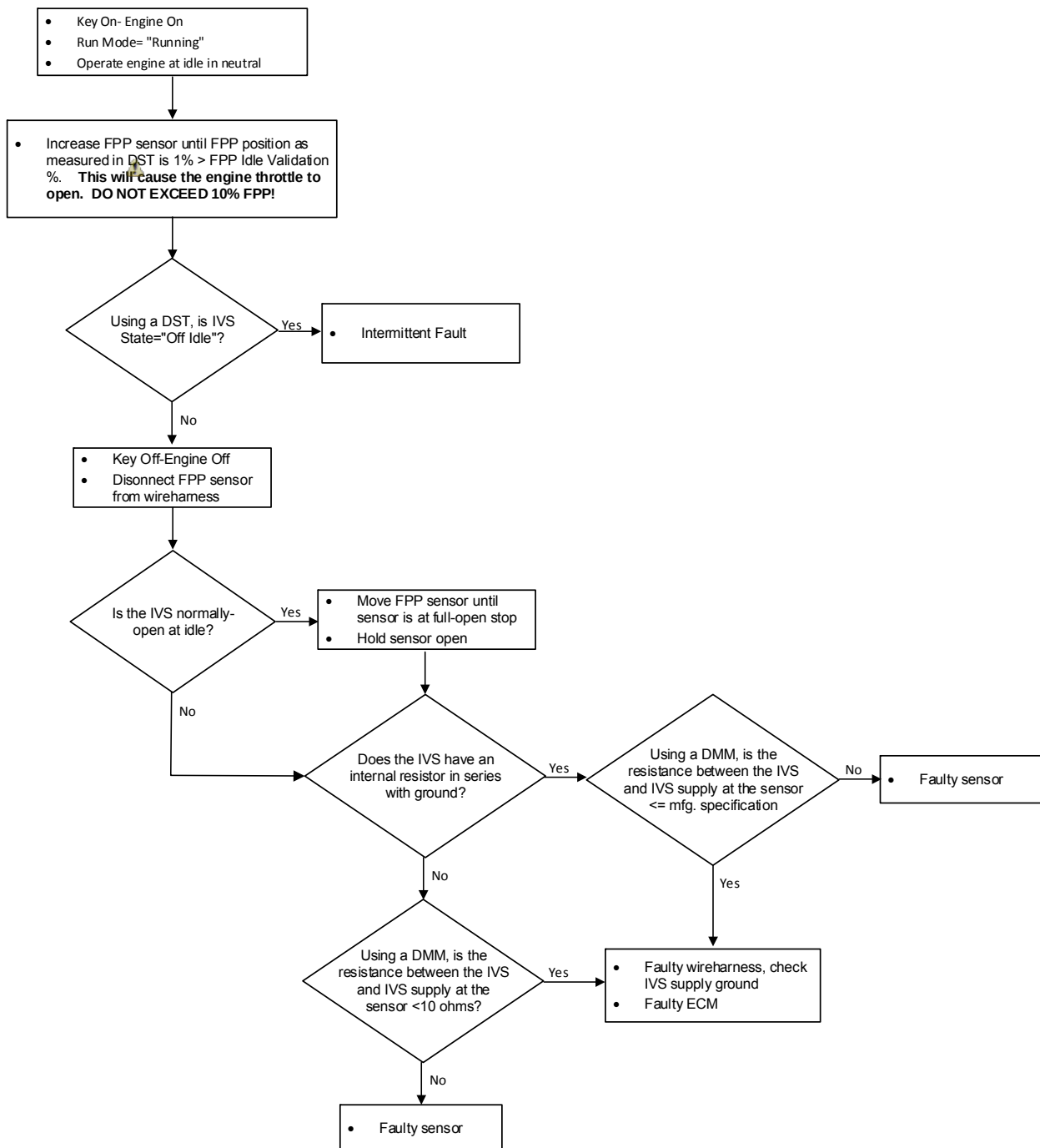
DTC 2127 - FPP2 LOW VOLTAGE (TROUBLE TREE)

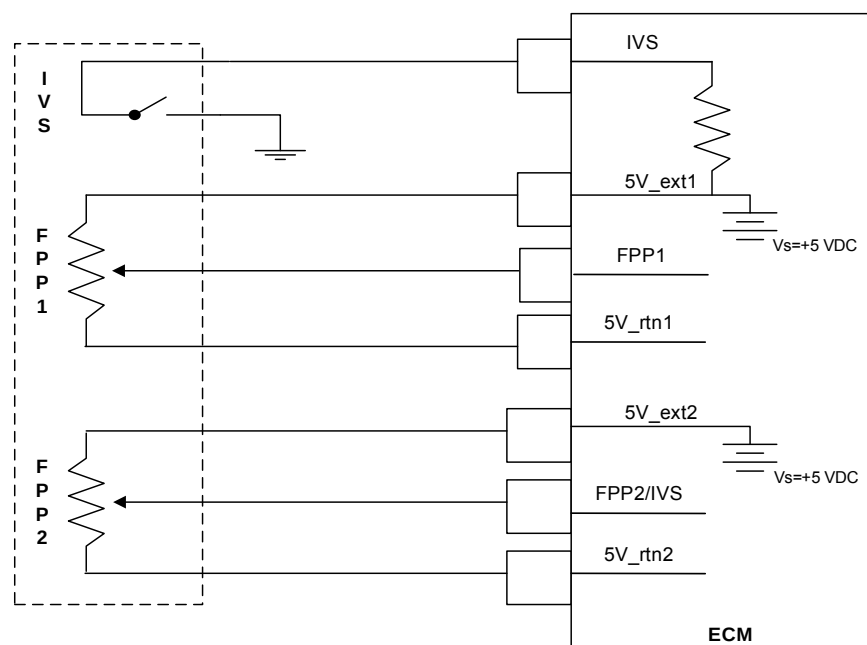
DTC 2130 - IVS STUCK AT-IDLE, FPP1/2 MATCH

DTC	2130	SPN	558	FMI	5
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• IVS at-idle when FPP1 >				TBD*	volts
• IVS at-idle when FPP2 >				TBD*	volts
Possible Causes: This fault is only applicable with dual potentiometer/single IVS sensors and indicates that the two FPP percentages correlate and register an off-idle condition but the IVS state reads at idle throughout entire operating range.					

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

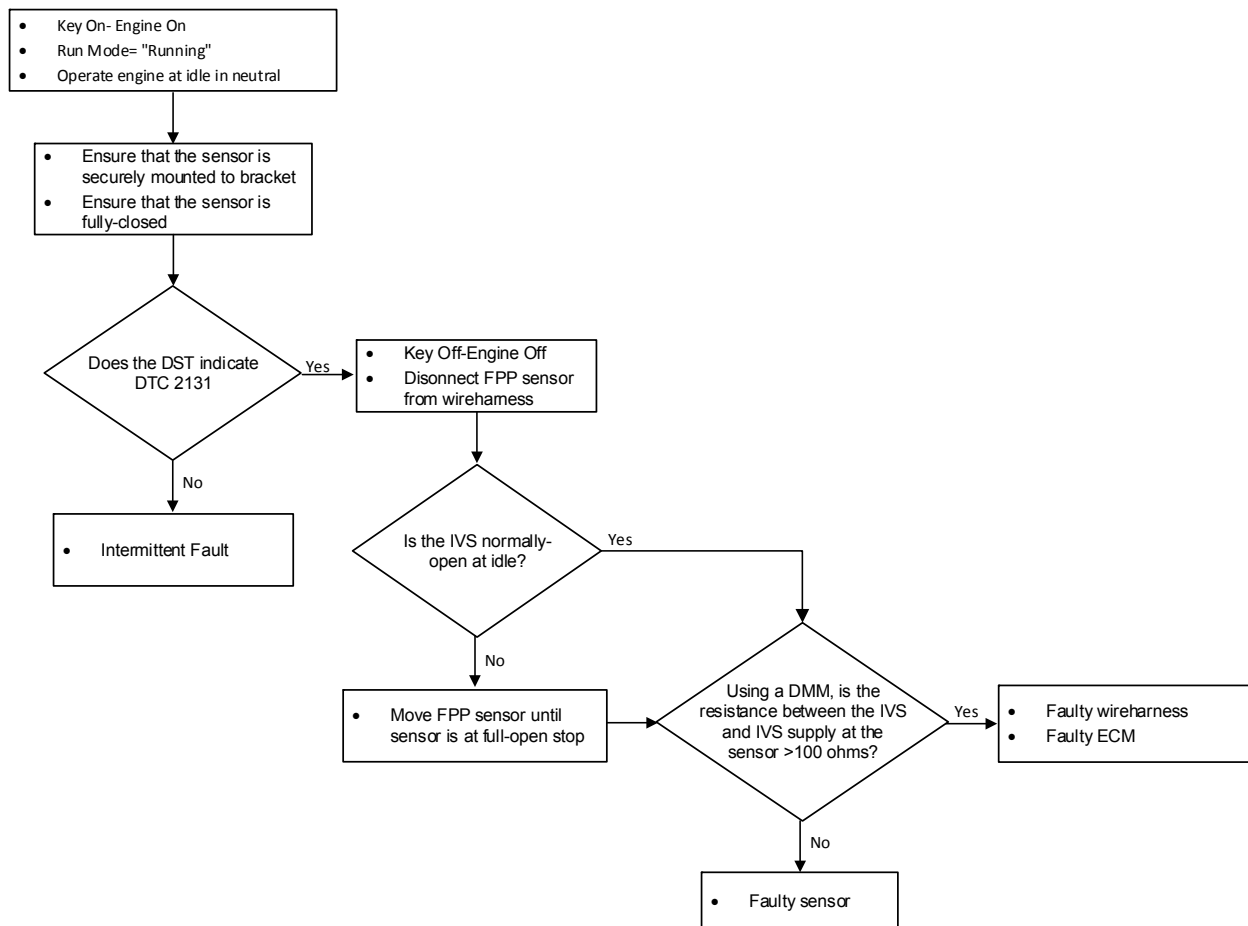
DTC 2130- IVS STUCK-AT-IDLE, FPP1/2 MATCH (TROUBLE TREE)

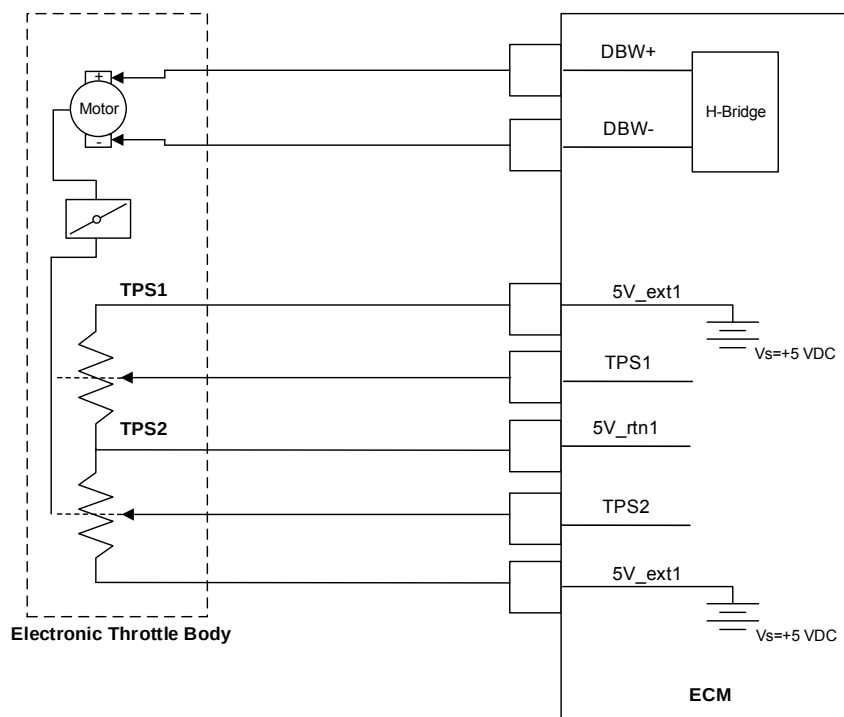
DTC 2131 - IVS STUCK OFF-IDLE, FPP1/2 MATCH

DTC	2131	SPN	558	FMI	6
Sensor/Circuit: Electronic foot pedal/throttle control sensor					
Description: The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. A FPP sensor may be, but is not limited to a foot pedal assembly, a cable-lever-sensor assembly, or a rotary potentiometer. General sensor configurations consist of single potentiometer with IVS, two potentiometers, or two potentiometers with IVS. The FPP sensor outputs are proportional to the commanded input. The ECM uses the FPP sensor inputs to control the throttle and adjust the engine's load in order to achieve the requested power. Since the FPP sensor inputs directly affect the engine's power output, redundant sensors are generally used to ensure safe, reliable operation.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine On			

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Fault Set Conditions (as defined in calibration):							
•	IVS at-idle when FPP1 >	TBD*	volts				
	Or -						
•	IVS off-idle when FPP1 <	TBD*	volts				
	or IVS off-idle if FPP1 @idle fault	(Enabled)					
	and FPP1 < FPP1 learned idle +	TBD*	volts				
AND							
•	IVS at-idle when FPP2 >	TBD*	volts				
	Or -						
•	IVS off-idle when FPP2 <	TBD*	volts				
	or IVS off-idle if FPP2 @idle fault	(Enabled)					
	and FPP2 < FPP2 learned idle +	TBD*	volts				
Possible Causes:							
This fault is only applicable with dual potentiometer/single IVS sensors and indicates that the two FPP percentages correlate and register an at idle condition but the IVS state reads off idle.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2131 - IVS STUCK OFF-IDLE, FPP1/2 MATCH (TROUBLE TREE)

DTC 2135 - TPS1/2 SIMULTANEOUS VOLTAGES OUT OF RANGE

DTC	2135	SPN	51	FMI	31
Sensor/Circuit: Electronic throttle body					
Description: The throttle is an air valve used to control the amount of air available to the engine for combustion and thereby the engine's power output. An electronic throttle simply means that a motor is controlled electronically through an electronic control system to actuate the throttle valve. Electronic throttle control is advantageous because it tends to offer improved starting, improved idle governing, improved maximum speed governing, excellent load acceptance and steady-state speed governing, permits engine synchronization, and offers flexibility to protect the engine during certain fault conditions.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• TPS1 voltage >				TBD*	volts
or TPS1 voltage <				TBD*	volts
AND					
• TPS2 voltage >				TBD*	volts
or TPS2 voltage <				TBD*	volts

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Possible Causes:

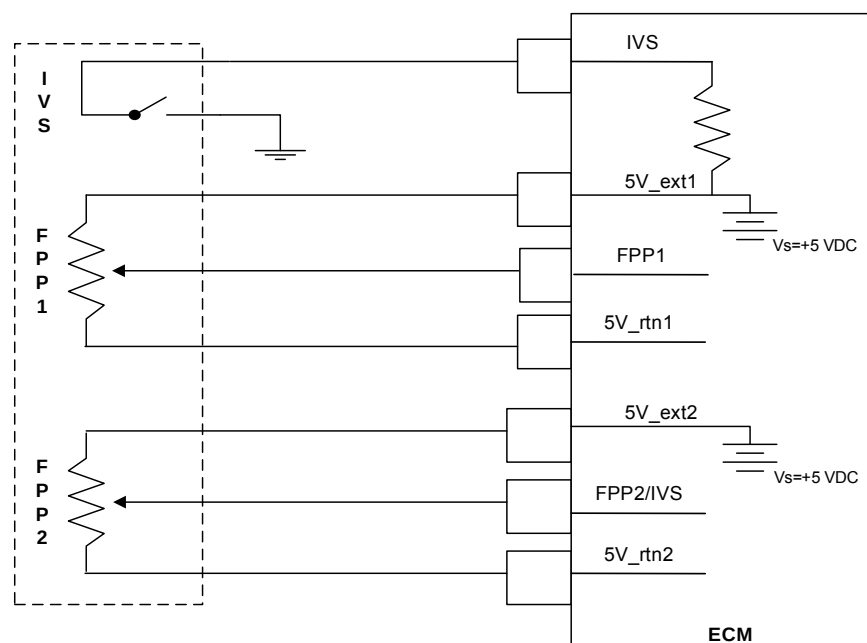
This fault is generated when both feedback sensors in the ETB (TPS1 and TPS2) simultaneously produce out-of-range faults. This fault indicates that there is no feedback of the throttle valve and as a result throttle control cannot take place. This fault is, and should always be, configured to shut the engine down.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids:

- ☐ Troubleshoot according to TPS1 voltage out-of-range following DTC 122 and 123 procedures.
- ☐ Troubleshoot according to TPS2 voltage out-of-range following DTC 222 and 223 procedures.

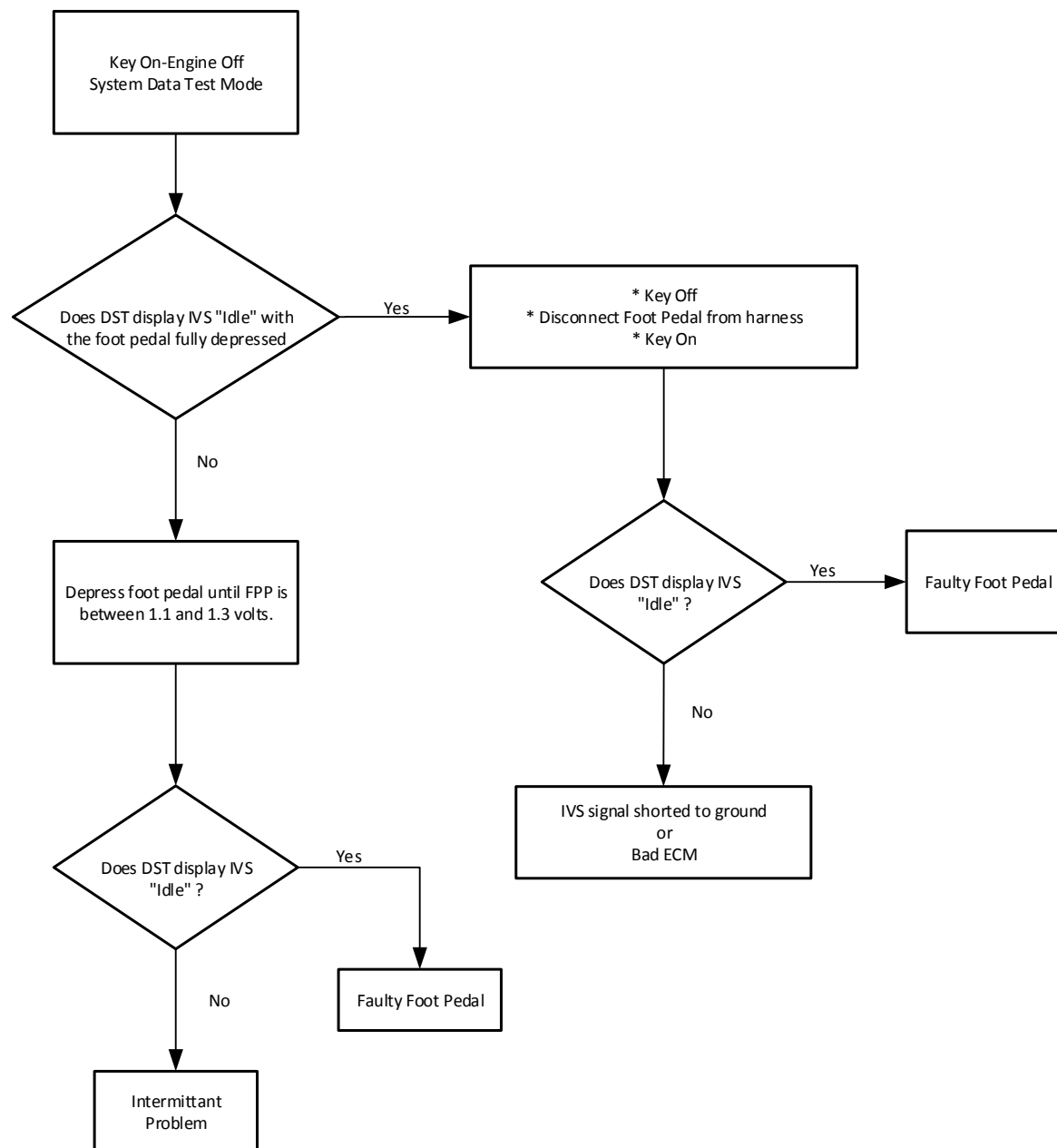
DTC 2139 - FPP1 LOWER THAN IVS LIMIT

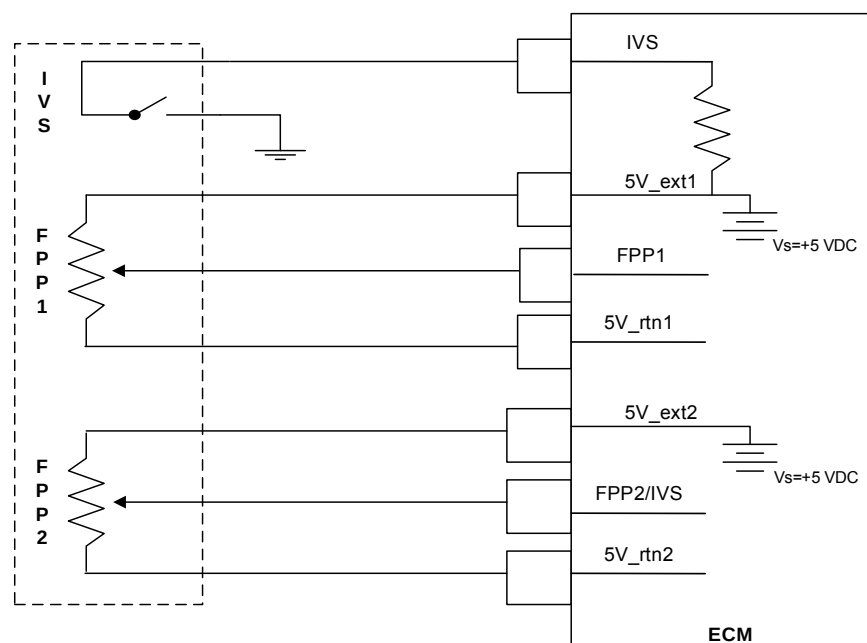
DTC	2139	SPN	91	FMI	1
Sensor/Circuit: Foot Pedal Position/Idle Validation Switch 1					
Description: The engine load command to the ECM is determined by operator depression of the electronic foot pedal. The ECM monitors the foot pedal position and controls the throttle to maintain the commanded power level. Because a problem with the foot pedal signal can result in a higher or lower power than intended by the operator, the pedal used with this control system incorporates a sensor with an idle validation switch. Checks and cross checks are constantly conducted by the ECM to determine the validity of the signals. The Idle Validation Switch (IVS) is a normally open contact (idle) that grounds (closed contacts) the IVS circuit to the ECM when the pedal is depressed more than the idle position.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Engine Cranking or Running			
Fault Set Conditions (as defined in calibration):					
• IVS off-idle when FPP1 <				TBD*	volts
– OR –					
• IVS off-idle if FPP1 @idle fault					
• and FPP1 < FPP1 learned idle +				TBD*	volts
Possible Causes: This fault will set if the IVS is at idle (open) and the FPP1 voltage is less than the fault limit defined in the calibration.					

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2139 - FPP1 LOWER THAN IVS LIMIT (TROUBLE TREE)

DTC 2140 - FPP2 LOWER THAN IVS LIMIT

DTC	2139	SPN	29	FMI	1
Sensor/Circuit: Foot Pedal Position/Idle Validation Switch 2					
Description: The engine load command to the ECM is determined by operator depression of the electronic foot pedal. The ECM monitors the foot pedal position and controls the throttle to maintain the commanded power level. Because a problem with the foot pedal signal can result in a higher or lower power than intended by the operator, the pedal used with this control system incorporates a sensor with an idle validation switch. Checks and cross checks are constantly conducted by the ECM to determine the validity of the signals. The Idle Validation Switch (IVS) is a normally open contact (idle) that grounds (closed contacts) the IVS circuit to the ECM when the pedal is depressed more than the idle position.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		NO			
Check Condition:		Engine Cranking or Running			
Fault Set Conditions (as defined in calibration):					
• IVS off-idle when FPP1 <				TBD*	volts
– OR –					
• IVS off-idle if FPP1 @idle fault					
• and FPP1 < FPP1 learned idle +				TBD*	volts

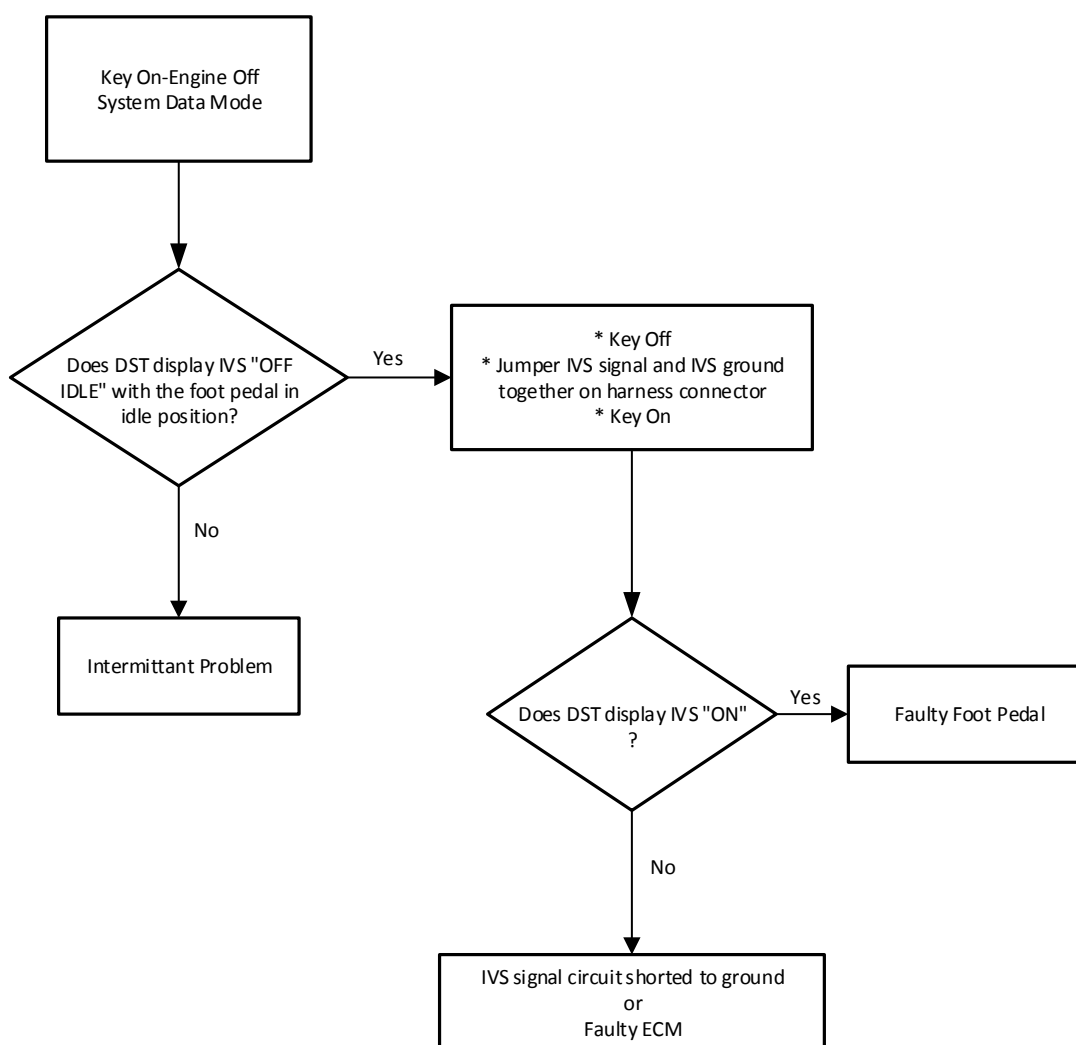
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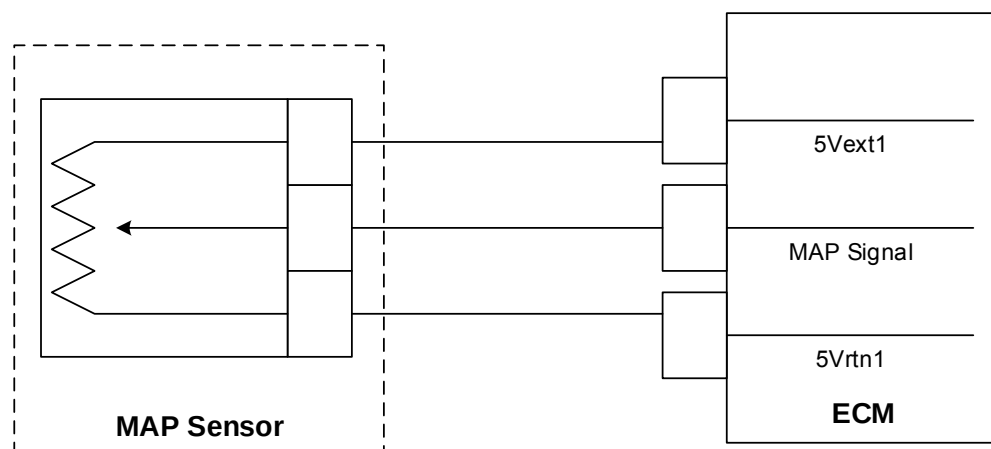
Possible Causes:

This fault will set if the IVS is off-idle (closed) and the FPP2 voltage is less than the fault limit defined in the calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

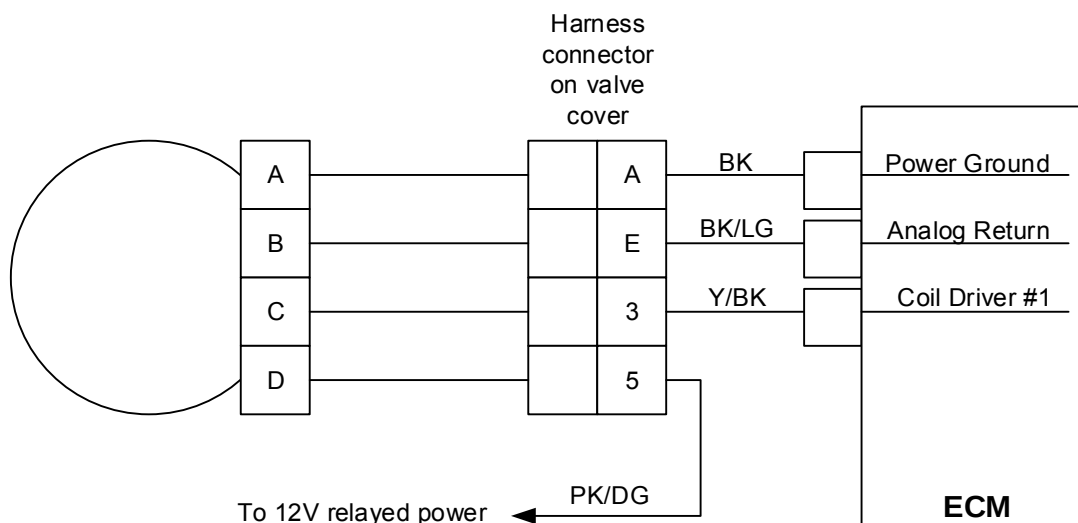
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2140 – FPP2 LOWER THAN IVS LIMIT (TROUBLE TREE)

DTC 2229 - BP HIGH PRESSURE

DTC	2229	SPN	108	FMI	0		
Hardware: Barometric Temperature / Manifold Absolute Pressure Sensor							
Hardware Description: Barometric Pressure is estimated from the MAP sensor at key-on and in some calibrations during low speed/high load operation as defined in the engine’s calibration. The barometric pressure value is used for fuel and airflow calculations and equivalence ratio targets based on altitude.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		YES					
Check Condition:		Key On, Engine Off or after BP estimate during low-speed/high load operation					
Fault Set Conditions (as defined in calibration):							
• BP pressure >				TBD*	psia		
Possible Causes: This fault sets if the barometric pressure is higher than <u>the maximum pressure (psia)</u> as defined in the diagnostic calibration.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2300 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 1)



DTC	2300	SPN	1268	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 1 (Dumb-coil ONLY)					
Description: Coil driver #1 fires either the 1st cylinder in the firing order or the 1st cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

