

DM

DIAGNOSIS MANUAL ECM SYSTEM

WG3800-E5C

Kubota

Record of Revisions

For pdf, use search function {Search word} to find all the revised locations.

Last digit of the Code No.	Month of Revision	Main Revised Point and Corrective Measures {Search word}	Reference Page
1	2020.04	Delete WG3800-N-E5C model	—

I INFORMATION

INFORMATION

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1. SAFETY FIRST	I-1
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1. SAFETY FIRST

SAFETY FIRST

- This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.
- It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

DANGER

- Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

- Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

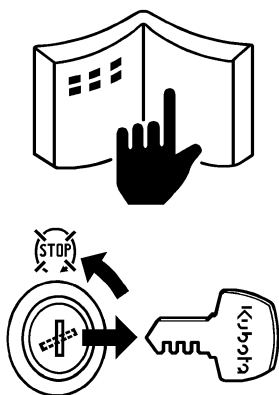
- Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

■ IMPORTANT

- Indicates that equipment or property damage could result if instructions are not followed.

■ NOTE

- Gives helpful information.



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BEFORE SERVICING AND REPAIRING

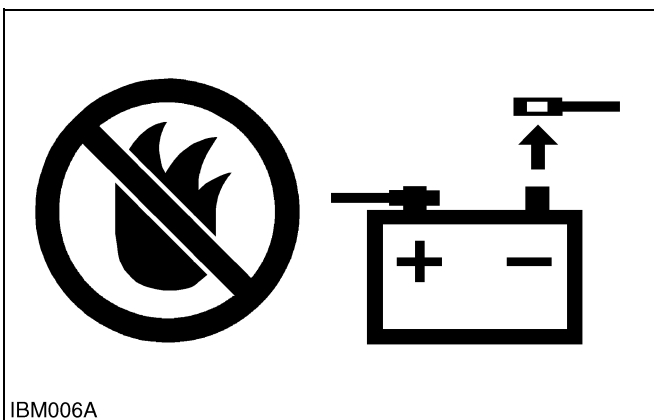
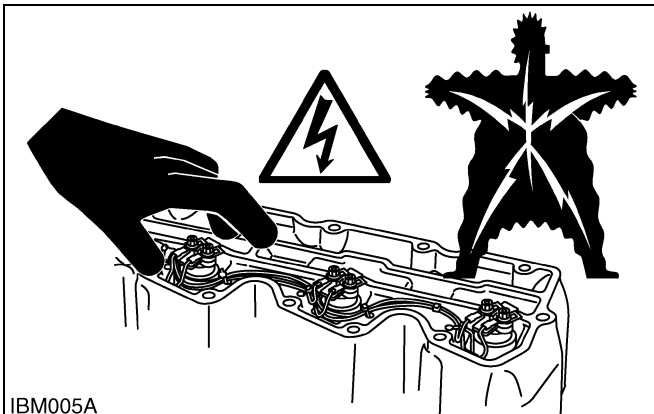
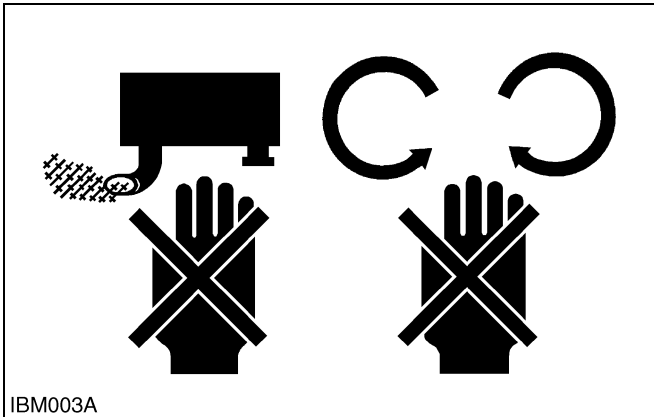
- Read all instructions and safety instructions in this manual and on your machine safety decals.
- Clean the work area and machine.
- Park the machine on a firm and level ground.
- Allow the engine to cool before proceeding.
- Stop the engine, and remove the key.
- Disconnect the battery negative cable.
- Hang a "DO NOT OPERATE" tag in operator station.

SAFETY STARTING

- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.



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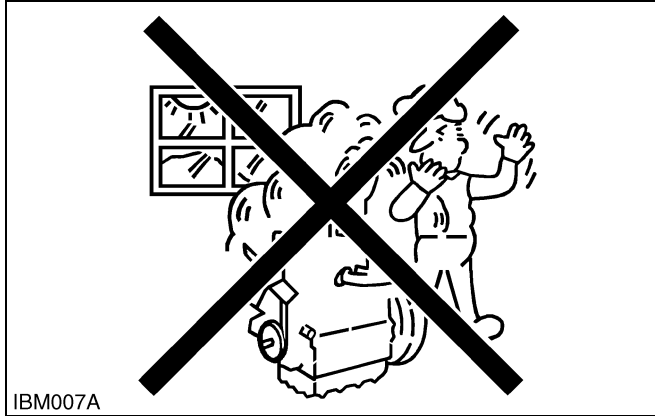


SAFETY WORKING

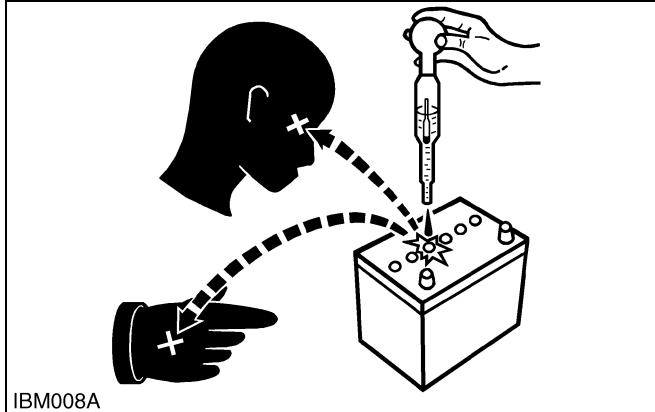
- Do not work on the machine while under the influence of alcohol, medication, or other substances or while fatigued.
- Wear close fitting clothing and safety equipment appropriate to the job.
- Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Do not touch the rotating or hot parts while the engine is running.
- Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
- Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.
- Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.
- Do not open high-pressure fuel system. High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt to repair fuel lines, sensors, or any other components between the high-pressure fuel pump and injectors on engines with high pressure common rail fuel system.
- High voltage exceeding 100 V is generated in the ECM and injector. Pay sufficient caution to electric shock when performing work activities.

AVOID FIRES

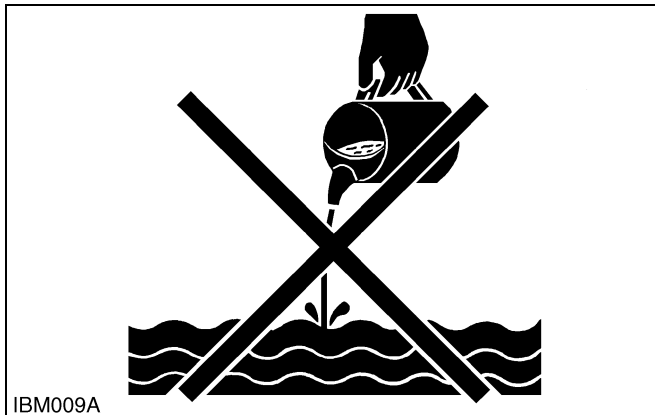
- Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- Make sure that no fuel has been spilled on the engine.

**VENTILATE WORK AREA**

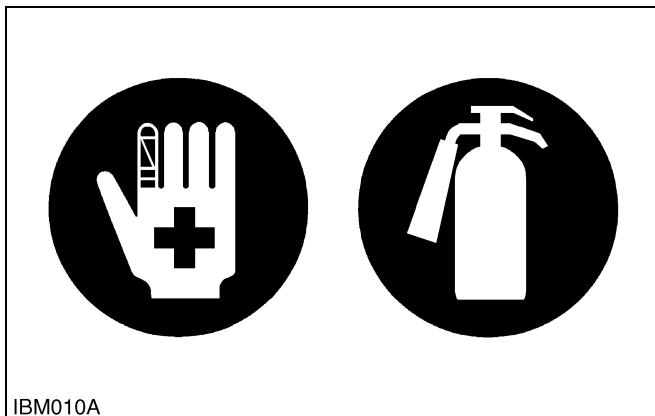
- If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

**PREVENT ACID BURNS**

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.

**DISPOSE OF FLUIDS PROPERLY**

- Do not pour fluids into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, electrolyte and other harmful waste.

**PREPARE FOR EMERGENCIES**

- Keep a first aid kit and fire extinguisher handy at all times.
- Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone.

1 ECM SYSTEM

SERVICING

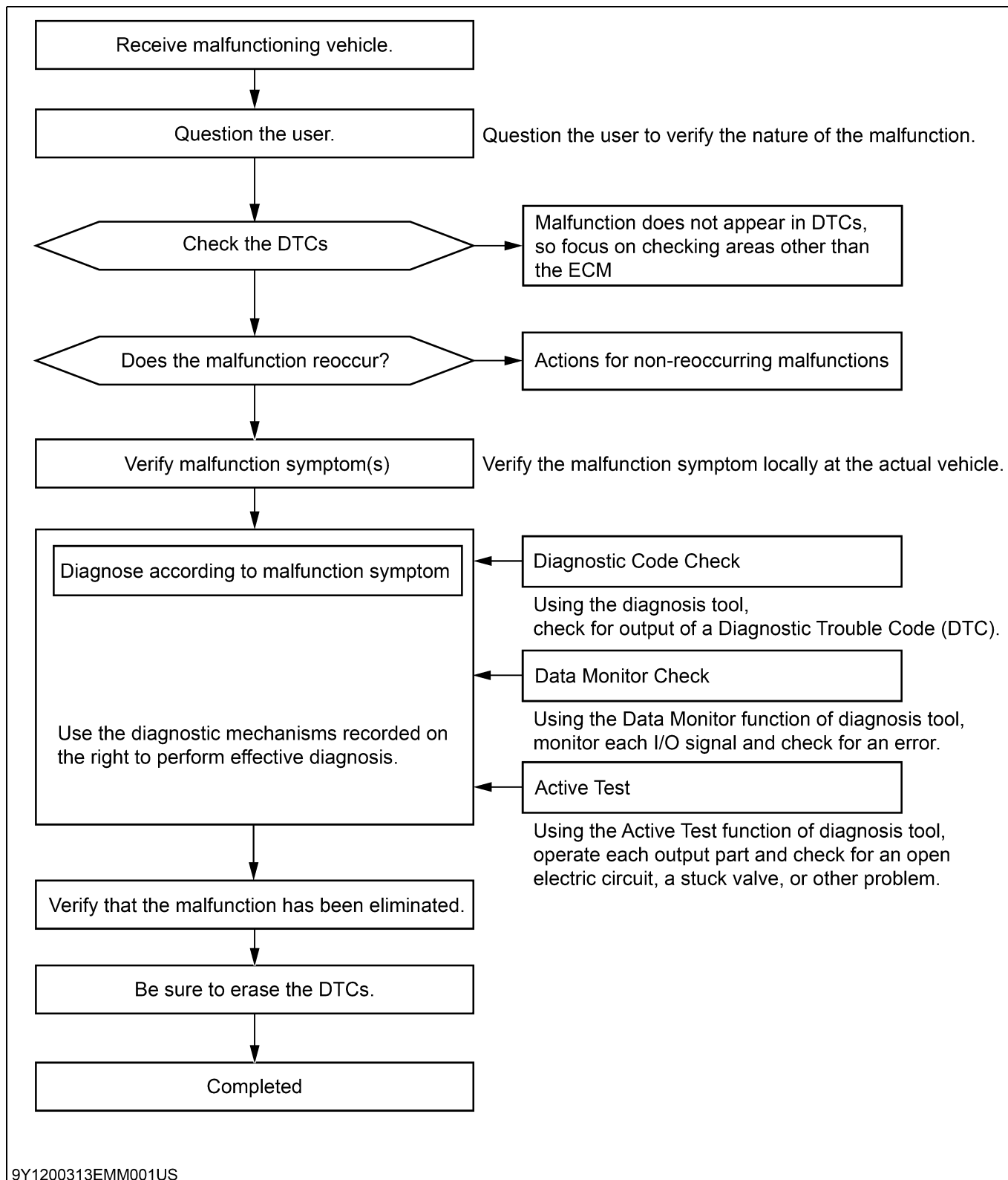
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1. OUTLINE

[1] OVERALL DIAGNOSTIC PROCEDURE



[2] QUESTIONING

- Use the trouble check sheet to ensure that the customer's explanation is fully understood.
- Accurately judge information concerning the malfunction.

Grasp the situation firmly, using five 5W1H (Who, What, When, Where, Why, How) as a basis.

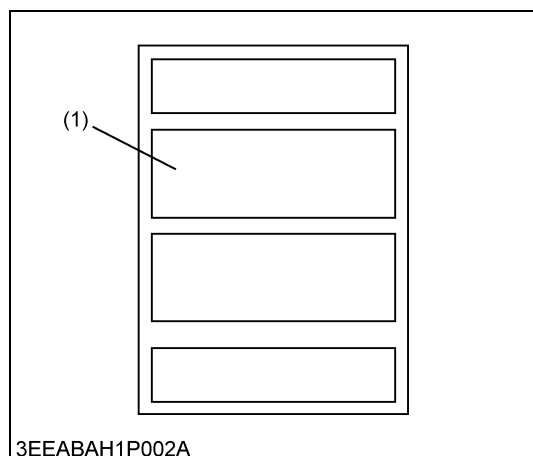
Ex: Low ambient temperature, starting, normal conditions, proximity to engine, metallic noise, etc.

(Reference)

Do not ask random questions. Ask questions that will aid in narrowing down the possible malfunctioning system while making educated guesses based on the malfunction symptoms.

Questioning Points

What?	Malfunction symptom
When?	Date, time, frequency of occurrence.
Where?	Field conditions
What were conditions like at the time of malfunction?	Driving conditions, operating conditions, weather.
What happened?	Type of malfunction.



Trouble Check Sheet for WG Engines

When the machine is received from the customer, it is necessary to verify the "malfunction symptoms" and the "generated malfunction data" with the customer. This is performed based on the trouble check sheet.

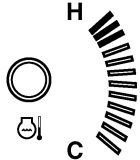
(1) Trouble Check Sheet

Because:

- The malfunction symptom may not be reproduced at the workshop.
- The customer's complaint does not always match the malfunction.
- If the person performing repairs is not working from the correct malfunction symptoms, man-hours will be wasted.

The question chart can aid the service person in diagnosing, repairing and verifying repair work.

Trouble Check Sheet for WG Engines				
Machine details				
Customer name				
Customer address				
Machine model		Machine serial number		
Engine serial number		Purchase date		
Repair date		Hourmeter indicator	hours	
Warranty				
Warranty Judgment	<input type="checkbox"/> Yes		<input type="checkbox"/> No	
Defective parts	<input type="checkbox"/> Injector		<input type="checkbox"/> Ignition Coil	
	<input type="checkbox"/> Fuel Filter			
	<input type="checkbox"/> Others ()			
Replace parts details				
Injector	Quantity	Units	Part number	
	Serial number	Cylinder 1 ()		Cylinder 2 ()
		Cylinder 3 ()		Cylinder 4 ()
	Defective injector	<input type="checkbox"/> Injector 1		<input type="checkbox"/> Injector 2
		<input type="checkbox"/> Injector 3		<input type="checkbox"/> Injector 4
Actual part replacement	<input type="checkbox"/> Injector		<input type="checkbox"/> Ignition Coil	
	<input type="checkbox"/> Fuel Filter			
	<input type="checkbox"/> ECM		<input type="checkbox"/> Others ()	
Customer complaint				
<input type="checkbox"/> 1. Engine no start	<input type="checkbox"/> a. No initial combustion		<input type="checkbox"/> b. No complete combustion	
	<input type="checkbox"/> c. No cranking			
<input type="checkbox"/> 2. Difficult to start	<input type="checkbox"/> a. Engine crank slowly			
	<input type="checkbox"/> b. Others ()			
<input type="checkbox"/> 3. Poor idling	<input type="checkbox"/> a. Incorrect first idle		<input type="checkbox"/> b. Noise	
	<input type="checkbox"/> c. Hunting idle from () to () min ⁻¹ (rpm)			
	<input type="checkbox"/> d. High idling () min ⁻¹ (rpm)			
	<input type="checkbox"/> e. Low idling () min ⁻¹ (rpm)			
	<input type="checkbox"/> f. Rough			
	<input type="checkbox"/> g. Others ()			
<input type="checkbox"/> 4. Poor driveability	<input type="checkbox"/> a. Hesitation		<input type="checkbox"/> b. Surging	
	<input type="checkbox"/> c. Knocking		<input type="checkbox"/> d. Lack of power	
	<input type="checkbox"/> e. Others ()			
<input type="checkbox"/> 5. Abnormal smoke	<input type="checkbox"/> a. Black		<input type="checkbox"/> b. White	
	<input type="checkbox"/> c. Others ()			
<input type="checkbox"/> 6. Fuel leakage	<input type="checkbox"/> a. Large quantity		<input type="checkbox"/> b. Blurred	
	Leaking from:	<input type="checkbox"/> Injector		<input type="checkbox"/> Ignition Coil
		<input type="checkbox"/> Others ()		
<input type="checkbox"/> 7. Engine not stop				
<input type="checkbox"/> 8. Engine stall				
<input type="checkbox"/> 9. Others				

Condition when problem occurs (Duplicated answers can be possible)		
1. Weather	<input type="checkbox"/> a. Fine	<input type="checkbox"/> b. Cloudy
	<input type="checkbox"/> c. Rainy	<input type="checkbox"/> d. Snow
	<input type="checkbox"/> e. Flood	
	<input type="checkbox"/> f. Others ()	
2. Outdoor temperature	Approx. °C (°F)	
3. Altitude	Approx. m	
4. Engine coolant	<input type="checkbox"/> a. Cold	Write the position of the indicator on coolant temperature gauge.  9Y1200058ENI031A
	<input type="checkbox"/> b. Warming up	
	<input type="checkbox"/> c. After warming up	
	<input type="checkbox"/> d. Any temperature	
	<input type="checkbox"/> e. Others ()	
5. Engine operation	<input type="checkbox"/> a. Starting	<input type="checkbox"/> b. Just after starting
	<input type="checkbox"/> c. Idling	<input type="checkbox"/> d. Racing
	<input type="checkbox"/> e. Acceleration	<input type="checkbox"/> f. Deceleration
	<input type="checkbox"/> g. While at work	
	<input type="checkbox"/> h. Others ()	
6. Problem frequency	<input type="checkbox"/> a. Constant	<input type="checkbox"/> b. Once only
	<input type="checkbox"/> c. Sometime (Time per day/month)	
7. Engine warning light	<input type="checkbox"/> Turn on a light	<input type="checkbox"/> Turn off a light
8. Optional parts	Fill the parts in if you use optional parts or non-genuine parts for electrical, intake/exhaust and fuel system. ()	
Dealer check		
1. Duplicate the problem	<input type="checkbox"/> a. Yes (Duplicate)	<input type="checkbox"/> b. No (Not occur)
2. Diagnosis trouble code	<input type="checkbox"/> a. Abnormal (What is code)	
	<input type="checkbox"/> b. Normal (No code)	
3. Appearance	<input type="checkbox"/> a. Normal	<input type="checkbox"/> b. Cracked
	<input type="checkbox"/> c. Discolored	
	<input type="checkbox"/> d. Others ()	
4. Fuel condition	<input type="checkbox"/> a. Normal	
	<input type="checkbox"/> b. Abnormal ()	

[3] ABBREVIATIONS

ACRONYM	DEFINITION
4G	4th Generation Global Control Platform
AC	Alternating Current
AF	Air Fuel Ratio
AL	Adaptive Learn
ATC	After Top Center
ATDC	After Top Dead Center
AVV	Air Valve Vacuum
BARO	Barometric Pressure
BAT	Battery
BHP	Brake Horse Power
BL	Block Learn
BP	Barometric Pressure
BTU	British Thermal Unit
°C	Celsius
CC	Cubic Centimeter
CAC	Charged Air Cooler
CAN	Controller Area Network
CARB	California Air Resources Board
CAT	Catalyst
CCP	CAN Calibration Protocol
CFM	Cubic Feet Per Minute
CHT	Cylinder Head Temperature
CID	Cubic Inch Displacement
CKP	Crankshaft Position Sensor
CL	Closed Loop
CMP	Camshaft Position Sensor
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CPP	Clutch Pedal Position Sensor
CTP	Closed Throttle Position
DBW	Drive-By-Wire
DC	Direct Current
DFCO	Decel Fuel Cut Off
DFI	Direct Fuel Injection
DLC	Data Link Connector
DM	Diagnostic Message
DMM	Digital Multi-Meter (high impedance)
DST	Diagnostic Scan Tool
DTC	Diagnostic Trouble Code
DVOM	Digital Voltage and Ohm Meter (high imp.)
ECIPP	EControls Proprietary Protocol
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EDIS	EControls Display and Interface Software
EGO	Exhaust Gas Oxygen Sensor
EGR	Exhaust Gas Recirculation

ACRONYM	DEFINITION
EI	Electronic Ignition
EMI	Electromagnetic Interference
EMWT	Exhaust Manifold Water Temperature
EOBD	Euro Onboard Diagnostic
EPR	Electronic Pressure Regulator
ERWT	Exhaust Manifold Riser Temperature
ETB	Electronic Throttle Body
ETC	Electronic Throttle Control
EVAP	Evaporative Emissions
°F	Fahrenheit
FC	Fan Control
FDR	Flight Data Recorder
FF	Flex Fuel
FMI	Failure Mode Indicator
FO	Firing Order
FP	Fuel Pressure
FPM	Fuel Pressure Manifold
FPP	Foot Pedal Position
FRP	Fuel Rail Pressure
FRT	Fuel Rail Temperature
FSS	Fault Snapshot
FT	Fuel Temperature
FT	Fuel Trim
ft. lb.	Foot Pounds
FTP	Federal Test Procedure
GCP	Global Control Platform
GEN	Generator
GND	Ground
GPM	Grams Per Mile
HC	Hydrocarbon
HVS	High Voltage Switch
HDGCP	Heavy-Duty Global Control Platform (On-Road Heavy-Duty)
HEGO	Heated Exhaust Gas Oxygen Sensor (same as HO ₂ S)
HO ₂ S	Heated Oxygen Sensor
HO ₂ S1	Upstream Heated Oxygen Sensor (Pre CAT)
HO ₂ S2	Downstream or Downstream Heated Oxygen Sensor (Pre CAT)
HP	Horsepower
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Ignition Control Circuit
ICM	Ignition Control Module
ICAV	Instant Crank Angle Velocity
ID	Inside Diameter
IFI	Indirect Fuel Injection
IGN	Ignition
IP	Instrument Panel
IPC	Instrument Panel Cluster
IVS	Idle Validation Switch
kHz	Kilohertz

ACRONYM	DEFINITION
Km	Kilometers
kPa	Kilopascals
KPH	Kilometers Per Hour
KOEC	Key On Engine Cranking
KOEO	Key On Engine Off
KOER	Key On Engine Running
KS	Knock Sensor
KV	Kilovolt
L.	Liter
lb.ft.	Pound Feet
LDGCP	Light-Duty Global Control Platform (Industrial, Smart/Logic Coil)
LED	Light Emitting Diode
LPG	Liquefied Propane Gas
LTFT	Long Term Fuel Trim
MAF	Mass Airflow Sensor
MAP	Manifold Absolute Pressure
MDGCP	Medium-Duty Global Control Platform (Industrial, Dumb Coil)
MDP	Manifold Differential Pressure
mP	Microprocessor
Mfg	Manufacture
MIL	Malfunction Indicator Lamp
mm	Millimeters
ms	Millisecond
mV	Millivolt
MPG	Miles Per Gallon
MPH	Miles Per Hour
NG	Natural Gas
Nm	Newton Meters
O ₂	Oxygen Sensor
OBD	On-Board Diagnostics
OBD I	On-Board Diagnostics generation one
OBD II	On-Board Diagnostics generation two
OBD III	On-Board Diagnostics generation three
OBD IV	On-Board Diagnostics generation four
OC	Oxidation Catalyst
OD	Outside Diameter
OEM	Original Equipment Manufacture
OHC	Overhead Cam
OL	Open Loop
PC	Personal Computer
PCM	Powertrain Control Module
PCU	Powertrain Control Unit
PCV	Positive Crankcase Ventilation
PFI	Port Fuel Injection
PGN	Parameter Group Number
PPM	Parts Per Million
PSA	Pressure Switch Assembly
psi	Pounds Per Square Inch
PWM	Pulse Width Modulated

ACRONYM	DEFINITION
RAM	Random Access Memory
RFI	Radio Frequency Interference
RPM	Revolutions Per Minute
Rx	Receive
SA	Source Address
SFI	Sequential Fuel Injection
SOHC	Single Overhead Cam
SPFI	Sequential Port Fuel Injection
SPN	Suspect Parameter Number
SRI	Service Reminder Indicator
SRT	System Readiness Test
Tach	Tachometer
TBI	Throttle Body Injection
TDC	Top Dead Center
TIP	Throttle Inlet Pressure
TPS1	Throttle Position Sensor One
TPS2	Throttle Position Sensor Two
TSC	Torque/Speed Control
TWC	Threeway Catalyst
TWC+OC	Threeway Catalyst + Oxidation Catalytic Converter
Tx	Transmit
UEGO	Universal Exhaust Gas Oxygen Sensor (also called wide-range EGO)
VBAT	Battery Voltage
VDC	Voltage, Direct Current
VIN	Vehicle Identification Number
VR	Variable Reluctance
VSS	Vehicle Speed Sensor
Vsw	Switched, Ignition Voltage
WGP	Waste-Gate Pressure
WOT	Wide Open Throttle

2. SYMPTOM CHARTS BY COMPONENTS

[1] LPG SYMPTOM CHARTS

	Important Preliminary Checks
Checks	Action
Before Using This Section	<p>Before using this section, you should have performed On Board Diagnostic Check and determined that:</p> <ul style="list-style-type: none"> • The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly. • There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists, but without a MIL. <p>Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem, without further checks, that may save valuable time. Most importantly talk to the operator about the failure this may provide important information about the fault.</p>
Important Question to Ask the Operator	<ul style="list-style-type: none"> • When and how did the operator first notice the fault condition • What engine speed and load condition did the fault occur at • Did the fault occur just after or before refueling • Did the fault occur at start up or shut down • Did the fault occur at a particular time of day or during the shift • Did the fault occur in a particular location • Has there been any recent repair to the engine or vehicle • Has the fault ever occurred before • Has there been any new external customer installed devices added to the vehicle and or engine
LPG Fuel System Check	<ul style="list-style-type: none"> • Verify the customer complaint. • Locate the correct symptom table. • Check the items indicated, under that symptom. • Operate the vehicle, under the condition the symptoms occurs. Verify HEGO is switching between lean and rich. <p>■ IMPORTANT</p> <ul style="list-style-type: none"> • Normal HEGO switching, indicates the LPG fuel system is in closed loop, and operating correctly at that time. • If a scan tool is available, take a snapshot, under the condition that the symptom occurs. Go to Engine Scan Tool Data List, to verify normal sensor values and parameters.
Visual and Physical Checks	<ul style="list-style-type: none"> • Check all ECM system fuses and/or circuit breakers. • Check the ECM ground for being clean, tight, and in its proper location. • Check the vacuum hoses for splits, kinks, and proper connections. • Check thoroughly for any type of leak or restriction. • Check for air leaks, at all the mounting areas, of the intake manifold sealing surfaces. • Check for proper installation of the mixer module assembly. • Check for air leaks, at the mixer assembly. • Check the wiring, for the following items: <ul style="list-style-type: none"> – Proper connections, pinches, or cuts. • Check the fuel level and fuel delivery system for leaks • Check the battery condition • The following symptom tables contain groups of possible causes, for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check, or most likely to occur first.

	Intermittent
Checks	Action
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL), or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	<ul style="list-style-type: none"> Refer to Important Preliminary Checks. Do not use the DTC tables, if a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections, or Wiring	<ul style="list-style-type: none"> Faulty electrical connections, or wiring, can cause most intermittent problems. Check the suspected circuit for the following conditions: <ul style="list-style-type: none"> Faulty fuse, or circuit breaker Connectors poorly mated Corrosion or loose pins in the connectors Terminals not fully seated, in the connector (backed out) Terminals not properly formed, or damaged Terminal to wire joints poorly connected Terminal tension, insufficient Wire strain from improper wire routing Burned or damaged wires from contacting hot surfaces or rotating devices Improper splicing method used when optional equipment is installed to the vehicle. Carefully remove all the connector terminals in the problem circuit, in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit, in order to ensure the proper contact tension. Checking for poor terminal, to wire connections, requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.
Intermittent Malfunction Indicator Lamp (MIL)	<p>The following components can cause intermittent MIL, and no DTC(s):</p> <ul style="list-style-type: none"> A defective relay Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. The ignition, secondary voltage, is shorted to a ground. The Malfunction Indicator Lamp (MIL) circuit, or the Diagnostic Test Terminal, is intermittently shorted to ground. The Control Module grounds.
Loss of DTC Memory	<p>To check for the loss of the DTC Memory:</p> <ol style="list-style-type: none"> Disconnect the TMAP sensor. Idle the engine, until the Malfunction Indicator Lamp illuminates. <p>The ECM should store a TMAP DTC. The TMAP DTC should remain in the memory, when the ignition is turned OFF. If the TMAP DTC does not store and remains, the ECM is faulty.</p>
Additional Checks	

	No Start
Checks	Action
DEFINITION: The engine cranks OK, but does not start.	
Preliminary Checks	<ul style="list-style-type: none"> Refer to Important Preliminary Checks.
Battery and Voltage Check	<ul style="list-style-type: none"> Check the battery charge condition. Check the battery cranking voltage, voltage less the 9.00 V are outside the parameters of operation. Check Battery positive and negative cable ends for corrosion build up.
Control Module Checks	<ul style="list-style-type: none"> Check the inline fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. Check battery power, ignition power, and ground circuits, to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity, for each circuit.
Sensor Checks	<ul style="list-style-type: none"> Crank sensor. Cam sensor.
Fuel System Checks	<p>■ IMPORTANT</p> <ul style="list-style-type: none"> A closed LPG manual fuel shut off valve, will create a no start condition. Check the fuel supply line connection to ensure the Excess flow check valve has not set Check for air intake system leakage, between the mixer and the throttle body. Verify proper operation, of the low pressure lock-off solenoids. Fuel filter plugging. Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. Check the low pressure fuel supply hose for restrictions and or blockage. Check for restrictions in the air intake system. Check for large vacuum leaks in the intake system. Check for proper mixer air valve operation. Check for exhaust pipe or catalyst restrictions.
Ignition System Checks	<p>■ NOTE</p> <ul style="list-style-type: none"> LPG being a gaseous fuel, requires higher secondary ignition system voltages, for the equivalent gasoline operating conditions. Check for the proper ignition voltage output. Verify that the spark plugs are correct, for use with LPG. Check the spark plugs, for the following conditions: <ul style="list-style-type: none"> Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits Check for loose ignition, coil connections, at the coil.
Engine Mechanical Checks	<p>■ IMPORTANT</p> <ul style="list-style-type: none"> The LPG Fuel system works on a fumigation principle, of fuel introduction, and is more sensitive, to intake manifold leakage, than the gasoline fuel supply system. Check for the following: <ul style="list-style-type: none"> Vacuum leaks Improper valve timing Low compression Bent pushrods Worn rocker arms Broken, or weak valve springs Worn camshaft lobes
Exhaust System Checks	<ul style="list-style-type: none"> Check the exhaust system, for a possible restriction: Inspect the exhaust system, for damaged or collapsed pipes. Inspect the muffler, for signs of heat distress, or for possible internal failure. Check for, possible, plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis.

	Hard Start
Checks	Action
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start, but immediately dies.	
Preliminary Checks	<ul style="list-style-type: none"> Refer to Important Preliminary Checks. Make sure the vehicle's operator is using the correct starting procedure. Be sure that there is fuel in the fuel tank. Check to make sure the manual tank valve is fully open.
Sensor Checks	<ul style="list-style-type: none"> Check the Crankshaft Position (CKP) sensor. Check the Camshaft sensor.
Fuel System Checks	<p>■ IMPORTANT</p> <ul style="list-style-type: none"> A closed LPG manual fuel shut off valve will create an extended crank, OR no start condition. Verify the excess flow valve, in the LPG manual shut-off valve, is not tripped. Check mixer module assembly, for proper installation and leakage. Verify proper operation, of the low pressure lock-off solenoids. Check for air intake system leakage, between the mixer and the throttle body. Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	<p>■ NOTE</p> <ul style="list-style-type: none"> LPG being a gaseous fuel, requires higher, secondary ignition system voltages, for the equivalent gasoline operating conditions. Check for the proper ignition voltage output Verify that the spark plugs are correct, for use with LPG. Check the spark plugs, for the following conditions: <ul style="list-style-type: none"> Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits Check for loose ignition coil connections. <p>■ IMPORTANT</p> <ol style="list-style-type: none"> If the engine starts, but then immediately stalls, check Crankshaft Position (CKP). Check for improper gap, debris, or faulty connections.
Engine Mechanical Checks	<p>■ IMPORTANT</p> <ul style="list-style-type: none"> The LPG Fuel system, works on a fumigation principle of fuel introduction, and is more sensitive to intake manifold leakage, than the gasoline fuel supply system. Check for the following: <ul style="list-style-type: none"> Vacuum leaks Improper valve timing Low compression Bent pushrods Worn rocker arms Broken or weak valve springs Worn camshaft lobes. Refer to Workshop Manual Check the intake and exhaust manifolds, for casting flash.
Exhaust System Checks	<ul style="list-style-type: none"> Check the exhaust system for a possible restriction: Inspect the exhaust system, for damaged or collapsed pipes. Inspect the muffler, for signs of heat distress, or for possible internal failure. Check for possible, plugged, catalytic converter. Refer to Restricted Exhaust System Diagnosis.
Additional Checks	

	Cuts Out, Misses
Checks	Action
DEFINITION: A surging or jerking, that follows engine speed, usually more pronounced as the engine load increases, which is not normally felt, above 1500 min ⁻¹ (rpm). The exhaust has a steady spitting sound at idle, low speed, or hard acceleration, for the fuel starvation, that can cause the engine to cut-out.	
Preliminary Checks	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks. • Check the battery condition. • Check the positive and negative cable connections. • Check the ECM and system grounds for corrosion at the connectors. • Check the coil electrical connections. • Check the air filter for restriction.
Ignition System Checks	<ul style="list-style-type: none"> • Start the engine. • Check for proper ignition output voltage, with spark tester. • Check for a cylinder misfire. • Verify that the spark plugs are correct for use, with LPG. • Remove the spark plugs and check for the following conditions: <ul style="list-style-type: none"> – Insulation cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Visually/Physically inspect the secondary ignition, for the following: <ul style="list-style-type: none"> – Ignition coils, for cracks or carbon tracking. • Wet down the secondary ignition system with water from a spray bottle and look / listen for arcing or misfiring as you apply water.
Engine Mechanical Checks	<ul style="list-style-type: none"> • Perform a cylinder compression check. • Check the engine for the following: <ul style="list-style-type: none"> – Improper valve timing – Bent pushrods – Worn rocker arms – Worn camshaft lobes. – Broken or weak valve springs. • Check the intake and exhaust manifold passages, for casting flash.
Fuel System Checks	<ul style="list-style-type: none"> • Check the fuel system-plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. • Check the condition of the wiring, to the low pressure lock-off solenoid. • Check the DEPR wire harness connection at the DEPR. • Check the VSW electrical connection to make sure it is fully seated and locked.
Additional Check	<p>Check for Electromagnetic Interference (EMI).</p> <ul style="list-style-type: none"> • EMI on the reference circuit can cause a missing condition. • Monitoring the engine RPM, with a scan tool, can detect an EMI. • A sudden increase, in the RPM, with little change in the actual engine RPM, indicates EMI is present. • If the problem exists, check the routing of the secondary wires, and the ground circuit. • Check for secondary electrical equipment improperly spliced into the engine electrical system.

	Hesitation, Sag, Stumble
Checks	Action
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	<ul style="list-style-type: none"> Refer to Important Preliminary Checks. Check the battery condition. Check the positive and negative cable connections. Check the ECM and system grounds for corrosion at the connectors. Check the coil electrical connections. Check the air filter for restriction.
Fuel System Checks	<ul style="list-style-type: none"> Check the fuel pressure. Refer to LPG Fuel System Diagnosis. Check for low fuel pressure, during a moderate, or full throttle acceleration. If the fuel pressure drops below specification, there is a possibility of a faulty low pressure regulator, or a restriction, in the fuel system. Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. Check LPL electrical connection. Check the mixer air valve for sticking or binding. Check the mixer module assembly, for proper installation and leakage.
Ignition System Checks	<p>■ NOTE</p> <ul style="list-style-type: none"> LPG being a gaseous fuel, requires higher secondary ignition system voltages, for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only, ignition system failure, and test the system accordingly. Check for proper ignition output voltage, with spark tester. Verify that the spark plugs are correct, for use with LPG. Check for fouled spark plugs.
Additional Check	<ul style="list-style-type: none"> Check for manifold vacuum, or air induction, system leaks. Check the generator, output voltage.

	Backfire
Checks	Action
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	<ul style="list-style-type: none"> Refer to Important Preliminary Checks.
Ignition System Checks	<p>■ IMPORTANT</p> <ul style="list-style-type: none"> LPG being a gaseous fuel, requires higher secondary ignition system voltages, for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition, to prevent backfire. Check for the proper ignition coil output voltage, using the spark tester. Check the connection, at each ignition coil. Check the spark plugs. Remove the plugs, and inspect them, for the following conditions: <ul style="list-style-type: none"> Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits
Engine Mechanical Check	<p>■ IMPORTANT</p> <ul style="list-style-type: none"> The LPG Fuel system, works on a fumigation principle, of fuel introduction, and is more sensitive to intake manifold leakage, than a gasoline fuel supply system. Check the engine for the following: <ul style="list-style-type: none"> Improper valve timing Engine compression Manifold vacuum leaks Intake manifold gaskets Sticking or leaking valves Exhaust system leakage Check the intake and exhaust system, for casting flash or other restrictions.
Fuel System Checks	<ul style="list-style-type: none"> Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.

Lack of Power, Sluggishness, or Sponginess	
Checks	Action
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed, when partially applying the accelerator pedal.	
Preliminary Checks	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks. • Refer to the LPG Fuel system, OBD System Check. • Compare the customer's vehicle, with a similar unit. Make sure the customer has an actual problem. Do not compare the power output, of the vehicle operating on LPG to a vehicle operating on gasoline, as the fuels do have different drive feel characteristics. • Remove the air filter, and check for dirt or restriction. • Check the vehicle transmission. Refer to the OEM transmission diagnostics. • Verify the fuel tank has fuel.
Fuel System Checks	<ul style="list-style-type: none"> • Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. • Check for the proper ignition output voltage, with the spark tester. • Check for proper installation, of the mixer module assembly. • Check all air inlet ducts, for condition and proper installation. • Check for fuel leaks, between the DSR, and the mixer. • Verify that the LPG tank manual shut-off valve is fully open. • Verify that liquid fuel (not vapor) is being delivered to the DSR.
Sensor Checks	<ul style="list-style-type: none"> • Check the Heated Exhaust Gas Oxygen Sensor (HEGO), for contamination and performance. • Check for proper operation of the MAP sensor. • Check for proper operation of the TPS sensor.
Exhaust System Checks	<ul style="list-style-type: none"> • Check the exhaust system, for a possible restriction: • Inspect the exhaust system, for damaged or collapsed pipes. • Inspect the muffler, for signs of heat distress, or for possible internal failure. • Check for possible plugged catalytic converter.
Engine Mechanical Check	<ul style="list-style-type: none"> • Check the engine for the following: <ul style="list-style-type: none"> – Engine compression – Valve timing • Improper or worn camshaft. Refer to Engine Mechanical, in the Service Manual.
Additional Check	<ul style="list-style-type: none"> • Check the ECM grounds, for being clean, tight, and in their proper locations. • Check the generator output voltage. • Visually and physically, inspect all electrical connections, within the suspected circuit and/or systems. • Check the scan tool data.

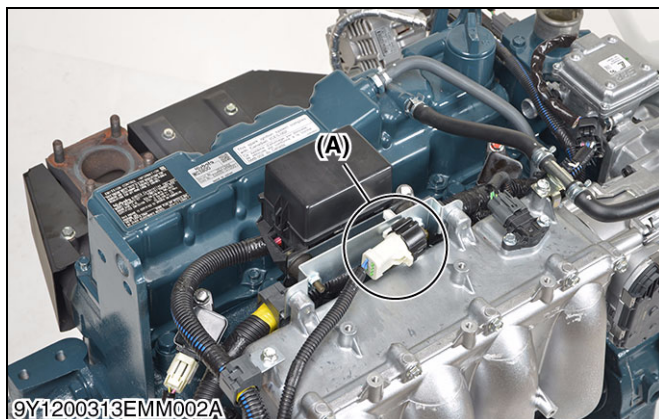
Poor Fuel Economy	
Checks	Action
DEFINITION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower, than it was on this vehicle at one time, as previously shown by refueling records.	
Preliminary Checks	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks. • Check the air cleaner element (filter), for dirt or being plugged. • Visually (Physically) check the vacuum hoses, for splits, kinks, and proper connections. • Check the operators driving habits, for the following items: <ul style="list-style-type: none"> – Is there excessive idling, or stop and go driving? – Are the tires at the correct air pressure? – Are excessively heavy loads being carried? – Is their often rapid acceleration? • Suggest to the owner, to fill the fuel tank, and to recheck the fuel economy. • Suggest that a different operator, use the equipment and record the results.
Fuel System Checks	<ul style="list-style-type: none"> • Check the DSR fuel pressure. Refer to LPG Fuel System Diagnosis. • Check the fuel system for leakage.
Sensor Checks	<ul style="list-style-type: none"> • Check the Temperature Manifold Absolute Pressure (TMAP) sensor.
Ignition System Checks	<ul style="list-style-type: none"> • Verify that the spark plugs are correct, for use with LPG. Check the spark plugs. Remove the plugs, and inspect them, for the following conditions: <ul style="list-style-type: none"> – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits
Cooling System Checks	<ul style="list-style-type: none"> • Check the engine thermostat, for always being open, or for the wrong heat range.
Engine Mechanical Check	<ul style="list-style-type: none"> • Check the engine for the following: <ul style="list-style-type: none"> – Engine compression – Valve timing • Improper or worn camshaft. Refer to Engine Mechanical, in the Service Manual.
Additional Check	<ul style="list-style-type: none"> • Check the transmission shift pattern. Refer to the OEM Transmission Controls section of the Service Manual. • Check for dragging brakes.

	Rough, Unstable, or Incorrect Idle, Stalling
Checks	Action
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary, in RPM. Either condition may be severe enough, to stall the engine.	
Preliminary Check	<ul style="list-style-type: none"> Refer to Important Preliminary Checks.
Sensor Checks	<ul style="list-style-type: none"> Check for silicon contamination, from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine, causing a severe driveability problem. Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: Check the Temperature Manifold Absolute Pressure (TMAP) sensor, response and accuracy.
Fuel System Checks	<ul style="list-style-type: none"> Check for rich or lean symptom, that causes the condition. Drive the vehicle, at the speed of the complaint. Monitoring the oxygen sensors, will help identify the problem. Check for a sticking mixer air valve. Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. Check the DSR fuel pressure. Refer to the LPG Fuel System Diagnosis. Check mixer module assembly, for proper installation and connection.
Ignition System Checks	<ul style="list-style-type: none"> Check for the proper ignition output voltage, using the spark tester. Verify that the spark plugs are correct, for use with LPG. Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> Wet plugs Cracks Wear Improper gap Burned electrodes Blistered insulators Heavy deposits
Additional Checks	<ul style="list-style-type: none"> ■ IMPORTANT <ul style="list-style-type: none"> The LPG Fuel system works on a fumigation principle, of fuel introduction, and is more sensitive to intake manifold leakage, than the gasoline fuel supply system. Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle, and low throttle angle control command. Check the ECM grounds, for being clean, tight, and in their proper locations. Check the battery cables, and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed, resulting in poor idle quality.
Engine Mechanical Check	<ul style="list-style-type: none"> Check the engine for the following: <ul style="list-style-type: none"> Broken motor mounts Improper valve timing Low compression Bent pushrods Worn rocker arms Broken or weak valve springs Worn camshaft lobes

	Surges/Chuggles
Checks	Action
DEFINITION: The engine has a power variation, under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down, with no change in the accelerator pedal.	
Preliminary Checks	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks. • Be sure the driver understands the Torque Converter Clutch operation.
Sensor Checks	Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance.
Fuel System Checks	<ul style="list-style-type: none"> • Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. • Check the fuel pressure, while the condition exists. Refer to LPG Fuel System Diagnosis. • Verify proper fuel control solenoid operation. • Verify that the LPG manual shut-off valve is fully open. • Check the in-line fuel filter for restrictions.
Ignition System Checks	<ul style="list-style-type: none"> • Check for the proper ignition output voltage, using a spark tester. • Verify that the spark plugs are correct, for use with LPG. • Check the spark plugs. Remove the plugs, and inspect them for the following conditions: <ul style="list-style-type: none"> – Wet plugs – Cracks – Wear – Improper gap – Burned electrodes – Heavy deposits • Check the Crankshaft Position (CKP) sensor.
Additional Check	<ul style="list-style-type: none"> • Check the ECM grounds, for being clean, tight, and in their proper locations. • Check the generator output voltage. • Check the vacuum hoses, for kinks or leaks. • Check Transmission.

3. SET UP AND PROCEDURE DIAGNOSTIC TOOL (EDIS)

[1] DIAGNOSTIC CONNECTOR POSITION



The connector for connecting the diagnostic tool is in the position shown in the photo.

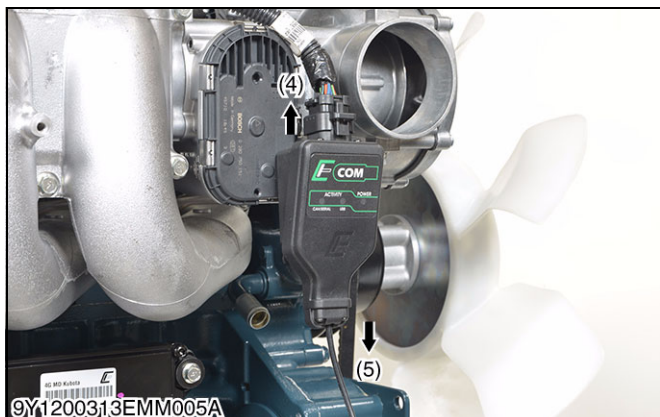
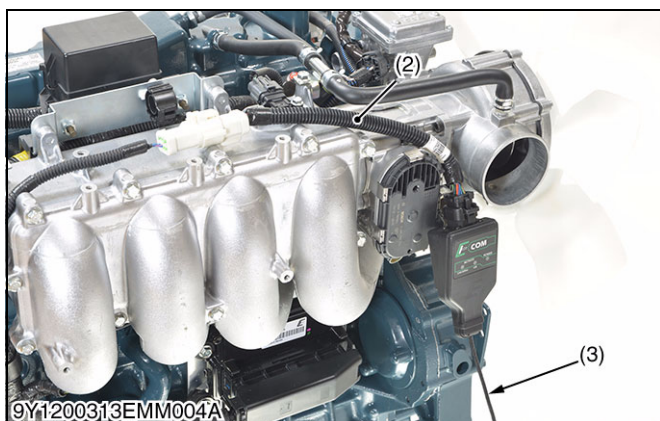
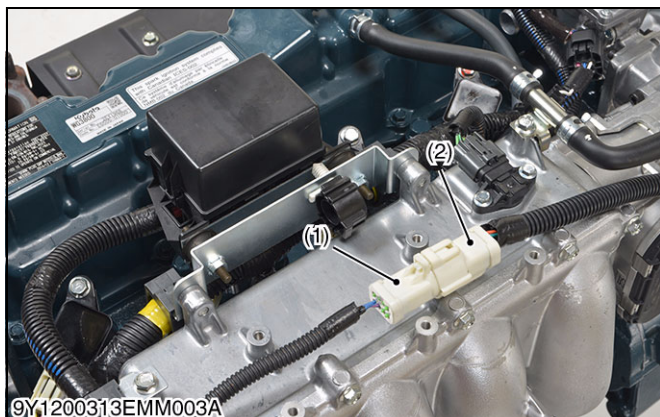
(A) Diagnostic Tool Connector



[2] DIAGNOSTIC TOOL CONNECTION PROCEDURE

■ IMPORTANT

- At first time usage, it is necessary to install the software with administrator user account.
- Prepare a PC on which the diagnostic software has been installed.
- When connecting the diagnosis cable, don't have to switch off the key of the vehicle.



1. Start up a PC on which diagnosis software has been installed with administrator user account.
2. Connect the vehicle-side connector (1) to the cable of interface (to vehicle) (2) with administrator user account.
3. Connect the cable of interface (to vehicle) (2) to the interface (to vehicle) (4).
4. Connect the cable of interface (to PC) (3) to the USB port on PC.
5. Start the diagnostic software.

■ NOTE

- The power of diagnostic tool is supplied by the USB port.
- After installed the software, all USB ports can be used to connect the diagnosis cable.
- Connecting orders of diagnosis cables are not important.

- | | |
|-------------------------------------|--------------------------------|
| (1) Vehicle-side Connector | (3) Cable of Interface (To PC) |
| (2) Cable of Interface (To Vehicle) | (4) Interface (To Vehicle) |
| | (5) Interface (To PC) |

[3] SET UP AND PROCEDURE

(1) Overview

This manual is intended to be used as an aid for KUBOTA LSI engine customers. Certain portions of this manual are only intended for use by the KUBOTA LSI engine customers to understand the fault detection system. This section of the manual defines the diagnostics and recommended troubleshooting procedures associated with an EControls 4G engine control module (ECM) for use on industrial and heavy-duty gas engines.

Kubota LSI engines use EControls diagnostic software to make the diagnosis of failure.

(2) Using the 4G Diagnostic Display Tool

Fault Code Broadcast

All diagnostic trouble codes are broadcast through EDIS for display on a PC. EDIS can acquire the data from the ECM through a protocol; CAN using the EControls Inc. Proprietary Protocol (ECIPP).

Faults may also be acquired over the CAN1 network through CAN J1939-based scan tools or multi-function display units.

Diagnostic Trouble Codes

The numeric diagnostic trouble codes assigned to the faults in 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 will assign both the DTC as displayed in EDIS as well as the flash code output on the MIL output pin. EDIS may be used to connect to the 4G using either RS232 (serial) or Controller Area Network (CAN) communication protocols.

Serial Network

Fault code information can only be acquired through a PC tool compatible with ECIPP.

CAN

The 4G supports 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)
- DM11: Diagnostic Data Clear/Reset For Active DTCs
- DM12: Emissions-Related Active Diagnostic Trouble Codes
- DM19: Calibration Information

All diagnostic trouble codes broadcast over CAN1 will be according to SAE J1939 DM1 and DM2. MY08 M4G ECUs are 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 engine calibration. There are 4 CAN SPN/FMI lists available in the 4G software set, contact EControls for a list of CAN SPN/FMIs.

The data capture at the occurrence of a fault, known in the ECM as 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: # of starts since fault was last
- Byte 15: Index into FSS_storage table for Fault Snap Shot retrieval.

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 1.

Table 1: J1939 Diagnostic Lamp Configuration

ECM 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)

Diagnostic Calibration Configuration and Corrective Actions

Each fault within the 4G 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 KUBOTA.

Table 2: 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".
Turn on MIL	Turn on MIL output when fault becomes active.
CL Disable	Disable closed-loop while the fault is active.
CL Disable Key-Cyc	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-Cyc	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 % set in the diagnostic calibration while the fault is active. The Power Derate 1 TPS % 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 % 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 % 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 the fault is active. If the 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.
Stopped Check	Run fault detection/checking while the engine is in a key-on, engine-off condition. ■ NOTE <ul style="list-style-type: none"> It is recommended that this feature only be used for general sensor faults (high/low voltage) and some output drivers.

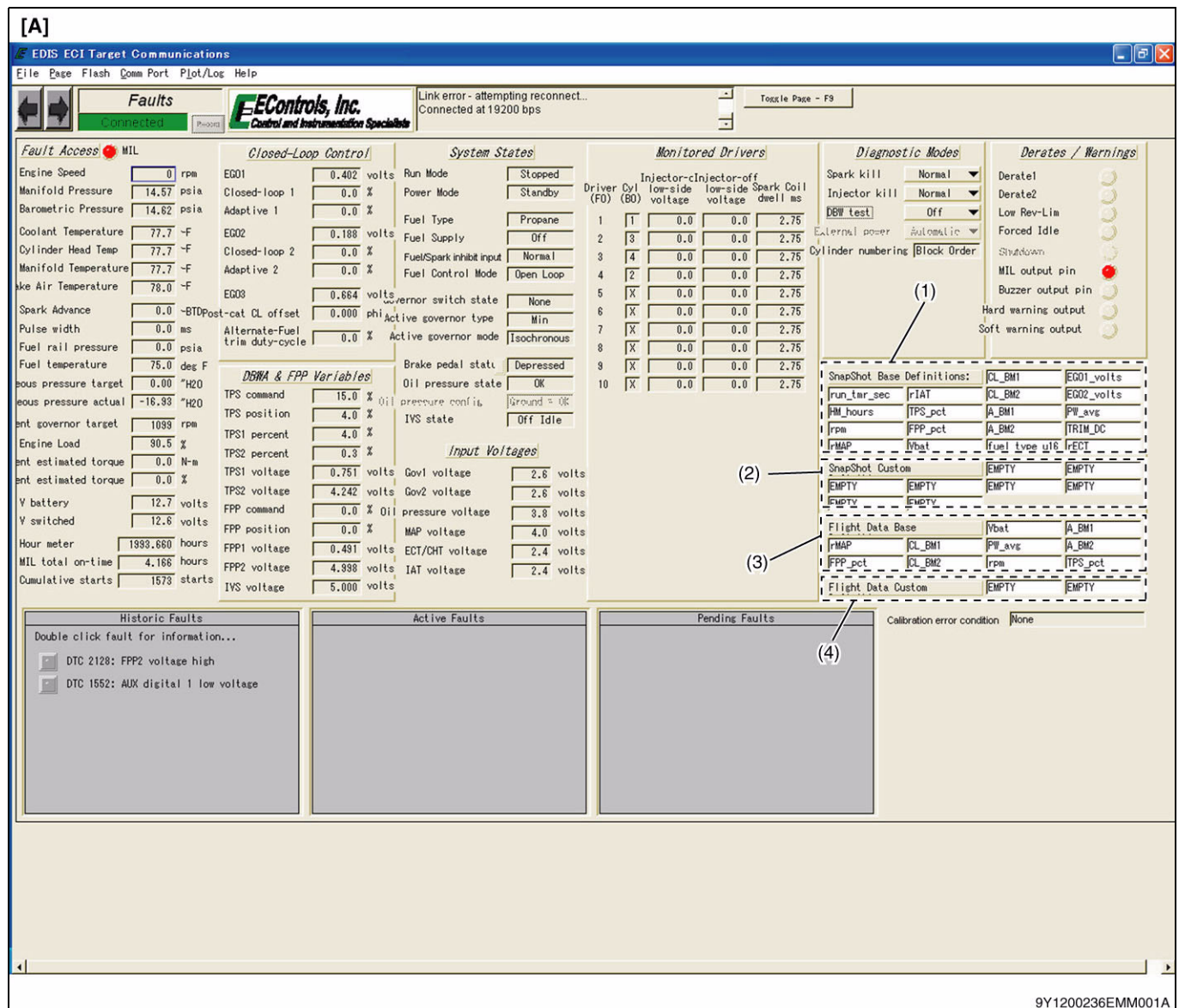
Fault/Diagnostic Trouble Code Interaction

All fault and diagnostic information is managed through the Faults page. Interaction includes viewing fault messages, downloading fault data (fault snapshot and flight data recorder), erasing faults from memory, and defining variables for fault data logging.

Faults are separated into two categories, Active and Historic. Active faults are active in real-time and historic faults have been generated at some instance in time that may or may not be active in real-time. Once a fault has become active, it is immediately logged as historic and a snapshot and flight data log is saved.

Figure [A] shows an example of the fault page when an active fault has been generated. Notice that the fault is present in both the active and historic lists and the malfunction indicator lamp (MIL) has been illuminated.

Figure [B] shows an example of the fault page with a historic fault stored in memory.



[A]: Custom Flight Data Recorder variable definitions (User Defined)

- | (1) Base Fault Snapshot Variable Definitions
(CAN Not Be Altered) | (2) Custom Fault Snapshot Variable Definitions
(User Defined) | (3) Base Flight Data Recorder Variable Definitions
(CAN Not Be Altered) | (4) Custom Flight Data Recorder Variable Definitions
(User Defined) |
|---|---|---|---|
| <p>Base Fault Snapshot Variable Definitions</p> <p>(CAN Not Be Altered)</p> | <p>Custom Fault Snapshot Variable Definitions</p> <p>(User Defined)</p> | <p>Base Flight Data Recorder Variable Definitions</p> <p>(CAN Not Be Altered)</p> | <p>Custom Flight Data Recorder Variable Definitions</p> <p>(User Defined)</p> |

[B]

EDIS ECI Target Communications

File Page Flash Comm Port Plot/Log Help

Connected

EEControls, Inc.
Control and Instrumentation Specialists

Link error - attempting reconnect...
Connected at 19200 bps

Toolbox Page - FS

Faults

Fault Access: MIL

Engine Speed: 0 rpm
Manifold Pressure: 14.57 psia
Barometric Pressure: 14.62 psia
Coolant Temperature: 77.7 °F
Cylinder Head Temp: 77.7 °F
Manifold Temperature: 77.7 °F
Inlet Air Temperature: 78.0 °F
Spark Advance: 0.0 °BTDP
Pulse width: 0.0 ms
Fuel rail pressure: 0.0 psia
Fuel temperature: 75.0 deg F
Fuel pressure target: 0.00 °H2O
Fuel pressure actual: -16.93 °H2O
Fuel governor target: 1093 rpm
Engine Load: 90.5 %
Estimated torque: 0.0 N-m
Estimated torque: 0.0 %
V battery: 12.7 volts
V switched: 12.6 volts
Hour meter: 1993.660 hours
MIL total on-time: 4.166 hours
Cumulative starts: 1573 starts

Closed-Loop Control:

EGD1: 0.402 volts
Closed-loop 1: 0.0 %
Adaptive 1: 0.0 %
EGD2: 0.188 volts
Closed-loop 2: 0.0 %
Adaptive 2: 0.0 %
EGD3: 0.664 volts
Post-cat CL offset: 0.000 phi
Alternate-Fuel trim duty-cycle: 0.0 %

DBWA & FPP Variables:

TPS command: 15.0 %
TPS position: 4.0 %
TPS1 percent: 4.0 %
TPS2 percent: 0.3 %
TPS1 voltage: 0.751 volts
TPS2 voltage: 4.242 volts
FPP command: 0.0 %
FPP position: 0.0 %
FPP1 voltage: 0.491 volts
FPP2 voltage: 4.998 volts
IVS voltage: 5.000 volts

System States:

Run Mode: Stopped
Power Mode: Standby
Fuel Type: Propane
Fuel Supply: Off
Fuel/Spark inhibit input: Normal
Fuel Control Mode: Open Loop
Governor switch state: None
Active governor type: Min
Active governor mode: Isochronous
Brake pedal status: Depressed
Oil pressure state: OK
pressure config: Ground = OK
IVS state: Off Idle

Input Voltages:

Gov1 voltage: 2.6 volts
Gov2 voltage: 2.6 volts
pressure voltage: 3.8 volts
MAP voltage: 4.0 volts
ECT/CHT voltage: 2.4 volts
IAT voltage: 2.4 volts

Monitored Drivers:

Driver (FO)	Cyl (BO)	Injector-on-side voltage	Injector-off-side voltage	Spark Coil dwell ms
1	1	0.0	0.0	2.75
2	3	0.0	0.0	2.75
3	4	0.0	0.0	2.75
4	2	0.0	0.0	2.75
5	X	0.0	0.0	2.75
6	X	0.0	0.0	2.75
7	X	0.0	0.0	2.75
8	X	0.0	0.0	2.75
9	X	0.0	0.0	2.75
10	X	0.0	0.0	2.75

Diagnostic Modes:

Spark kill: Normal
Injector kill: Normal
DBW test: Off
External power: Automatic
Cylinder numbering: Block Order

Derates / Warnings:

Derate1: ☐
Derate2: ☐
Low Rev-Lim: ☐
Forced Idle: ☐
Shutdown: ☐
MIL output pin: ☒
Buzzer output pin: ☐
Hard warning output: ☐
Soft warning output: ☐

SnapShot Base Definitions:

Parameter	Value	Unit
CL_BM1	EGD1_volts	
CL_BM2	EGD2_volts	
TPS_pct	A_BM1	FW_avg
FPP_pct	A_BM2	TRIM_DC
Vbat	Fuel_type_u16	RECT

SnapShot Custom:

Parameter	Value	Unit
EMPTY	EMPTY	EMPTY
EMPTY	EMPTY	EMPTY
EMPTY	EMPTY	EMPTY

Flight Data Base:

Parameter	Value	Unit
Vbat	A_BM1	
FW_avg	A_BM2	
TRIM_DC	FW_avg	
FW_avg	FW_avg	
FW_avg	FW_avg	

Flight Data Custom:

Parameter	Value	Unit
EMPTY	EMPTY	EMPTY
EMPTY	EMPTY	EMPTY
EMPTY	EMPTY	EMPTY

Historic Faults:

Double click fault for information...

- DTC 2128: FPP2 voltage high
- DTC 1552: AUX digital 1 low voltage

Active Faults:

Pending Faults:

Calibration error condition: None

9Y1200236EMM001B

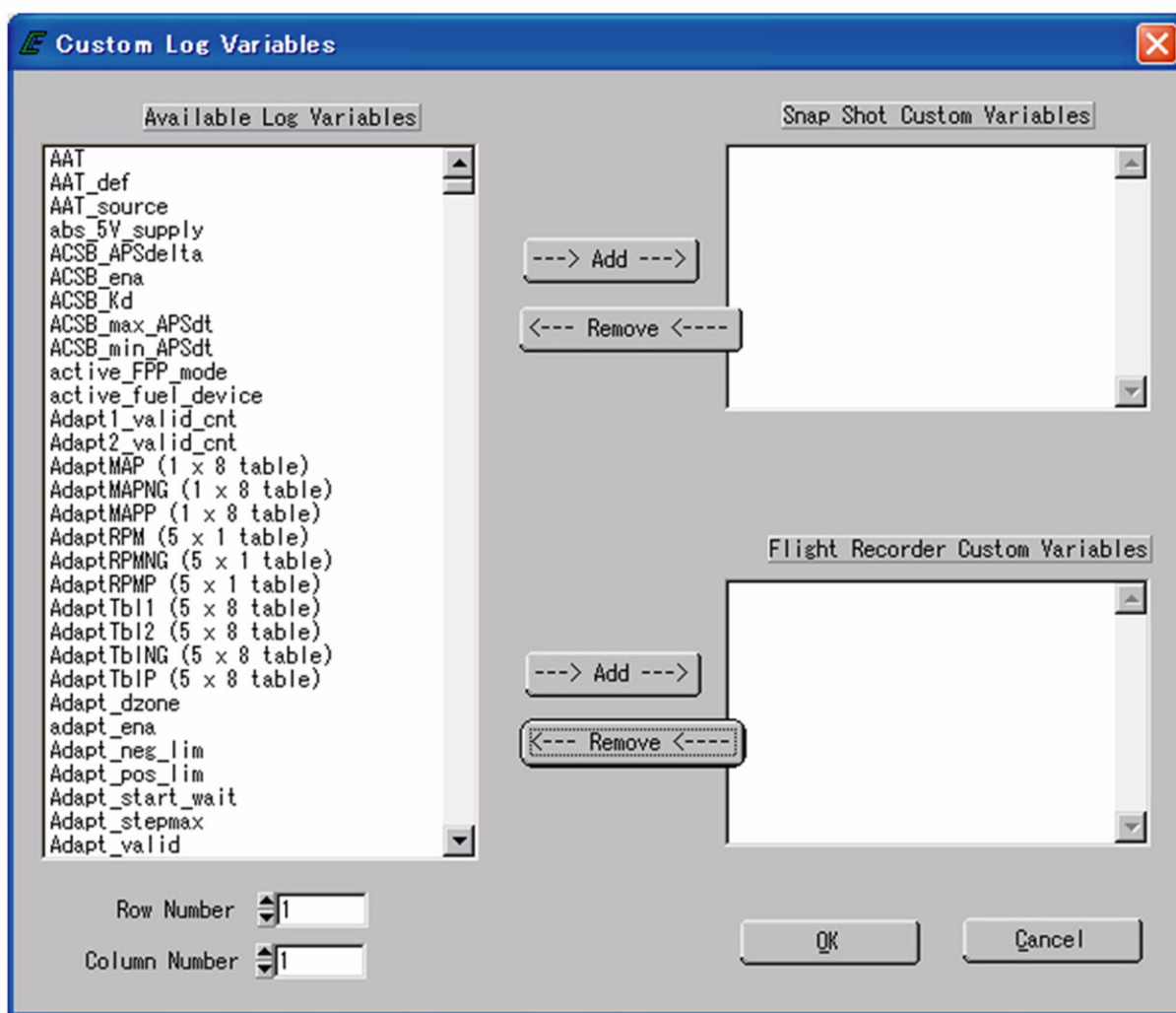
[B]: Faults Page with Historic Fault Message

Once an active fault has occurred two sets of data are recorded, fault snapshot and flight data recorder. The fault snapshot (FSS) is a sample of data taken at the instance the fault triggered. Variables included in the FSS are defined in the Snapshot Base and Snapshot Custom Definition fields found on the Faults Page. A FSS is saved with each of the first eight (8) faults for the first time the fault becomes active. Conversely, the flight data recorder (FDR) is a ten-second stream of data that includes eight-seconds prior and two-seconds after triggering the fault. An FDR is saved for each of the first two (2) faults for the first time the fault becomes active. Variables included in the FDR are defined in the Flight Data Base and Flight Data Custom Definition fields found on the Faults Page.

The memory location of the FDR is RAM, therefore this data is only available if the ECM has not lost battery power. In addition, if there is a "Dirty Flash Page" in the ECM, the FDR data will not be available. The memory location of the FSS data is EEPROM and is retained when the ECM loses battery power.

