POWERTECH® 6.8 & 8.1 L Compressed Natural Gas Engines

Operation and Diagnostics

For complete service information also see:

POWERTECH® 6.8 L CNG Engines—Repair . .	CTM146
POWERTECH® 8.1 L CNG Engines—Repair . .	CTM87

Deere Power Systems Group
CTM113 (08DEC00)

LITHO IN U.S.A.
ENGLISH

Introduction

Foreword

This manual is written for an experienced technician. Essential tools required in performing certain service work are identified in this manual and are recommended for use.

Live with safety: Read the safety messages in the introduction of this manual and the cautions presented throughout the text of the manual.

CAUTION: This is the safety-alert symbol. When you see this symbol on the machine or in this manual, be alert to the potential for personal injury.

Use this component technical manual in conjunction with the engine repair manual (for 6068 CNG engines use CTM146 and for 6081 CNG engines use CTM87) and the respective machine technical manual. See the repair manual for information on component removal and installation. See the machine technical manual for information on gaining access to the components.

This manual is divided into two parts: theory of operation and diagnostics. The theory of operation section contains information that explains how the engine subsystems operate. The diagnostics section helps identify the cause of engine problems.

Applicable special tools needed to do the job, specifications, and helpful reference materials are covered in separate groups toward the end of this manual.

Fundamental service information is available from other sources covering basic theory of operation, fundamentals of troubleshooting, general maintenance, and basic type of failures and their causes.

DX,TMIFC –19–22MAY92–1/1

John Deere Dealers

IMPORTANT: The changes listed below makes your CTM obsolete. Discard CTM 113 dated 01Sept00. Please copy this page and route through your service department.

GROUP 100

- Electronic Engine Controls Theory of Operation Definition of Terms.
- Revised figure for Cooling System Operation on a 6068 CNG Engine.
- Added Cooling System Operation on a 6081 HFN02 CNG Engine.
- Revised Pressure Sensors.
- Added Fuel Control on a 6081 CNG HFN02 Engine.
- Added Electronic Engine Controls System Overview on a 6081 CNG HFN02 Engine

GROUP 115

- Revised DST screens so they are current with DST software.
- Revised Listing of DTCs.
- Revised wiring schematics for all DTCs to distinguish the difference between the Current Wiring Harness and Early Wiring Harness.
- Revised Injector Cleaning to demonstrate current injection cleaning on a 6068 engine.
- Revised and added new diagnostics procedures throughout this Group.

GROUP 198

- Revised picture of the wiring harness on the engine for 6081 CNG Engines.
- Added picture of the wiring harness on the engine for a 6081 HFN02 CNG Engines.
- Revised table for ECU terminal identification wire colors and circuit numbers to support the Early and Current Wiring Harnesses.
- Added four wiring schematics for each of the wiring harnesses.

GROUP 199

- Added tools for compression test on 6068 engines.
- Added Connector Adapter kit for wiring harness trouble shooting.

Wallcharts

- Converted Wallchart schematic format into foldouts in Group 198 later in this manual.

RG41221,0000009 –19–05SEP00–1/1

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INDX

All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

INDX

Operation and Diagnostics

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Handle Fluids Safely — Avoid Fires

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

Do not store oily rags; they can ignite and burn spontaneously.

TS227 –UN–23AUG88

RG,RG34710,3001 –19–15JUL96–1/1

Handle Natural Gas Safely

Handle natural gas with care; it is highly flammable. Do NOT smoke while working on or around natural gas equipment.

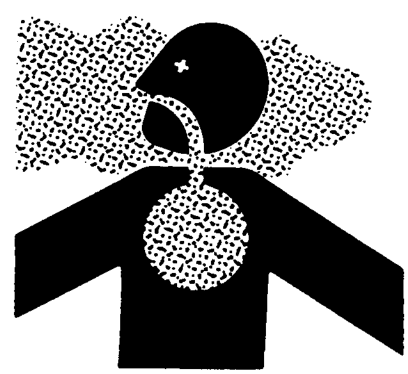
Natural gas fumes may cause sickness or death. Work in well ventilated area.

Shut off natural gas supply before servicing equipment.

Have a manual valve installed away from the engine to shut off gas supply in case of an emergency.

Prevent fires by keeping machine clean of accumulated trash, grease, and debris.