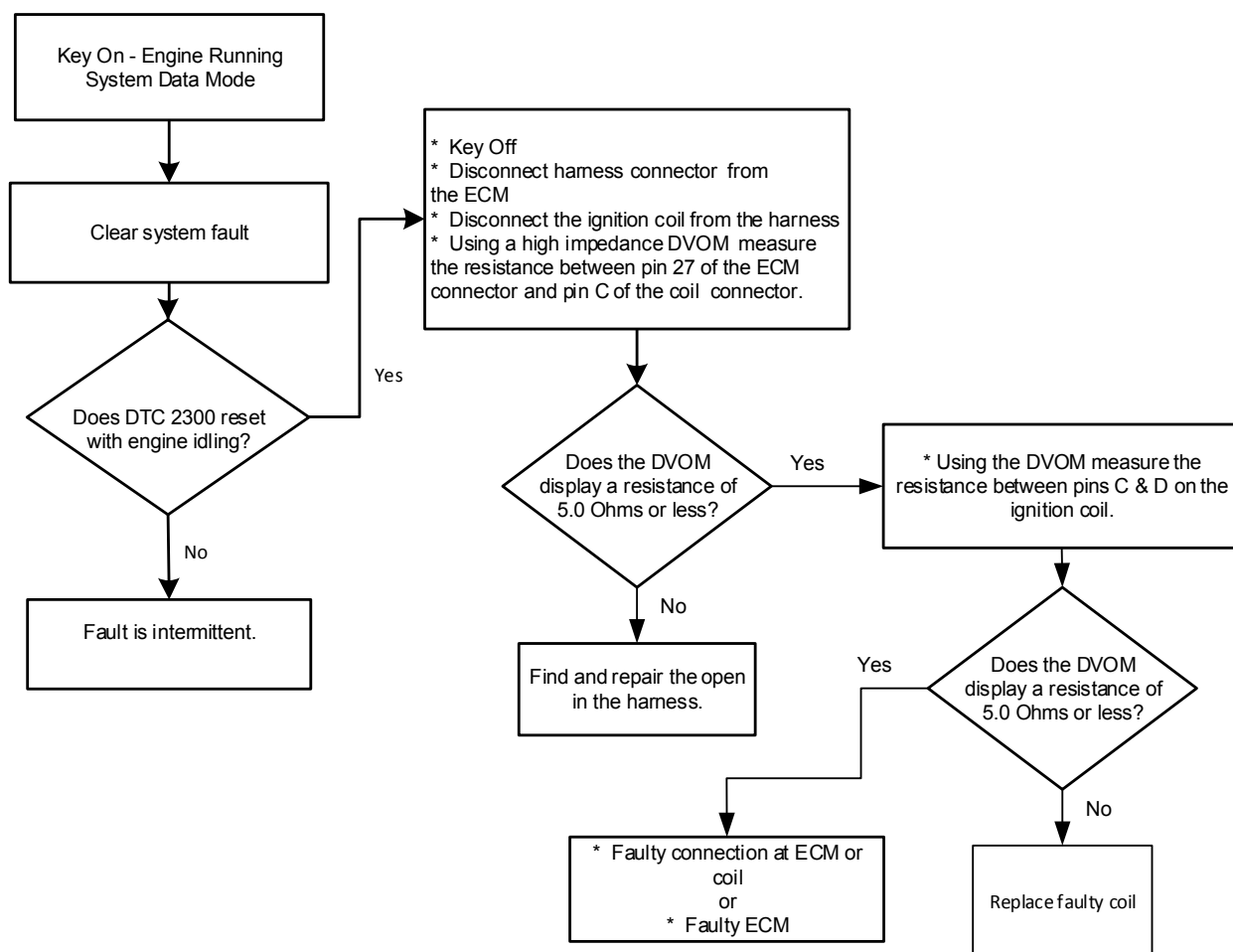
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Possible Causes:

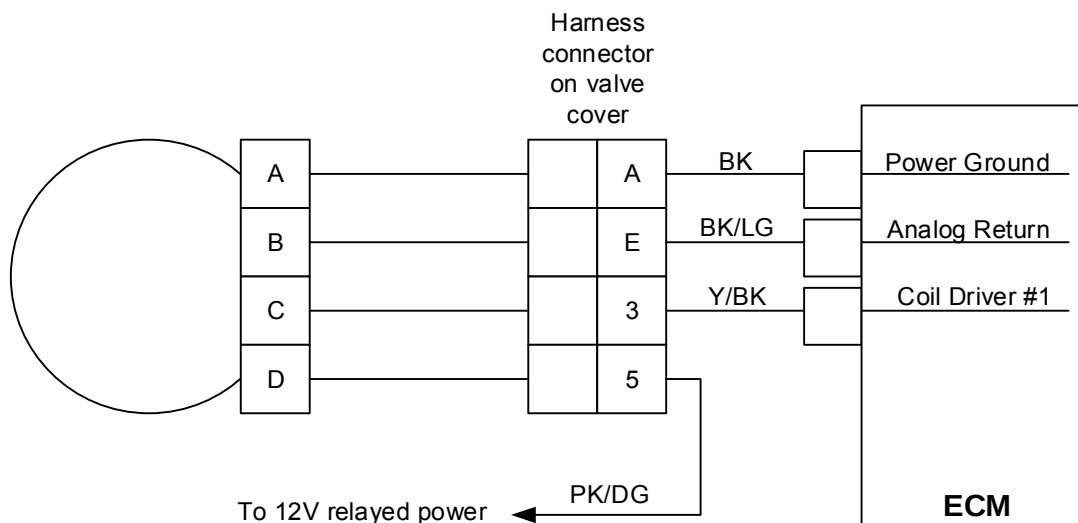
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2300 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2301 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 1)



DTC	2301	SPN	1268	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 1 (Dumb-coil ONLY)					
Description: Coil driver #1 fires either the 1st cylinder in the firing order or the 1st cylinder in the block order depending on the configuration of the ‘Injector/Spark Diagnostic Numbering’ scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

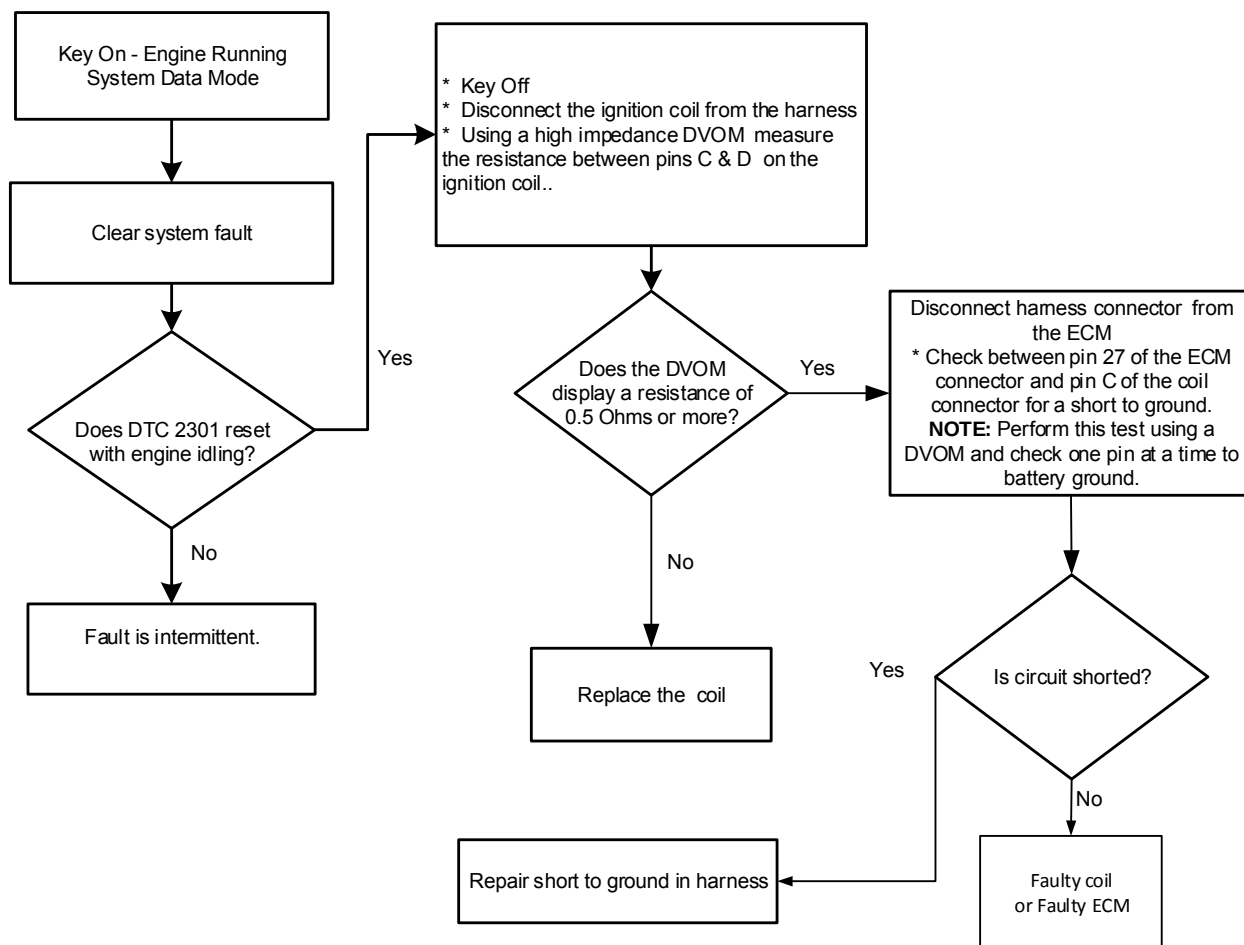
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Possible Causes:

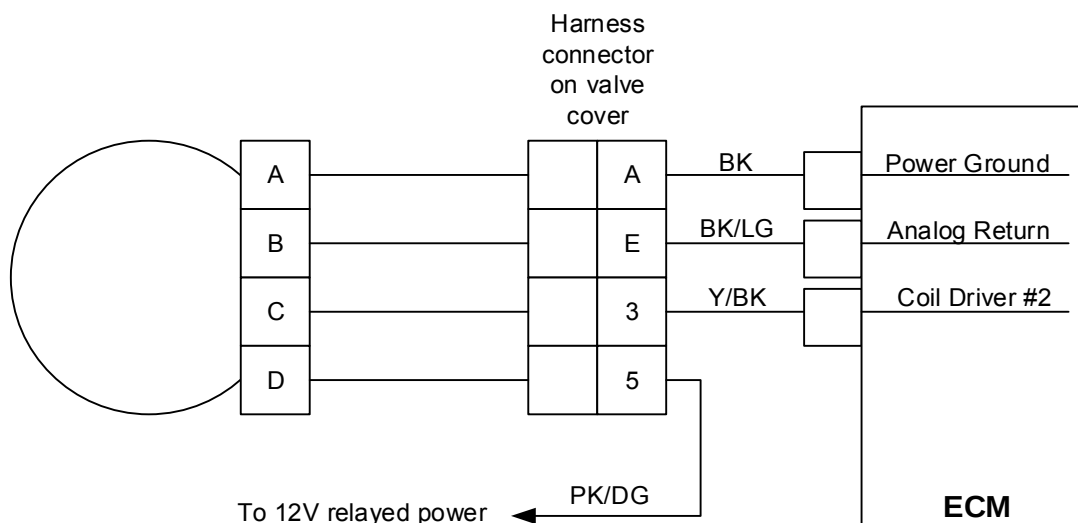
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2301 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2303 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 2)



DTC	2303	SPN	1269	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 2 (Dumb-coil ONLY)					
Description: Coil driver #2 fires either the 2 nd cylinder in the firing order or the 2 nd cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

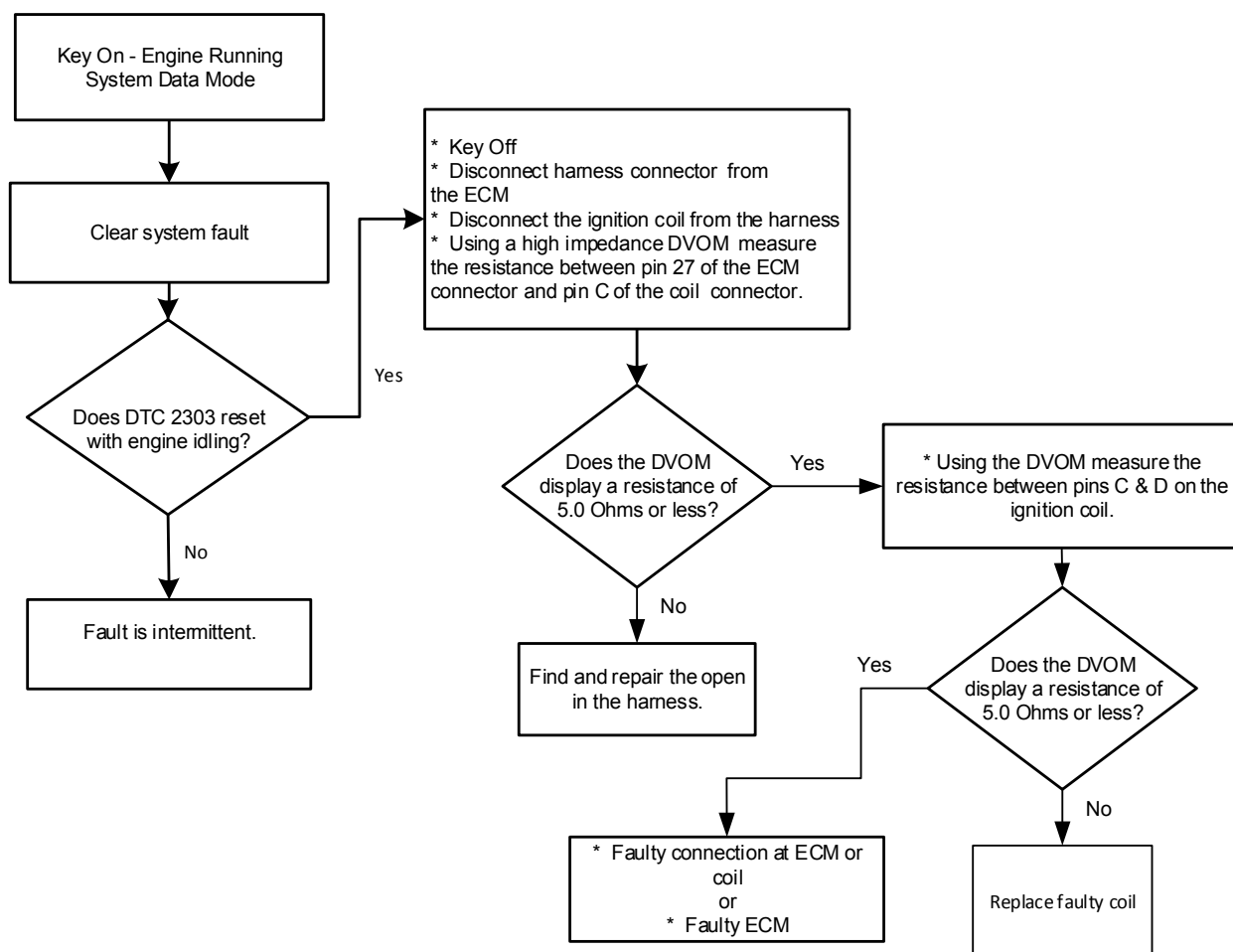
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Possible Causes:

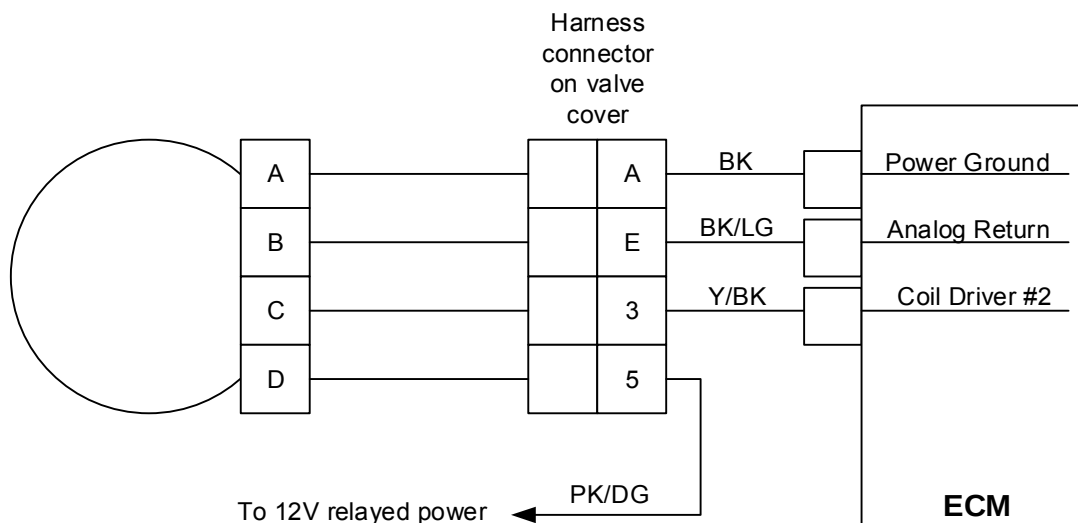
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2303 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2304 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 2)



DTC	2304	SPN	1269	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 2 (Dumb-coil ONLY)					
Description: Coil driver #2 fires either the 2 nd cylinder in the firing order or the 2 nd cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
Diagnose faults while cranking				Disabled/Enabled	
Battery voltage >				TBD*	volts
Battery voltage <				TBD*	volts
External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
dwell adjustment <=				TBD*	ms
or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
dwell adjustment <=				TBD*	amps
or total dwell <=				TBD*	us

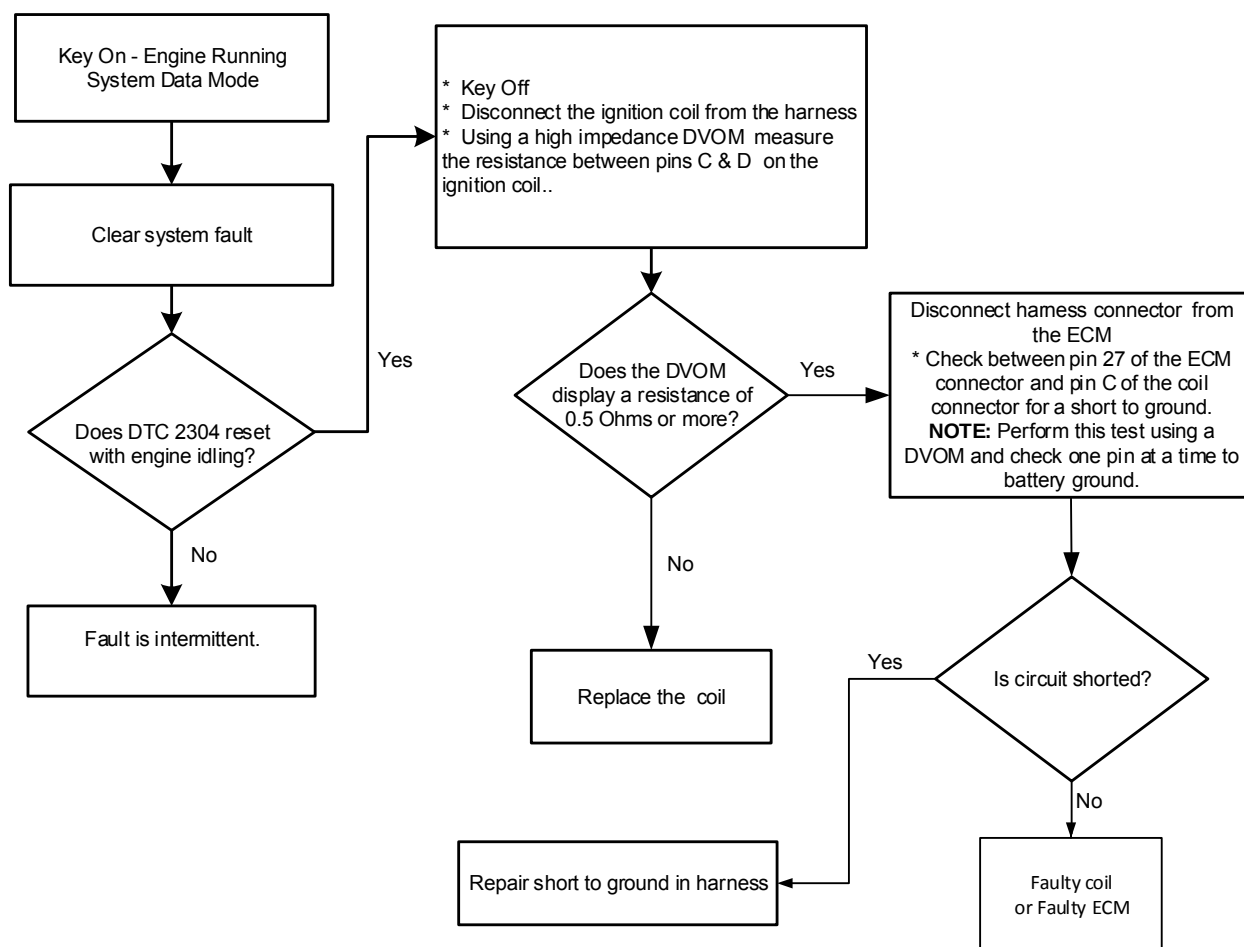
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Possible Causes:

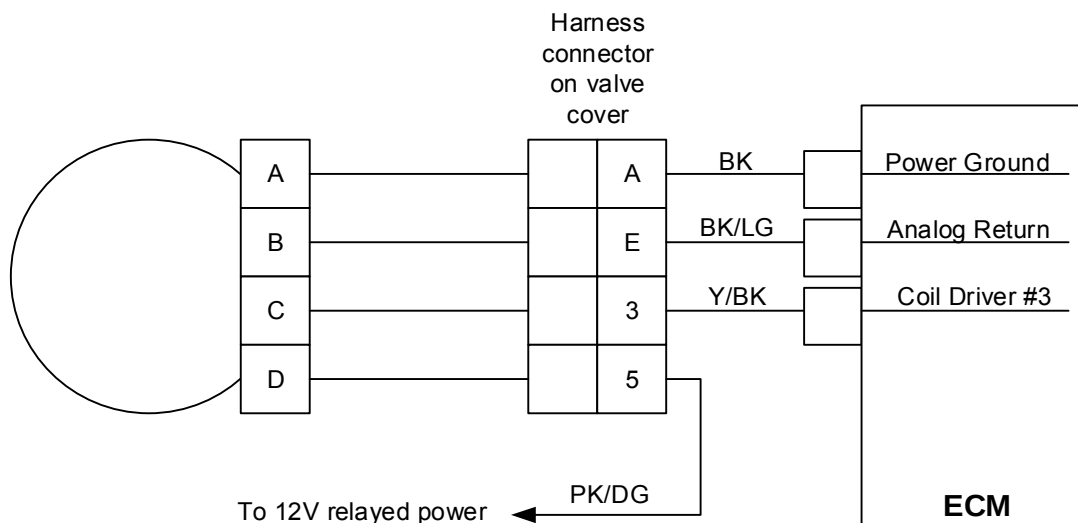
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2304 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2306 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 3)



DTC	2306	SPN	1270	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 3 (Dumb-coil ONLY)					
Description: Coil driver #3 fires either the 3 rd cylinder in the firing order or the 3 rd cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

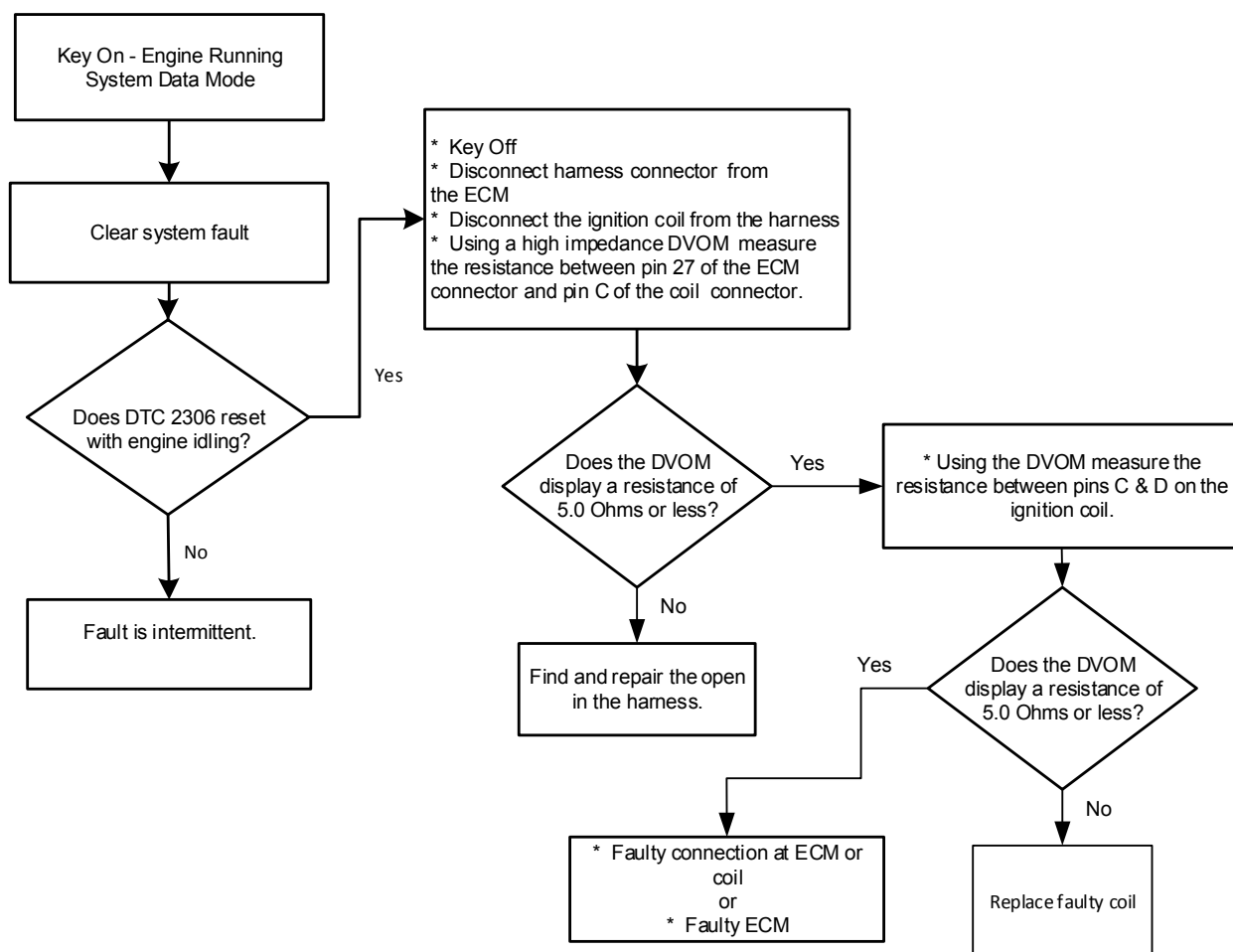
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Possible Causes:

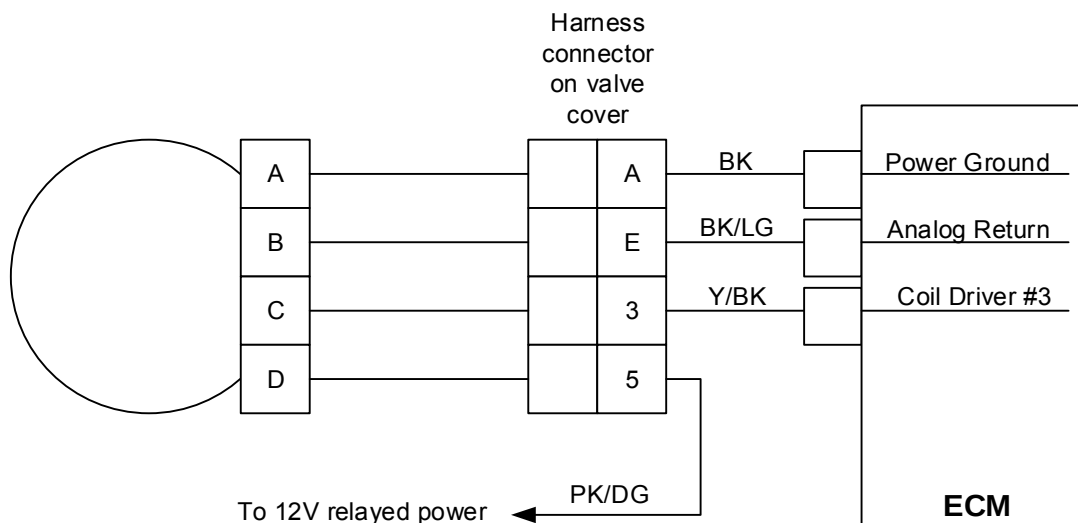
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2306 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2307 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 3)



DTC	2307	SPN	1270	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 3 (Dumb-coil ONLY)					
Description: Coil driver #3 fires either the 3 rd cylinder in the firing order or the 3 rd cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

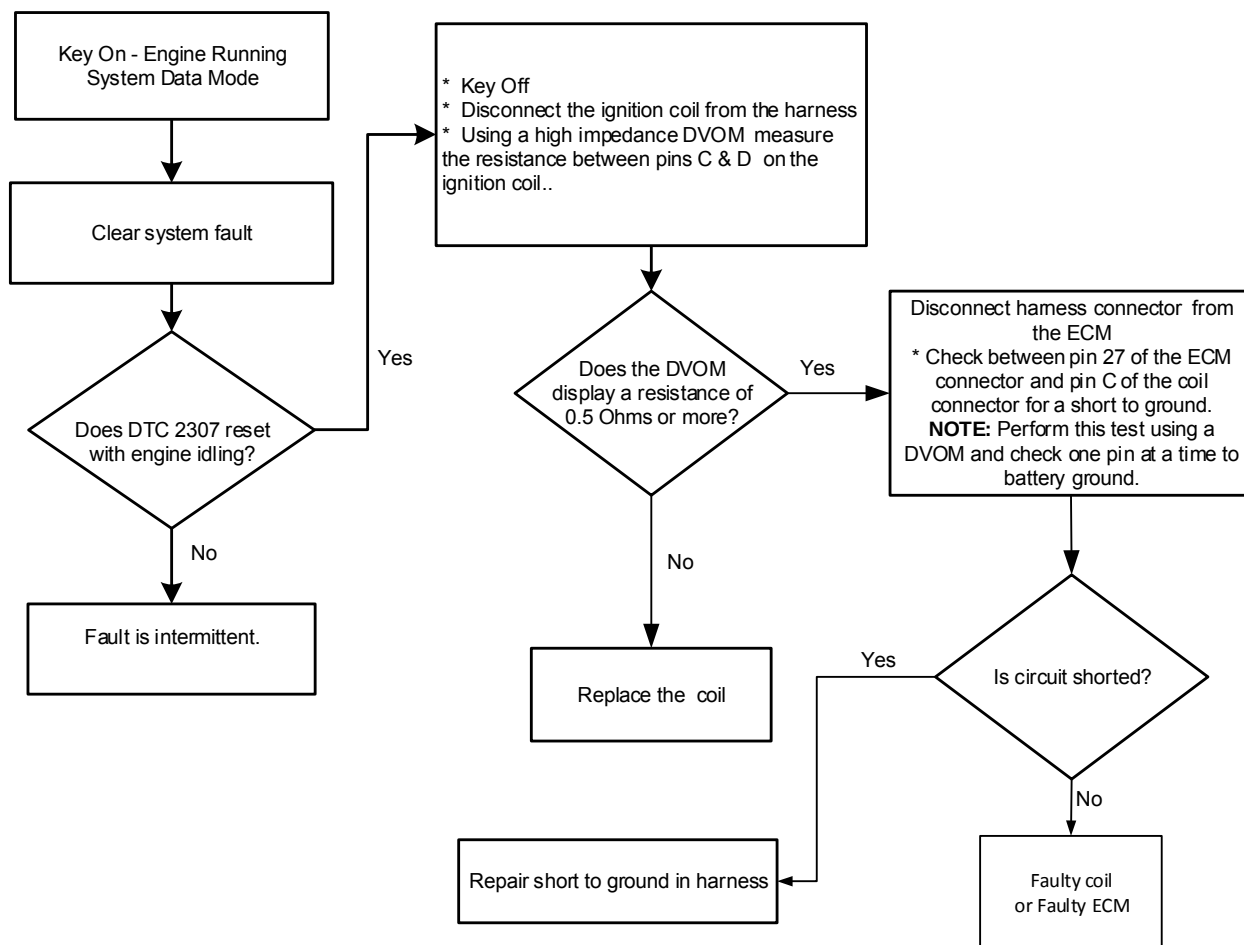
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Possible Causes:

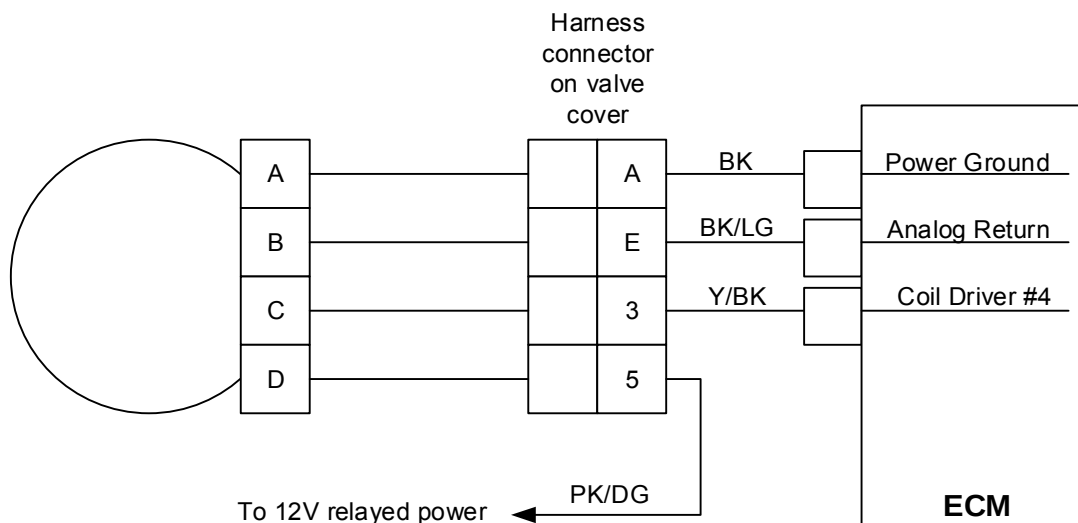
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2307 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2309 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 4)



DTC	2309	SPN	1271	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 4 (Dumb-coil ONLY)					
Description: Coil driver #4 fires either the 4 th cylinder in the firing order or the 4 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
Diagnose faults while cranking				Disabled/Enabled	
Battery voltage >				TBD*	volts
Battery voltage <				TBD*	volts
External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
dwell adjustment >=				TBD*	ms
or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
final current <				TBD*	amps
and crank dwell (external module only) <				TBD*	ms

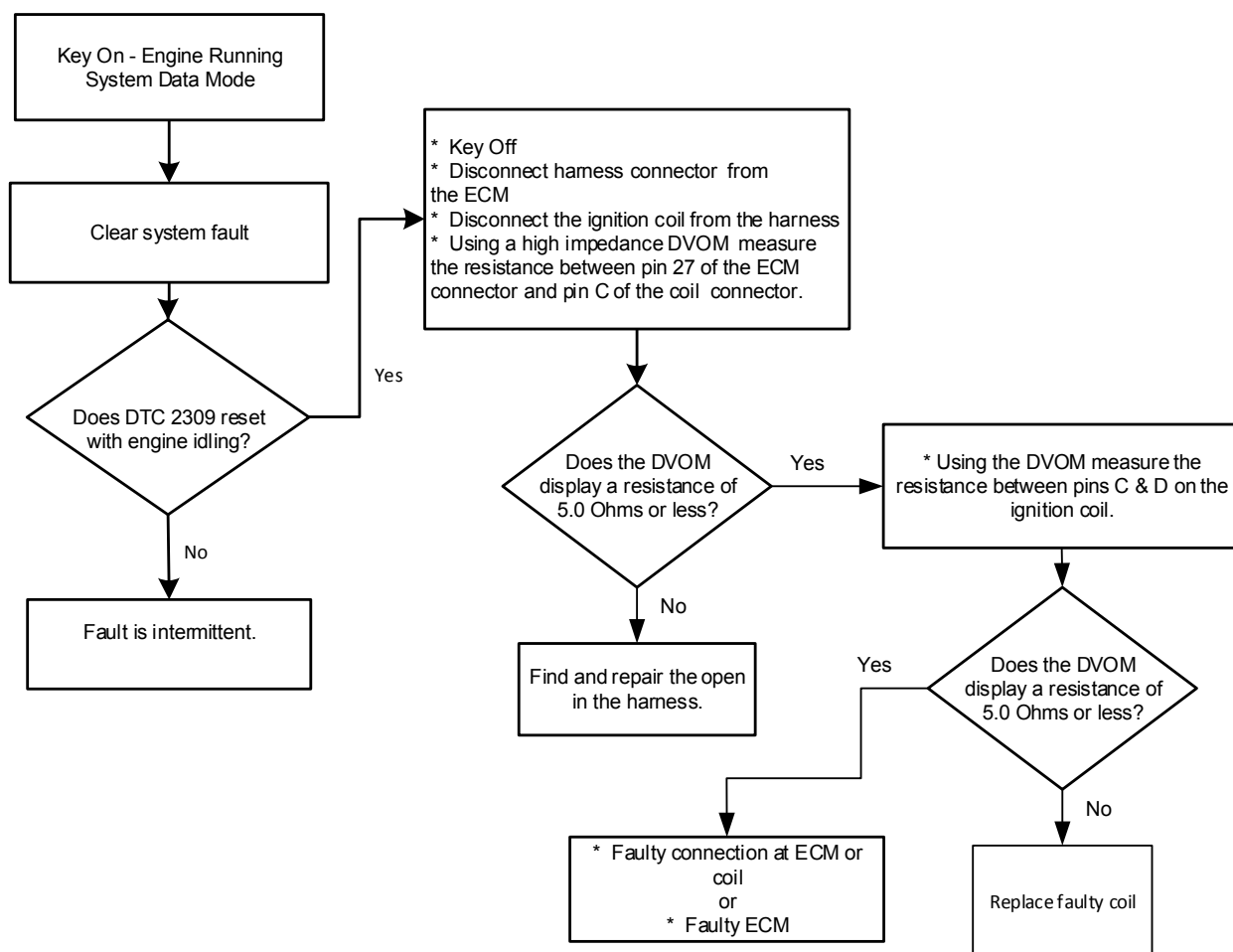
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Possible Causes:

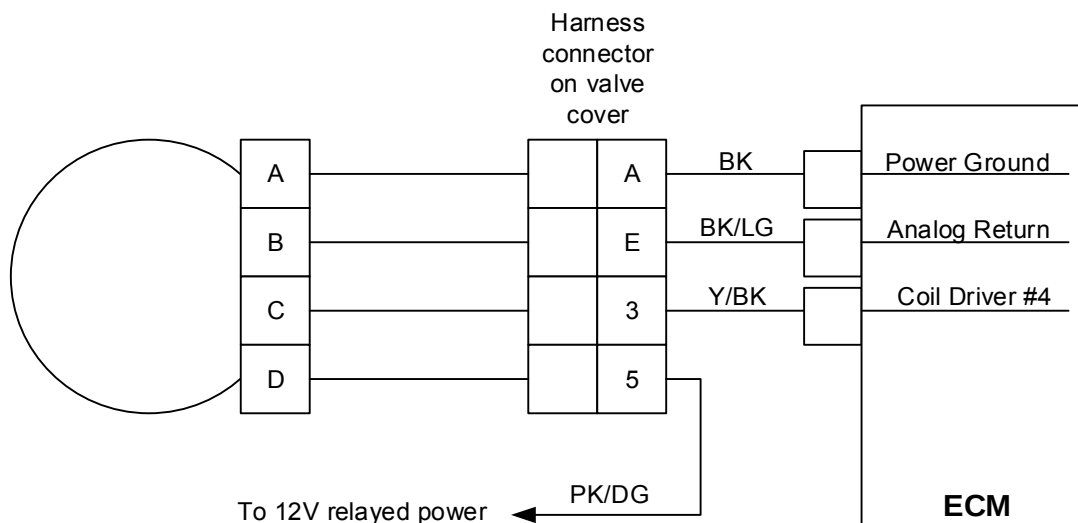
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2309 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2310 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 4)



DTC	2310	SPN	1271	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 4 (Dumb-coil ONLY)					
Description: Coil driver #4 fires either the 4 th cylinder in the firing order or the 4 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

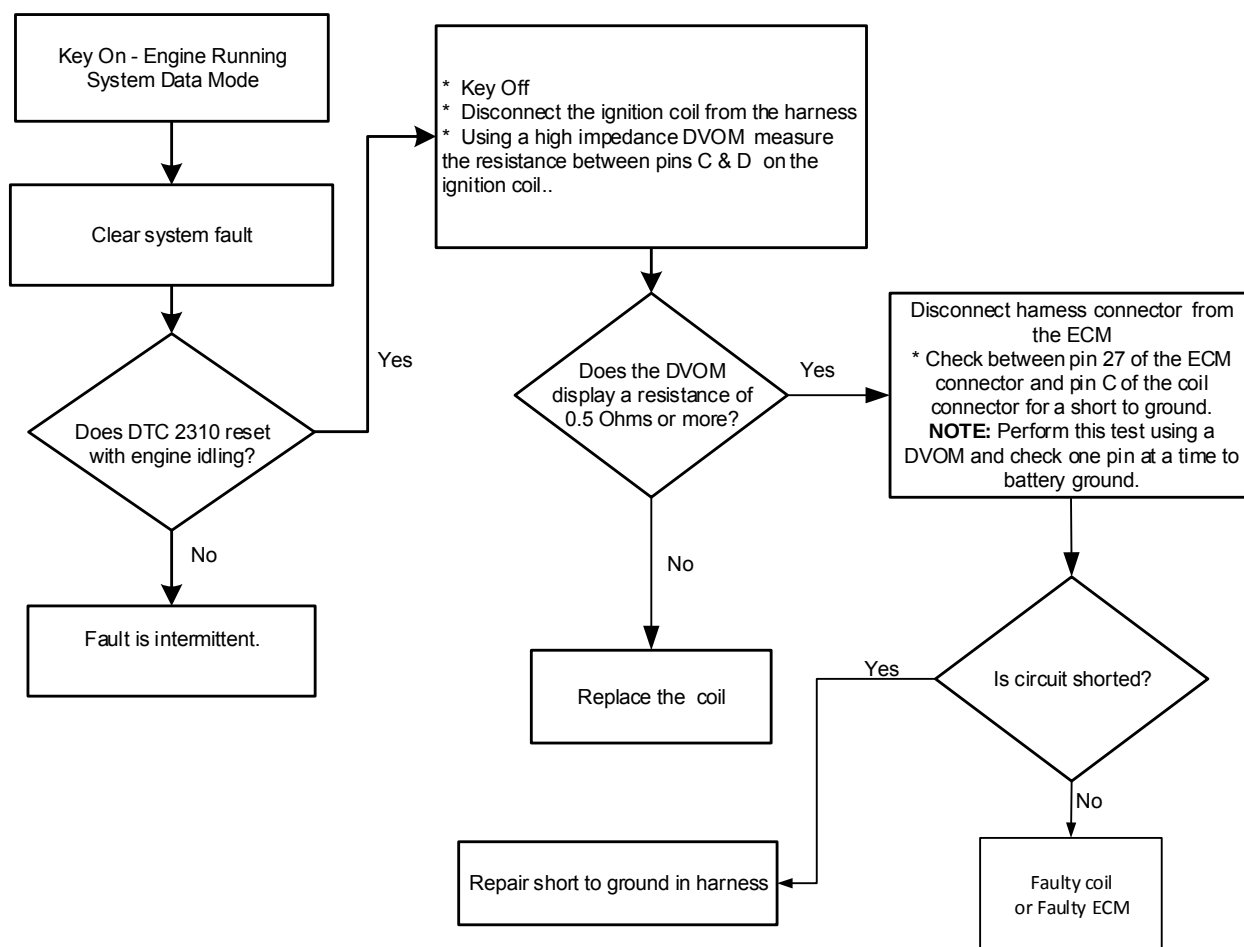
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Possible Causes:

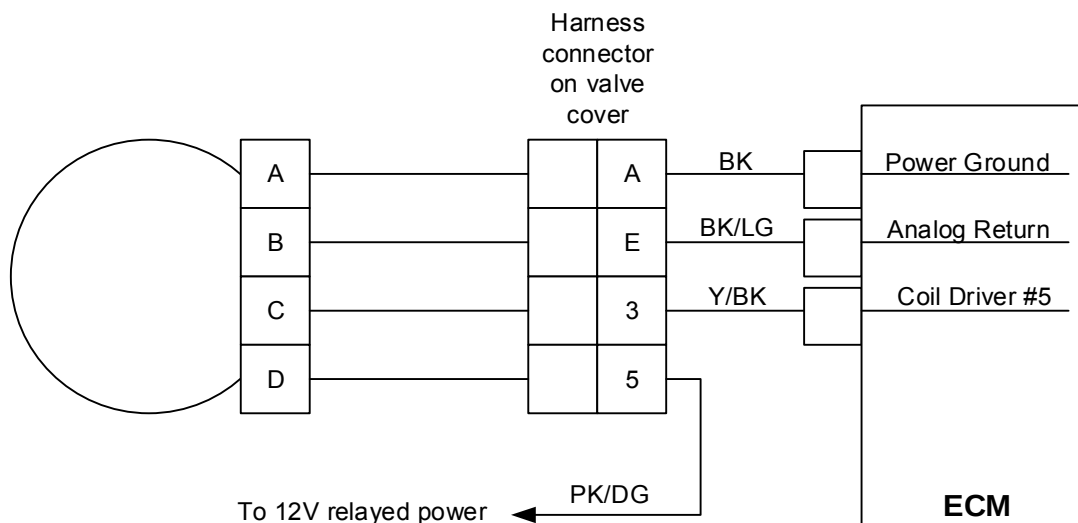
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2310 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2312 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 5)



DTC	2312	SPN	1272	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 5 (Dumb-coil ONLY)					
Description: Coil driver #5 fires either the 5 th cylinder in the firing order or the 5 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

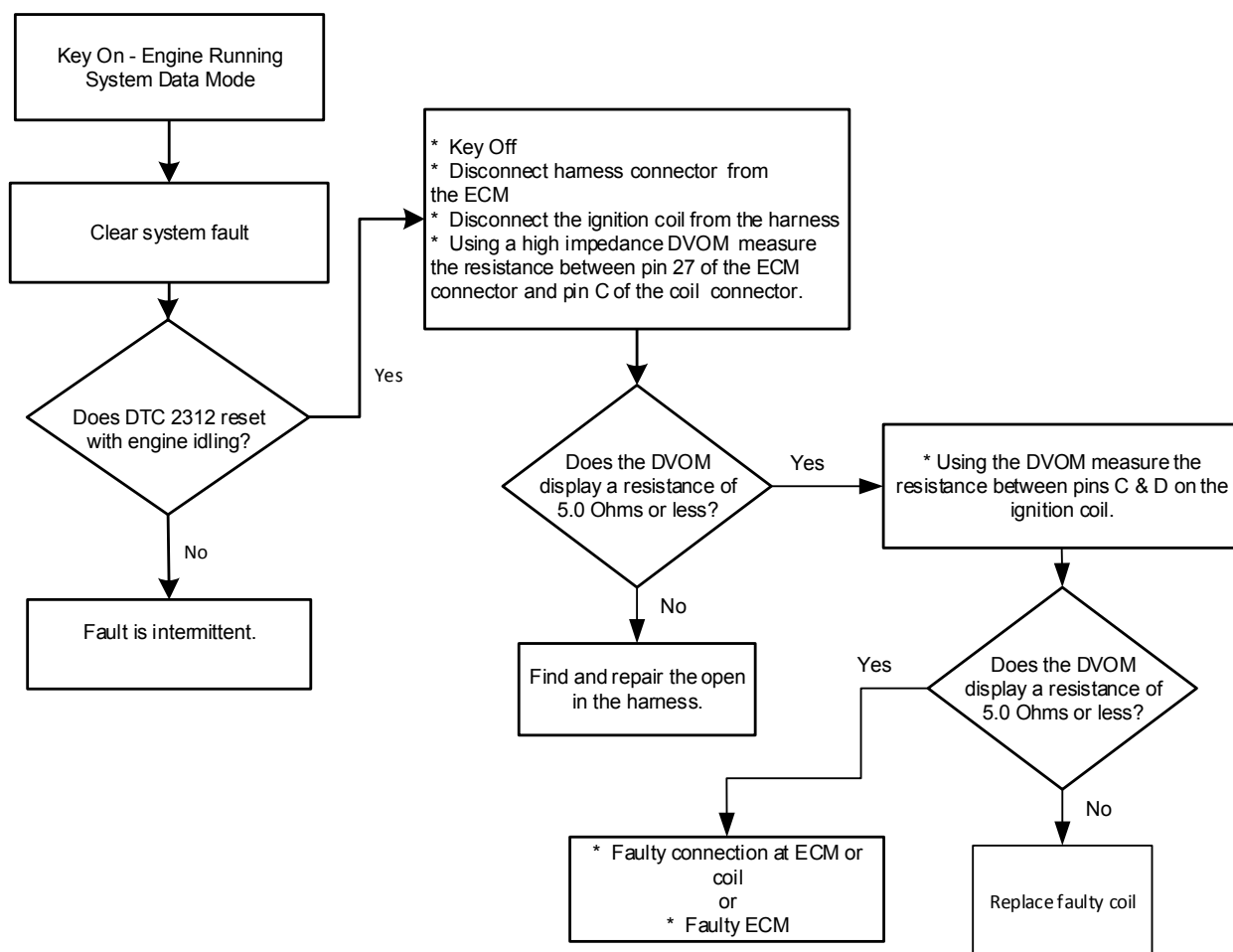
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Possible Causes:

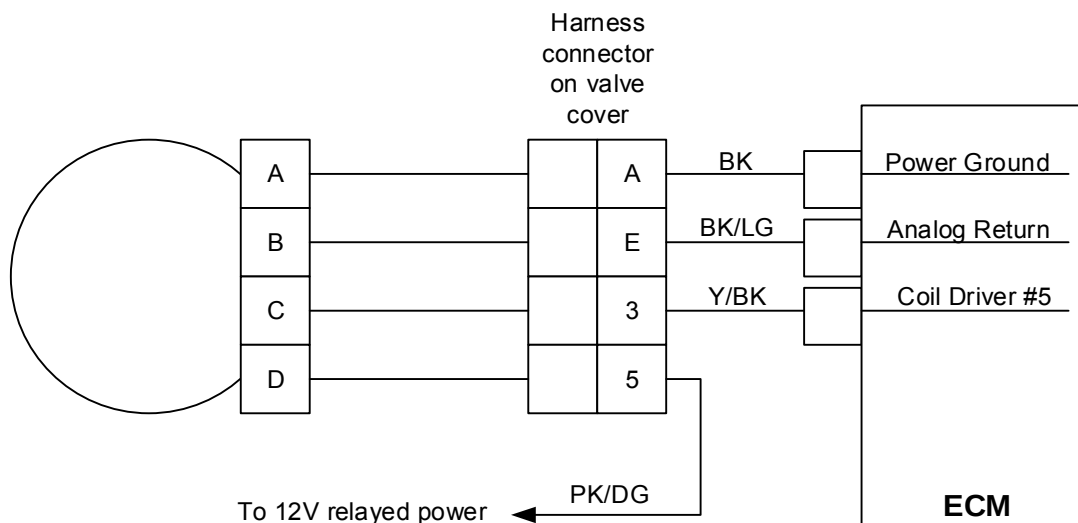
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2312 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2313 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 5)



DTC	2313	SPN	1272	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 5 (Dumb-coil ONLY)					
Description: Coil driver #5 fires either the 5 th cylinder in the firing order or the 5 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

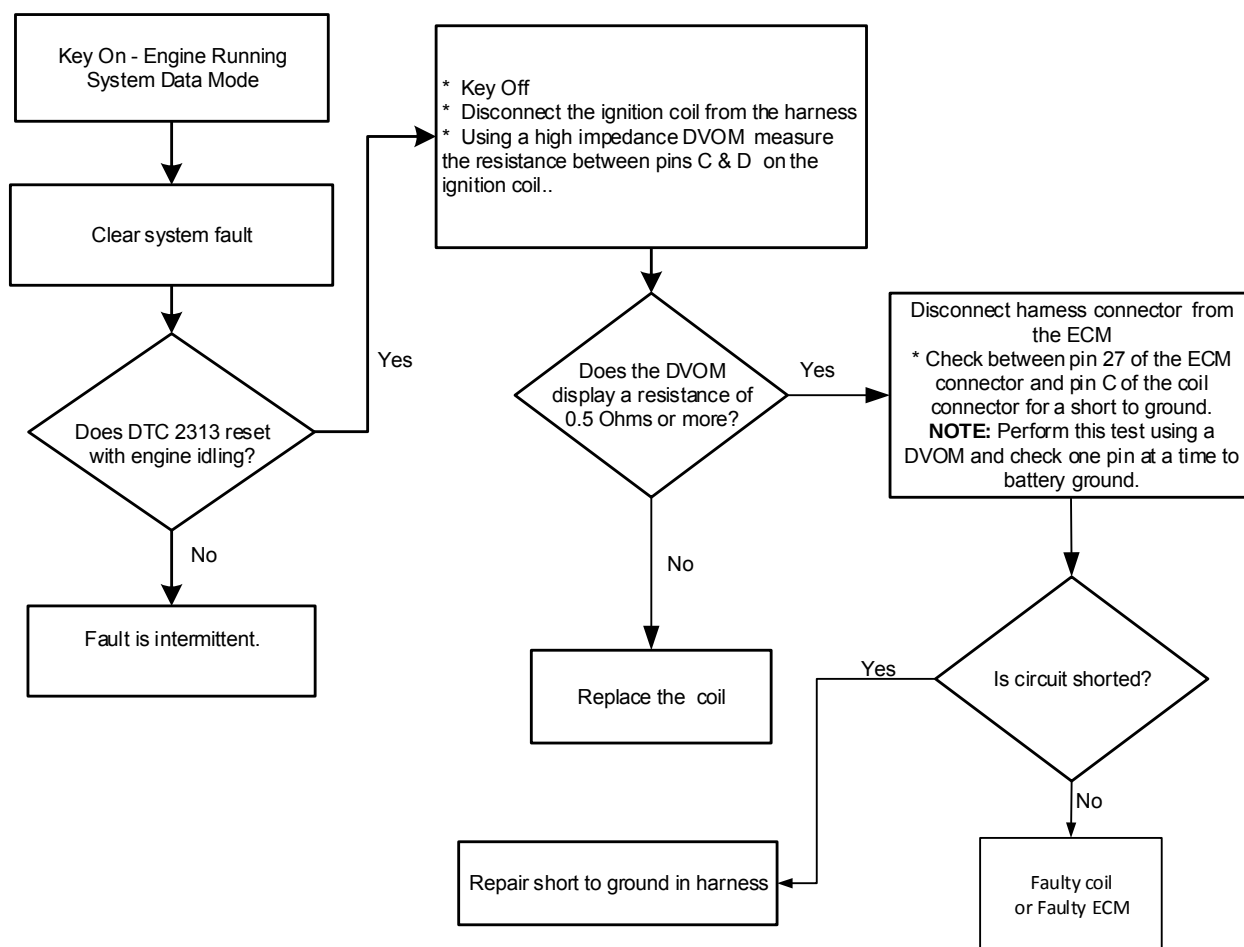
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Possible Causes:

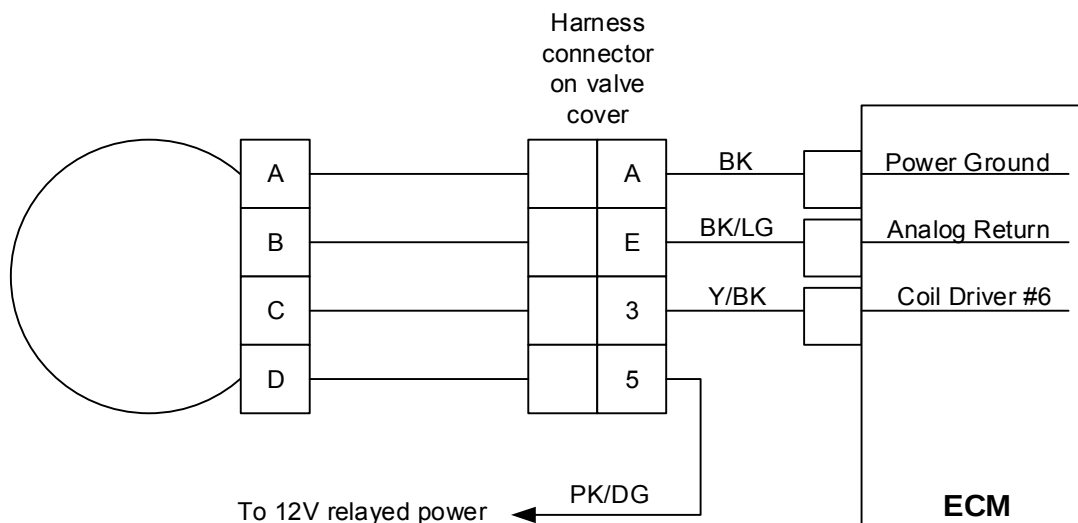
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2313 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2315 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 6)



DTC	2315	SPN	1273	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 6 (Dumb-coil ONLY)					
Description: Coil driver #6 fires either the 6 th cylinder in the firing order or the 6 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

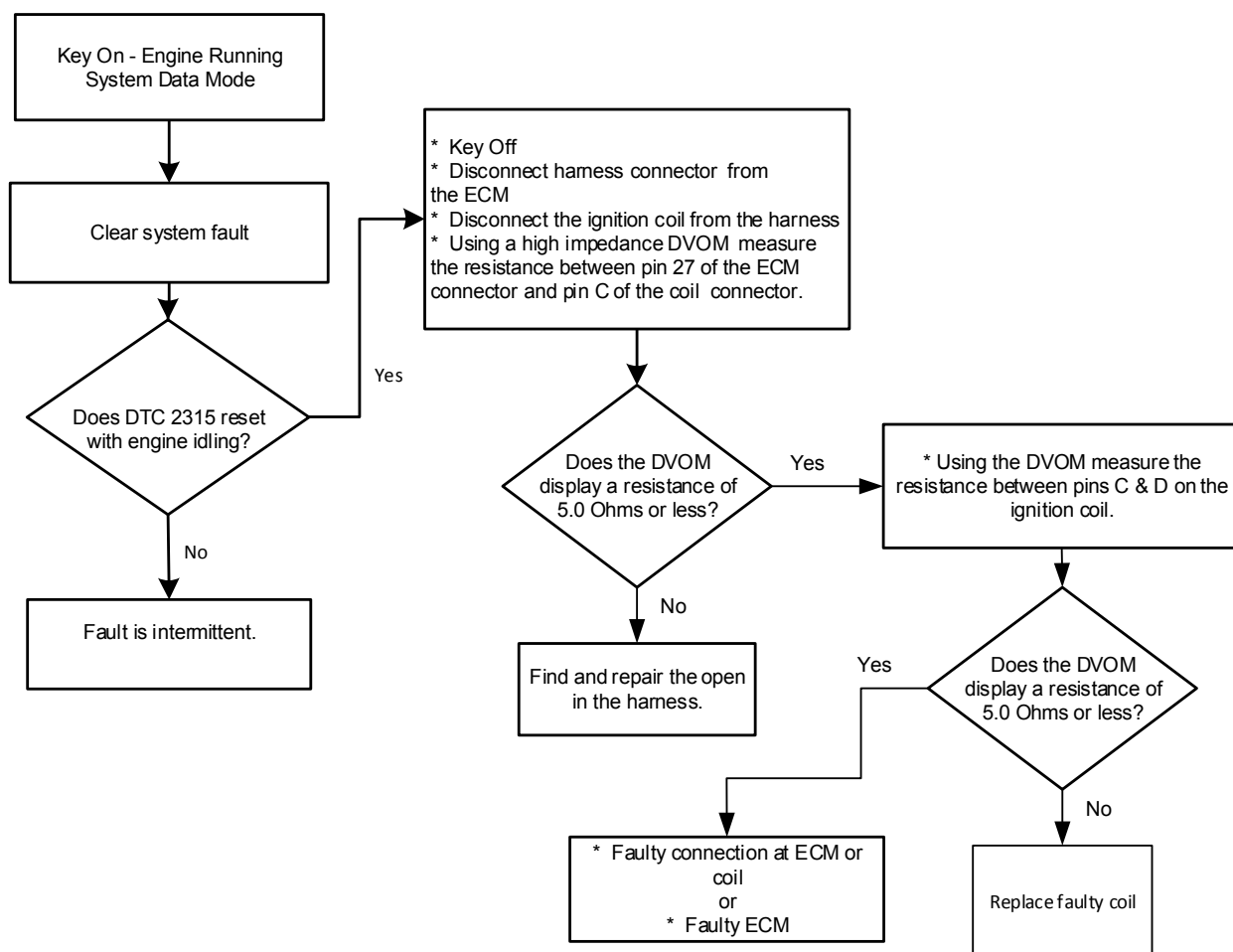
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Possible Causes:

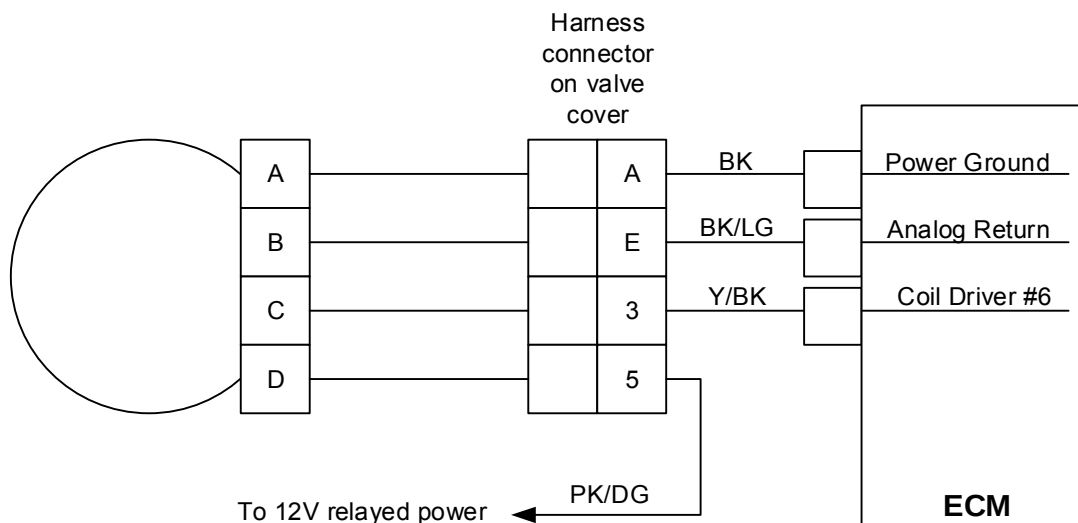
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2315 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2316 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 6)



DTC	2316	SPN	1273	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 6 (Dumb-coil ONLY)					
Description: Coil driver #6 fires either the 6 th cylinder in the firing order or the 6 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