Both sets of data are accessed from the Historic Fault Information interface and can be saved to the PC upon retrieval. Base variables for FSS and FDR are generally defined by the Kubota to include variables most often referenced during fault diagnosis. The base definitions are not fault dependent. Additional variables may be selected for capture during a fault occurrence through a single, left-click of the custom table and selecting the desired variables from a list. An example of custom fault variable definitions is shown in Figure [C].

[C]

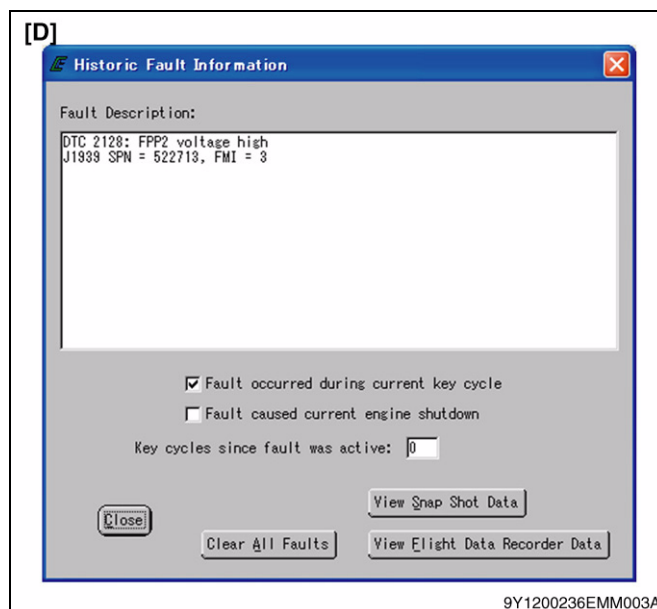


9Y1200236EMM002A

[C]: Custom Fault Variable Interface

Accessing fault information is accomplished through a double left-click of the fault LED in the historic fault list. This produces the Historic Fault Information interface shown in Figure [D]. From this interface the user can interpret a diagnostic trouble code (DTC) message, identify whether or not the fault occurred during the current key cycle, identify if the fault caused the engine to shutdown, determine how many key cycles have occurred since the fault was last active, clear selected or all historic faults, and view snapshot and flight data.

Table 3 outlines the options displayed in the Historic Fault Information screen. Historic faults are not overwritten if the same fault becomes active, storing data from the original active fault.



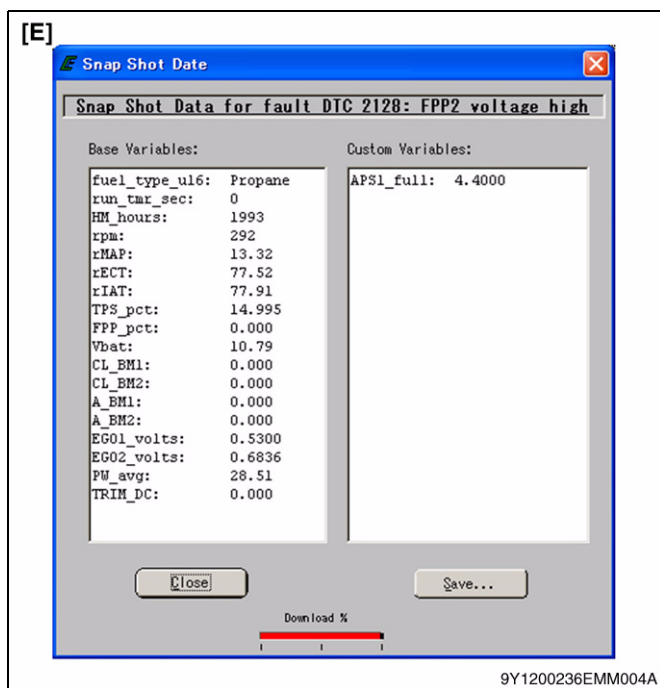
[D]: Historic Fault Information Interface

Historic Fault Information Interface Functions

Fault Description Message Box	Customized text that references the DTC flash code and describes the fault.
Fault During Key Cycle Checkbox	Informs that the fault occurred during the current key-on event.
Fault Caused Engine Shutdown Checkbox	Informs that the fault caused the engine to shutdown.
Key Cycles Since Fault Active Indicator	Displays the amount of key-on events since the fault was last active.
Clear This Fault Button*	Erases the selected historic fault from the ECM.
Clear All Faults Button*	Erases all historic faults from the ECM.
View Snap Shot Data Button	Retrieves a data "snap shot" from the ECM for variables defined in the base and custom snapshot variable definition lists. An example of a fault snap shot is shown in Figure [E] of page 1-36.
View Flight Data Recorder Data Button	Retrieves a 10-second data strip chart (8 seconds prior, 2 seconds after fault trigger) from the ECM for variables defined in the base and custom flight data recorder definition lists. An example of a fault snap shot is shown in Figure [F] of page 1-36.
Close Button	Exits the Historic Fault Information interface. DOES NOT cancel or clear any faults.
* Snapshot and flight data recorder data for historic faults is erased after the prompt shown in Figure [G] of page 1-37. is satisfied.	

Figure [E] is an example of a fault snapshot after View Fault Snapshot is selected. Data is presented in two columns, base and custom variables.

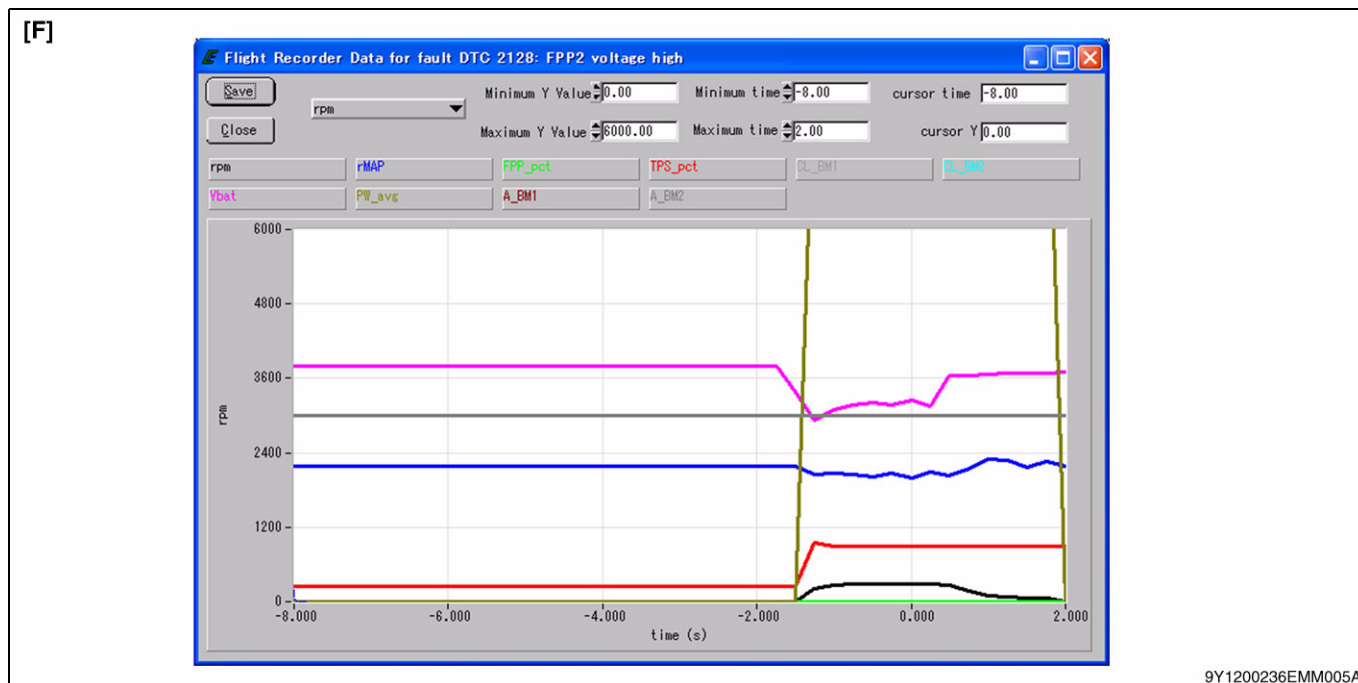
Once retrieved, the FSS data may be saved to the PC in text format with an.fss extension. A FSS saved to a PC may be reviewed in any ASCII based software program.



[E]: Snapshot Data Interface

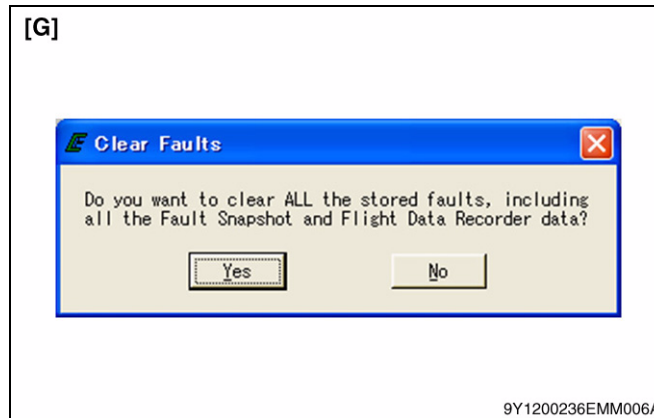
Figure [F] shows the Flight Data Recorder interface after View Flight Data Recorder is selected. The FDR captures a ten second (eight seconds prior and two seconds after generating the fault) strip of data for base and custom variables. FDR data is presented in an interface similar to the Plot interface for a quick graphical presentation.

From this interface, the FDR data may be saved to the PC in text, tab-delimited format with an .fdr file extension. Once saved to PC, FDR data may be reviewed using any graphical post-processing software capable of handling tab-delimited formatting.



[F]: Flight Data Recorder Interface

Fault information may be manually erased using the "Clear" button functions. Once a "Clear" function has been selected, the dialog prompt shown in Figure [G] will be displayed. Choosing YES deletes all fault information from the ECM.



[G]: Clear Faults Prompt

[4] DIAGNOSTIC TESTS

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

Diagnostic tests is software which can be initiated via CAN using CCP.

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 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 time-out expires.

■ NOTE

- **This test should not be initiated prior to the "Injector Kill" test when the engine is attached 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 block order
- 3) Coil 2: Disables coil or spark for cylinder 2 in block order
- 4) Coil 3: Disables coil or spark for cylinder 3 in block order
- 5) Coil 4: Disables coil or spark for cylinder 4 in block order

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished (time-out achieved)
- 8) Cannot start test

Injector Kill Test

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

■ NOTE

- **This test should not be initiated at high loads or for more than five (5) seconds if the engine is attached with a catalyst. If done so, a large quantity of oxygen will fuel undesirable reactions 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) Inj 1: Disables injector 1 in block order
- 3) Inj 2: Disables injector 2 in block order
- 4) Inj 3: Disables injector 3 in block order
- 5) Inj 4: Disables injector 4 in block order

Monitored Status

- 1) Test not started
- 2) Test is running
- 3) Test finished (time-out achieved)
- 8) Cannot start test

DBW Test

Permits full-authority operation of an electronic throttle via the throttle command input while the engine is in the "Stopped" state only. 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

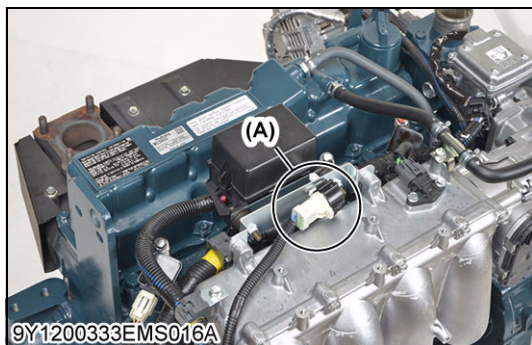
- 1) Test not started
- 2) Test is running
- 3) Test finished
- 8) Cannot start test (speed is sensed)

4. SET UP AND PROCEDURE DIAGNOSTIC TOOL (KGST)

[1] DIAGNOSTIC CONNECTOR POSITION

The connector for connecting the diagnostic tool is in the position shown in the photo.

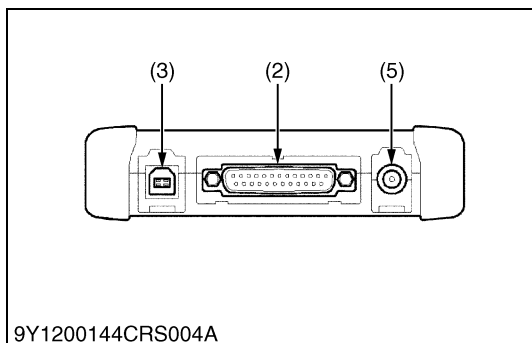
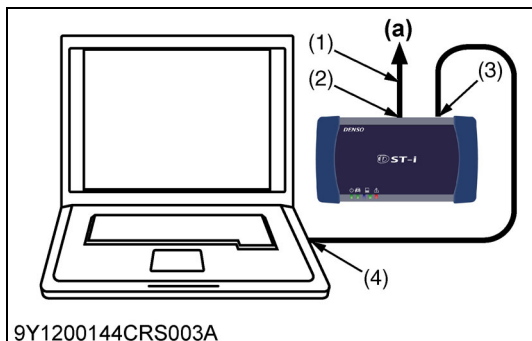
(A) Diagnostic Tool Connector



[2] DIAGNOSTIC TOOL CONNECTION PROCEDURE

■ IMPORTANT

- At first time usage, it is necessary to install the software with administrator user account.
- Prepare a PC on which the diagnostic software has been installed.
- When connecting the diagnosis cable, don't have to switch off the key of the vehicle.



1. Start up a PC on which the diagnostic software has been installed with administrator user account.
2. Connect the machine-side CAN1 connector (a) to the interface connector (To Machine) (2) with the cable (To Machine) (1).
3. Connect the cable (USB) (4) to the USB connector (To PC) (3) and then connect the USB cable to the USB port on PC.
4. Start the diagnostic software.
5. Select "Communication Setting" from "System Setting" in the menu and execute. (Only when performing the initial settings.)

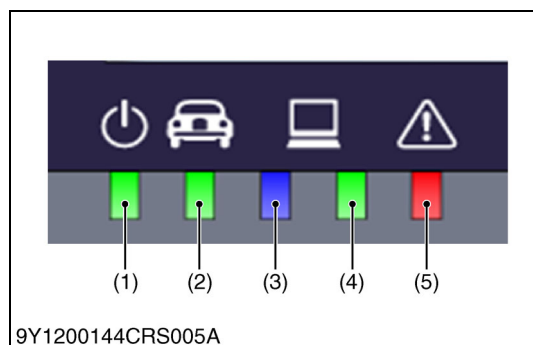
■ NOTE

- The USB port used while the "Communication Setting" process, should always be used.

- (1) Cable (To Machine) (a) CAN1 Connector
 (2) Interface Connector (To Machine)
 (3) USB Connector (To PC)*
 (4) Cable (USB)
 (5) DC Jack (Reserved)*

* Rubber cap is attached to USB connector and DC jack each

[3] CHECKING THE COMMUNICATION OPERATION OF THE INTERFACE (DST-i)



The communication operation can be checked with the illuminating condition of the five indicators on the DST-i unit.

If a communication error occurs, check the illuminating condition of each indicator and repair or replace the malfunction (including cable open circuits).

- (1) Power Indicator
- (2) Machine Communication Indicator
- (3) PC Communication (Bluetooth) Indicator
- (4) PC Communication (USB) Indicator
- (5) Error Detection Indicator

No.	Type of LED	Color	LED Status	Details
(1)	Power Indicator	Green	Light OFF	Power OFF
			Light ON	Power is supplied from machine cable or USB cable
(2)	Machine Communication Indicator	Green	Light OFF	Stand-by for communication
			Light Flashing (synchronized with communication)	Communication in progress
(3)	PC Communication (Bluetooth) Indicator	Blue	Reserved	Bluetooth communication status (Bluetooth is option)
(4)	PC Communication (USB) Indicator	Green	Light OFF	USB cable has not connected to PC or USB driver has not installed to PC
			Light ON	Stand-by for communication
			Light Flashing	Stand-by for establishment of communication
			Light Flashing (synchronized with communication)	Communication in progress
(5)	Error Detection Indicator	Red	Light OFF	Normal conditions
			Light Flashing	Error occurs

DST-i operation Status and Display Specification

■ Light Operation During Normal Conditions

DST-i Status	LED Status			
	Power	Machine	USB	Error
Power OFF	□	□	□	□
Power ON	■	□	□	□
USB stand-by status	■	□	●	□
USB cable has not connected to PC or USB driver has not installed to PC	■	□	□	□
Machine stand-by for communication	■	□	■	□
Machine / USB communication in progress	■	★	★	□

■ Light Operation During Abnormal Operation

DST-i Status	LED Status			
	Power	Machine	USB	Error
System Error	■	●	●	●
	■	■	■	●

□: Light OFF

■: Light ON

●: Light Flashing

★: Light Flashing (Synchronized with Communication)

[4] SET UP AND PROCEDURE

(1) Introduction

To diagnose ECU communication of WG3800 engine, it is used the software Kubota Gasoline Service Tool (KGST) and interface driver DST-i.

When you diagnose the engine for the first time, you should install the latest version of this software, DST-i interface driver and DST-i interface firmware before diagnosing the engine.

(2) Recommended PC Hardware/Software Environment

The table 1 and 2 below indicate recommended PC hardware/software environment.

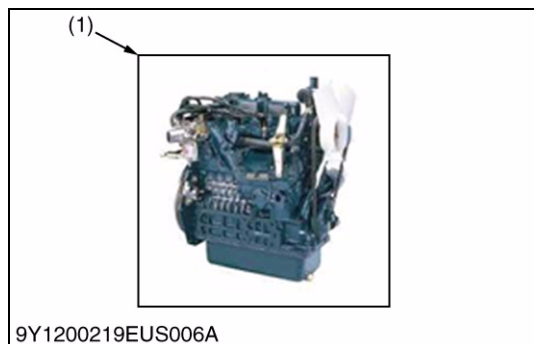
Table1: PC hardware environment

CPU	Intel Pentium 4 or equivalent running at 1 GHz or higher.
Memory	512 MB or larger.
Hard disk drive capacity	500 MB or larger free space.
Display	Display supporting screen resolution of XGA (1024 × 768) or higher/256 or more colors.
USB port	One port of version 1.1/2.0 to be occupied by the DST-i interface connection. Operation of the software cannot be guaranteed when the interface is connected via a hub.

Table2: PC software environment

OS	<ul style="list-style-type: none"> 32/64bit, Microsoft Windows 7 Japanese/English version 32/64bit, Microsoft Windows 8/8.1 Japanese/English version 32/64bit, Microsoft Windows 10 Japanese/English version
Required components	Microsoft.NET Framework 4 Client Profile or higher. DST-i interface driver.

(3) How to Install the Software and Interface Driver



To install diagnosis software, double-click setup.exe and when the installation is successful, the icon (1) is placed on the desktop.

To install interface driver, double-click setup.exe and when the installation successful, you can use all USB ports.

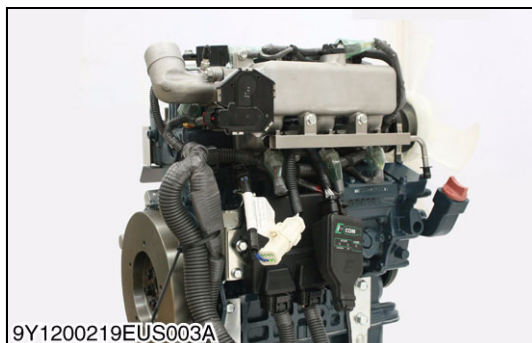
■ NOTE

- This software must be installed by the user with administrator authority. If it is installed by any other user, it may malfunction.
- Be sure to quit the other applications and virus detection software before starting installation of this software. Otherwise, the ongoing applications or software may prevent normal installation of this software.
- When Microsoft. Net Framework of the specified version or higher is not installed in the computer, installation of Net Framework will start. Follow the instructions displayed on the screen for installation.
- The DST-i interface driver and diagnosis software is another setup.exe.
Separately execute and install Driver_Setup.exe existing on the same hierarchy as setup.exe.

(1) Desktop Icon

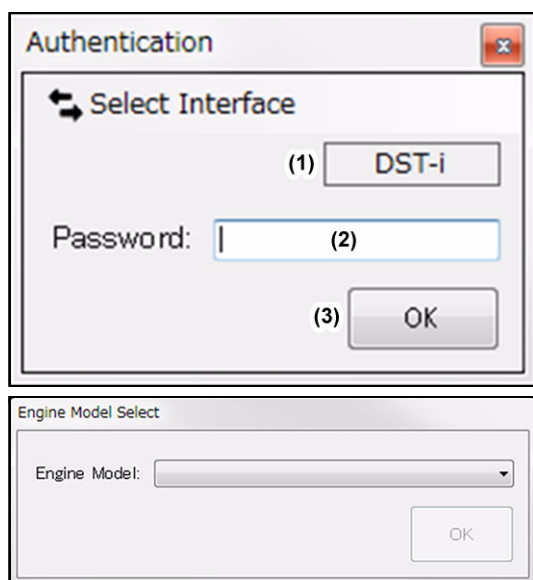
[5] HOW TO USE DIAGNOSIS SOFTWARE

(1) Start Up



- a. Connect DST-i cable to the engine and USB port of the computer.
- b. Turn the engine key on. (It is not necessary to start the engine.)
- c. Start the program and enter a password.
- d. Execute an engine diagnosis using the Model/Tests/Faults screens.

(2) User Authentication



The following authentication screen is displayed at start up.

- (1) Select the interface DST-i.
- (2) Area where a password for authentication is entered.
- (3) When the authentication is successful, the main screen of the application appears.

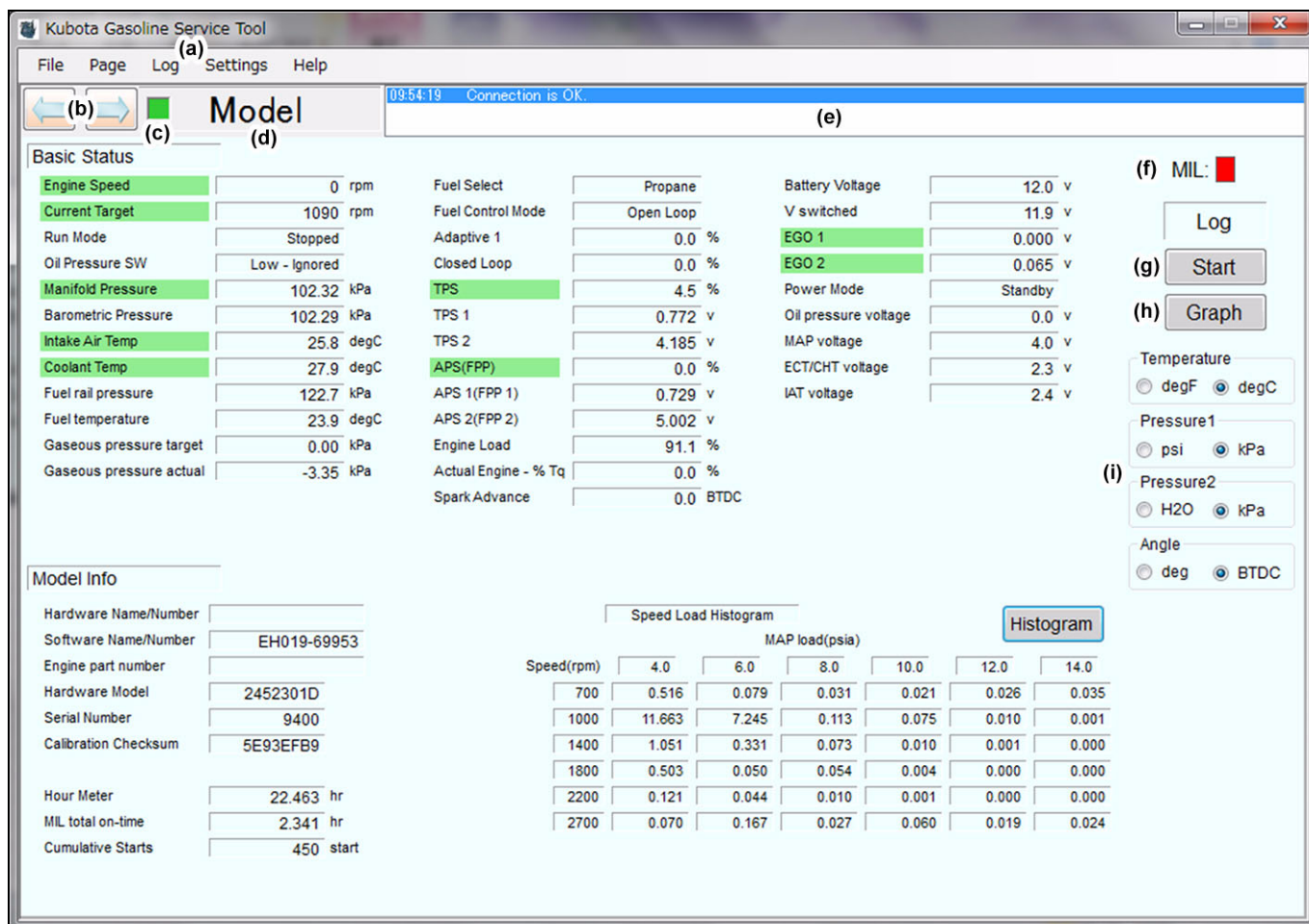
■ NOTE

- If you forgot to turn the key on or use KGST at offline, you have to select the engine model.

(3) Description of Monitor Command

When you succeeded the authentication, follow window is appeared by the monitor.

The part in the frame located on the top of the screen is common to the respective screens of Model/Faults/Tests. The following functions are available and freely operated during measurements.



(a) Load and save file and end operation.

- File:
 - Setup:
 - Save: Save current monitor object settings* to a file.
 - Load: Load a previously saved settings file.
 - Load Graph: Select a previously saved graph data file to display on the Graph screen.
 - Exit: Close the application.
- (*): Specifies items currently selected for monitoring and graphing and all monitor display item graph Y-axis range and line segment color.
- Page: Switches the display menus (same function as (b))
- Log: Selects SPN or hex dump in log files.

(b) Switches display menu between the Models, Faults, and Tests screens.

(c) Displays transmission status of data between the program and ECU.

- Flashing green light: Data is being transmitted.
- Red: Indicates a transmission error or no transmission from the ECU for at least 3 seconds.

(d) Displays the name of the currently opened screen (Model, Faults, or Tests).

(e) Displays error data that occurred during ECOM device transmission.

(f) Displays the MIL lamp status.

- Green: Data is being transmitted at least every 3 seconds without errors.
- Red: Error data transmitted, error currently active.
- Gray: No data is received for 3 seconds or more.

(To be continued)

(Continued)**(g) Button to start/stop acquisition of log.**

- SPN mode requires selecting in advance with the mouse the item you want to log. Left click the name you want with the mouse. The selected item turns green and can be saved to the log. You can select up to 20 items at a time.
- HexDump mode saves all received transmissions.

(h) Button to open the graph screen.

- This requires selecting an item with the mouse in advance for display as a graph. Left click the item you want with the mouse. The selected item turns green and a graph appears. You can work with a graph and log at the same time.

(i) Select the unit of temperature, pressure and angle.

- This function does not work while gobbling down the logging data and showing the graph monitor.

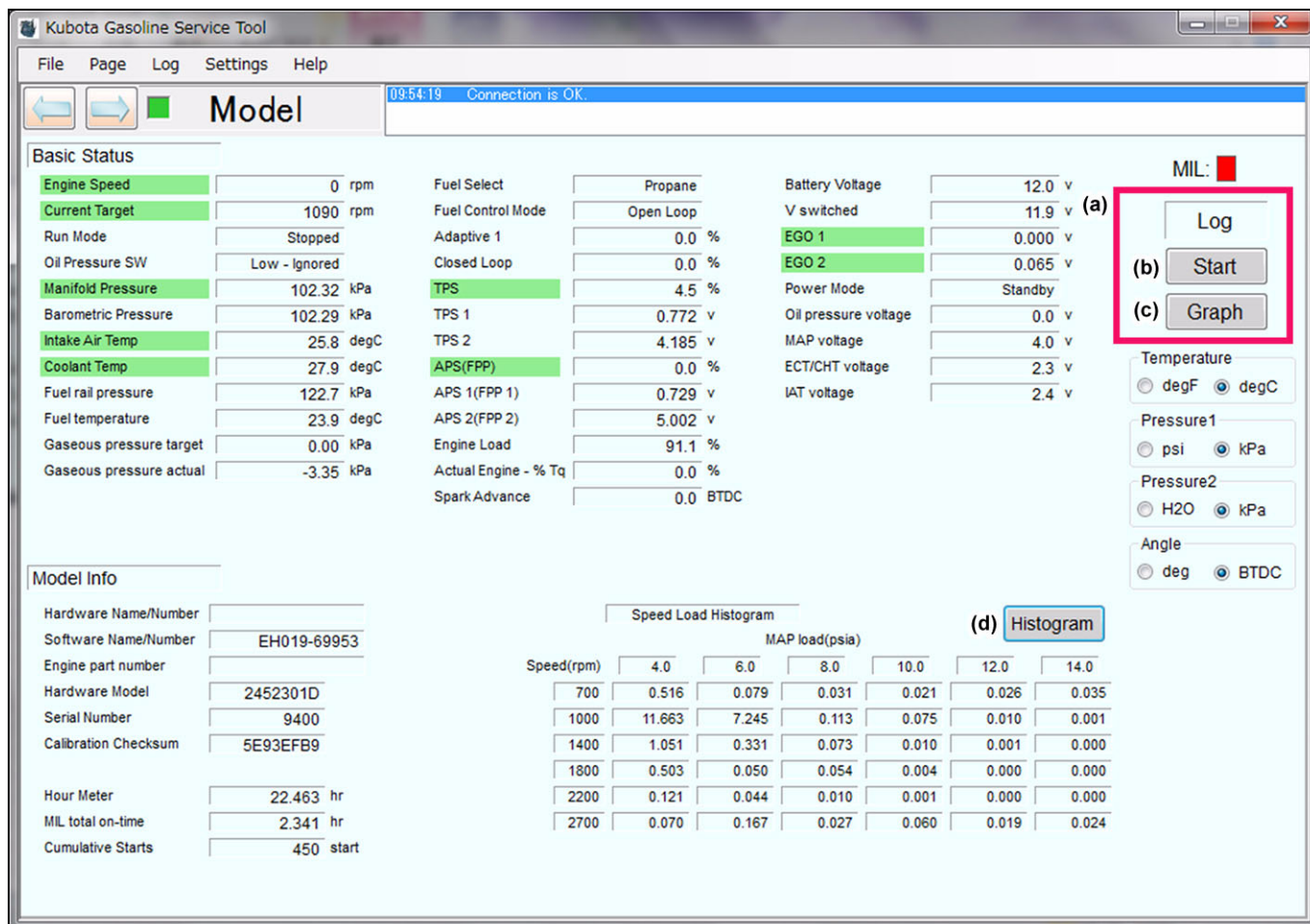
(4) Model Screen

The Model screen displays the received data from ECU.

After left-clicking the name with the mouse, the item will be selected and added to the items whose graphs are displayed/whose logs are output (green cells in the figure).

Selection operation by left-clicking is disabled while the graph screen is starting or a log is being acquired.

Information on ECU, etc. is displayed on the lower half of the screen. Only "Hour Meter" can be displayed on graphs.



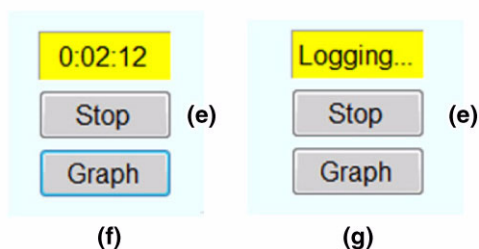
Log Function

During transmission/reception of data between ECU, clicking the [Start] button (b) allows you to acquire a log. The log will be recorded in ¥log under the directory in which the program is located.

During acquisition of a log, the screen (a) switches as left figure. Click the [Stop] button (e) to terminate recording the log.

If data is logging at SPN mode, the monitor changes (f), and if data is logging at Hex Dump mode, the monitor changes (g).

(To be continued)



(Continued)

There are two types of logs, including SPN mode and HexDump mode.

SPN mode	<ul style="list-style-type: none"> • Logs label data selected with the mouse at a fixed time interval, usually 100 msec. • Switches data units to correspond with the content on the screen. When fault data is included in Histeric Faults, logs the SPN-FMI • To save as a file, after finishing logging, you need to click the Save button on the Graph screen, and then specify a file name and save folder. • Data saved in a file can be loaded as graph data.
HexDump mode	<p>When logging is finished, the file is automatically compiled in the directory %log in which the program is saved and assigned the logging date as its name.</p> <p>The CAN signal received by the interface is not converted and output, regardless of the label cricked with the mouse.</p>

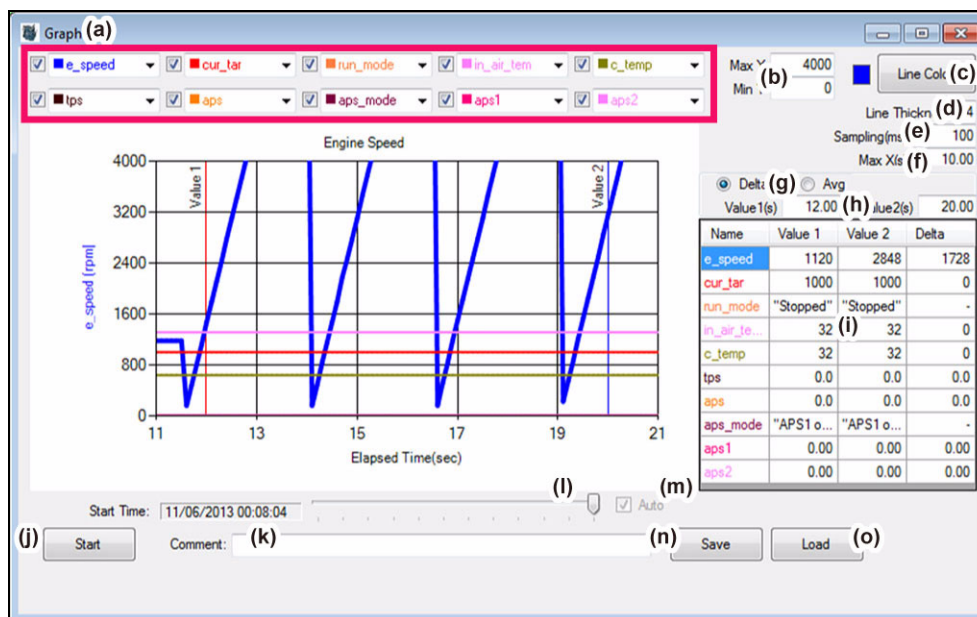
■ **Histogram button (d)**

Speed Load Histogram content is output in CSV format.

Content includes date and time executed, serial number, and hour meter information.

■ Graph function

You can display data being transmitted from the ECU as a graph by clicking the Graph button.



(a) Select items to display in the graph from the items selected in the monitor display.

- From the maximum of 10 items displayed in the pull-down menu, select one.
- Click the checkbox to indicate whether or not to display an item.

(b) Specifies the Y-axis range for the item currently selected in (a).

(c) Displays a dialogue box for selecting color. You can change the graph color for the item currently selected in (a).

(d) Specifies graph line thickness for the item currently selected in (a).

(e) Specifies the time cycle in millisecond units for collecting the data value, usually 100 milliseconds.

(f) Specifies the elapsed time displayed in the X-axis.

(g) Switches the display of the "Delta row" and "Average row" in the Graph (i).

(h) Specifies X-coordinates for drawing marker lines in the graph.

(i) Displays the value associated with the value 1 and Value 2 in (h) for the item selected in (a), and displays the difference (or Delta), from subtracting Value 1 from Value 2, or the average value (or Average), adding from Value 1 to Value 2.

(j) The start/stop button for drawing the graph.

This button also starts and stops logging.

Logging operates in SPN mode only.

(k) A text box for writing additional comments when saving graph data.

(l) A track bar to specify the time frame displayed for all information contained in the graph. You can use the track bar when (l) is off.

(m) When this function is on, the graphing time frame for collecting and displaying data is automatically updated to the most recent time that it was collected. When this function is off, graphing is performed as specified in (k).

(n) Specify a file name and then save recorded graph data.

The Save button is available when you stop graphing by clicking the Stop button, as described in (j).

(o) Click this button to load previously recorded graph data.

This button is available before and after graphing.

There are two types of logs, including SPN mode and HexDump mode.

SPN mode	Records data of the label clicked with the mouse at regular time intervals (normally, every 100 msec). Converts the unit according to the contents displayed on the screen. Records SPN-FMI if DM1 contains any fault information. Measurement items are recorded on the second line and measurement units on third line of the log.
HexDump mode	Regardless of the label clicked with the mouse, CAN signals received by the interface are output without conversion.

(5) Faults Screen

The Faults screen displays the fault codes of ECU (DM1 and DM2).

The fault codes are displayed as P-codes.

Kubota Gasoline Service Tool

File Page Log Settings Help

09:59:12 Connection is OK.
10:08:00 No response from the ECU.
10:14:59 Connection is OK.

Faults

Basic Status

Engine Speed	0 rpm	Fuel Select	Gasoline	Battery Voltage	12.4 v
Current Target	922 rpm	Fuel Control Mode	Open Loop	V switched	12.4 v
Run Mode	Stopped	Adaptive 1	0.0 %	EGO 1	0.085 v
Oil Pressure SW	Low - Ignored	Closed Loop	0.0 %	EGO 2	0.000 v
Manifold Pressure	101.86 kPa	TPS	4.7 %	Power Mode	Standby
Barometric Pressure	101.78 kPa	TPS 1	0.779 v	Oil pressure voltage	0.0 v
Intake Air Temp	71.1 degC	TPS 2	4.180 v	MAP voltage	4.0 v
Coolant Temp	71.7 degC	APS(FPP)	0.0 %	ECT/CHT voltage	0.8 v
Fuel rail pressure	133.7 kPa	APS 1(FPP 1)	0.733 v	IAT voltage	5.0 v
Fuel temperature	29.2 degC	APS 2(FPP 2)	5.002 v		
Gaseous pressure target	0.00 kPa	Engine Load	91.1 %		
Gaseous pressure actual	-1.44 kPa	Actual Engine - % Tq	0.0 %		
		Spark Advance	0.0 BTDC		

MIL: ■

Log
Start
Graph

Temperature
☐ degF ☒ degC

Pressure1
☐ psi ☒ kPa

Pressure2
☐ H2O ☒ kPa

Angle
☐ deg ☒ BTDC

Faults Viewer

(a) Historic Faults

P0337 Loss of Crankshaft Input Signal
P0113 IAT High Voltage
P0118 ECT/CHT High Voltage

(b) Active Faults

P0337 Loss of Crankshaft Input Signal

(c)
Clear Historic

(a) Displays historic faults (DM2).

While DTCs are displayed, double-clicking the relevant line displays the DTC Detail screen.

(b) Displays active faults (DM1).

While DTCs are displayed, double-clicking the relevant line displays the DTC Detail screen.

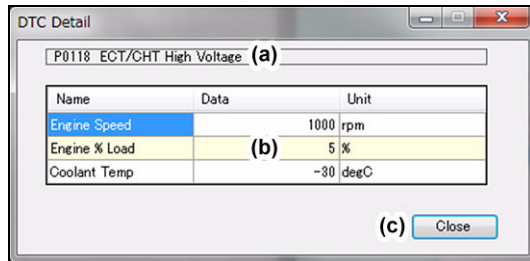
(c) Clears the fault information.

Clear Historic: Clear historic information

Depending on the data update time, clearing may require several seconds.

■ DTC Detail Screen

You can double-click a Historic Fault or Active Fault to display its fault diagnosis details.



(a) Displays the fault code (PCode) and basic text.

Displays the same content as the Faults screen.

(b) This area displays ECU data values (SnapShot) when the error occurred.

This area cannot be displayed when no data has been received.

Since more than one failure record cannot be saved in the ECU, the detailed information of P-Code error displayed on the screen is only about the first failure even after the second or subsequent failures occur.

(c) Closes the screen.

(6) Tests Screen

Basic Status

Engine Speed	0 rpm	Fuel Select	Propane	Battery Voltage	12.0 v
Current Target	1090 rpm	Fuel Control Mode	Open Loop	V switched	11.9 v
Run Mode	Stopped	Adaptive 1	0.0 %	EGO 1	0.000 v
Oil Pressure SW	Low - Ignored	Closed Loop	0.0 %	EGO 2	0.065 v
Manifold Pressure	102.32 kPa	TPS	4.5 %	Power Mode	Standby
Barometric Pressure	102.29 kPa	TPS 1	0.772 v	Oil pressure voltage	0.0 v
Intake Air Temp	25.8 degC	TPS 2	4.184 v	MAP voltage	4.0 v
Coolant Temp	27.9 degC	APS(FPP)	0.0 %	ECT/CHT voltage	2.3 v
Fuel rail pressure	122.4 kPa	APS 1(FPP 1)	0.729 v	IAT voltage	2.4 v
Fuel temperature	23.9 degC	APS 2(FPP 2)	5.001 v		
Gaseous pressure target	0.00 kPa	Engine Load	91.0 %		
Gaseous pressure actual	-3.35 kPa	Actual Engine - % Tq	0.0 %		
		Spark Advance	0.0 BTDC		

Test Function

Spark Kill Test

Spark Kill Number: Normal

Start

Test Not Started

Spark Fire Test

Spark Firing Test Number: Disabled

Start

Test Not Started

DBW Test

Start

Stop

Injector Kill Test

Injector Kill Number: Normal

Start

Test Not Started

Injector Fire Test

Injector Firing Test Number: Disabled

Start

Test Not Started

Idle Speed Test

Idle Speed Target: 0 rpm

Start

Stop

Test Not Started

Temperature

degF ☐ degC ☒

Pressure1

psi ☐ kPa ☒

Pressure2

H2O ☐ kPa ☒

Angle

deg ☐ BTDC ☒

MIL: ■

Log

Start

Graph

You perform function tests from the Tests screen.

(a)	Use this area to perform a Spark Kill Test. *Before performing the test, operate the engine in idle status. From the pull-down menu, select a cylinder number, and then click the Start button to test the selected cylinder number.
(b)	Use this area to perform an Injector Kill Test. *Before performing the test, operate the engine in idle status. From the pull-down menu, select a cylinder number, and then click the Start button to test the selected cylinder number.
(c)	These tests are prohibited at service level.
(d)	Use this area to perform a DBW (Drive By Wire) Test. *Before performing the test, turn the Key ON with the engine stopped. Then click the Start button to perform DBW Test. DBW Test will be kept performing unless you turn the engine powered-OFF or you click the Stop button in this area on the screen. While a test is in progress, you cannot perform a different test.

While a test is in progress, you cannot perform a different test or switch to a different screen.

■ Confirming That a Test Has Been Performed

You can check the status of a test by referring to the Test screen.

Spark Kill Test

Spark Kill Number: 1

Start

Not Started

Injector Kill Test

Injector Kill Number: 1

Start

Not Started

Not Started	The test is waiting to be performed.
Running	The test is in progress. After the test is finished, the display returns to Not Started.
N/A	This indicates that the test could not be performed for some reason. Double-check the parameters for the test and the connection with the ECU, and then start the test again.

Refer to the Workshop manual for the engine being tested for monitoring data items, engine equipment, and other details related to test results.

(7) Diagnostic Calibration Configuration and Corrective Actions

Diagnostic Calibration Configuration and Corrective Actions

Each fault within the 4G type of engine ECU 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 1 identifies the configuration options and corrective actions available for configuration of each fault. The desired action is set by KUBOTA.

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".
Turn on MIL	Turn on MIL output when fault becomes active.
CL Disable	Disable closed-loop while the fault is active.
CL Disable Key-Cyc	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-Cyc	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 % set in the diagnostic calibration while the fault is active. The Power Derate 1 TPS % 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 % 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 % 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 the fault is active. If the 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.
Stopped Check	Run fault detection/checking while the engine is in a key-on, engine-off condition. ■ NOTE <ul style="list-style-type: none"> It is recommended that this feature only be used for general sensor faults (high/low voltage) and some output drivers.

5. BASIC SYSTEM INFORMATION

[1] FUEL SYSTEM

KUBOTA FUEL SYSTEMS

Kubota LSI engines use EControls fuel system. In this section of the manual, Kubota fuel system will be explained further to provide the technician the ability to understand how each system operates and the general layout of each system. A typical installation schematic has been included to identify where in the system the components are located, and how the component communicates to other fuel system components, and the EControls ECM.

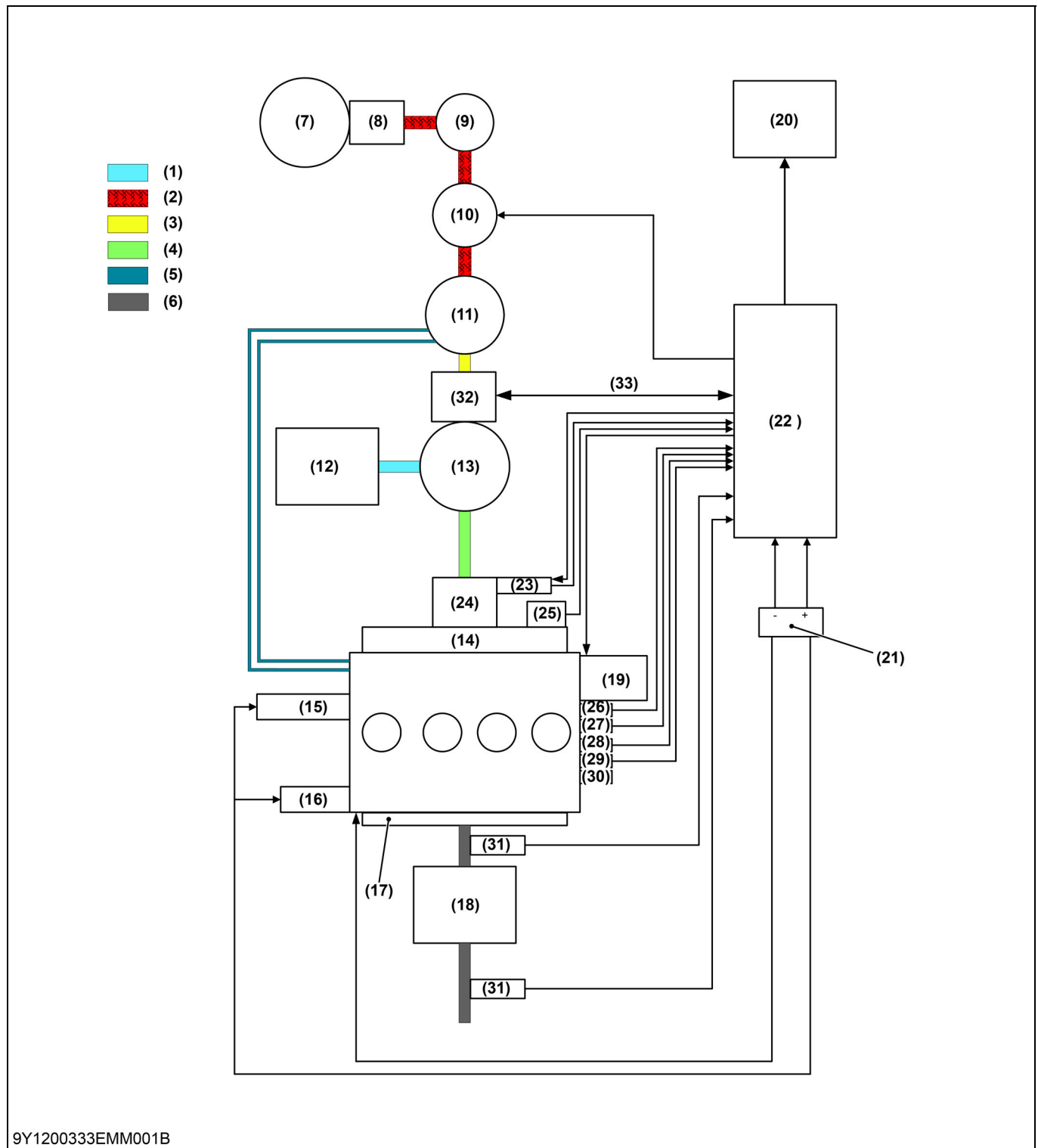
FUEL METERING SYSTEMS

In all cases where EControls has supplied the fuel metering system for Kubota, EControls has designed the system for peak engine performance, durability, precise fuel metering and control of the exhaust emission. Each design has been tested and developed in conjunction with Kubota. When servicing an EControls system, you should always follow the prescribed service instructions and procedures, to repair the engine fuel system. When replacing parts within the fuel metering system you should use only Kubota replacement parts. Failure to do so may result in improper performance, an unsafe conditions, and lack of emissions control.

ENGINE CONTROL MODULE

Kubota fuel system will utilize an EControls Engine Control Module (ECM), to control fueling and control emissions output, in the exhaust. In some cases the ECM provides signal output to the vehicle instrument panel. The ECM will utilize signal inputs, from the engine sensors, to control the fuel metering and speed control, while the engine is running. As well, the ECM will provide diagnostic control, over the fuel system.

The diagnostics within the ECM, continually monitor the fuel system performance, by measuring sensor voltage, and if the ECM determines that a sensor value has exceeded the high or low threshold value, the ECM will make changes in the fuel metering system operation, to protect the engine fuel system. These changes were developed during the EControls calibration activities, and during the design of the system. To assist the technician, in determining the fault condition, in the EControls fuel system, Diagnostic Trouble Codes (DTC), are used, to identify the fault conditions. These fault codes can be identified, by using the EControls Global Control Platform laptop diagnostic tool (4G). To determine fault codes and corrective action to be taken, the technician will use the 4G and the Diagnostic Trouble Code section, of this manual, to determine the root cause of the failure, the effective changes in the EControls fuel system, as well as what repairs must be made, to correct the fault in the fuel system.



LPG Schematic

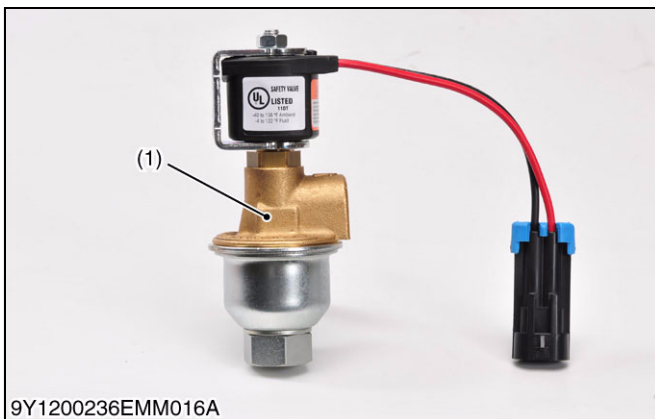
- | | | | |
|-------------------------------|----------------------------|-------------------------|-----------|
| (1) FRESH AIR | (9) FUEL FILTER | (17) EXHAUST MANIFOLD | (26) ECT |
| (2) LIQUID FUEL HIGH PRESSURE | (10) LPG LOCK OFF DEVICE | (18) MUFFLER | (27) OIL |
| (3) LOW PRESSURE FUEL | (11) DUAL STAGE REGULATOR | (19) IGNITION COIL PACK | (28) CCK |
| (4) AIR FUEL MIXTURE | (12) AIR FILTRATION SYSTEM | (20) INSTRUMENT PANEL | (29) CPK |
| (5) ENGINE COOLANT | (13) MIXER | (21) BATTERY | (30) KNK |
| (6) EXHAUST GASES | (14) INTAKE MANIFOLD | (22) ECI ECM | (31) HEGO |
| (7) LPG TANK | (15) ALTERNATOR | (23) TPS 1&2 | (32) EPR |
| (8) MANUAL VALVE | (16) STARTER | (24) ETB | (33) CAN |
| | | (25) TMAP | |

SERVICE LINE

LPG flows from the fuel tank to the electric lock, via the service line. The service line is most commonly connected to the tank, utilizing a quick coupler. The other end of the service line is connected to a "bulkhead connector" which is used to allow the service line, to pass through the metal enclosure, vehicle body panels, or hoods. This hose is made of special material, which protects the inner core of the hose, from chemicals contained within the LPG, which could result in a failure of the hose. The hose should never be kinked or allowed to come into contact with the chassis, or other engine components, and electrical connection or wiring. When replacing the fuel line, use care as there may be fuel retained in the line between the tank manual valve connection, and the electric lock off device.

LPG FUEL LOCK OFF

The LPG fuel lock off device (1) is an integrated assembly. The electric lock assembly is a 12.0 V, normally closed valve. The solenoid is mounted to the valve body. When energized the solenoid opens the pilot valve, within the lock off, which uses the tank pressure, to assist in opening the valve. By using the pilot valve, to help open the valve, the service life of the valve, is extended, and requires less electrical energy, to open the valve. The valve opens, during cranking, and remains open, during the run cycles of the engine. The lock off supply voltage is controlled by the Engine Control Module (ECM), or may be energized by a relay, which supplies battery voltage, when energized.

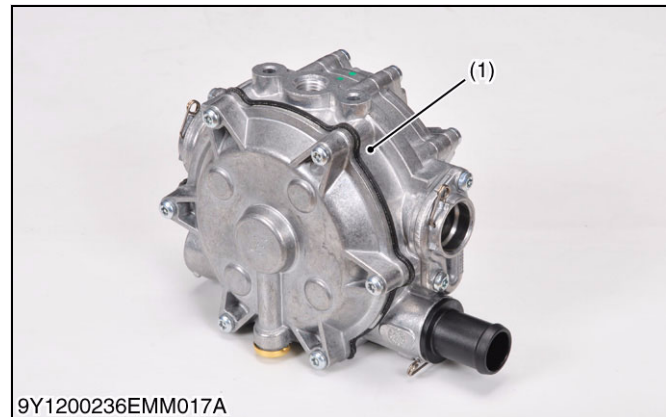


(1) Fuel Lock Off Device

DUAL STAGE REGULATOR (DSR)

The Dual Stage Regulator (DSR) (1) is a combination vaporizer, pressure regulating device. The DSR is a two stage regulator that is normally open, when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line, which connects the regulator to the Direct Electronic Pressure Regulators (DEPR), and mixer. This partial vacuum opens the second stage regulator, permitting fuel to flow to the DEPR, and mixer.

As the propane passes through the heat exchanger, the fuel expands, and creates pressure inside the chamber. The pressure rises as the fuel expands, when the pressure rises above 10 kPa (0.10 kgf/cm², 1.4 psi); sufficient pressure is exerted on the primary diaphragm, to cause the diaphragm plate to pivot, and press against the primary valve pin, thus closing off the flow of fuel. This action causes the flow of fuel, into the regulator to be regulated. When the engine is cranking, sufficient vacuum will be introduced into the secondary chamber, from the EPR/mixer, drawing the secondary diaphragm down onto the spring loaded lever, and opening the secondary valve, allowing vaporized fuel, to pass to the mixer. Increased vacuum, in the secondary chamber, increases the downward action on the secondary lever, causing it to open wider, allowing more fuel to flow to the mixer.



(1) Dual Stage Regulator (DSR)

DIRECT ELECTRONIC PRESSURE REGULATOR (DEPR)

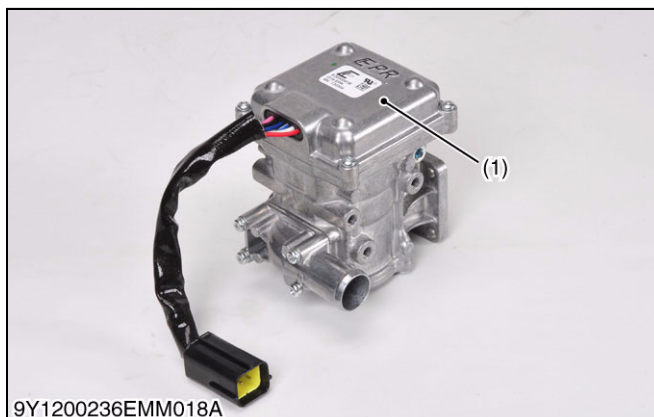
The Direct Electronic Pressure Regulator (DEPR) (1) is the primary fuel control device, used to maintain both performance and emissions control. The DEPR contains an internal computer, which communicates to the EControls Engine Control Module (ECM), via a Communications Area Network (CAN), high speed connection.

The DEPR precisely controls the fuel flow required to insure Stoichiometric (correct air/fuel mixture for complete burn) fuel delivery to the engine combustion chambers. The DEPR also contains internally mounted fuel pressure and temperature sensors, which provide input across the CAN link, to the ECM, for fuel calculation. The ECM will process this information and command changes back across the CAN link, to the DEPR, to adjust fueling.

The DEPR internal computer also maintains certain levels of diagnostics within the system, to ensure emissions control is always maintained. If the DEPR detects a fault within the regulator or fuel delivery system, the DEPR will send that fault information across the CAN link to the ECM. The ECM will then activate the Malfunction Indicator Light (MIL), in the operator control panel. Depending on the type of fault, and its effect on fuel control, or engine performance, the ECM may command the DEPR to change fueling, limit fuel delivery, or in some cases shut down the engine.

The DEPR is connected directly to the mixer on all certified engines. A special designed inlet fitting, is mounted to the DEPR, which allows for the connection, to the DSR. The outlet connection is bolted directly to the mixer.

The DEPR utilized on USA emission certified engines is a critical part of the certified emissions system, and do not require any periodic adjustment.



(1) Direct Electronic Pressure Regulator (DEPR)

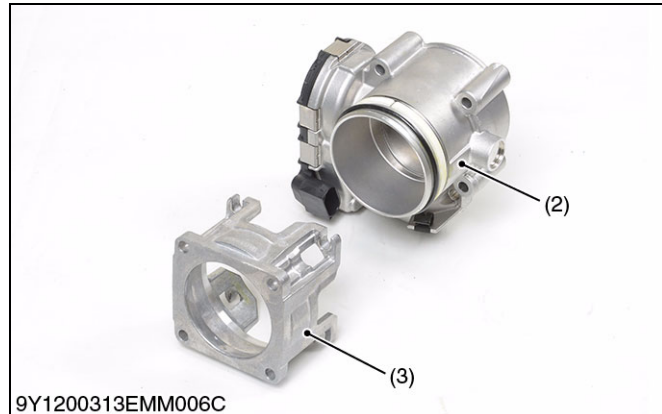
MIXER ASSEMBLY

The air valve mixer is an air-fuel metering device, and is completely self-contained. The mixer (1) is an air valve design, utilizing a relatively constant pressure drop, to draw fuel into the mixer (1) from cranking, to full load. The mixer (1) is mounted in the air stream, ahead of the throttle control device.

When the engine begins to crank, it draws in air, with the air valve covering the inlet, negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber, through 4 vacuum ports, in the air valve assembly. A pressure/force imbalance begins to build, across the air valve diaphragm, between the air valve vacuum chamber, and the atmospheric pressure, below the diaphragm. The air valve vacuum spring is calibrated, to generate from 101.6 mm (4.000 inches) of water column at start, to as high as 355.60 mm (14.000 inches) of water column, at full throttle. The vacuum being created is referred to as Air Valve Vacuum (AVV). As the air valve vacuum reaches 101.6 mm (4.000 inches) of water column, the air valve begins to lift against the air valve spring. The amount of AVV generated is a direct result of the throttle position. At low engine speed, the air valve vacuum is low and the air valve position is low, thus creating a small venturi, for the fuel to flow. As the engine speed increases, the AVV increases, and the air valve is lifted higher, thus creating a much larger venturi. This air valve vacuum is communicated from the mixer venture, to the DSR secondary chamber, via DEPR and the low pressure fuel supply hose. As the AVV increases in the secondary chamber, the secondary diaphragm is drawn further down, forcing the secondary valve lever to open wider.

The DEPR maintains the precise fuel control to the mixer, despite the air valve position, and AVV being sent to the DSR secondary chamber. The mixer (1) acts as the secondary fuel metering device, and delivery device, in the EControls emission control systems. The mixer (1) is attached to the Electronic Throttle Body (ETB) (2), via Electronic Throttle Body (ETB) Adapter (3). The adapter is fitted with specific spacers and o-rings, to insure a seal tight fit, with the ETB.

The mixer (1) is designed such that the air valve diaphragm assembly can be replaced, should the diaphragm be damaged, during operation, from fuel contaminants. Refer to Mixer Diaphragm Replacement section in this manual. The mixer (1) utilized on USA emission certified engines are a critical part of the certified emissions system, and do not require any periodic adjustment. The mixer (1) does not have any external nor internal adjustments.



- (1) Mixer
- (2) Electronic Throttle Body (ETB)
- (3) Electronic Throttle Body (ETB) Adapter

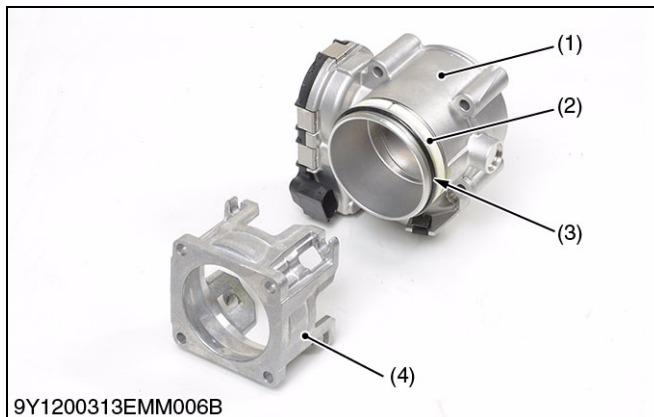
ELECTRONIC THROTTLE BODY (ETB)

The Kubota fuel systems utilize Drive By Wire (DBW), to control engine speed, in this type of application. There is no direct connection between the operator pedal, and the throttle shaft. Speed and load control are determined by the ECM. Defaults programmed into the ECM software, and throttle position sensors, allow the ECM, to maintain safe operating control, over the engine.

In a drive by wire application, the Electronic Throttle Body (ETB) (1) device, or "throttle body assembly", is connected to the intake manifold of the engine. The electronic throttle control device, utilizes an electric motor, connected to the throttle shaft. In addition, a Foot Pedal Position sensor (FPP) is located in the operator's compartment. When the engine is running, electrical signals are sent from the foot pedal position sensor, to the engine ECM, when the operator depresses or release the foot pedal. The ECM then sends an electrical signal to the motor, on the electronic throttle control, to increase or decrease the angle of the throttle blade, thus increasing or decreasing the air flow to the engine.

The electronic throttle control device also incorporates two internal Throttle Position Sensors (TPS), which provide output signals to the ECM, as to the location of the throttle shaft and blade. The TPS information is used by the ECM, to correct for speed and load control, as well as emission control, and engine protection.

The ETB (1) utilized on USA emission certified engines do not require any periodic adjustment.



- (1) Electronic Throttle Body (ETB)
- (2) Spacer
- (3) O-Ring
- (4) Electronic Throttle Body (ETB) Adapter

THREE WAY CATALYST

The emission certified engine has been designed and calibrated, to meet the emission standards in effect for 2010. To help meet the emission requirements, the vehicle has been attached with a Three Way Catalyst (TWC). Kubota has designed and supplied the catalyst in a separate unit. The catalyst function is the final treatment, of the exhaust gases, which are created from the combustion process. The three-way catalyst consists of a honeycomb, coated with a mixture of platinum, palladium, and rhodium. As the hot gases flow through the catalyst section, an oxidation and reduction reactions takes place. This chemical reaction reduces the amount of CO, HC and NOx, in the engines exhaust. The Exhaust gas then flows through the outlet.

HEATED EXHAUST GAS OXYGEN SENSOR (HEGO)

The Heated Exhaust Gas Oxygen Sensor (HEGO) (1) is mounted in the exhaust system, downstream of the engine, but before the catalyst, referred to as the "Pre Catalyst" sensor. The ECM continuously monitors the HEGO sensor output if a rich or lean condition is present for an extended period of time, and if the ECM cannot correct the condition, the ECM will set a diagnostic code, and turn on the MIL light in the dash.

The HEGO (1) is used to measure the amount of oxygen, present in the exhaust stream, and communicate that to the ECM, via an electrical signal. The amount of oxygen, present in the exhaust stream, indicates whether the fuel air ratio is too rich or too lean. If the HEGO (1) sensor signal indicates that the exhaust stream is too rich, the ECM will decrease or lean the fuel mixture, during engine operation. If the mixture is too lean, the ECM will richen the mixture.

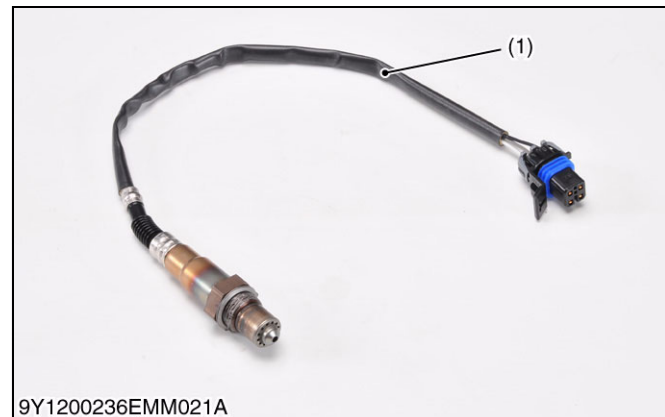
When the air/fuel mixture is rich, and there is little oxygen in the exhaust, the difference in oxygen levels, across the sensing element, generates a voltage through the sensor's electrodes: typically 0.800 to 0.900 V. When the air/fuel mixture is lean and there is more oxygen in the exhaust, the sensor's voltage drops to 0.100 to 0.300 V. When the air/fuel mixture is perfectly balanced and combustion is cleanest, the sensor's output voltage is around 0.450 V.

The oxygen sensor's voltage signal is monitored by the EControls ECM, to regulate the fuel mixture. When the ECM sees a rich signal (high voltage), from the O₂ sensor, it commands the fuel mixture to go lean. When the computer receives a lean signal (low voltage) from the O₂ sensor, it commands the fuel mixture to go rich. The continued cycling, back and forth from rich to lean, averages out the overall air/fuel mixture, to minimize emissions, and to help the catalytic converter operate at peak efficiency, which is often referred to as the "duty cycle".

The speed with which the oxygen sensor reacts to oxygen changes in the exhaust is very important for accurate fuel control, peak fuel economy, and low emissions. Aging of the sensor due to exposure to contaminants in the fuel, will occur over time, and may cause the sensor to slow down.