TS227 –UN–23AUG88



TS220 –UN–23AUG88

RG,RG34710,3002 –19–15JUL96–1/1

Prevent Battery Explosions

Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

TS204 –UN–23AUG88

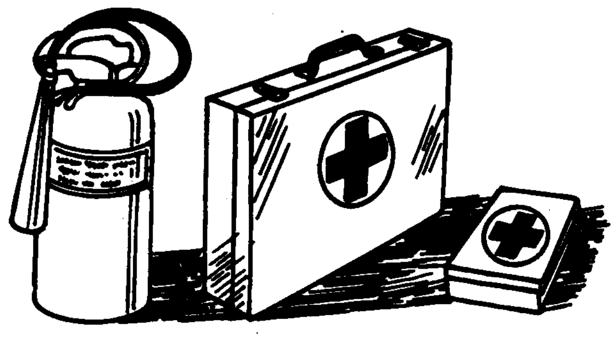
RG,RG34710,3003 –19–15JUL96–1/1

Prepare for Emergencies

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



TS291 –UN–23AUG88

RG,RG34710,3004 –19–15JUL96–1/1

Prevent Acid Burns

Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid the hazard by:

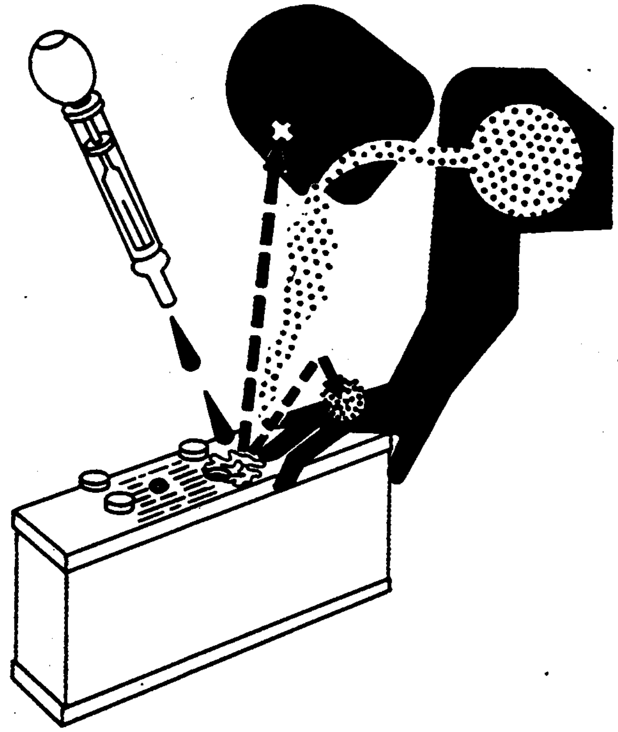
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 15—30 minutes. Get medical attention immediately.

If acid is swallowed:

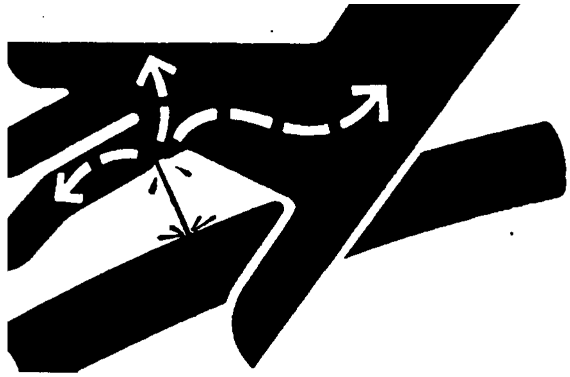
1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 2 L (2 qt).
3. Get medical attention immediately.



TS203 –UN–23AUG88

RG,RG34710,3005 –19–15JUL96–1/1

Avoid High-Pressure Fluids



Escaping fluid under pressure can penetrate the skin causing serious injury.

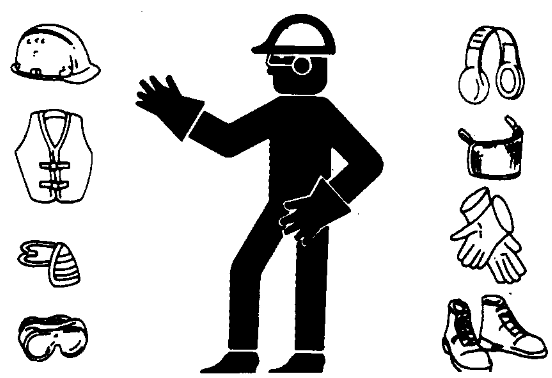
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere and Company Medical Department in Moline, Illinois, U.S.A.