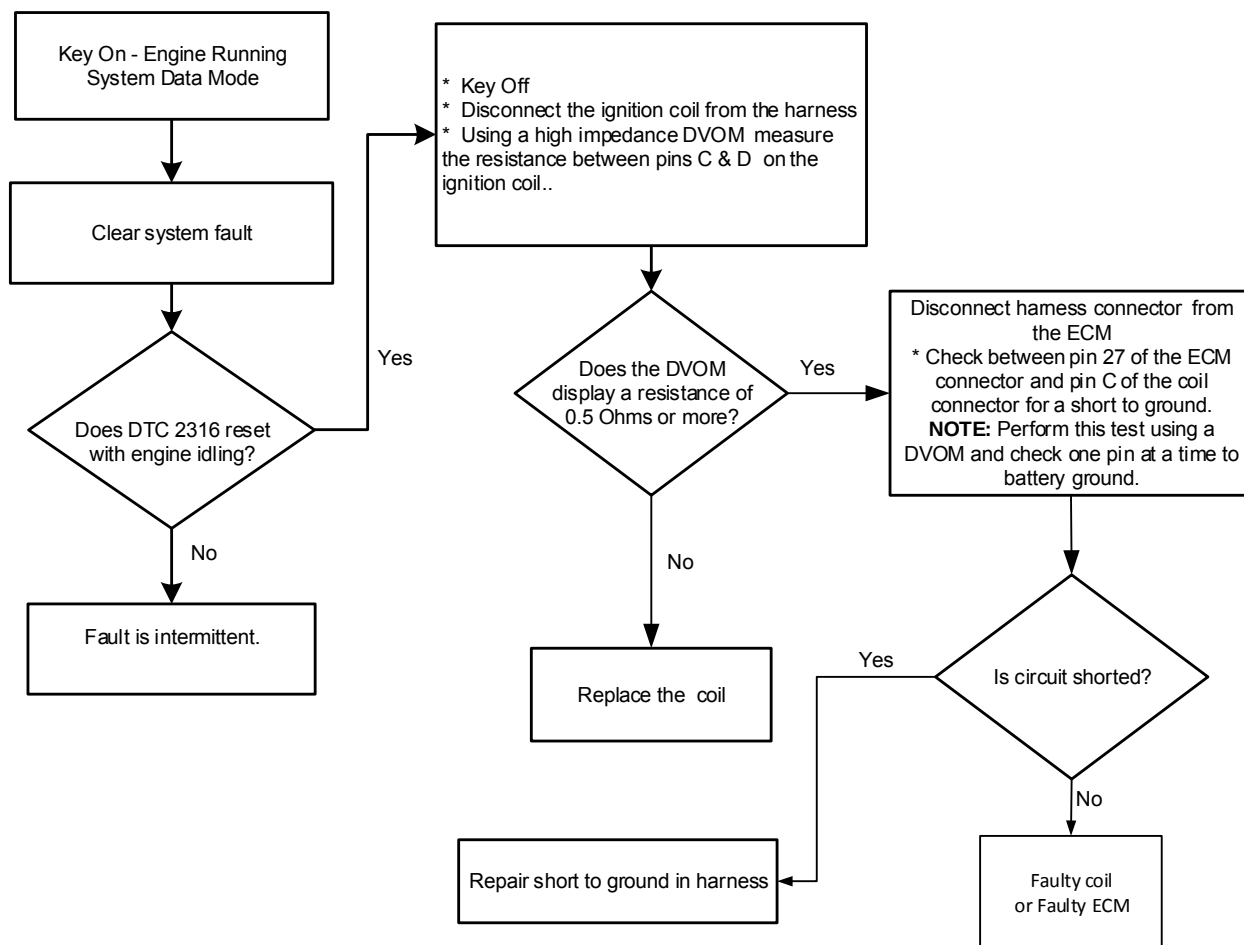
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Possible Causes:

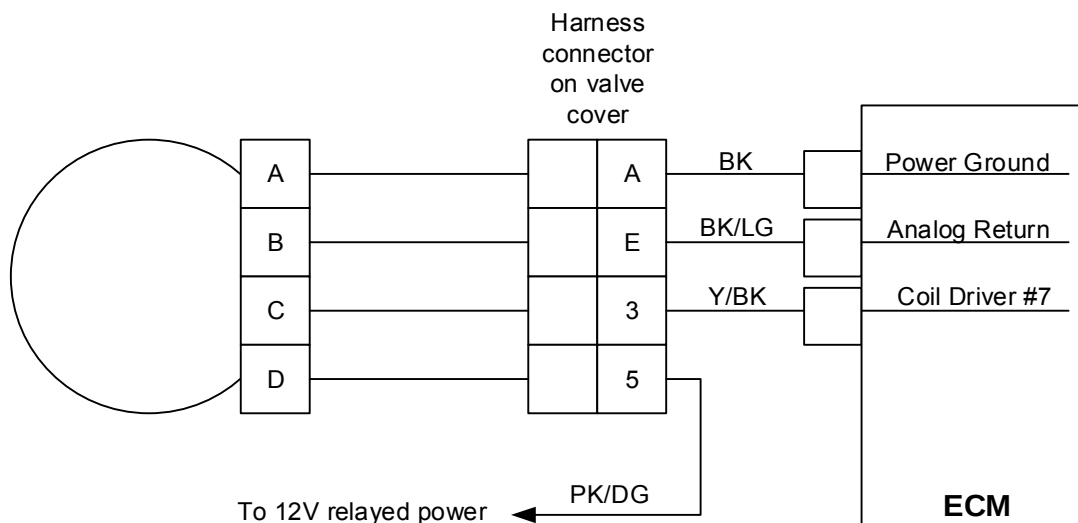
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2316 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2318 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 7)



DTC	2318	SPN	1274	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 7 (Dumb-coil ONLY)					
Description: Coil driver #7 fires either the 7 th cylinder in the firing order or the 7 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

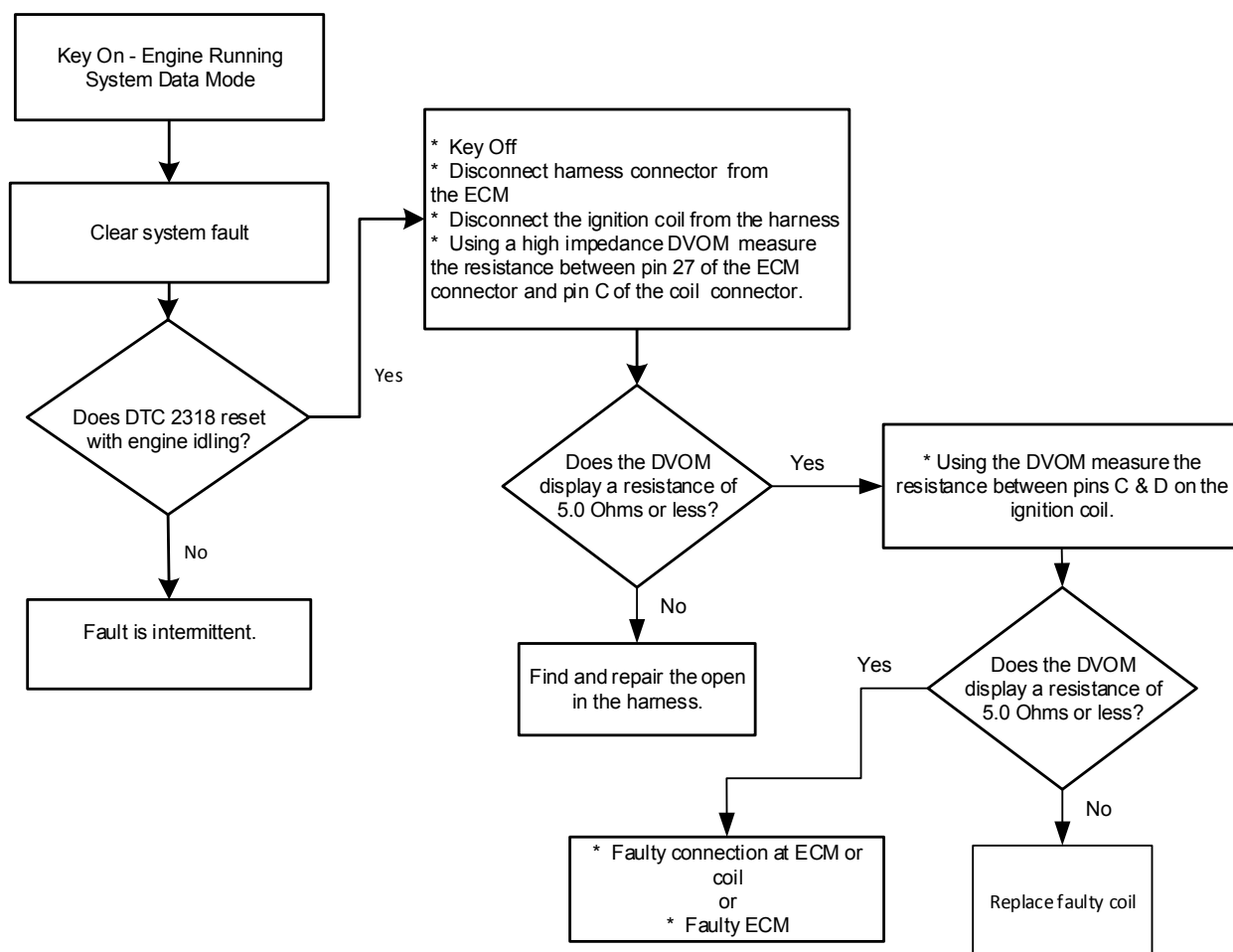
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Possible Causes:

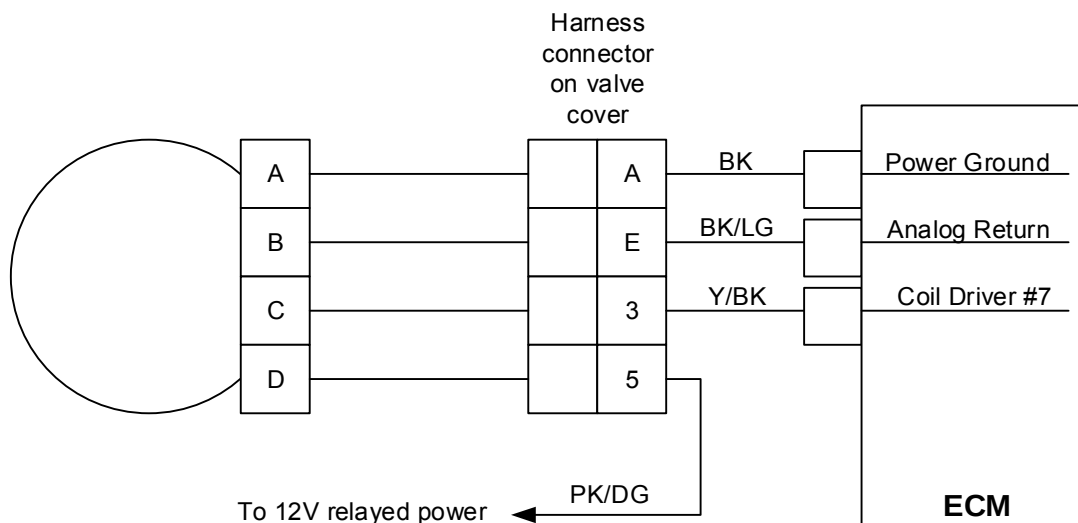
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2318 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2319 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 7)



DTC	2319	SPN	1274	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 7 (Dumb-coil ONLY)					
Description: Coil driver #7 fires either the 7 th cylinder in the firing order or the 7 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

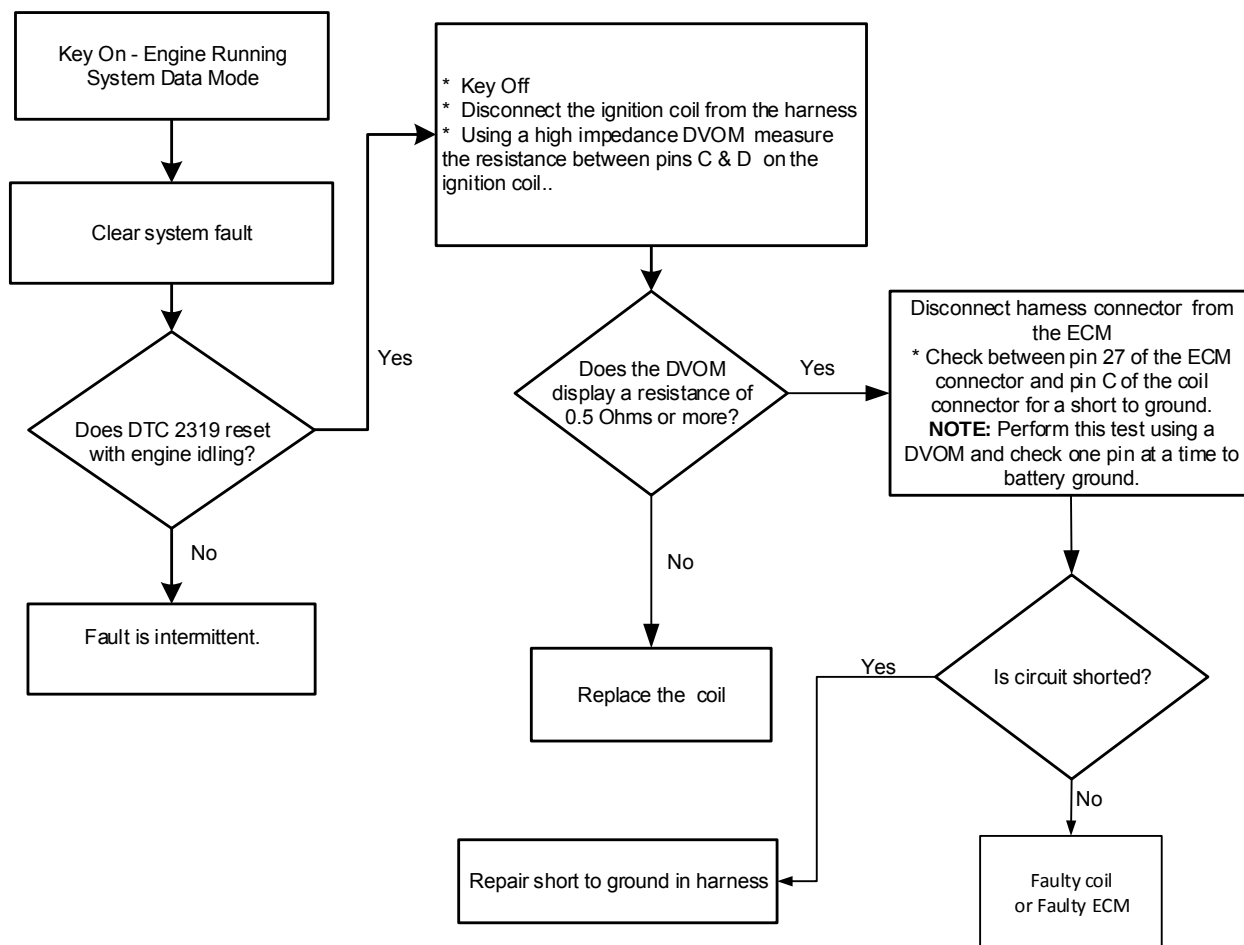
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Possible Causes:

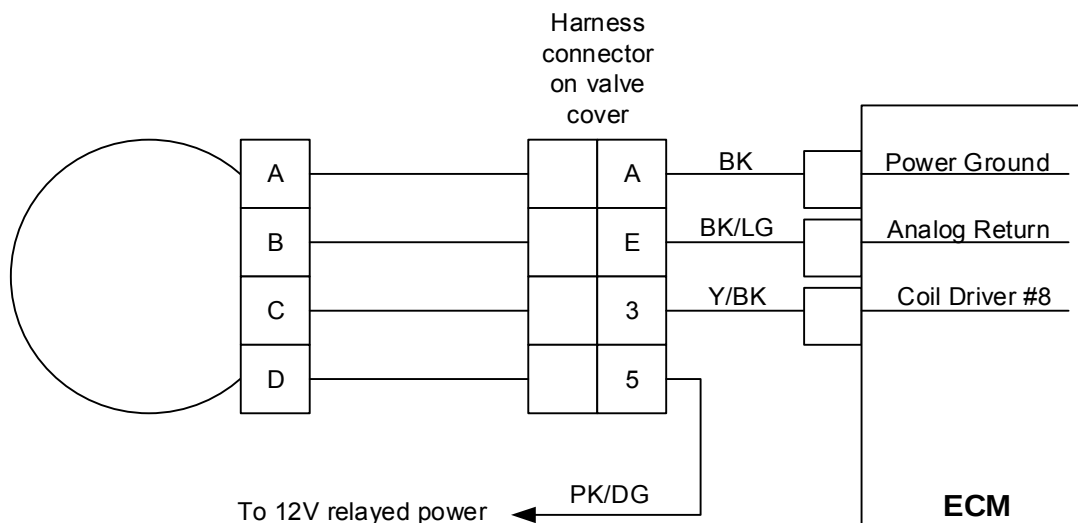
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2319 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2321 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 8)



DTC	2321	SPN	1275	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 8 (Dumb-coil ONLY)					
Description: Coil driver #8 fires either the 8 th cylinder in the firing order or the 8 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

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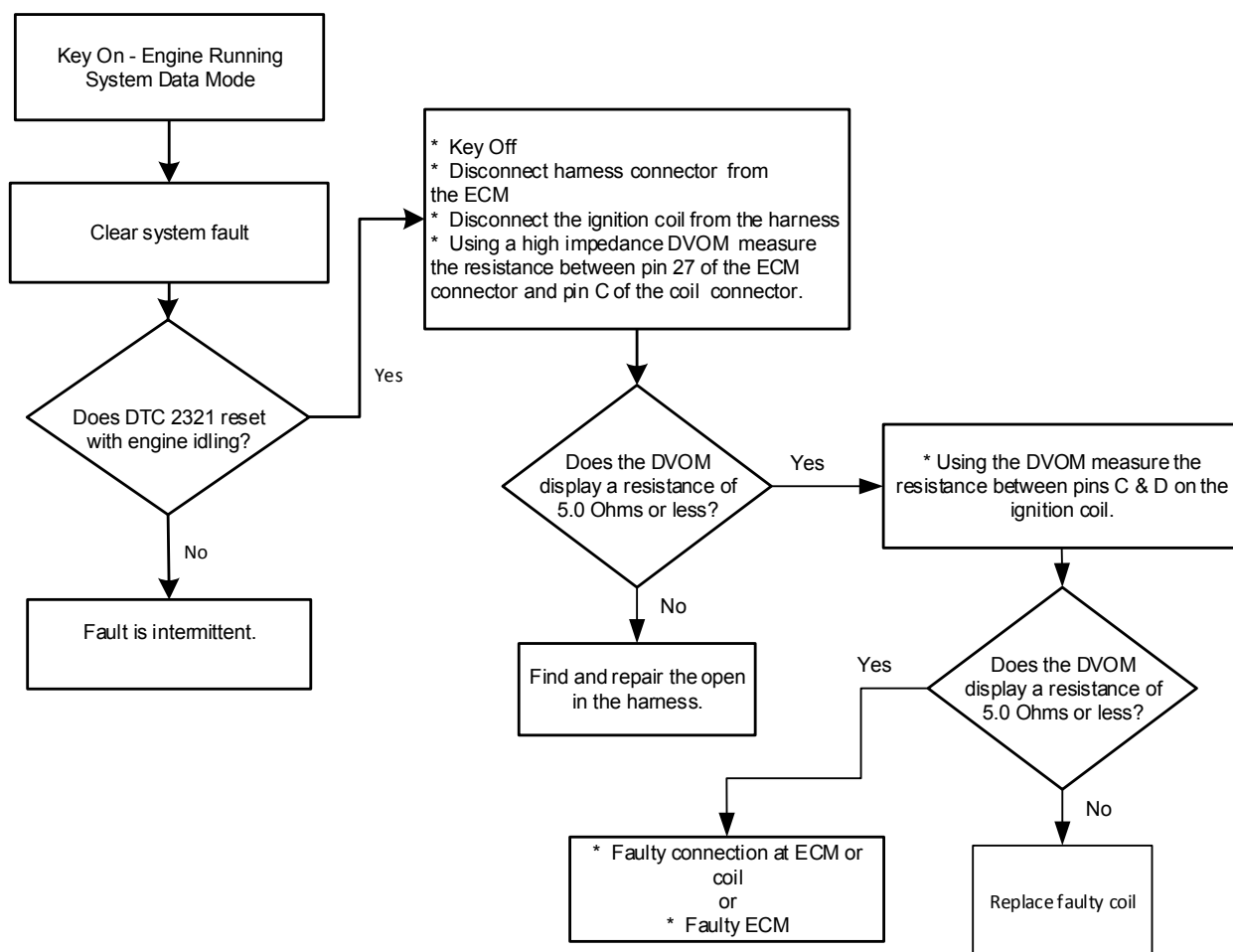
Possible Causes:

This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

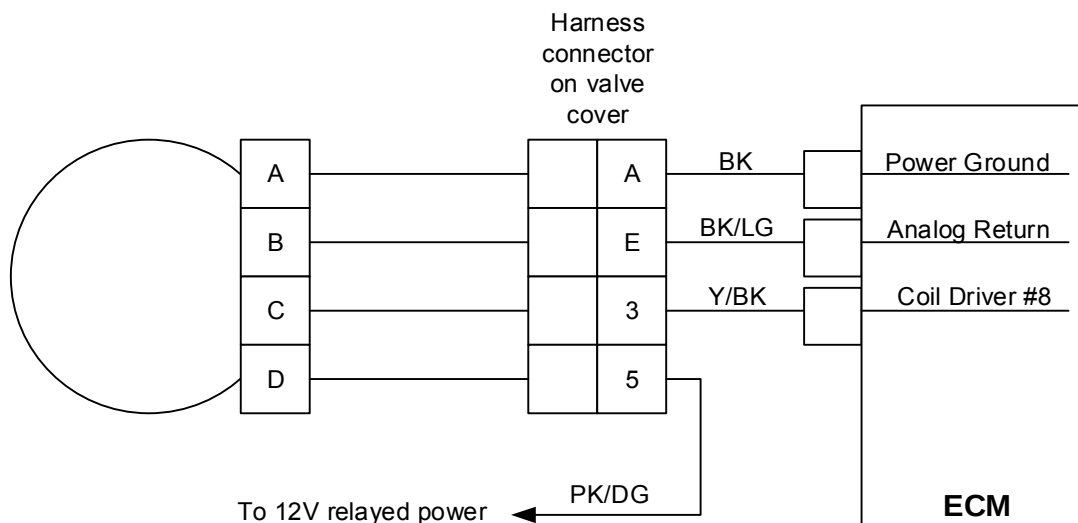
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2321 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)



DTC 2322 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 8)



DTC	2322	SPN	1275	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 8 (Dumb-coil ONLY)					
Description: Coil driver #8 fires either the 8 th cylinder in the firing order or the 8 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

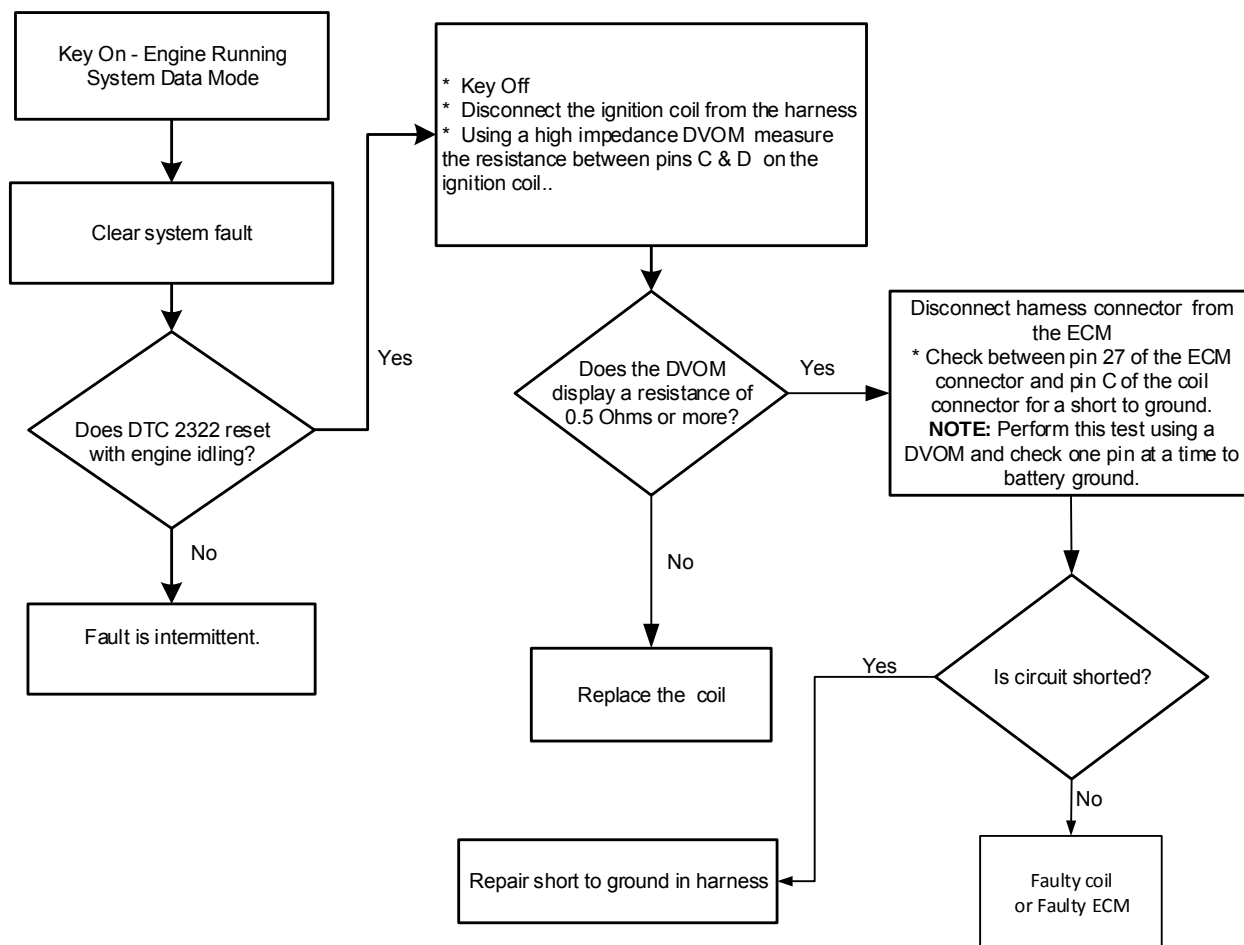
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Possible Causes:

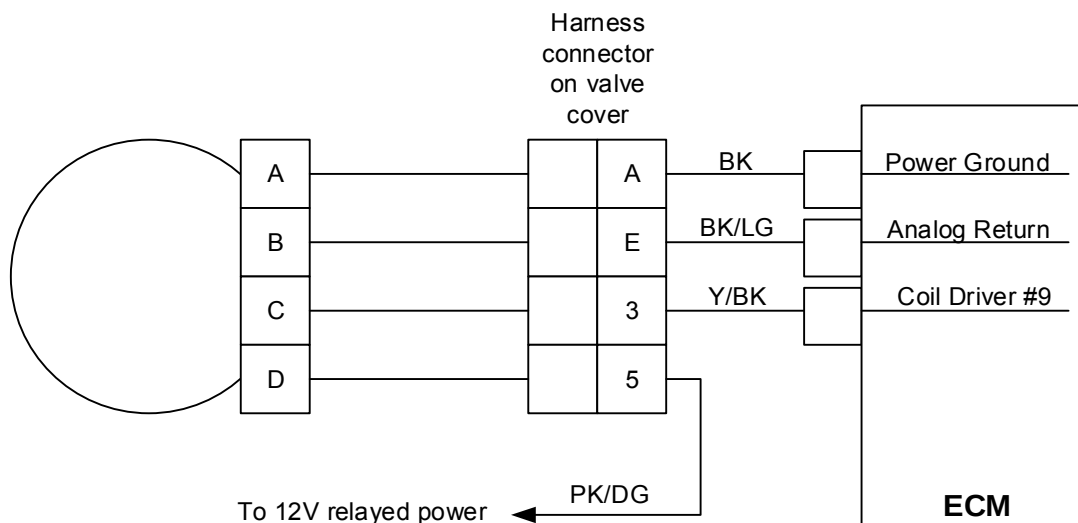
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2322 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2324 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 9)



DTC	2324	SPN	1276	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 9 (Dumb-coil ONLY)					
Description: Coil driver #9 fires either the 9 th cylinder in the firing order or the 9 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

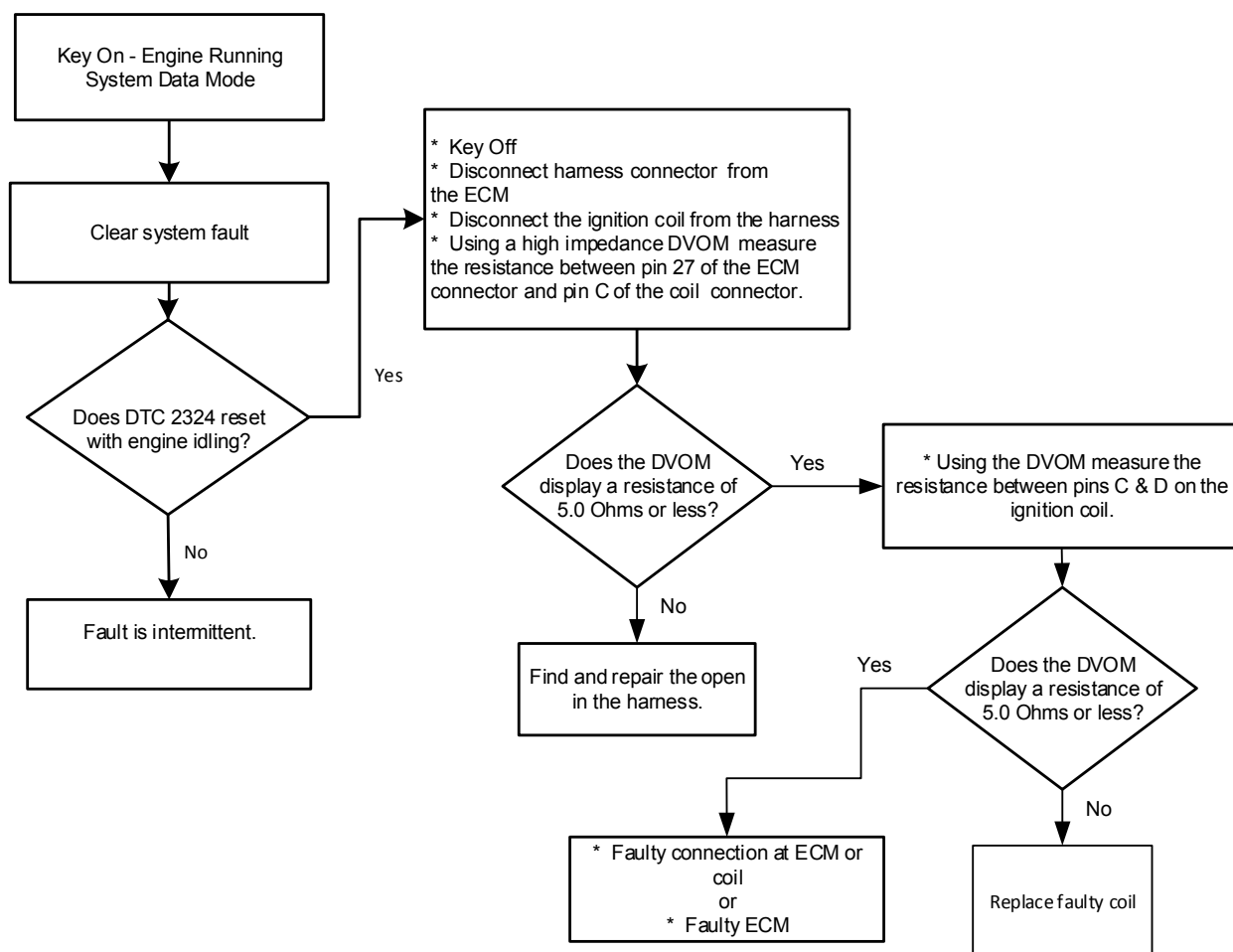
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Possible Causes:

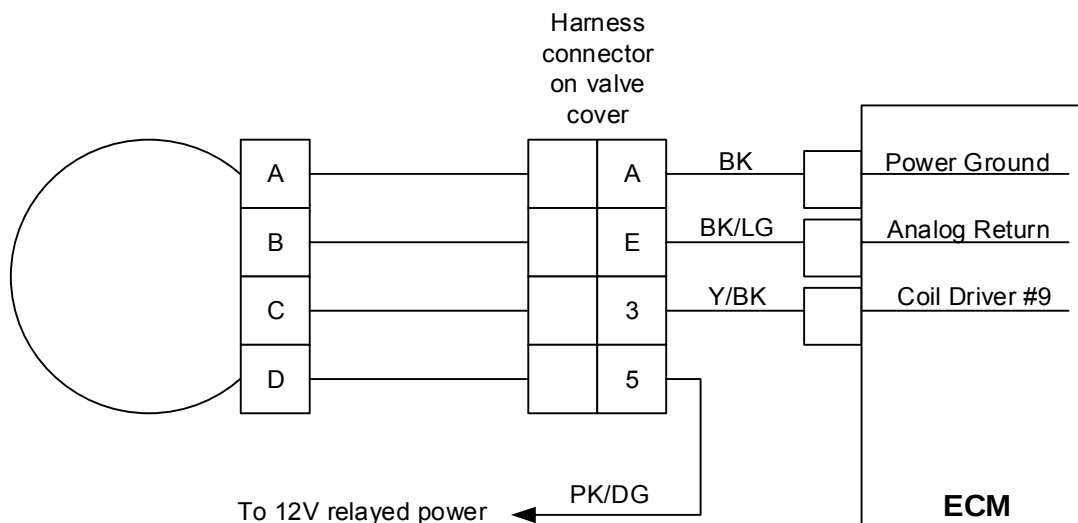
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2324 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2325 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 8)