On all USA Emission certified engines, the exhaust system is attached with a second HEGO, located after the catalyst, referred to as the "Post Catalyst" sensor. The function of the second HEGO is to monitor the efficiency of the catalyst and fuel control. The operation of the HEGO is the same as the Pre Catalyst sensor; it provides an output voltage to the ECM, to determine the level of oxygen, in the exhaust stream after the catalyst. This type of monitoring is referred to as the On Board Diagnostic, in which additional sensors are installed in the system, to monitor the fuel control systems.

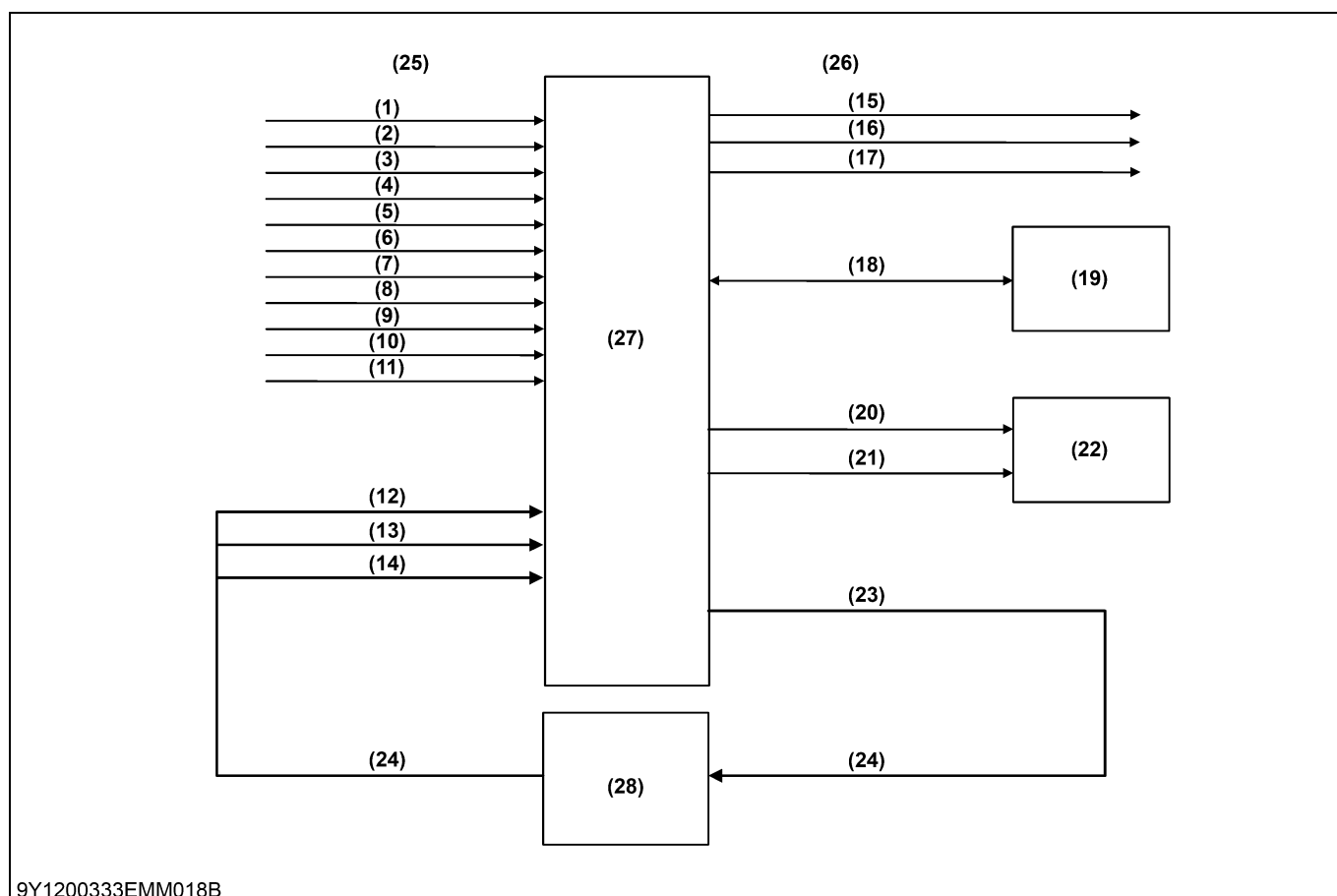
The ECM continuously monitors the HEGO sensors output, if a rich or lean condition is present for an extended period of time and the ECM cannot correct the condition, the ECM will set a diagnostic code and turn on the MIL light in the dash.



(1) Heated Exhaust Gas Oxygen Sensor (HEGO)

CAUTION

The Heated Exhaust Gas Oxygen Sensor is an emissions control component. If the HEGO fails to operate, replace only with Kubota replacement part. The HEGO sensor is sensitive to silicone based products and can become contaminated. Avoid using silicone sealers or hoses, treated with silicone lubricant, in the air stream or fuel supply lines.

ENGINE CONTROL MODULE (ECM)**LPG ECM Input and Outputs**

(1) BATTERY PLUS	(10) PRE CAT HEGO	(17) THROTTLE SPEED	(22) INSTRUMENT PANEL
(2) BATTERY MINUS	(11) POST CAT HEGO	CONTROL	(23) FUEL METERING
(3) ENGINE COOLANT	(12) FUEL PRESSURE	(18) CAN COMMUNICATION	CORRECTION
(4) CRANK SHAFT SENSOR	(13) FUEL TEMP	USING ECIPP (EControls Inc.	(24) HIGH SPEED CAN LINK
(5) INTAKE AIR TEMP	(14) FUEL CONTROL LOCATION	Proprietary Protocol)	(25) INPUTS
(6) MANIFOLD PRESSURE	(15) SPARK CONTROL TO	(19) DIAGNOSTIC TOOL	(26) OUTPUT
(7) THROTTLE POSITION 1	IGNITION COILS	(20) MIL LIGHT	(27) ECU
(8) THROTTLE POSITION 2	(16) LOCK OFF CONTROL	(21) GAGE OUTPUT	(28) EPR
(9) FOOT PEDAL POSITION			

In Kubota fuel systems, the Engine Control Module (ECM) provides total control, of the engine, fuel control, ignition spark control, and auxiliary features. The ECM depends on Kubota designed wire harness, to receive the required input data, from sensors, and sends the appropriate outputs. The harness is specifically designed to provide the necessary electrical supply, to the engine, through the life of the equipment. All electrical connectors utilize sealed connectors, to prevent damage from moisture intrusion, necessary shielding, when required, and protective covering, to protect the wiring.

To obtain maximum effect from the catalyst and accurate control of the air fuel ratio, the emissions certified engine is attached with an onboard computer known as the ECM. The ECM is a 32 bit controller, which receives input data from sensors, fitted to the engine and fuel system, and then outputs various signals, to control engine operation.

Engine sensors are used for fuel calculation and control, and are also used for the diagnostics. Those sensors are defined in the sensor group, in this section.

ENGINE SENSOR GROUP

To maintain fuel control, and insure the system provides the optimum performance, the ECM depends on sensors installed in the engine and fuel system, to provide input to the ECM, for calculating fuel delivery, as well as fuel system diagnostics. This section will provide the technician, with the understanding of the function of each sensor.

TEMPERATURE MANIFOLD ABSOLUTE PRESSURE (TMAP)

The TMAP sensor is a combination sensor, and provides the ECM with the Intake Air Temperature (IAT), and the Manifold Absolute Pressure (MAP). The ECM uses the intake air temperature to correct fueling based on the density of the air.

The MAP portion of the TMAP sensor provides the ECM with a measurement of the pressure in the intake manifold. During the start up, the MAP provides the ECM with the barometric pressure, to allow the ECM to adjust fueling, based on barometric pressure. Once the engine has started, the ECM uses the MAP to measure the load on the engine, and make fuel and RPM corrections, to compensate for changing load conditions.

In Kubota fuel system design, the TMAP is mounted to the intake manifold. The TMAP is a 5.00 V reference signal sensor, which operates by the resistance change in the sensor, to output a reference voltage for the ECM to use. The sensor can be a 0 to 5.00 V which is supplied by the engine. During the development phase of the system, the minimum and maximum thresholds of operation are determined, and are part of the fuel calibration and diagnostics, programmed into the ECM. These thresholds are used to establish the point at which the ECM will set the MIL light, to indicate that a fault has been detected in the fuel system.

ENGINE COOLANT TEMPERATURE (ECT)

The ECM monitors the engine coolant temperature, through the ECT sensor mounted in the engine. The ECM uses this sensor input to make corrections in fueling, and to protect the engine from overheating during normal operation.

In Kubota fuel system designs, the ECT is mounted in the water flange, and is usually supplied by Kubota. The ECT is a 5.00 V reference signal sensor, which operates by the resistance change in the sensor, to output a reference voltage for the ECM to use. The sensor can be a 0 to 5.00 V which is supplied by the engine. During the development phase of the system, the minimum and maximum threshold of engine temperature, during normal operation, are determined and are part of the fuel calibration and diagnostics, programmed into the ECM. These thresholds are used to establish the point at which the ECM will set the MIL light, to indicate that a fault has been detected in the fuel system. Should the temperature be exceeded, the ECM will first reduce the engine performance capabilities, often referred to as "limp home", which allows the

operator to move the equipment to a facility for repair, or safely shut down the system. In the event the temperature continues to rise, the ECM will shut down the engine in a specified period of time, after the "limp home" strategy has been activated.

ENGINE OIL PRESSURE (EOP)

The ECM monitors the engine oil pressure, through the EOP switch, mounted in the engine. The ECM uses this switch input, to protect the engine from damage, from the lack of oil in the crank case.

In Kubota fuel system designs, the EOP is mounted in the cylinder block, and is supplied by Kubota.

THROTTLE POSITION SENSORS 1 & 2 (TPS 1&2)

Kubota fuel systems use an Electronic Throttle Body (ETB) for speed and load control. Internal to the ETB, are two Throttle Position Sensors (TPS), which provide an "actual position" of the throttle plate. During the calibration development, the throttle blade variation, from actual to command, is defined. A maximum variation threshold is determined and included in the calibration, this threshold insures that the variation between actual and command do not vary above this threshold. In the event the variation exceeds the threshold, the ECM will command the ETB to idle, or shutdown the engine. The ECM will also set a diagnostic code, and turn on the MIL light

FOOT PEDAL POSITION SENSORS (FPP)

Kubota fuel systems, utilize a "drive by wire" technique, to allow the operator to accelerate the engine. This type of technique does not use a physical connection, between the operator foot pedal and the throttle body. Therefore control of the engine is managed by electrical signals, using a Foot Pedal Position Sensor (FPP), to determine the location, or how much the pedal is being depressed or released, which is relative to the command, that the operator desires. The FPP is a reference voltage sensor, therefore changing the voltage output level up or down, indicates a different desired position to the ECM. The ECM then changes the output signal, to the ETB, thus changing the throttle blade position, to correspond to the desired foot pedal command. The FPP is generally integrated, in the foot pedal mechanism, mounted in the operator's platform.

CRANKSHAFT POSITION SENSOR (CKP)

To determine the engine RPM and piston position of number one cylinder, the ECM receives this information from the Crankshaft Sensor. The CKP is mounted at the front of the engine (gear case side), and is supplied by the engine. CKPs vary in design, depending on the signal that the sensor produces. Induction sensors produce a sine wave signal, where as the pick-up crank position sensor, which reads a notched metal "interrupter" ring, on the back of the harmonic balancer, creates a square wave pattern.

CAMSHAFT POSITION SENSOR (CMP)

The cam shaft sensor is used to determine which stroke of the engine cycle the engine is running on for control of the fuel and spark. The sensor is mounted at the front of the engine (gear case side) and reads a pick up wheel mounted internally within the engine. The pick up wheel can be of vary design and number of pulses.

KNOCK SENSOR (KCS)

To prevent engine "knock", which occurs when the fuel air mixture does not burn smoothly, during this condition timing is generally decreased, to assist with the fuel burn process. Kubota fuel system, utilizes a Knock Sensor, which is installed to the engine block, and attached by Kubota. The Knock Sensor is a 5 volt reference signal sensor, which operates by the resistance change in the sensor, to output a reference voltage for the ECM to use. The knock sensor sends a base or "no knock" signal to the EControls ECM, when knocking does occur the sensor detects the increased vibration, and increases the voltage output to the ECM. When the ECM receives the voltage change, the ECM will slightly retard the timing, until such time, the knocking no longer exists.

[2] ELECTRICAL SYSTEM

INTRODUCTION

This section of the Kubota's manual has been designed to allow the technician to be able to select the section of the electrical system which is applicable to the fuel system being used. EControls systems are designed such that variation in fuel, engine size and auxiliary control feature are controlled by only several variations of Engine Control Modules (ECM). During the design of each of Kubota fuel systems Kubota defines the components that will interface with the EControls ECM and what options and auxiliary system are to be controlled by the ECM. Kubota fuel system wire harness varies slightly not only in circuits but in length and connector end. However each of the EControls ECM has identical 90 pin connectors. Variations in each ECM will dictate what the individual pin function is however there are many of the pins which have the same function regardless of fuel system or engine size. Some pins may not be used in certain Kubota fuel system and are blanked in the connector.

SYSTEM WIRING DIAGRAM

This section has shown the detail specific wire harness diagram for Kubota fuel system and electrical circuit. It is shown a connection to the vehicle side and engine side each for each specification.

CONNECTOR VIEWS

For those circuits which are not likely to vary, the individual circuits are documented in the harness section of this manual. Also included are the standard connector mating views which define the pin location in each connection. The view display is from mating connector perspective. Each connector in the overall wire harness has a connector number which begins with the prefix **CO-** followed by a three (3) digit number.

CIRCUIT IDENTIFICATION

Circuit numbers are not identified and wire colors may vary slightly as Kubota request specific wire colors for certain circuits. Standard circuit descriptions are used to identify each circuit. (example: Injector #1+)

WIRE DESCRIPTION

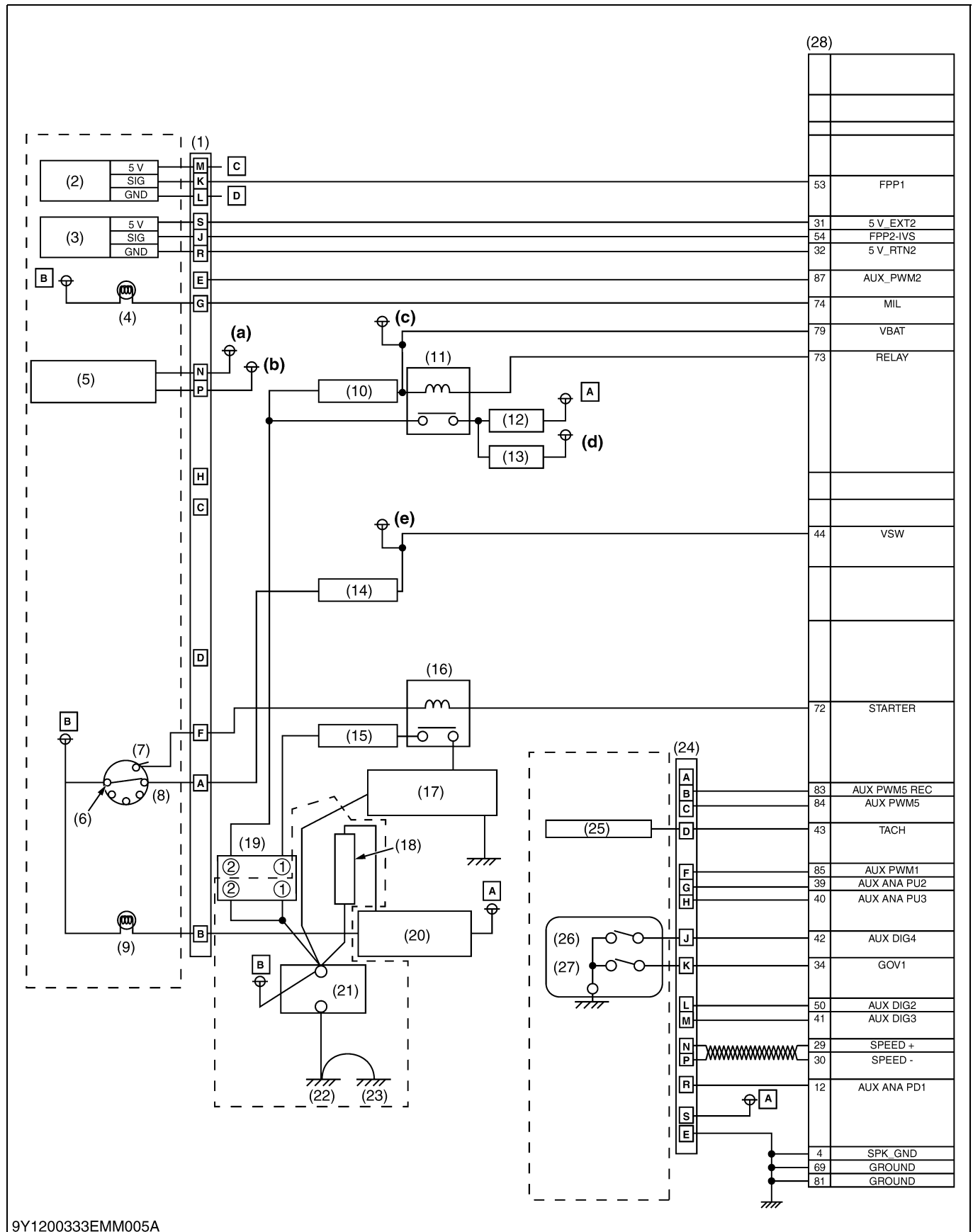
Each of the individual circuit diagrams contains the wiring information necessary for the technician to make repairs to that circuit without causing future damage to any electrical component or the wiring harness itself. All components use a crimped connector unless otherwise defined.

REPAIR OF WIRING HARNESS

EControls recognizes that through normal wear or improper handling of the main wire harness damage can occur over time. Wires, connector ends, and pins may become damaged and require replacement or repair. EControls has provided in this manual a section which described the proper repair procedures when making repairs to any wire harness. Use this section and the proper tools when making splices or repairs to the harness.

■ NOTE

- **BEFORE DIAGNOSING ANY ELECTRICAL PROBLEM CHECK THE MAIN ECM CONNECTOR TO IDENTIFY WHAT PINS ARE BLANKED.**
- **BEFORE MAKING HARNESS REPAIRS BE SURE TO USE THE CORRECT WIRE HARNESS REPAIR TOOLS SUCH AS CRIMPING TOOLS, WIRE STRIPPING TOOLS, AND ELECTRICAL DIAGNOSTIC TOOLS**
- **BEFORE ADDING ANY OPTIONAL ELECTRICAL EQUIPMENT TO THE VEHICLE FITTED WITH AN ECONTROLS SYSTEM CONSULT WITH KUBOTA OF THE EQUIPMENT TO VERIFY THAT THE ELECTRICAL SYSTEM CAN SUSTAIN THE NEW ELECTRICAL LOADS AND WHERE TO CONNECT THE ADDITIONAL LOAD.**
- **WHEN ADDING OPTIONAL ELECTRICAL EQUIPMENT BE SURE TO USE A IN-LINE FUSE OF THE PROPER ELECTRICAL LOAD TO PROTECT THE VEHICLE ELECTRICAL SYSTEM.**

(1) System Wiring Diagram**[A] VEHICLE SIDE OF SYSTEM WIREING DIAGRAM (WG3800-L)**

JOINT POINTS (A, B, C, D)• **A: The points below are jointed.**

IGNITION_FUSE (15A)
 ALTERNATOR_PIN_2
 VIC2_PIN_S
 COIL_CYL_#1,2,3,4_PIN_1
 INJ_CYL_#1,2,3,4_PIN_2
 O₂_SENSOR_PRE_CATALYST_PIN_C
 O₂_SENSOR_POST_CATALYST_PIN_C

• **B: The points below are jointed.**

BATTERY +
 KEY_SWITCH_PIN_OFF
 ALTERNATOR_CHARGE_INDICATION_LAMP
 MIL_LAMP

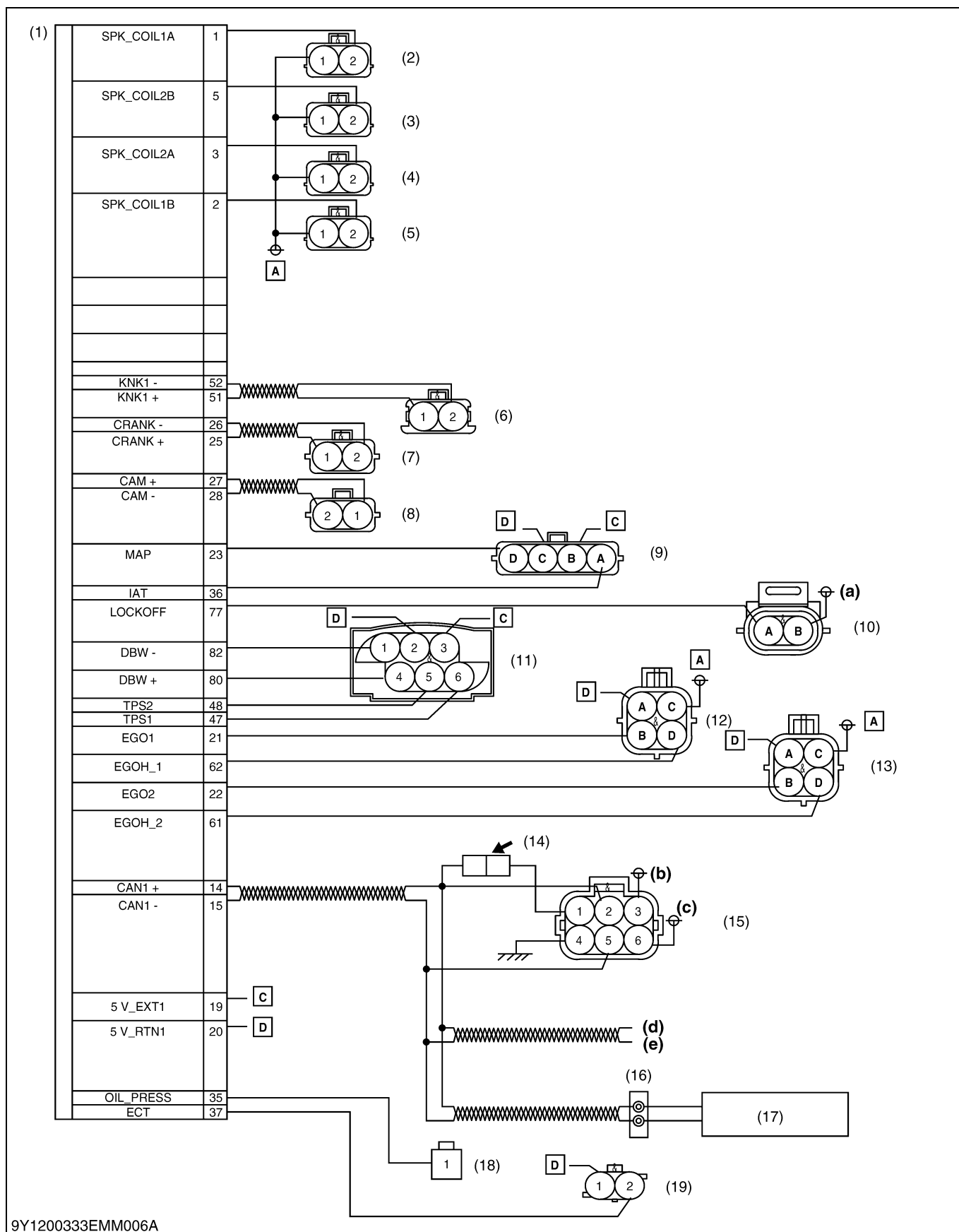
• **C: The points below are jointed.**

ECM_PIN_19 (5 V_EXT1)
 THROTTLE_ACTUATOR_PIN_3
 TMAP (BOOST) PIN_B
 FPM_PIN_C
 VIC1_PIN_M

• **D: The points below are jointed.**

ECM_PIN_20 (5 V_RTN1)
 COOLANT_TEMPERATURE_SENSOR_PIN_1
 O₂_SENSOR_PRE_CATALYST_PIN_A
 O₂_SENSOR_POST_CATALYST_PIN_A
 THROTTLE_ACTUATOR_PIN_2
 TMAP (BOOST)_PIN_C
 FPM_PIN_A
 VIC1_PIN_L

(1) VIC1 Connector	(11) Power Relay	(19) BATT+ Connector	(a) to ECM_PIN_14 (CAN1 +)
(2) ACCEL SENSOR1	(12) IGNITION 15A FUSE	(20) ALTERNATOR	(b) to ECM_PIN_15 (CAN1 -)
(3) ACCEL SENSOR2	(13) DEPR 10A FUSE	(21) BATTERY	(c) to DEPR_PIN_6
(4) MIL	(14) VSW 5A FUSE	(22) BODY EARTH	(d) to DEPR_PIN_3
(5) CAN for Vehicle	(15) STARTER 30A FUSE	(23) ENG. BODY	(e) to LPG_LOCKOFF_VALVE_PIN_B
(6) KEY OFF	(16) Starter Relay	(24) VIC2 Connector	
(7) KEY ST	(17) STARTER	(25) SPEED_METER	
(8) KEY IG	(18) SLOW-BLOW FUSE	(26) GOV_SEL2	
(9) Charge Indication	(Depend on the Alternator Size)	(27) GOV_SEL1	
(10) ECM 10A FUSE		(28) ECM (1/2)	

[B] ENGINE SIDE OF SYSTEM WIREING DIAGRAM (WG3800-L)

JOINT POINTS (A, B, C, D)• **A: The points below are jointed.**

IGNITION_FUSE (15A)
 ALTERNATOR_PIN_2
 VIC2_PIN_S
 COIL_CYL_#1,2,3,4_PIN_1
 INJ_CYL_#1,2,3,4_PIN_2
 O₂_SENSOR_PRE_CATALYST_PIN_C
 O₂_SENSOR_POST_CATALYST_PIN_C

• **B: The points below are jointed.**

BATTERY +
 KEY_SWITCH_PIN_OFF
 ALTERNATOR_CHARGE_INDICATION_LAMP
 MIL_LAMP

• **C: The points below are jointed.**

ECM_PIN_19 (5 V_EXT1)
 THROTTLE_ACTUATOR_PIN_3
 TMAP (BOOST) PIN_B
 FPM_PIN_C
 VIC1_PIN_M

• **D: The points below are jointed.**

ECM_PIN_20 (5 V_RTN1)
 COOLANT_TEMPERATURE_SENSOR_PIN_1
 O₂_SENSOR_PRE_CATALYST_PIN_A
 O₂_SENSOR_POST_CATALYST_PIN_A
 THROTTLE_ACTUATOR_PIN_2
 TMAP (BOOST)_PIN_C
 FPM_PIN_A
 VIC1_PIN_L

■ **NOTE**

- The picture shows the pin arrangement of the connector housing viewed from the harness connector mating side.

(1) ECM (2/2)	(9) TMAP (BOOST)	(15) DEPR	(a) to VSW_FUSE (5A)
(2) COIL_CYL_#1	(10) LPG Lockoff Valve	(16) DIAG_TOOL Connector	(b) to DEPR_FUSE (10A)
(3) COIL_CYL_#2	(11) Throttle Actuator	(17) CAN Tool	(c) to ECM_FUSE (10A)
(4) COIL_CYL_#3	(12) O ₂ Sensor Pre Catalyst	(18) Oil SW	(d) to VIC1_PIN_N
(5) COIL_CYL_#4	(13) O ₂ Sensor Post Catalyst	(19) Coolant Temperature Sensor	(e) to VIC1_PIN_P
(6) Knock Sensor	(14) Can Termination Connector		
(7) Crank Sensor	Open: Termination OFF		
(8) Cam Sensor	Close: Termination ON		

(2) ECU Terminal Layout

Connector Number: C001

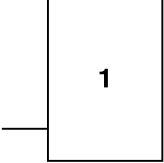
Name: ECM CONNECTOR

ECM PIN LOCATIONS								
<div><div>B</div><div>90 ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ 76</div><div>60 ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ 46</div><div>30 ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ 16</div></div>					<div><div>A</div><div>75 ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ 61</div><div>45 ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ 31</div><div>15 ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ 1</div></div>			
9Y1200176ENM047A								
PIN	DISCRIPTION		PIN	DISCRIPTION		PIN	DISCRIPTION	
1	SPK_COIL1A	GRAY	31	5 V EXT 2	RED	61	EGOH 2	YELLOW
2	SPK_COIL1B	BLUE	32	5 V RTN 2	BLACK	62	EGOH 1	WHITE
3	SPK_COIL2A	BROWN	33	–	–	63	–	–
4	SPK_GRND	BLACK	34	GOV 1	GRAY	64	–	–
5	SPK_COIL2B	GREEN	35	OIL PRESSURE	GREEN	65	–	–
6	–	–	36	IAT	YELLOW	66	–	–
7	–	–	37	ECT	BROWN	67	–	–
8	–	–	38	–	–	68	–	–
9	–	–	39	AUX ANA PU2	GRAY	69	GND	BLACK
10	–	–	40	AUX ANA PU3	ORANGE	70	–	–
11	–	–	41	AUX DIG 3	GREEN	71	–	–
12	AUX ANA PD1	ORANGE	42	AUX DIG 4	YELLOW	72	STARTER	YELLOW
13	–	—	43	TACH	BLUE	73	RELAY	BROWN
14	CAN 1 +	BLUE	44	VSW	RED	74	MIL	ORANGE
15	CAN 1 –	GREEN	45	–	–	75	–	–
16	–	–	46	–	–	76	–	–
17	–	–	47	TPS 1	GREEN	77	LOCK OFF	GREEN
18	–	–	48	TPS 2	YELLOW	78	–	–
19	5 V EXT 1	RED	49	AUX DIG 1	WHITE	79	VBAT	ORANGE
20	5 V RTN 1	BLACK	50	AUX DIG 2	BROWN	80	DBW +	WHITE
21	EGO 1	GREEN	51	KNK1 +	YELLOW	81	GND	BLACK
22	EGO 2	BLUE	52	KNK1 –	BLACK	82	DBW –	RED
23	MAP	BROWN	53	FPP1	ORANGE	83	AUX PWM5 REC	BROWN
24	–	–	54	FPP2 IVS	BLUE	84	AUX PWM5	BLUE
25	CRANK +	BLUE	55	–	–	85	AUX PWM1	YELLOW
26	CRANK –	YELLOW	56	–	–	86	–	–
27	CAM +	GREEN	57	–	–	87	AUX PWM2	RED
28	CAM –	RED	58	–	–	88	–	–
29	SPEED +	WHITE	59	–	–	89	–	–
30	SPEED –	BROWN	60	VBAT	ORANGE	90	–	–

(3) Connector Views

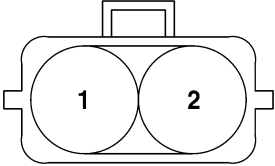
Connector Number: C002*¹

Name: Starter Solenoid

		
9Y1200176ENM049A		
Pin Number	Description	Wire Color
1	Starter Solenoid	WHITE

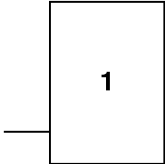
Connector Number: C003*¹

Name: Crankshaft Position Sensor

		
9Y1200176ENM197B		
Pin Number	Description	Wire Color
1	CRANK +	BLUE
2	CRANK -	YELLOW

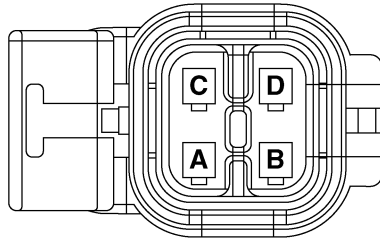
Connector Number: C004*¹

Name: Oil Pressure Switch

		
9Y1200176ENM049A		
Pin Number	Description	Wire Color
1	OIL PRESSURE	GREEN

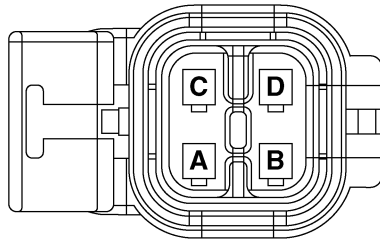
■ NOTE

- *1: All connector views are the mating connector view.

Connector Number: C005*1**Name: Heated O₂ Sensor (Pre-Cat)**

9Y1200176ENM051A

Pin Number	Description	Wire Color
A	5 V_RTN 1	BLACK
B	EGO 1	GREEN
C	12 V_RELAYED_POWER	ORANGE
D	EGOH 1	WHITE

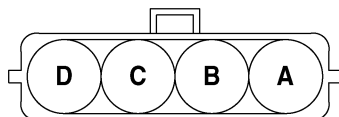
Connector Number: C006*1**Name: Heated O₂ Sensor (Post-Cat)**

9Y1200176ENM051A

Pin Number	Description	Wire Color
A	5 V_RTN 1	BLACK
B	EGO 2	BLUE
C	12 V_RELAYED_POWER	ORANGE
D	EGOH 2	YELLOW

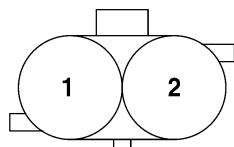
NOTE

- *1: All connector views are the mating connector view.

Connector Number: C007*¹**Name: TMAP**

9Y1200176ENM198A

Pin Number	Description	Wire Color
A	IAT	YELLOW
B	5 V_EXT 1	RED
C	5 V_RTN 1	BLACK
D	MAP	BROWN

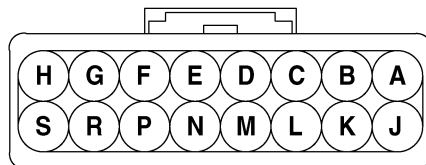
Connector Number: C008*¹**Name: Engine Coolant Temperature**

9Y1200176ENM199B

Pin Number	Description	Wire Color
1	5 V_RTN 1	BLACK
2	ECT	BROWN

■ NOTE

- *1: All connector views are the mating connector view.

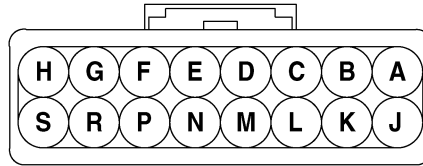
Connector Number: C009*1**Name: Vehicle Interface Connector1**

9Y1200176ENM200A

Pin Number	Description	Wire Color
A	VSW	RED
B	CHARGE_INDICATION	WHITE
C	–	–
D	–	–
E	AUX_PWM2	RED
F	START_COMMAND	BLUE
G	MIL	ORANGE
H	–	–
J	(FPP 2) FPP 2_IVS	BLUE
K	FPP1	ORANGE
L	5 V_RTN	RED
M	5 V_EXT	BLACK
N	CAN1 +	BLUE
P	CAN1 –	GREEN
R	5 V_RTN2	BLACK
S	5 V_EXT2	RED

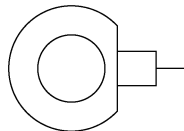
■ **NOTE**

- *1: All connector views are the mating connector view.

Connector Number: C010*¹**Name: Vehicle Interface Connector2**

9Y1200176ENM200A

Pin Number	Description	Wire Color
A	–	–
B	AUX_PWM5_REC	BROWN
C	AUX_PWM5	BLUE
D	TACH	BLUE
E	GND	BLACK
F	AUX_PWM1	YELLOW
G	AUX_ANA_PU3	GRAY
H	AUX_ANA_PU1	ORANGE
J	AUX DIG 4	YELLOW
K	GOV 1	GRAY
L	AUX_DIG2	BROWN
M	AUX_DIG3	GREEN
N	SPEED +	WHITE
P	SPEED –	BROWN
R	AUX_ANA_PD1	ORANGE
S	12 V_RELAYED_POWER	RED

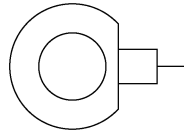
Connector Number: C011**Name: System Ground Connection**

9Y1200176ENM055A

Pin Number	Description	Wire Color
1	SYSTEM GND	BLACK

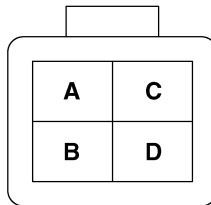
NOTE

- *1: All connector views are the mating connector view.

Connector Number: C012**Name: Alternator Battery +**

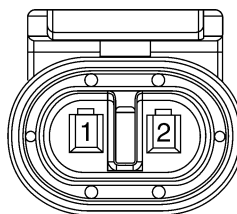
9Y1200176ENM055A

Pin Number	Description	Wire Color
1	Battery 12 V +	RED

Connector Number: C013*1**Name: Diagnostic Tool Connector**

9Y1200219EUS023A

Pin Number	Description	Wire Color
A	VSW	RED
B	GND	BLACK
C	CAN1 +	BLUE
D	CAN1 -	GREEN

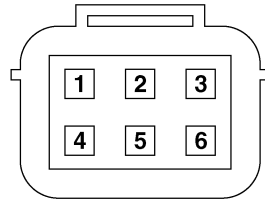
Connector Number: C014*1**Name: Alternator Connector**

9Y1200333EMM012A

Pin Number	Description	Wire Color
1	Charge Indication	WHITE
2	12 V_RELAYED_POWER	ORANGE

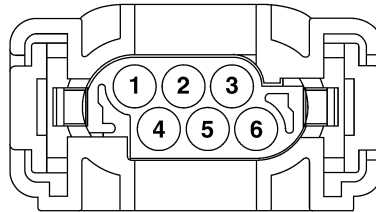
NOTE

- *1: All connector views are the mating connector view.

Connector Number: C015*¹**Name: DEPR Connector**

9Y1200176ENM059A

Pin Number	Description	Wire Color
1	CAN Termination	BLUE
2	CAN 1 +	BLUE
3	RELAY	WHITE
4	GND	BLACK
5	CAN -	GREEN
6	VBAT	RED

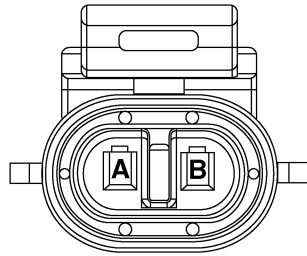
Connector Number: C016*¹**Name: Bosch Throttle Connector**

9Y1200333EMM009A

Pin Number	Description	Wire Color
1	DBW -	RED
2	5 V_RTN 1	BLACK
3	5 V_EXT 1	RED
4	DBW +	WHITE
5	TPS 2	YELLOW
6	TPS 1	GREEN

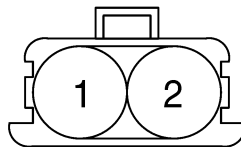
■ NOTE

- *1: All connector views are the mating connector view.

Connector Number: C017*1**Name: LPG Fuel Lock Off Connector**

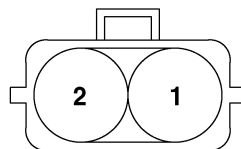
9Y1200176ENM062A

Pin Number	Description	Wire Color
A	LOCK OFF	GREEN
B	VSW	RED

Connector Number: C018*1**Name: Knock Sensor Connector**

9Y1200333EMM010A

Pin Number	Description	Wire Color
1	KNK1 +	YELLOW
2	KNK1 -	BLACK

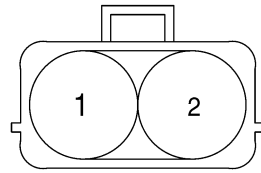
Connector Number: C019*1**Name: Camshaft Position Sensor Connector**

9Y1200176ENM201A

Pin Number	Description	Wire Color
1	CAM +	RED
2	CAM -	GREEN

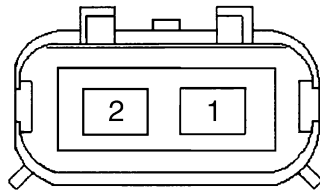
NOTE

- *1: All connector views are the mating connector view.

Connector Number: C020*¹**Name: Ignition Coil Connector**

9Y1200176ENM203B

Cylinder Number	Pin Number	Description	Wire Color
1 to 4 (All)	1	12 V_RELAYED_POWER	ORANGE
1	2	SPK_COIL1A	GRAY
2	2	SPK_COIL2B	GREEN
3	2	SPK_COIL2A	BROWN
4	2	SPK_COIL1B	BLUE

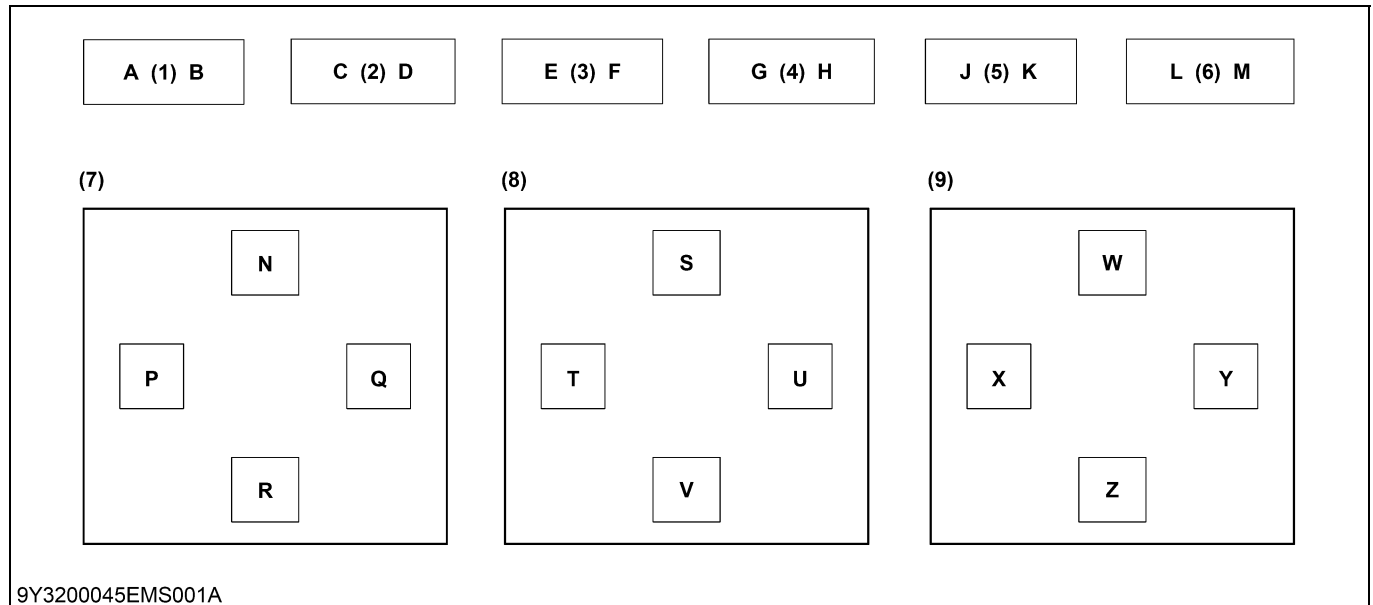
Connector Number: C021*¹**Name: BATT+ Connector**

9Y1200333EMM015A

Pin Number	Description	Wire Color
1	STARTER_FUSE	RED
2	ECM_FUSE	RED

NOTE

- *1: All connector views are the mating connector view.

Connector Number: C022**Name: FUSE BOX (LAYOUT)**

9Y3200045EMS001A

Pin Number	Wire Color	Pin Number	Wire Color	Pin Number	Wire Color
A	RED	J	WHITE	S	ORANGE
B	ORANGE	K	WHITE	T	RED
C	RED	L	ORANGE	U	ORANGE
D	RED	M	ORANGE	V	BROWN
E	RED	N	–	W	BLUE
F	RED	P	–	X	RED
G	–	Q	–	Y	WHITE
H	–	R	–	Z	YELLOW

(1) 10 A FUSE
 (2) 5 A FUSE
 (3) 30 A FUSE

(4) BLANK
 (5) 10 A FUSE

(6) 15 A FUSE
 (7) BLANK

(8) POWER RELAY
 (9) STARTER RELAY

(4) Repair of Wiring Harness

INTRODUCTION

The EControls ECM for both certified and non-certified fuel system relies on precise voltage input and outputs to maintain precise fuel control during normal operation. The ECM utilizes reference voltage signals to calculate fuel control, command throttle and engine speed and provide data to the operator through the instrument cluster.

When diagnosing faults in the system often the technician is required to disconnect the electrical connectors in the wire harness. Technicians should always use care when working on the wire harness. Special care should be given to the following items:

- When disconnecting connectors always grasp the connector at its base **DO NOT PULL ON THE WIRES** this may cause extreme stress on the crimped or solder joints
- Always depress or unlatch the connector **DO NOT USE A SCREW DRIVER TO PRY THE CONNECTOR APART** as damage to the connector or mating electrical device can occur
- When disconnecting a electrical connector always check the connector for corrosion in the connector pins, moisture in the connector, missing or damage water seals.
- **DO NOT PUSH THE ELECTRICAL PROBES INTO THE PINS WHEN TESTING CIRCUITS** as this will cause the pin to become enlarged and result in intermittent electrical problems
- When reconnecting an electrical connector "PUSH" the connector together until you here the "CLICK" then "PULL" on the connector base to make sure it is seated and locked.
- Make sure to route the harness in the original fashion and secure the harness using straps, wire ties or clips to prevent the harness from contact with hot surfaces, rotating devices or damage for external elements

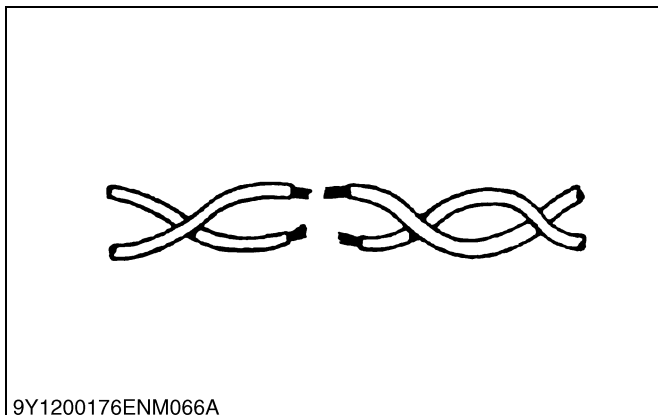
Because the critical sensor control circuits operate at low voltage it is always best to use solder to make joints and replace connector pins. Refer to next page "REPAIR OF WIRING HARNESS". If a connector is the "Molded" type and requires repair the complete connector must be replaced using a "pig tail" replacement.

CONNECTORS AND TERMINALS

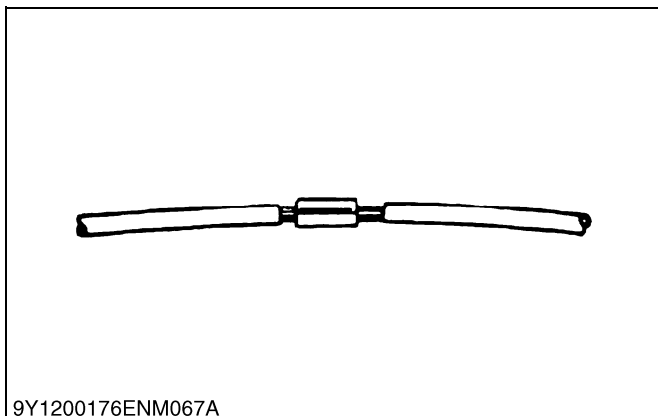
As stated earlier always use care when probing a connector or replacing terminals in a connector housing. Improper repair of a connector can resulting in shorts at the connector and can damage critical electrical components. Always use a jumper wire between the terminal when checking circuits. **NEVER USE A SHARP POINTED OBJECT TO PROBE THROUGH THE WEATHER TIGHT SEALS**, doing so will allow water to intrude into the circuit and will result in future electrical faults in the system or may deter system performance.

Using the proper tools when working on the wire harness is essential to making proper and durable repairs. Use of an improper tool may result in damaging other electrical components and will result in needless repair costs. When working with the use proper wire stripping and cutting tools, use a fuse removal tool when replacing or check fuses, use a small screw driver to unlock connector latches, use electrical probes when testing wires, it is often best to find mating connectors to the EControls wire harness connectors for testing circuits as this will ensure a positive connection when reading ohms or voltage. Use the proper "Pin Removal Tool" when removing a connector terminal from its housing.³

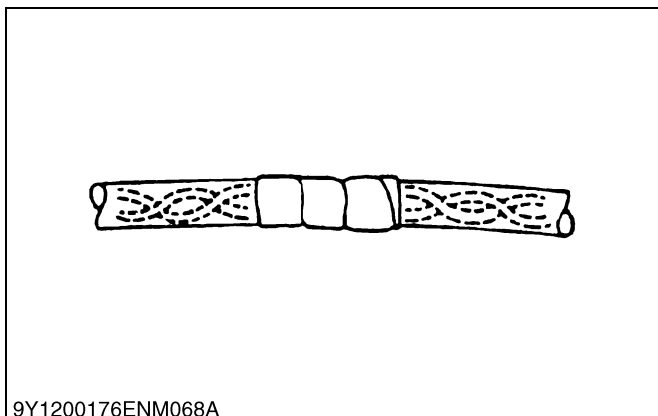
When diagnosing intermittent shorts in the electrical system is often easy to find the fault by wiggling the wires in a connector while the engine is operating as this may cause the misalignment, or corrosion to negatively affect the connection. Corrosion is a primary cause of electrical faults within the system, always look for visible signs of corrosion when diagnosing an electrical fault.

REPAIR OF WIRING HARNESS**TWISTED LEADS**

1. Locate the damaged wire remove only sufficient insulation to allow for a complete sealing of the wire in the connector splice.



2. Place a proper sized heat shrink tube over one of the cut end and slide back from the splice area.
3. position each of the stripped wire ends into the splice and ensure there is no bare wire exposed.
4. Solder the connection using a Rosin Core solder
5. Slide the heat shrink tube over the splice and use heat to shrink the tube over the connection to create a water tight seal.



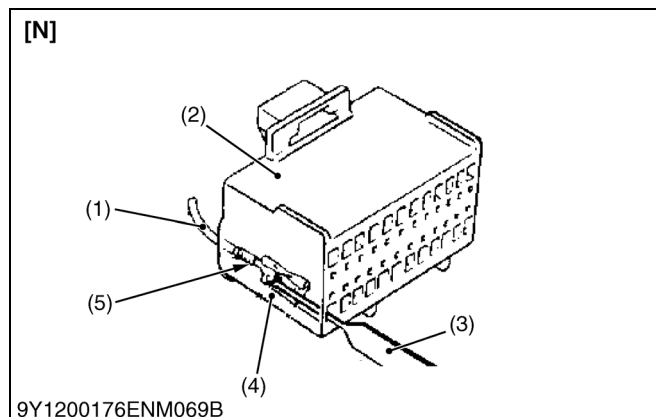
6. Re-twist the wire and secure the splice are with electrical tape to tightly seal the area.

CONNECTOR END REPAIR OR REPLACEMENT

Before making a connector repair, be certain of the type of connector for example Weather-Pack connectors and Compact Three connectors look very similar but are service differently.

MICRO-PACK CONNECTOR

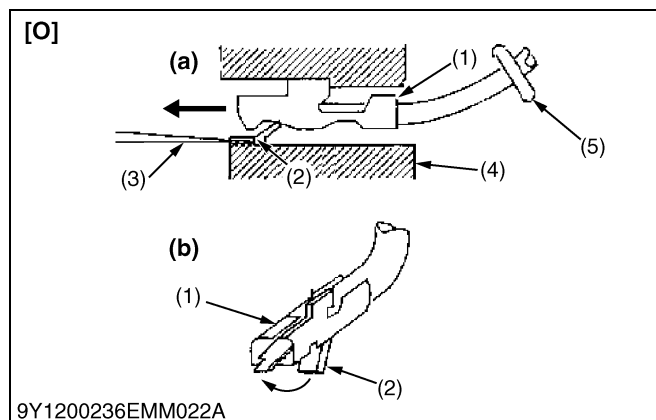
Refer to below figure [N] for the repair procedure for the repair of a MICRO-PACK connector

**[N]: MICRO PACK CONNECTOR REPAIR**

- | | |
|---------------------------------------|------------------|
| (1) Connector Housing | (4) Locking Tang |
| (2) Cable | (5) Terminal |
| (3) Pin Removal Tool J33095, BTB234-A | |

METRI-PACK CONNECTORS

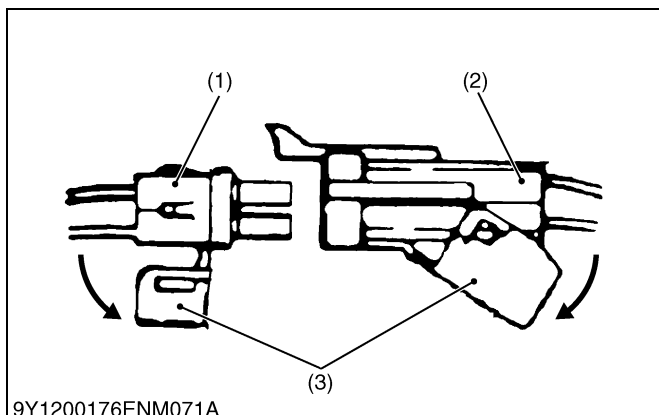
Some electrical connectors on the harness may utilize a METRI-PACK connector. Refer to below figure [O] for removal and repair of the terminal.

**[O]: METRI-PACK Terminal Repair**

- | | |
|---|----------------------------|
| (1) METRI-PACK Series 150 Female Terminal | (a) Cut image of connector |
| (2) Locking Tang | (b) End of Wire harness |
| (3) Tool J35689, or Bt-8446 | |
| (4) Connector Body | |
| (5) Seal | |

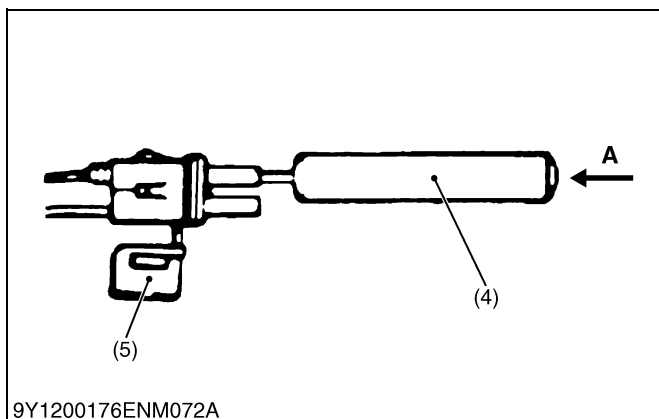
WEATHER PACK CONNECTOR

A Weather-Pack connector can be identified by a rubber seal installed to the wire at the rear of the connector. This type of connector is used in the engine compartment to protect against moisture intrusion into the connector. Refer to below procedure 1 to 7 for terminal removal and repair.



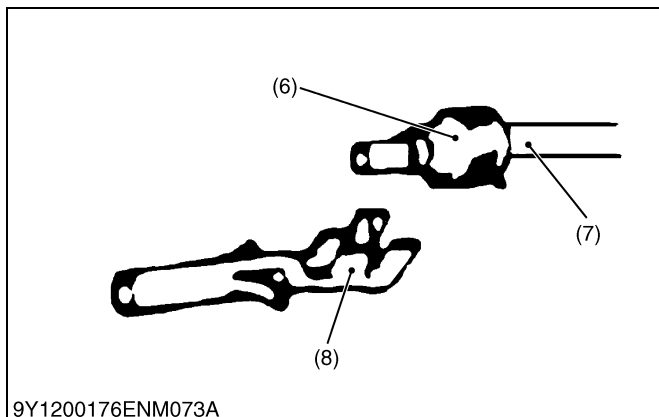
9Y1200176ENM071A

1. Open the secondary lock hinge to the female connector and separate the connectors.



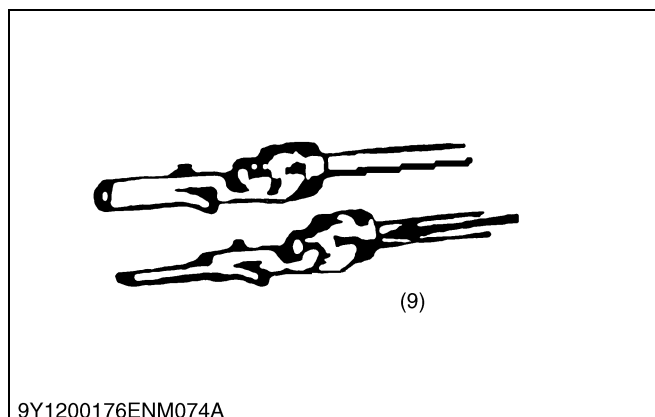
9Y1200176ENM072A

2. Remove the terminal using the pin tool.



9Y1200176ENM073A

3. Cut the wire immediately behind the cable seal.



9Y1200176ENM074A

4. Replace the terminal
 - a) Slip the new seal onto the wire.
 - b) Strip 5 mm (0.2 in.) of insulation from the wire.
 - c) Crimp the terminal over the wire and seal.
5. Push the terminal back into the connector until the locking tangs are seated.
6. Connect the male and female terminals.
7. Close the secondary locks.

- | | |
|-----------------------------|---------------------------|
| (1) Male Connector | (6) Seal |
| (2) Female Connector | (7) Wire |
| (3) Secondary Lock Hinge | (8) Terminal |
| (4) Tool J-28742 / BT8234-A | (9) Wire Harness Terminal |
| (5) Terminal | |

6. DIAGNOSIS

[1] FUEL SYSTEM CHECKS

INTRODUCTION

The maintenance of the engine fitted with Kubota LPG fuel systems, and its related components, is critical to the life of the engine and optimum performance, during its useful life. All engines require a certain amount of maintenance. The suggested maintenance requirements are contained in this section. Industrial engines operate in various environmental conditions, and various temperature ranges.

■ NOTE

- **This is a recommended guide line only; each user must assess the daily operational usage and environmental conditions, and determine an appropriate schedule.**

In addition, the owner may have installed additional equipment to the vehicle, which may also increase the requirements for service on certain components. Therefore, the owner and the service agent, should review the operating condition of the equipment, and determine if more frequent inspections, and maintenance cycles maybe required.

This section of the service manual supplement, covers the maintenance items of both the LPG fuel systems, which are designed and supplied by EControls, and general information on those items which are supplied by Kubota, and requires regularly scheduled maintenance. For maintenance of the base engine and or chassis, refer to the Kubota manual which covers the maintenance of the equipment.

GENERAL LPG FUEL TANK MAINTENANCE

LPG TANKS

The typical LPG fuel storage cylinder should be inspected daily or at the beginning of each shift for any of the following.

- External leaks, external damage
- Manual service valve is fully open
- Securely mounted; inspect the securing straps for damage, and that the securing devices are closed and locked.
- Insure that the fuel storage cylinder is properly positioned in the locating pin, in the tank collar, on all horizontally mounted tanks. This will insure that the tank pressure relief device will always be in the correct position, to function if required.

When refueling or exchanging a cylinder, check the following:

- Quick fill valve for thread damage
- Insure that the o-ring seal is in place
- Check the o-ring for cracks, separation or chunking;
- Replace the o-ring if necessary before refueling
- Check the service line quick coupler for any thread damage
- Check the coupler o-ring for cracks, separation, or chunking

■ IMPORTANT

- **When refueling the cylinder, clean both the fill hose and the tank connector with a clean cloth to remove any dust, dirt or debris to prevent contamination of the fuel system.**



WARNING

NEVER CUT OR WELLD ON EITHER THE LPG OR GASOLINE FUEL TANK. REPAIRS TO THE FUEL TANL SHOULD ONLY BE MADE BY A CREATIFIED TANK REPAIR FACILITY. FAILURE TO OBSERVE THIS WARNING COULD RESULT IN SERIOUS BODILY INJURY AND OR DEATH AND COULD RESULT IN SERIOUS PROPERETY DAMAGE.

FUEL FILTER MAINTENANCE

Kubota fuel systems will be designed with a specification, which requires filtration of the system. With the EControls designed fuel system; the filter have been attached with additional filtration, (Refer to Kubota Base engine section).

To determine the recommended maintenance intervals, refer to the Maintenance check list at workshop manual (WSM). However, engines which operate in extremely dirty environment will require more frequent maintenance.

When inspecting the fuel filtration systems, check the following:

- Check for any fuel leaks at the inlet and outlet fittings.
- Check to make sure the filter is securely mounted.
- Check for any external damage or distortion; if damaged replace the filter element.

To replace the filters use the following steps:

1. Move the equipment to a well ventilated area and insure there are no external ignition sources.
2. On LPG systems start the engine and close the manual valve on the cylinder, and run the engine until the engine runs out of fuel.
3. Remove and replace the fuel filter.
4. Leak check the connections with a soapy solution, or electronic leak detector.



WARNING

ALWAYS WEAR PROTECTIVE EYEWEAR AND GLOVES WHEN PERFORMING MAINTENANCE ON THE LPG OR GASOLINE FUEL SYSTEMS, TO PREVENT SERIOUS INJURY. ALWAYS PERFORM MAINTENANCE PROCEDURES IN A WELL VENTILATED AREA AND INSURE THAT THERE ARE NO EXTERNAL SOURCES OF IGNITION

FUEL SUPPLY AND RETURN LINE MAINTENANCE

Kubota LPG and Gasoline fuel system utilize fuel supply and return lines that are attached by Kubota. These lines are made of special rubber or metal material, which meet the design working pressures, regional requirements, and provide the proper protection from chemicals found in the fuels. It is recommended that all the fuel line connections be leak checked annually at a minimum, or anytime the lines have been removed. The routing of the lines should also be inspected annually, to insure that the lines have not come into contact with any rotating devices, hot surfaces, or are located in a position in which they may be impacted by debris.

LPG PRESSURE REGULATORS

LPG DUAL STAGE REGULATOR (DSR)

The EControls LPG DSR is a two stage mechanical regulator with an integral vaporizer which reduces the fuel inlet or tank pressure to a specific lower pressure and adds heat to the fuel for vaporization. You should check the following items at a minimum of once per year:

- Check for any fuel leaks at the inlet and outlet fittings.
- Check for any fuel leaks at the connecting seams of the regulator body.
- Check the inlet and outlet coolant fittings at the regulator body.
- Check the inlet and outlet coolant lines for hardening, cracking, chaffing or splits. If any of these conditions exist replace the coolant lines.
- Check the inlet and outlet coolant line hose clamps at each connection, tighten if necessary.
- Check the mounting bracket to insure the regulator is securely mounted, tighten if necessary.
- Check any of the rubber isolators used for mounting for cracking, hardening or separation.
- Check the regulator for a buildup of oil in the second stage chamber of the regulator.

■ NOTE

- **Certain Kubota LPG systems may be fitted with a Direct Electronic Pressure Regulator (DEPR) which is downstream of the DSR. Check these items when inspecting the DEPR:**
- Check the harness connection on the electronic control section, to insure it is seated and locked.
- Check to make sure the DEPR assembly is securely mounted.

■ NOTE

- **All EControls LPG systems are fitted with an LPG Fuel Lock Off device which is typically mounted to the inlet of the DSR. These are the additional items when inspecting the regulator:**
- Check for any fuel leaks at the inlet and outlet fittings.
- Check the Lock Off electrical connector, to insure it is seated and locked.
- Check to insure the solenoid retaining nut is tightened and fully seated.

ELECTRICAL SYSTEM CHECKS

The electrical system, sensors, wiring harness, and ECM do not require any periodic adjustments. You should annually inspect the following items.

BATTERY

- Check and clean the battery terminal connections and insure the connections are tight.
- Check the battery for any cracks or damage to the case.
- Check the Positive and Negative battery cables for any corrosion build up, rubbing or chaffing, and check ground connections on chassis, to insure they are tight.

ECM CHECKS

- Check the mounting bracket for the EControls ECM, for cracks or breaking.
- Check the controller mounting bracket, securing bolts to insure they are securely fastened.
- Check the rubber isolators for cracks or deterioration.
- Check the electrical connector and insure the connector is securely attached, locked and the secondary lock is in position. Check the connector for any corrosion in the connector, or on the pins. Clean if observed.

WIRE HARNESS CHECKS

- Check the wire harness routing, under the hood, to insure the main harness and injector harness have not come into contact with any rotating devices, hot surfaces, or have come loose from their securing points, and are hanging in an unsafe location.
- Check all wire ties and / or clamps used to secure the harness for cracking, splitting, or breakage, replace if necessary.
- Check the harness routing and insure the harness is securely attached to the frame and protected from any hot surfaces, rotating devices or road debris, repair any unsafe condition.

SENSORS

- While inspecting the wire harness connector for each sensor, check for any damage to the sensor.
- If the sensor is retained by threads or by fasteners, insure the retaining device is fully secured.

IGNITION SYSTEM

- Check ignition coil and spark plug cables for hardening, cracking, chaffing, separation, split boot covers and properly fitted.
- Replace spark plugs at the proper intervals, as prescribed in the recommended maintenance.
- Check to make sure all electrical components are fitted securely.

MISCELLANEOUS ELECTRICAL

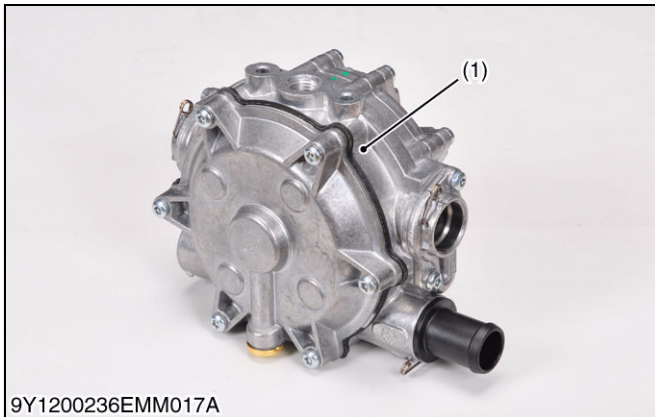
- Check the instrument panel to insure all warning lights are functioning, MIL, oil pressure and temperature gauges are registering
- Check the ignition switch and electrical connectors to insure the connections are fully seated and locked and the tumbler mechanism is working properly.

RECOMMENDED MAINTENANCE

The maintenance schedule represents manufacturers recommended maintenance intervals to maintain proper engine/equipment function. Specific state and federal regulations may require equipment operators to conduct comprehensive engine/equipment inspections at more periodic intervals than those specified above.

[2] FUEL SYSTEM DIAGNOSIS

LPG Fuel System Diagnosis (Open & Closed Loop Systems)



(1) Dual Stage Regulator (DSR)

DUAL STAGE REGULATOR (DSR)

This section of the manual has been prepared to allow the technician to check the mechanical functions, of the regulator and fuel delivery devices, of the EControls "closed loop" fuel control delivery system. The design of the EControls closed loop system is such that, Diagnostic Trouble Codes (DTC) are employed to monitor the fuel delivery system. To properly diagnose fuel delivery system faults, you should first install the EControls GCP diagnostic laptop tool to check for any DTC present in the ECM first, and refer to the proper DTC chart, prior to utilizing this diagnostic section.