RG,RG34710,3006 –19–15JUL96–1/1

Wear Protective Clothing



Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

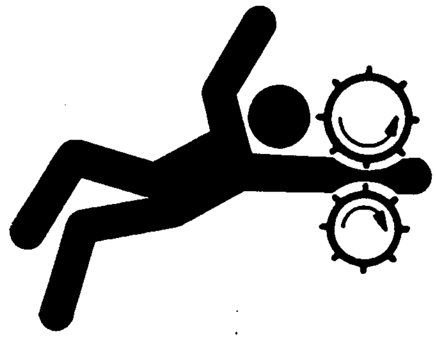
Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

RG,RG34710,3007 –19–15JUL96–1/1

Service Machines Safely

Tie long hair behind your head. do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.



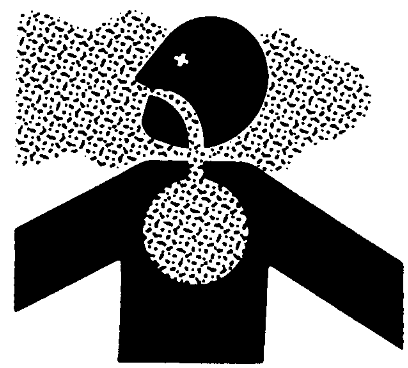
TS228 –UN–23AUG88

RG,RG34710,3008 –19–15JUL96–1/1

Work in Ventilated Area

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.



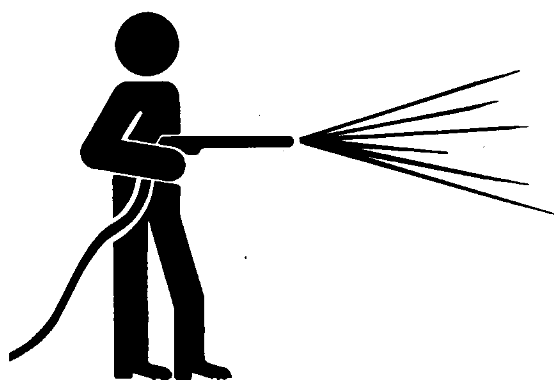
TS220 –UN–23AUG88

RG,RG34710,3009 –19–15JUL96–1/1

Work in Clean Area

Before starting a job:

- Clean work area and machine.
- Make sure you have all necessary tools to do your job.
- Have the right parts on hand.
- Read all instructions thoroughly; do not attempt shortcuts



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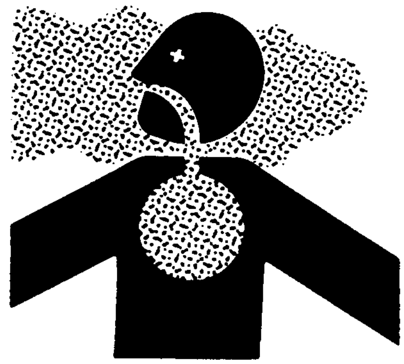
RG,RG34710,3010 –19–15JUL96–1/1

Remove Paint Before Welding or Heating



TS220 –UN–23AUG88

Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. allow fumes to disperse at least 15 minutes before welding or heating.

RG,RG34710,3011 –19–15JUL96–1/1

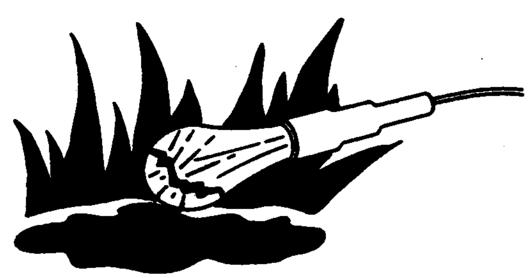
Avoid Heating Near Pressurized Fluid Lines

TS953 –UN–15MAY90

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

RG,RG34710,3012 –19–15JUL96–1/1

Illuminate Work Area Safely



TS223 –UN–23AUG88

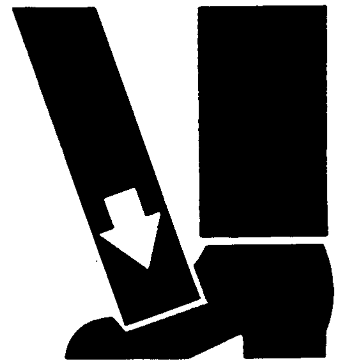
Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite fuel or oil.