DTC	2325	SPN	1276	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 9 (Dumb-coil ONLY)					
Description: Coil driver #9 fires either the 9 th cylinder in the firing order or the 9 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

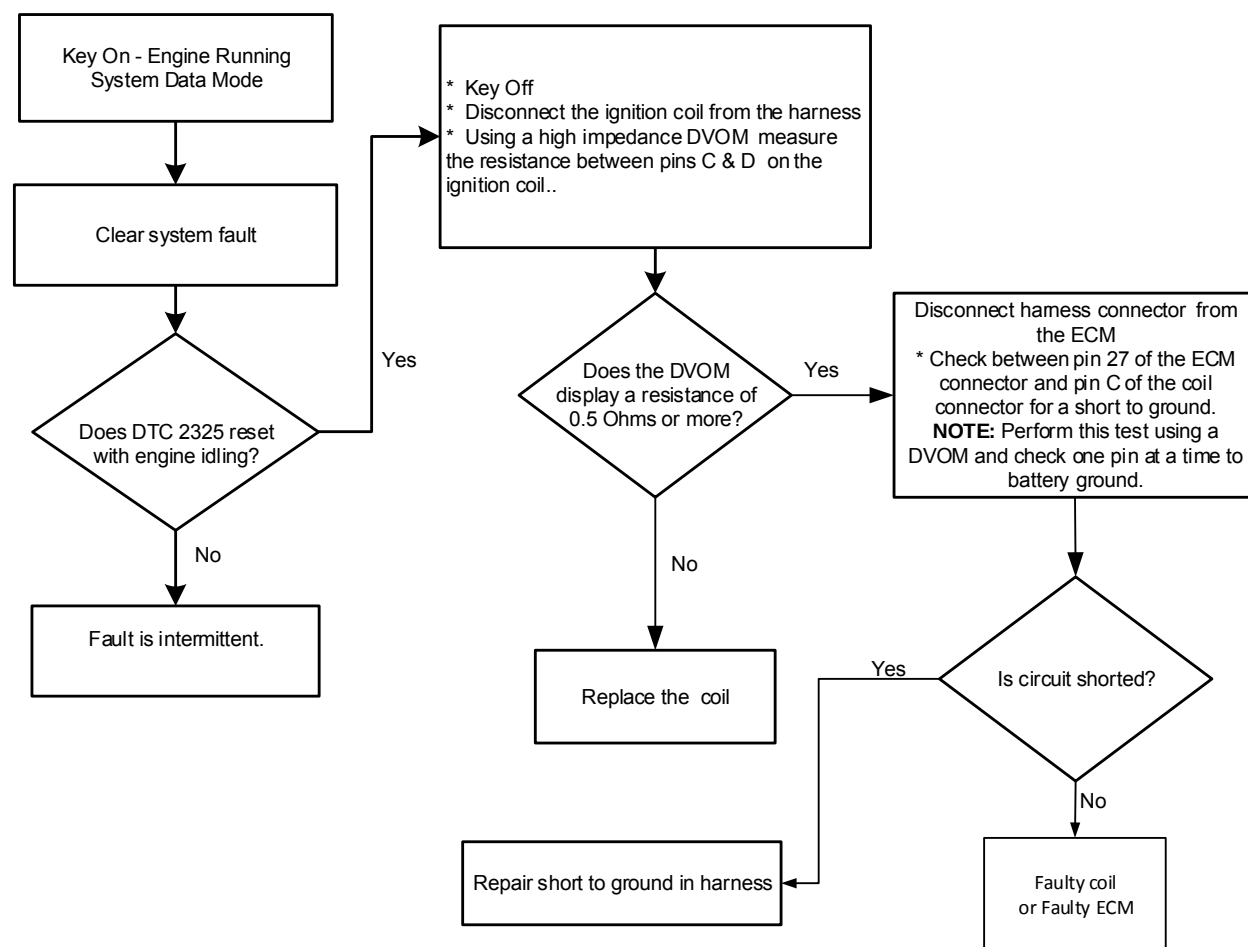
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Possible Causes:

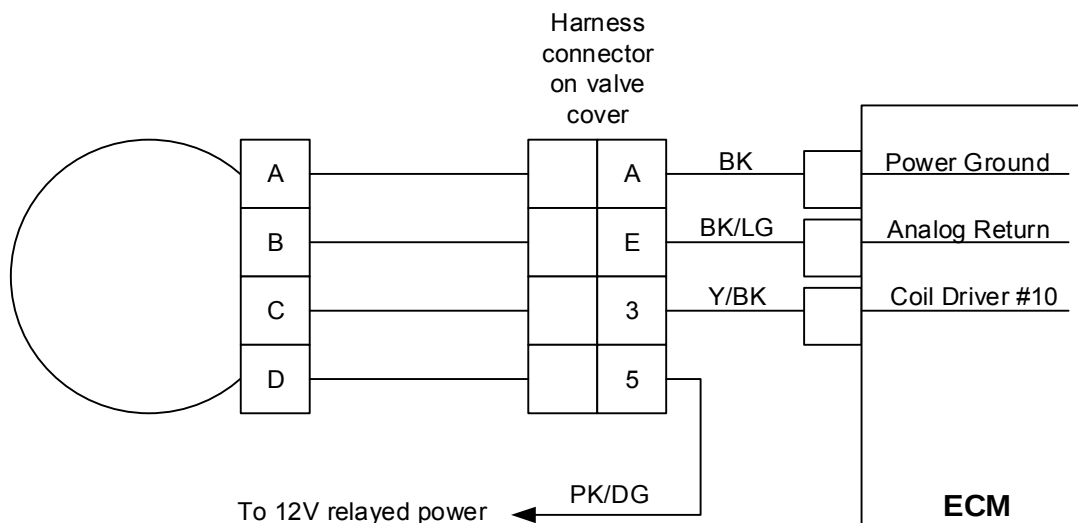
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2325 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2327 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (CURR. MEAS. REQD)(CYLINDER 10)



DTC	2327	SPN	1277	FMI	5
Sensor/Circuit: Ignition/Spark Coil, cylinder 10 (Dumb-coil ONLY)					
Description: Coil driver #10 fires either the 10 th cylinder in the firing order or the 10 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment >=				TBD*	ms
• or total dwell >=				TBD*	ms
If dwell current control = 'Monitor Only':					
• final current <				TBD*	amps
• and crank dwell (external module only) <				TBD*	ms

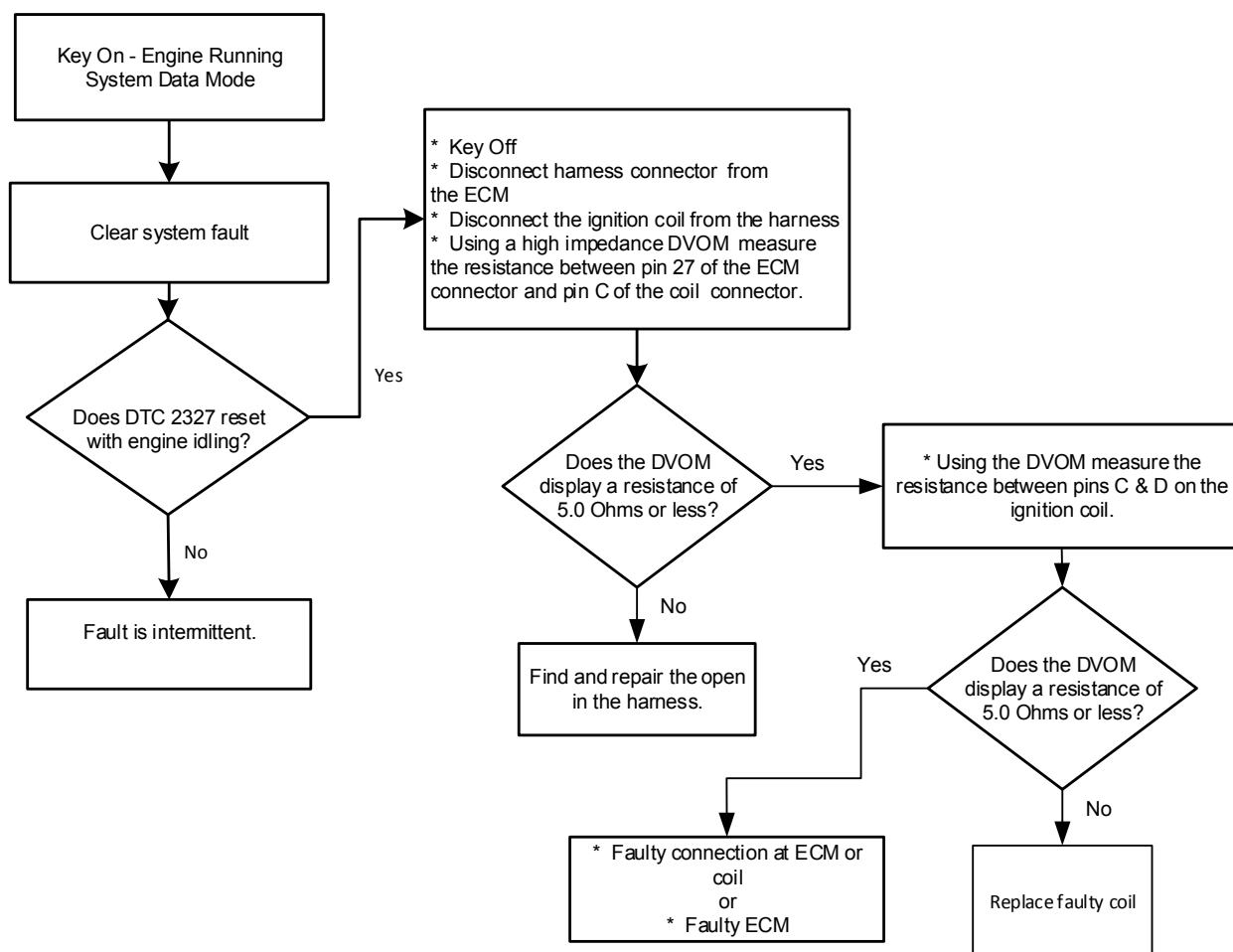
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Possible Causes:

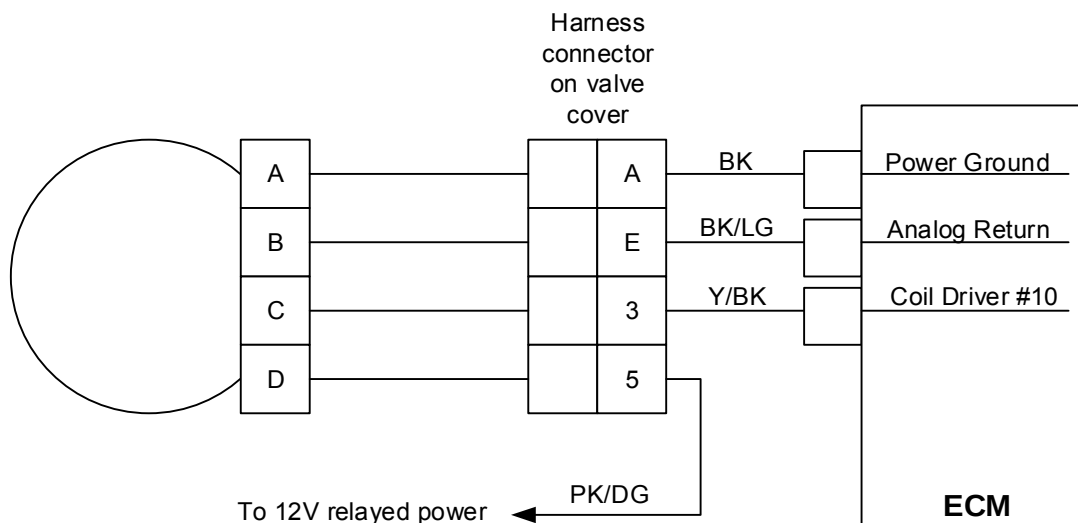
This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is greater than y ms. or the total dwell is greater than w ms. and battery voltage is greater than z volts as defined in the diagnostic calibration.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2327 - PRIMARY LOOP OPEN OR LOW-SIDE SHORT TO GROUND (TROUBLE TREE)

DTC 2328 - PRIMARY COIL SHORTED (CURRENT MEASUREMENT REQUIRED)(CYLINDER 10)



DTC	2328	SPN	1277	FMI	6
Sensor/Circuit: Ignition/Spark Coil, cylinder 10 (Dumb-coil ONLY)					
Description: Coil driver #10 fires either the 10 th cylinder in the firing order or the 10 th cylinder in the block order depending on the configuration of the 'Injector/Spark Diagnostic Numbering' scheme as set in calibration. The purpose of this fault is to detect a short-to-ground or open circuit in the harness or internal to the primary coil.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Key On, Engine On			
Fault Set Conditions (as defined in calibration):					
• Diagnose faults while cranking				Disabled/Enabled	
• Battery voltage >				TBD*	volts
• Battery voltage <				TBD*	volts
• External spark module voltage >				TBD*	volts
If dwell current control = 'Adaptive Dwell':					
• dwell adjustment <=				TBD*	ms
• or total dwell <=				TBD*	ms
If dwell current control = 'Monitor Only':					
• dwell adjustment <=				TBD*	amps
• or total dwell <=				TBD*	us

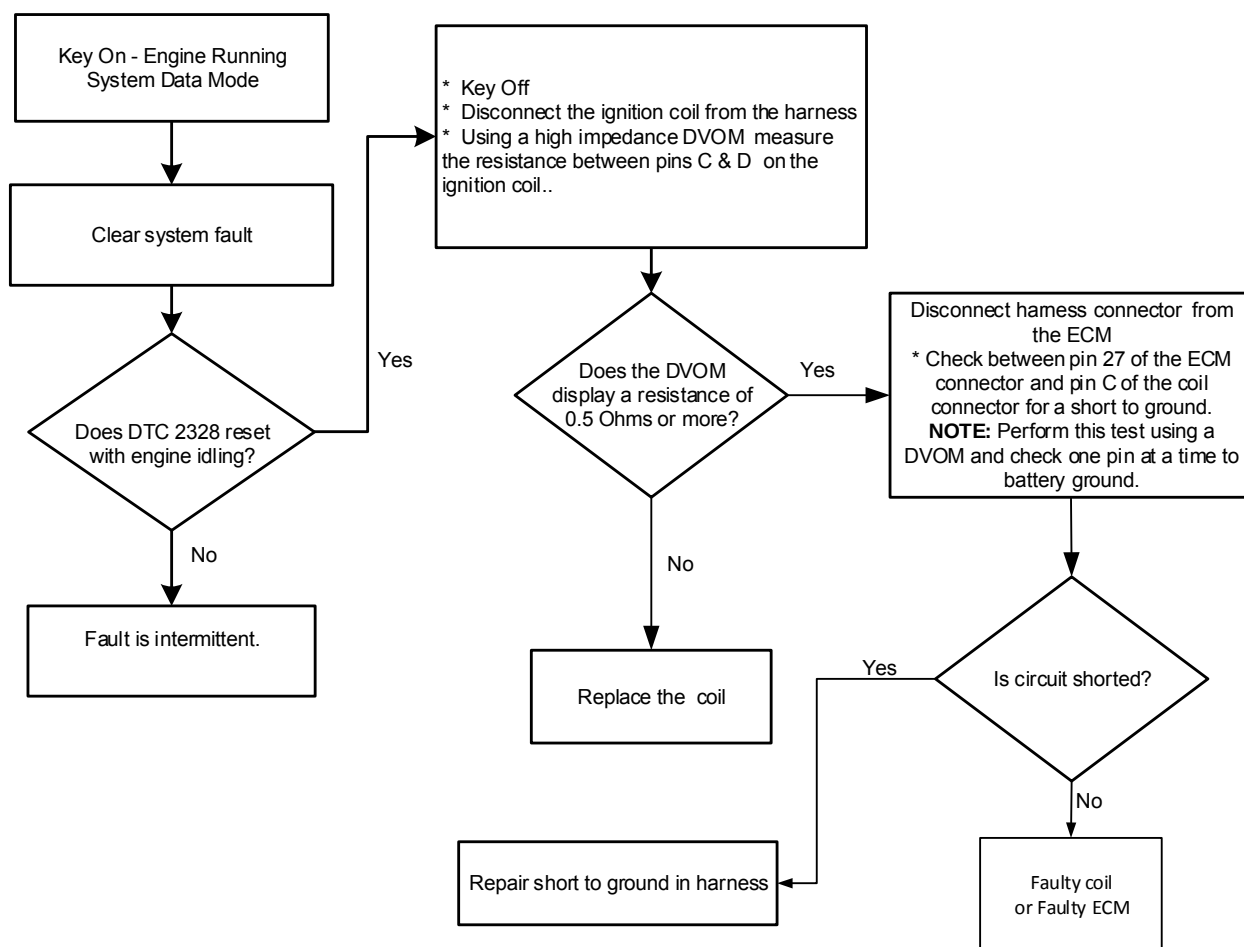
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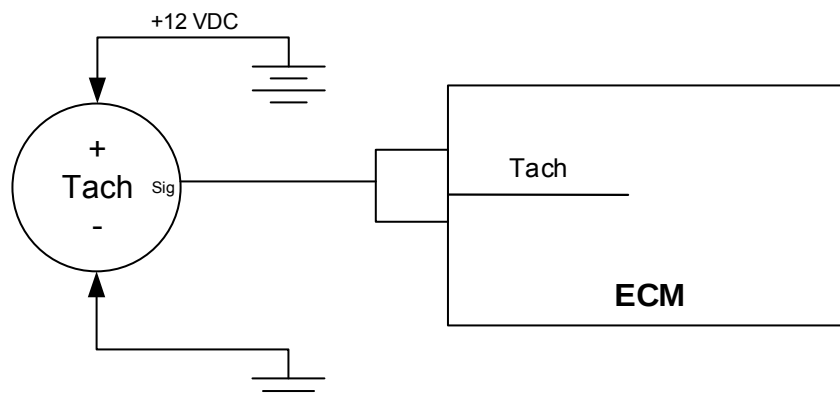
Possible Causes:

This fault will set if the ECM detects x number of coil firings in which the adaptive dwell adjustment is less than y ms. or the total dwell is less than w ms. and battery voltage is less than z volts as defined in the diagnostic calibration.

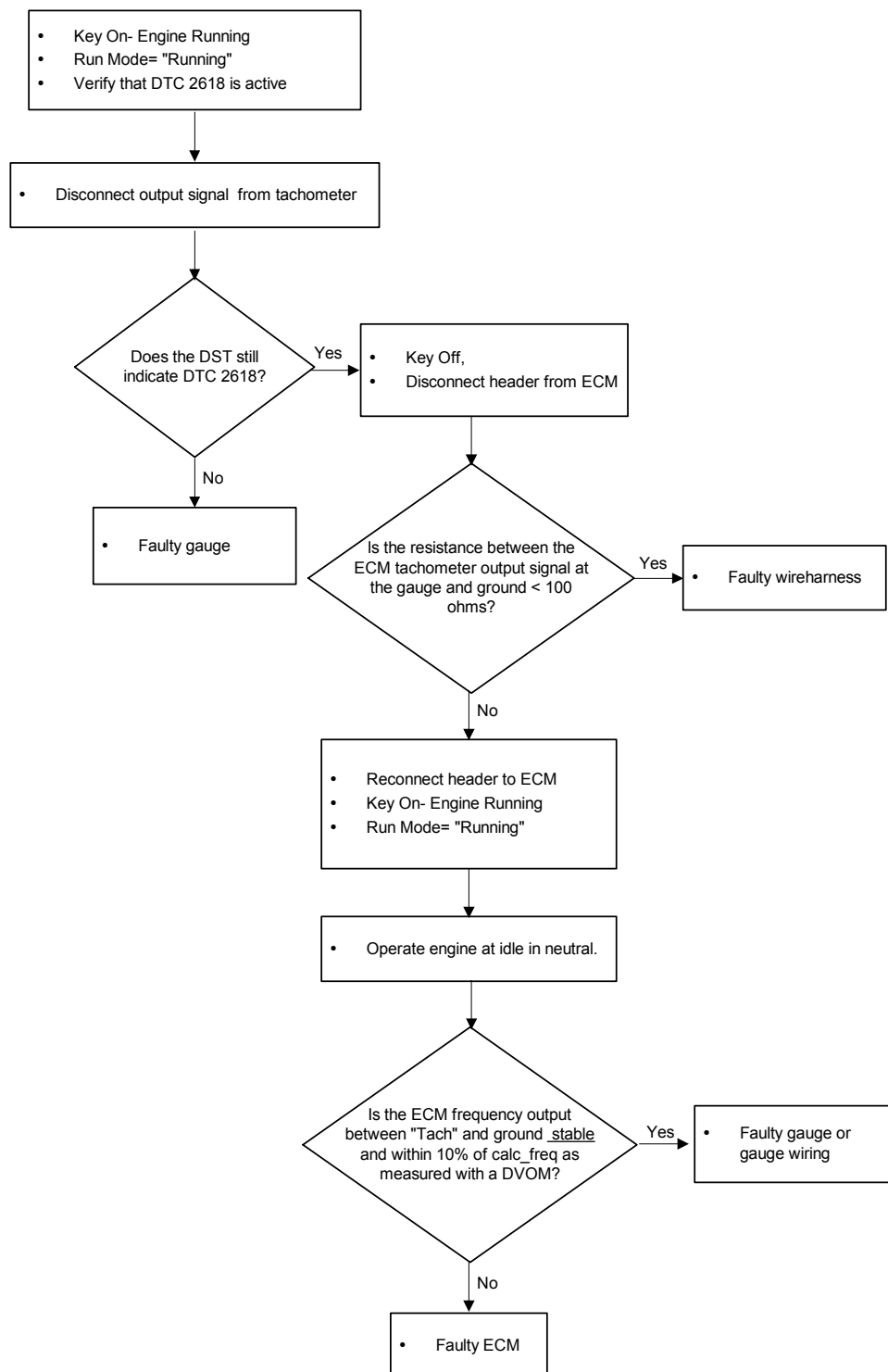
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

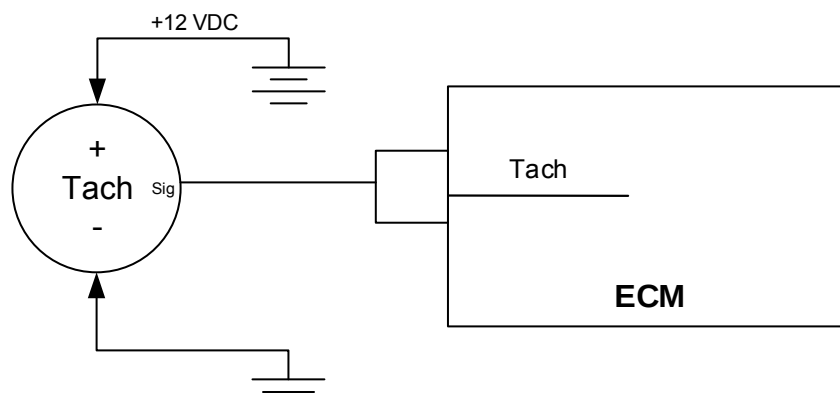
DTC 2328 - PRIMARY COIL SHORTED (TROUBLE TREE)

DTC 2618 - TACH OUTPUT GROUND SHORT

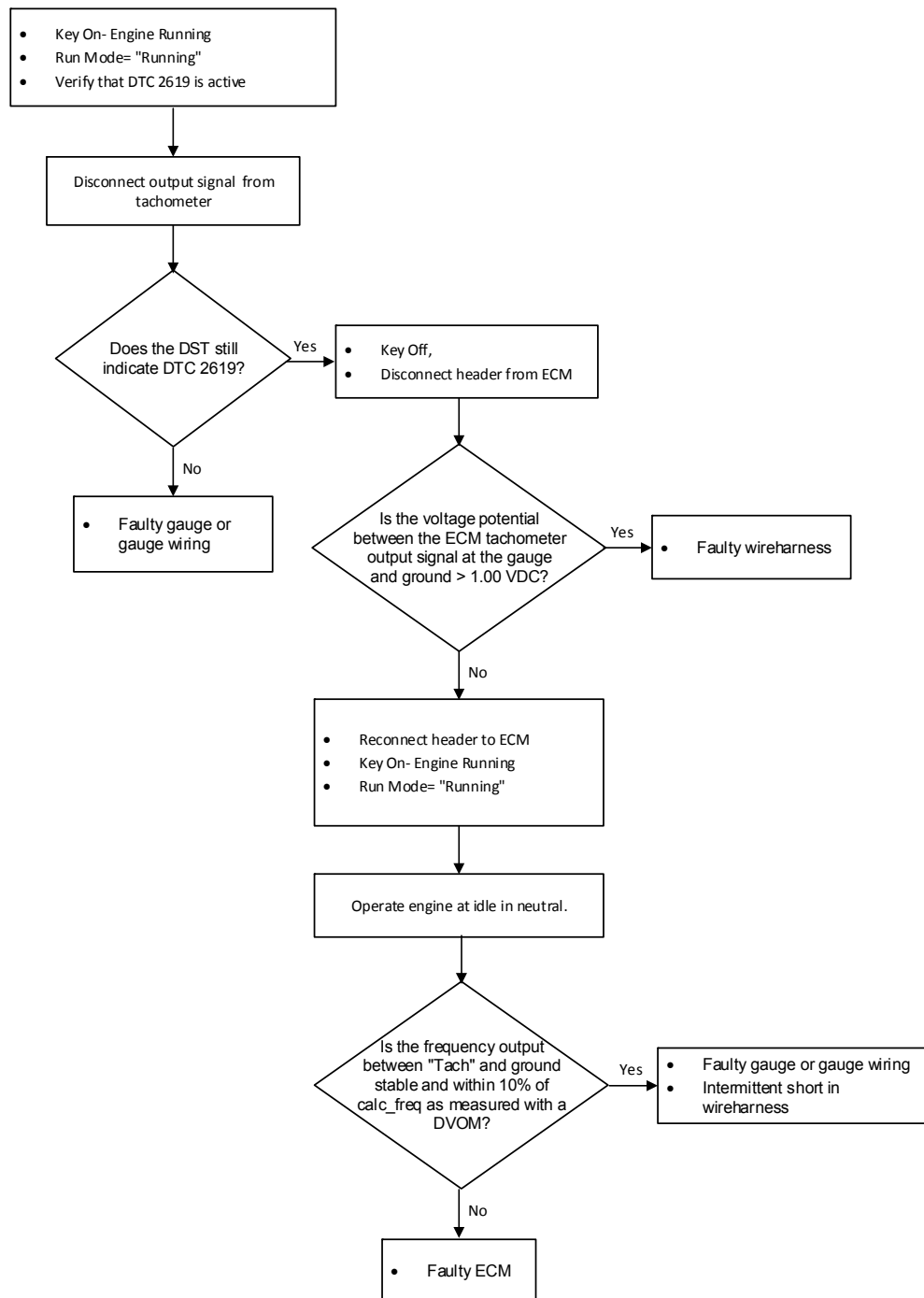
DTC	2618	SPN	645	FMI	4		
Sensor/Circuit: Tachometer Gauge							
Description: This output is a 0-12 VDC constant duty-cycle, variable frequency square-wave used to drive a digital tachometer.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback <				TBD*	% Vbat		
Possible Causes: This fault sets if the ECM tachometer output senses a short to ground.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2618- TACH OUTPUT GROUND SHORT (TROUBLE TREE)

$$\text{calc\_freq (hz.)} = \frac{\# \text{ of cyl}}{2} \times \frac{N}{60}, \text{ where } N = \text{engine speed in RPM}$$

DTC 2619 - TACH OUTPUT SHORT TO POWER

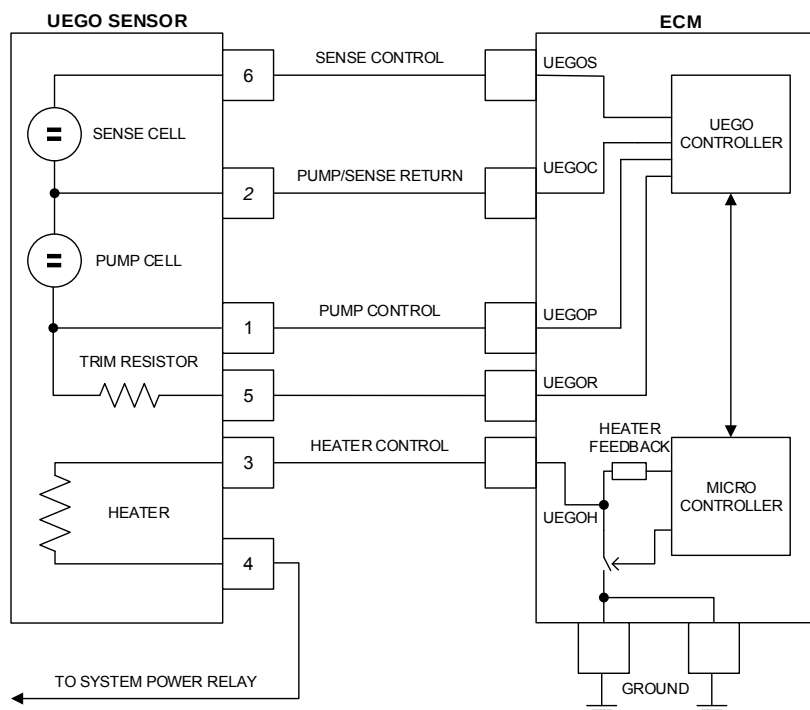
DTC	2619	SPN	645	FMI	3		
Sensor/Circuit: Tachometer Gauge							
Description: This output is a 0-12 VDC constant duty-cycle, variable frequency square-wave used to drive a digital tachometer.							
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)					
Emissions-related Fault?		NO					
Check Condition:		Key On, Engine On					
Fault Set Conditions (as defined in calibration):							
• Low-side feedback >				TBD*	% Vbat		
Possible Causes: This fault sets if the ECM tachometer output senses a short to power.							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 2619- TACH OUTPUT SHORT TO POWER (TROUBLE TREE)

$$\text{calc\_freq (hz.)} = \frac{\text{\# of cyl}}{2} \times \frac{N}{60}, \text{ where } N = \text{engine speed in RPM}$$

DTC 2665 - CFV RLV TEST FAILED

DTC	2665	SPN	3601	FMI	7		
Check Condition:		Engine Running					
Emissions-related Fault?		NO					
Fault Set Conditions (as defined in calibration):							
• CFV interstage pressure > trigger pressure				TBD*	psia		
• and test time > test time limit				TBD*	sec		
Possible Causes:							
The CFV RLV test failed fault is set when the test surpasses the CFV RLV test time limit without the inter-stage pressure dropping below the trigger pressure. This indicates that the lockoff did not close as commanded and the lockoff is verified as failed. There are no latch/unlatch values defined for this fault. A single occurrence will latch this fault.							
The CFV RLV test failed fault will also be set if the minimum pressure drop time mode is enabled and the pressure drops below the trigger pressure before the minimum pressure drop time delay limit has been reached. This indicates that the primary lockoff closed instead of the secondary lockoff.							
** From Release Notes: Release 156C**							
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):							
Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*
Diagnostic Aids:							
1) Replace lockoff with known good unit and retest.							

DTC 3011 - UEGO1 INTERNAL PROCESSOR FAULT

DTC	3011	SPN	3221	FMI	31
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. Internal to the ECM there is an application specific integrated circuit/controller that controls the sensor. The UEGO controller communicates internally within the ECM to the main microcontroller. The UEGO controller must always be functioning and communicating with the main microcontroller for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Break in communication has occurred between the UEGO controller and the main micro-controller (both devices inside the ECM). The UEGO controller is no longer responsive.					
Possible Causes: This fault may set if the power supplied to the ECM (alternator or battery power) is excessively noisy and exhibits low voltage dips or dropouts. It may also indicate an internal failure within the ECM. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.					