The DSR is a combination vaporizer, pressure regulating device. The DSR is a two stage regulator that is a positive pressure regulator that is normally open in the secondary chamber, when the engine is not running. When the engine is cranking or running, pressure from the secondary chamber passes from the regulator to Direct Electronic Pressure Regulators (DEPR), and mixer.

LPG fuel enters the primary port of the DSR, and passes through the primary jet, and into the primary/exchanger chamber. As the LPG passes through the heat exchanger, the fuel expands and creates pressure inside the chamber. The pressure rises as the fuel expands. When the pressure rises above 10 kPa (0.10 kgf/cm², 1.4 psi), sufficient pressure is exerted on the primary diaphragm, to cause the diaphragm plate, to pivot and press against the primary valve pin, thus closing off the flow of fuel. This action causes the flow of fuel into the regulator, to be regulated. The secondary diaphragm is spring loaded on top of the secondary diaphragm, causing the secondary lever to be pressed down, which opens the secondary seat. When the pressure in the primary chamber enters the secondary chamber, the diaphragm is forced in an upward motion, thus closing the secondary lever against the valve seat. When commanded by the ECM, the DEPR will open, which causes a pressure drop in the secondary seat, and allows the secondary seat to open,

and allow fuel to flow to the DEPR. The DEPR regulates the fuel delivery to the mixer, based on the calibration required, for the specific engine load and speed, determined during engine fuel system development.

The DSR requires a connection to the engine coolant, to prevent freezing in the regulator, during the pressure reduction phase, within the regulator. Coolant connections on the DSR are fitted with "Push In" fittings. These fitting are designed with an o-ring seal, which allows the fitting to be pushed into the water connection on the DSR, and are then locked by spring locks, and retained by screws.

The DSR is connected to the DEPR, by a low pressure flexible hose. Like the other fuel hoses used in the fuel system, the low pressure hose is designed with a special inner core and may also be wire reinforced, to prevent collapse of the hose, during high demand fueling operations. The low pressure hose should only be replaced with the recommended Kubota hose replacement.

The packaging of the regulator, into the engine and chassis, has been approved by EControls, to insure continued long term operation, of the fuel delivery and emissions control system.

■ NOTE

- **You should never relocate the regulator or any of the fuel system components, as doing so may cause excess build up of oil in the regulator, improper coolant flow, or improper fuel delivery.**

In certain regions, fuel supplies may contain different chemicals and may employ different manufacturing processes to make the LPG, which during the heating of the fuel in the heat exchange section of the regulator, may cause "heavy ends", to accumulate over time. The DSR is attached with a drain plug, to allow the technician to drain excess oil and other contaminants from the regulator. To determine the frequency for draining the regulators, refer to the Recommended Maintenance Schedule.

The regulator utilized on USA emissions certified engines, are a critical part of the certified emissions system, and do not require any periodic adjustment.

(To be continued)

(Continued)**Tools Required:**

- 7/16 Open end wrench (for test port plugs)
- Straight Blade screw driver
- DVOM

Diagnostic Scan Tool

- EDIS or KGST Software (laptop)

Pressure Gauges

- 0 to 69 kPa (0 to 0.70 kgf/cm², 0 to 10 psi) Gauge

Test Description

The numbers below refer to step numbers, on the diagnostic table which identify faulty components.

1. This step will determine if the DSR primary fuel pressure regulation is correct.
2. This step determines if the LPG Fuel Lock Off is functioning properly
3. This step checks for Plugged filters if attached
4. This step determines if fuel is available, from the fuel tank & supply system.

LPG Fuel System Diagnosis

Step	Action	Value(s)	Yes	No
L1	Were you referred to this procedure by a DTC diagnostic chart?	—	Go to Step L3	Go to Step L2
L2	Connect the EDIS or KGST. Key On Engine Off System Mode Stopped Are any DTCs present in the ECM?	—	Go to the applicable DTC Table	Go to Step L3
L3	Verify that the LPG fuel tank has a minimum 1/4 tank of fuel, and that the manual valve is open. Is the tank valve open and fuel in the tank?	—	Go to Step L4	Refuel tank and Open Valve
L4	Connect a 0 to 69 kPa (0 to 0.70 kgf/cm ² , 0 to 10 psi) gauge to the primary test port of the dual stage regulator (DSR). Key On Engine Running System Running Mode Observe the pressure reading, for the DSR primary pressure. Is the fuel pressure ABOVE the specified value?	14 to 24 kPa (0.15 to 0.24 kgf/cm ² , 2.1 to 3.4 psi)	Go to Step L13	Go to Step L5
L5	Turn OFF the ignition. Disconnect the LPG Fuel lock Off electrical connector. Install a test light between the 12 V supply pin of the LPG Fuel lock-off connector and battery ground, or connect a DVOM between the two pins. Crank the engine. The test light should illuminate or 12 V should be present. Does the test light illuminate?	12 V	Go to Step L6	Go to Step L12
L6	Using a DVOM, check the resistance of the LPG fuel lock-off. Is the resistance within the specified range?	12 to 24 W	Go to Step L7	Go to Step L14
L7	Turn the ignition OFF. Close the manual shut-off valve on the LPG tank. ⚠ CAUTION • When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area. Slowly loosen the fuel inlet hose fitting, at the inlet of the LPL (Low Pressure Lockoff). Was fuel present, when the fitting was loosened?	—	Go to Step L8B	Go to Step L8A
L8A	Engines fitted with a LPG in-line fuel filter: Slowly loosen the inlet to the fuel filter. Was fuel present, when the fitting was loosened?	—	Go to Step L11	Go to Step L9
L8B	Engines fitted with a integrated filter to the LPL. Remove the filter from the LPL. Empty the contents, of the inlet side of the LPG fuel filter, onto a clean surface. Inspect the contents of the LPG fuel filter, for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. Verify if the LPG fuel filter is not restricted or plugged. Was a problem found?	—	Go to Step L11	Go to Step L9

Step	Action	Value(s)	Yes	No
L9	With the fuel line loose at the fuel filter inlet (in-line filter) or at the LPL inlet. Slowly open and close the manual valve. Did fuel begin to flow when the manual valve was opened?	–	Go to Step L14	Go to Step L10
L10	Check the fuel supply system, the hoses are plugged or restricted or the tank valve is not opening. Locate and repair the problem. Is the action complete?	–	Go to Step L16	–
L11	Replace the fuel filter. Refer to Fuel Filter Replacement. Is the action complete?	–	Go to Step L16	–
L12	Repair the open or short, in the lock-off circuit. Is the action complete?	–	Go to Step L16	–
L13	Replace the dual stage regulator (DSR). Refer to Dual Stage Regulator Replacement. Is the action complete?	–	Go to Step L16	–
L14	Replace the lock-off. Refer to Low Pressure Lock-off (LPL) Replacement. Is the action complete?	–	Go to Step L16	–
L15	The fuel supply system is operating normally. Install the test plug, in the DSR secondary chamber. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure. Is the action complete?	–	System OK	–
L16	Disconnect all test equipment. Install the primary and secondary test port plugs, if removed. Start the engine. Using SNOOP® ? or equivalent, leak check the test port plugs, if removed. Is the action complete?	–	System OK	–

(1) Restricted Exhaust System Diagnosis

Exhaust System Description

The emission certified engine has been designed and calibrated to meet the emission standards in effect for 2010. To help meet the emission requirements the vehicle has been attached with a three way catalyst. The catalyst is a three way catalyst, sound damping and spark arresting unit. Besides controlling the noise created from the combustion process, and preventing sparks from escaping from the exhaust system the most important function is treating the exhaust gases which are created from the combustion process. The three-way catalyst consists of a honeycomb core coated with a mixture of precious metals. The hot gases flow through the catalyst honeycomb core where an oxidation and reduction reactions take place. These chemical reactions reduce the amount of CO, HC and NOX in the engines exhaust. The Exhaust gas then flows through the tailpipe outlet.

During normal operation the exhaust system could become damaged. Damage which reduces the flow of the exhaust gas will create increased back pressure in the engine. Reduction in exhaust flow can result from crushed muffler outlets or melted catalyst brick inside the converter.

It may be necessary to measure the back pressure in the exhaust system. To determine if the back pressure in the engine is correct use the following procedure.

Diagnostic Aids

Tools Required:

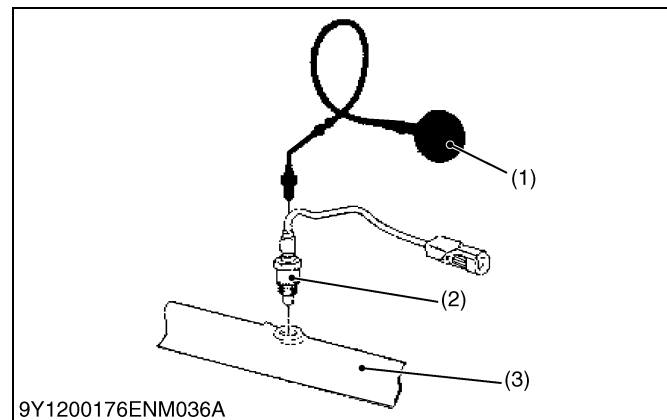
- Back pressure gage 0 to 69 kPa (0 to 0.70 kgf/cm², 0 to 10 psi)

Diagnostic Scan Tool:

- EDIS or KGST software (laptop)

Check at Heated Exhaust Gas Oxygen Sensor (HEGO)

1. Carefully remove the HEGO.
2. Install exhaust back pressure gage in place of the HEGO. (Refer to below figure.)
3. With the engine idling at normal operating temperature, observe the exhaust system back pressure reading on the gage. Reading should not exceed 8.6 kPa (0.088 kgf/cm², 1.2 psi).
4. Increase engine speed to 2000 min⁻¹(rpm) and observe gage. Reading should not exceed 20.7 kPa (0.211 kgf/cm², 3.00 psi).
5. If the back pressure at either speed exceeds specification, a restricted exhaust system is indicated.
6. Inspect the entire exhaust system for a collapsed pipe, heat distress or possible internal muffler failure.
7. If there are no obvious reasons for the excessive back pressure, the catalytic converter is suspected to be restricted and should be replaced using the recommended procedures.



- | | |
|--------------------------------------|----------------------|
| (1) Back Pressure Gage | (3) Exhaust Manifold |
| (2) Oxygen Sensor (O ₂ S) | |

[3] DTC LIST

DTC		16	107	108
Name		Cam/Crank Sensors	MAP	MAP
DTC Name		Crank and/or Cam Could Not Synchronize During Start	MAP Low Voltage	MAP high pressure
J1939	SPN	636	106	106
	FMI	8	4	16
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Mechanical misalignment between cam and crank 	<ul style="list-style-type: none"> Sensor/wiring harness open/short to ground Sensor malfunction 	<ul style="list-style-type: none"> Sensor/wiring harness short to power Sensor malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Cranking or Running 	<ul style="list-style-type: none"> Engine Cranking or Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> Cranking revs without sysnc > 4.0 revs and RPM > 90 min⁻¹ (rpm) 	<ul style="list-style-type: none"> MAP voltage < 0.050 V and TPS > 2.0 % and RPM < 4000 min⁻¹ (rpm) 	<ul style="list-style-type: none"> MAP pressure > 110.3 kPa [abs] (1.125 kgf/cm², 16.00 psia) and TPS < 10.0 % and RPM > 700 min⁻¹ (rpm)
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 2 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 2 sec
System Action		<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		111	112	113
Name		IAT	IAT	IAT
DTC Name		IAT Higher Than Expected Stage 1	IAT Low Voltage	IAT High Voltage
J1939	SPN	105	105	105
	FMI	15	4	3
MIL		OFF	ON	ON
Detected Item		<ul style="list-style-type: none"> Intake air temperature abnormality (High side stage 1) 	<ul style="list-style-type: none"> Sensor/wiring harness short to ground Sensor malfunction 	<ul style="list-style-type: none"> Sensor/wiring harness open/short to power Sensor malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off
DTC Set Conditions		<ul style="list-style-type: none"> IAT > 71.1 degC (160 degF) and RPM > 1000 min⁻¹ (rpm) 	<ul style="list-style-type: none"> IAT voltage < 0.100 V 	<ul style="list-style-type: none"> IAT voltage > 4.90 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 10 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 1 sec
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		116	117	118
Name		ECT/CHT	ECT/CHT	ECT/CHT
DTC Name		ECT Higher Than Expected Stage 1	ECT/CHT Low Voltage	ECT/CHT High Voltage
J1939	SPN	110	110	110
	FMI	15	4	3
MIL		OFF	ON	ON
Detected Item		<ul style="list-style-type: none"> Engine coolant temperature abnormality (High side stage 1) 	<ul style="list-style-type: none"> Sensor/wiring harness short to ground Sensor malfunction 	<ul style="list-style-type: none"> Sensor/wiring harness open/short to power Sensor malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off
DTC Set Conditions		<ul style="list-style-type: none"> Run time wait for ECT HiExp faults 30.0 sec ECT > 110 degC (230 degF) and RPM > 600 min⁻¹ (rpm) 	<ul style="list-style-type: none"> ECT voltage < 0.100 V 	<ul style="list-style-type: none"> ECT voltage > 4.90 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 20 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 1 sec
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		121	122	123
Name		TPS	TPS	TPS
DTC Name		TPS1 % Lower Than TPS2 %	TPS1 Signal Voltage Low	TPS1 Signal Voltage High
J1939	SPN	51	51	51
	FMI	1	4	3
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> TPS malfunction 	<ul style="list-style-type: none"> TPS circuit in the harness short to ground TPS malfunction 	<ul style="list-style-type: none"> TPS circuit in the harness short to power TPS malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> (TPS1 % – TPS2 %) < –20.0 % 	<ul style="list-style-type: none"> TPS1 voltage < 0.200 V 	<ul style="list-style-type: none"> TPS1 voltage > 4.80 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 0.5 sec
System Action		<ul style="list-style-type: none"> Engine Stop 	<ul style="list-style-type: none"> Engine Stop 	<ul style="list-style-type: none"> Engine Stop
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		127	129	134
Name		IAT	IAT	EGO Sensors
DTC Name		IAT Higher Than Expected Stage 2	BP Low Pressure	EGO1 Open/Lazy (HO2S1)
J1939	SPN	105	108	3217
	FMI	0	1	5
MIL		OFF	ON	ON
Detected Item		<ul style="list-style-type: none"> Intake air temperature abnormality (High side stage 2) 	<ul style="list-style-type: none"> Sensor out of calibration Loss for 5V reference feed (5V_ext1) to MAP Signal wire open or shorted to ground 	<ul style="list-style-type: none"> Open feed circuit to O₂ heater Open or shorted to ground O₂ signal wire Open sensor ground (5Vrtn1) Inoperative sensor
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Key On, Engine Off or after BP estimate during low-speed or high load operation 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> IAT > 87.8 degC (190 degF) and RPM > 1000 min⁻¹ (rpm) 	<ul style="list-style-type: none"> BP < 57.2 kPa [abs] (0.584 kgf/cm², 8.30 psia) 	<ul style="list-style-type: none"> EGO cold persistently > 120.0 sec
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 10 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 5 sec
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 2 Force Idle 	<ul style="list-style-type: none"> AL Disable 	<ul style="list-style-type: none"> CL Disable AL Disable
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		154	187	217
Name		EGO Sensors	FT	ECT/CHT
DTC Name		EGO2 Open/Lazy (HO2S2)	FT Gaseous Fuel Extremely Low	ECT Higher Than Expected 2
J1939	SPN	3227	3468	110
	FMI	5	1	0
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Open feed circuit to O₂ heater Open or shorted to ground O₂ signal wire Open sensor ground (5Vrtn1) Inoperative sensor 	<ul style="list-style-type: none"> Not vaporized completely 	<ul style="list-style-type: none"> Engine coolant temperature abnormality (High side stage 2)
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> EGO cold persistently > 120.0 sec 	<ul style="list-style-type: none"> Fuel temp < -40 degC (-40 degF) 	<ul style="list-style-type: none"> Run time wait for ECT HiExp faults 30.0 sec ECT > 116 degC (240 degF) and RPM > 600 min⁻¹ (rpm)
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 5 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 10 sec
System Action		<ul style="list-style-type: none"> AL Disable 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> AL Disable Power Derate 2 Forced Idle
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		219	221	222
Name		Engine Speed	TPS	TPS
DTC Name		RPM Higher Than Max Allowed Governed Speed	TPS1 % Higher Than TPS2 %	TPS2 Signal Voltage Low
J1939	SPN	515	51	3673
	FMI	15	0	4
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Engine over speed condition, stuck throttle, large vacuum leak into intake manifold after throttle blade 	<ul style="list-style-type: none"> TPS malfunction 	<ul style="list-style-type: none"> TPS circuit in the harness short to ground TPS malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> RPM > 3000 min⁻¹ (rpm) 	<ul style="list-style-type: none"> (TPS1 % – TPS2 %) > 20.0 % 	<ul style="list-style-type: none"> TPS2 voltage < 0.200 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 0.5 sec
System Action		<ul style="list-style-type: none"> Reduce throttle to limit speed 	<ul style="list-style-type: none"> Engine Stop 	<ul style="list-style-type: none"> Engine Stop
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		223	326	327
Name		TPS	Knock	Knock
DTC Name		TPS2 Signal Voltage High	Knock 1 Excessive or Erratic Signal	Knock 1 Sensor Open or Not Present
J1939	SPN	3673	731	731
	FMI	3	2	4
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> TPS circuit in the harness short to power TPS malfunction 	<ul style="list-style-type: none"> Knock signal abnormality (High side) Sensor malfunction 	<ul style="list-style-type: none"> Sensor/wiring harness open/short to power Sensor malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> TPS2 voltage > 4.80 V 	<ul style="list-style-type: none"> KNK1 sensor input > 0.250 V MAP < 55.2 kPa [abs] (0.562 kgf/cm², 8.00 psia) 	<ul style="list-style-type: none"> KNK1 sensor input < 0.002 V and RPM > 1400 min⁻¹ (rpm) and MAP > 82.7 kPa [abs] (0.843 kgf/cm², 12.0 psia)
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 3 sec 	<ul style="list-style-type: none"> 3 sec
System Action		<ul style="list-style-type: none"> Engine Stop 	<ul style="list-style-type: none"> Retard Fault KNK Power Derate 1 	<ul style="list-style-type: none"> Retard Fault KNK Power Derate 1
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		336	337	341
Name		Cam/Crank Sensors	Cam/Crank Sensors	Cam/Crank Sensors
DTC Name		Crank Input Signal Noise	Loss of Crankshaft Input Signal	Camshaft Input Signal Noise
J1939	SPN	636	636	723
	FMI	2	4	2
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> • Crank+ or Crank– circuits in wrong connector terminal slot 	<ul style="list-style-type: none"> • Loss of sensor feed • Open sensor ground • Open or shorted to ground signal wire 	<ul style="list-style-type: none"> • Cam+ or Cam– circuits in wrong connector terminal slot
DTC Set Preconditions		<ul style="list-style-type: none"> • Engine Running 	<ul style="list-style-type: none"> • Engine Cranking or Running 	<ul style="list-style-type: none"> • Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> • Number of invalid cam re-syncs 3 re-syncs • Within a time window of ≤ 800 ms 	<ul style="list-style-type: none"> • Cam pulsed without crank activity > 3 cam pulses 	<ul style="list-style-type: none"> • Number of invalid cam re-syncs 3 re-syncs • Within a time window of ≤ 700 ms
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> • 1 sec 	<ul style="list-style-type: none"> • 1 sec 	<ul style="list-style-type: none"> • 1 sec
System Action		<ul style="list-style-type: none"> • AL Disable 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • AL Disable
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		342	359	524
Name		Cam/Crank Sensors	Lockoff/Fuel Diagnostics	Oil Pressure
DTC Name		Loss of Camshaft Input Signal	Fuel run-out longer than expected	Oil Pressure Low
J1939	SPN	723	632	100
	FMI	4	31	1
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> • Loss of feed voltage to Cam sensor • Loss of signal or ground circuits • Faulty sensor 	<ul style="list-style-type: none"> • Leak fuel at solenoid • Faulty solenoid • Open or short to ground 	<ul style="list-style-type: none"> • Low Oil Pressure
DTC Set Preconditions		<ul style="list-style-type: none"> • Engine Running 	<ul style="list-style-type: none"> • Key Off, Engine Running 	<ul style="list-style-type: none"> • Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> • No cam pulse in 2.0 cycles • and RPM > 150 min^{-1} (rpm) 	<ul style="list-style-type: none"> • Fuel run-out engine run time > 20000 ms 	<ul style="list-style-type: none"> • Run time wait for oil pressure low faults 10.0 sec • RPM lower limit for oil pressure low faults 600 min^{-1} (rpm) • Oil pressure pulled-up input less than a threshold voltage of 2.50 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> • 1 sec 	<ul style="list-style-type: none"> • N/A 	<ul style="list-style-type: none"> • 3 sec
System Action		<ul style="list-style-type: none"> • AL Disable 	<ul style="list-style-type: none"> • Engine Stop 	<ul style="list-style-type: none"> • Engine Stop
Engine Warning Light		ON Hard Warning	OFF	ON Hard Warning

DTC		562	563	601
Name		Battery Voltage	Battery Voltage	Internal Processor Diagnostics
DTC Name		Battery Voltage (VBAT) Low	Battery Voltage (VBAT) High	Microprocessor Failure-FLASH
J1939	SPN	168	168	628
	FMI	17	15	13
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Wiring harness open/short/damage Battery abnormality 	<ul style="list-style-type: none"> System voltage abnormality (High side) 	<ul style="list-style-type: none"> Faulty ECU
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Key on
DTC Set Conditions		<ul style="list-style-type: none"> Voltage < 9.00 V and RPM > 1000 min⁻¹ (rpm) 	<ul style="list-style-type: none"> Voltage > 16.00 V 	<ul style="list-style-type: none"> Internal microprocessor error
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 5 sec 	<ul style="list-style-type: none"> 3 sec 	<ul style="list-style-type: none"> N/A
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit 	<ul style="list-style-type: none"> AL Disable Low Rev Limit 	<ul style="list-style-type: none"> Never Forget AL Disable Power Derate 2
Engine Warning Light		ON Hard Warning	ON Hard Warning	OFF

DTC		604	606	642
Name		Internal Processor Diagnostics	Internal Processor Diagnostics	5 V External
DTC Name		Microprocessor Failure-RAM	Microprocessor Failure-COP	Sensor Supply Voltage 1 Low (5Vext1)
J1939	SPN	630	629	1079
	FMI	12	31	4
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Faulty ECU 	<ul style="list-style-type: none"> Faulty ECU 	<ul style="list-style-type: none"> Wiring harness short to ground ECM malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Key on 	<ul style="list-style-type: none"> Key on 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off
DTC Set Conditions		<ul style="list-style-type: none"> Internal ECM microprocessor memory access failure 	<ul style="list-style-type: none"> Internal microprocessor error 	<ul style="list-style-type: none"> 5VE1 < 4.60 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 1 sec
System Action		<ul style="list-style-type: none"> Never Forget AL Disable Power Derate 2 	<ul style="list-style-type: none"> Never Forget AL Disable Power Derate 2 	<ul style="list-style-type: none"> AL Disable Power Derate 1
Engine Warning Light		OFF	OFF	ON Hard Warning

DTC		643	652	653
Name		5 V External	5 V External	5 V External
DTC Name		Sensor Supply Voltage 1 High (5Vext1)	Sensor Supply Voltage 2 Low (5Vext2)	Sensor Supply Voltage 2 High (5Vext2)
J1939	SPN	1079	1080	1080
	FMI	3	4	3
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Wiring harness short to 12.0 V power ECM malfunction 	<ul style="list-style-type: none"> Wiring harness short to ground ECM malfunction 	<ul style="list-style-type: none"> Wiring harness short to 12.0 V power ECM malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off
DTC Set Conditions		<ul style="list-style-type: none"> 5VE1 > 5.40 V 	<ul style="list-style-type: none"> 5VE2 < 4.60 V 	<ul style="list-style-type: none"> 5VE2 > 5.40 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 1 sec
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1 	<ul style="list-style-type: none"> AL Disable Power Derate 1
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		686	687	1111
Name		Power Relay Control/Coil	Power Relay Control/Coil	Engine Speed
DTC Name		Power Relay Ground Short	Power Relay Coil Short-To-Power	RPM Above Fuel Rev Limit Level
J1939	SPN	1485	1485	515
	FMI	4	3	16
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Short to ground in relay pull in coil Short to ground in relay driver circuit in wire harness 	<ul style="list-style-type: none"> Shorted relay pull in coil Relay driver circuit shorted to voltage in wire harness 	<ul style="list-style-type: none"> Engine overspeed condition, faulty Crank sensor or input
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> Power relay coil output shorted to ground 	<ul style="list-style-type: none"> Power relay coil output short to power/voltage 	<ul style="list-style-type: none"> RPM > 3200 min⁻¹ (rpm)
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 10 samples 	<ul style="list-style-type: none"> 10 samples 	<ul style="list-style-type: none"> 1 sec
System Action		<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Disable fuel injectors or gaseous fuel control actuator
Engine Warning Light		OFF	OFF	ON Hard Warning

DTC		1112	1121	1151
Name		Engine Speed	FPP	Closed Loop
DTC Name		RPM Above Spark Rev Limit Level	FPP1/2 Simultaneous Voltages Out-of-Range	Closed Loop High (LPG)
J1939	SPN	515	91	4236
	FMI	0	31	0
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Engine overspeed condition, faulty Crank sensor or input 	<ul style="list-style-type: none"> FPP malfunction 	<ul style="list-style-type: none"> Exhaust leaks upstream or near the EGO sensor Reduced fuel supply pressure to the gaseous fuel control system A fuel supply or manifold leak A non-responsive EGO sensor
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Key on, Engine Off 	<ul style="list-style-type: none"> Engine Running, Closed Loop Mode
DTC Set Conditions		<ul style="list-style-type: none"> RPM > 3400 min⁻¹ (rpm) 	<ul style="list-style-type: none"> User same parameter as individual FPP1/2 voltage fault detection above 	<ul style="list-style-type: none"> CL_BM > 35 %
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 1 sec 	<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 5 updates
System Action		<ul style="list-style-type: none"> Disable Spark 	<ul style="list-style-type: none"> Power Derate2 Force Idle 	<ul style="list-style-type: none"> Power Derate 2 AL Disable CL Disable
Engine Warning Light		ON Hard Warning	OFF	ON Hard Warning

DTC		1152	1161	1162
Name		Closed Loop	Adaptive Learn	Adaptive Learn
DTC Name		Closed Loop Low (LPG)	Adaptive Learn High (LPG)	Adaptive Learn Low (LPG)
J1939	SPN	4236	4237	4237
	FMI	1	0	1
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> High fuel supply pressure to the gaseous fuel control or faulty pressure regulator A non-responsive EGO sensor 	<ul style="list-style-type: none"> Exhaust leaks upstream or near the EGO sensor Reduced fuel supply pressure to the gaseous fuel control system A fuel supply or manifold leak A non-responsive EGO sensor 	<ul style="list-style-type: none"> High fuel supply pressure to the gaseous fuel control or faulty pressure regulator A non-responsive EGO sensor
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running, Closed Loop Mode 	<ul style="list-style-type: none"> Engine Running, Adaptive Mode 	<ul style="list-style-type: none"> Engine Running, Adaptive Mode
DTC Set Conditions		<ul style="list-style-type: none"> CL_BM < -35 % 	<ul style="list-style-type: none"> AL_BM > 30 % 	<ul style="list-style-type: none"> AL_BM < -30 %
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 5 updates 	<ul style="list-style-type: none"> 3 updates 	<ul style="list-style-type: none"> 3 updates
System Action		<ul style="list-style-type: none"> Power Derate 2 AL Disable CL Disable 	<ul style="list-style-type: none"> Power Derate 1 AL Disable 	<ul style="list-style-type: none"> Power Derate 1 AL Disable
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		1165	1171	1172
Name		Catalyst	EPR Diagnostics	EPR Diagnostics
DTC Name		Catalyst inactive on LPG	Megajector/EPR Regulation Pressure Higher than Expected	Megajector/EPR Regulation Pressure Lower than Expected
J1939	SPN	3050	520260	520260
	FMI	11	0	1
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Physically damaged catalyst Contaminated catalyst element Post signal circuit shorted to pre signal 	<ul style="list-style-type: none"> Inlet pressure to DEPR is too high. 	<ul style="list-style-type: none"> Inlet pressure to DEPR is too low. Malfunctioning lock off valve, plugged fuel filter, closed manual valve or fuel tank out of fuel
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> EGO2RMS > EGO1RMS × 50 % 	<ul style="list-style-type: none"> EPR actual-commanded pressure > 63.5mm H₂O (2.50 in. H₂O) 	<ul style="list-style-type: none"> EPR actual-commanded pressure < -63.5mm H₂O (-2.50 in. H₂O)
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 100 updates 	<ul style="list-style-type: none"> 5 sec 	<ul style="list-style-type: none"> 5 sec
System Action		<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> AL Disable 	<ul style="list-style-type: none"> AL Disable
Engine Warning Light		ON	ON Hard Warning	ON Hard Warning

DTC		1173	1174	1175
Name		EPR Diagnostics	EPR Diagnostics	EPR Diagnostics
DTC Name		Megajector/EPR Comm Lost	Megajector/EPR Voltage Supply High	Megajector/EPR Voltage Supply Low
J1939	SPN	520260	520260	520260
	FMI	31	3	4
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Faulty CAN connection CAN termination incorrect 	<ul style="list-style-type: none"> Wiring harness open/short/damage 	<ul style="list-style-type: none"> Wiring harness open/short/damage Faulty EPR power circuit
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> No EPR packets receive 		
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 5 sec 	<ul style="list-style-type: none"> 5 sec
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit 	<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit 	<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		1176	1177	1611
Name		EPR Diagnostics	EPR Diagnostics	5V External
DTC Name		Megajector/EPR Internal Actuator Fault Detection	Megajector/EPR Internal Circuitry Fault Detection	Sensor Supply Voltage (5Vext 1/2) Simultaneous Out-of-Range
J1939	SPN	520260	520260	1079
	FMI	12	12	31
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Short or open circuit in actuator coil Associated wiring Overheating of actuator drive electronics 	<ul style="list-style-type: none"> DEPR internal microprocessor or memory failure, fuel temperature sensor failure. 	<ul style="list-style-type: none"> Wiring harness short to 12V power or ground ECM malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Cranking or Running Key On, Engine Off
DTC Set Conditions		<ul style="list-style-type: none"> The DEPR electronics detect a fault condition associated with its internal actuator. 	<ul style="list-style-type: none"> The DEPR electronics detect a fault condition associated with its internal circuitry. 	<ul style="list-style-type: none"> 5VE1/2 > 5.40 V 5VE1/2 < 4.60 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 0.25 sec 	<ul style="list-style-type: none"> 0.25 sec 	<ul style="list-style-type: none"> 1 sec
System Action		<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit 	<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit 	<ul style="list-style-type: none"> AL Disable Power Derate 2 Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		1612	1613	1614
Name		Internal Processor Diagnostics	Internal Processor Diagnostics	Internal Processor Diagnostics
DTC Name		Microprocessor Failure-RTI 1	Microprocessor Failure-RTI 2	Microprocessor Failure-RTI 3
J1939	SPN	629	629	629
	FMI	31	31	31
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Faulty ECU 	<ul style="list-style-type: none"> Faulty ECU 	<ul style="list-style-type: none"> Faulty ECU
DTC Set Preconditions		<ul style="list-style-type: none"> Key on 	<ul style="list-style-type: none"> Key on 	<ul style="list-style-type: none"> Key on
DTC Set Conditions		<ul style="list-style-type: none"> Internal microprocessor error 	<ul style="list-style-type: none"> Internal microprocessor error 	<ul style="list-style-type: none"> Internal microprocessor error
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A
System Action		<ul style="list-style-type: none"> Never Forget AL Disable Power Derate 2 	<ul style="list-style-type: none"> Never Forget AL Disable Power Derate 2 	<ul style="list-style-type: none"> Never Forget AL Disable Power Derate 2
Engine Warning Light		ON	OFF	OFF

DTC		1615	1616	1629
Name		Internal Processor Diagnostics	Internal Processor Diagnostics	J1939 Network
DTC Name		Microprocessor Failure-A/D	Microprocessor Failure-Interrupt	J1939 TSC1 Message Receipt Loss
J1939	SPN	629	629	695
	FMI	31	31	9
MIL		ON	ON	ON
Detected Item		• Faulty ECU	• Faulty ECU	
DTC Set Preconditions		• Key on	• Key on	• Engine Running
DTC Set Conditions		• Internal microprocessor error	• Internal microprocessor error	• Loss of TSC1 after engine running > 1.0 sec
Period for Judgment or Number of Occurrence for Judgment		• N/A	• N/A	• 1 sec
System Action		• Never Forget • AL Disable • Power Derate 2	• Never Forget • AL Disable • Power Derate 2	• Forced Idle
Engine Warning Light		OFF	OFF	ON

DTC		1674	2111	2112
Name		Internal Processor Diagnostics	TPS	TPS
DTC Name		Hardware ID Failure	Unable to Reach Lower TPS	Unable to Reach Higher TPS
J1939	SPN	1634	51	51
	FMI	2	7	7
MIL		ON	ON	ON
Detected Item		• Faulty ECU	• TPS malfunction	• TPS malfunction
DTC Set Preconditions		• Key On	• Engine Running	• Engine Running
DTC Set Conditions		• Internal microprocessor error	• Target TPS-actual TPS < -20.0 % • Persistently longer than 200 ms while battery voltage > 9.00 V	• Target TPS-actual TPS > 20.0 % • Persistently longer than 200 ms while battery voltage > 9.00 V
Period for Judgment or Number of Occurrence for Judgment		• N/A	• 1 sec	• 1 sec
System Action		• Never Forget • AL Disable • Power Derate 2	• Engine Stop	• Engine Stop
Engine Warning Light		OFF	ON Hard Warning	ON Hard Warning

DTC		2121	2122	2123
Name		FPP	FPP	FPP
DTC Name		FPP1 Lower Than FPP2	FPP1 Voltage High	FPP1 Voltage Low
J1939	SPN	91	91	91
	FMI	18	3	4
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Wiring harness open/short/damage FPP malfunction 	<ul style="list-style-type: none"> Wiring harness open/short/damage FPP malfunction 	<ul style="list-style-type: none"> Wiring harness open/short/damage FPP malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> (FPP 1 % - FPP 2 %) < -20.0 % 	<ul style="list-style-type: none"> FPP1 voltage > 4.80 V 	<ul style="list-style-type: none"> FPP1 voltage < 0.200 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 1.5 sec 	<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 0.5 sec
System Action		<ul style="list-style-type: none"> Power Derate 1 Low Rev Limit 	<ul style="list-style-type: none"> Power Derate 1 Low Rev Limit 	<ul style="list-style-type: none"> Power Derate 1 Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		2126	2127	2128
Name		FPP	FPP	FPP
DTC Name		FPP1 Higher Than FPP2	FPP2 voltage low	FPP2 voltage high
J1939	SPN	91	29	29
	FMI	16	4	3
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> Wiring harness open/short/damage FPP malfunction 	<ul style="list-style-type: none"> Wiring harness open/short/damage FPP malfunction 	<ul style="list-style-type: none"> Wiring harness open/short/damage FPP malfunction
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Running
DTC Set Conditions		<ul style="list-style-type: none"> (FPP 1 % - FPP 2 %) > 20.0 % 	<ul style="list-style-type: none"> FPP2 voltage < 0.100 V 	<ul style="list-style-type: none"> FPP2 voltage > 2.400 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 1.5 sec 	<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 0.5 sec
System Action		<ul style="list-style-type: none"> Power Derate 1 Low Rev Limit 	<ul style="list-style-type: none"> Power Derate 1 Low Rev Limit 	<ul style="list-style-type: none"> Power Derate 1 Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

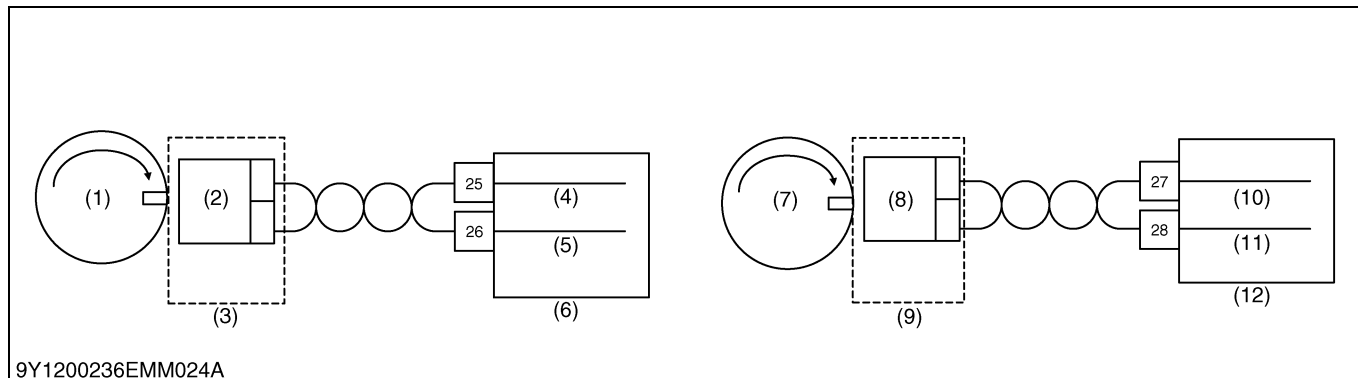
DTC		2135	2300	2301
Name		TPS	Spark Coil Primary	Spark Coil Primary
DTC Name		TPS1/2 Simultaneous Voltages out of range	Spark Coil #1 Primary Open/Short-to-Ground	Spark Coil #1 Primary Short-to-Power
J1939	SPN	51	1268	1268
	FMI	31	5	6
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> TPS malfunction 	<ul style="list-style-type: none"> A short to ground or open circuit in the harness An open internal to the primary coil 	<ul style="list-style-type: none"> A short to power in the harness A short internal to the primary coil
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Running 	<ul style="list-style-type: none"> Engine Cranking or Running 	<ul style="list-style-type: none"> Engine Cranking or Running
DTC Set Conditions		<ul style="list-style-type: none"> User same parameter as individual TPS1/2 voltage fault detection above 	<ul style="list-style-type: none"> Adaptive dwell adjustment \geq 1.9 ms or total dwell \geq 15.0 ms and battery voltage $>$ 10.0 V, $<$ 16.0 V 	<ul style="list-style-type: none"> Adaptive dwell adjustment \leq -1.9 ms or total dwell \leq 0.5 ms and battery voltage $>$ 10.0 V, $<$ 16.0 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 0.5 sec 	<ul style="list-style-type: none"> 10 sparks 	<ul style="list-style-type: none"> 10 sparks
System Action		<ul style="list-style-type: none"> Engine Stop 	<ul style="list-style-type: none"> AL Disable Low Rev Limit 	<ul style="list-style-type: none"> AL Disable Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		2303	2304	2306
Name		Spark Coil Primary	Spark Coil Primary	Spark Coil Primary
DTC Name		Spark Coil #2 Primary Open/Short-to-Ground	Spark Coil #2 Primary Short-to-Power	Spark Coil #3 Primary Open/Short-to-Ground
J1939	SPN	1269	1269	1270
	FMI	5	6	5
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> A short to ground or open circuit in the harness An open internal to the primary coil 	<ul style="list-style-type: none"> A short to power in the harness A short internal to the primary coil 	<ul style="list-style-type: none"> A short to ground or open circuit in the harness An open internal to the primary coil
DTC Set Preconditions		<ul style="list-style-type: none"> Engine Cranking or Running 	<ul style="list-style-type: none"> Engine Cranking or Running 	<ul style="list-style-type: none"> Engine Cranking or Running
DTC Set Conditions		<ul style="list-style-type: none"> Adaptive dwell adjustment \geq 1.9 ms or total dwell \geq 15.0 ms and battery voltage $>$ 10.0 V, $<$ 16.0 V 	<ul style="list-style-type: none"> Adaptive dwell adjustment \leq -1.9 ms or total dwell \leq 0.5 ms and battery voltage $>$ 10.0 V, $<$ 16.0 V 	<ul style="list-style-type: none"> Adaptive dwell adjustment \geq 1.9 ms or total dwell \geq 15.0 ms and battery voltage $>$ 10.0 V, $<$ 16.0 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> 10 sparks 	<ul style="list-style-type: none"> 10 sparks 	<ul style="list-style-type: none"> 10 sparks
System Action		<ul style="list-style-type: none"> CL Disable AL Disable Low Rev Limit 	<ul style="list-style-type: none"> CL Disable AL Disable Low Rev Limit 	<ul style="list-style-type: none"> CL Disable AL Disable Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

DTC		2307	2309	2310
Name		Spark Coil Primary	Spark Coil Primary	Spark Coil Primary
DTC Name		Spark Coil #3 Primary Short-to-Power	Spark Coil #4 Primary Open/Short-to-Ground	Spark Coil #4 Primary Short-to-Power
J1939	SPN	1270	1271	1271
	FMI	6	5	6
MIL		ON	ON	ON
Detected Item		<ul style="list-style-type: none"> • A short to power in the harness • A short internal to the primary coil 	<ul style="list-style-type: none"> • A short to ground or open circuit in the harness • An open internal to the primary coil 	<ul style="list-style-type: none"> • A short to power in the harness • A short internal to the primary coil
DTC Set Preconditions		<ul style="list-style-type: none"> • Engine Cranking or Running 	<ul style="list-style-type: none"> • Engine Cranking or Running 	<ul style="list-style-type: none"> • Engine Cranking or Running
DTC Set Conditions		<ul style="list-style-type: none"> • Adaptive dwell adjustment <= -1.9 ms or total dwell <= 0.5 ms • and battery voltage > 10.0 V, < 16.0 V 	<ul style="list-style-type: none"> • Adaptive dwell adjustment >= 1.9 ms or total dwell >= 15.0 ms • and battery voltage > 10.0 V, < 16.0 V 	<ul style="list-style-type: none"> • Adaptive dwell adjustment <= -1.9 ms or total dwell <= 0.5 ms • and battery voltage > 10.0 V, < 16.0 V
Period for Judgment or Number of Occurrence for Judgment		<ul style="list-style-type: none"> • 10 sparks 	<ul style="list-style-type: none"> • 10 sparks 	<ul style="list-style-type: none"> • 10 sparks
System Action		<ul style="list-style-type: none"> • AL Disable • Low Rev Limit 	<ul style="list-style-type: none"> • AL Disable • Low Rev Limit 	<ul style="list-style-type: none"> • AL Disable • Low Rev Limit
Engine Warning Light		ON Hard Warning	ON Hard Warning	ON Hard Warning

[4] DIAGNOSIS PROCEDURE BY DTC

(1) Crank/Cam Sensors (DTC 16, 336, 337, 341, 342)



(1) Crankshaft
(2) Magnetic Crank Sensor
(3) Sensor

(4) Crank +
(5) Crank -
(6) ECM

(7) Camshaft
(8) Magnetic Cam Sensor
(9) Sensor

(10) Cam +
(11) Cam -
(12) ECM

DTC 16-Crank and/or Cam Could Not Synchronize During Start

- Hardware: Crankshaft Position Sensor/Camshaft Position Sensor Input Circuits
- Enabling Conditions: Engine Cranking or Running
- Set Conditions: Engine cranking longer than 4 revolutions above 90 min⁻¹ (rpm) without crank and/or cam synchronization
- Corrective Action(s): Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Emissions related fault
- Possible causes: Mechanical misalignment between cam and crank, CMP or CKP signal (+)/ground (-) wires misplaced in connectors, bad ECM

The crankshaft position sensor is a magnetic pick-up sensor installed in the engine block adjacent to a "coded" trigger wheel located on the flywheel. 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.

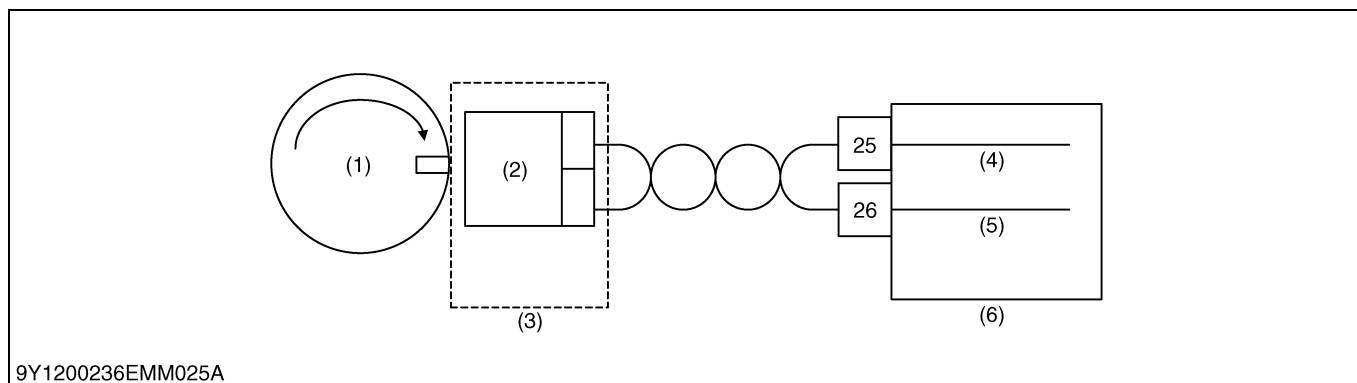
The camshaft position sensor is a magnetic pick-up sensor installed in the engine block or valve train adjacent to a "coded" trigger wheel located on or off of the camshaft. The sensor-trigger wheel combination is used to determine cam position (with respect to TDC cylinder #1 compression). Determination 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.

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

DTC 16-Crank and/or Cam Could Not Synchronize During Start

Diagnostic Aids

- If there are any other CMP or CKP DTC's, diagnose them first
- Ensure that all 3 terminals are in the correct slot in the connector for both the CMP and the CKP sensors
- Ensure that the cam and crank are properly installed and timed
- 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
- Connect a 2 channel oscilloscope, scope CMP and CKP inputs and compare to known good waveforms



- | | | | |
|---------------------------|-------------|-------------|---------|
| (1) Crankshaft | (3) Sensor | (5) Crank - | (6) ECM |
| (2) Magnetic Crank Sensor | (4) Crank + | | |

DTC 336-Crank Input Signal Noise

- Hardware: Crankshaft Position sensor
- Enabling Conditions: Engine Running
- Set Conditions: Electrical noise or irregular crank pattern detected causing more than 3 crank re-synchronization events in less than 800 ms
- Corrective Action(s): Illuminate MIL and AL disable
- Emissions related fault
- Possible Causes: CKP+ or CKP- circuits in wrong connector terminal slot, improper CKP signal due to sensor air gap too large, excessive metal on sensor tip, improper wiring, intermittent connection in sensor circuitry, intermittent sensor internal problem

The crankshaft position sensor is a magnetic pick-up sensor installed in the engine block adjacent to a "coded" trigger wheel located on the flywheel. 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 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 (see set conditions above), 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 run out and/or gear lash.

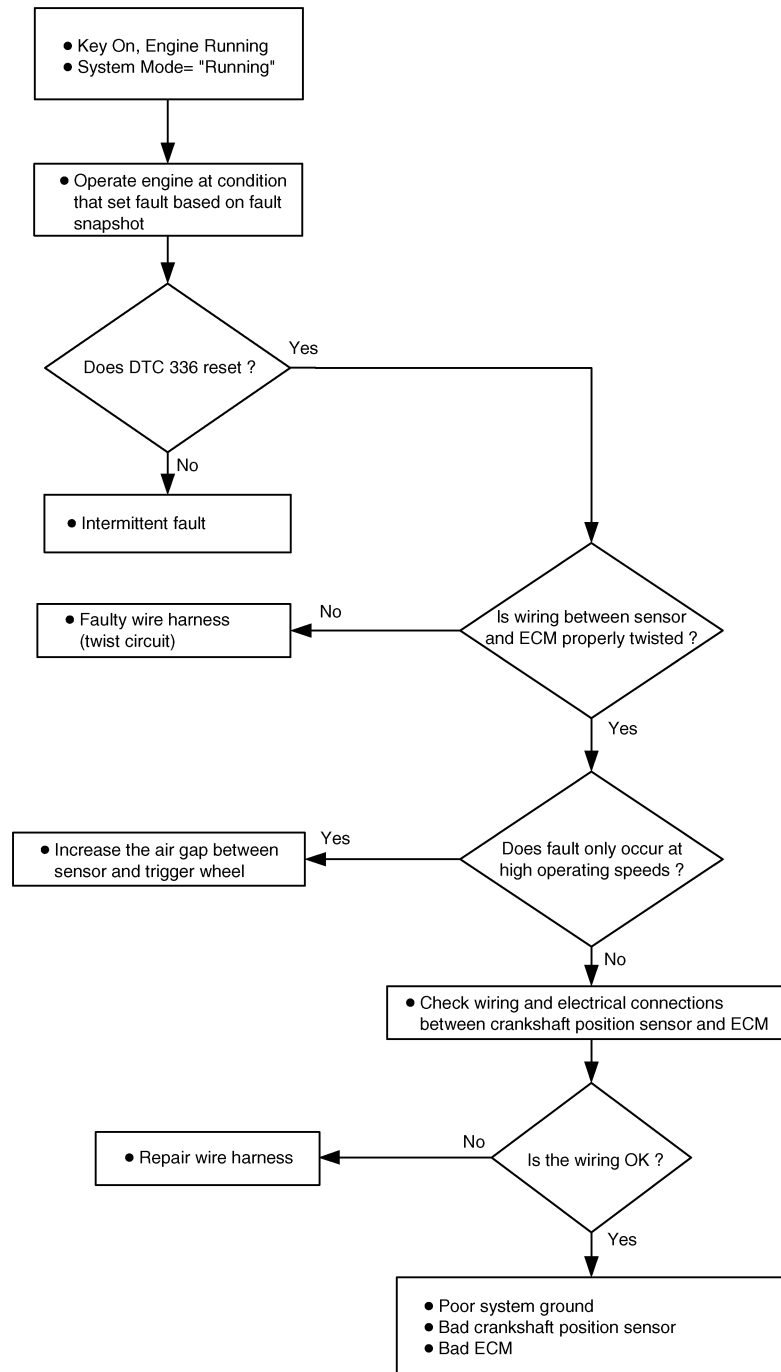
Ensure crank circuit used with VR/magnetic pick-up sensors are properly twisted.

DTC 337-Loss of Crankshaft Input Signal

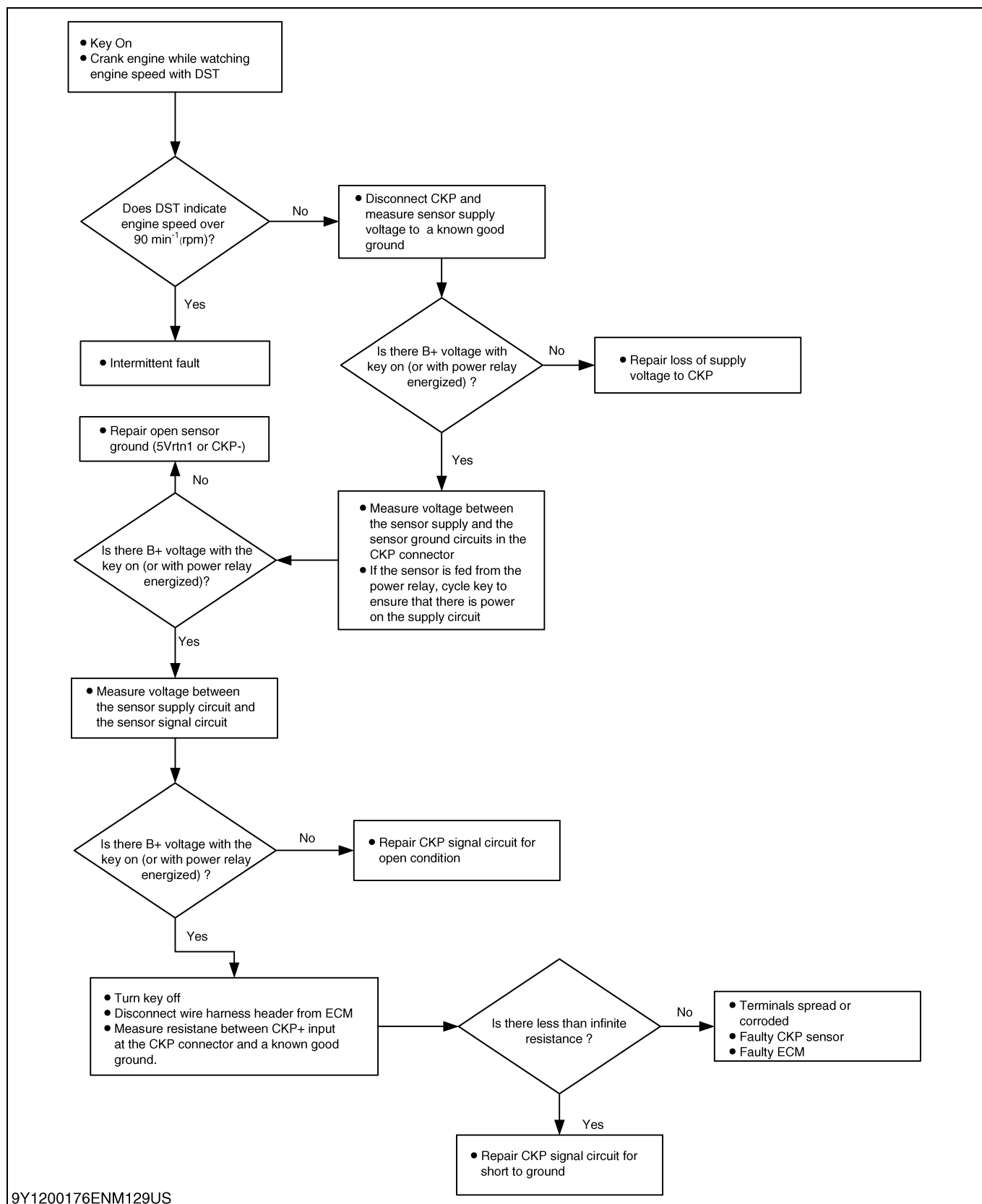
- Hardware: Crankshaft Position sensor
- Enabling Conditions: Engine Cranking or Running
- Set Conditions: Loss of crankshaft position signal (CKP) with more than 3 cam pulses from the camshaft position sensor (CMP).
- Corrective Action(s): Illuminate MIL
- Emissions related fault
- Possible Causes: Loss of sensor feed, open sensor ground (5 Vrtn1 and CKP-), open or shorted to ground signal wire

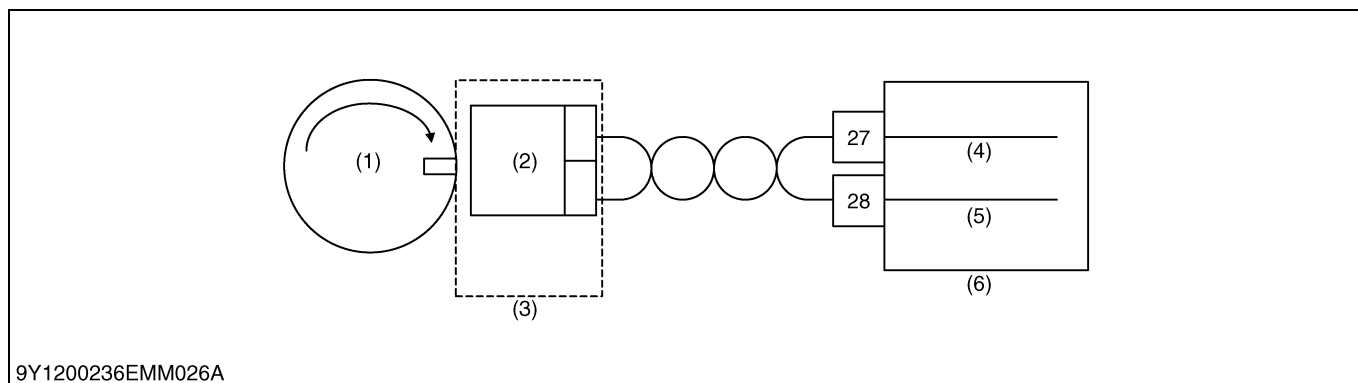
The crankshaft position sensor is a magnetic pick-up sensor installed in the engine block adjacent to a "coded" trigger wheel located on the flywheel. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine 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 ECM must see a valid crankshaft position signal while running. 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.

DTC 336-Crank Input Signal Noise**Diagnostic Aids Chart**

9Y1200176ENM128US

DTC 337-Loss of Crankshaft Input Signal**Diagnostic Aids Chart**



- | | | | |
|-------------------------|-------------|-------------|---------|
| (1) Camshaft | (3) Sensor | (5) Crank - | (6) ECM |
| (2) Magnetic Cam Sensor | (4) Crank + | | |

DTC 341-Camshaft Input Signal Noise

- Hardware: Camshaft Position sensor
- Enabling Conditions: Engine Running
- Set Conditions: Electrical noise or irregular cam pattern detected causing more than 3 cam re-synchronization events in less than 700 ms.
- Corrective Action(s): Illuminate MIL and AL disable
- Emissions related fault
- Possible Causes: CMP+ or CMP- circuits in wrong connector terminal slot, improper CMP signal due to sensor air gap too large, excessive metal on sensor tip, improper wiring, intermittent connection in sensor circuitry, intermittent sensor internal problem

The camshaft position sensor is a magnetic pick-up sensor 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 so the ECM can determine which piston is coming up on TDC. 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.

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 this fault will set. Irregular cam patterns can be detected by the ECM and can be caused by: electrical noise, poor machining of trigger wheel, or trigger wheel run out and/or gear lash. In some instances this fault can cause rough engine operation and can cause the engine to stall or die if attached with coil-on-plug ignition engines.

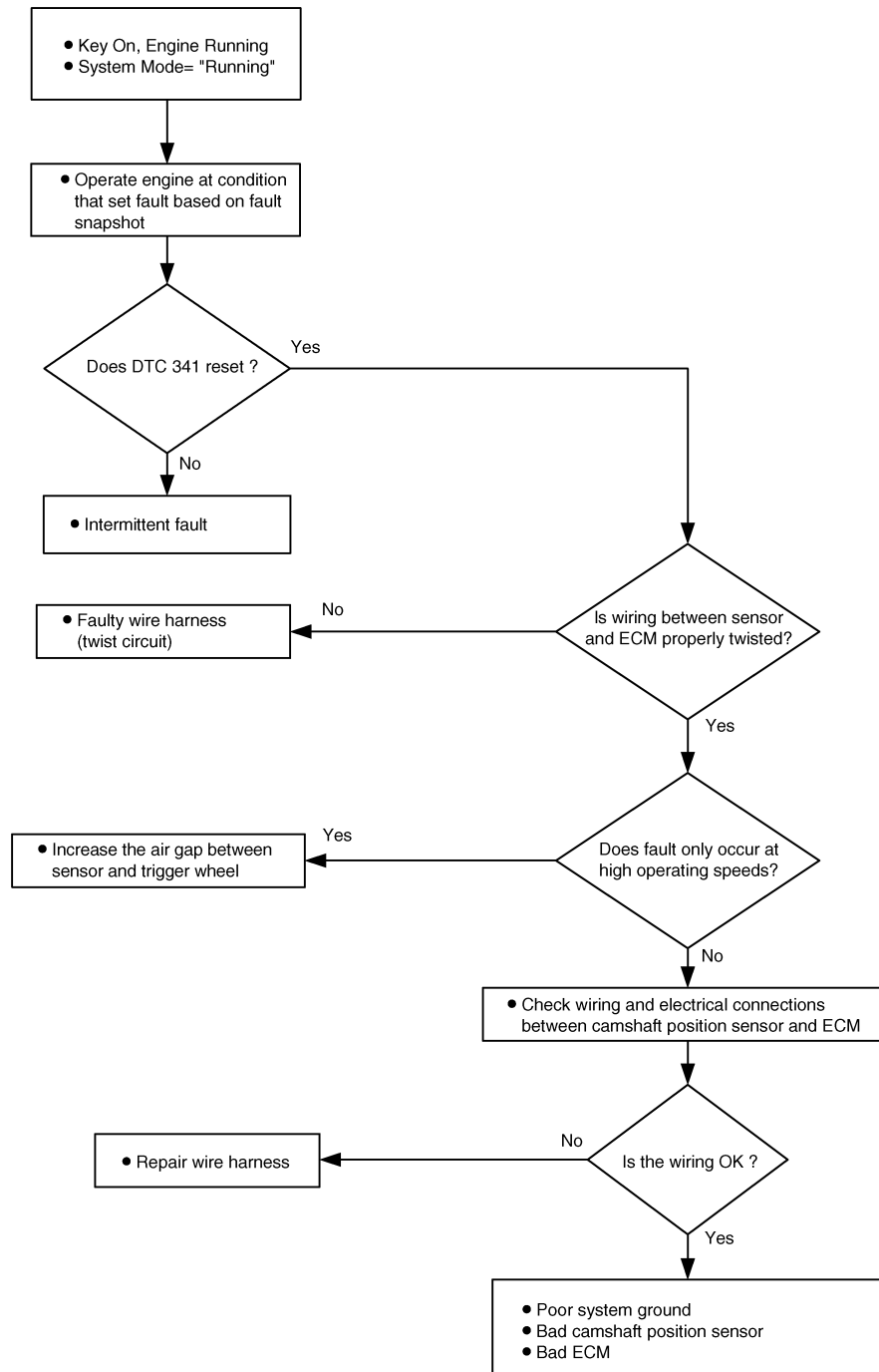
Ensure cam circuit used with VR/magnetic pick-up sensors are properly twisted.

DTC 342-Loss of Camshaft Input Signal

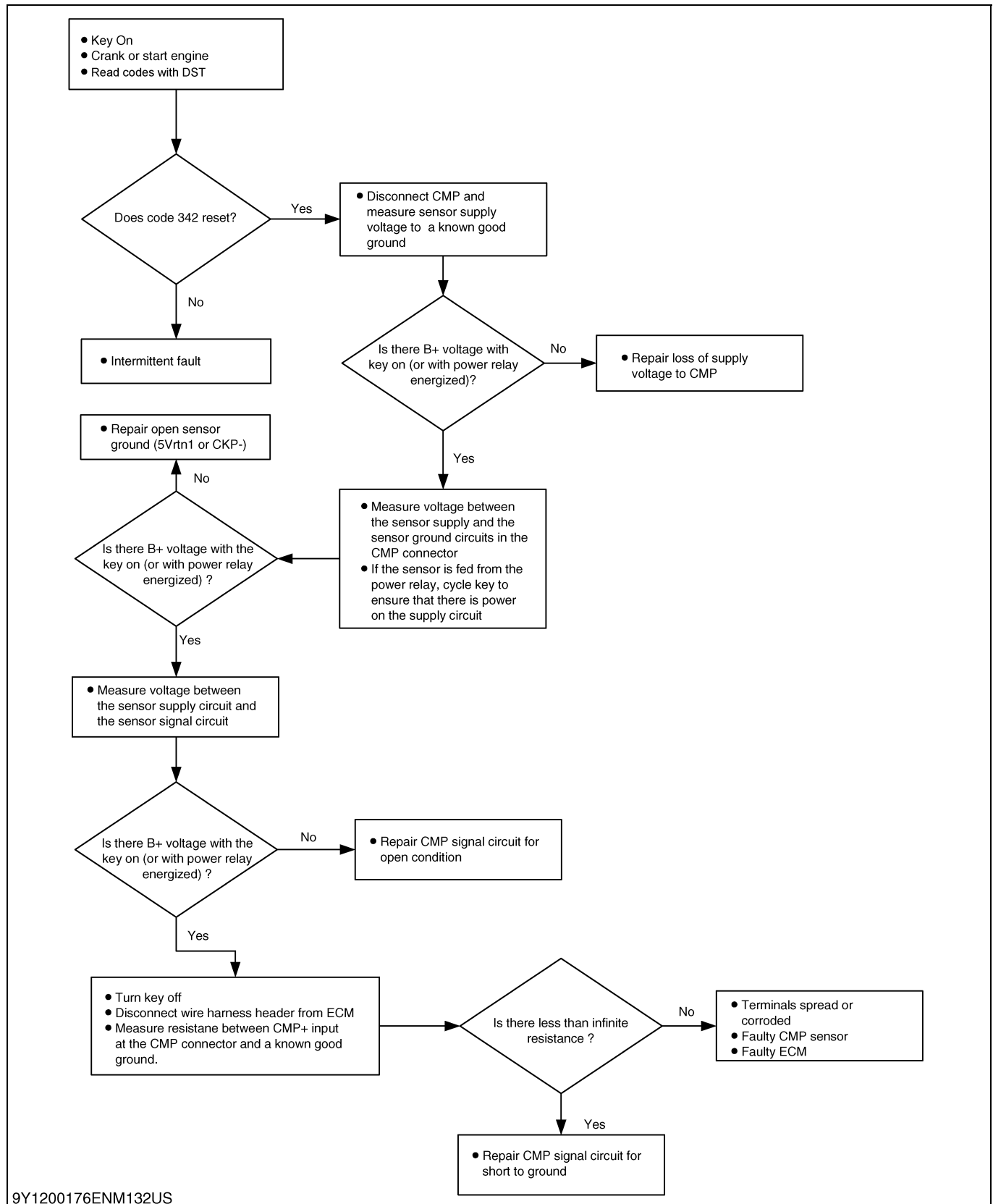
- Hardware: Camshaft Position sensor
- Enabling Conditions: Engine Running
- Set Conditions: Loss of camshaft position signal while valid crankshaft position signals continue for 2 engine cycles for longer than 1 second and engine speed is higher than 150 min⁻¹ (rpm)
- Corrective Action(s): Illuminate MIL
- Emissions related fault
- Possible Causes: Loss of feed voltage to CMP sensor, loss of signal or ground circuits, faulty sensor, faulty ECM or damaged engine components

The camshaft position sensor is a magnetic sensor (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.