RG,RG34710,3013 –19–15JUL96–1/1

Use Proper Lifting Equipment

Lifting heavy components incorrectly can cause severe injury or machine damage.

Follow recommended procedure for removal and installation of components in the manual.



TS226 –UN–23AUG88

RG,RG34710,3014 –19–15JUL96–1/1

Practice Safe Maintenance

Understand service procedure before doing work. Keep area clean and dry.

Never lubricate, service, or adjust machine while it is moving. Keep hands, feet, and clothing from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow machine to cool.

Securely support any machine elements that must be raised for service work.

Keep all parts in good condition and properly installed. Fix damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.

Disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

TS218 –UN–23AUG88

RG,RG34710,3015 –19–15JUL96–1/1

Use Proper Tools


TS779 –UN–08NOV89

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards.

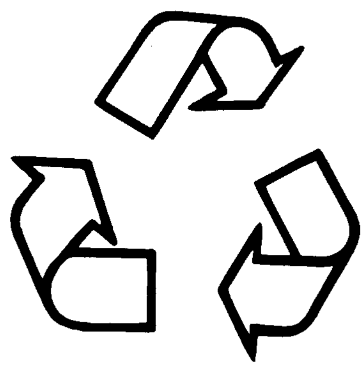
Use power tools to loosen threaded parts and fasteners.

For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches.

Use only service parts meeting John Deere specifications.

RG,RG34710,3016 –19–15JUL96–1/1

Dispose of Waste Properly


TS1133 –UN–26NOV90

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Air conditioning refrigerants escaping into the air can damage the Earth’s atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

RG,RG34710,3017 –19–15JUL96–1/1

Handle Compressed Natural Gas (CNG) Safely

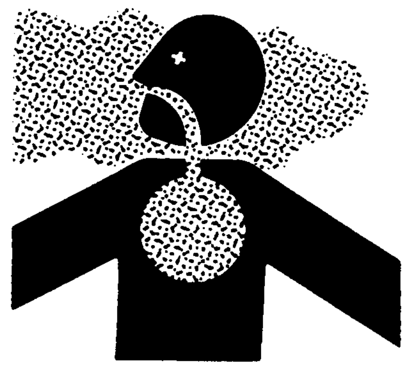
CNG is methane (natural gas) stored at high pressure. It spreads into air quickly.

Natural gas fumes can cause sickness or death. Always work in a well ventilated area.

Do not smoke when refueling or working on or around natural gas vehicles or equipment.

Keep natural gas vehicles away from sparks, flames, and electrical devices in operation, especially if you suspect a natural gas leak.

TS227 –UN–23AUG88



TS220 –UN–23AUG88

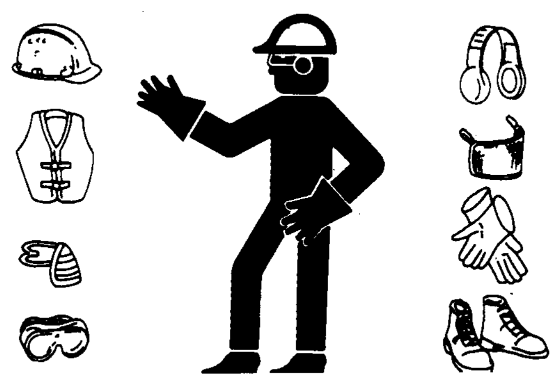
RG,RG34710,3018 –19–15JUL96–1/1

Service Compressed Natural Gas (CNG) Systems Safely

Improper installation, service, or operation of CNG storage and delivery components can result in fire, explosion, and/or serious injury.

See INJECTOR CLEANING in Group 115 of this manual before servicing the CNG fuel system.

Relieve CNG fuel system pressure before working on the system. Properly tighten connections and check for leaks before pressurizing the CNG fuel system.



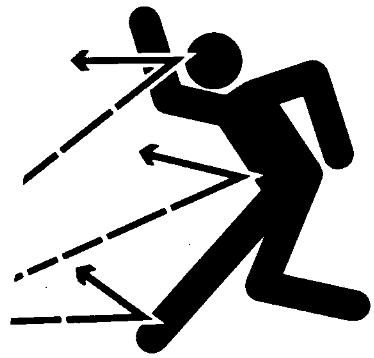
TS206 –UN–23AUG88

RG,RG34710,3019 –19–15JUL96–1/1

Protect Against High Pressure

CNG fuel systems operate at high pressures. DO NOT disassemble or remove any CNG fuel system components under pressure. Explosive separation of components, and the escaping natural gas can cause serious injury.