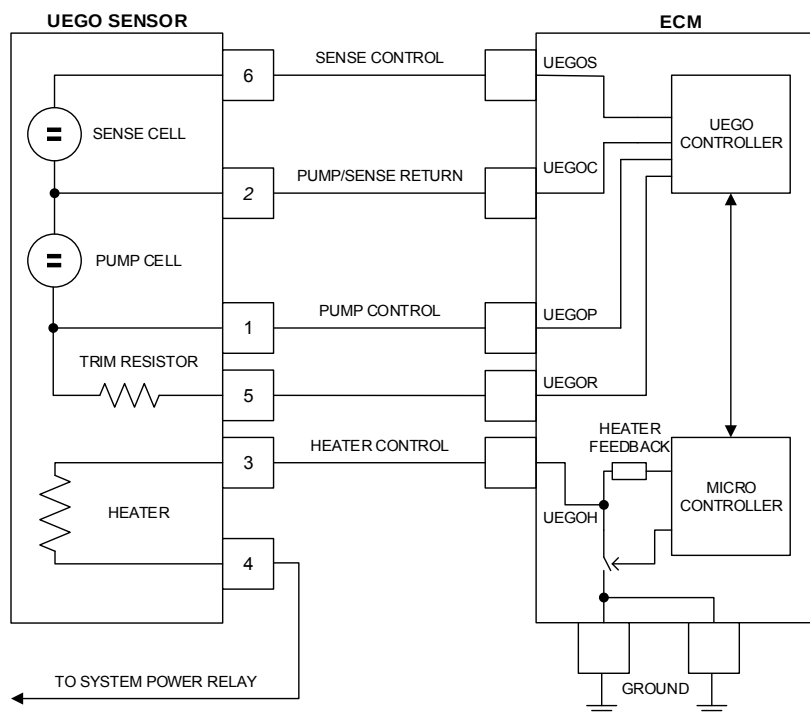
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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids:

- ☐ Verify that the alternator is working properly and there is not excessive noise on the alternator output or battery power from other loads. This fault may occur if power repeatedly dips but does not completely drop to zero.
- ☐ Verify the ECM ground is sufficient (clean and tight to the engine block)
- ☐ Swap ECM with a known good part, run engine for 10 minutes, and then retest.

DTC 3012 - UEGO1 HEATER SUPPLY HIGH VOLTAGE

DTC	3012	SPN	3222	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistor element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to Vbattery. If the control signal does not reach zero volts when the heater is turned on then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• UEGO1 heater supply voltage >				TBD*	volts

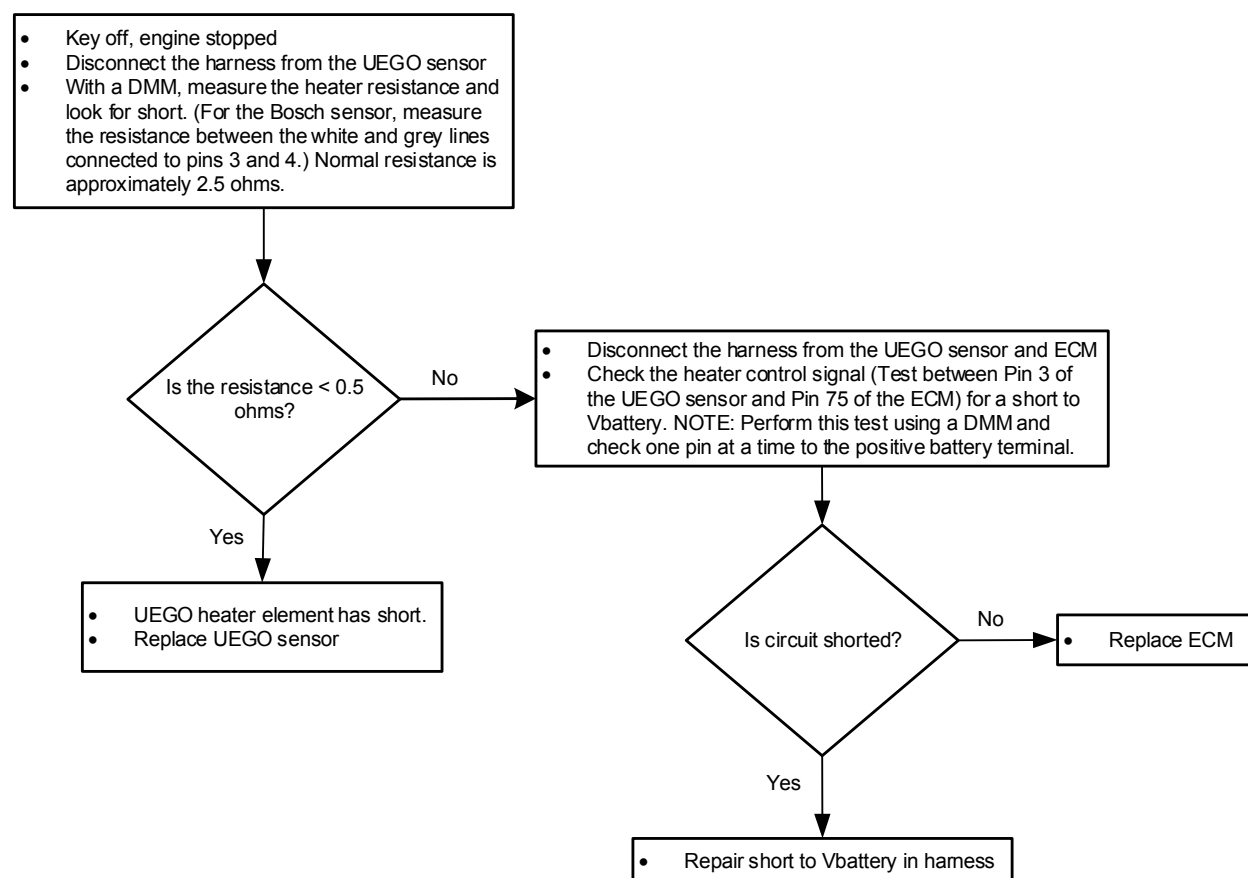
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Possible Causes:

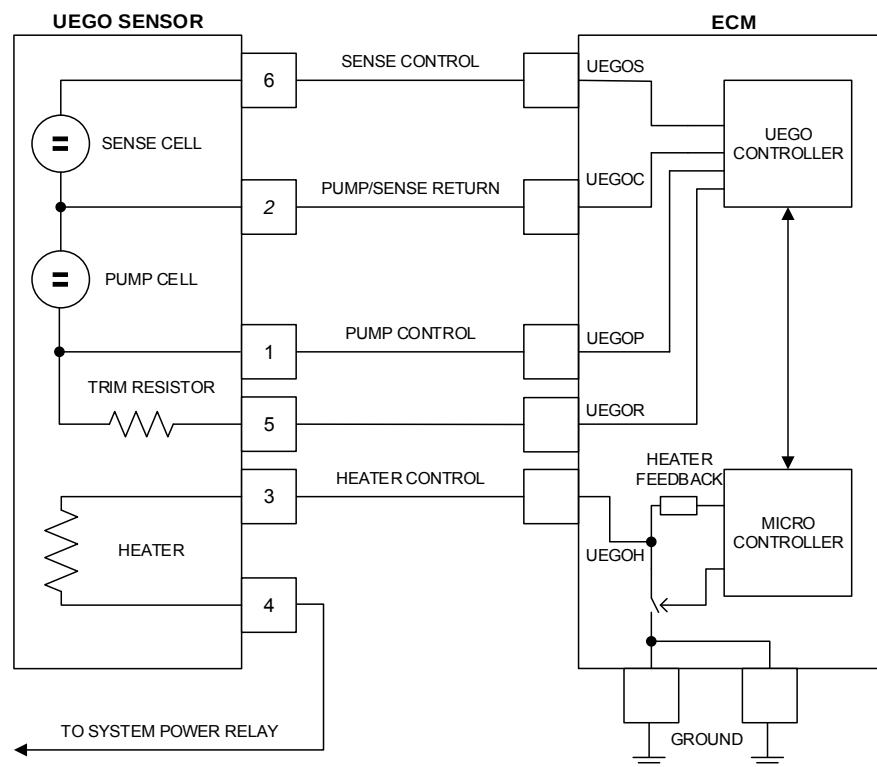
This fault will set when the UEGO heater control signal does not achieve zero volts when the heater is switched on. This may be caused by an internal fault within the ECM. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3012 - UEGO1 HEATER SUPPLY HIGH VOLTAGE (TROUBLE TREE)

DTC 3013 - UEGO1 HEATER SUPPLY LOW VOLTAGE



DTC	3013	SPN	3222	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistor element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to Vbattery. If the control signal does not reach zero volts when the heater is turned on then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• UEGO1 heater supply voltage <				TBD*	volts

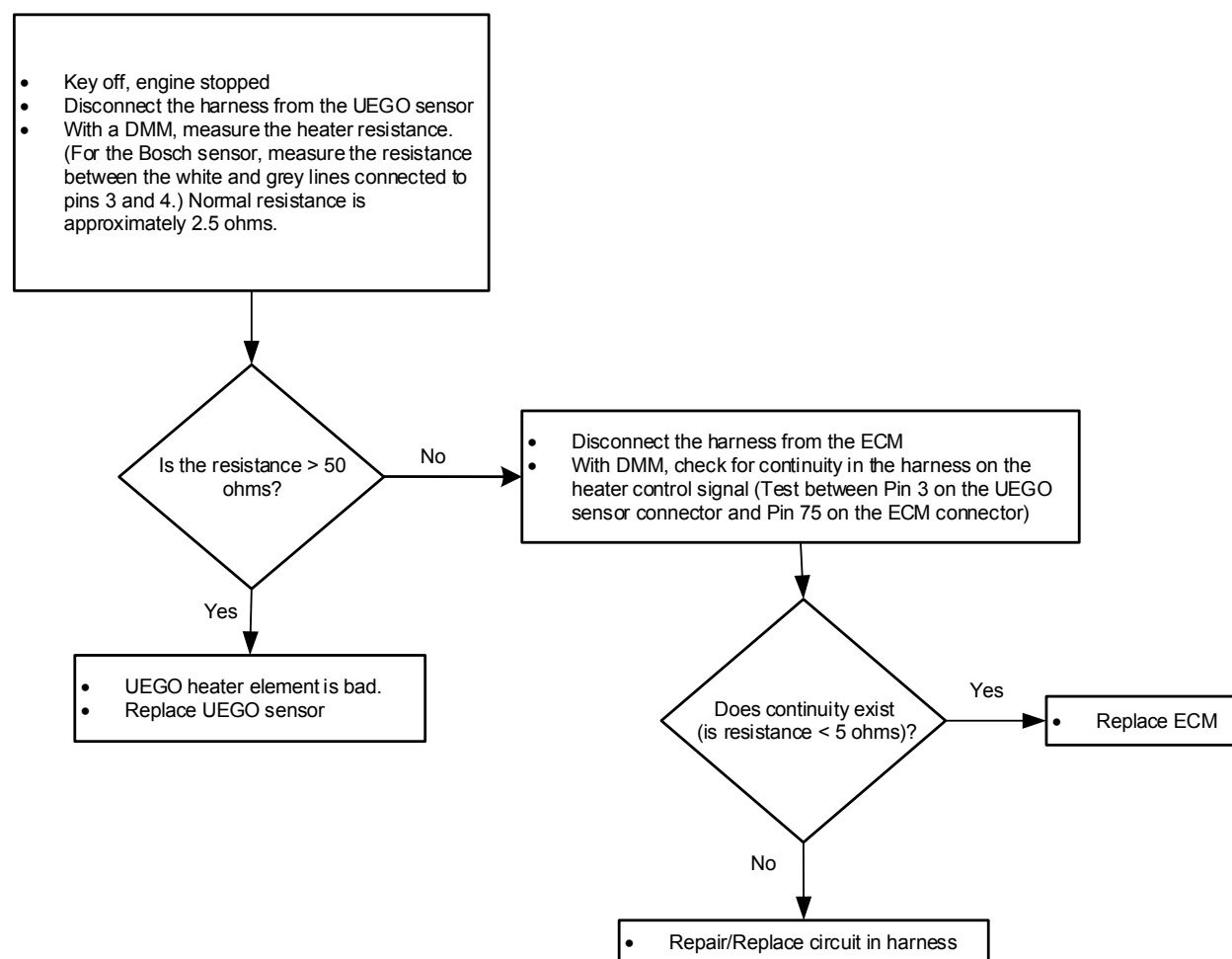
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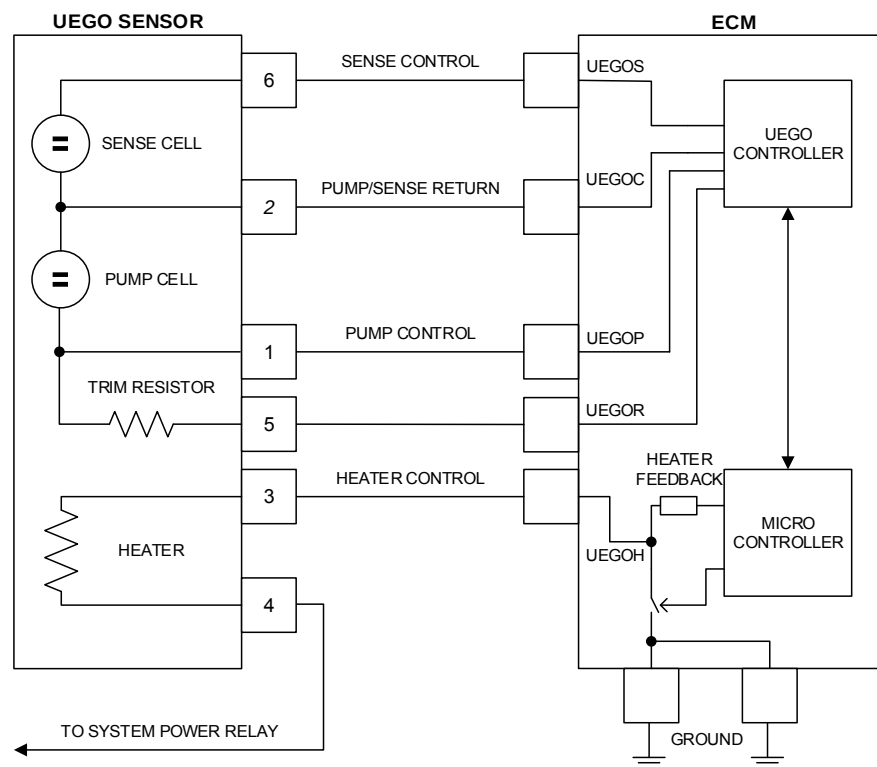
Possible Causes:

This fault will set when the UEGO heater control signal does not achieve Vbattery when the heater is switched off. This may be caused by a bad heater element in the UEGO sensor, a break in the wire harness on the heater supply or control circuits, or fault within the ECM. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3013 - UEGO1 HEATER SUPPLY LOW VOLTAGE (TROUBLE TREE)

DTC 3018 - UEGO1 PUMP VOLTAGE SHORTED HIGH

DTC	3018	SPN	3218	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a pump control signal between the pump cell and the ECM. The ECM monitors the pump control signal for a short to Vbattery. The UEGO pump circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor pump control signal is equal to battery or supply voltage (short to Vbattery.)					

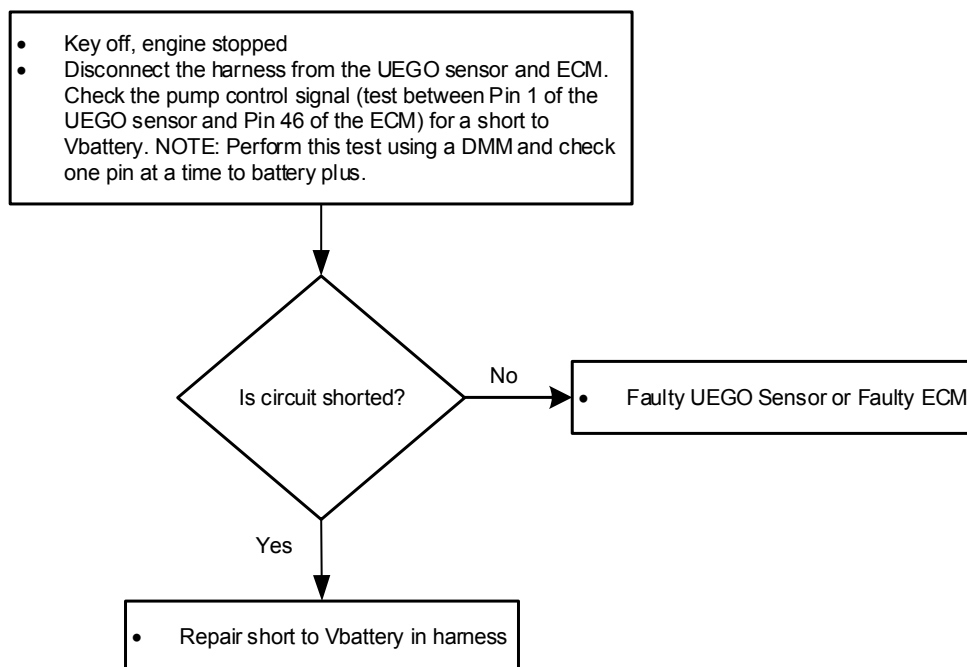
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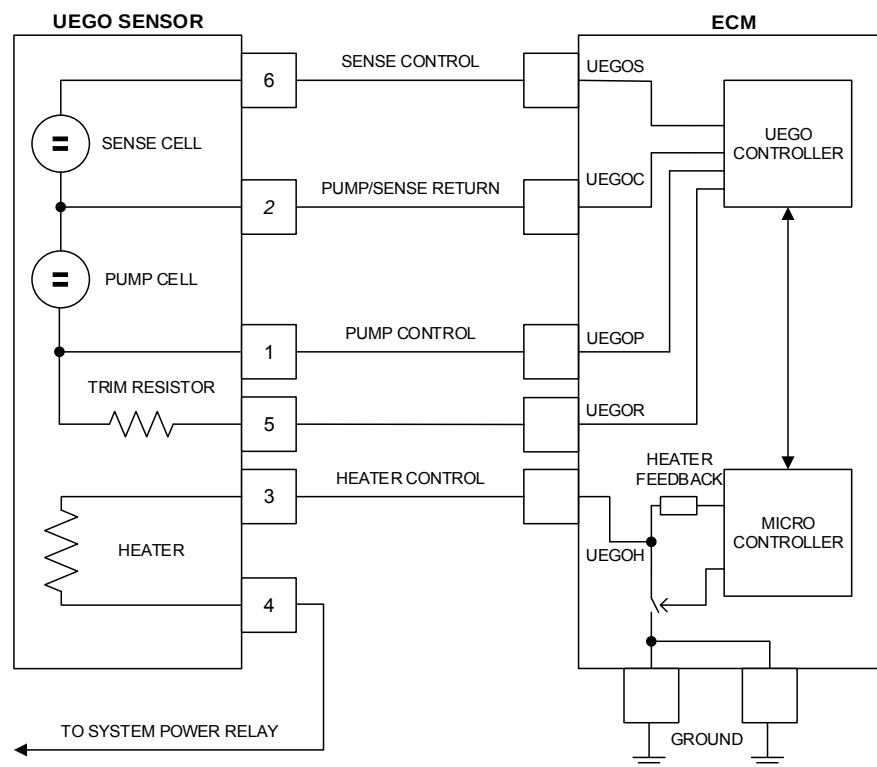
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Possible Causes:

This fault will set when the UEGO pump control signal is continuously equal to battery voltage (short to Vbattery.) This may be caused by a faulty UEGO sensor or a short in the harness to Vbattery. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

DTC 3018 - UEGO1 PUMP VOLTAGE SHORTED HIGH (TROUBLE TREE)

DTC 3019 - UEGO1 PUMP VOLTAGE SHORTED LOW

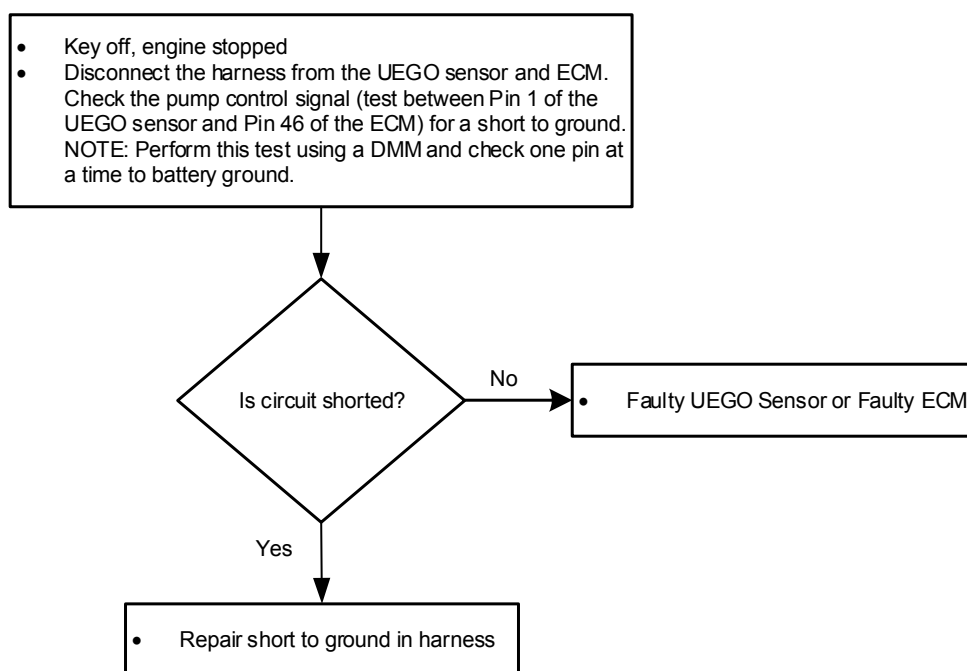
DTC	3019	SPN	3218	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a pump control signal between the pump cell and the ECM. The ECM monitors the pump control signal for a short to Vbattery. The UEGO pump circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor pump control signal is equal to ground voltage (short to ground.)					

Possible Causes:

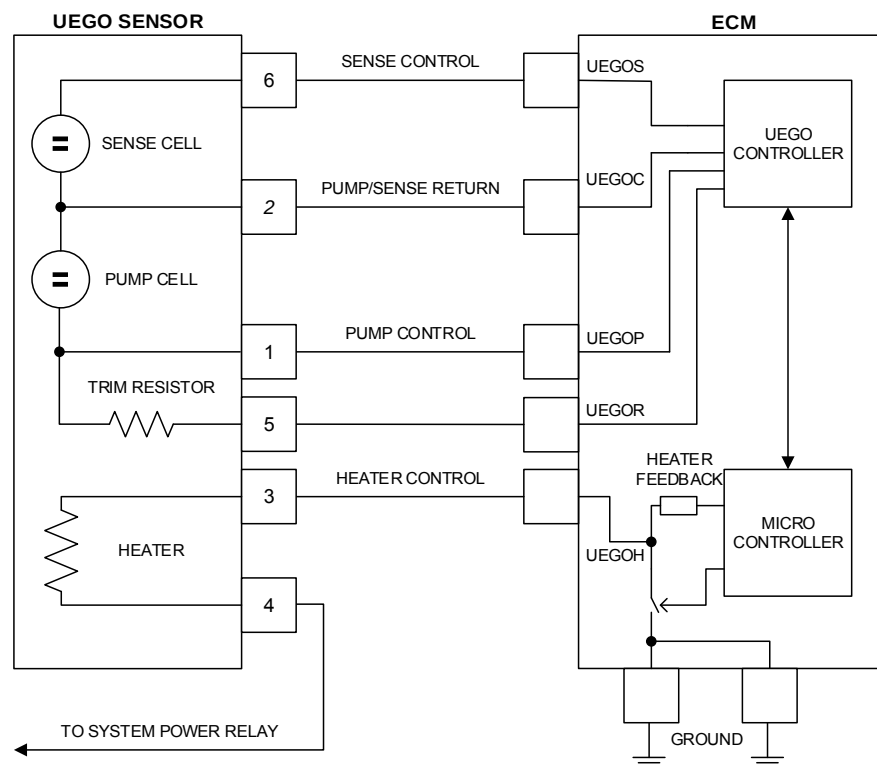
This fault will set when the UEGO pump control signal is continuously equal to ground voltage (short to ground.) This may be caused by a faulty UEGO sensor or a short in the harness to ground. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3019 - UEGO1 PUMP VOLTAGE SHORTED LOW (TROUBLE TREE)

DTC 3020 - UEGO1 SENSE CELL VOLTAGE HIGH



DTC	3020	SPN	3217	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a sense control signal between the sense cell and the ECM. The ECM monitors the sense control signal for a short to Vbattery. The UEGO sense circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor sense control signal is equal to battery or supply voltage (short to Vbattery.)					

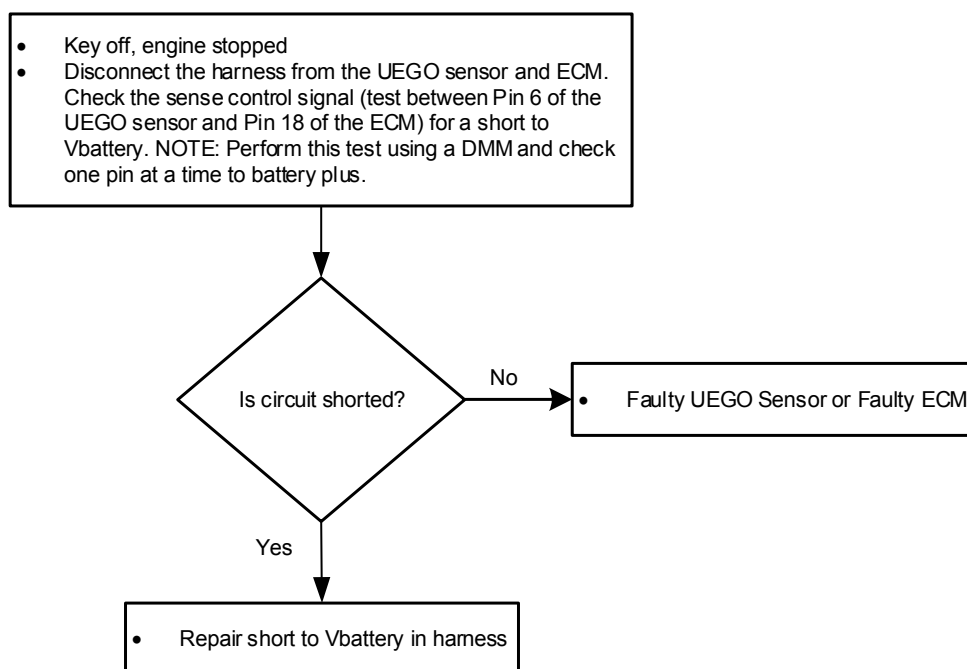
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Possible Causes:

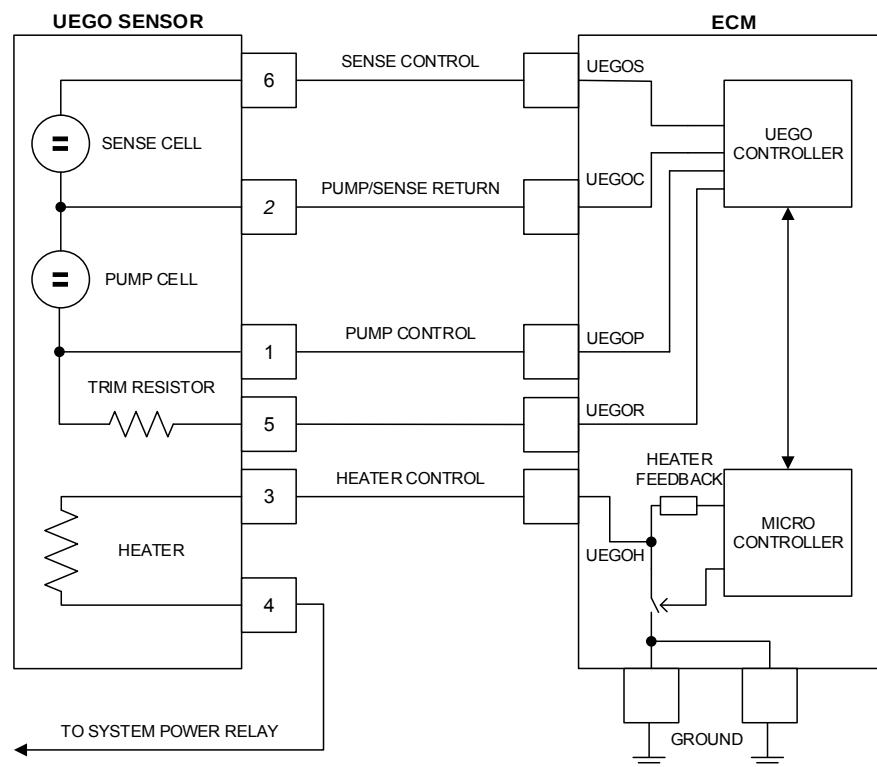
This fault will set when the UEGO sense control signal is continuously equal to battery voltage (short to Vbattery.) This may be caused by a faulty UEGO sensor or a short in the harness to Vbattery. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3020 - UEGO1 SENSE CELL VOLTAGE HIGH (TROUBLE TREE)

DTC 3021 - UEGO1 SENSE CELL VOLTAGE LOW



DTC	3021	SPN	3217	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a sense control signal between the sense cell and the ECM. The ECM monitors the sense control signal for a short to Vbattery. The UEGO sense circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor sense control signal is equal to ground voltage (short to ground.)					