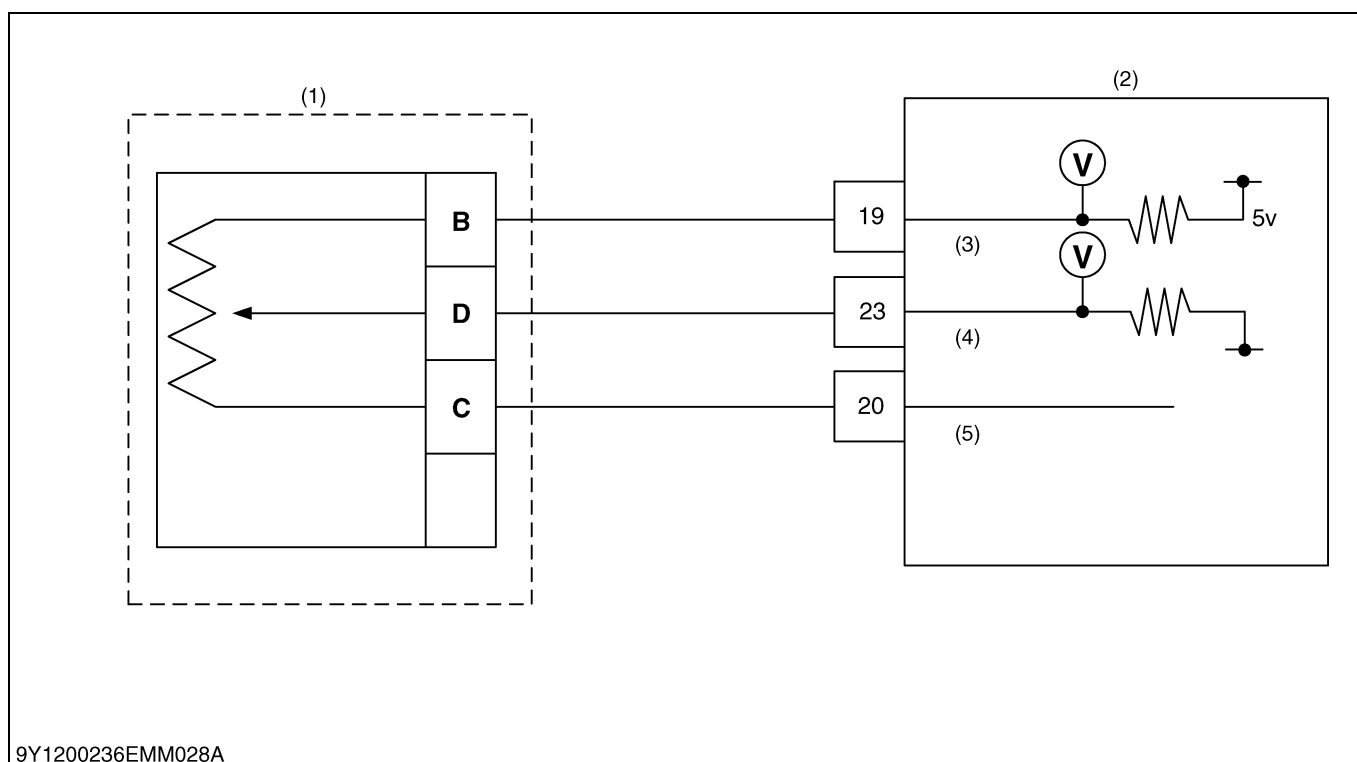
For a cam synchronized engine, the ECM must see a valid camshaft position signal while running. In some instances this fault can cause rough engine operation and can cause the engine to stall or die if attached with coil-on-plug ignition engines.

DTC 341-Camshaft Input Signal Noise**Diagnostic Aids Chart**

9Y1200176ENM131US

DTC 342-Loss of Camshaft Input Signal**Diagnostic Aids Chart**

(2) MAP (Manifold Absolute Pressure Sensor) (DTC 107, 108)



(1) TAMP Sensor
(2) ECM

(3) 5V Ext 1

(4) MAP Signal

(5) 5V Rtn 1

DTC 107-MAP Low Voltage

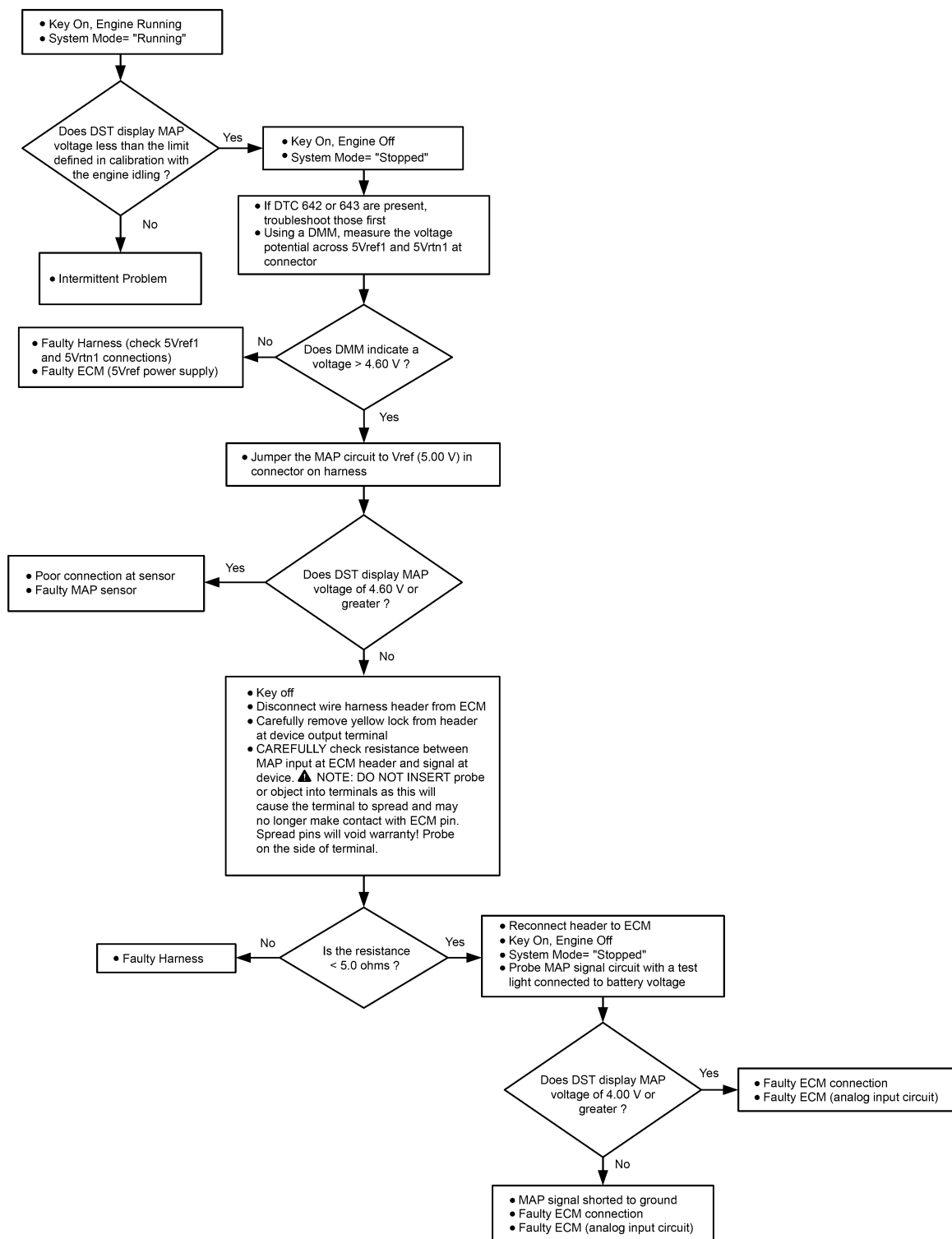
- Hardware: Manifold Absolute Pressure Sensor
- Enabling Conditions: Engine Cranking or Running
- Set Conditions: MAP sensor voltage feedback less than 0.050 V when throttle position is greater than 2 % and engine speed is less than 4000 min⁻¹ (rpm).
- Corrective Action(s): Illuminate MIL and AL disable
- Emissions related fault
- Possible Causes: Loss of 5.00 V reference feed to sensor, open or shorted to ground sensor signal wire, faulty sensor or faulty ECM.

DTC 108-MAP High Pressure

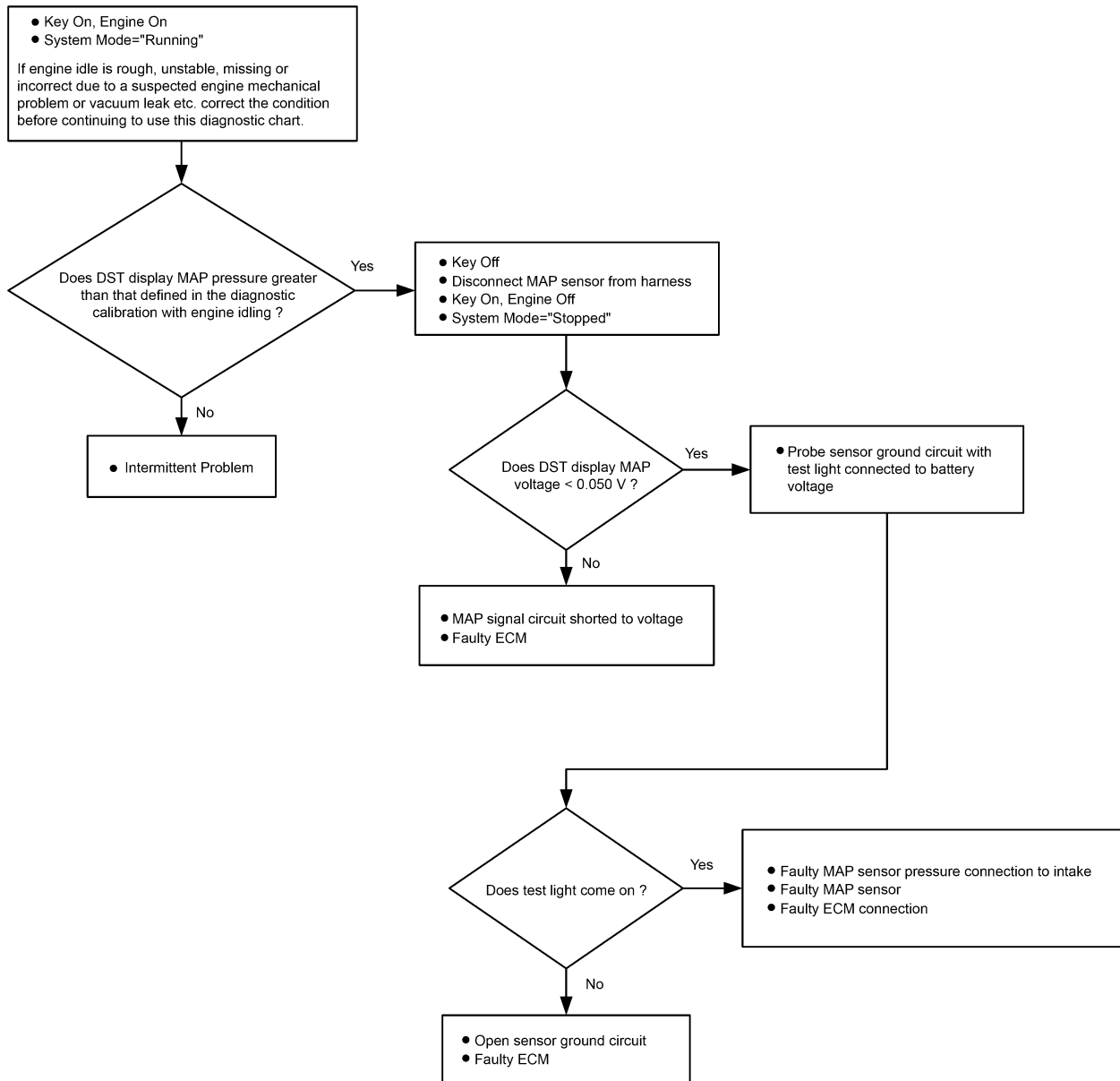
- Hardware: Manifold Absolute Pressure Sensor
- Enabling Conditions: Engine Running
- Set Conditions: MAP is higher than 110 kPa [abs] (1.12 kgf/cm², 16.0 psia) when throttle position is less than 10 % and engine speed is higher than 700 min⁻¹ (rpm).
- Corrective Action(s): Illuminate MIL and AL disable
- Emissions related fault
- Possible Causes: 5.00 V reference feed shorted to voltage, signal circuit shorted to voltage, open 5 Vrtn1 (sensor ground), faulty sensor or faulty ECM.

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. The rate of airflow into the engine is used to determine the required fuel flow rate.

When these fault are active, the ECM operates in a limp home mode in which an estimated MAP based on TPS feedback is used to fuel the engine.

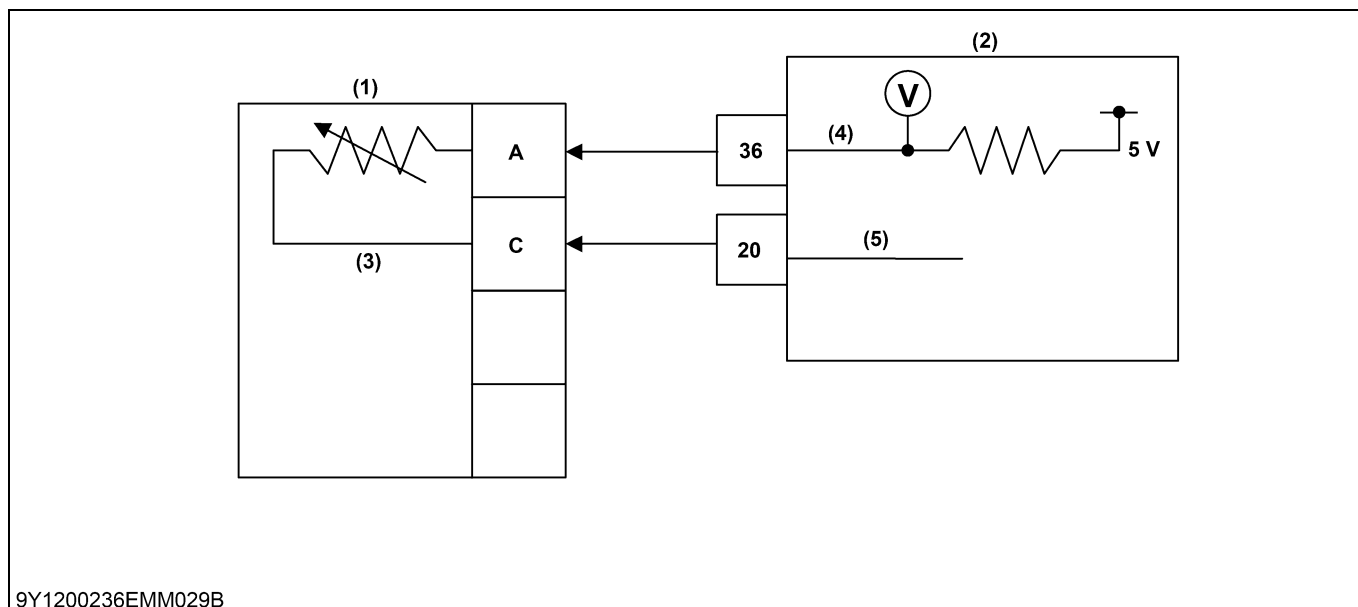
DTC 107-MAP Low Voltage**Diagnostic Aids Chart**

9Y1200333EMS003US

DTC 108-MAP High Pressure**Diagnostic Aids Chart**

9Y1200333EMS004US

(3) IAT (Intake Air Temperature Sensor) (DTC 111, 112, 113, 127, 129)



(1) TMAP Sensor

(3) Thermistor

(4) IAT

(5) 5V Rtn 1

(2) ECM

DTC 111-IAT Higher Than Expected Stage 1

- Hardware: Intake Air Temperature Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Intake Air Temperature greater than stage 1 limit (71.1 °C (160 °F)) for longer than 10 seconds when engine speed is higher than 1000 min⁻¹ (rpm).
- Corrective Action(s): Activate power derate 1 (max 20 % throttle angle), AL disable
- Non-emissions related fault
- Possible Causes: Damaged inlet air system allowing hotter than normal air into engine intake system

DTC 112-IAT Low Voltage

- Hardware: Intake Air Temperature Sensor
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Set Conditions: IAT sensor voltage less than 0.100 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Emissions related fault
- Possible Causes: Faulty ECM (no voltage on signal wire), signal wire shorted to ground or sensor internally shorted

DTC 113-IAT High Voltage

- Hardware: Intake Air Temperature Sensor
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Set Conditions: IAT sensor voltage greater than 4.90 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Emissions related fault
- Possible Causes: Signal wire shorted to 12.0 V, signal wire open, sensor open internally or open 5 Vrtn1 (sensor ground)

DTC 127-IAT Higher Than Expected Stage 2

- Hardware: Intake Air Temperature
- Enabling Conditions: Engine Running
- Set Conditions: Intake Air Temperature greater than stage 2 limit (87.8 °C (190 °F)) for longer than 10 seconds when engine speed is higher than 1000 min⁻¹ (rpm)
- Corrective Action(s): Illuminate MIL, Power derate 2, Forced idle and AL disable
- Emissions related fault
- Possible Causes: Damaged inlet air system allowing hotter than normal air into engine intake system

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.

DTC 129-BP Low Pressure

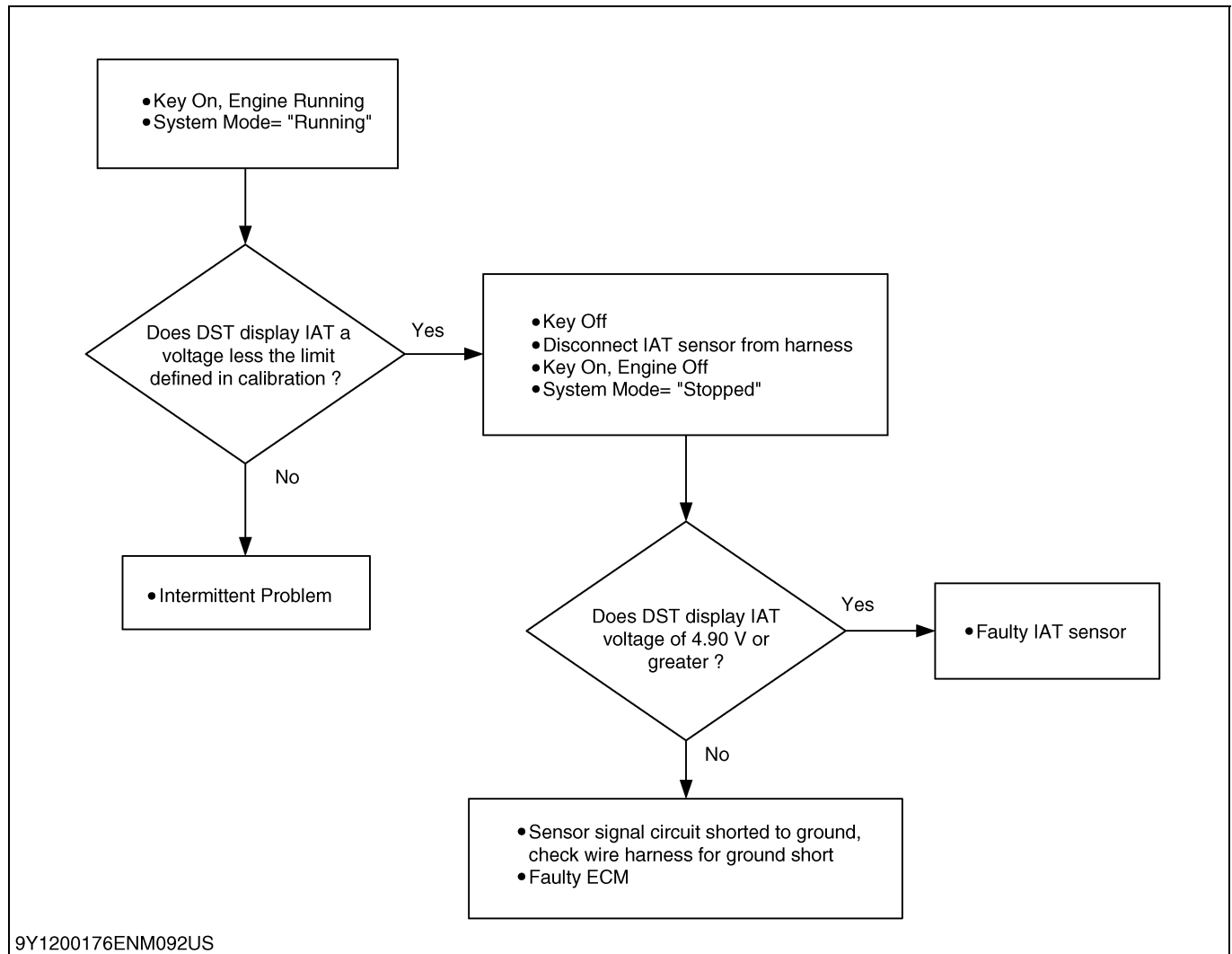
- Hardware: Barometric Temperature / Manifold Absolute Pressure Sensor
- Enabling Conditions: Key On, Engine Off or after BP estimate during low-speed or high load operation
- Set Conditions: BP pressure is less than 57.2 kPa [abs] (0.584 kgf/cm², 8.30 psia) for longer than 1 second
- Corrective Action(s): Illuminate MIL and AL disable
- Emissions related fault
- Possible Causes: Faulty ECM (no voltage on signal wire), signal wire shorted to ground or sensor internally shorted

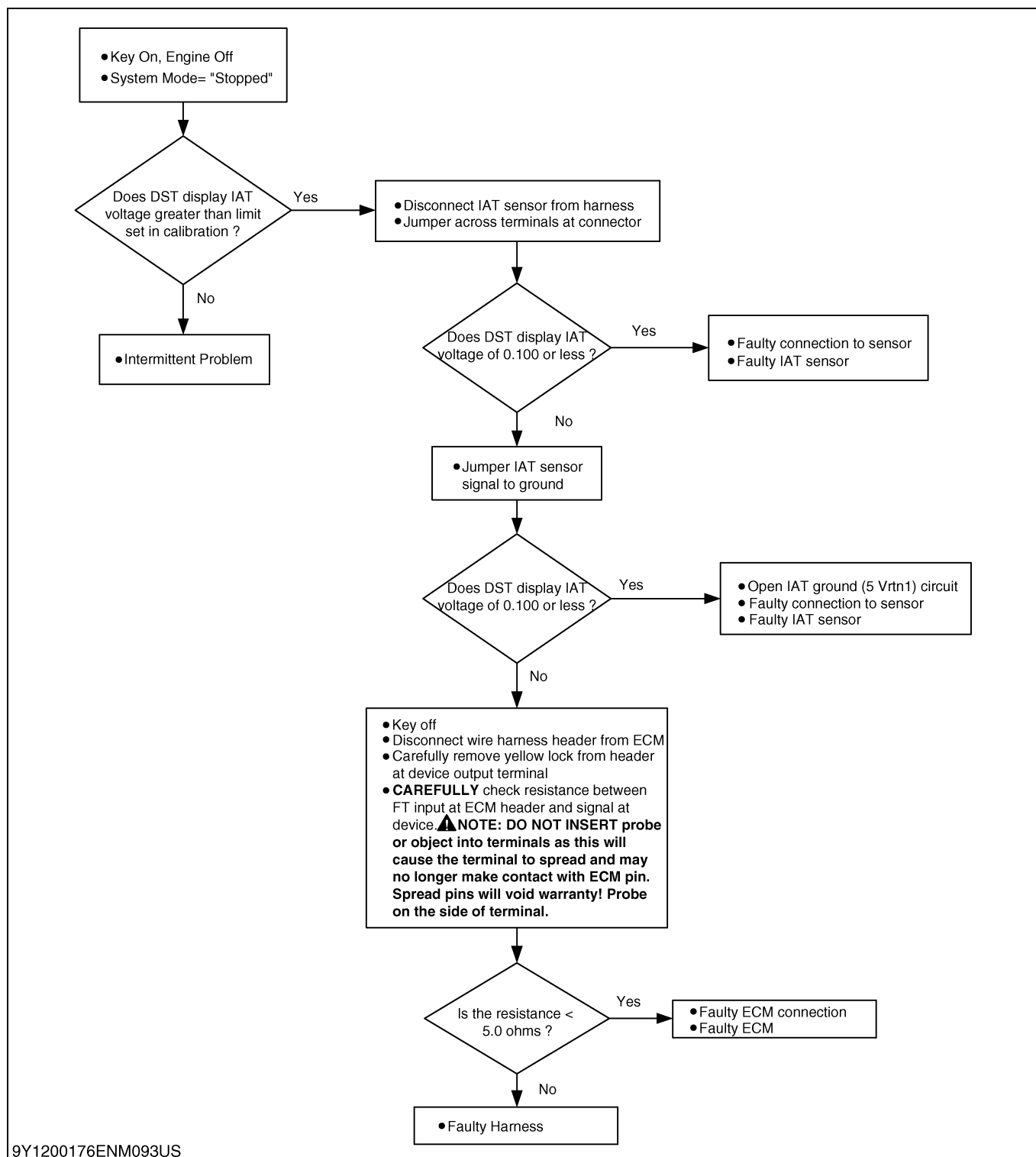
This fault sets if the barometric pressure is lower than the minimum set pressure (psia) as defined in the diagnostic calibration. In the event of an active fault, the MIL is illuminated for the remainder of the key on cycle, an audible warning and/or a secondary warning lamp is activated, and the Adaptive Learn function is disabled to prevent improper learning and population of the table.

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.

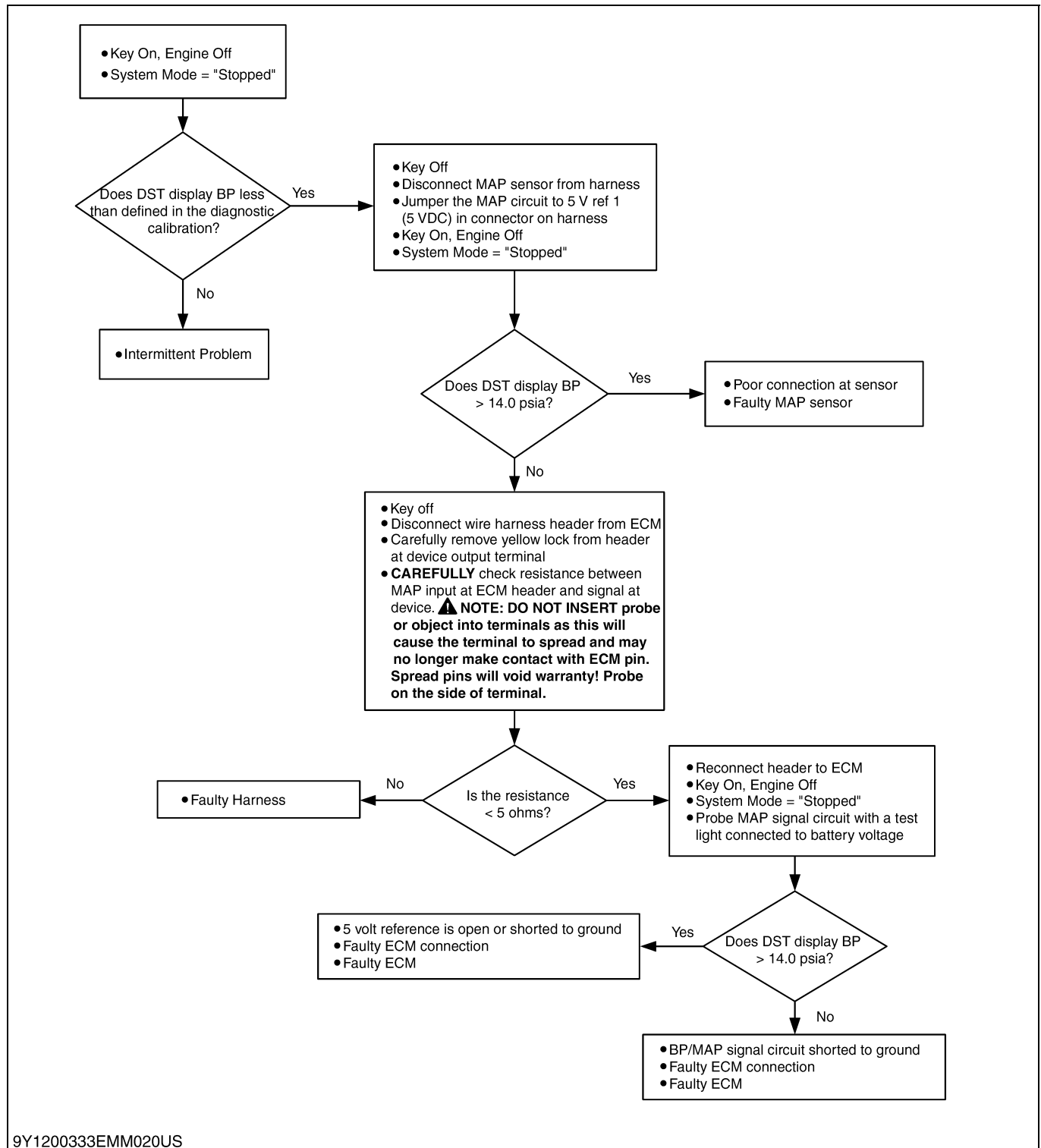
DTC 111-IAT Higher Than Expected Stage 1**Diagnostic Aids**

- 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.

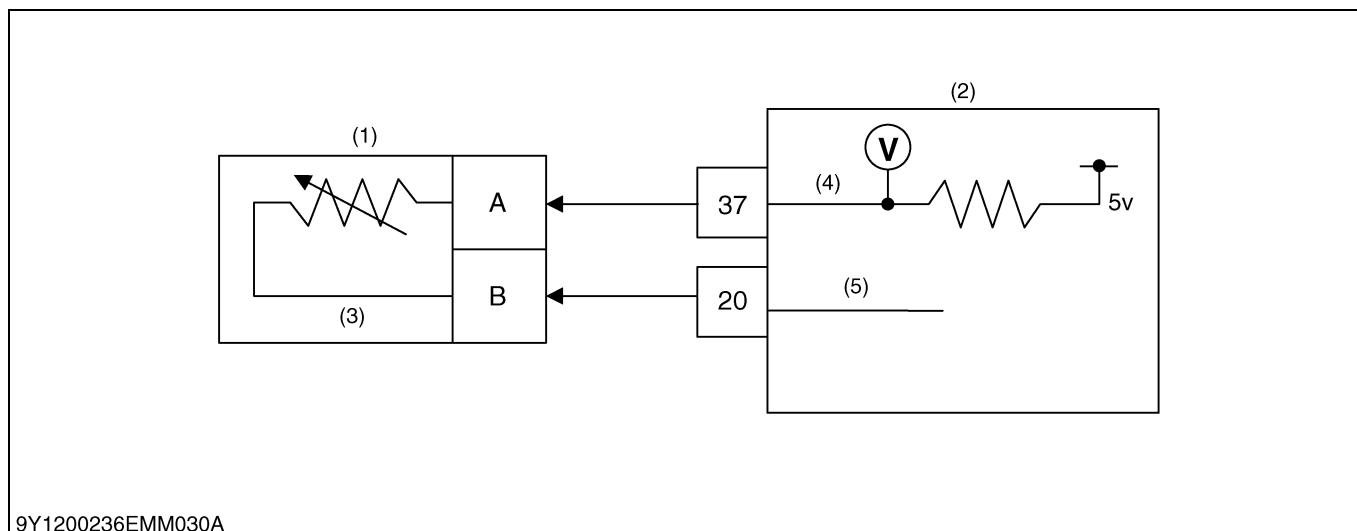
DTC 112-IAT Low Voltage**Diagnostic Aids Chart**

DTC 113-IAT High Voltage**Diagnostic Aids Chart****DTC 127-IAT Higher Than Expected Stage 2****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 129-BP Low Pressure**Diagnostic Aids Chart**

(4) ECT (Engine Coolant Temperature) (DTC 116, 117, 118, 217)



(1) ECT Sensor
(2) ECM

(3) Thermistor

(4) ECT

(5) 5V Rtn 1

DTC 116-ECT Higher Than Expected Stage 1

- Hardware: Engine Coolant Temperature Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Engine Coolant Temperature reading or estimate greater than the stage 1 limit (110 °C (230 °F)) for longer than 30 seconds when engine speed is higher than 600 min⁻¹ (rpm)
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Non-emissions related fault
- Possible Causes: Overheating engine, sensor out of calibration, signal wire partially shorted to ground or faulty ECM

DTC 117-ECT Low Voltage

- Hardware: Engine Coolant Temperature Sensor
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Set Conditions: ECT sensor voltage less than 0.100 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Emissions related fault
- Possible Causes: Faulty ECM (no voltage on signal wire), signal wire shorted to ground or sensor internally shorted

DTC 118-ECT High Voltage

- Hardware: Engine Coolant Temperature Sensor
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Set Condition: ECT sensor voltage greater than 4.90 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Emissions related fault
- Possible Causes: Signal wire shorted to 12.0 V, signal wire open, sensor open internally or open 5 V_{rtn1} (sensor ground)

DTC 217-ECT Higher Than Expected Stage 2

- Hardware: Engine Coolant Temperature Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Engine Coolant Temperature reading or estimate greater than the stage 1 limit (116 °C (240 °F)) for longer than 30 seconds when engine speed is higher than 600 min⁻¹ (rpm)
- Corrective Action(s): Illuminate MIL, Power derate 2, Forced idle and AL disable
- Emissions related fault
- Possible Causes: Overheating engine, sensor out of calibration, signal wire partially shorted to ground or faulty ECM

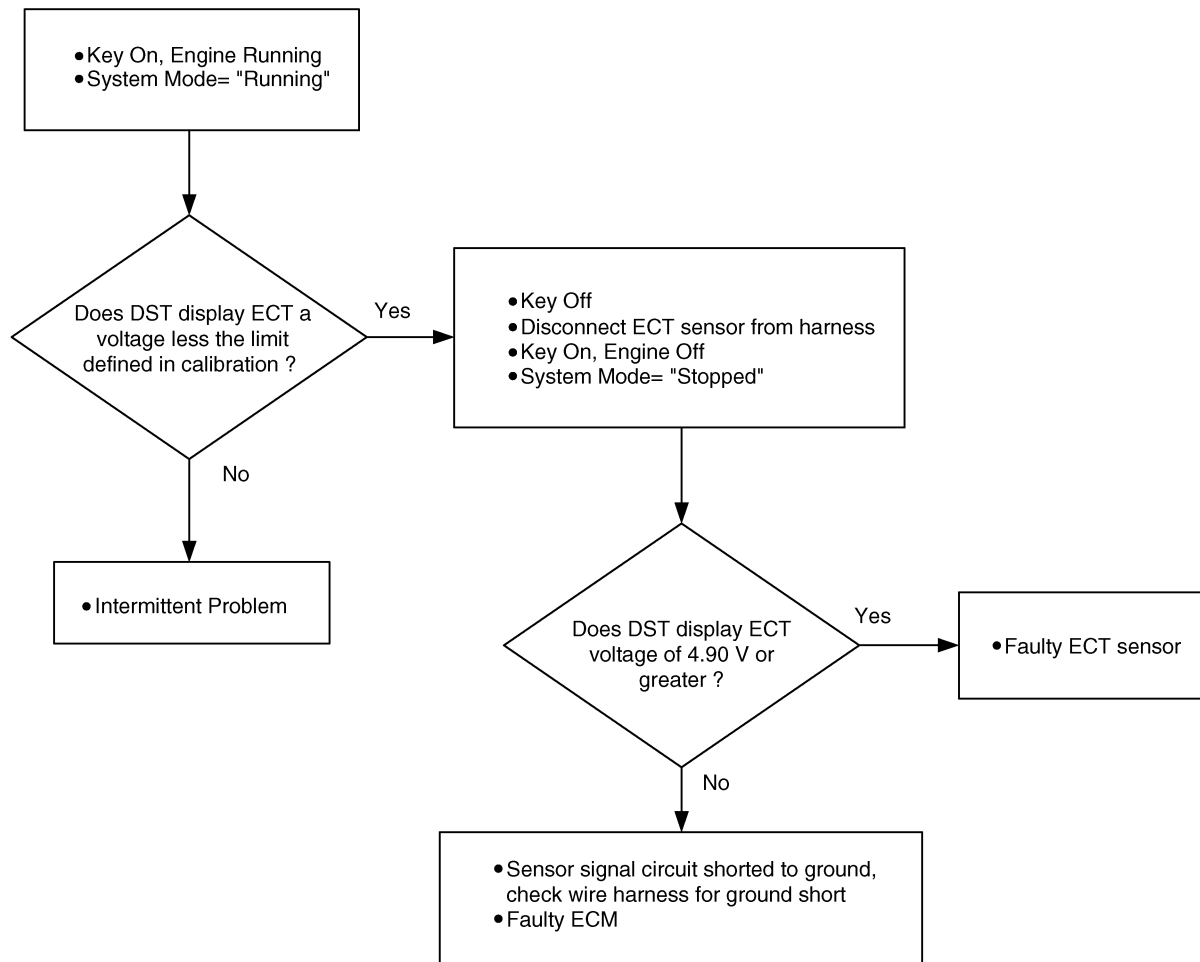
The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. The ECT is used for engine fuel calculation (cold engine), ignition timing control, to enable certain features, and for engine protection (overheats). The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

The fault of DTC 116 and DTC 217 will help protect the engine in the event of over temperature.

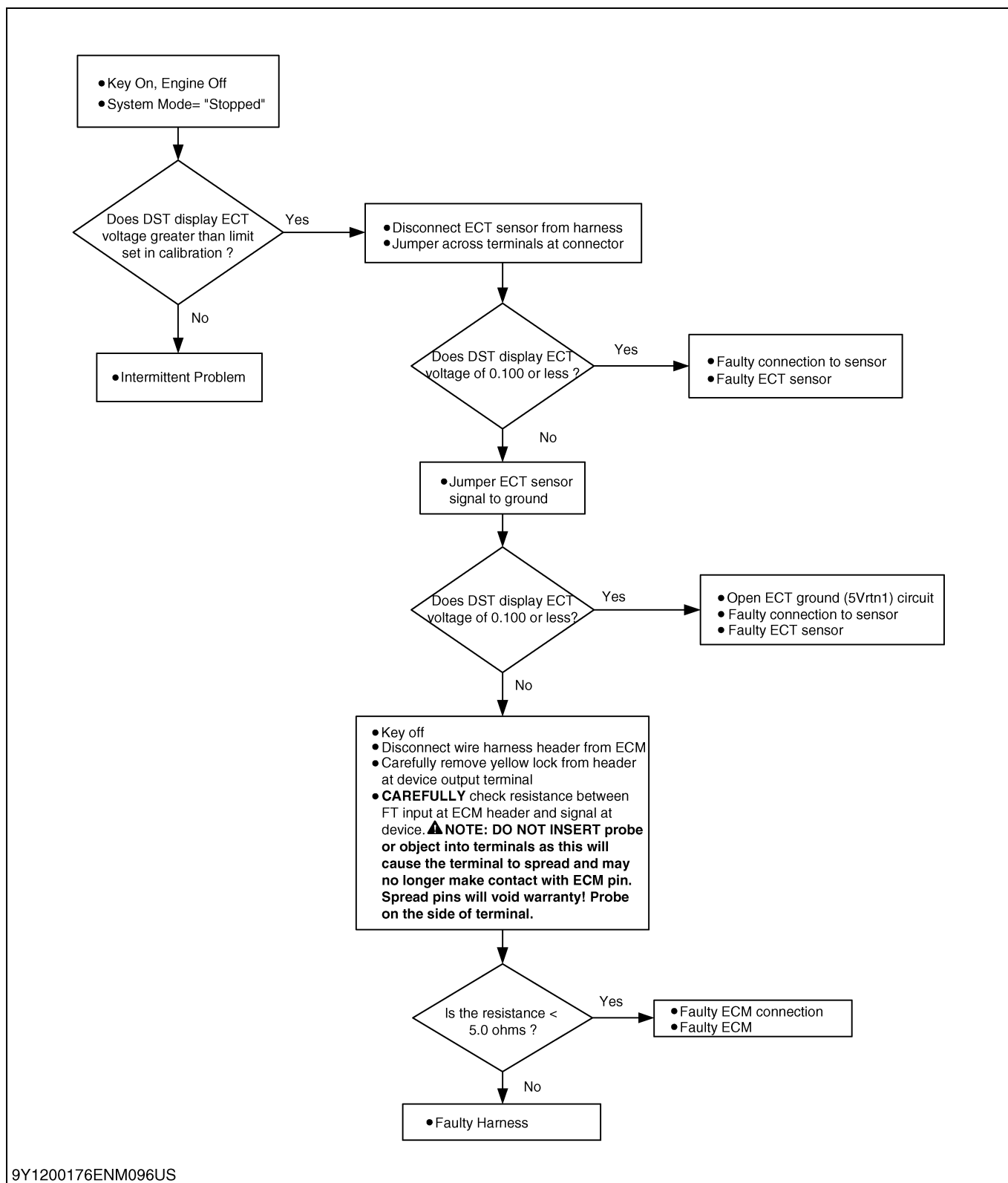
The ECM will use a default value for the ECT sensor in the event of the faults of DTC 117 or DTC 118.

DTC 116-ECT 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:
 - Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
 - Ensure that there is no trapped air in the cooling path
 - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - Check that the fan is operating properly
 - Check that the thermostat is not stuck closed
- If the cooling system utilizes a water-to-water heat exchanger:
 - Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
 - Ensure that there is no trapped air in the cooling path
 - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
 - Check that the thermostat is not stuck closed
 - Check that the raw water pump/impeller is tact and that it is not restricted

DTC 117-ECT Low Voltage**Diagnostic Aids Chart**

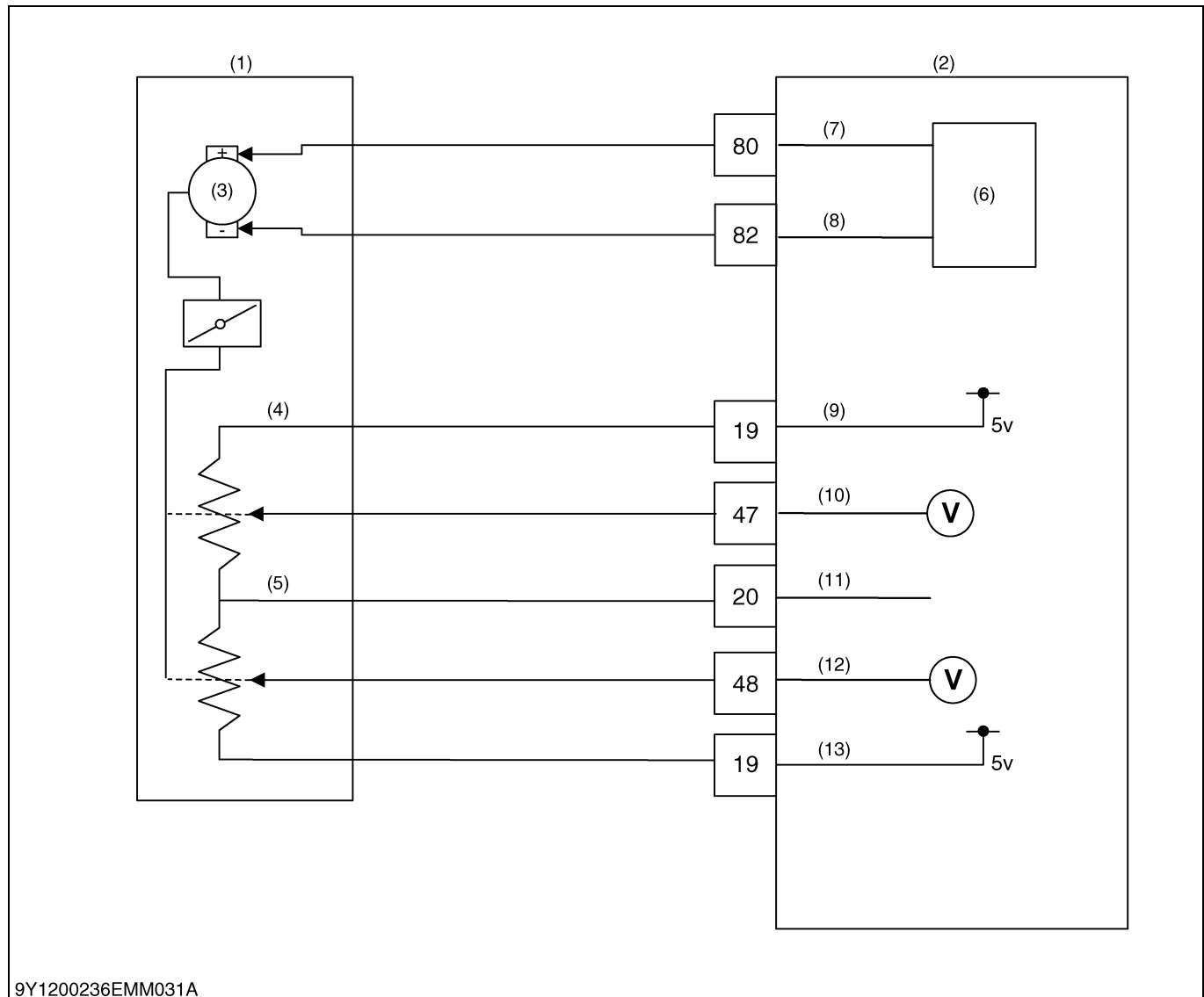
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DTC 118-ECT High Voltage**Diagnostic Aids Chart**

DTC 217-ECT Higher Than Expected Stage 2**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:
 - Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
 - Ensure that there is no trapped air in the cooling path
 - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - Check that the fan is operating properly
 - Check that the thermostat is not stuck closed
- If the cooling system utilizes a water-to-water heat exchanger:
 - Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
 - Ensure that there is no trapped air in the cooling path
 - Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
 - Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
 - Check that the thermostat is not stuck closed
 - Check that the raw water pump/impeller is tact and that it is not

(5) TPS (Throttle Position Sensor) (DTC 121 to 123, 221 to 223, 2111, 2112, 2135)



(1) Electronic Throttle Body

(2) ECM

(3) Motor

(4) TPS1

(5) TPS2

(6) H-Bridge

(7) DBW+

(8) DBW-

(9) 5V Ext 1

(10) TPS1

(11) 5V Rtn 1

(12) TPS2

(13) 5V Ext 1

DTC 121-TPS1 % Lower Than TPS2 %

- Hardware: Throttle Body-Throttle Position Sensors 1 & 2 relationship
- Enabling Conditions: Engine Running
- Set Conditions: TPS1 % lower than TPS2 % by more than 20 % for longer than 1 second
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes: TPS1 or TPS2 out of calibration in throttle body, unwanted resistance in either TPS1 or TPS2 signal circuits, unwanted resistance in either the shared reference feed (5 V_ext1) or shared sensor ground (5 Vrtn1), bad ECM

DTC 122-TPS1 Signal Voltage Low

- Hardware: Throttle Body-Throttle Position Sensor 1
- Enabling Conditions: Engine Running
- Set Conditions: TPS1 sensor voltage lower than 0.200 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes: Loss of 5.00 V reference feed, open or shorted to ground signal circuit, open or shorted to ground TPS in throttle body, bad ECM

DTC 123-TPS1 Signal Voltage High

- Hardware: Throttle Body-Throttle Position Sensor 1
- Enabling Conditions: Engine Running
- Set Conditions: TPS1 sensor voltage higher than 4.80 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes: 5.00 V reference feed (5 V_ext1) shorted to voltage, Open sensor ground (5 Vrtn1) circuit, signal wire shorted to voltage or bad TPS in throttle body

DTC 221-TPS1 % Higher Than TPS2 %

- Hardware: Throttle Body-Throttle Position Sensor 1 & 2 relationship
- Enabling Conditions: Engine Running
- Set Conditions: TPS1 % higher than TPS2 % by more than 20 % for longer than 1 second
- Corrective Action(s): Illuminate MIL and Engine stop
- Non-emissions related fault
- Possible Causes: TPS1 or TPS2 out of calibration in throttle body, unwanted resistance in either TPS1 or TPS2 signal circuits, unwanted resistance in either the shared reference feed (5 V_ext1) or shared sensor ground (5 vrtn1), bad ECM

DTC 222-TPS2 Signal Voltage Low

- Hardware: Throttle Body-Throttle Position Sensor 2 (electronic throttle body only)
- Enabling Conditions: Engine Running
- Set Condition: TPS2 sensor voltage lower 0.200 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes: Loss of 5.00 V reference feed, open or shorted to ground signal circuit, open or shorted to ground TPS in throttle body, bad ECM

DTC 223-TPS2 Signal Voltage High

- Hardware: Throttle Body-Throttle Position Sensor 2 (electronic throttle body only)
- Enabling Conditions: Engine Running
- Set Conditions: TPS2 sensor voltage higher than 4.80 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes: 5.00 V reference feed (5 V_ext1) shorted to voltage, Open sensor ground (5 Vrtn1) circuit, signal wire shorted to voltage or bad TPS in throttle body

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.

Each Throttle Position Sensor uses a variable resistor and voltage divider circuit 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) are used to perform speed governing with improved safety and redundancy.

DTC 2111: Unable to Reach Lower TPS

- Hardware: Throttle Position Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Throttle command is 20 % less than actual throttle position
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes: Follow at DTC 2112

DTC 2112: Unable to Reach Higher TPS

- Hardware: Throttle Position Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Throttle command is 20 % more than actual throttle position
- Corrective Action(s): Illuminate MIL and Engine stop
- Emissions related fault
- Possible Causes:

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 % ages are calculated from these voltages. Although the voltages are different, the calculated values for the throttle position % ages should be very close to the same. The TPS values are used by the ECM to determine if the throttle is opening as commanded.

The DBW motor is a 2 wire DC motor that is PWM controlled by the ECM. Neither of these wires is watched by the ECM for electrical problems. DTCs 2111 and 2112 usually indicate that the ECM has lost control of the motor due to an electrical problem with the motor or a mechanical problem with the motor.

This fault of DTC 2111 will set if the throttle command is 20 % lower or more than the actual throttle position. During this active fault the MIL light will be on and the engine will stop.

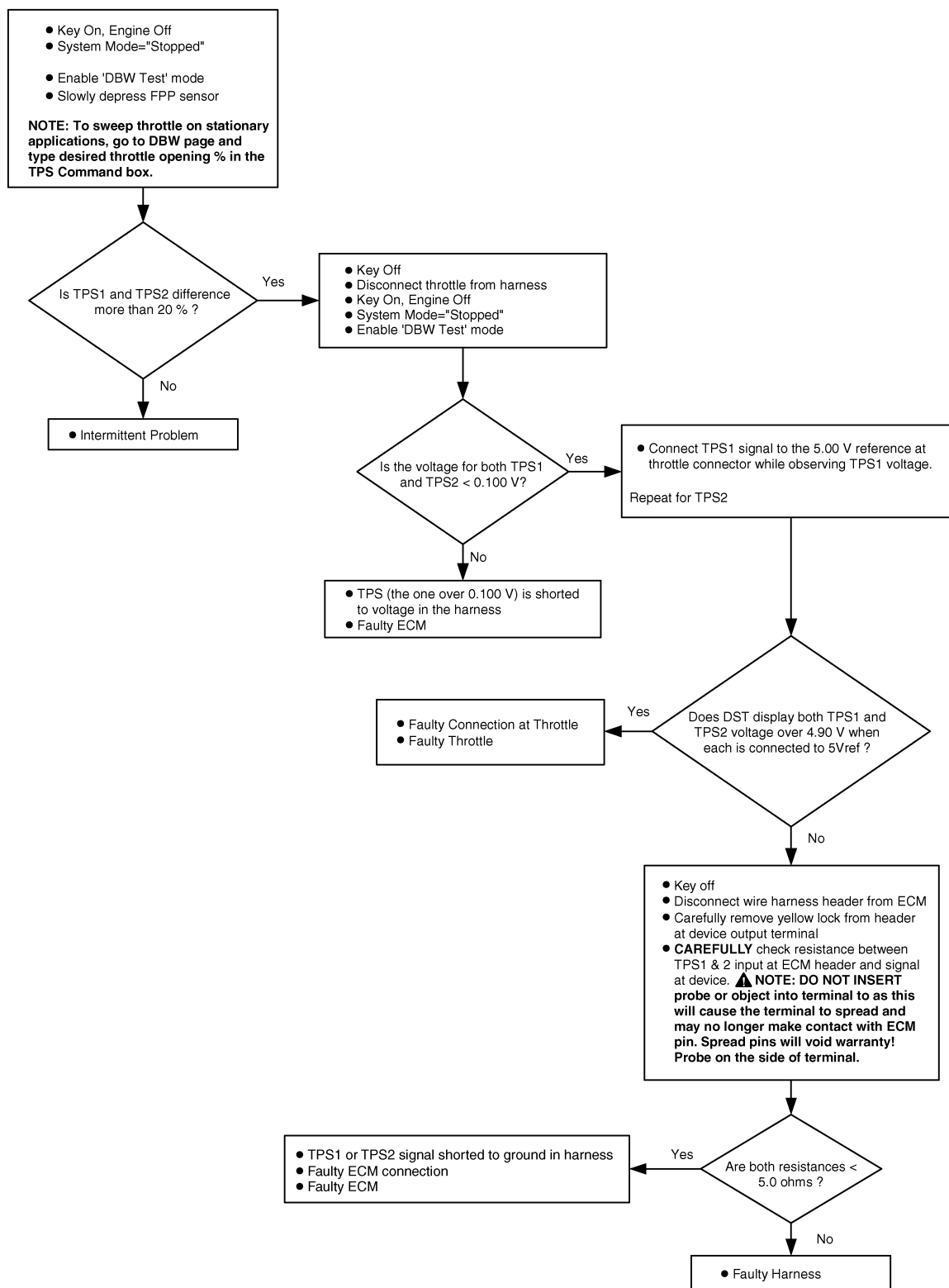
This fault of DTC 2112 will set if the throttle command is 20 % lower or more than the actual throttle position. During this active fault the MIL light will be on and the engine will stop.

DTC 2135-TPS1/2 Simultaneous Voltages Out-of-Range

- Hardware: Electronic throttle body
- Enabling Conditions: Engine Running
- Set Condition: TPS1 and TPS2 voltages are both simultaneously out-of-range for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL and Engine stop
- Non-emissions related fault
- Possible Causes: Loss of 5.00 V feed to both sensors, loss of ground (5 V_rtn1) to both sensors, problem with both TPSs at the same time

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.

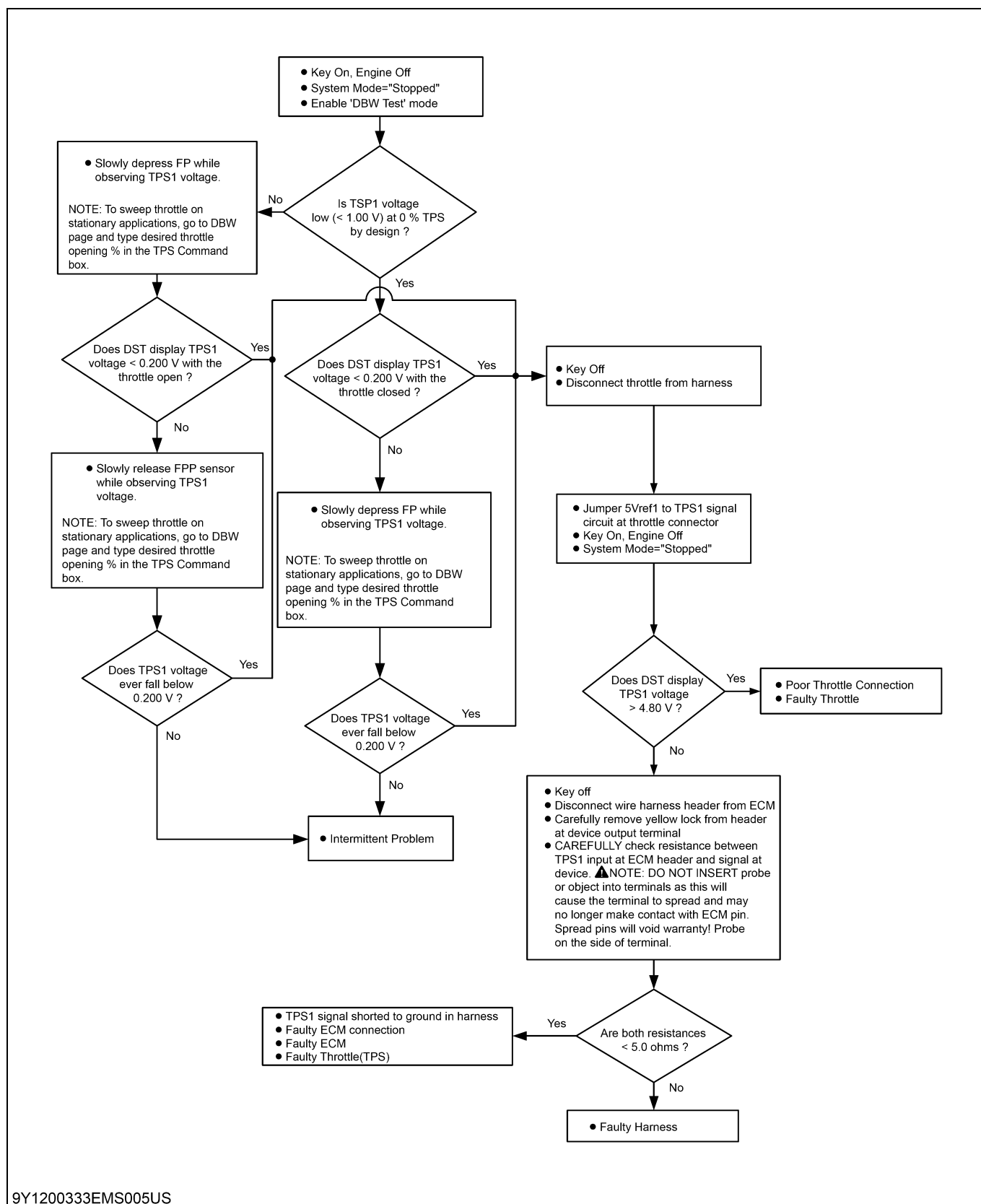
This fault is generated when both feedback sensors in the ETB (TPS1 and TPS2) simultaneously produce out-of-range faults. This fault indicates that there is no feedback of the throttle valve and as a result throttle control cannot take place.