Relieve CNG fuel system pressure before disconnecting any fuel system component.



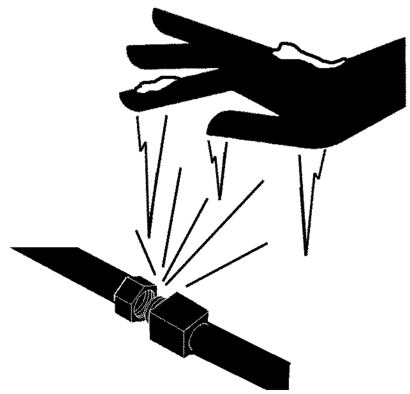
TS265 —UN—23AUG88

RG,RG34710,3020 –19–15JUL96–1/1

Protect Against Extremely Cold CNG Leakage

Gas escaping from the CNG fuel system is very cold. Frostbite and skin damage can occur from contact with cold escaping gas or surrounding components.

Inspect for leaks by spraying a soap and water solution on joints, fittings, and other areas. Look for bubbles that indicate leakage from the system.



RG8110 —UN—20AUG98

RG,RG34710,3021 –19–15JUL96–1/1

Live With Safety

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

TS231 –19–07OCT88

RG,RG34710,3022 –19–15JUL96–1/1

General Engine Operation

The 6068 CNG and 6081 CNG engines are vertical stroke, in-line, valve-in-head, 6-cylinder engines. The firing order is 1-5-3-6-2-4.

Each engine is turbocharged. Operated by exhaust gases, the turbocharger compresses intake air from the air cleaner and routes it through the mixing elbow and intake manifold to each cylinder's combustion chamber. The turbocharger's wastegate is controlled by the electronic control unit (ECU) and has liquid cooled center housing.

An air-to-air aftercooler cools the turbocharger compressor discharge air by routing it through a heat exchanger (mounted in front of the radiator) before it enters the intake manifold. The heat exchanger uses no liquid coolant, but relies on air flow to cool the charge air.

The camshaft and followers are made of chilled iron. The cam lobes are individually flame hardened to provide excellent wear characteristics. Spherically ground followers riding on tapered cam lobes help insure positive follower rotation. The camshaft has two different nose diameters to accommodate a pressed on timing wheel and a pressed on cam gear. The timing wheel is on the inside, and is used in conjunction with the camshaft position sensor to measure engine speed and to determine engine position.

Intake and exhaust valves are operated by cam followers, push rods, and rocker arm assembly. Cylinder head has replaceable inserts and valves, and has exhaust valve stem seals.

The crankshaft is a one-piece, heat treated, dynamically balanced steel forging which rotates in replaceable two-piece main bearings. The rear thrust bearing has a flange on each side to reduce crankshaft deflection and to limit end play during high load operation.

Cylinder liners are of a wet sleeve, flanged, and centrifugally cast design. O-rings are used to seal the connection between cylinder block and liners. Liners are induction hardened and are individually replaceable.