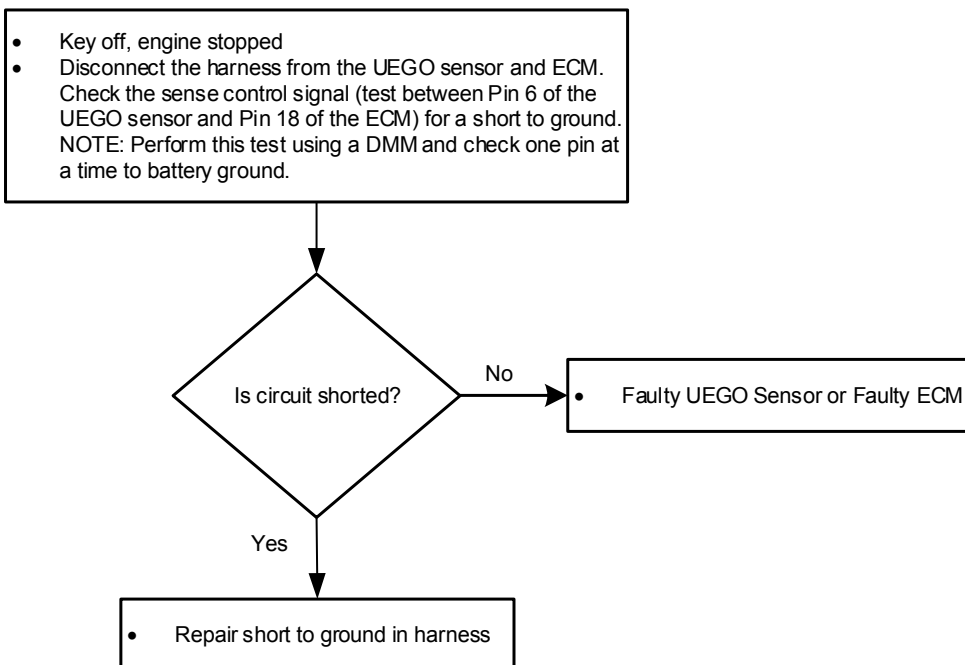
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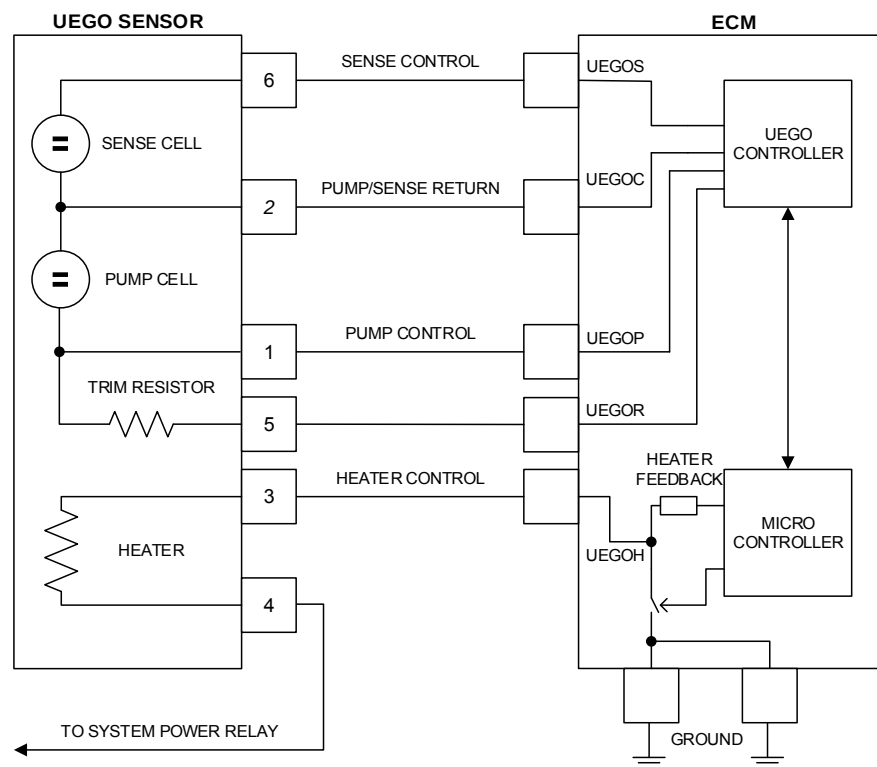
Possible Causes:

This fault will set when the UEGO sense control signal is continuously equal to ground voltage (short to ground.) This may be caused by a faulty UEGO sensor or a short in the harness to ground. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3021 - UEGO1 SENSE CELL VOLTAGE LOW (TROUBLE TREE)

DTC 3029 - UEGO1 DRIFT IS OUT-OF-TOLERANCE

DTC	3029	SPN	3221	FMI	15
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor output drifts over time as the sensor ages. Software within the ECM monitors and adjusts for the amount of drift. The software measures the sensor output during periods of fuel shutoff when only air is passing by the sensor. In this condition, the expected output of the sensor is known and can be compared to the actual output. The drift is calculated as the difference between the expected and measured outputs during these periods of fuel shutoff. The UEGO drift adjustment calculations must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor sense control signal is equal to battery or supply voltage (short to Vbattery.)					

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Possible Causes:

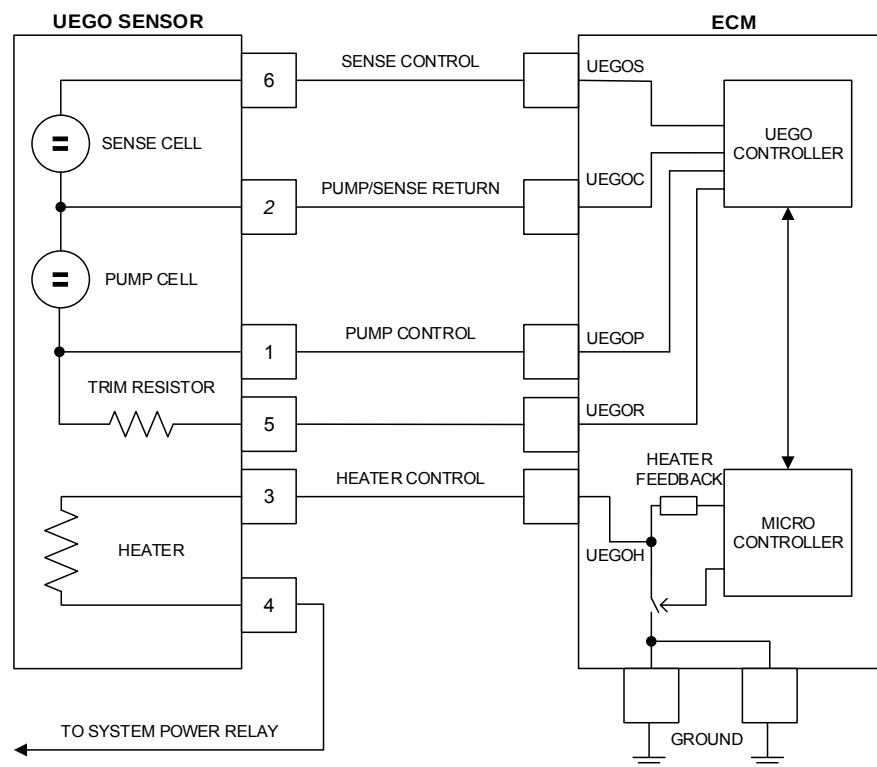
This fault will set when the UEGO drift adjustment (accumulator) exceeds the maximum positive or negative thresholds (pump current Ip) set in the diagnostic calibration. This fault is caused by a faulty UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids:

Due to the nature of this fault, and given the internal diagnostic checks that occur prior to setting this fault, the best diagnostic course of action is to replace the sensor and clear the code.

DTC 3031 - UEGO1 HEATER OPEN / GROUND SHORT

DTC	3031	SPN	3222	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistive element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to ground. If the control signal is not equal to Vbattery when the heater is turned off then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• Voltage feedback from the UEGO sensor heater is always equal to ground voltage.					

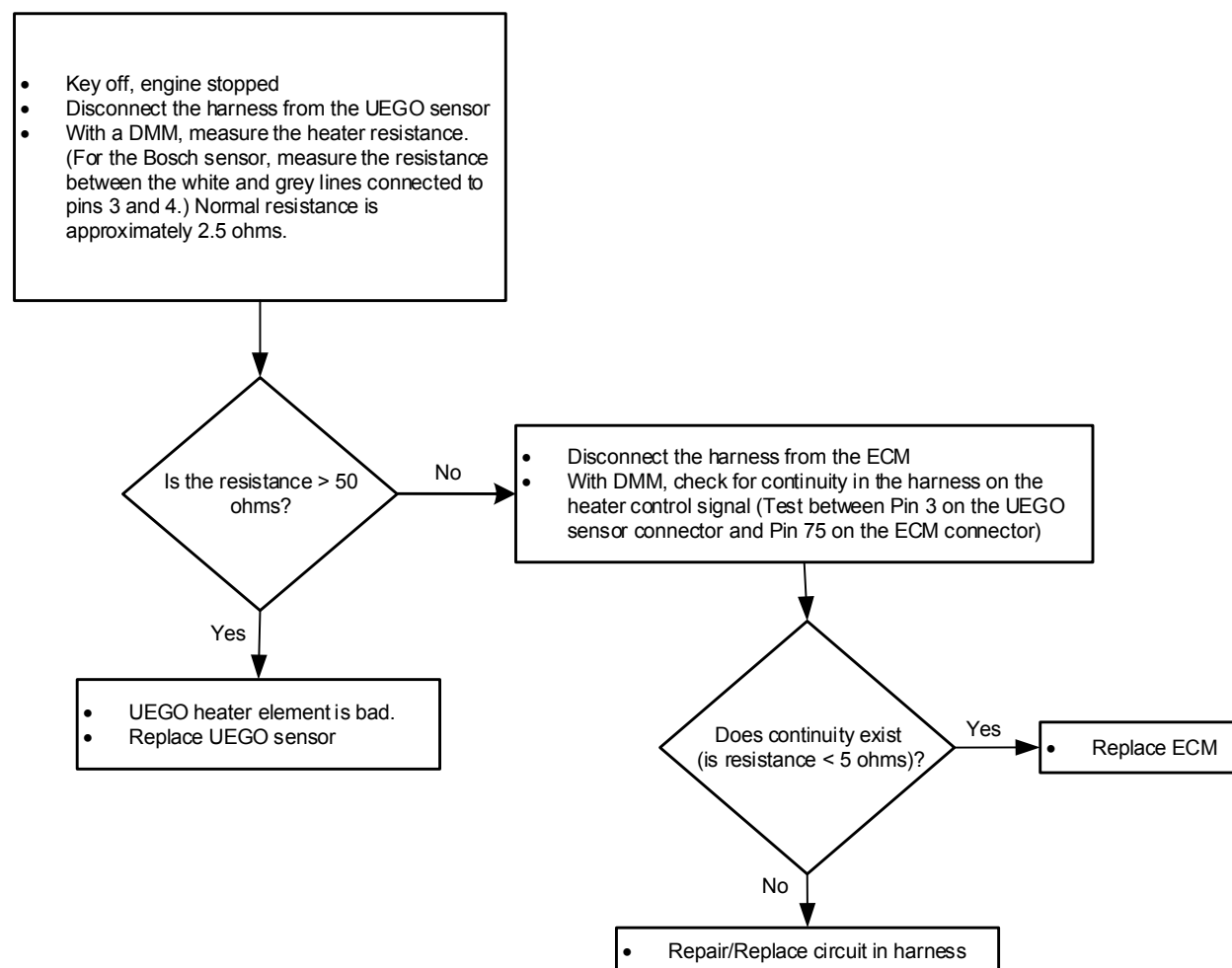
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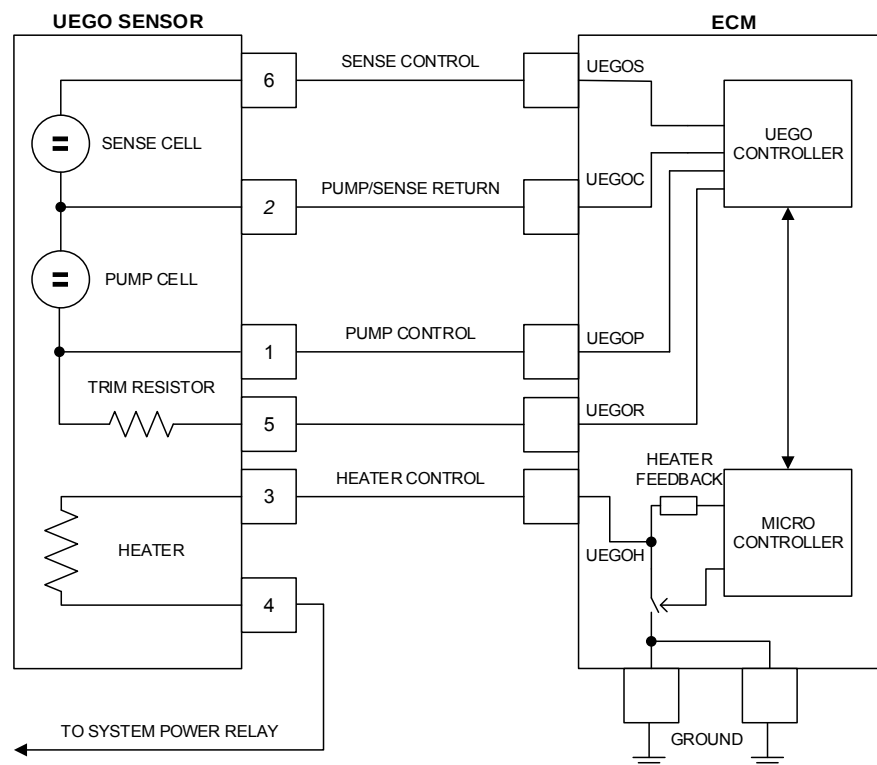
Possible Causes:

This fault will set when the UEGO heater control signal does not achieve Vbattery when the heater is switched off. This may be caused by a bad heater element in the UEGO sensor, a break in the wire harness on the heater supply or control circuits, or fault within the ECM.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3031 - UEGO1 HEATER OPEN / GROUND SHORT (TROUBLE TREE)

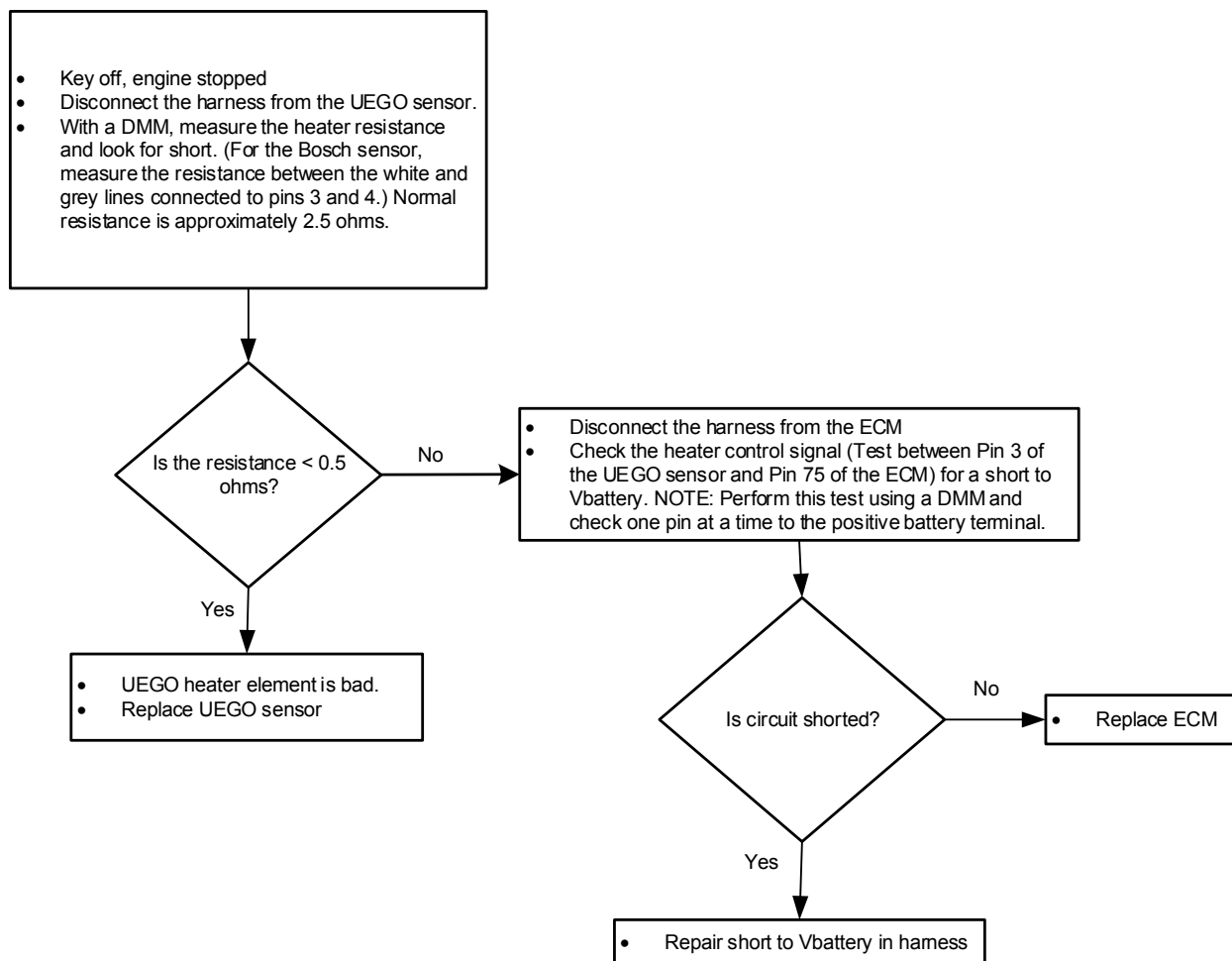
DTC 3032 - UEGO1 HEATER SHORT TO POWER

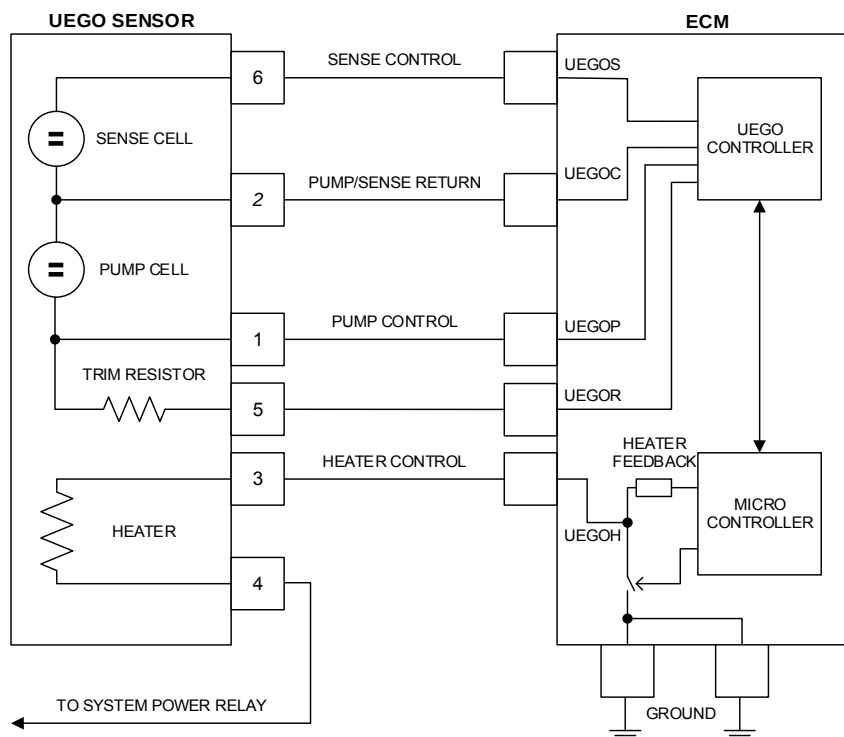
DTC	3032	SPN	3222	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistive element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to ground. If the control signal is not equal to Vbattery when the heater is turned off then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration): Voltage feedback from the UEGO sensor heater is always equal to the battery or supply voltage (short to Vbattery.)					
Possible Causes: This fault will set when the UEGO heater control signal does not achieve zero volts when the heater is switched on. This may be caused by an internal fault within the ECM.					

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Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3032 - UEGO1 HEATER SHORT TO POWER (TROUBLE TREE)

DTC 3033 - UEGO2 INTERNAL PROCESSOR FAULT

DTC	3033	SPN	3260	FMI	31
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. Internal to the ECM there is an application specific integrated circuit/controller that controls the sensor. The UEGO controller communicates internally within the ECM to the main microcontroller. The UEGO controller must always be functioning and communicating with the main microcontroller for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Break in communication has occurred between the UEGO controller and the main microcontroller (both devices inside the ECM). The UEGO controller is no longer responsive.					

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Possible Causes:

This fault may set if the power supplied to the ECM (alternator or battery power) is excessively noisy and exhibits low voltage dips or dropouts. It may also indicate an internal failure within the ECM. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

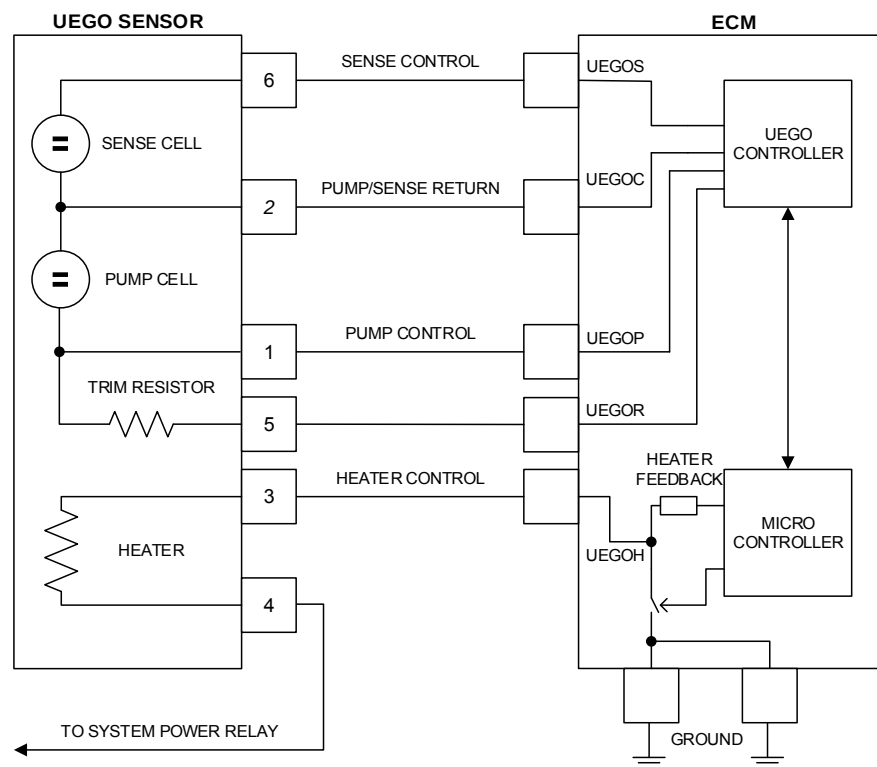
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids:

- ☐ Verify that the alternator is working properly and there is not excessive noise on the alternator output or battery power from other loads. This fault may occur if power repeatedly dips but does not completely drop to zero.
- ☐ Verify the ECM ground is sufficient (clean and tight to the engine block)
- ☐ Swap ECM with a known good part, run engine for 10 minutes, and then retest.

DTC 3034 - UEGO2 DRIFT IS OUT-OF-TOLERANCE



DTC	3034	SPN	3260	FMI	15
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor output drifts over time as the sensor ages. Software within the ECM monitors and adjusts for the amount of drift. The software measures the sensor output during periods of fuel shutoff when only air is passing by the sensor. In this condition, the expected output of the sensor is known and can be compared to the actual output. The drift is calculated as the difference between the expected and measured outputs during these periods of fuel shutoff. The UEGO drift adjustment calculations must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor sense control signal is equal to battery or supply voltage (short to Vbattery.)					

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Possible Causes:

This fault will set when the UEGO drift adjustment (accumulator) exceeds the maximum positive or negative thresholds (pump current I_p) set in the diagnostic calibration. This fault is caused by a faulty UEGO sensor. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

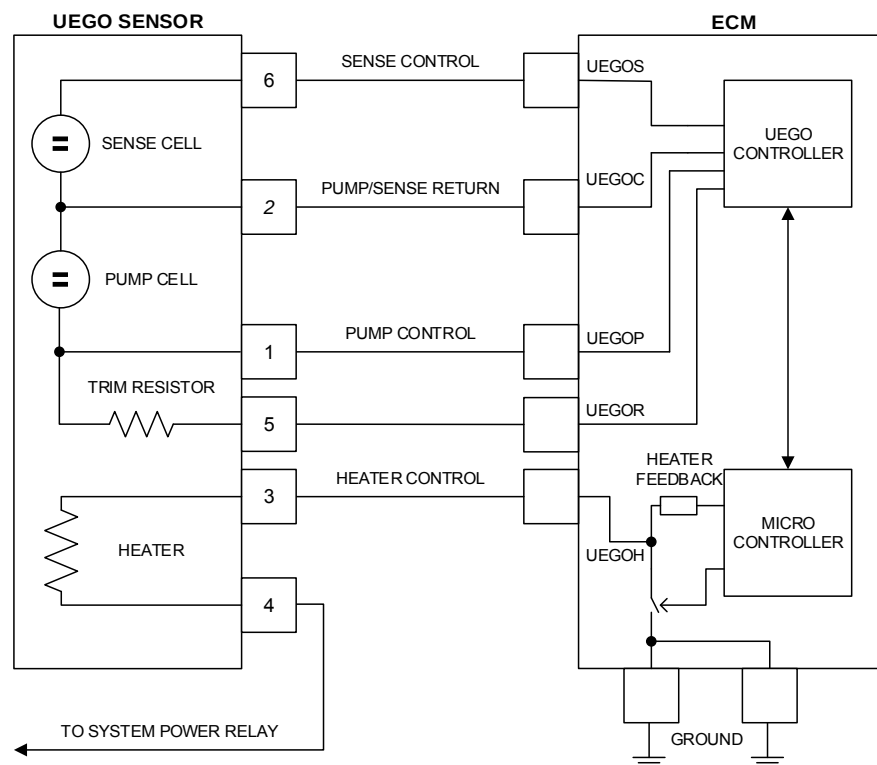
Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

Diagnostic Aids:

Due to the nature of this fault, and given the internal diagnostic checks that occur prior to setting this fault, the best diagnostic course of action is to replace the sensor and clear the code.

DTC 3036 - UEGO2 HEATER SUPPLY HIGH VOLTAGE



DTC	3036	SPN	3261	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistor element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to Vbattery. If the control signal does not reach zero volts when the heater is turned on then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• UEGO1 heater supply voltage >				TBD*	volts

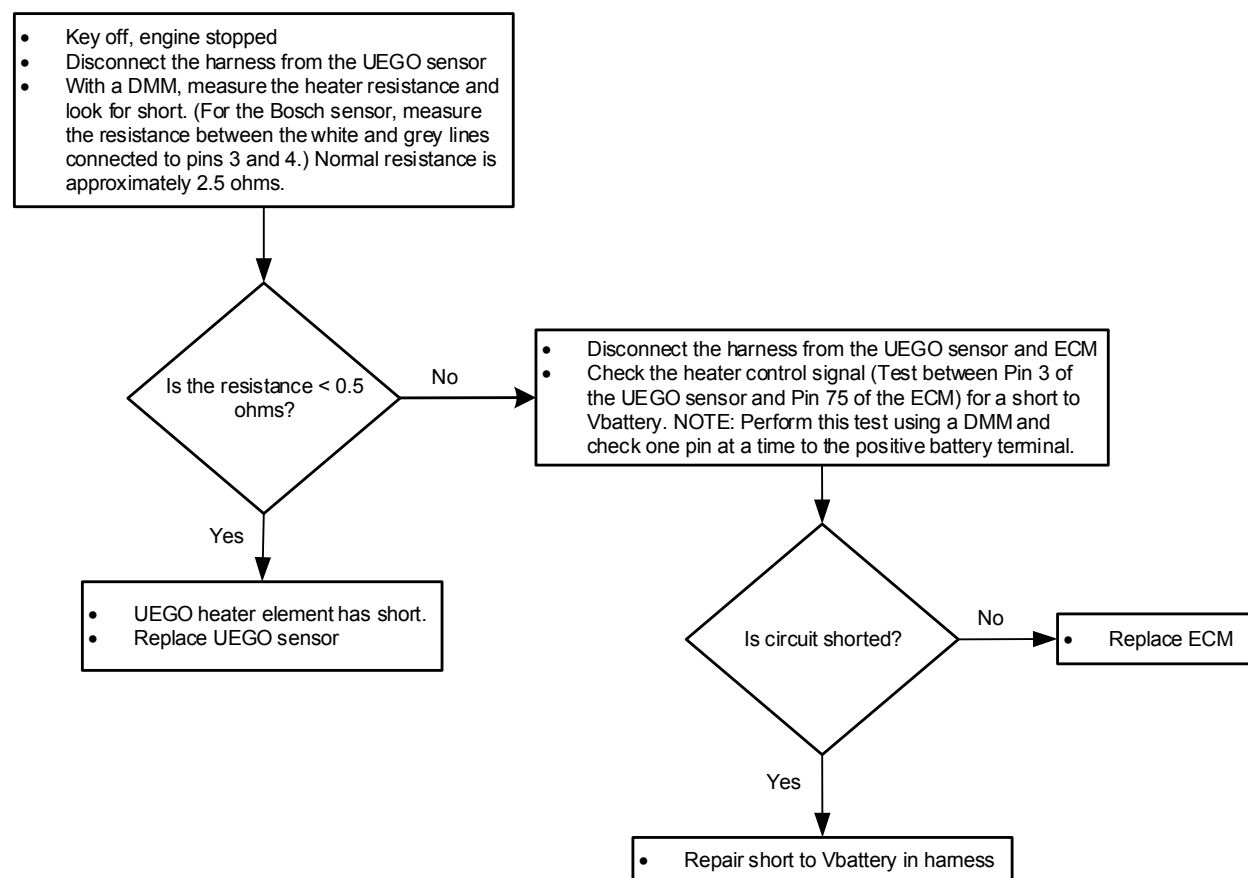
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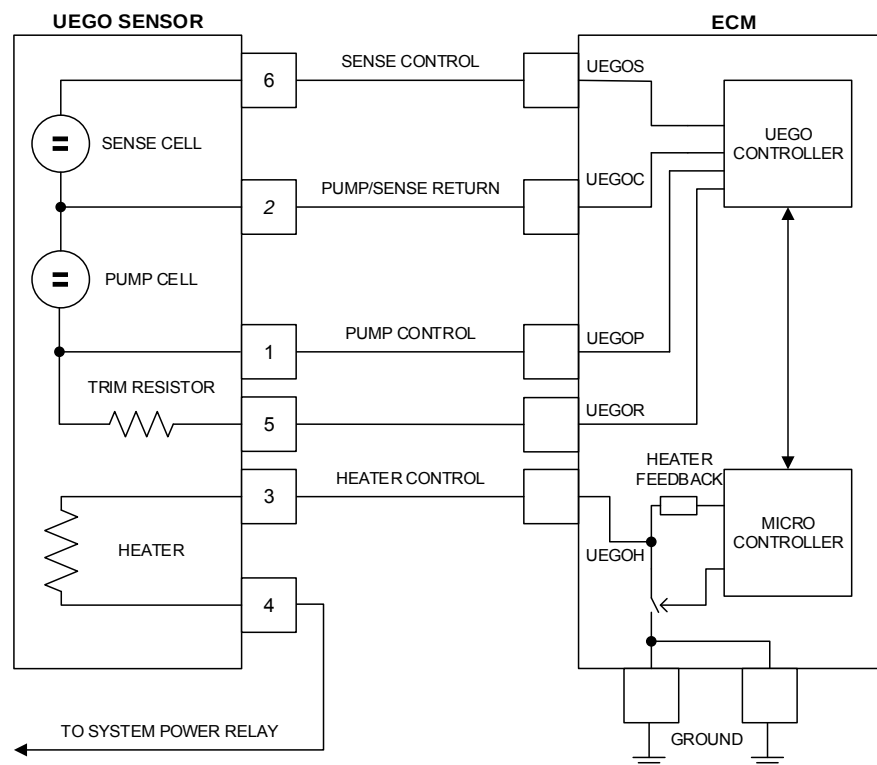
Possible Causes:

This fault will set when the UEGO heater control signal does not achieve zero volts when the heater is switched on. This may be caused by an internal fault within the ECM. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3036 – UEGO2 HEATER SUPPLY HIGH VOLTAGE (TROUBLE TREE)

DTC 3037 - UEGO2 HEATER SUPPLY LOW VOLTAGE

DTC	3037	SPN	3261	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistor element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to Vbattery. If the control signal does not reach zero volts when the heater is turned on then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• UEGO1 heater supply voltage <				TBD*	volts