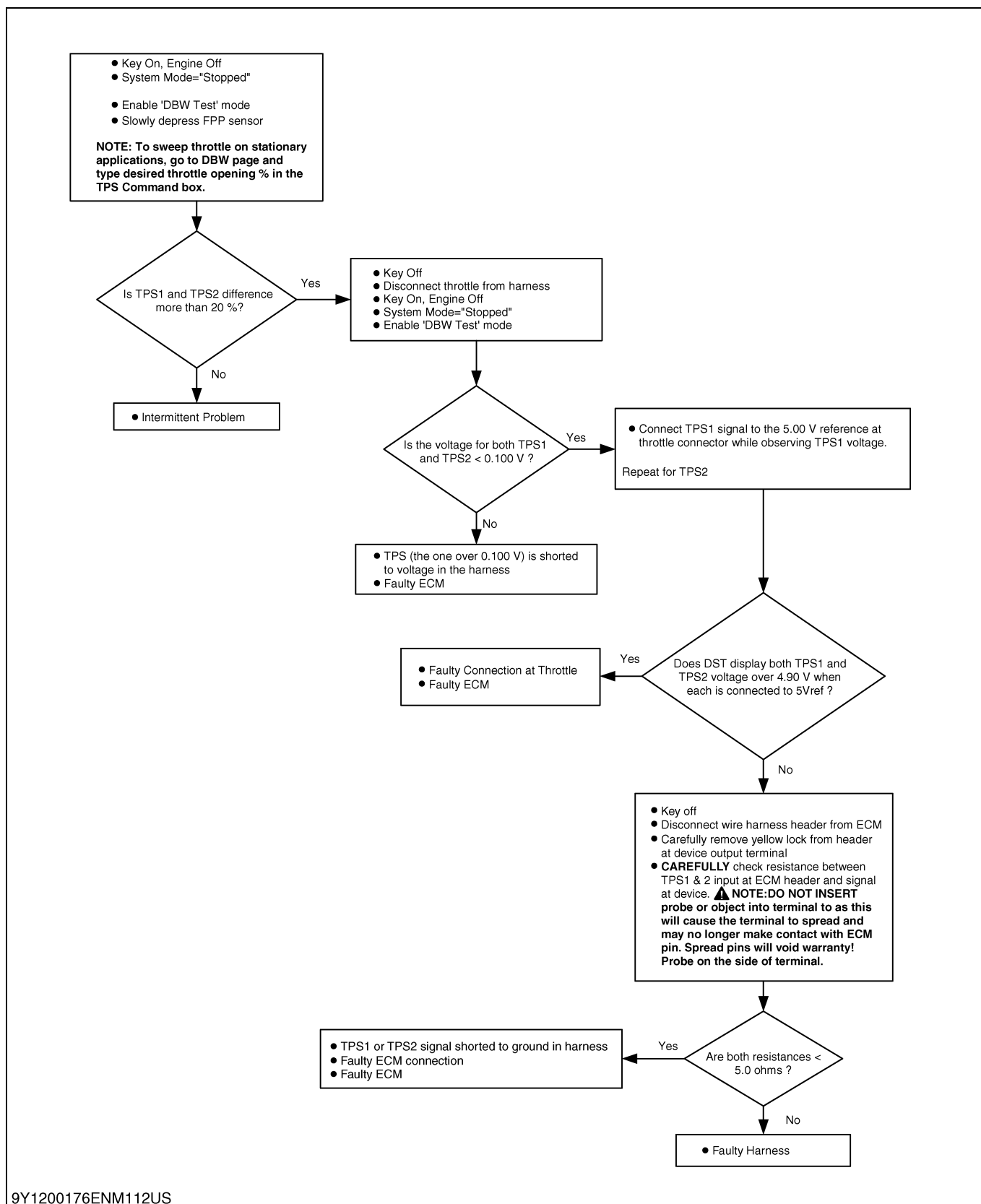
DTC 121-TPS1 % Lower Than TPS2 %**Diagnostic Aids Chart**

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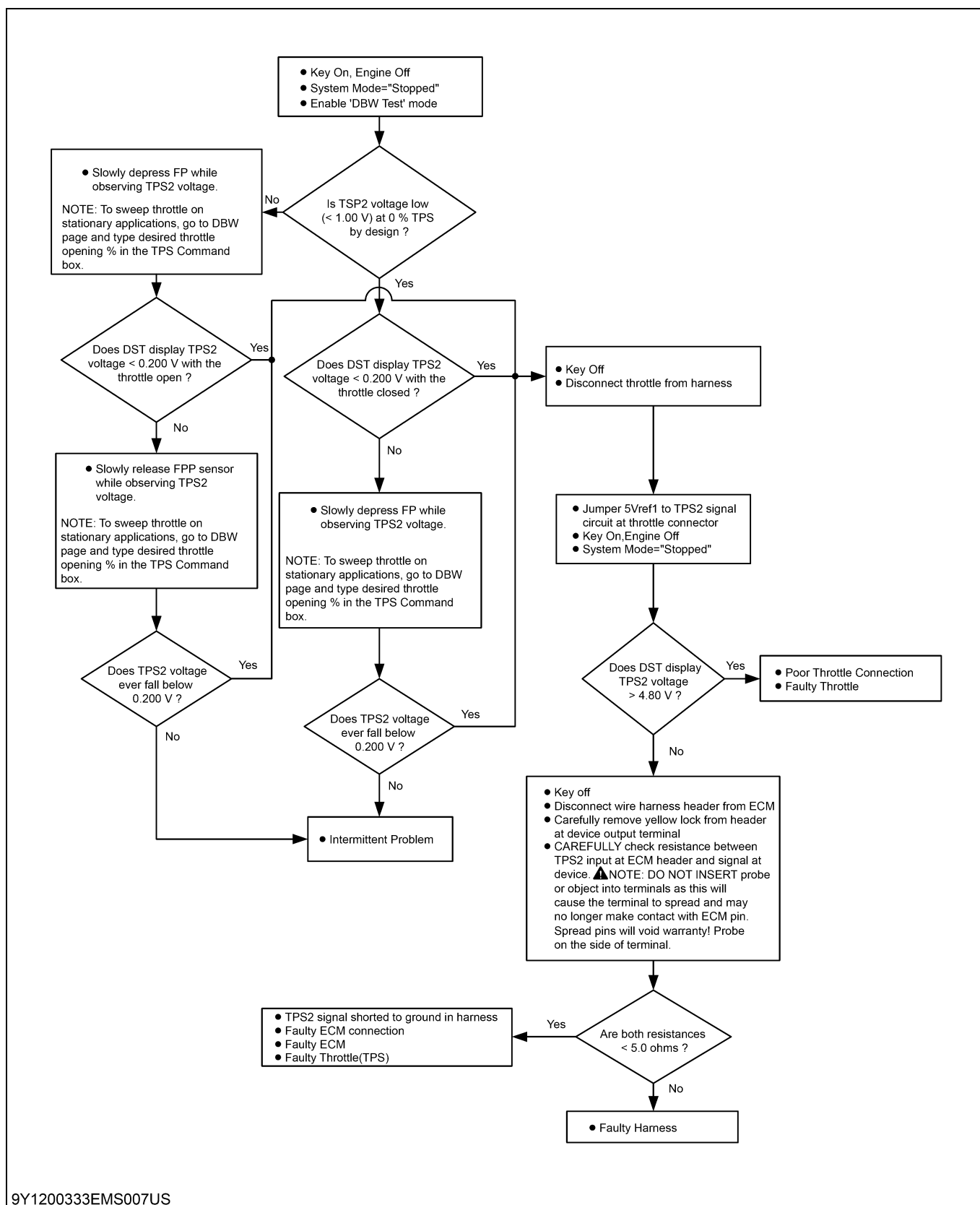
DTC 122-TPS1 Signal Voltage Low

Diagnostic Aids Chart

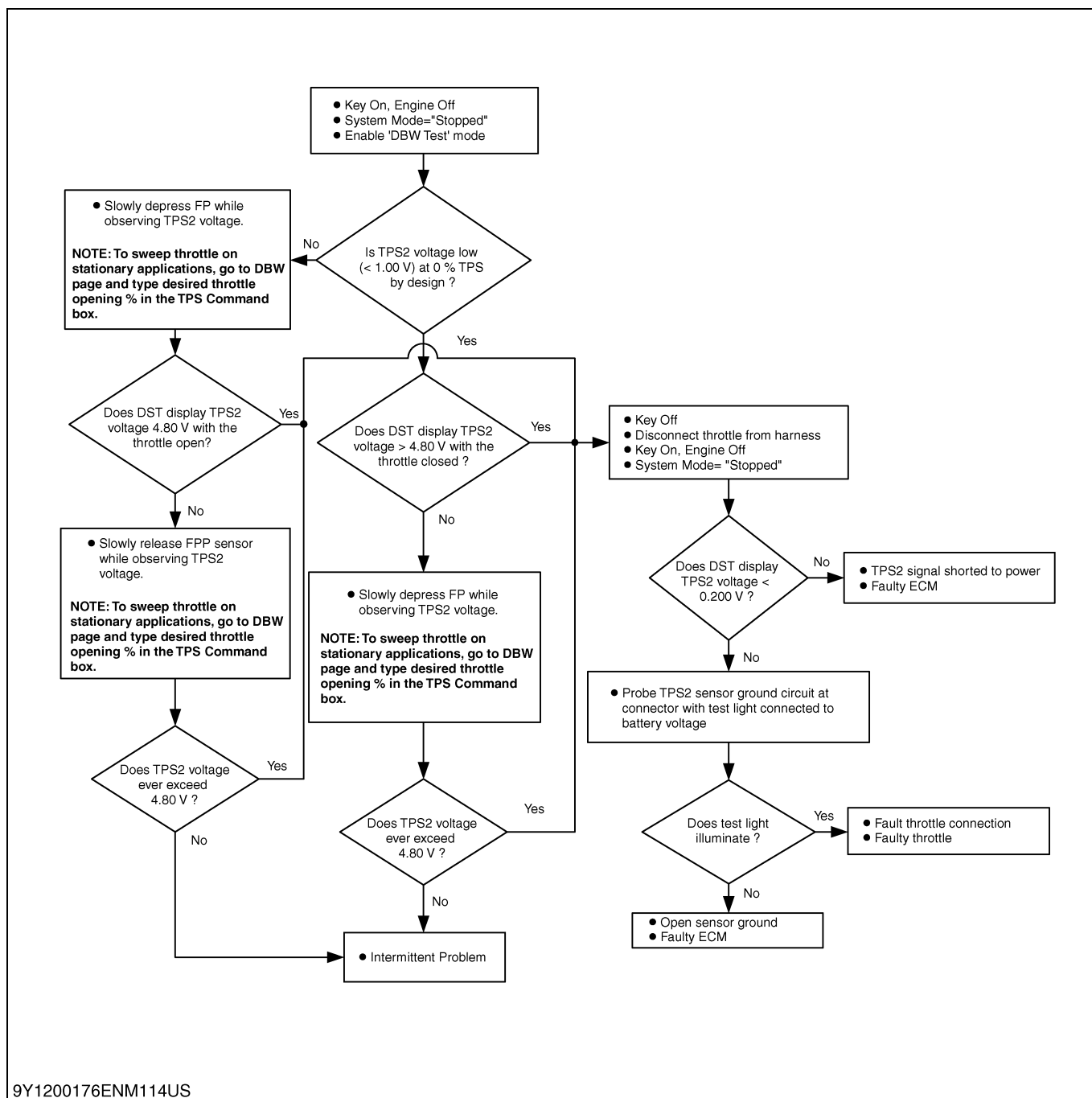


DTC 221-TPS1 % Higher Than TPS2 %**Diagnostic Aids Chart**

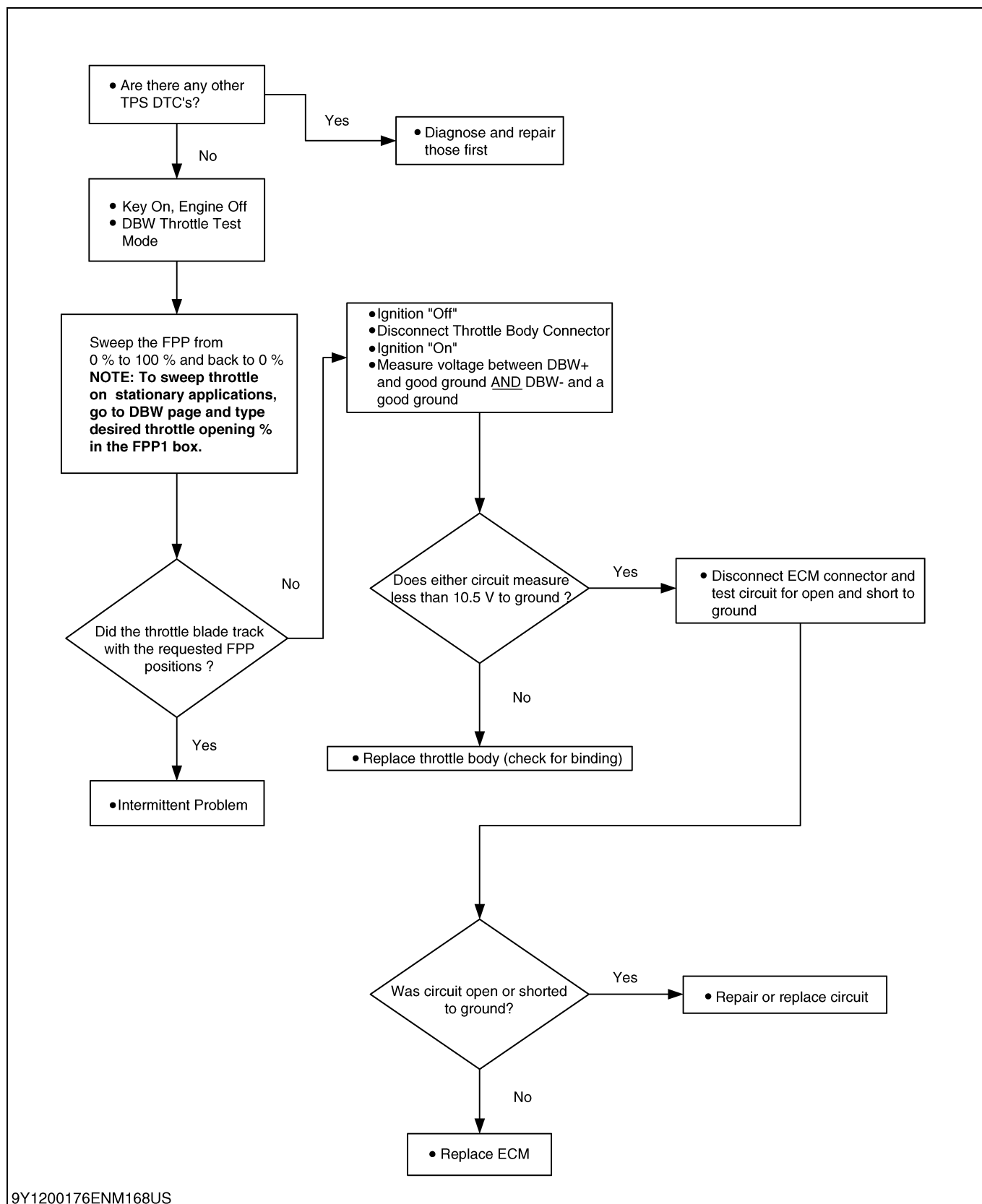
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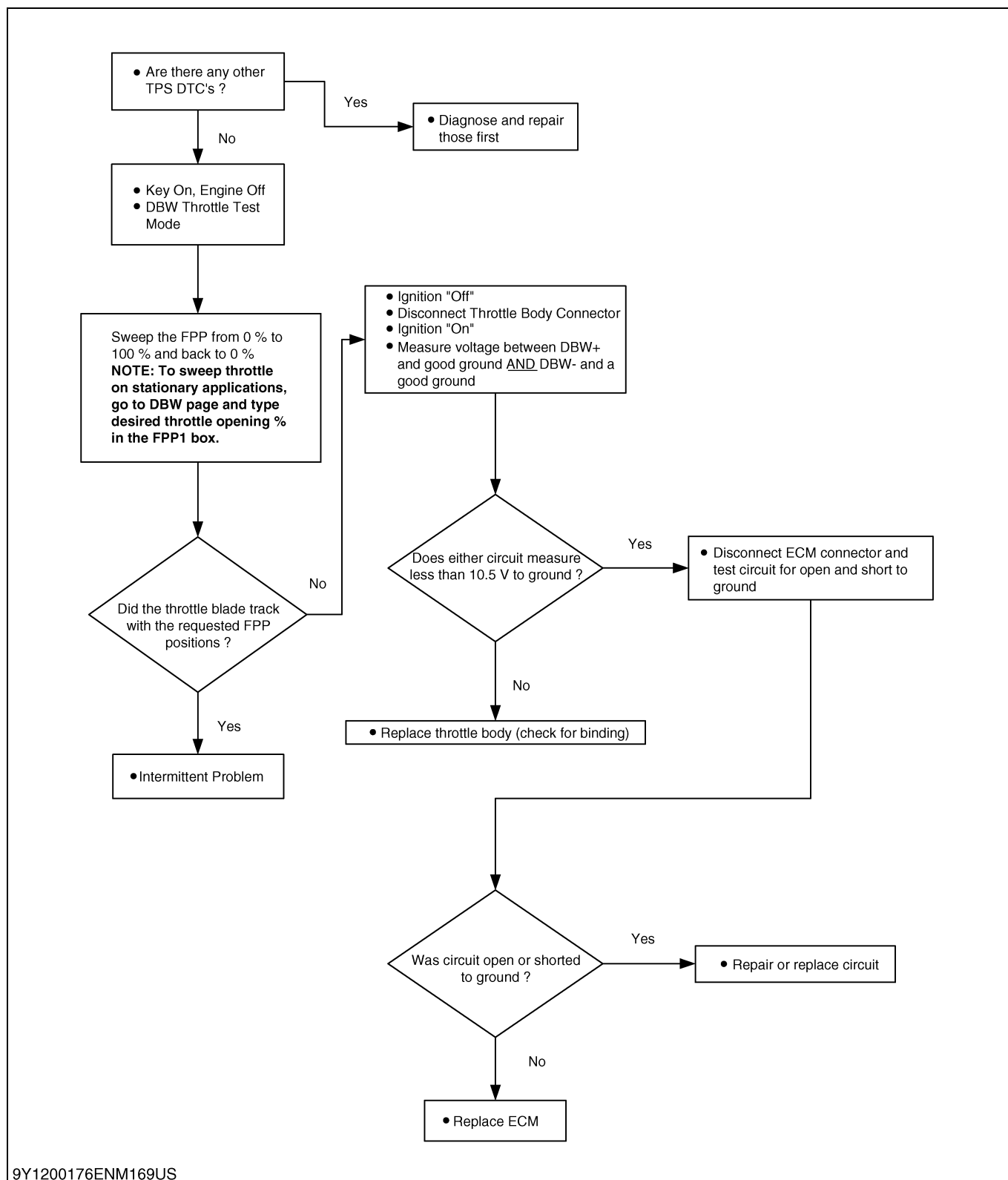
DTC 222-TPS2 Signal Voltage Low**Diagnostic Aids Chart**

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DTC 223-TPS2 Signal Voltage High**Diagnostic Aids Chart**

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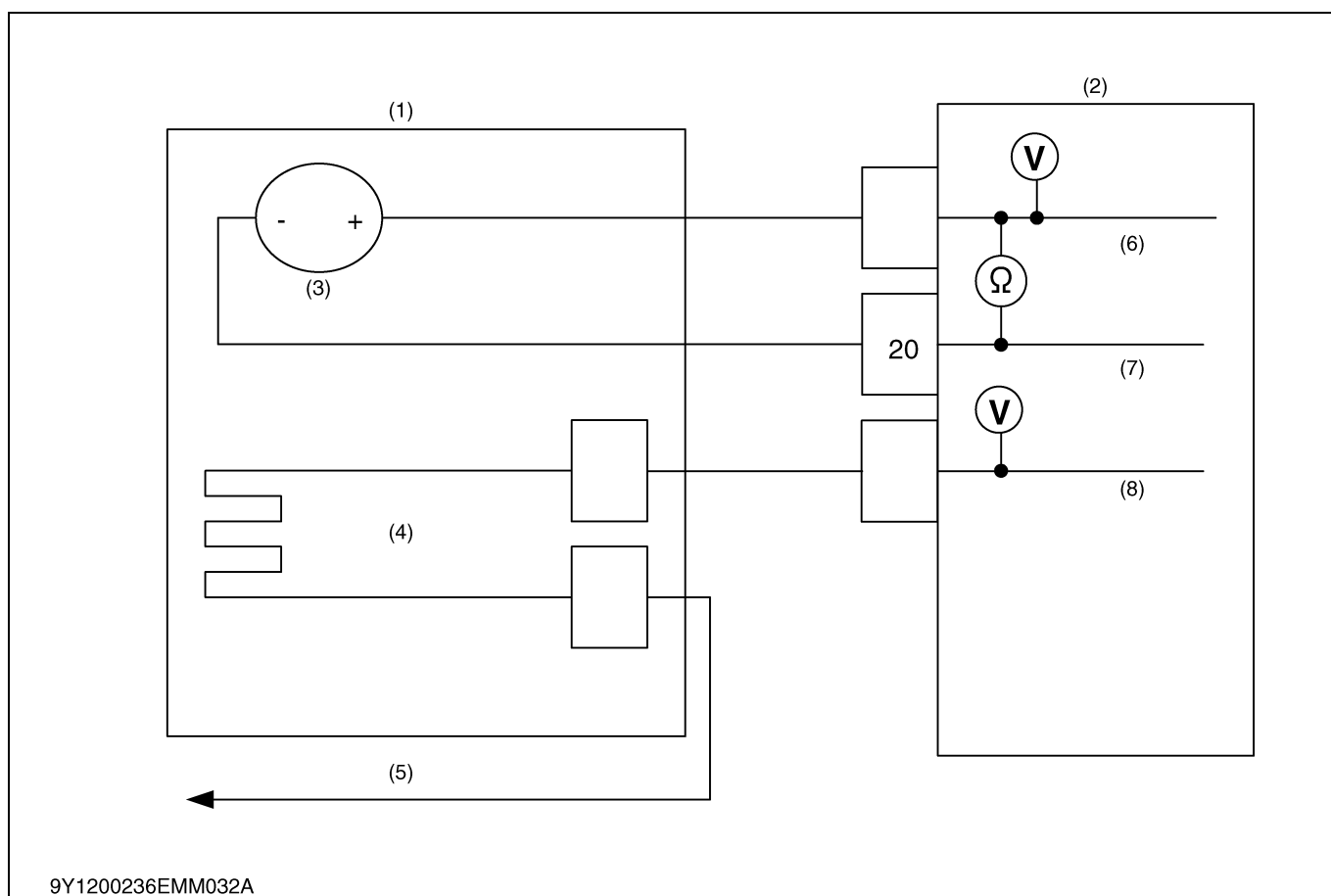
DTC 2111: Unable to Reach Lower TPS**Diagnostic Aids Chart**

DTC 2112: Unable to Reach Higher TPS**Diagnostic Aids Chart****DTC 2135-TPS1/2 Simultaneous Voltages Out-of-Range****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.

(6) EGO Sensors ((Exhaust Gas Oxygen) Sensors) (DTC 134, 154)



(1) HEEO
(2) ECM

(3) Sensor
(4) Heater

(5) To System Power Relay
(6) EGO 1 (21), EGO 2 (22)

(7) 5V Rtn 1
(8) EGOH 1 (62), EGOH 2 (61)
(PWM to GND)

DTC 134-EGO1 Open/Lazy (HO₂S1)

- Hardware: Exhaust Gas Oxygen Sensor (Pre-Catalyst)
- Enabling Conditions: Engine Running
- Set Conditions: EGO sensor cold or non-responsive for longer than 120 seconds
- Corrective Action(s): Illuminate MIL, CL disable and AL disable
- Emissions related fault
- Possible Causes: Open feed circuit to O₂ heater, Open heater ground circuit, Open or shorted to ground O₂ signal wire, open sensor ground (5 Vrtn1), inoperative sensor

The EGO 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. 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.

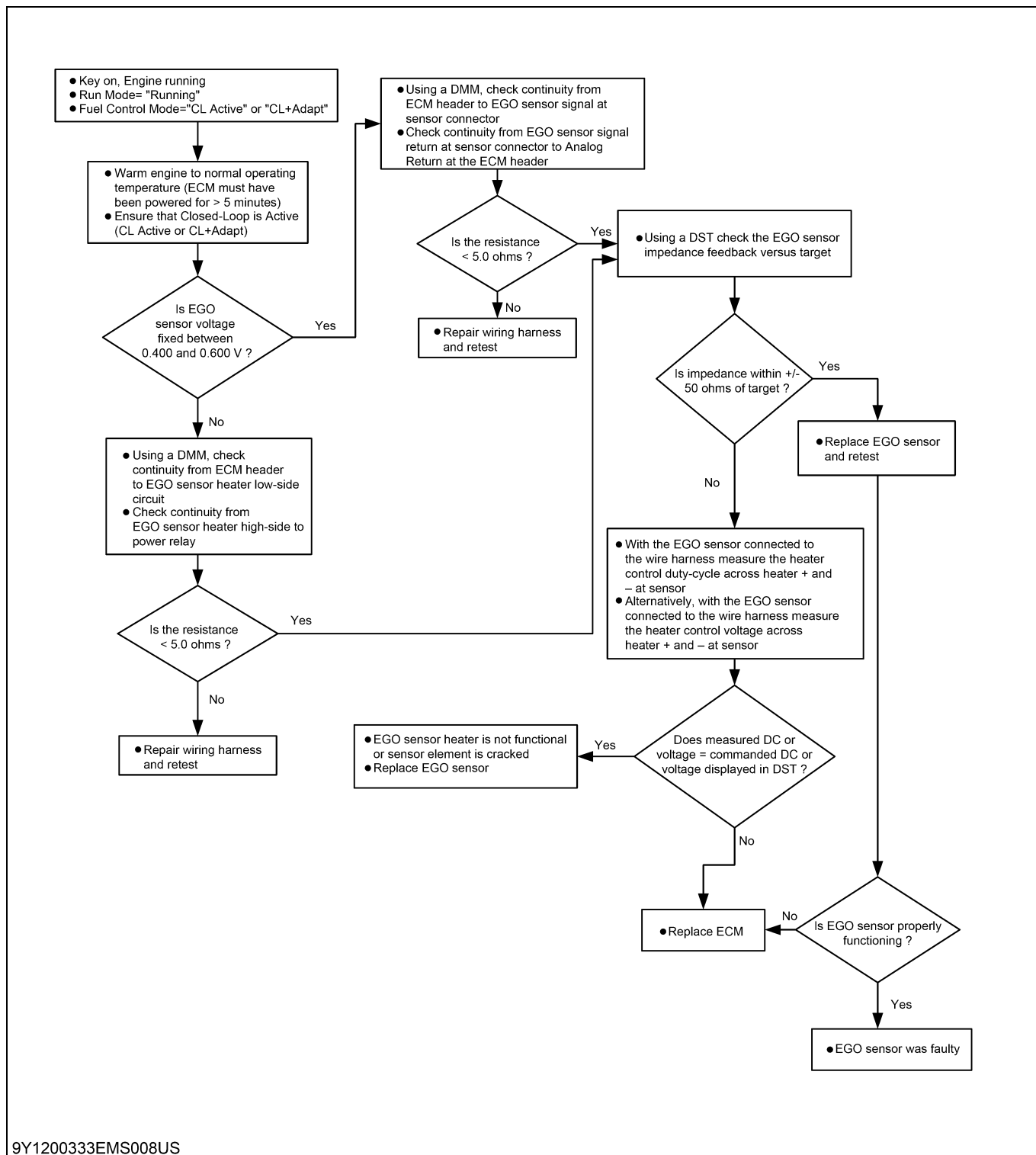
Cold or non-responsive is defined as the actual impedance of the sensor heater not reaching the target impedance.

DTC 154-EGO2 Open/Lazy (HO₂S2)

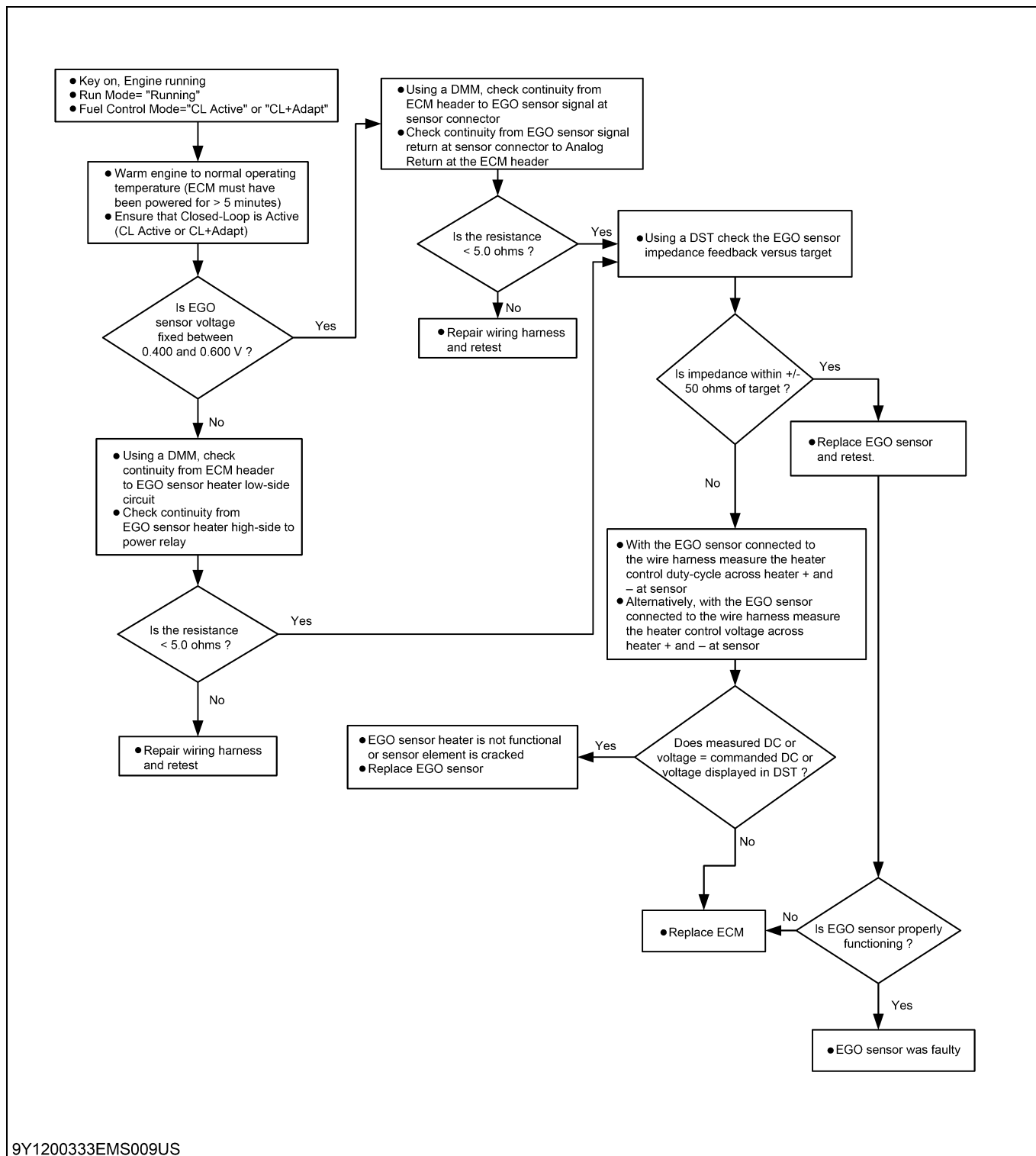
- Hardware: Exhaust Gas Oxygen Sensor (Post-Catalyst)
- Enabling Conditions: Engine Running
- Set Conditions: EGO sensor cold or non-responsive longer than 120 seconds
- Corrective Action(s): Illuminate MIL and AL disable
- Emissions related fault
- Possible Causes: Open feed circuit to O₂ heater, Open heater ground circuit, Open or shorted to ground O₂ signal wire, open sensor ground (5 Vrtn1), inoperative sensor

In a post-catalyst configuration the EGO 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.

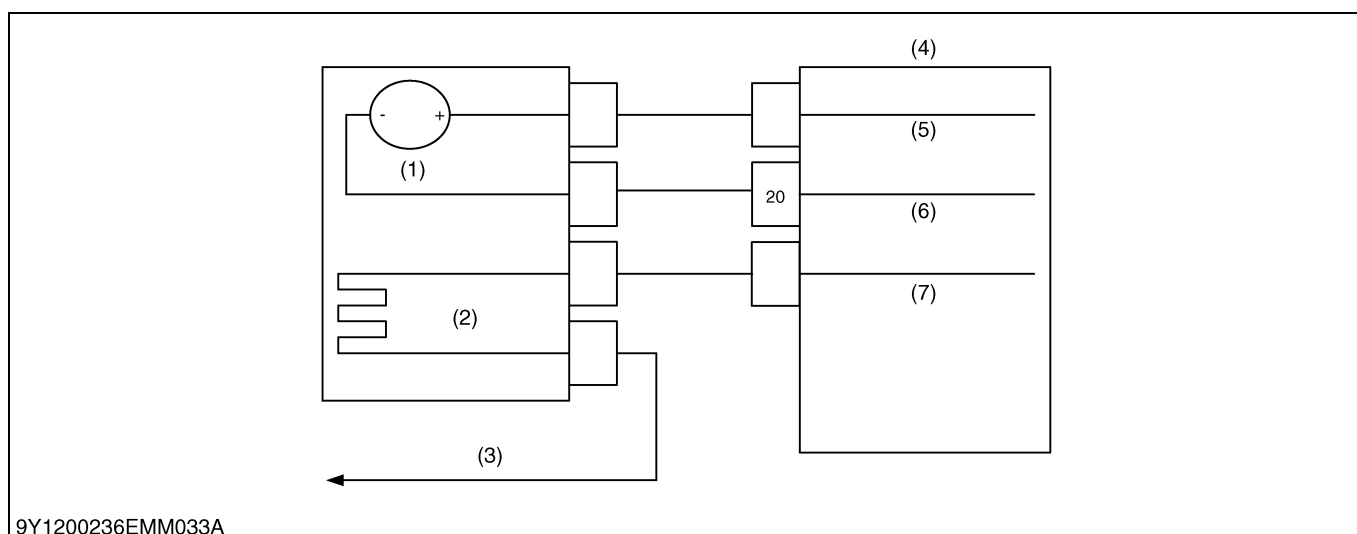
Cold or non-responsive is defined as the actual impedance of the sensor heater not reaching the target impedance.

DTC 134-EGO1 Open/Lazy (HO₂S1)**Diagnostic Aids Chart**

9Y1200333EMS008US

DTC 154-EGO2 Open/Lazy (HO₂S2)**Diagnostic Aids Chart**

(7) Adaptive Learn (DTC 1161, 1162)



- | | | | |
|------------|---------------------------|---|-------------------------------|
| (1) Sensor | (3) To System Power Relay | (5) EGO 1/2/3/4 (HO ₂ S 1/2/3/4) | (7) EGOH 1/2/3/4 (PWM to GND) |
| (2) Heater | (4) ECM | (6) 5V Rtn 1 | |

DTC 1161-Adaptive Learn High (LPG)

- Hardware: Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)
- Enabling Conditions: Engine Running in closed loop active mode updating adaptive learn multiplier (CL+Adap mode)
- Set Conditions: Adaptive fuel multiplier higher than 30 % for longer than 3 updates
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Emissions related fault
- Possible Causes:

The EGO 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.

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 EGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive EGO 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.

DTC 1162-Adaptive Learn Low (LPG)

- Hardware: Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)
- Enabling Conditions: Engine Running in closed loop active mode updating adaptive learn multiplier (CL+Adap mode)
- Set Conditions: Adaptive fuel multiplier lower than -30 % for longer than 3 updates
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Emissions related fault
- Possible Causes:

The EGO 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.

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 EGO 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.

DTC 1161-Adaptive Learn High (LPG)

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 EGO sensor with a known good part and retest.

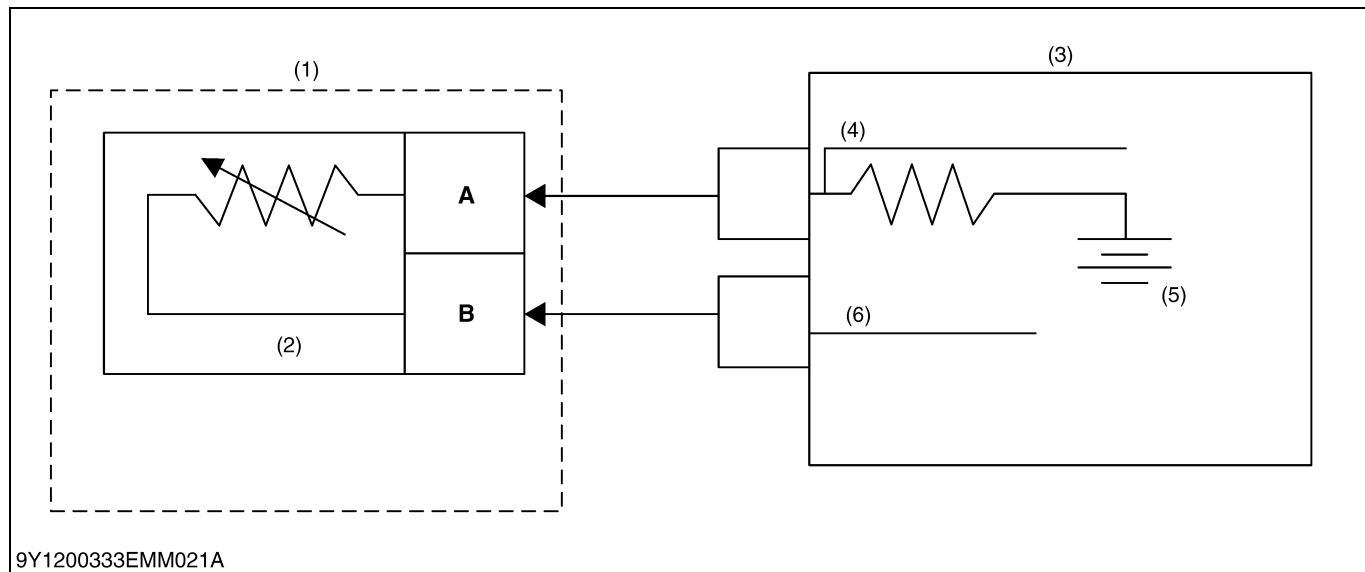
DTC 1162-Adaptive Learn Low (LPG)

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 EGO sensor with a known good part and retest.

(8) Fuel Temp (Fuel Temperature Sensor) (DTC 187)



(1) FT Sensor

(3) ECM

(5) $V_s = +5 \text{ VDC}$

(6) 5V Rtn 1

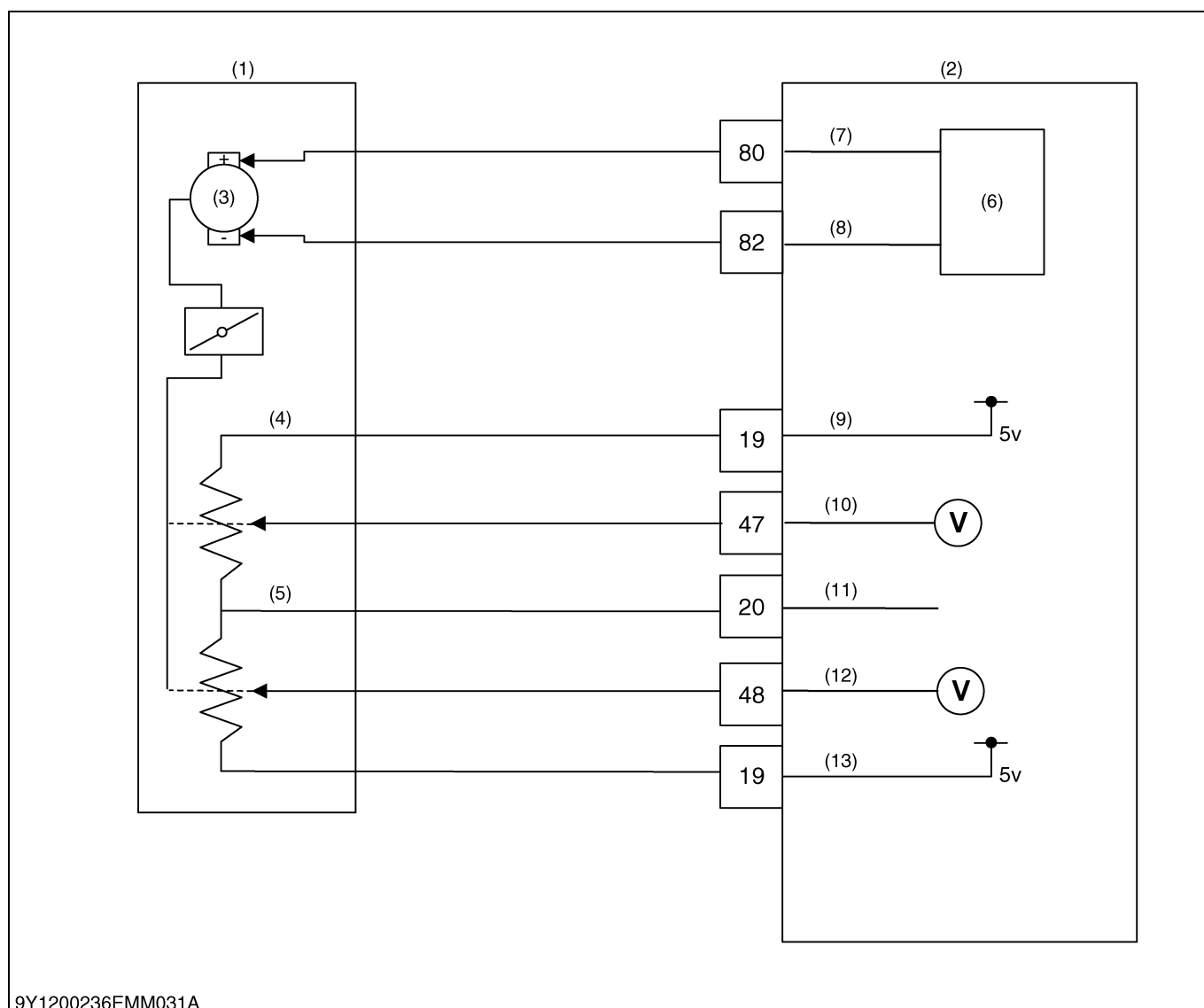
(2) Thermistor

(4) FT (AUX Ana PU1, PU2, etc.)

DTC 187-BP FT Gaseous Fuel Extremely Low

- Hardware: Gaseous Fuel Temperature Sensor (built-in DEPR)
- Enabling Conditions: Engine Running
- Set Conditions: Fuel temperature is lower than -40°C (-40°F) for longer than 1 sec.
- Corrective Action(s): Illuminate MIL
- NO emissions related fault
- Possible Causes: Not vaporized completely

(9) Engine Speed (DTC 219, 1111, 1112)



(1) Electronic Throttle Body

(2) ECM

(3) Motor

(4) TPS1

(5) TPS2

(6) H-Bridge

(7) DBW+

(8) DBW-

(9) 5V Ext 1

(10) TPS1

(11) 5V Rtn 1

(12) TPS2

(13) 5V Ext 1

DTC 219-RPM Higher Than Max Allowed Governed Speed

- Hardware: Max Govern Speed Override- Crankshaft Position Sensor
- Enabling Conditions: Engine Running
- Fault Condition: Engine speed greater 3000 min^{-1} (rpm) for longer than 1 second
- Corrective Action(s): Illuminate MIL and reduce throttle to limit speed
- Non-emissions related fault
- Possible Causes: Engine over speed condition, stuck throttle, large vacuum leak into intake manifold after throttle blade

DTC 1111-RPM Above Fuel Rev Limit Level

- Hardware: Fuel Rev Limit- Crankshaft Position Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Engine speed greater than the Fuel Rev Limit speed (3200 min^{-1} (rpm)) for longer than 1 second
- Corrective Action(s): Illuminate MIL and disable fuel injectors or gaseous fuel control actuator
- Non-emissions related fault
- Possible Causes: Engine over speed condition, faulty CKP sensor or input

DTC 1112-RPM Above Spark Rev Limit Level

- Hardware: Spark Rev Limit- Crankshaft Position Sensor
- Enabling Conditions: Engine Running
- Set Conditions: Engine speed greater than the Spark Rev Limit speed (3400 min⁻¹ (rpm)) for longer than 1 second
- Corrective Action(s): Illuminate MIL and disable spark
- Non-emissions related fault
- Possible Causes: Engine over speed condition, faulty CKP sensor or input

The fault of DTC 219 will set anytime the engine RPM exceeds 3000 min⁻¹ (rpm) for longer than 1 second. This fault is designed to help prevent engine or equipment damage. The throttle will be lowered in order to govern the engine to the speed set in the diagnostic calibration.

The fault of DTC 1111 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. 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.

The fault of DTC 1112 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. 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.

DTC 219-RPM Higher Than Max Allowed Governed Speed**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

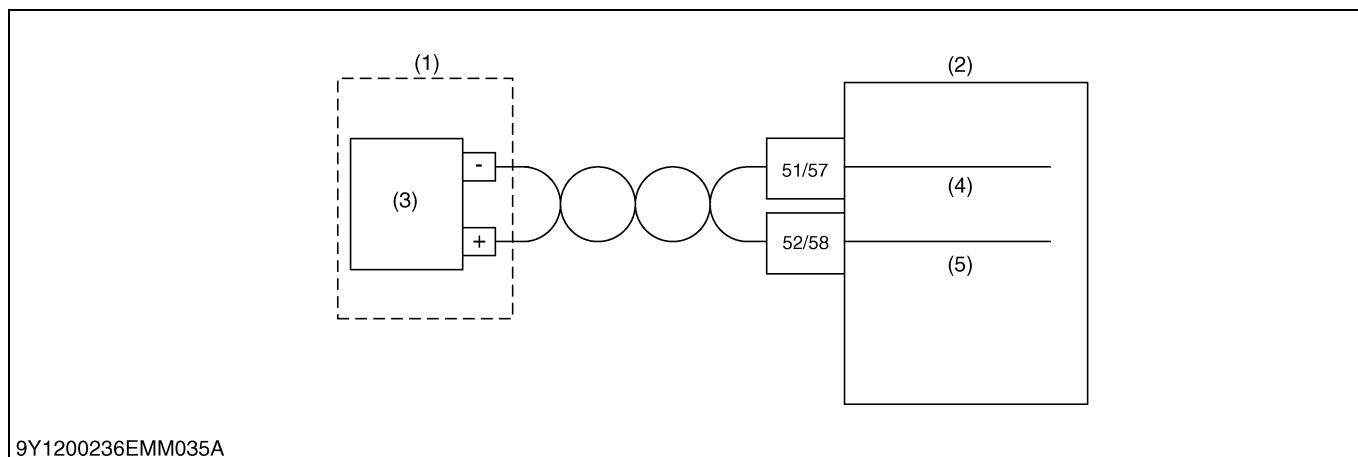
DTC 1111-RPM Above Fuel Rev Limit Level**Diagnostic Aids****■ NOTE**

- **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**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

(10) Knock Sensor (DTC 326, 327)



(1) Sensor
(2) ECM

(3) Flat Response KNK

(4) Knock 1/Knock 2 +

(5) Knock 1/Knock 2 -

DTC 326-Knock 1 Excessive or Erratic Signal

- Hardware: Knock sensor #1
- Enabling Conditions: Engine Running
- Set Conditions: Knock sensor 1 voltage above 0.250 V with MAP less than 55 kPa [abs] (0.56 kgf/cm², 8.0 psia) for longer than 3 seconds.
- Corrective Action(s): Illuminate MIL, Power derate 1 and Retard fault KNK
- Emissions related fault
- Possible Causes: Internal engine damage causing audible noise, knock sensor signal wire routed too close to spark plug wire, bad sensor, bad ECM

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. The knock sensor is used to protect the engine from damage that can be caused from detonation or knock based on fixed spark advance.

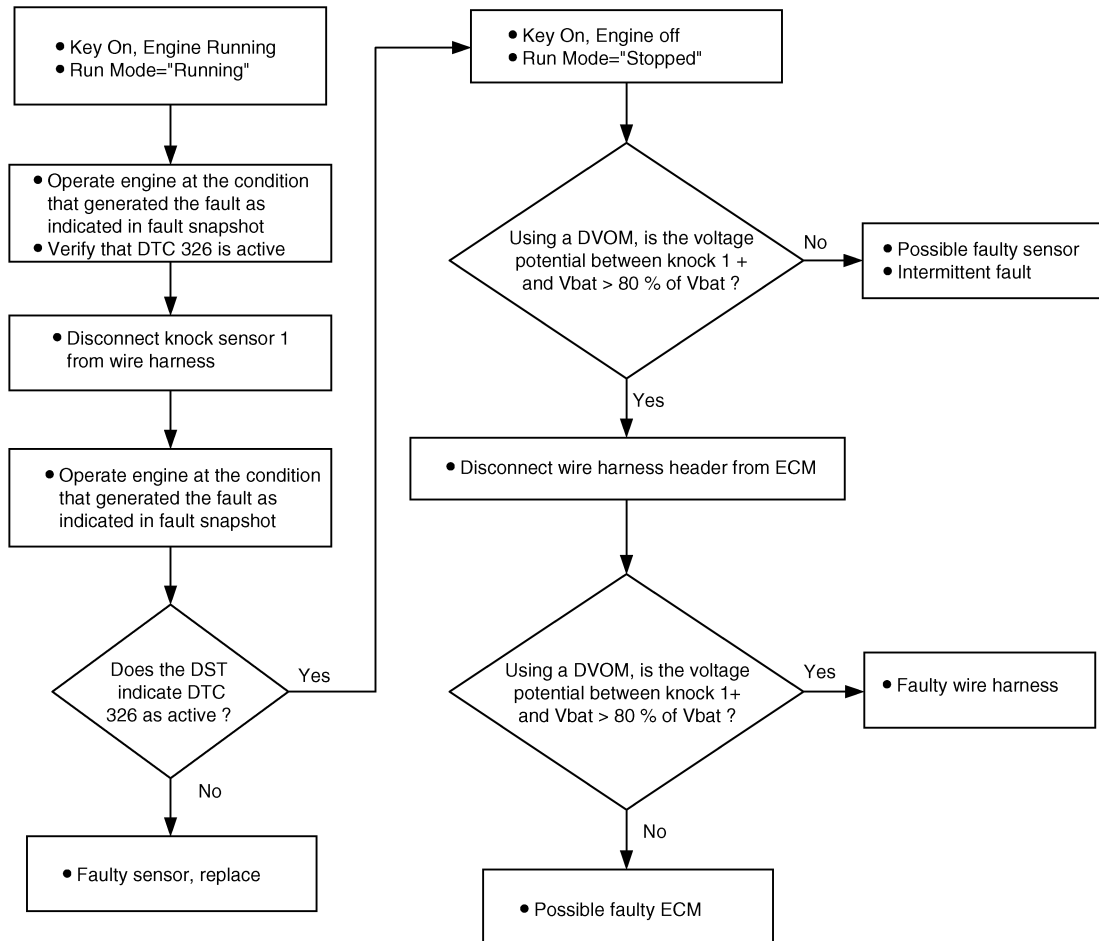
This fault sets if the signal from knock sensor 1 is higher than expected for low load operation as defined in calibration. If this fault sets, spark is lowered by the amount defined in calibration for Faulted KNK Retard.

DTC 327-Knock 1 Sensor Open or Not Present

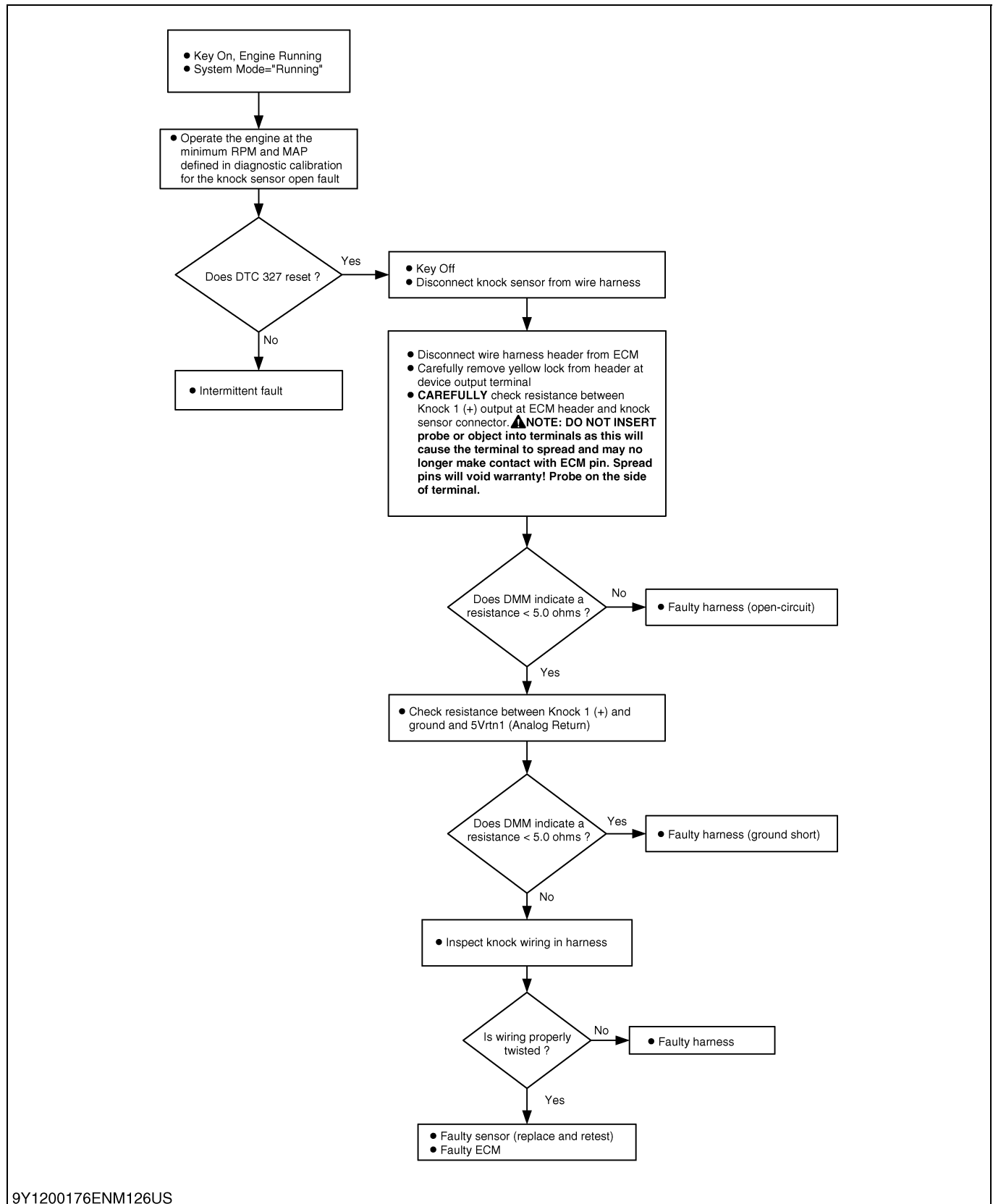
- Hardware: Knock sensor #1
- Enabling Conditions: Engine Running
- Set Conditions: Knock sensor 1 signal below 0.005 V, engine speed is above 1400 min⁻¹ (rpm) and MAP above 83 kPa [abs] (0.85 kgf/cm², 12 psia) for longer than 3 seconds.
- Corrective Action(s): Illuminate MIL, Power derate 1 and Retard fault KNK
- Emissions related fault
- Possible Causes: Knock sensor open internally, signal circuit open or shorted to ground or bad ECM

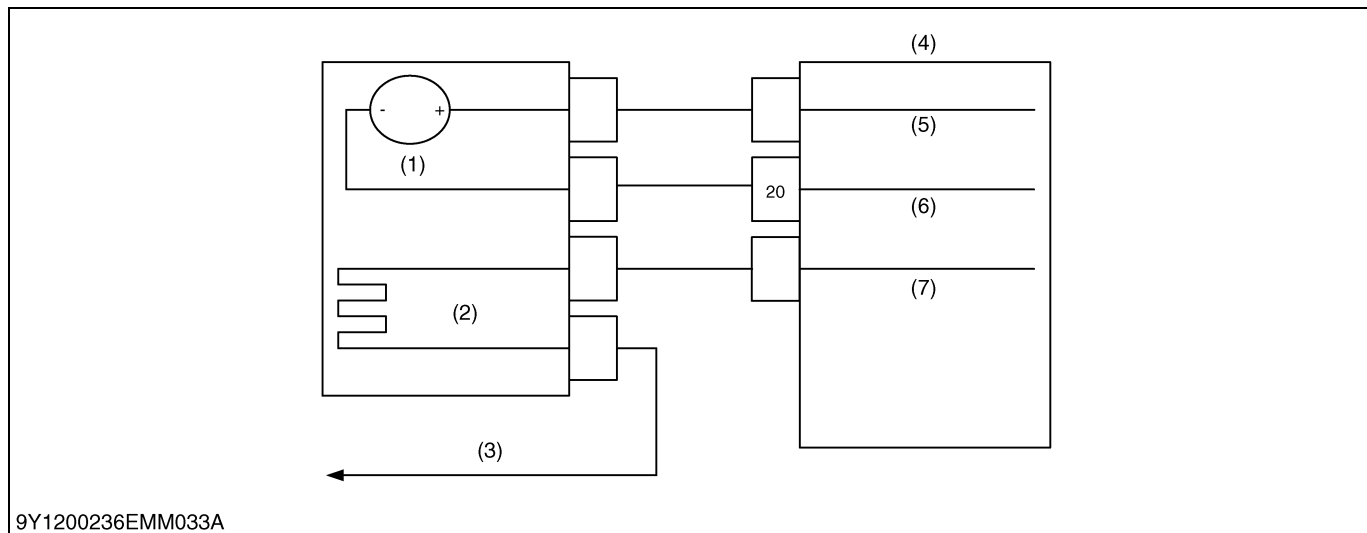
The knock sensor is used to detect detonation through mechanical vibration in the engine block and/or cylinder heads and provide feedback for the ignition system to retard spark to reduce knock intensity. In most applications the knock sensor is used to protect the engine from damage that can be caused 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.

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 Faulted KNK Retard.

DTC 326-Knock 1 Excessive or Erratic Signal**Diagnostic Aids Chart**

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DTC 327-Knock 1 Sensor Open or Not Present**Diagnostic Aids Chart**

(11) Catalyst Monitor (DTC 1165)

(1) Sensor
(2) Heater

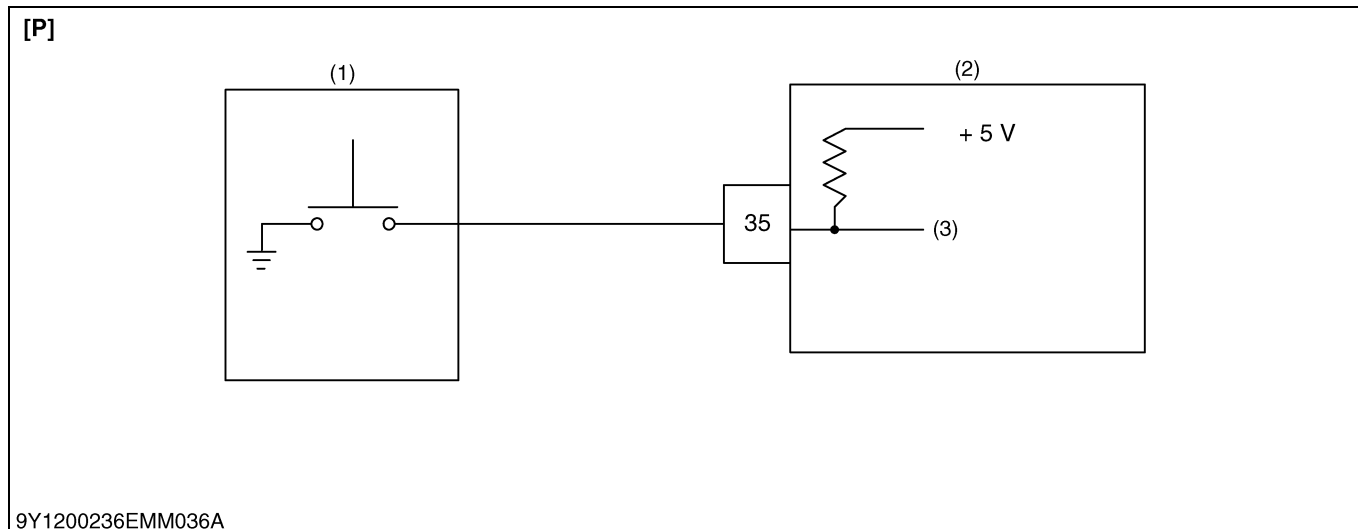
(3) To System Power Relay
(4) ECM

(5) EGO 1/2/3/4 (HO₂S 1/2/3/4) (7) EGOH 1/2/3/4 (PWM to GND)
(6) 5V Rtn 1

DTC 1165-Catalyst Inactive on LPG

- Hardware: Bank 1 Catalyst, Heated or Universal Exhaust Gas Oxygen Sensor (Bank 1-Sensor 2-After Catalyst)
- Enabling Conditions: Engine Running
- Set Conditions: Catalyst inactive on LPG
- Corrective Action(s): Illuminate MIL
- Emissions related fault
- Possible Causes: Physically damaged catalyst element, contaminated catalyst element

(12) Oil Pressure Sensor (DTC 524)



(1) Oil Pressure Switch

(2) ECM

(3) Pressure Voltage

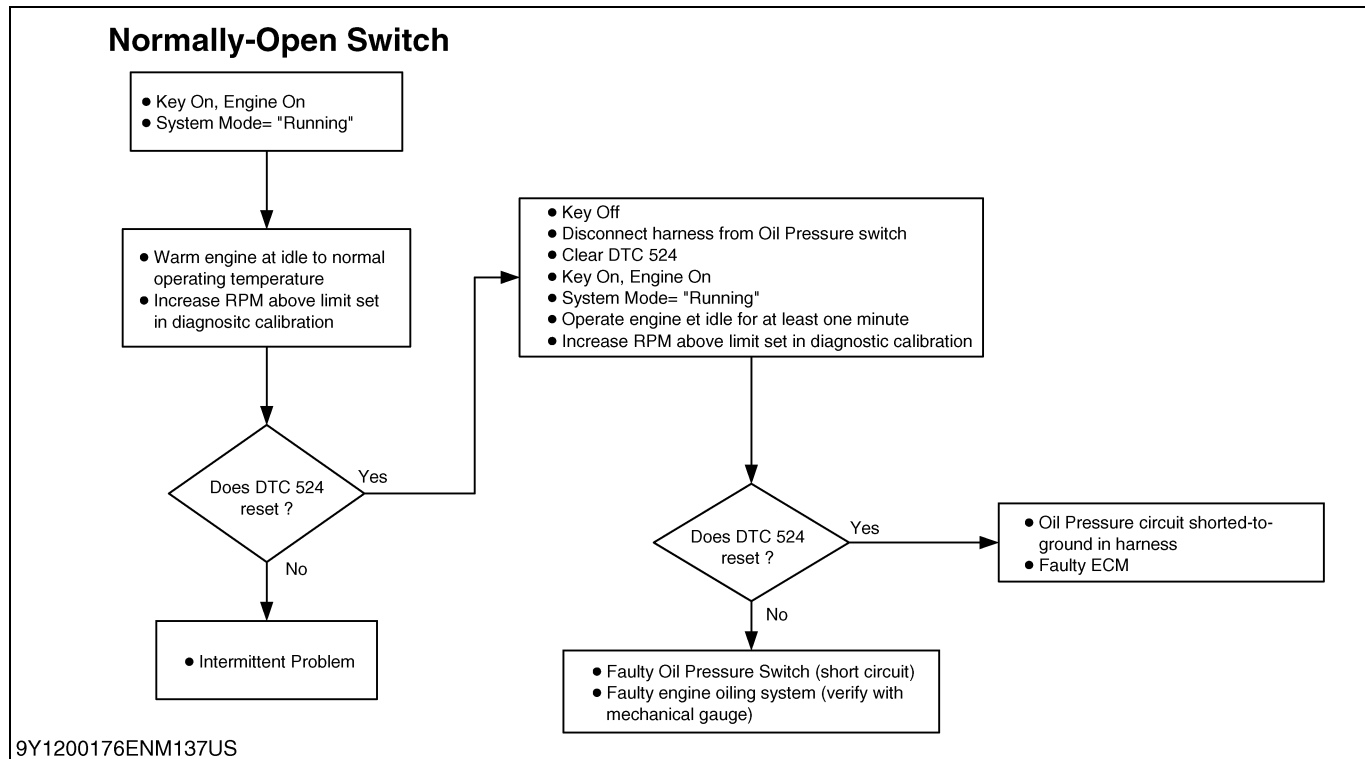
[P] Normally Open Switch Type

DTC 524-Oil Pressure Low

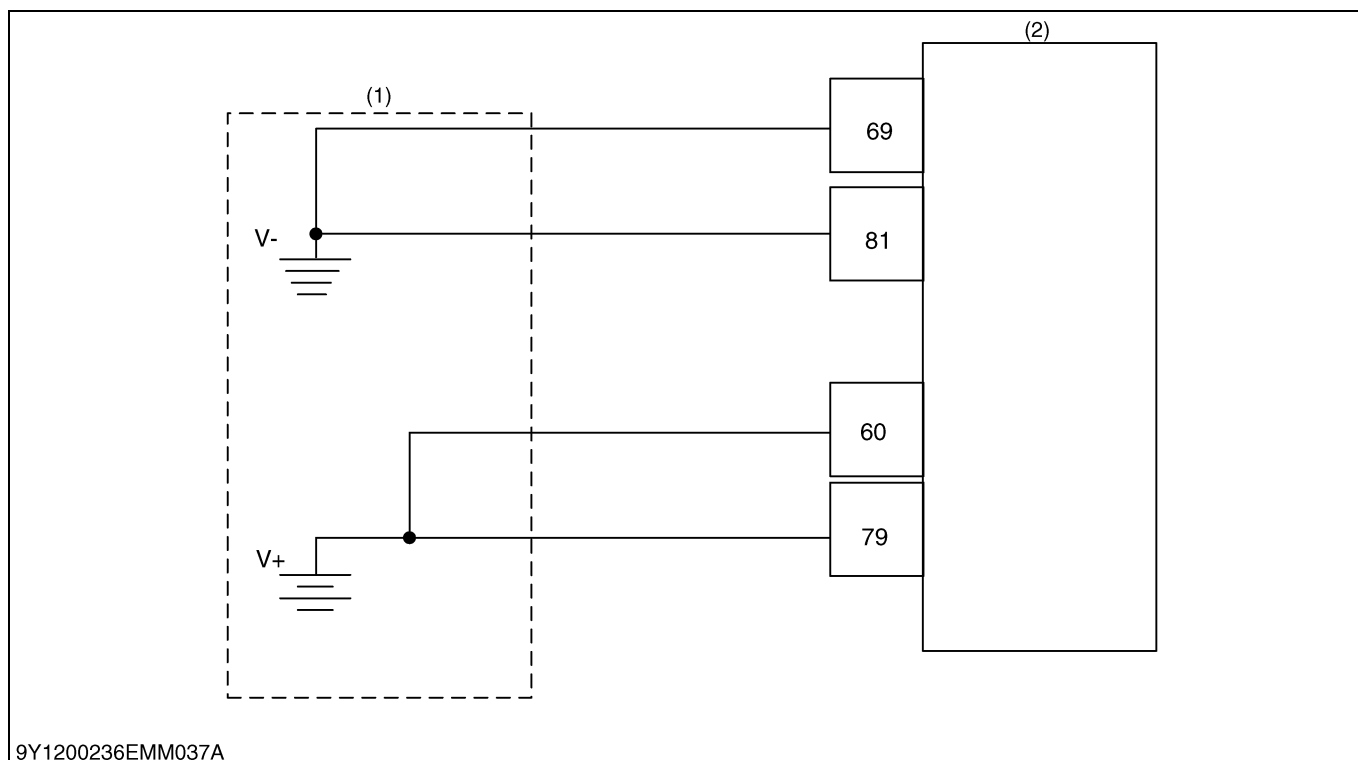
- Hardware: Engine Oil Pressure Sensor or Switch
- Enabling Conditions: Engine Running
- Set Conditions: Engine oil pressure switch circuit < 2.50 V for longer than 3 seconds and engine speed is higher than 600 min⁻¹ (rpm) after past 10 seconds from engine running
- Corrective Action(s): Illuminate MIL and engine stop
- Non-emissions related fault
- Possible Causes: Oil pressure problem with engine, oil pressure switch failure, oil pressure switch circuit shorted to ground, faulty ECM

The ECM can be configured to monitor oil pressure 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.

If the switch is normally open, the fault will set if the circuit becomes grounded. Go to the Faults page in EDIS to determine how the input is configured. ("Open=OK" is normally open). 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.

DTC 524-Oil Pressure Low**Diagnostic Aids Chart**

(13) Battery Voltage (DTC 562, 563)



(1) Battery

(2) ECM

DTC 562-Battery Voltage (VBat) Low

- Hardware: System voltage to ECM
- Enabling Conditions: Engine Running
- Set Conditions: Battery voltage to ECM less than 9.00 V for longer than 5 seconds and engine speed is higher than 1000 min⁻¹ (rpm)
- Corrective Action(s): Illuminate MIL, Power derate 2, Low rev limit and AL disable
- Non-emissions related fault
- Possible Causes: Low charging system output, low voltage input into ECM, faulty battery

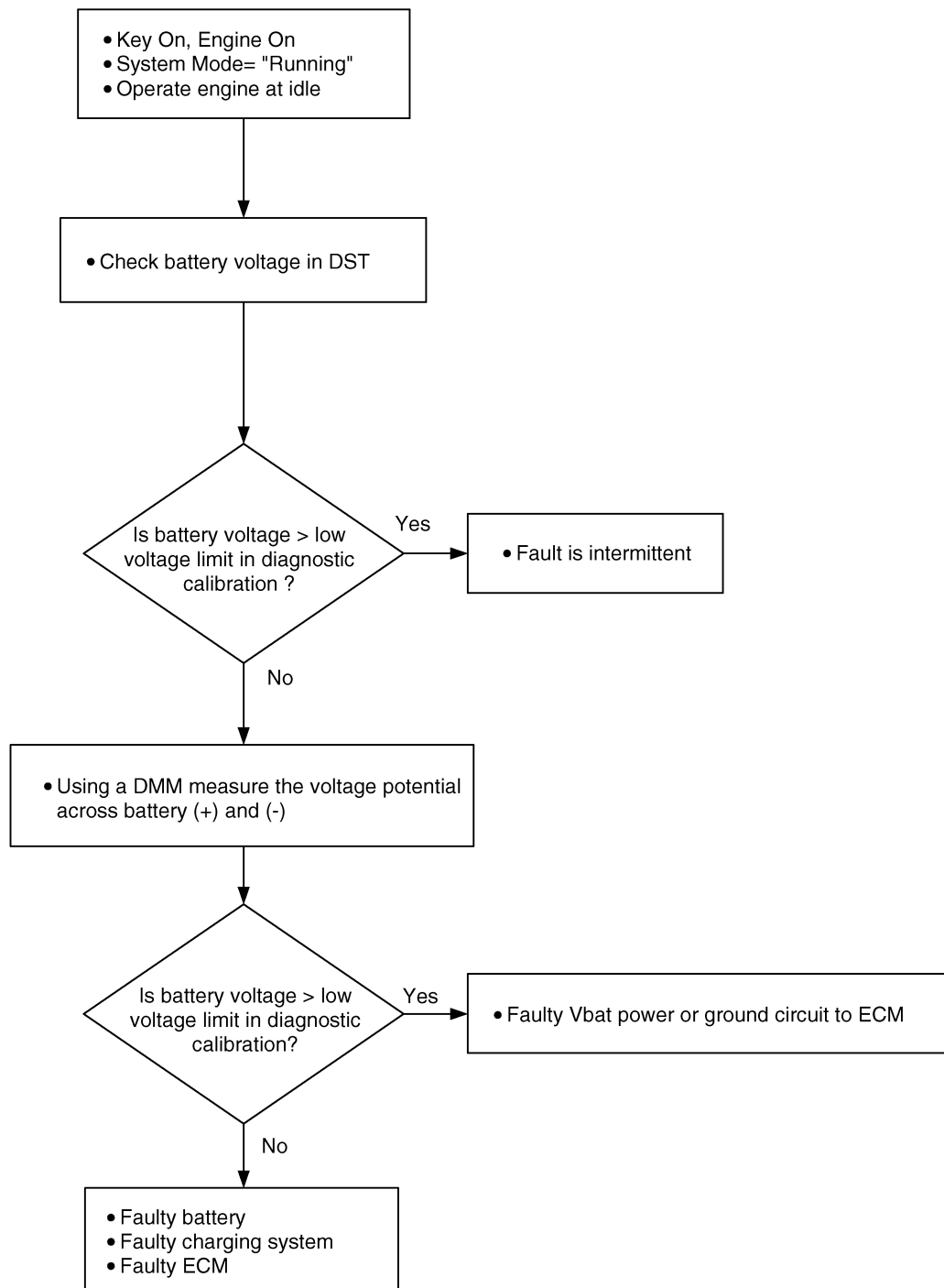
DTC 563-Battery Voltage (VBat) High

- Hardware: System voltage to ECM
- Enabling Conditions: Engine Running
- Set Conditions: Battery voltage to ECM greater than 16.0 V for longer than 3 seconds
- Corrective Action(s): Illuminate MIL, Low rev limit and AL disable
- Non-emissions related fault
- Possible Causes: Charging system overcharging

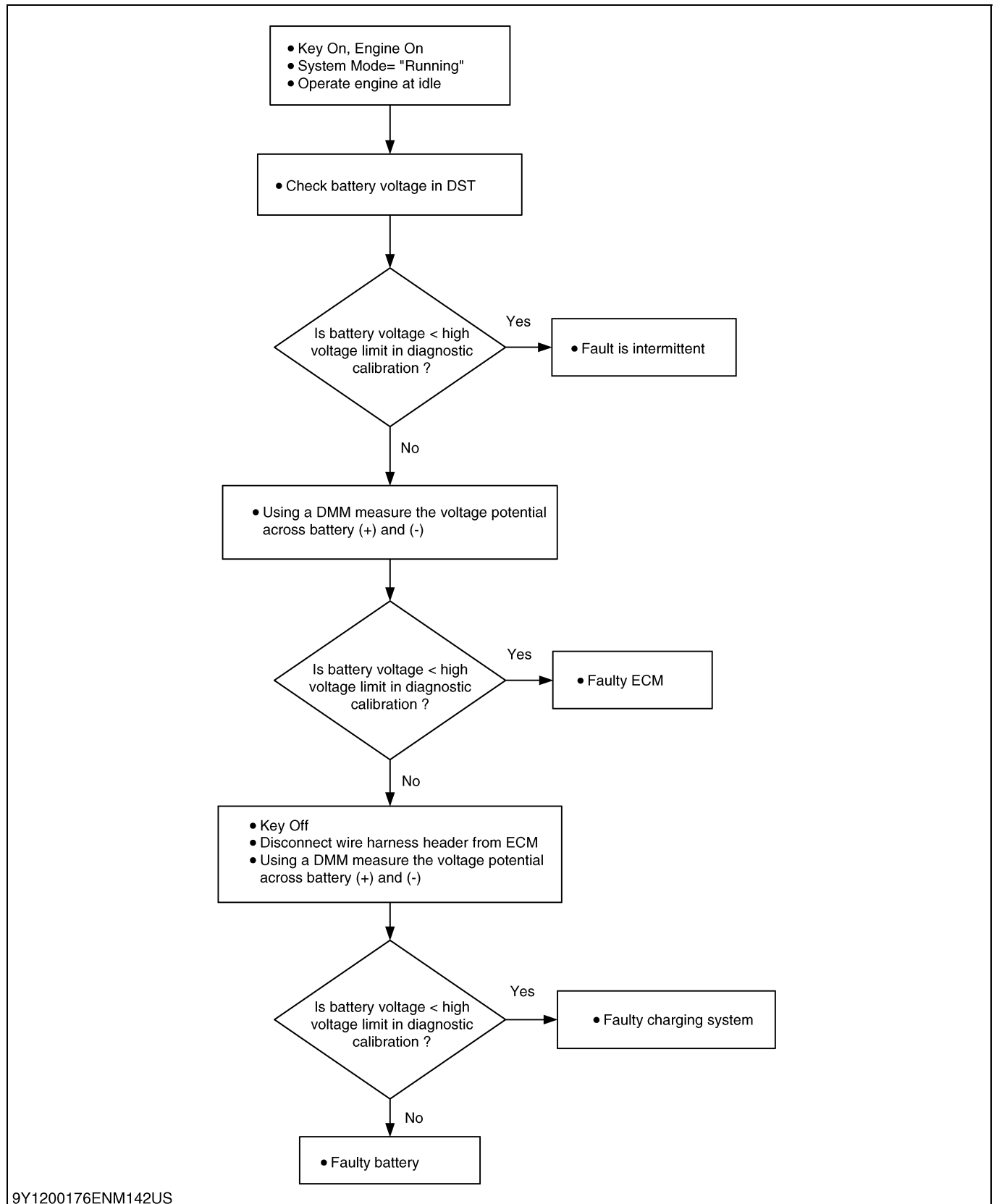
The battery voltage powers the ECM and must be within limits to correctly operate injector drivers, ignition coils, throttle, power supplies, and other powered devices that the ECM controls.

The fault of DTC 562 will set if the ECM detects system voltage less than 9.00 V while the engine is operating at above 1000 min⁻¹ (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.

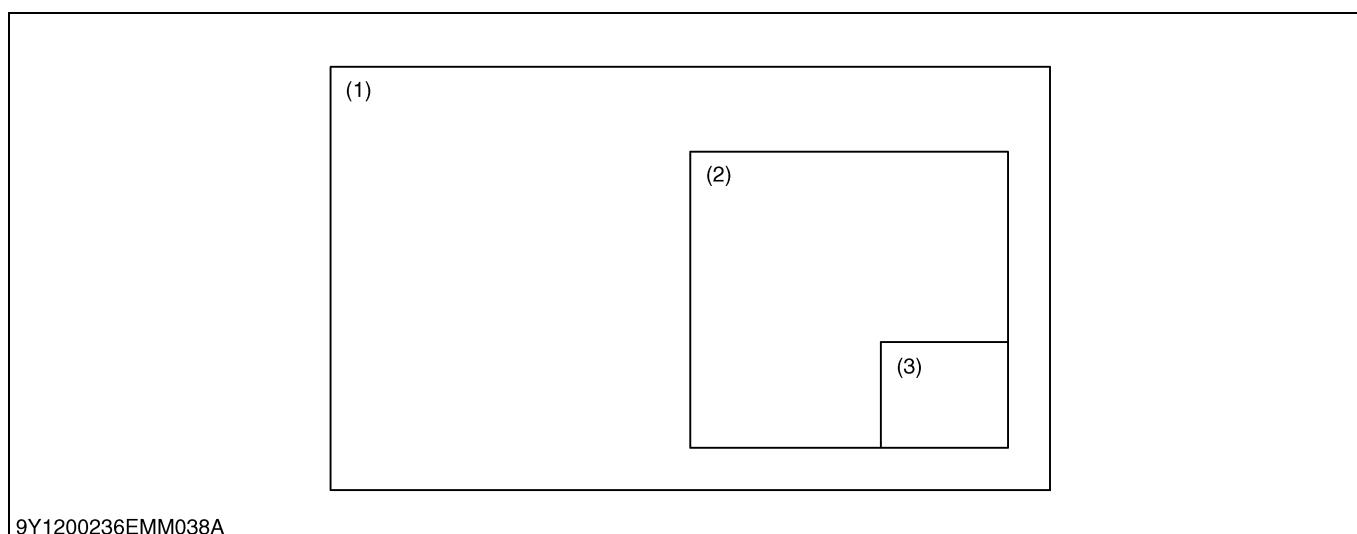
The fault of DTC 563 will set if the ECM detects system voltage greater than 16.0 V for longer than 3 seconds while the engine is running. The adaptive learn is disabled to avoid improper adaptive learning.

DTC 562-Battery Voltage (VBat) Low**Diagnostic Aids Chart**

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DTC 563-Battery Voltage (VBat) High**Diagnostic Aids Chart**

(14) Internal Processor Diagnostics (DTC 601, 604, 606, 1612 to 1616, 1674)



(1) ECM

(2) Microprocessor

(3) RAM

DTC 601-Microprocessor Failure-FLASH

- Hardware: Engine Control Module-Flash Memory
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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.

If this fault sets, the ECM will reset itself and log the code. A fault of flash memory can occur for any calibration variable set and thus could cause undesirable operation.

DTC 604-Microprocessor Failure-RAM

- Hardware: Engine Control Module-Random Access Memory
- Enabling Conditions: Key on
- Set Conditions: Internal ECM microprocessor memory access failure
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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 adaptation tables, and closed loop fuel multipliers. The ECM has checks that must be satisfied each time an instruction is executed.

This fault will set if the ECM detects a problem accessing or writing information to RAM. 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.

DTC 606-Microprocessor Failure-COP

- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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.

If this fault sets, the ECM will reset itself and log the code.

DTC 1612-Microprocessor Failure-RTI 1

- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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. 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 using a scan tool. It will not self-erase.

During this active fault, Power Derate 2 will be enforced. When this is enforced, maximum throttle position will be 15 %.

DTC 1613-Microprocessor Failure-RTI 2

- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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. 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 using a scan tool. It will not self-erase.

During this active fault, Power Derate 2 will be enforced. When this is enforced, maximum throttle position will be 15 %.

DTC 1614-Microprocessor Failure-RTI 3

- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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. 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 using a scan tool. It will not self-erase.

During this active fault, Power Derate 2 will be enforced. When this is enforced, maximum throttle position will be 15 %.

DTC 1615-Microprocessor Failure-A/D

- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

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. 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 using a scan tool. It will not self-erase.

During this active fault, Power Derate 2 will be enforced. When this is enforced, maximum throttle position will be 15 %.

DTC 1616-Microprocessor Failure-Interrupt

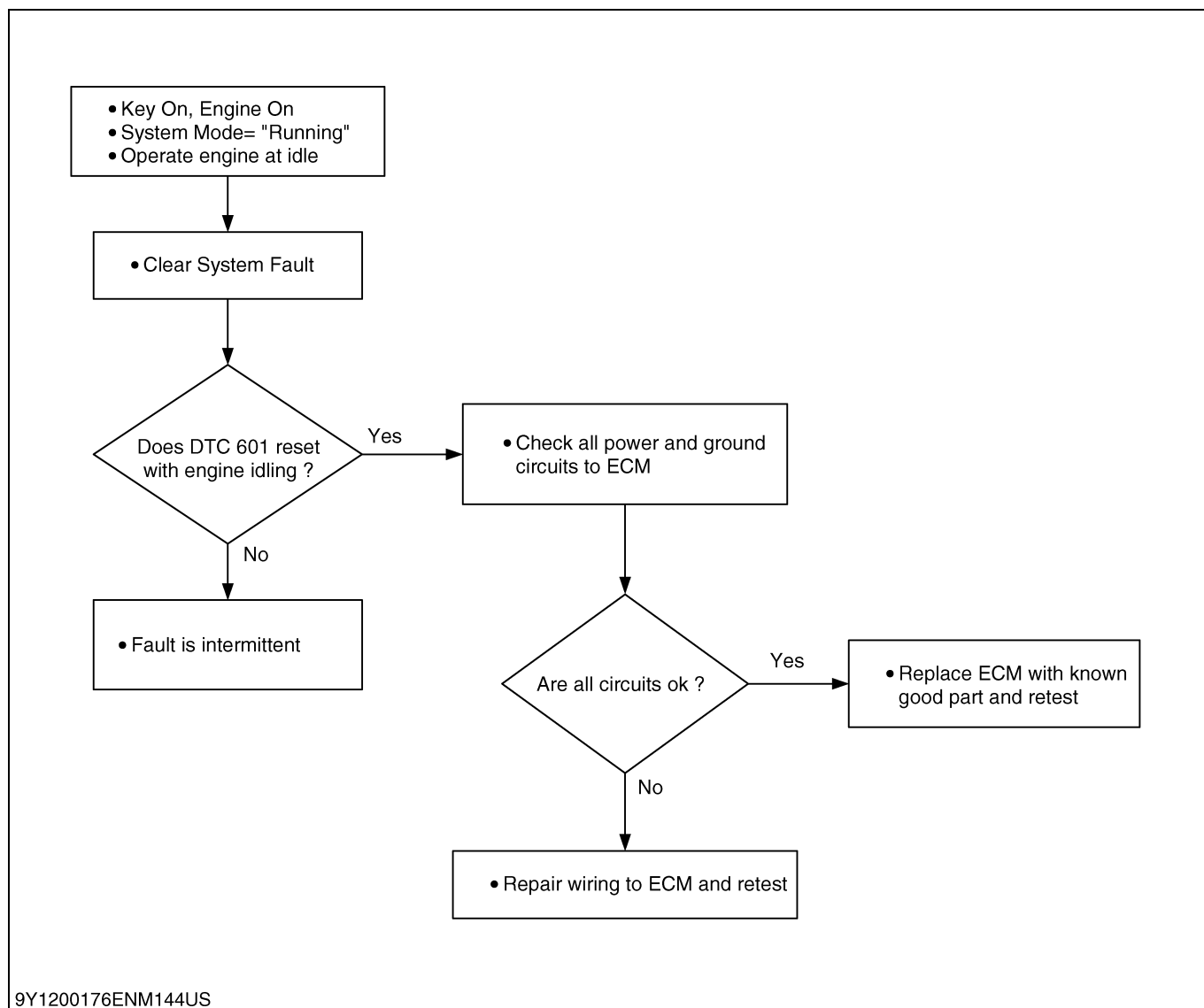
- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Non-emissions related fault
- Possible Causes: Faulty ECM

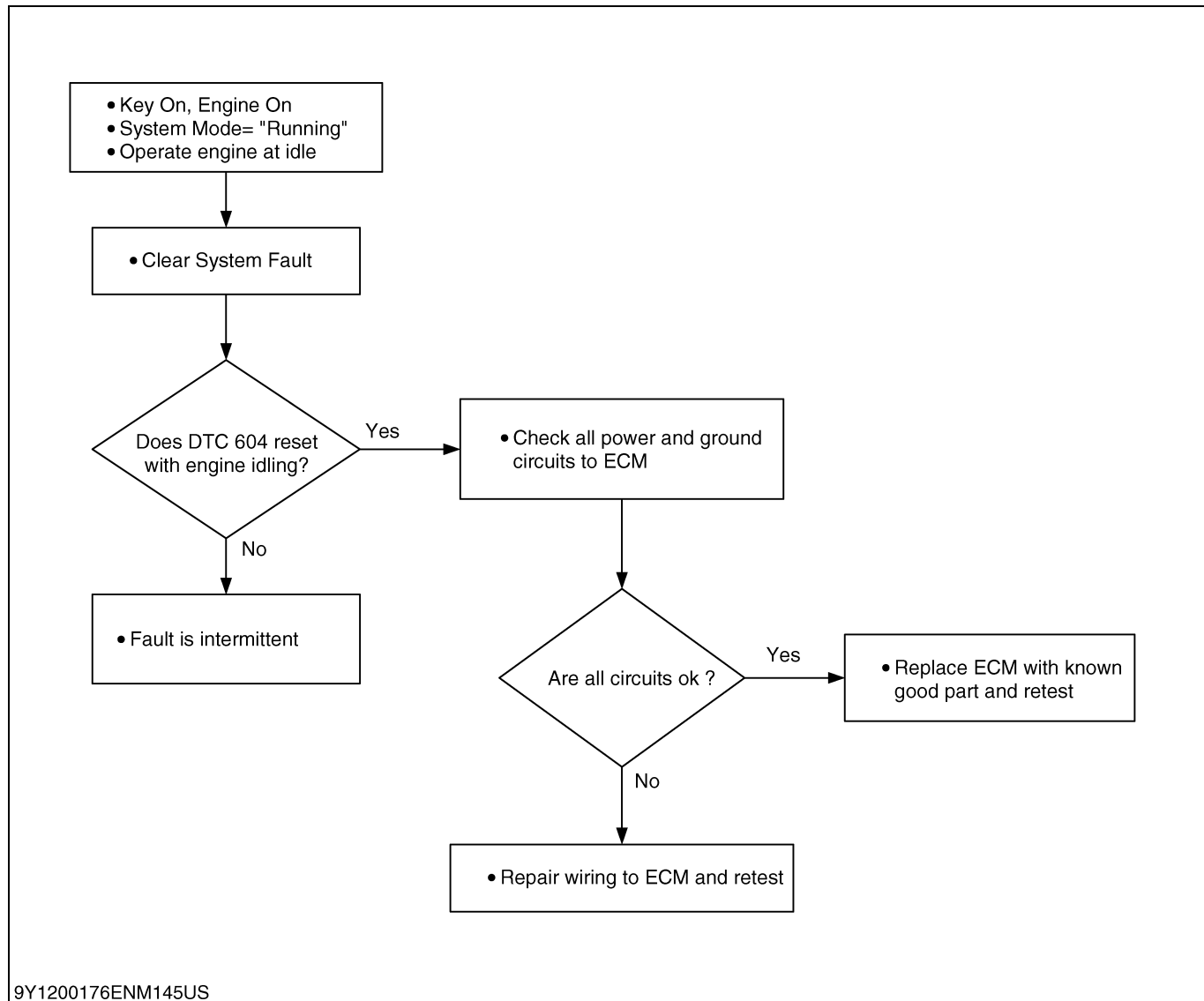
DTC 1674-Hardware ID Failure

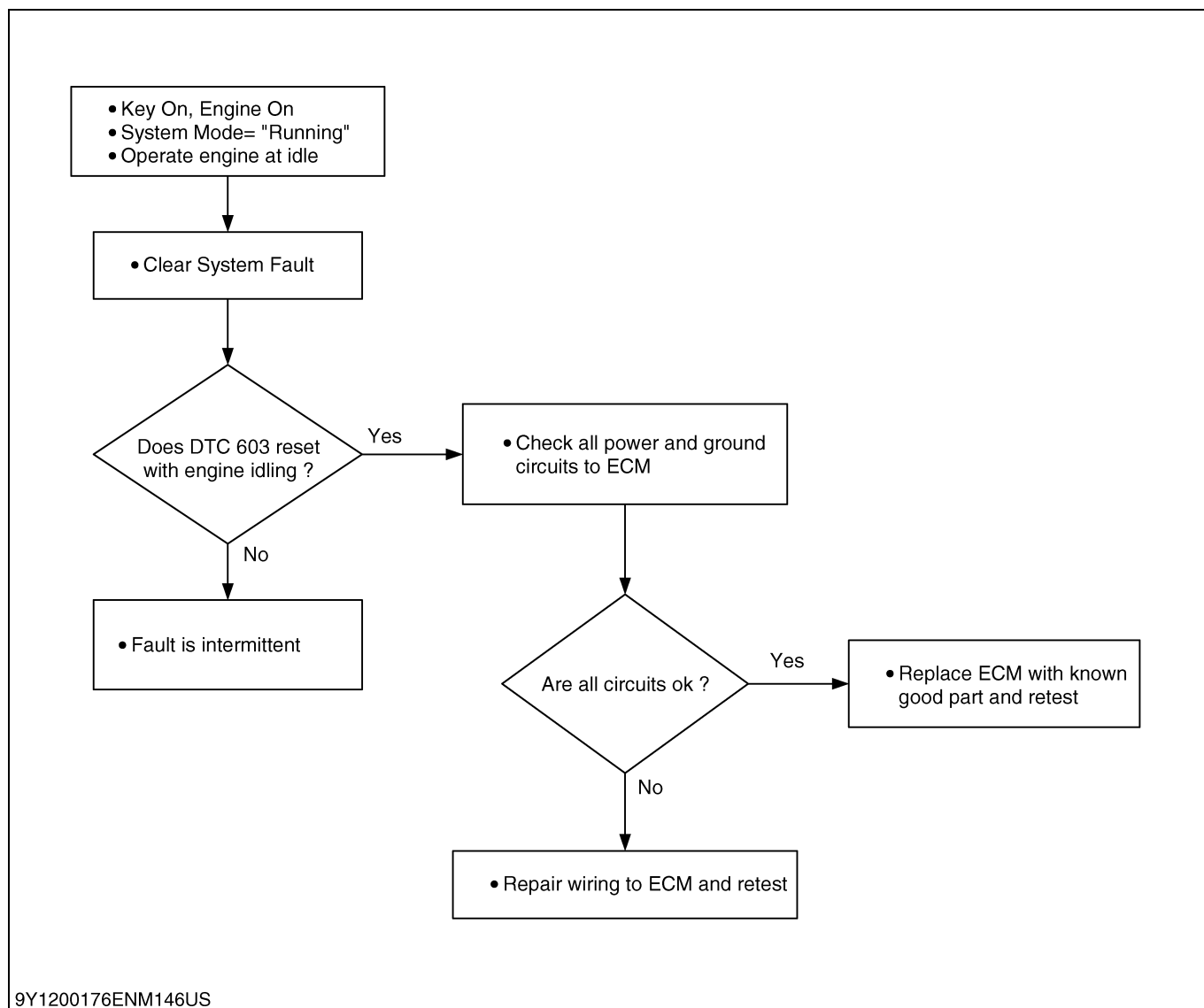
- Hardware: Engine Control Module
- Enabling Conditions: Key on
- Set Conditions: Internal microprocessor error
- Corrective Action(s): Illuminate MIL, AL disable, Power derate 2 and Never forget (this code must be manually erased with EDIS or KGST)
- Emissions related fault
- Possible Causes: Faulty ECM

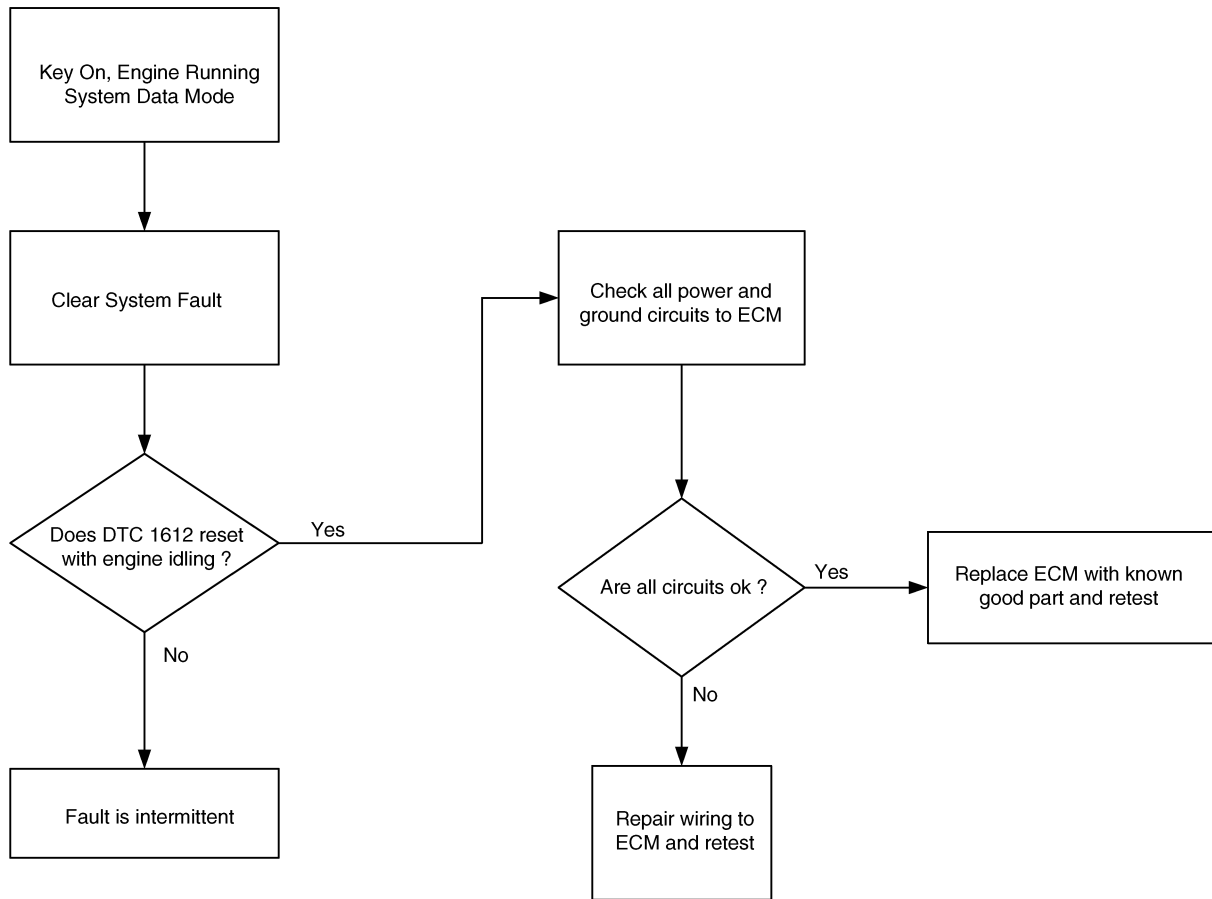
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis using a scan tool. It will not self-erase.

During this active fault, Power Derate 2 will be enforced. When this is enforced, maximum throttle position will be 15 %.

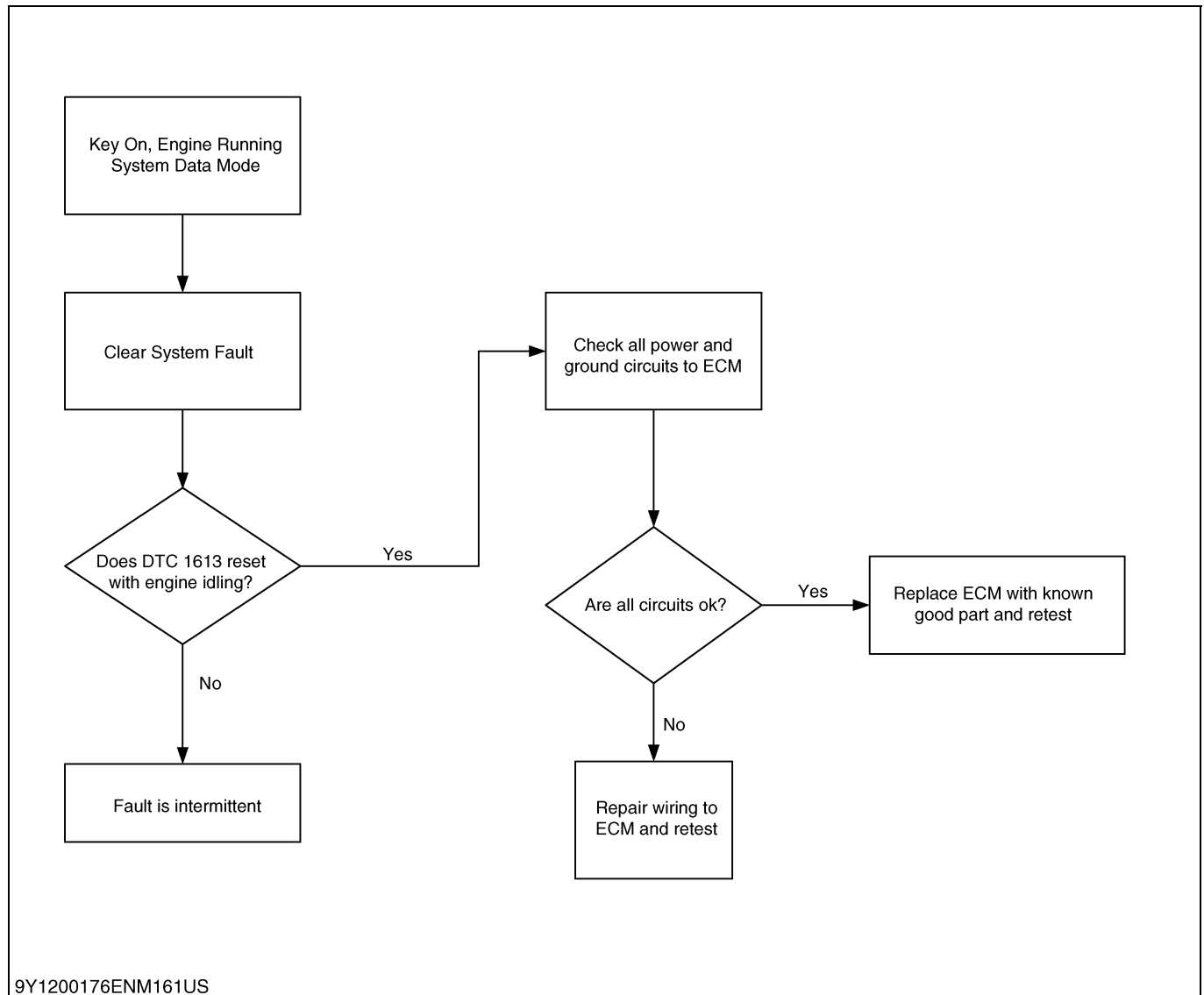
DTC 601-Microprocessor Failure-FLASH**Diagnostic Aids Chart**

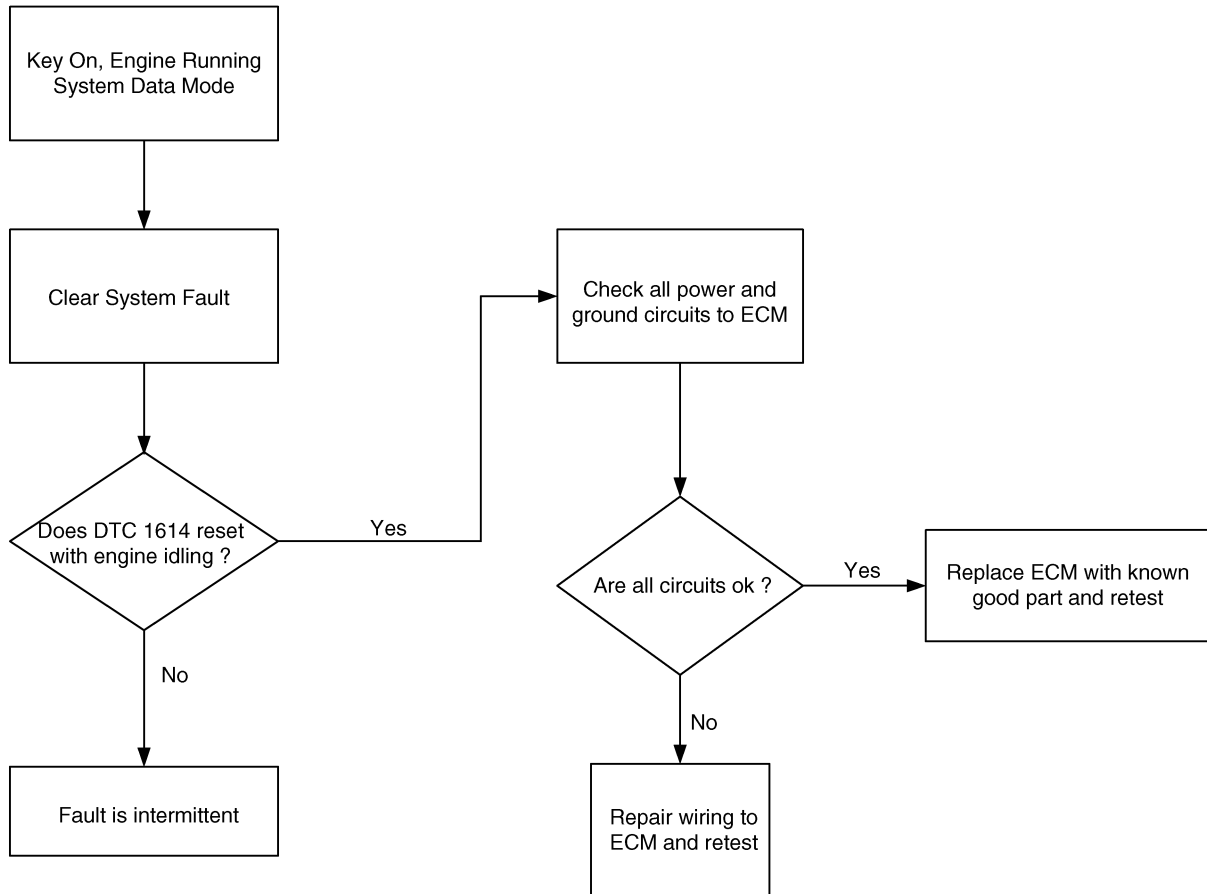
DTC 604-Microprocessor Failure-RAM**Diagnostic Aids Chart**

DTC 606-Microprocessor Failure-COP**Diagnostic Aids Chart**

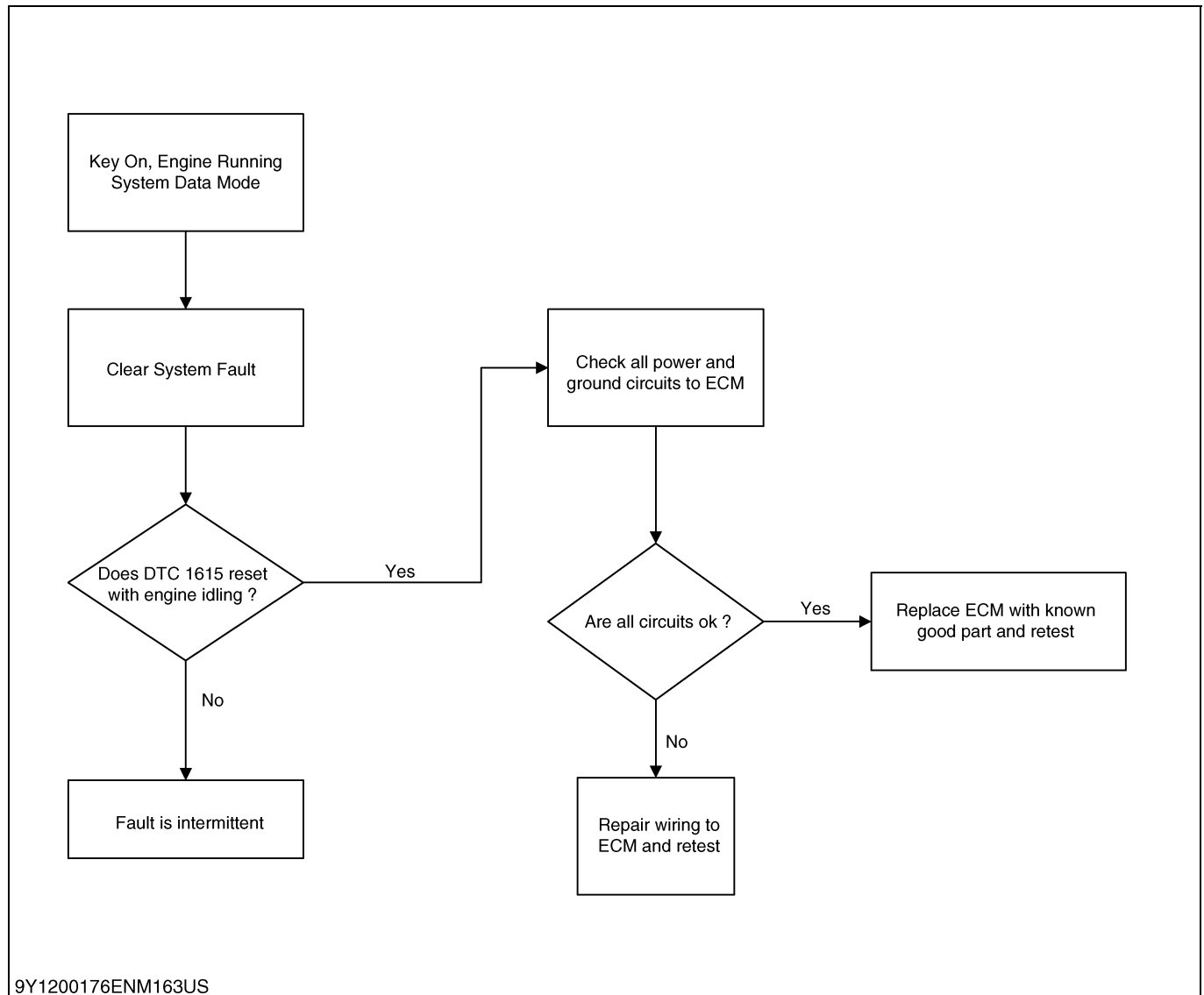
DTC 1612-Microprocessor Failure-RTI 1**Diagnostic Aids Chart**

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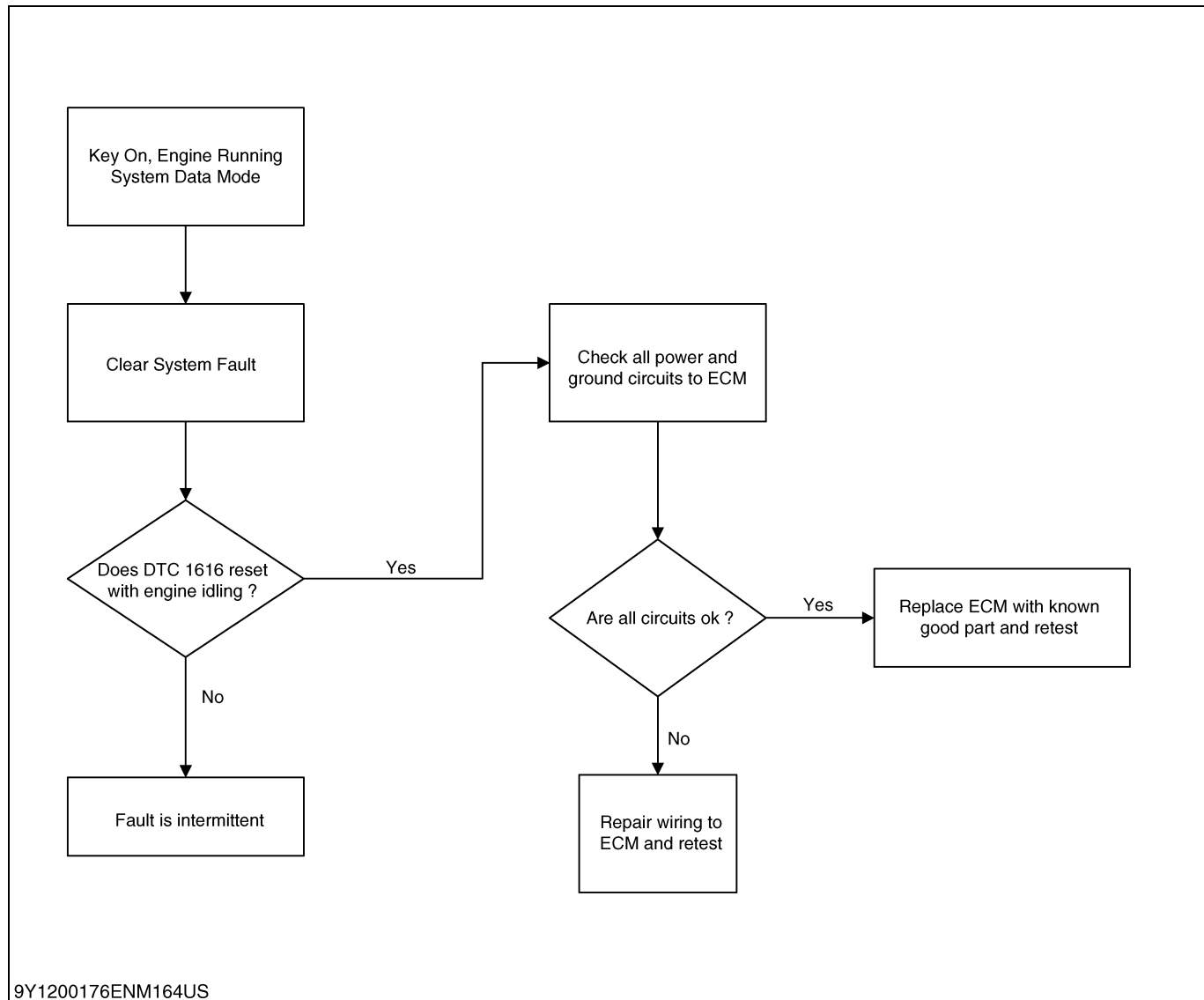
DTC 1613-Microprocessor Failure-RTI 2**Diagnostic Aids Chart**

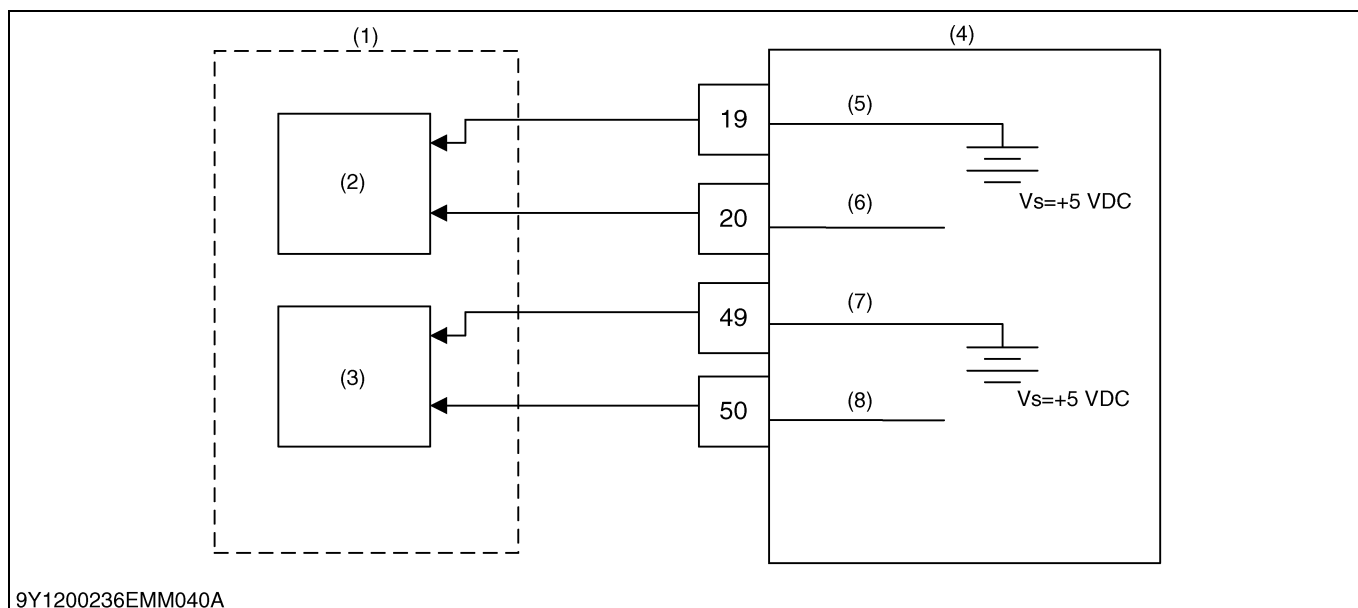
DTC 1614-Microprocessor Failure-RTI 3**Diagnostic Aids Chart**

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DTC 1615-Microprocessor Failure-A/D**Diagnostic Aids Chart**

9Y1200176ENM163US

DTC 1616-Microprocessor Failure-nterrupt**Diagnostic Aids Chart**

(15) 5 V External (DTC 642, 643, 652, 653, 1611)

(1) Sensors & Actuators

(3) FPP 2 Sensor (Only)

(5) 5V Ext 1

(7) 5V Ext 2

(2) Sensors & Actuators

(4) ECM

(6) 5V Rtn 1

(8) 5V Rtn 2

DTC 642-Sensor Supply Voltage 1 Low (5 Vext1)

- Hardware: External Sensor Supply Voltage Regulator 1
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Fault Condition: Voltage feedback on sensor supply circuit #1 below 4.60 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Non-emissions related fault
- Possible Causes: Internal short to ground in any sensor fed by 5 Vext1 supply, 5 Vext1 shorted to ground in wire harness, faulty ECM (no 5 V output on 5 Vext1)

DTC 643-Sensor Supply Voltage 1 High (5 Vext1)

- Hardware: External Sensor Supply Voltage Regulator 1
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Set Conditions: Voltage feedback on sensor supply circuit #1 is greater than 5.40 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Non-emissions related fault
- Possible Causes: 5 Vext1 circuit shorted to 12.0 V in wire harness

DTC 652-Sensor Supply Voltage 2 Low (5 Vext2)

- Hardware: External Sensor Supply Voltage Regulator 2
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Fault Condition: Voltage feedback on sensor supply circuit #2 below 4.60 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Non-emissions related fault
- Possible Causes: Internal short to ground in any sensor fed by 5 Vext2 supply, 5 Vext2 shorted to ground in wire harness, faulty ECM (no 5 V output on 5 Vext2)

DTC 653-Sensor Supply Voltage 2 High (5 Vext2)

- Hardware: External Sensor Supply Voltage Regulator 2
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Set Conditions: Voltage feedback on sensor supply circuit #2 is greater than 5.40 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 1 and AL disable
- Non-emissions related fault
- Possible Causes: 5 Vext2 circuit shorted to 12.0 V in wire harness

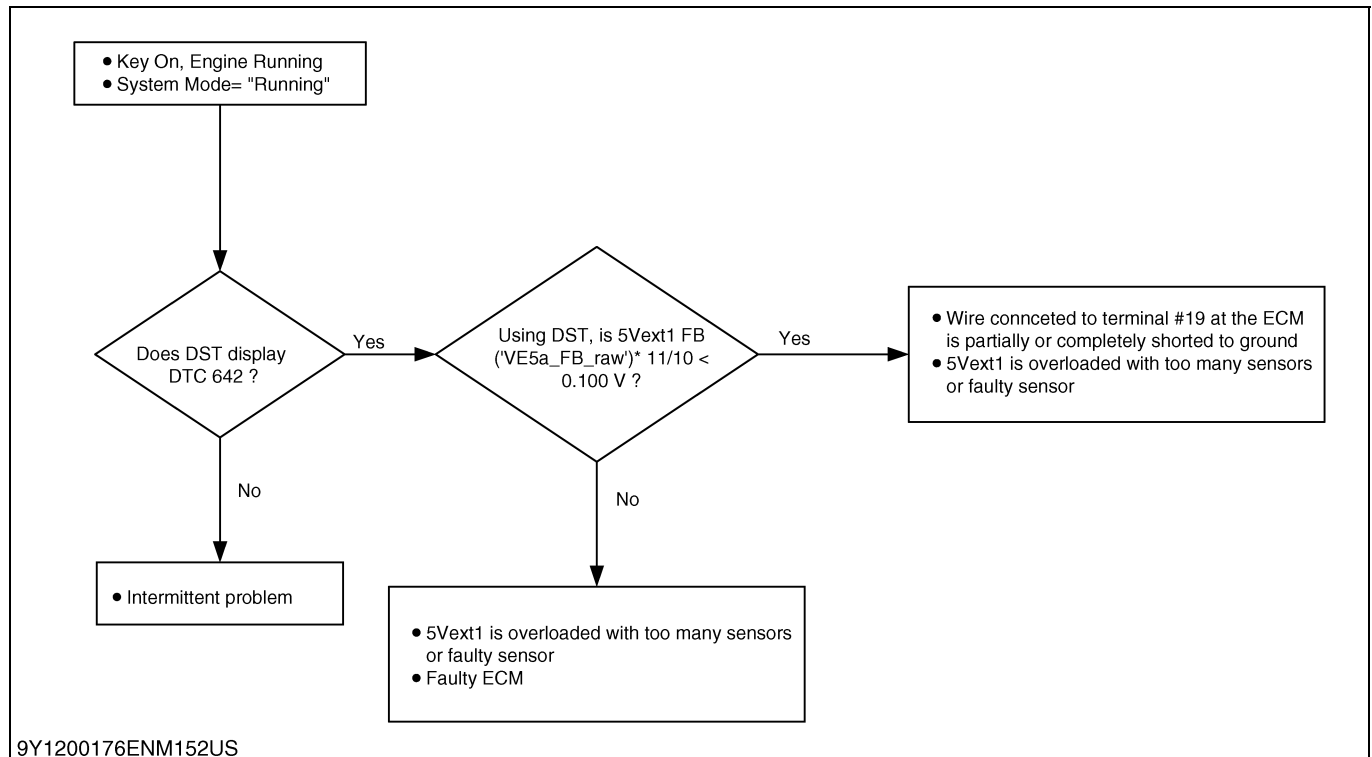
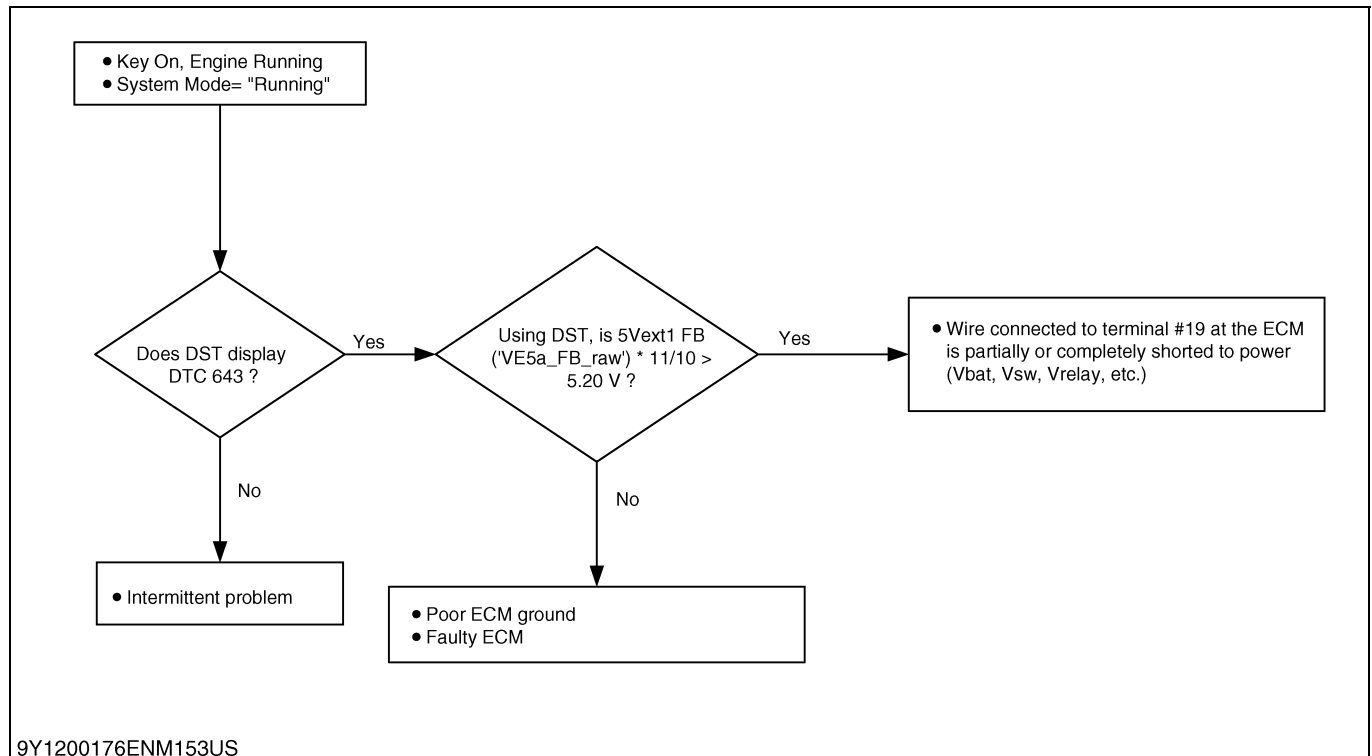
DTC 1611-Sensor Supply Voltage (5 Vext1/2) Simultaneous Out-of-Range

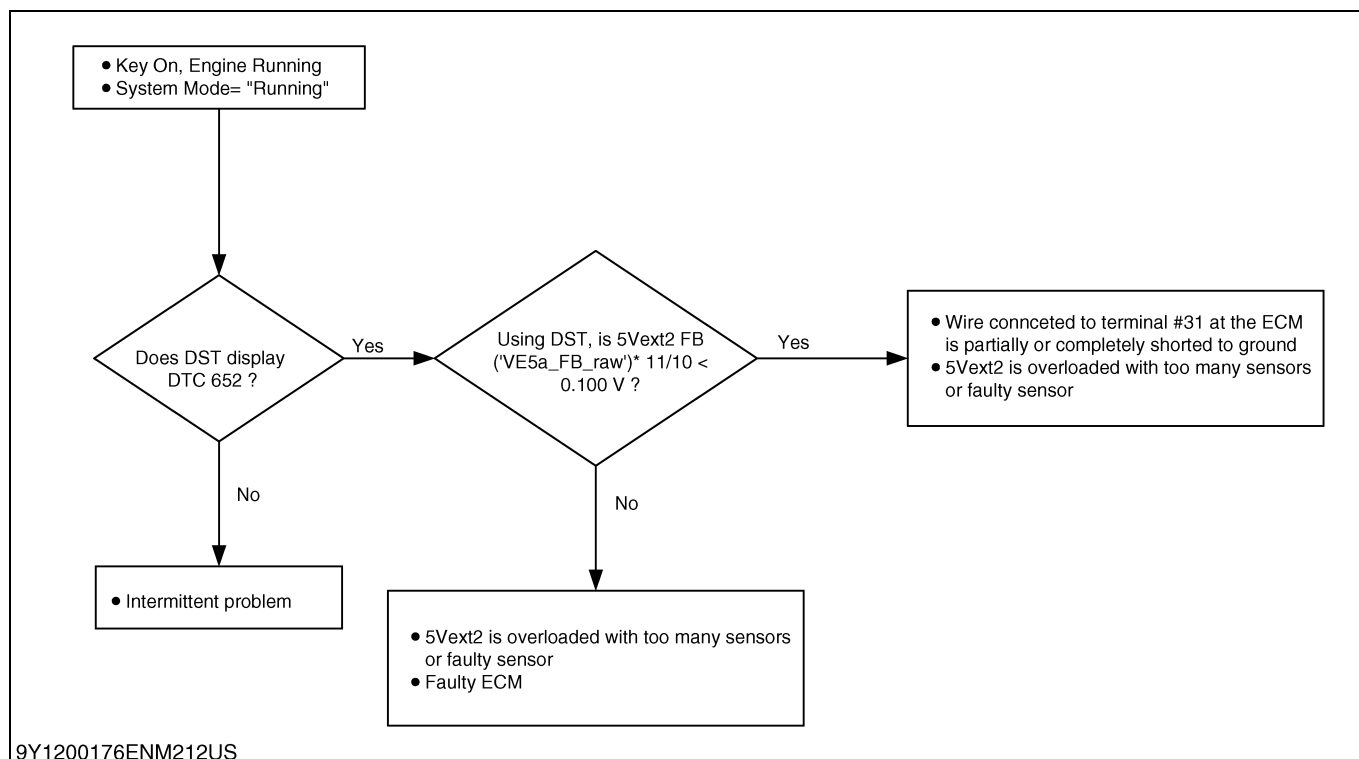
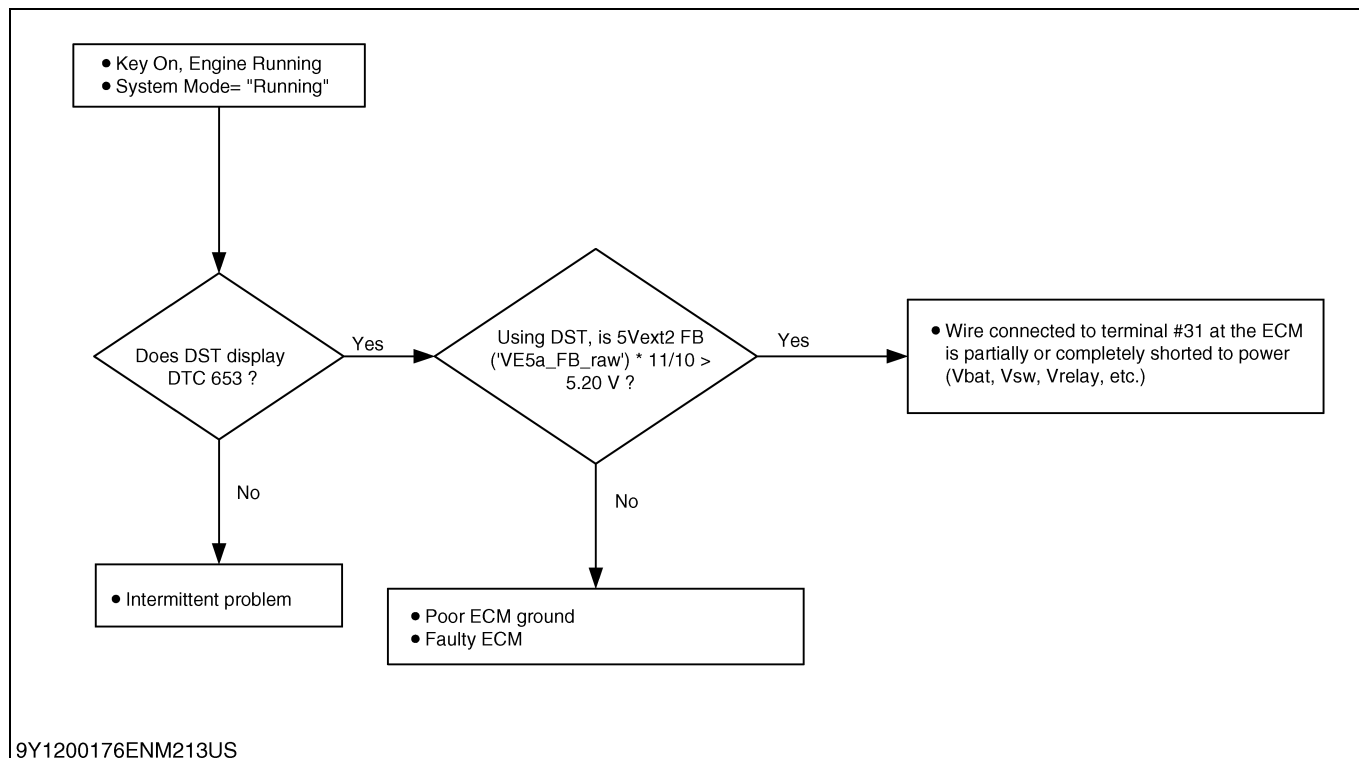
- Hardware: External Sensor Supply Voltage Regulator 1/2
- Enabling Conditions: Engine Cranking or Running, or Key On, Engine Off
- Fault Condition: Voltage feedback on sensor supply circuit #1 above 5.40 V or below 4.60 V for longer than 1 second, and Voltage feedback on sensor supply circuit #2 above 5.40 V or below 4.60 V for longer than 1 second
- Corrective Action(s): Illuminate MIL, Power derate 2, Low rev limit and AL disable
- Non-emissions related fault
- 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.

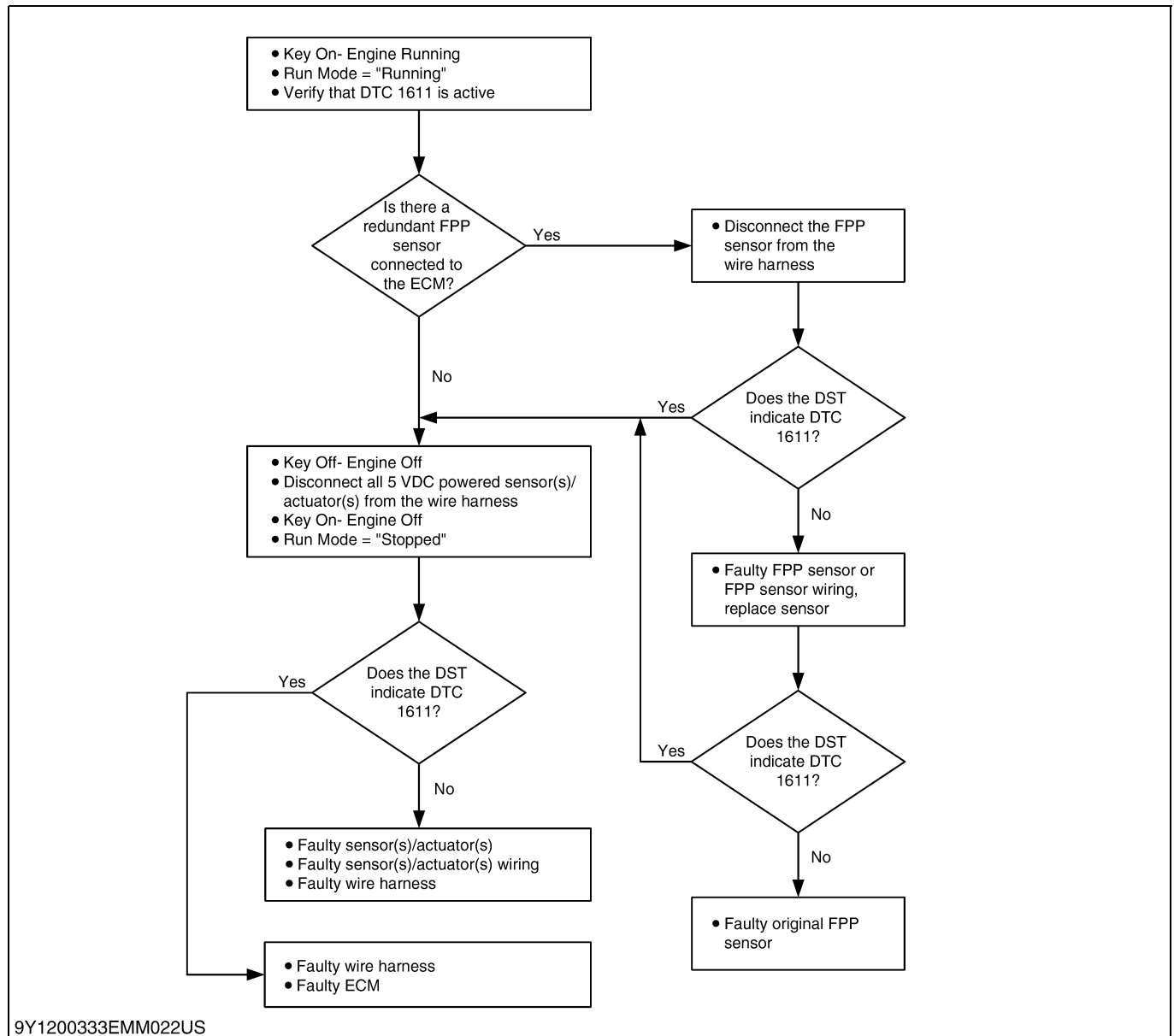
The external 5-volt supply powers sensors and other components in the engine control system. The accuracy of this supply is critical to the accuracy of the sensors' feedback, therefore, it is supplied from a precision regulator whose output is internally monitored by the ECM. The ECM monitors the 5-volt supply to ratio metrically correct sensor feedback and determine if the circuit is overloaded, shorted, or otherwise out of specification.

The fault of DTC 642 and DTC 652 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).

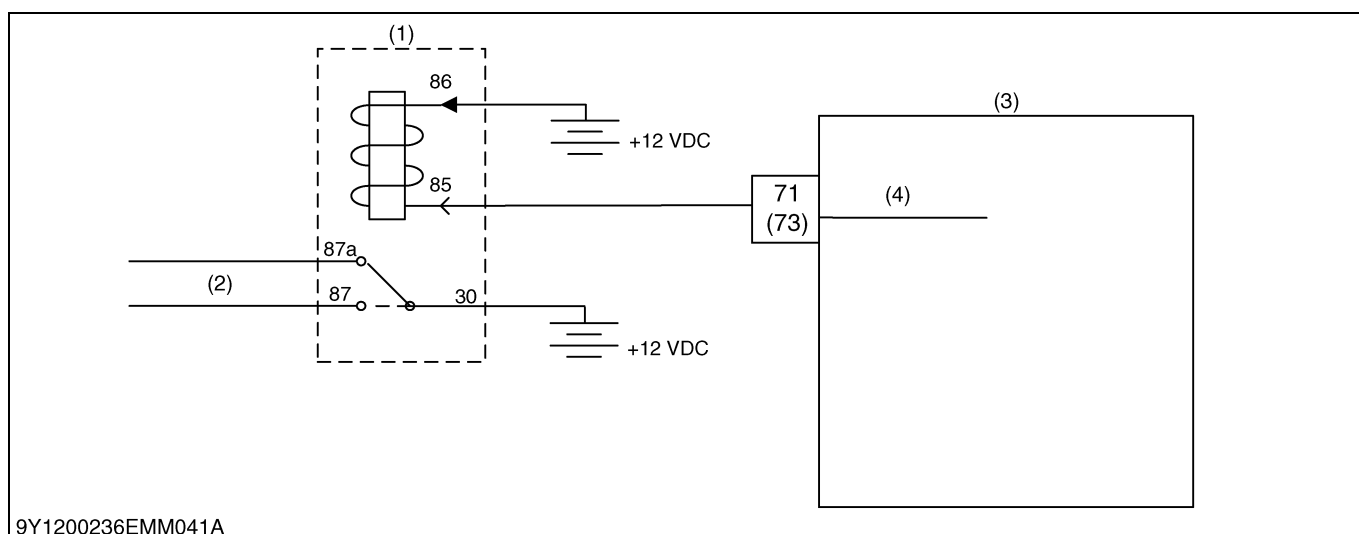
The fault of DTC 643 and DTC 653 will set if the internally measured voltage feedback of the regulator output is higher than the high voltage limit as defined in the diagnostic calibration anytime the engine is running or stopped at key-on (if applicable).