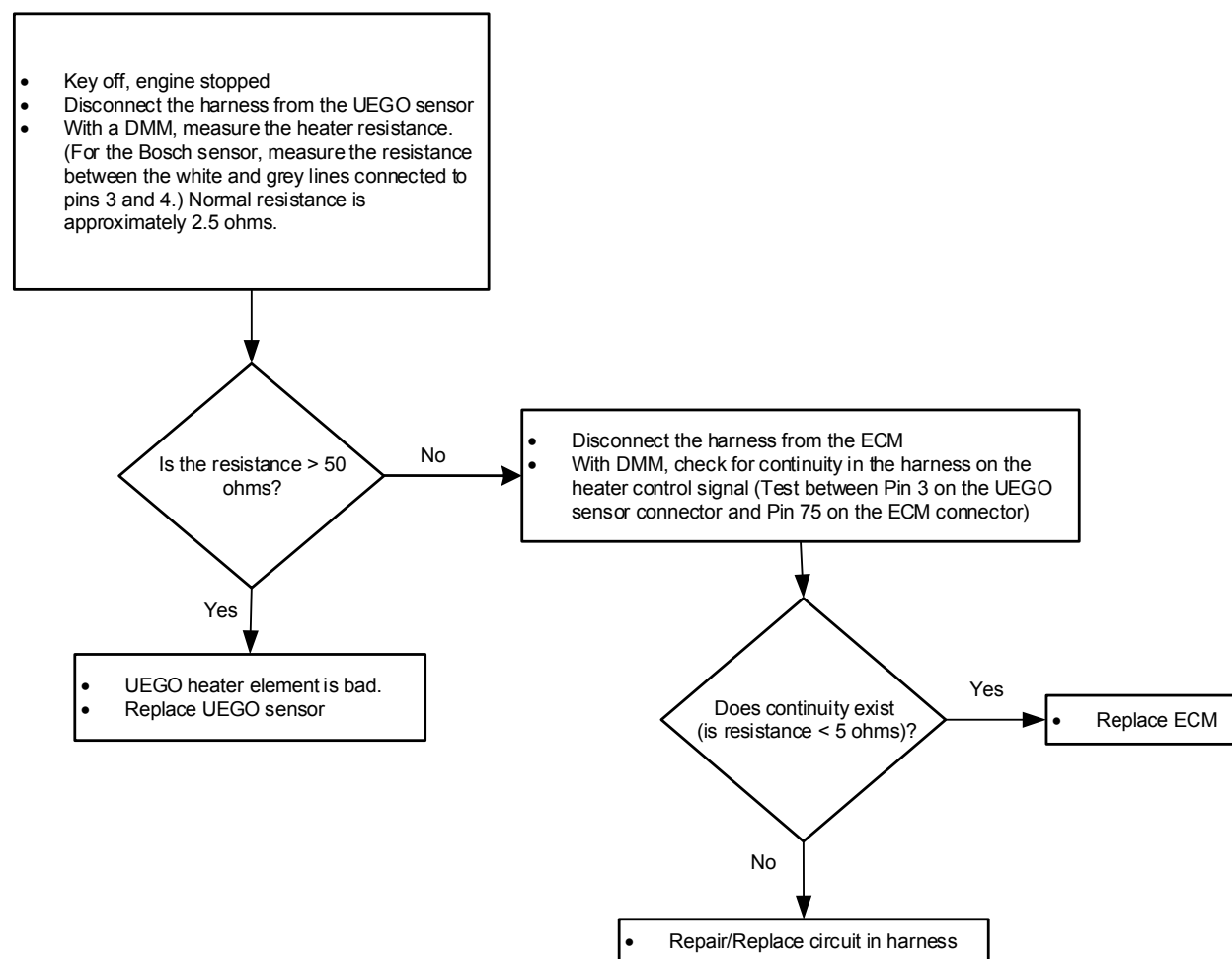
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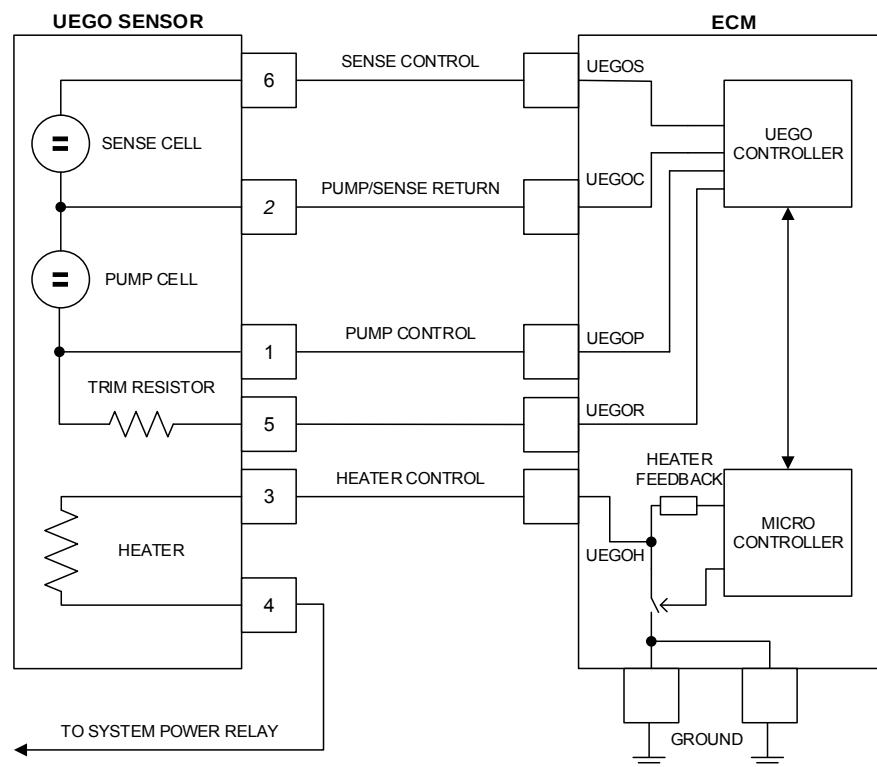
Possible Causes:

This fault will set when the UEGO heater control signal does not achieve Vbattery when the heater is switched off. This may be caused by a bad heater element in the UEGO sensor, a break in the wire harness on the heater supply or control circuits, or fault within the ECM. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3037 – UEGO2 HEATER SUPPLY LOW VOLTAGE (TROUBLE TREE)

DTC 3042 - UEGO2 PUMP VOLTAGE SHORTED HIGH

DTC	3042	SPN	3257	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a pump control signal between the pump cell and the ECM. The ECM monitors the pump control signal for a short to Vbattery. The UEGO pump circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor pump control signal is equal to battery or supply voltage (short to Vbattery.)					

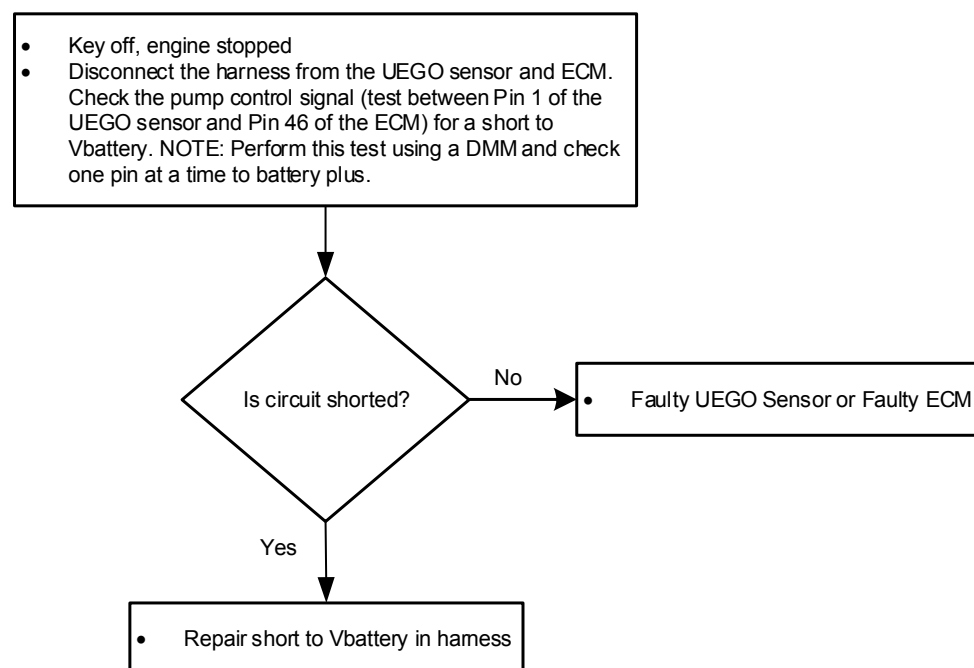
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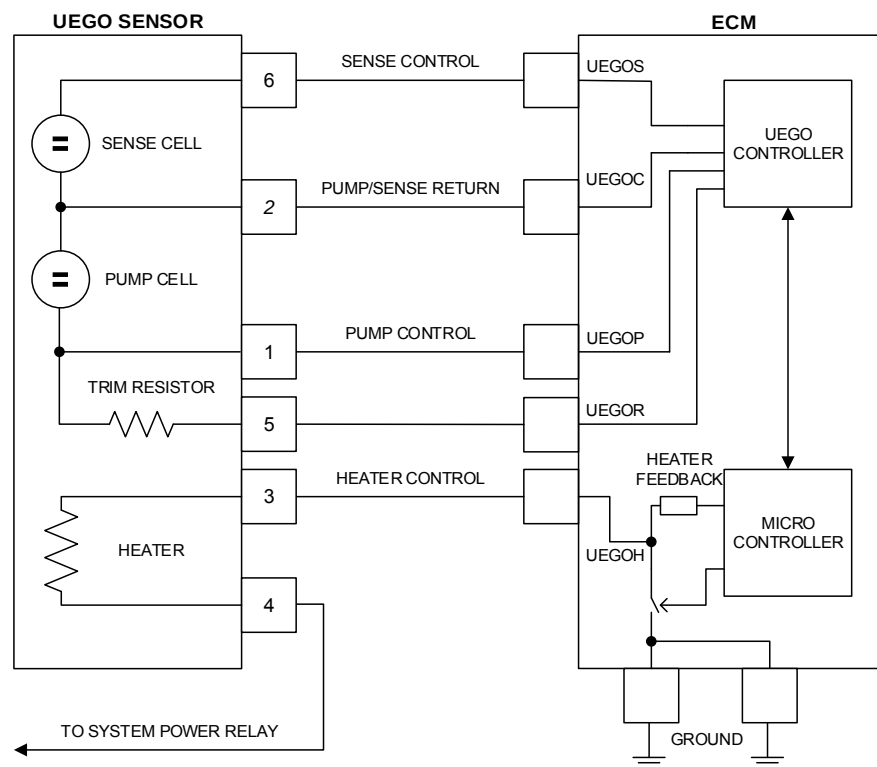
Possible Causes:

This fault will set when the UEGO pump control signal is continuously equal to battery voltage (short to Vbattery.) This may be caused by a faulty UEGO sensor or a short in the harness to Vbattery. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3042 – UEGO2 PUMP VOLTAGE SHORTED HIGH (TROUBLE TREE)

DTC 3043 - UEGO2 PUMP VOLTAGE SHORTED LOW

DTC	3043	SPN	3257	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a pump control signal between the pump cell and the ECM. The ECM monitors the pump control signal for a short to Vbattery. The UEGO pump circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor pump control signal is equal to ground voltage (short to ground.)					

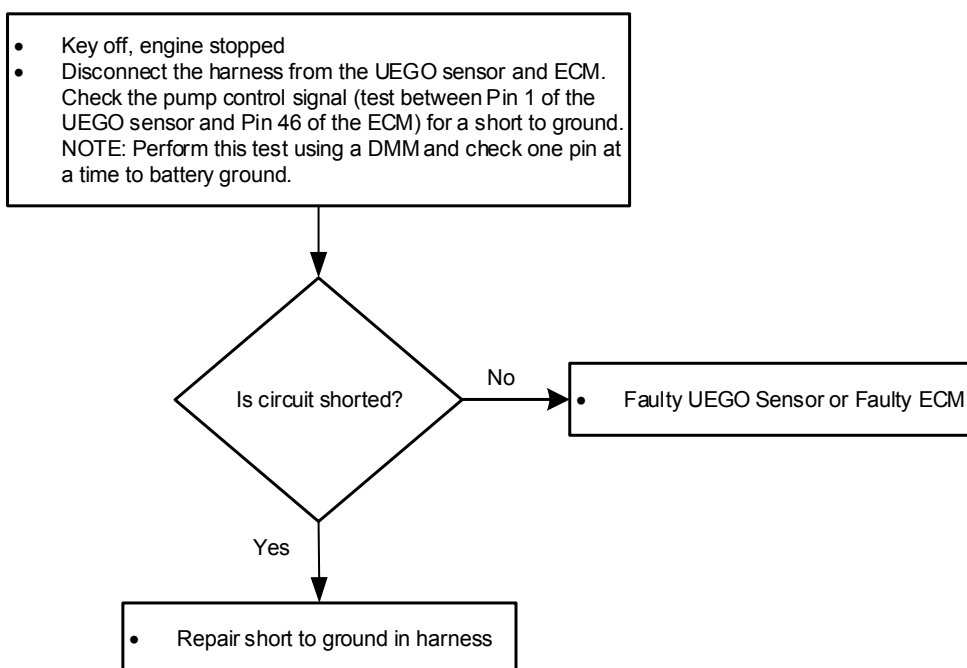
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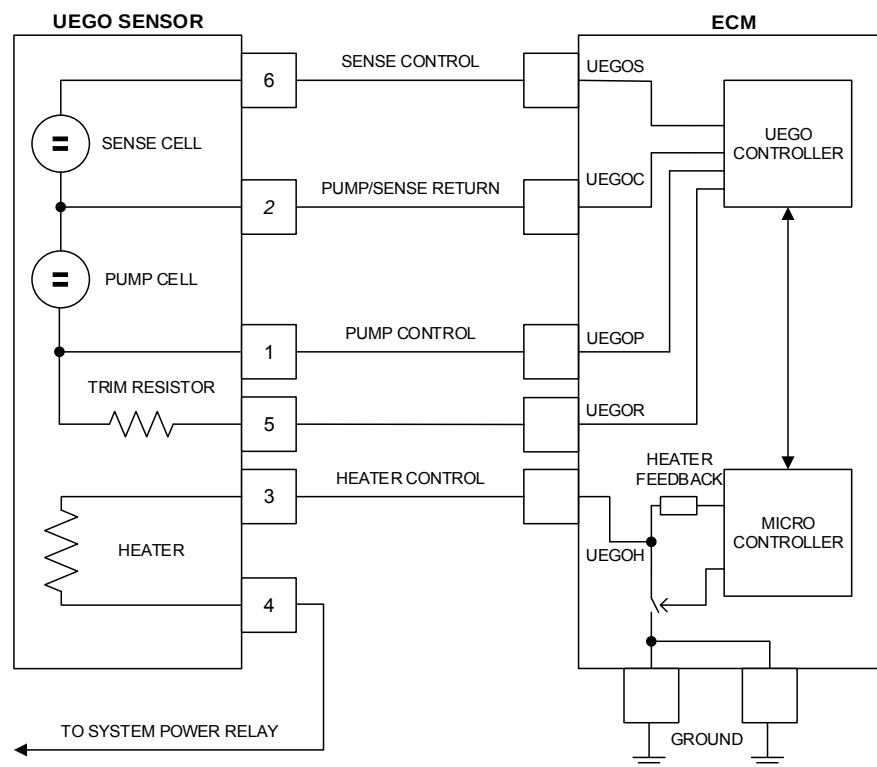
Possible Causes:

This fault will set when the UEGO pump control signal is continuously equal to ground voltage (short to ground.) This may be caused by a faulty UEGO sensor or a short in the harness to ground. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3043 – UEGO2 PUMP VOLTAGE SHORTED LOW (TROUBLE TREE)

DTC 3044 - UEGO2 SENSE CELL VOLTAGE HIGH

DTC	3044	SPN	3256	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a sense control signal between the sense cell and the ECM. The ECM monitors the sense control signal for a short to Vbattery. The UEGO sense circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor sense control signal is equal to battery or supply voltage (short to Vbattery.)					

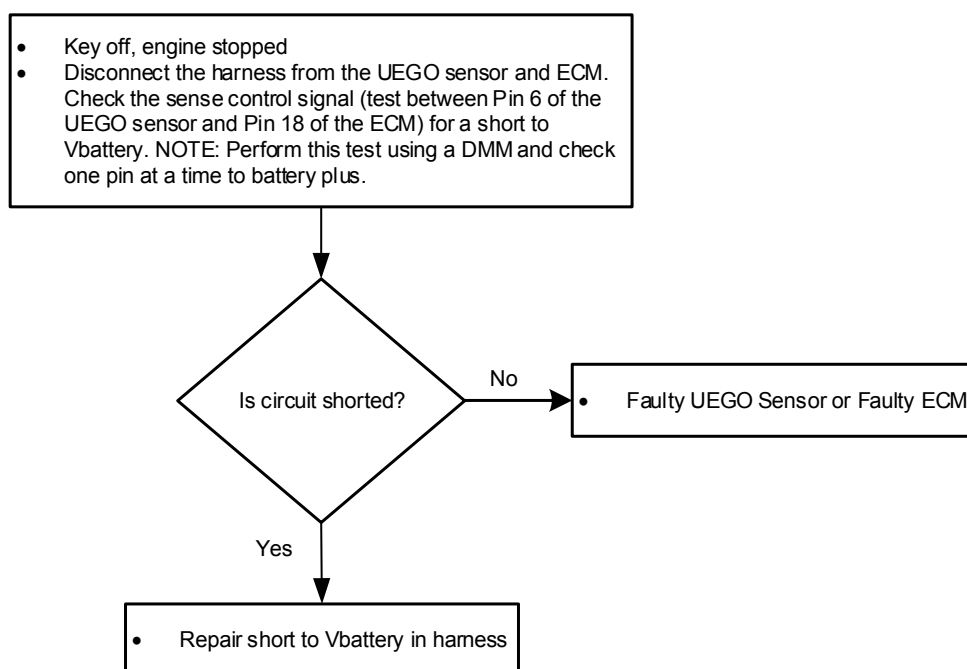
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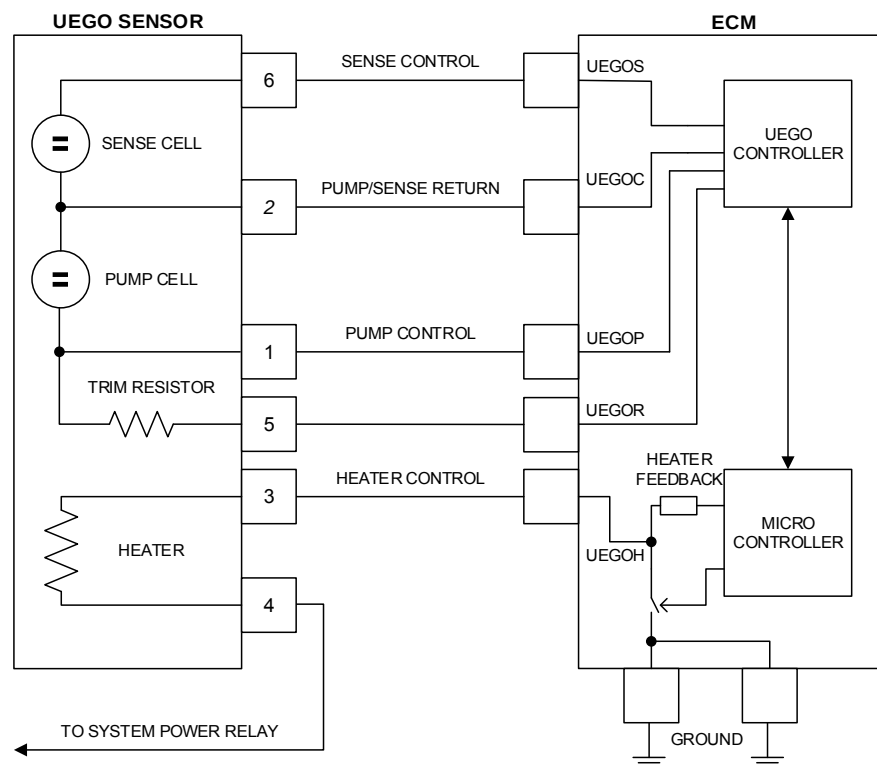
Possible Causes:

This fault will set when the UEGO sense control signal is continuously equal to battery voltage (short to Vbattery.) This may be caused by a faulty UEGO sensor or a short in the harness to Vbattery. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3044 – UEGO2 SENSE CELL VOLTAGE HIGH (TROUBLE TREE)

DTC 3045 - UEGO2 SENSE CELL VOLTAGE LOW

DTC	3045	SPN	3256	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor has a sense control signal between the sense cell and the ECM. The ECM monitors the sense control signal for a short to Vbattery. The UEGO sense circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor sense control signal is equal to ground voltage (short to ground.)					

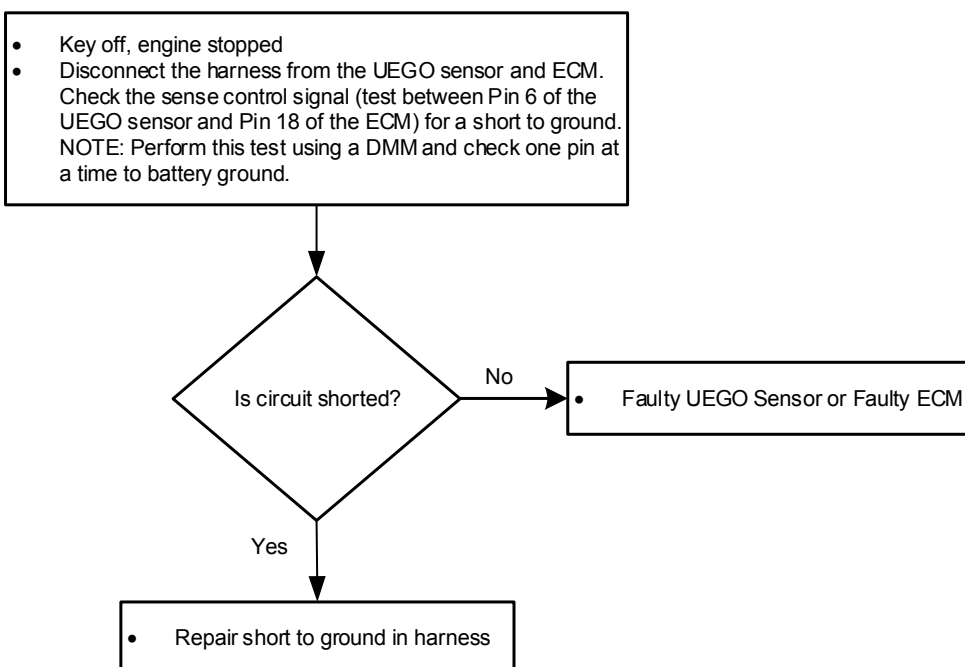
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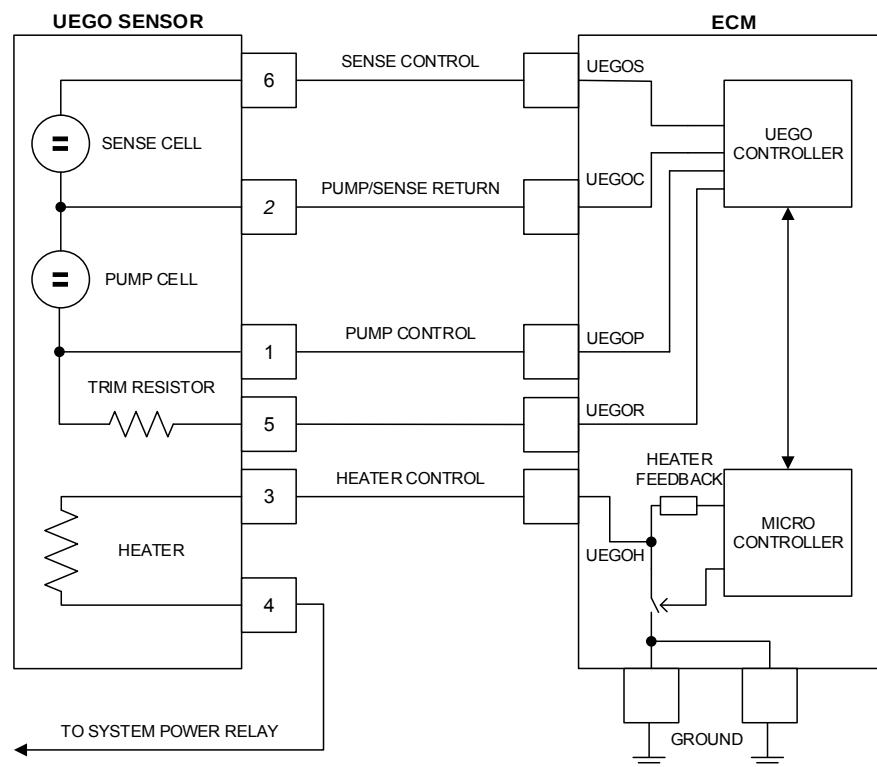
Possible Causes:

This fault will set when the UEGO sense control signal is continuously equal to ground voltage (short to ground.) This may be caused by a faulty UEGO sensor or a short in the harness to ground. This fault should be configured to disable adaptive learn for the remainder of the key-cycle to avoid improperly learning the adaptive learn table and may be configured to disable closed loop.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3045 – UEGO2 SENSE CELL VOLTAGE LOW (TROUBLE TREE)

DTC 3053 - UEGO2 HEATER OPEN / GROUND SHORT

DTC	3053	SPN	3261	FMI	4
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistive element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to ground. If the control signal is not equal to Vbattery when the heater is turned off then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
• Voltage feedback from the UEGO sensor heater is always equal to ground voltage.					

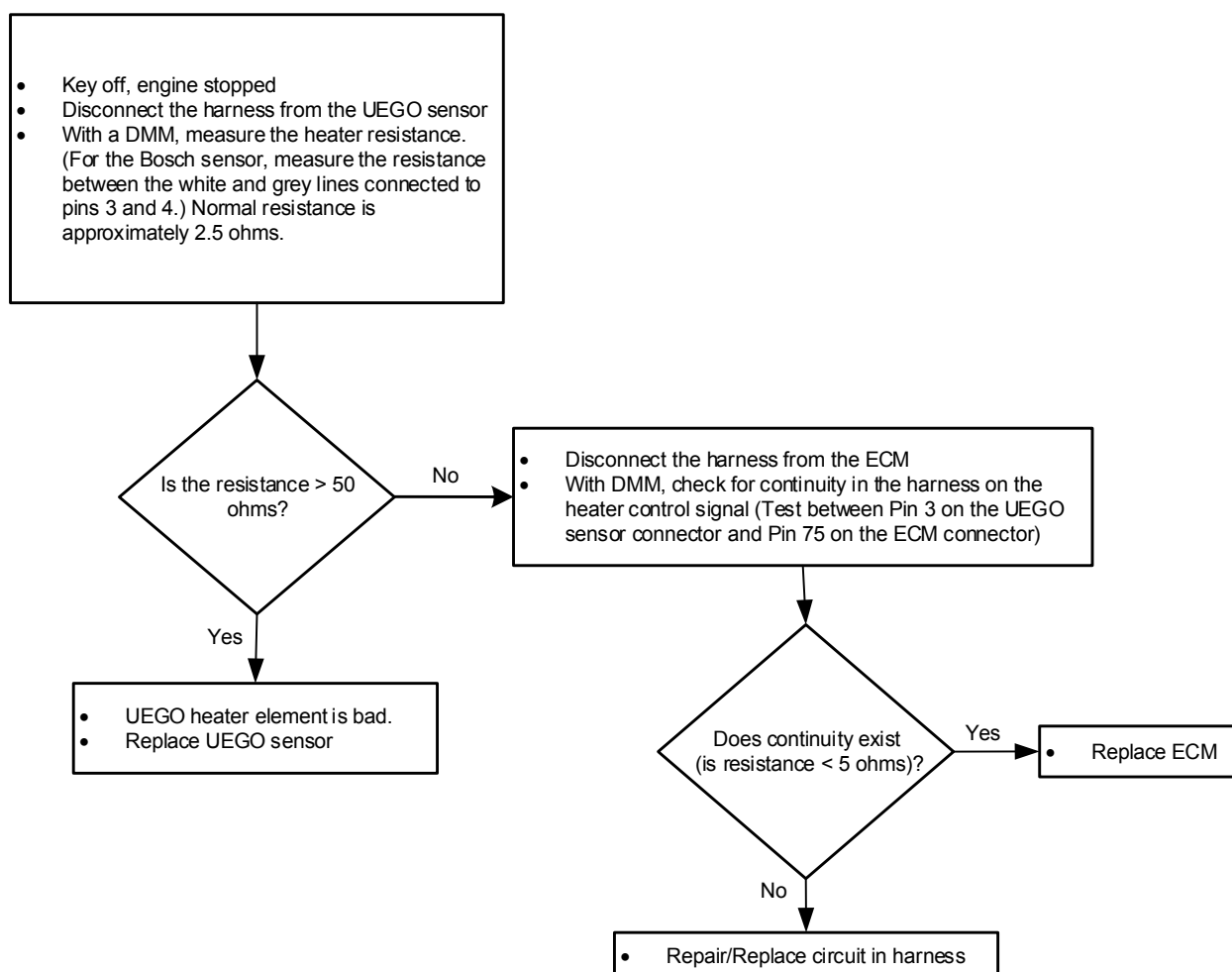
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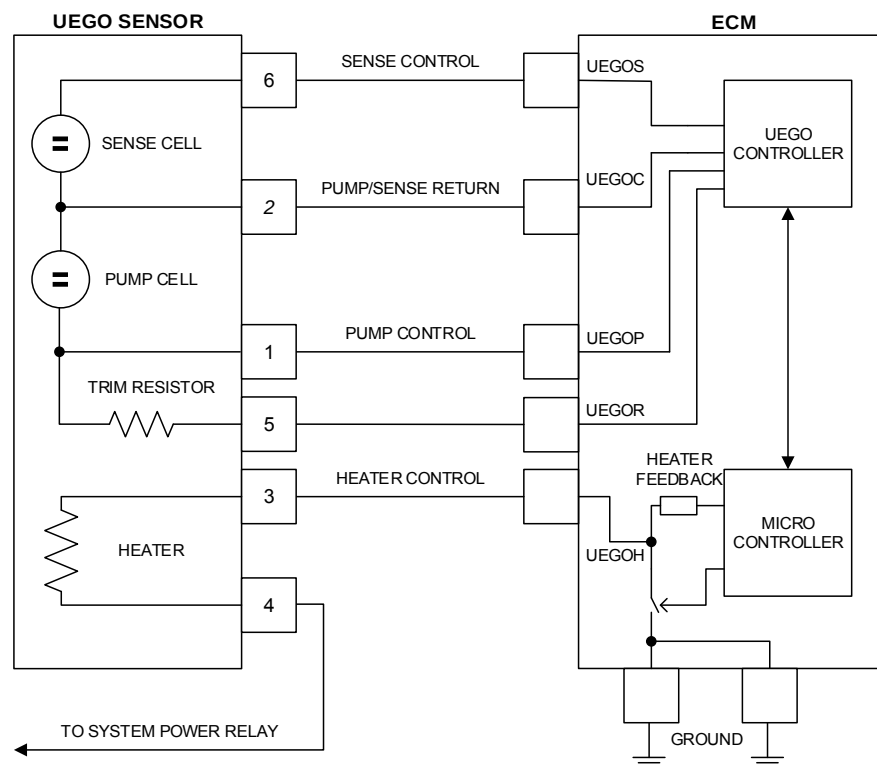
Possible Causes:

This fault will set when the UEGO heater control signal does not achieve Vbattery when the heater is switched off. This may be caused by a bad heater element in the UEGO sensor, a break in the wire harness on the heater supply or control circuits, or fault within the ECM.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3053 – UEGO2 HEATER OPEN / GROUND SHORT (TROUBLE TREE)

DTC 3054 - UEGO2 HEATER SHORT TO POWER

DTC	3054	SPN	3261	FMI	3
Sensor/Circuit: Universal Exhaust Gas Oxygen Sensor (Bank 2-Sensor 1/Bank 1-After Catalyst)					
Description: A UEGO sensor measures the exhaust content across a wide-range of air-fuel ratios with a linear output proportional to lambda/equivalence ratio/air-fuel ratio. The sensor is heated with an internal resistive element that is supplied by the battery voltage and switched on/off by the ECM. The ECM will pull the heater control signal to ground when turning on the heater. The ECM monitors the heater control signal for a short to ground. If the control signal is not equal to Vbattery when the heater is turned off then the circuit is not functioning properly. The UEGO heater circuit must always be functioning for proper emissions control.					
Fault Enabled in Calibration?		TBD* (*Application-Specific – see calibration)			
Emissions-related Fault?		YES			
Check Condition:		Engine Running			
Fault Set Conditions (as defined in calibration):					
Voltage feedback from the UEGO sensor heater is always equal to the battery or supply voltage (short to Vbattery.)					

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Possible Causes:

This fault will set when the UEGO heater control signal does not achieve zero volts when the heater is switched on. This may be caused by an internal fault within the ECM.

Corrective Actions (see section 4.1 for descriptions of individual corrective actions):

Shutdown	TBD*	CL Disable key cyc.	TBD*	Power Derate 2	TBD*	Hard Warning	TBD*
Never Forget	TBD*	AL Disable	TBD*	Low Rev Limit	TBD*	MIL Persist Disable	TBD*
Turn on MIL	TBD*	AL Disable key cyc.	TBD*	Force Idle	TBD*	Stopped Check	TBD*
CL Disable	TBD*	Power Derate 1	TBD*	Soft Warning	TBD*	NOx Control System	TBD*

DTC 3054 – UEGO2 HEATER SHORT TO POWER (TROUBLE TREE)