DTC 642-Sensor Supply Voltage 1 Low (5 Vext1)**Diagnostic Aids Chart****DTC 643-Sensor Supply Voltage 1 High (5 Vext1)****Diagnostic Aids Chart**

DTC 652-Sensor Supply Voltage 2 Low (5 Vext2)**Diagnostic Aids Chart****DTC 653-Sensor Supply Voltage 2 High (5 Vext2)****Diagnostic Aids Chart**

DTC 1611-Sensor Supply Voltage (5 Vext1/2) Simultaneous Out-of-Range**Diagnostic Aids Chart**

(16) Power Relay Control / Coil (DTC 685 to 687)



(1) Relay

(2) Relay Power (+)

(3) ECM

(4) Relay

DTC 686-Power Relay Ground Short

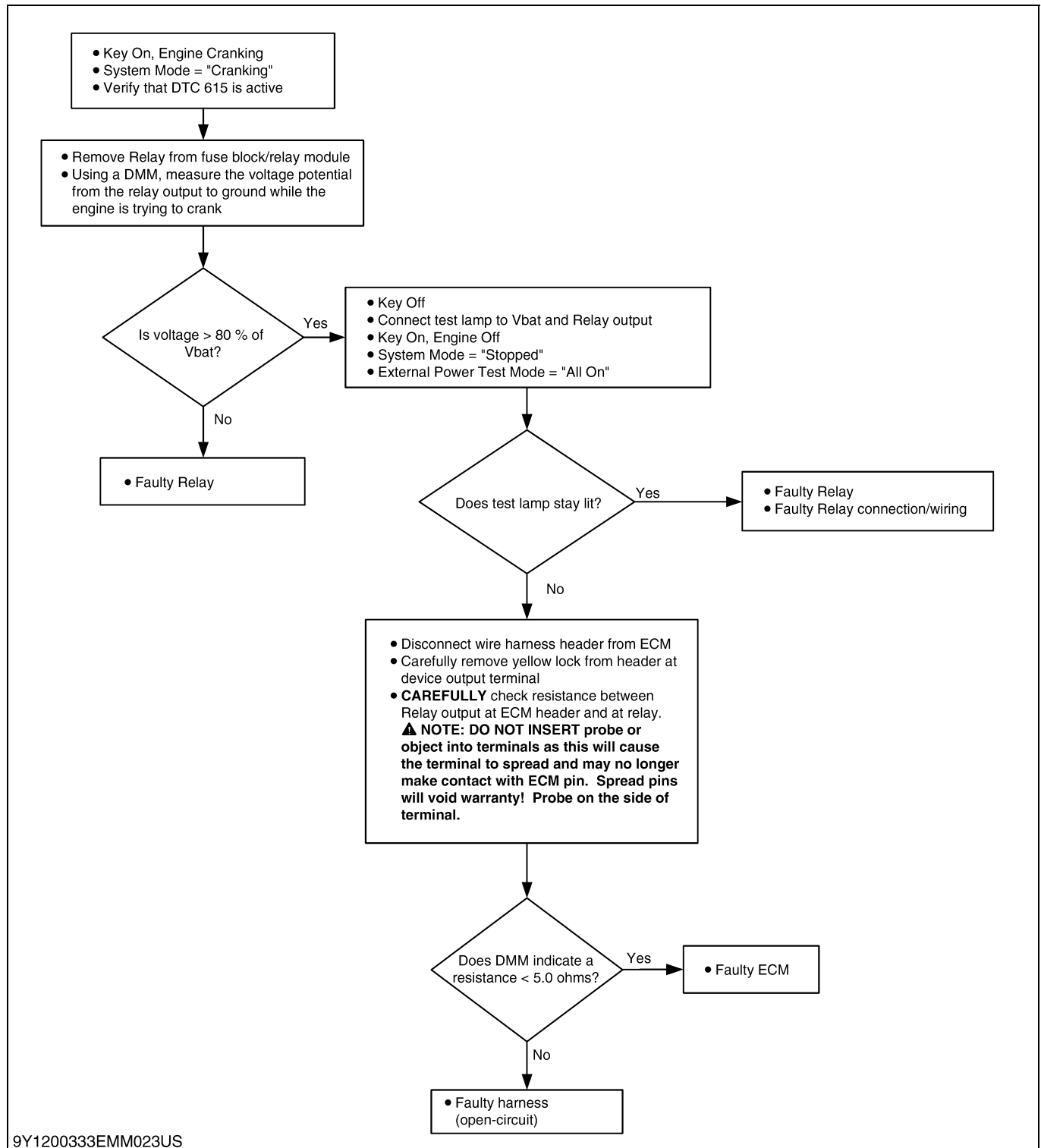
- Hardware: Power Relay Pull in Coil
- Enabling Conditions: Engine Running
- Set Conditions: Power relay coil output shorted to ground for more than 10 samples of circuit
- Corrective Action(s): Illuminate MIL
- Non-emissions related fault
- Possible Causes: Short to ground in relay pull in coil, short to ground in relay driver circuit in wire harness, faulty ECM

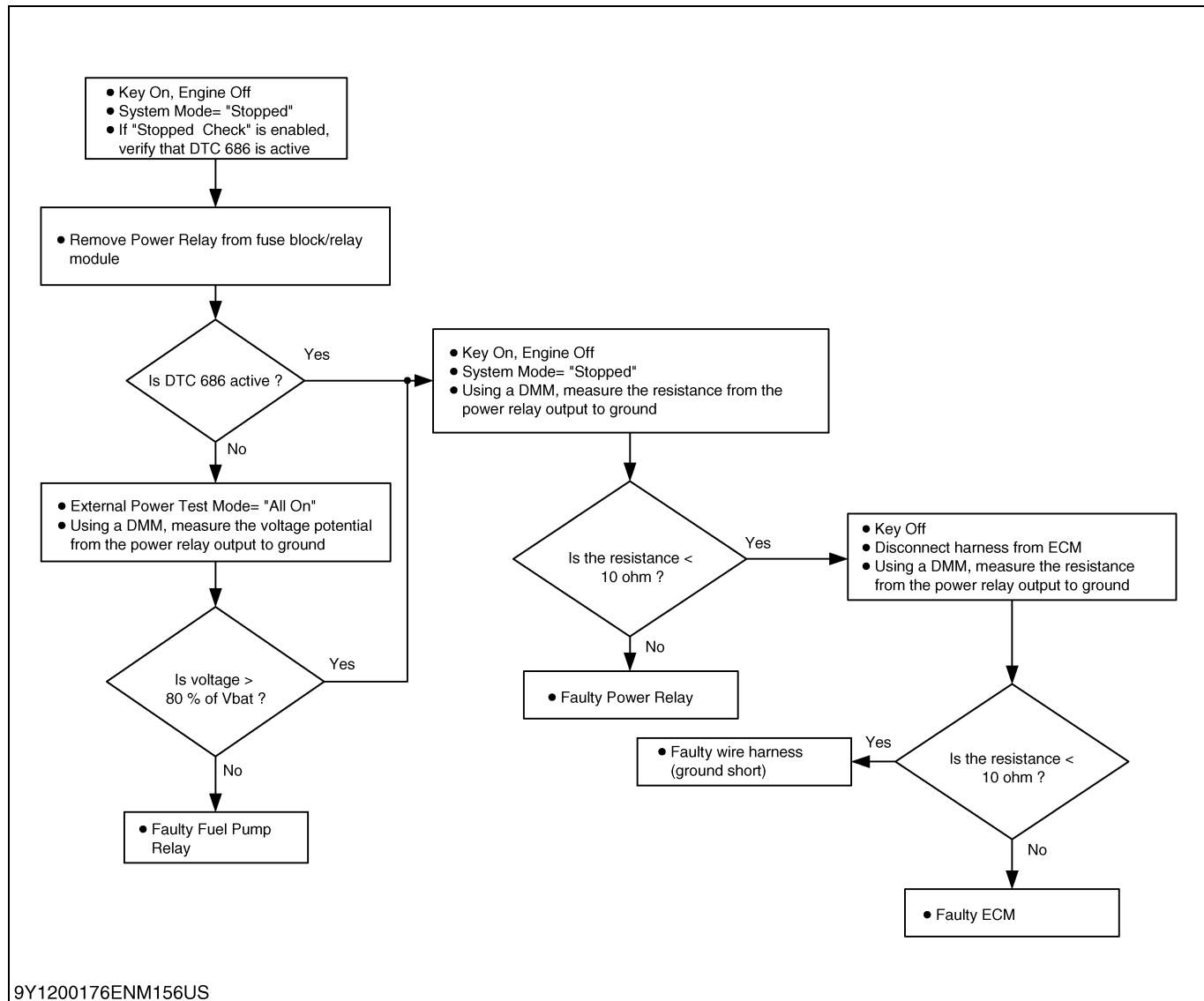
DTC 687-Power Relay Coil Short-To-Power

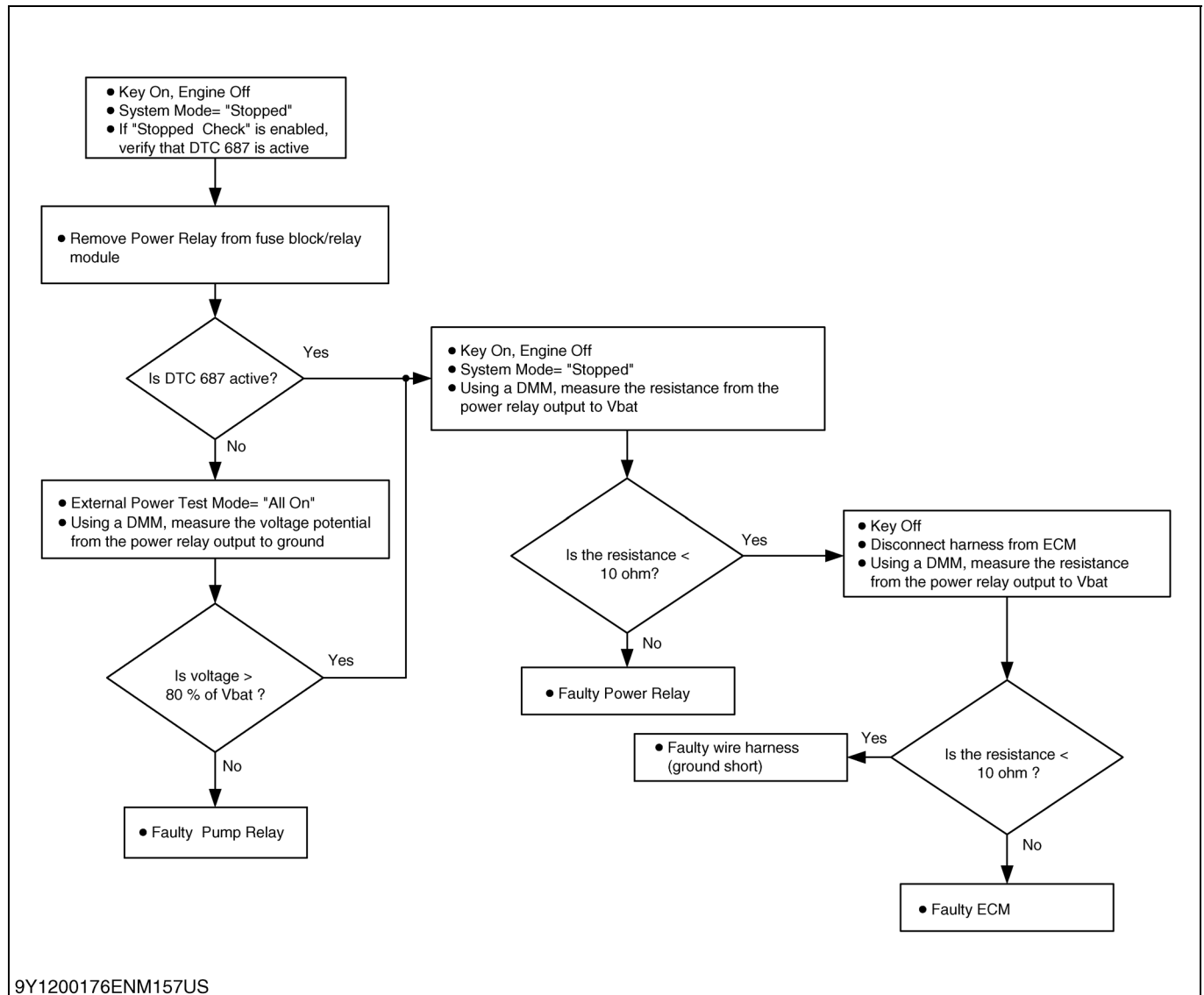
- Hardware: Power Relay Pull in Coil
- Enabling Conditions: Engine Running
- Set Conditions: Power relay coil output short to power/voltage for more than 10 samples of circuit
- Corrective Action(s): Illuminate MIL
- Non-emissions related fault
- Possible Causes: Shorted relay pull in coil, relay driver circuit shorted to voltage in wire harness

The fault of DTC 686 sets if the output for the power relay is detected as being shorted to ground. If this fault is active and the high-side of the power relay is supplied, the following components will have power until the relay or high-side power is removed: CMP sensor, CKP sensor, both O2 sensors and the DEPR.

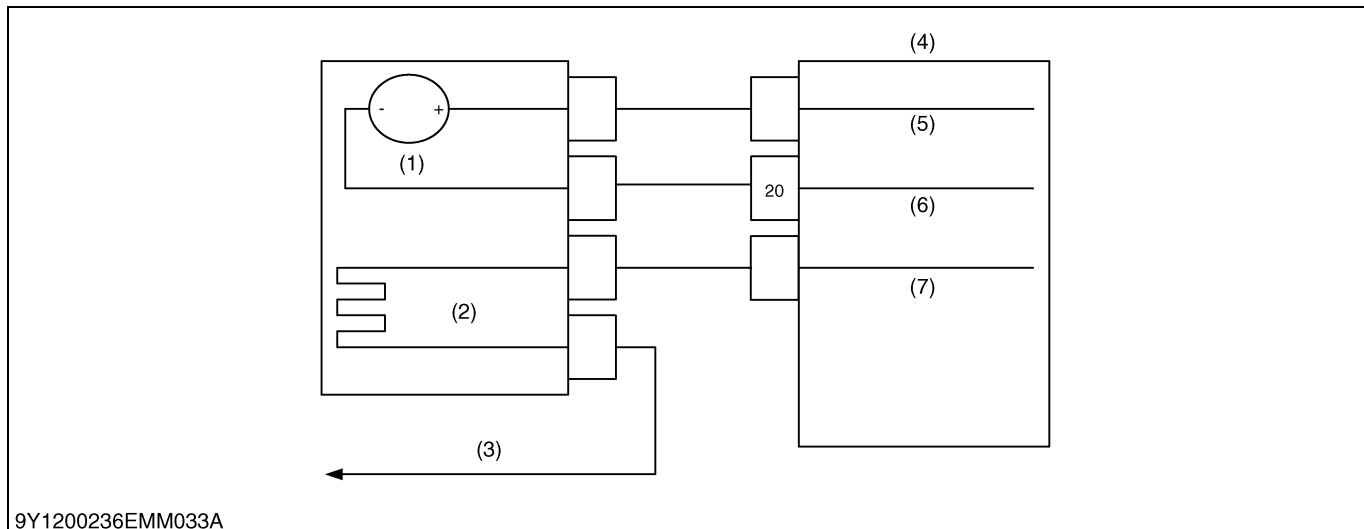
The fault of DTC 687 sets if the output for the power relay is detected as shorted to power.

DTC 685-Power Relay Coil Open**Diagnostic Aids Chart**

DTC 686-Power Relay Ground Short**Diagnostic Aids Chart**

DTC 687-Power Relay Coil Short-To-Power**Diagnostic Aids Chart**

(17) Closed Loop (DTC 1151, 1152)



(1) Sensor
(2) Heater

(3) To System Power Relay
(4) ECM

(5) EGO 1/2/3/4 (HO₂S 1/2/3/4) (7) EGOH 1/2/3/4 (PWM to GND)
(6) 5V Rtn 1

DTC 1151-Closed Loop High (LPG)

- Hardware: Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)
- Enabling Conditions: Engine Running, closed loop mode
- Set Conditions: Closed Loop fuel multiplier higher than 35 % for longer than 5 updates
- Corrective Action(s): Illuminate MIL, Power derate 2, CL disable and AL disable
- Emissions related fault

DTC 1152-Closed Loop Low (LPG)

- Hardware: Exhaust Gas Oxygen Sensor (Bank 1-Sensor 1/Bank 1-Before Catalyst)
- Enabling Conditions: Engine Running, closed loop mode
- Set Conditions: Closed Loop fuel multiplier lower than -35 % for longer than 5 updates
- Corrective Action(s): Illuminate MIL, Power derate 2, CL disable and AL disable
- Emissions related fault

The EGO 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. An EGO 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.

The fault of DTC 1151 and DTC 1153 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 EGO sensor, 2) reduced fuel supply pressure to the gaseous fuel control system, 3) a fuel supply or manifold leak, 4) a non-responsive EGO sensor, and/or 5) a defective gaseous fuel control component (actuator/valve and/or mixer). These faults 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.

The fault of DTC 1152 and DTC 1154 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 EGO sensor. These faults 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 1151-Closed Loop High (LPG)**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 EGO sensor with a known good part and retest.

DTC 1152-Closed Loop Low (LPG)**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 EGO sensor with a known good part and retest.

(18) Megajector or EPR (DTC 1171 to 1177)

DTC 1171-Megajector/EPR Regulation Pressure Higher Than Expected

- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: EPR (actual-commanded) pressure is higher than 2.5 in H₂O for longer than 5 seconds
- Corrective Action(s): Illuminate MIL, AL disable
- Emissions related fault
- Possible Causes: This fault sets if the actual pressure sensed in the Megajector/EPR 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)

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.

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.

DTC 1172-Megajector/EPR Regulation Pressure Lower Than Expected

- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: EPR (actual-commanded) pressure is lower than –2.5 in H₂O for longer than 5 seconds
- Corrective Action(s): Illuminate MIL, AL disable
- Emissions related fault
- Possible Causes: This fault sets if the actual pressure sensed in the Megajector/EPR 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)

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.

DTC 1173-Megajector/EPR Comm Lost

- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: No Megajector/EPR packets received within 500 ms
- Corrective Action(s): Illuminate MIL, AL disable, AL disable in key-cycle, power derate 2, Low rev limit
- Emissions related fault
- Possible Causes: This fault indicates that the ECM is no longer receiving CAN packets from the Megajector/EPR which also results in the Megajector or EPR not receiving communication from the ECM. This is often a result of a power loss at the Megajector/EPR or improper CAN termination or wiring.

DTC 1174-Megajector/EPR Voltage Supply High

- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: Voltage supply to EPR is higher than 33.0 VDC for longer than 5 seconds.
- Corrective Action(s): Illuminate MIL, AL disable, AL disable in key-cycle, power derate 2, Low rev limit
- Emissions related fault
- Possible Causes:

DTC 1175-Megajector/EPR Voltage Supply Low

- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: Voltage supply to EPR is lower than 18.0 VDC for longer than 5 seconds.
- Corrective Action(s): Illuminate MIL, AL disable, AL disable in key-cycle, power derate 2, Low rev limit
- Emissions related fault
- Possible Causes:

DTC 1176-Megajector/EPR Internal Actuator Fault Detection

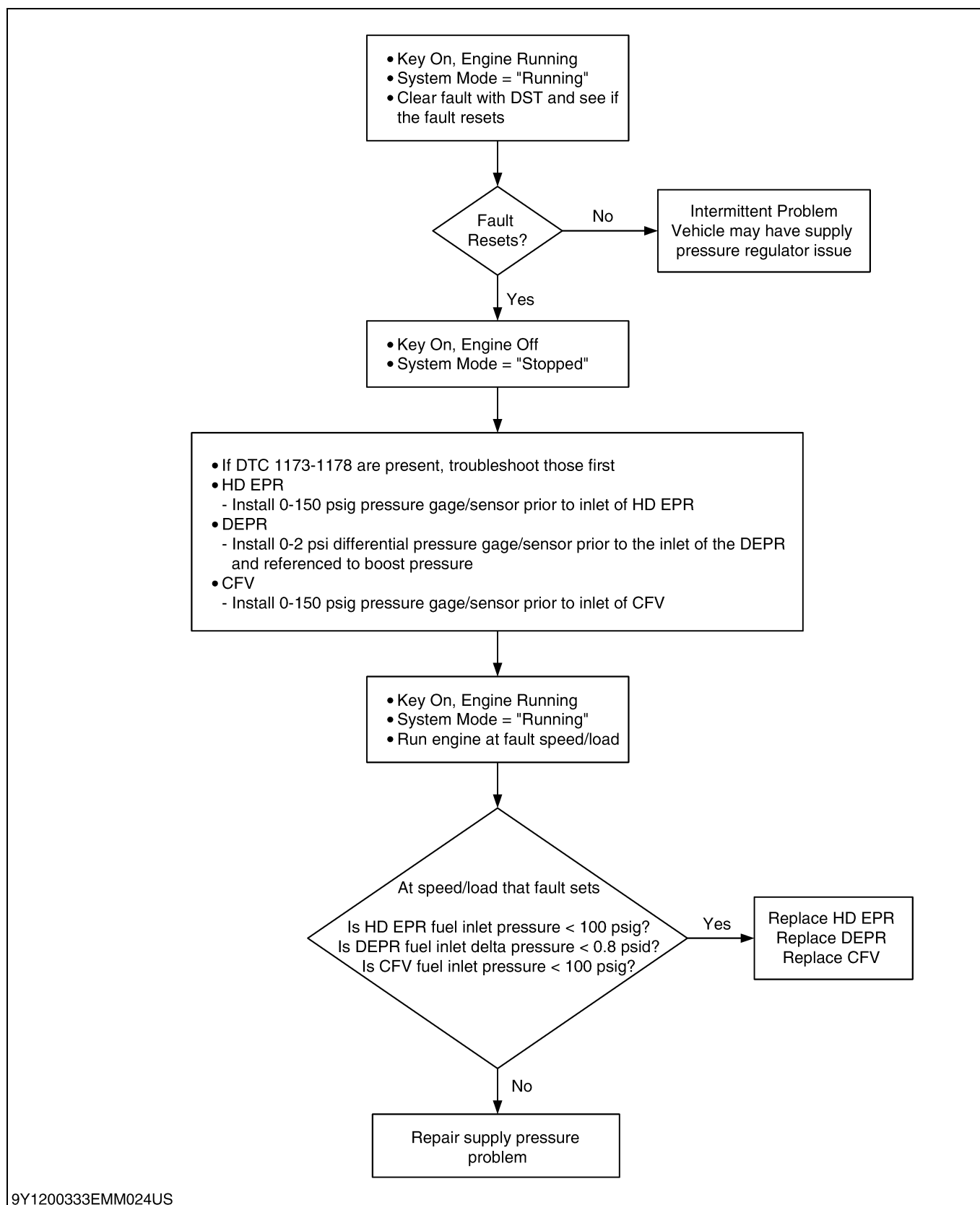
- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: Internal Actuator Fault detected
- Corrective Action(s): Illuminate MIL, AL disable
- Emissions related fault
- Possible Causes: The fault is transmitted from the Megajector/EPR to the ECM via CAN.

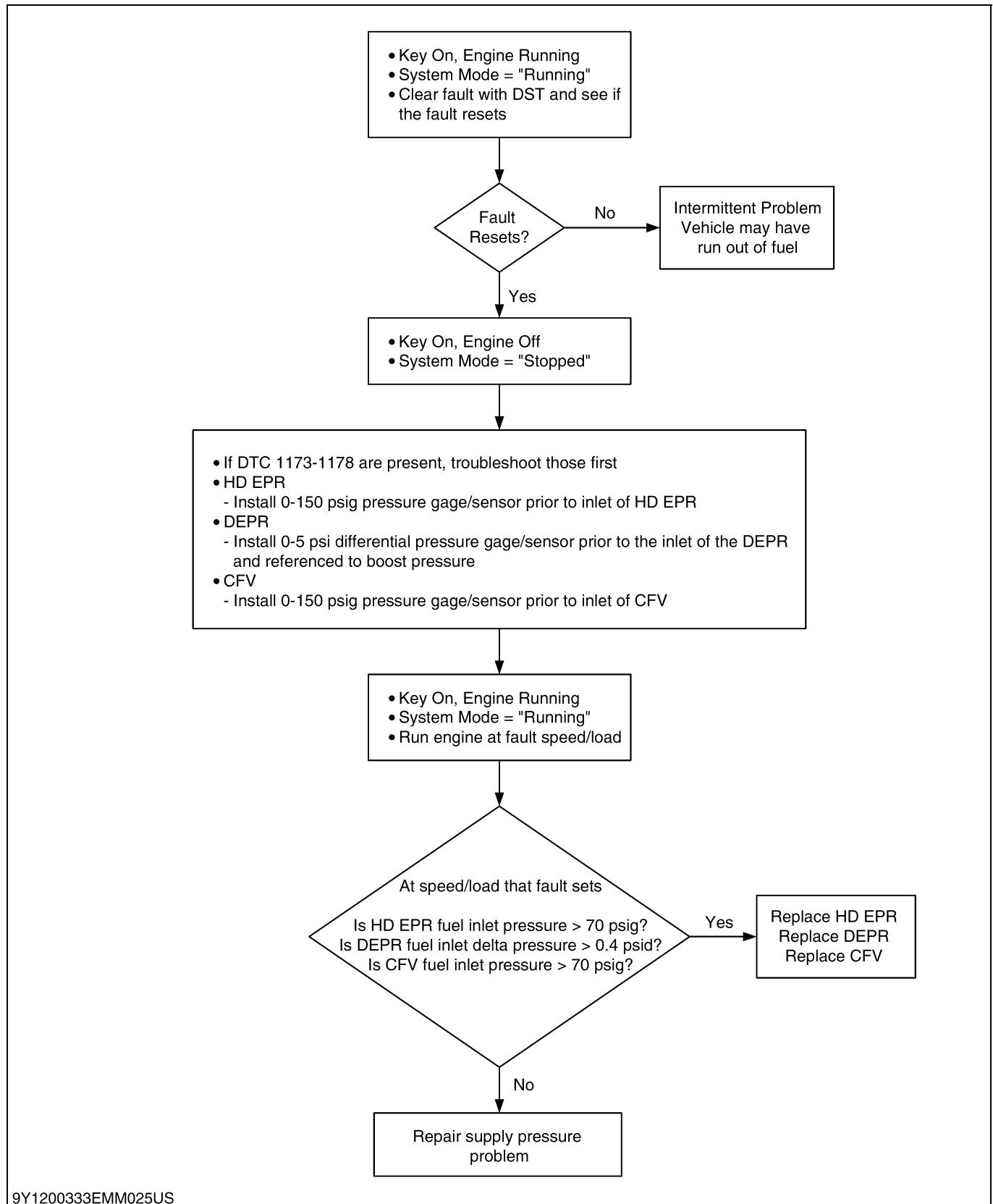
If the Megajector/EPR does not trigger either 1171, 1172, or either of the CFV Flow fault code(s), there is no issue with the Megajector/EPR. If one or more of these faults are triggered, refer to the appropriate section for diagnostic information.

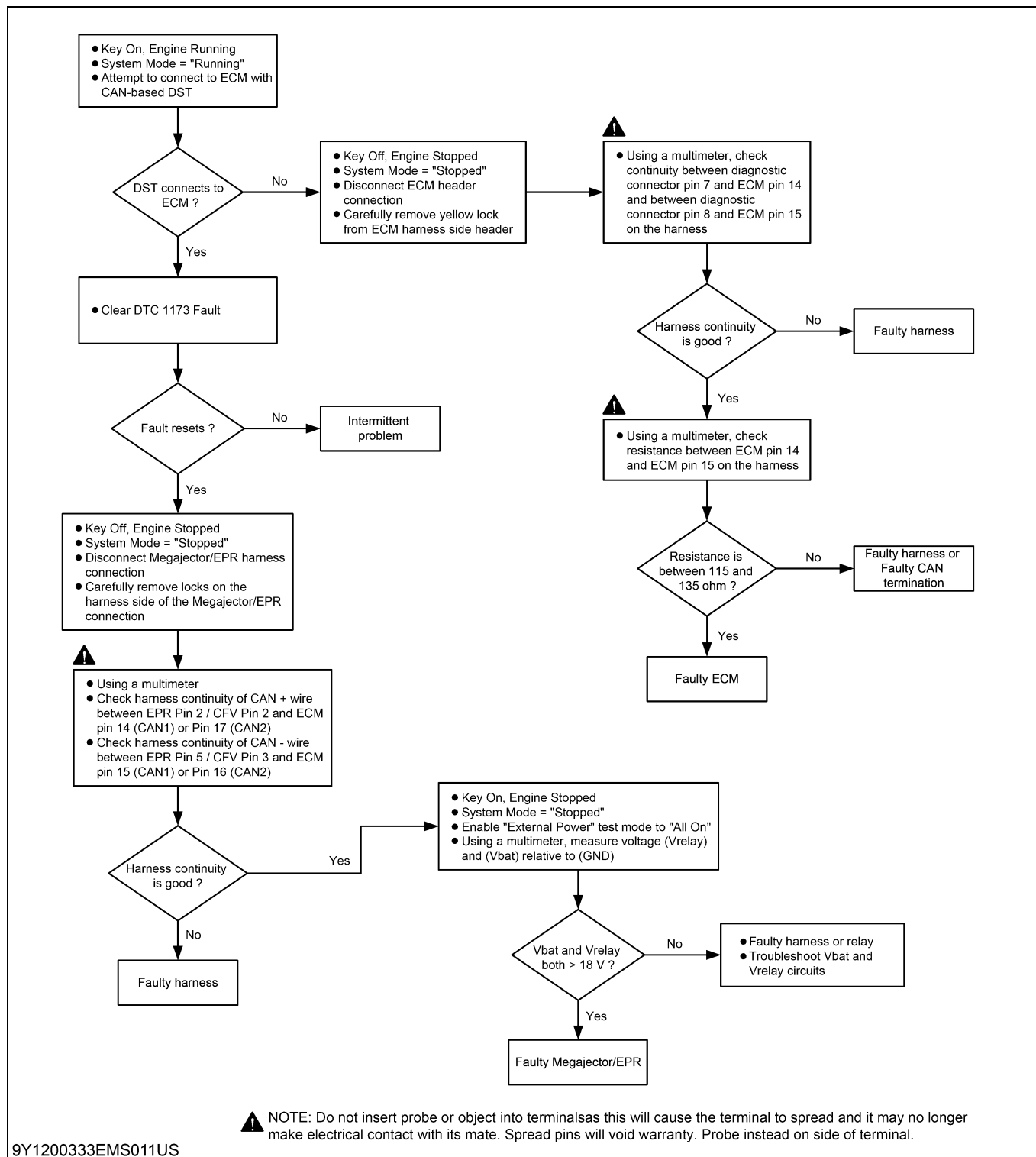
DTC 1177-Megajector/EPR Internal Circuitry Fault Detection

- Hardware: Megajector or EPR
- Enabling Conditions: Engine Running
- Set Conditions: Internal circuitry fault detected
- Corrective Action(s): Illuminate MIL, AL disable
- Emissions related fault
- Possible Causes: The fault is transmitted from the Megajector/EPR to the ECM via CAN.

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

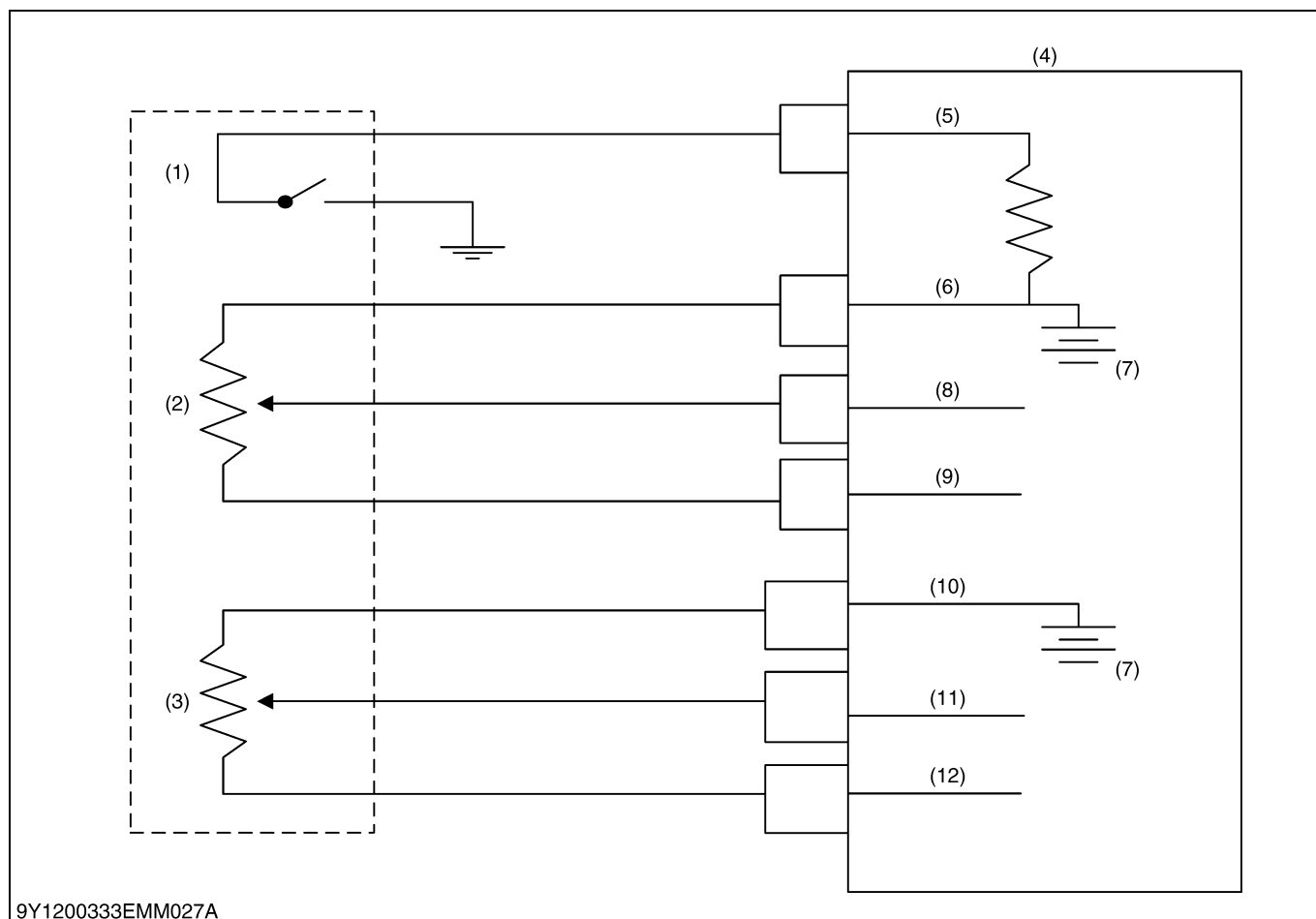
DTC 1171-Megajector/EPR Regulation Pressure Higher Than Expected**Diagnostic Aids Chart**

DTC 1172-Megajector/EPR Regulation Pressure Lower Than Expected**Diagnostic Aids Chart**

DTC 1173-Megajector/EPR Comm Lost**Diagnostic Aids Chart**

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(19) FPP (Foot Pedal Position Switch) (DTC 1121, 2121, 2126, 2122, 2123, 2127, 2128)



(1) IVS	(4) ECM	(7) Vs = +5 VDC	(10) 5V Ext 2
(2) FPP 1	(5) IVS	(8) FPP 1	(11) FPP 2 / IVS
(3) FPP 2	(6) 5V Ext 1	(9) 5V Rtn 1	(12) 5V Rtn 2

DTC 1121-FPP1/2 Simultaneous Voltages Out-of-Range

- Hardware: Foot Pedal Position / Throttle control sensor
- Enabling Conditions: Engine Running
- Set Conditions: FPP 1 voltage is higher than 4.80 V or lower than 0.20 V, and FPP 2 voltage is higher than 2.40 V or lower than 0.10 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 2 and Forced idle
- Non-emissions related fault
- 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.

DTC 2121-FPP1 Lower Than FPP2

- Hardware: Foot Pedal Position / Throttle control sensor
- Enabling Conditions: Engine Running
- Set Conditions: (FPP1 % - FPP2 %) is lower than -20 for longer than 1.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 1, Low rev limit
- Non-emissions related fault
- Possible Causes: This fault indicates that the measured % deflection of sensor 1 is less than sensor 2 by an amount defined in calibration.

DTC 2126-FPP1 Higher Than FPP2

- Hardware: Foot Pedal Position /Throttle control sensor
- Enabling Conditions: Engine Running
- Set Conditions: (FPP1 % - FPP2 %) is higher than 20 for longer than 1.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 1, Low rev limit
- Non-emissions related fault
- Possible Causes: This fault indicates that the measured % deflection of sensor 1 is greater than sensor 2 by an amount defined in calibration.

DTC 2122-FPP1 Voltage High

- Hardware: Electronic foot pedal/throttle control sensor
- Enabling Conditions: Engine Running
- Set Conditions: FPP1 voltage > 4.80 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 1 and Low rev limit
- Non-emissions related fault
- Possible Causes: FPP signal shorted to voltage, 5 V_rtn1 open to FPP, FPP open internally

DTC 2128-FPP2 Voltage High

- Hardware: Electronic foot pedal/throttle control sensor
- Enabling Conditions: Key On, Engine Off
- Set Conditions: FPP2 voltage > 2.40 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 1 and Low rev limit
- Non-emissions related fault
- Possible Causes: FPP signal shorted to voltage, 5 V_rtn1 open to FPP, FPP open internally

DTC 2123-FPP1 Voltage Low

- Hardware: Electronic foot pedal/throttle control sensor
- Enabling Conditions: Key On, Engine Off
- Set Conditions: FPP1 voltage < 0.20 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 1 and Low rev limit
- Non-emissions related fault
- Possible Causes: Loss of 5 V supply, FPP1 signal circuit open or shorted to ground, faulty FPP, faulty ECM

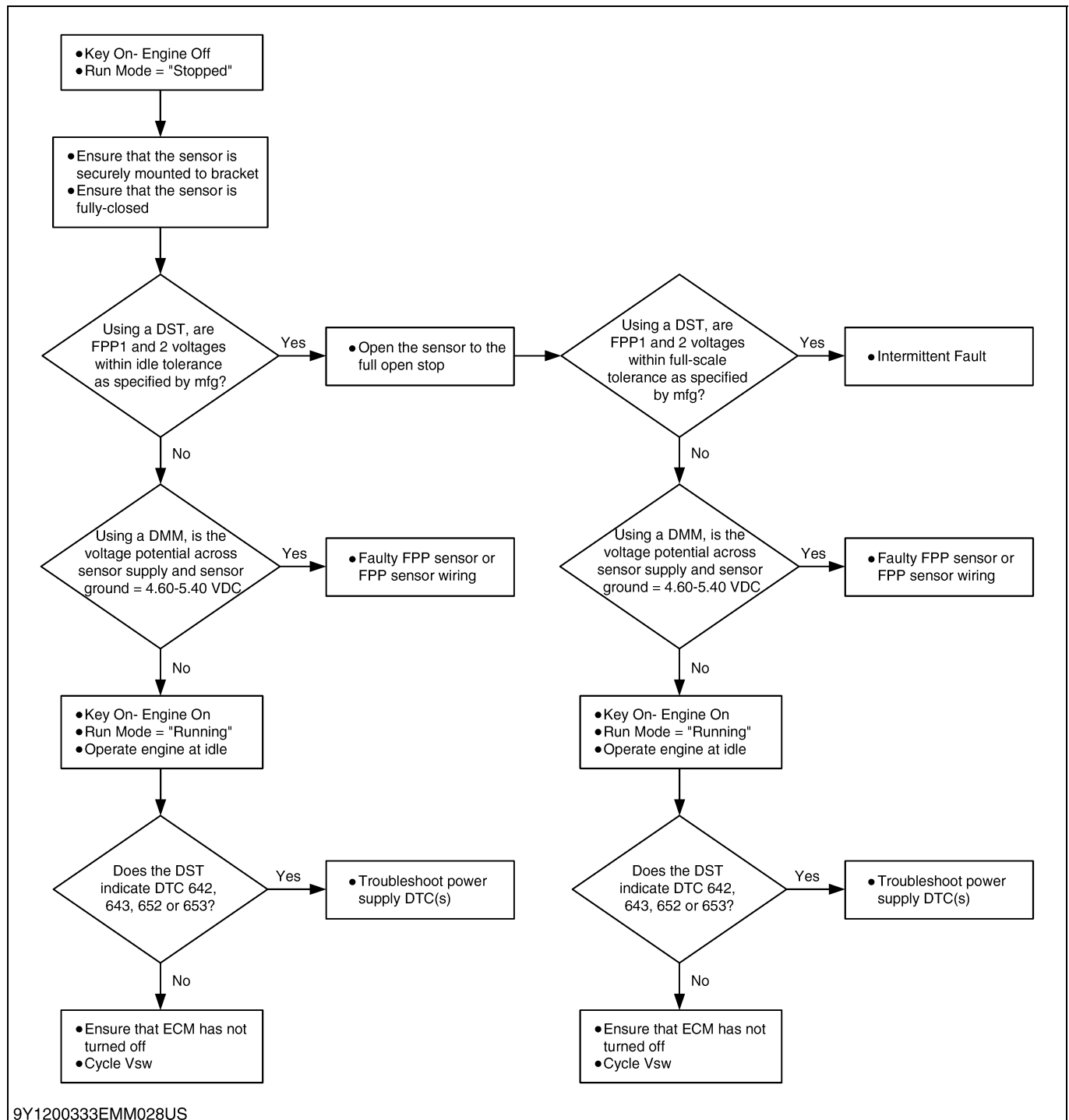
DTC 2127-FPP2 Voltage Low

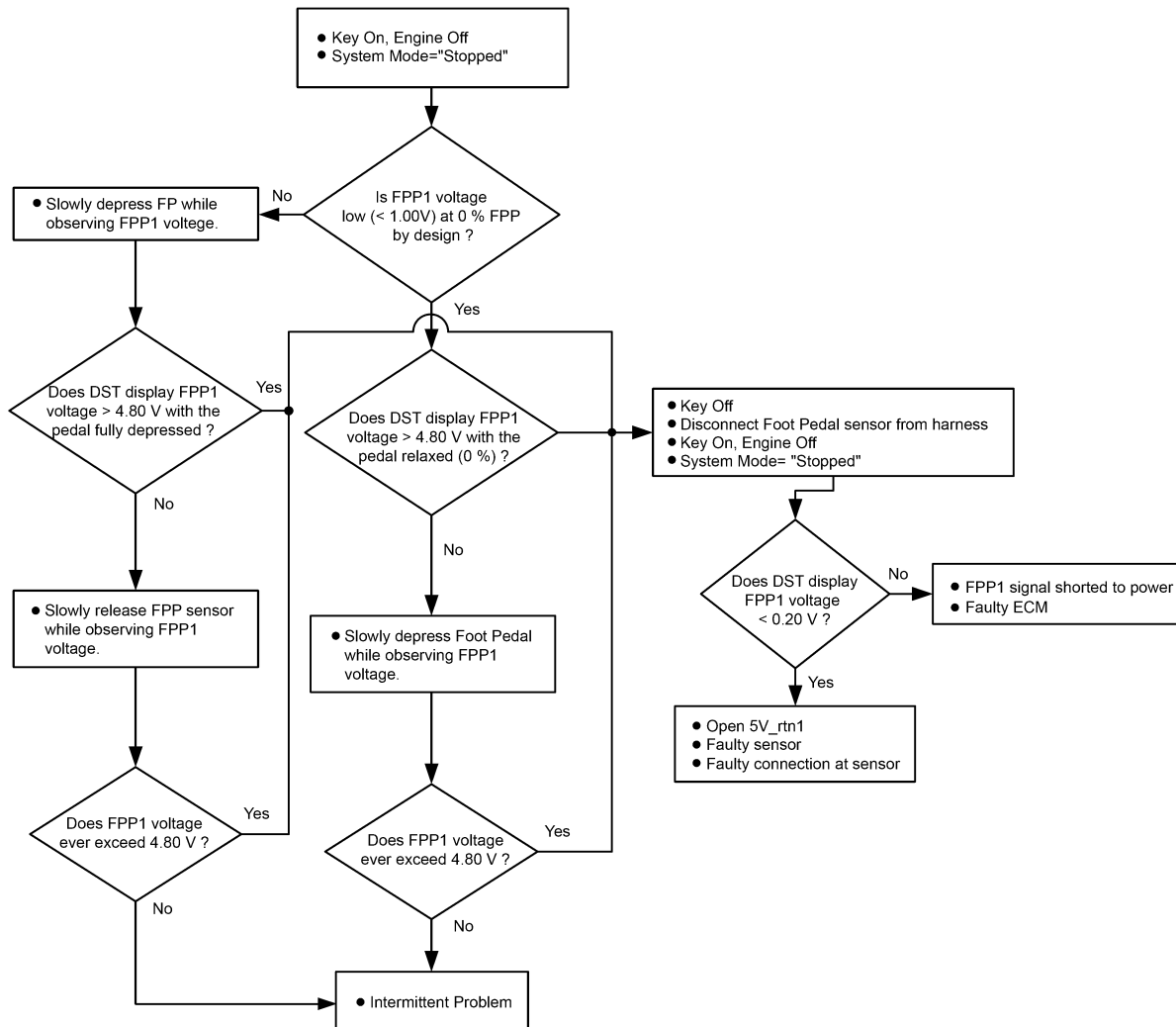
- Hardware: Electronic foot pedal/throttle control sensor
- Enabling Conditions: Key On, Engine Off
- Set Conditions: FPP2 voltage < 0.10 V for longer than 0.5 seconds
- Corrective Action(s): Illuminate MIL, Power derate 1 and Low rev limit
- Non-emissions related fault
- Possible Causes: Loss of 5 V supply, FPP2 signal circuit open or shorted to ground, faulty FPP, faulty ECM

The FPP sensor is an electronic device that is coupled to a mechanically driven input as commanded by the vehicle/engine operator. The FPP sensor output is proportional to the commanded input. The ECM uses the FPP sensor input 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 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.

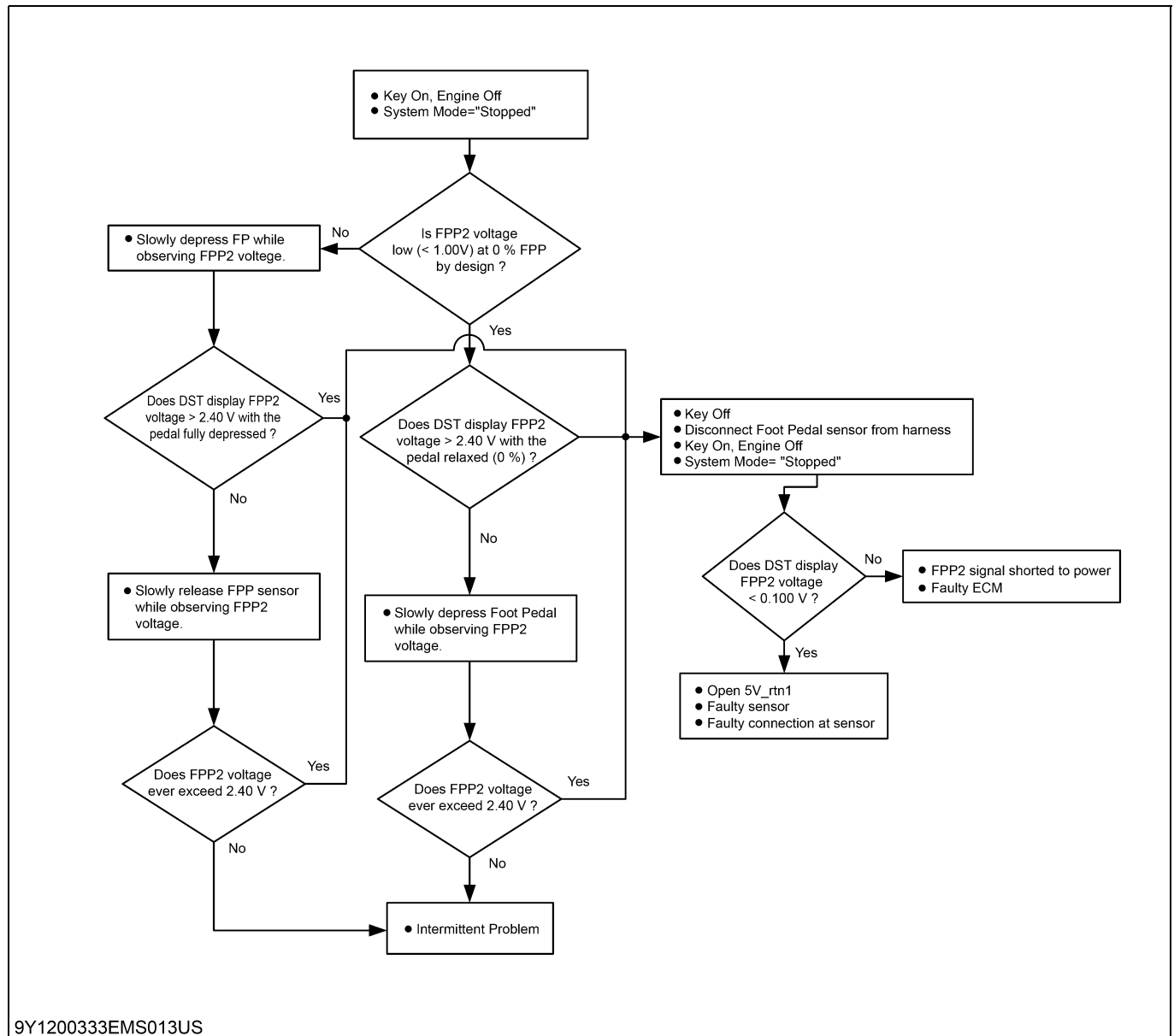
DTC 1121-FPP1/2 Simultaneous Voltages Out-of-Range**Diagnostic Aids Chart**

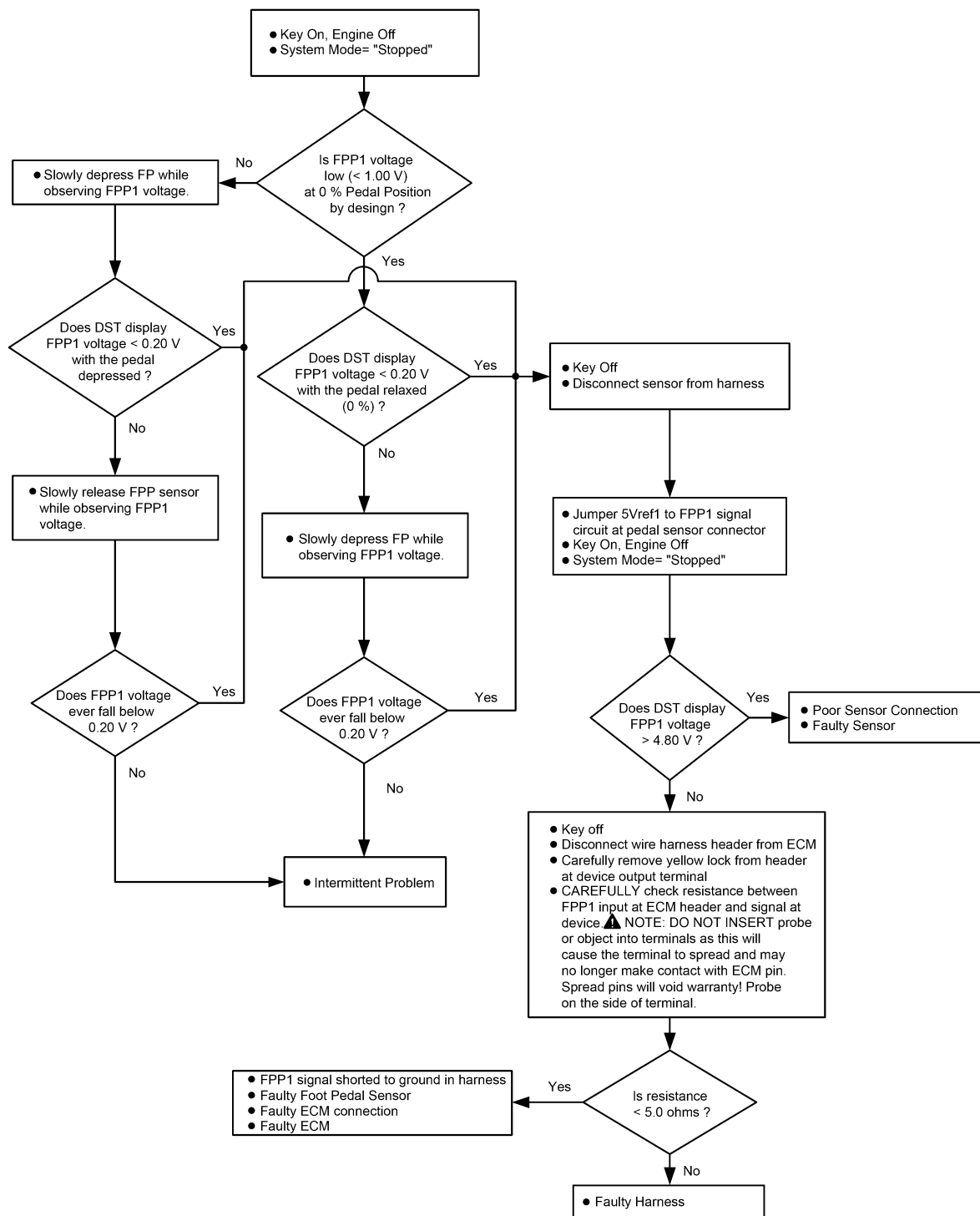
- Troubleshoot according to FPP1 voltage out-of-range following DTC 2122 and 2123 procedures.
- Troubleshoot according to FPP2 voltage out-of-range following DTC 2127 and 2128 procedures.

DTC 2121-FPP1 Lower Than FPP2**DTC 2126-FPP1 Higher Than FPP2****Diagnostic Aids Chart**

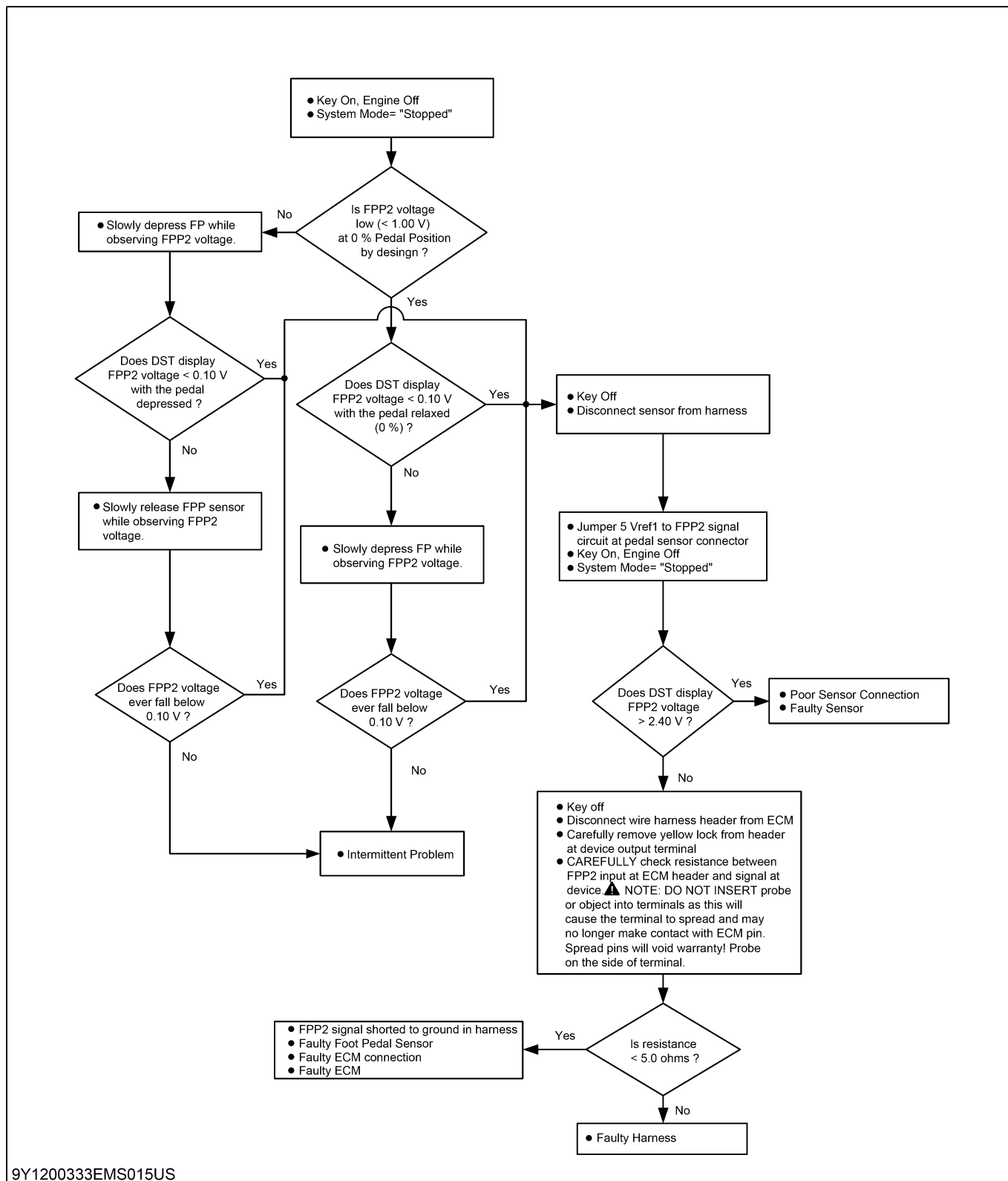
DTC 2122-FPP1 Voltage High**Diagnostic Aids Chart**

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DTC 2128-FPP2 Voltage High**Diagnostic Aids Chart**

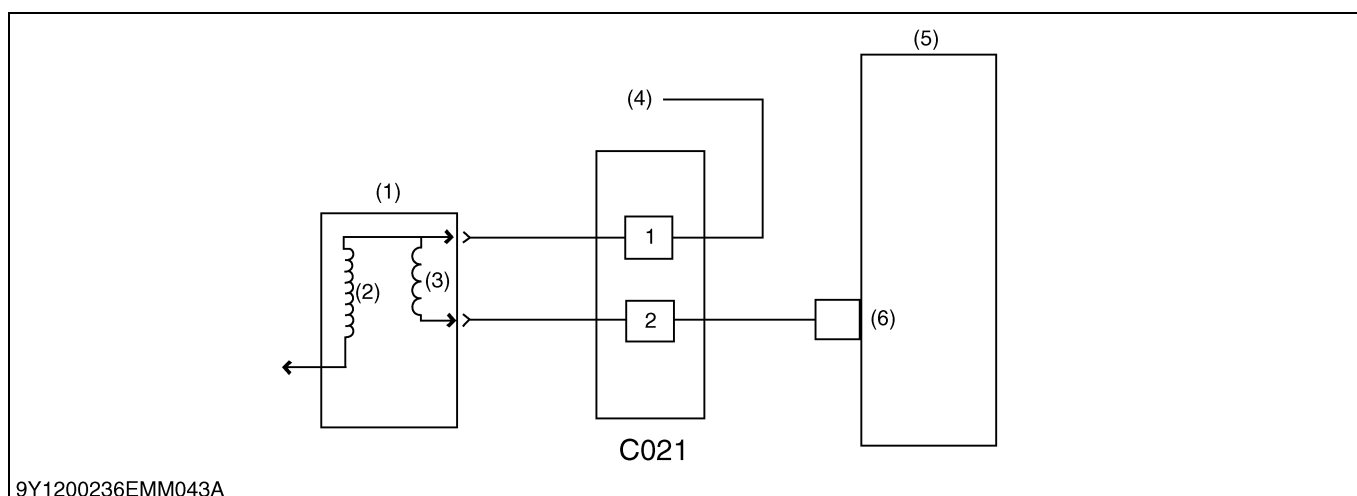
DTC 2123-FPP1 Voltage Low**Diagnostic Aids Chart**

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DTC 2127-FPP2 Voltage Low**Diagnostic Aids Chart**

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(20) Spark Coil Primary (DTC 2300, 2301, 2303, 2304, 2306, 2307, 2309, 2310)



- | | | | |
|--------------------|--------------------------|---------------------------------|-----------------|
| (1) Ignition Coil | (3) Primary Coil | (5) Engine Control Module (ECM) | (6) Coil Driver |
| (2) Secondary Coil | (4) 12V from Power Relay | | |

DTC 2300-Spark Coil #1 Primary Open/Short-to-Ground

DTC 2303-Spark Coil #2 Primary Open/Short-to-Ground

DTC 2306-Spark Coil #3 Primary Open/Short-to-Ground

DTC 2309-Spark Coil #4 Primary Open/Short-to-Ground

- Hardware: Ignition/Spark Coil (Dumb-coil ONLY)
- Enabling Conditions: Engine Cranking or Running
- Set Conditions: Adaptive dwell adjustment is over than 1.9 ms or total dwell is over than 15.0 ms and battery voltage is between 10.0 to 16.0 V
- Corrective Action(s): Illuminate MIL, Low rev limit and AL disable
- Emissions related fault
- Possible Causes:

Each coil driver #1, #2, #3 and #4 fires the corresponding cylinder, the 1st, 2nd, 3rd and 4th cylinder each in the block order.

These faults will set if the ECM detects 10 coil firings in which the adaptive dwell adjustment is greater than 1.9 ms. or the total dwell is greater than 15 ms. and battery voltage is between 10.0 to 16.0 V.

The purpose of these faults is to detect a short-to-ground or open circuit in the harness or an open internal to the primary coil.

DTC 2301-Spark Coil #1 Primary Short-to-Power

DTC 2304-Spark Coil #2 Primary Short-to-Power

DTC 2307-Spark Coil #3 Primary Short-to-Power

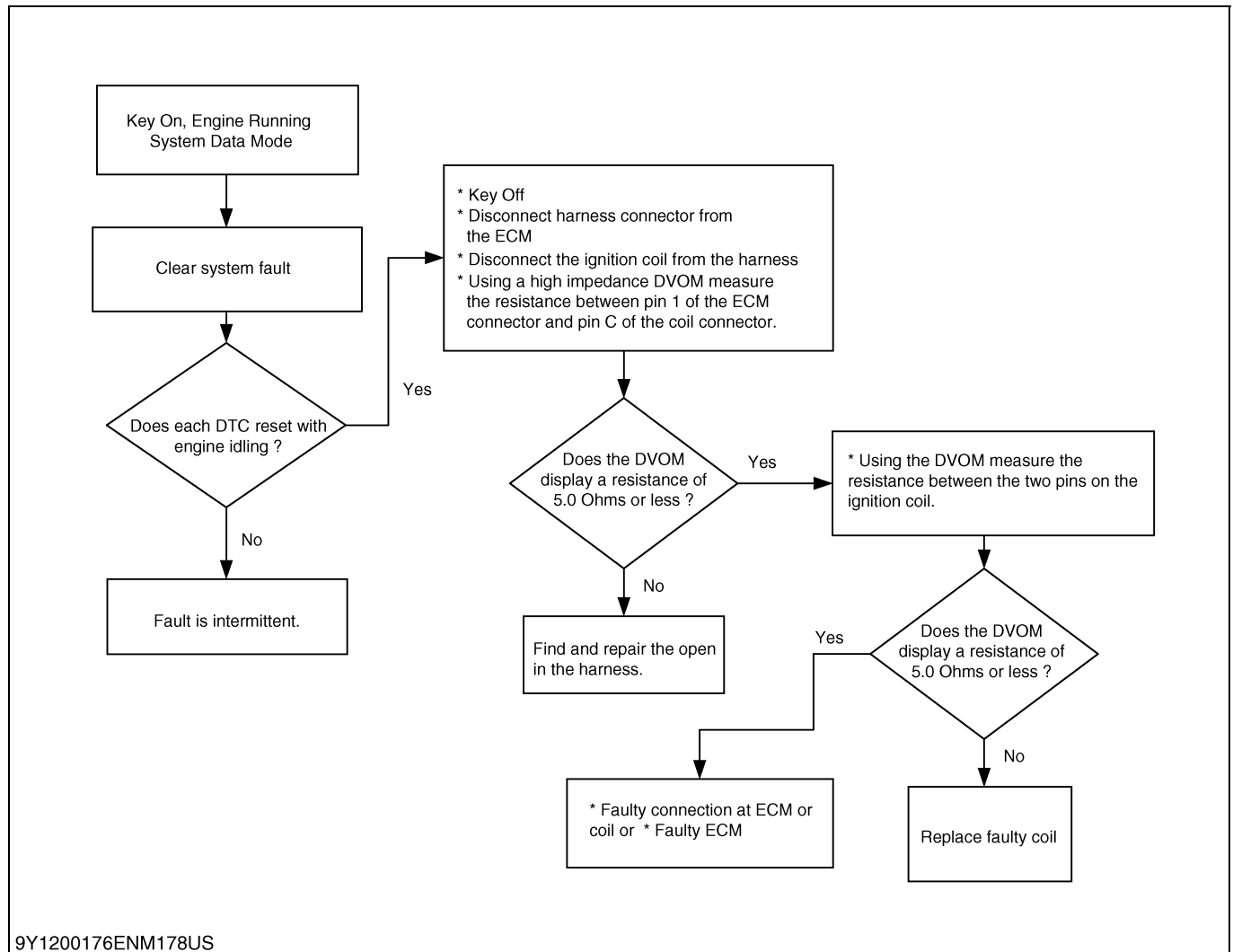
DTC 2310-Spark Coil #4 Primary Short-to-Power

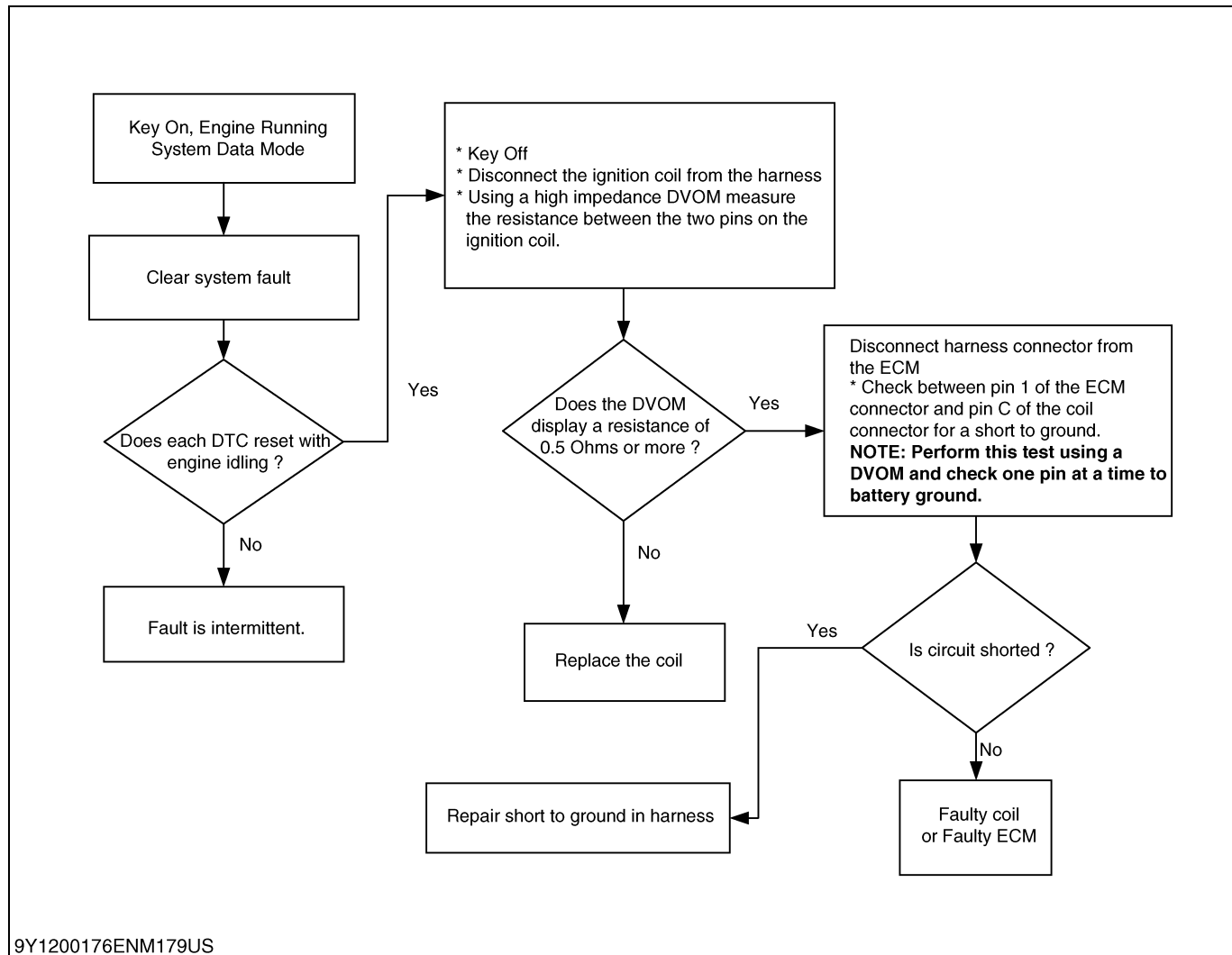
- Hardware: Ignition/Spark Coil (Dumb-coil ONLY)
- Enabling Conditions: Engine Cranking or Running
- Set Conditions: Adaptive dwell adjustment is less than -1.9 ms or total dwell is less than 0.5 ms and battery voltage is between 10.0 to 16.0 V
- Corrective Action(s): Illuminate MIL, Low rev limit and AL disable
- Emissions related fault
- Possible Causes:

Each coil driver #1, #2, #3 and #4 fires the corresponding cylinder, the 1st, 2nd, 3rd and 4th cylinder each in the block order.

These faults will set if the ECM detects 10 coil firings in which the adaptive dwell adjustment is less than -1.9 ms. or the total dwell is less than 0.5 ms. and battery voltage is between 10.0 to 16.0 V.

The purpose of these faults is to detect a short-to-power in the harness or internal to the primary coil.

DTC 2300-Spark Coil #1 Primary Open/Short-to-Ground**DTC 2303-Spark Coil #2 Primary Open/Short-to-Ground****DTC 2306-Spark Coil #3 Primary Open/Short-to-Ground****DTC 2309-Spark Coil #4 Primary Open/Short-to-Ground****Diagnostic Aids Chart**

DTC 2301-Spark Coil #1 Primary Short-to-Power**DTC 2304-Spark Coil #2 Primary Short-to-Power****DTC 2307-Spark Coil #3 Primary Short-to-Power****DTC 2310-Spark Coil #4 Primary Short-to-Power****Diagnostic Aids Chart**

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