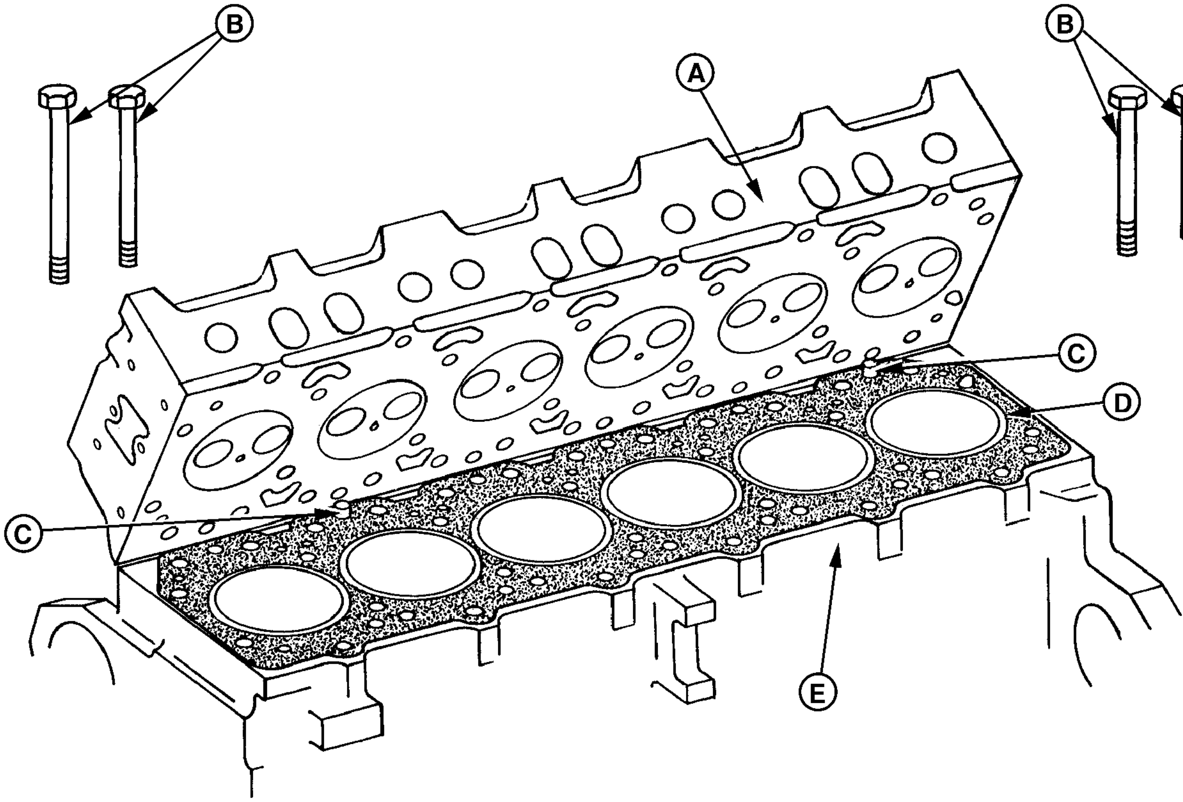
Pistons are constructed of high-silicone aluminum alloy. A "cereal bowl" shaped piston crown lowers the compression ratio to 10:1 compared to the diesel engine and provides a compact, high efficiency combustion chamber that promotes lean-burn combustion. The piston utilizes a three ring design. The top two rings are compression rings and the lower ring is an oil control ring. A double Ni-Resist ring carrier is cast integrally in the piston to greatly improve the life of the piston ring grooves.

The highly polished, hardened piston pins are fully-floating and held in position by means of snap rings. Spray jets (piston cooling orifices) in cylinder block direct pressure oil to lubricate piston pins and cool pistons.

Connecting rods are of forged steel and have replaceable bushing and bearing inserts. They are weight controlled (by machining) on both ends to minimize engine vibration.

RG,RG34710,3023 –19–15JUL96–1/1

Head Gasket Joint Construction and Operation



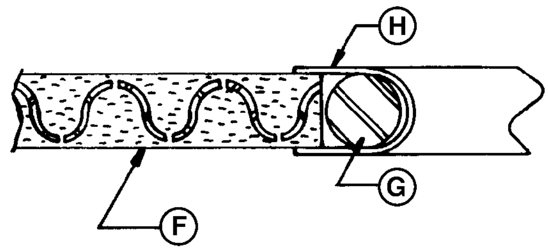
RG6447 –UN–26NOV97

NOTE: The drawings for Head Gasket Joint Construction and Operation represent the 6081 CNG engine.

The head gasket joint consists of:

- Cylinder head gasket
- Cylinder head (A)
- Cylinder head cap screws (B)
- Cylinder liners (D)
- Cylinder block (E)

Refer to text on next page.



RG6430 –UN–03NOV97

A—Cylinder Head
B—Cylinder Head Cap Screws
C—Dowel Pins
D—Cylinder Liners
E—Cylinder Block
F—Gasket Body
G—Fire Ring Combustion Seal
H—Stainless Steel Flange

Continued on next page

The head gasket must be an air-tight seal between cylinder liners and cylinder head that can withstand the temperatures and pressures of the combustion process. The gasket must also form a liquid-tight seal between the cylinder head and the cylinder block to retain coolant and oil in their respective passages. The gasket is constructed of thin, formed sheets of steel-inserted, non-asbestos material (F). The surface of gasket is treated to improve liquid sealing and anti-stick characteristics. A firing ring combustion seal (G) is located at each cylinder bore and is held in place by a U-shaped stainless steel flange (H).

The cylinder head and block must be flat to provide an even clamping pressure over the entire surface of the gasket, and must have the proper surface finish to keep gasket material from moving in the joint. Dowels (C) are used to properly locate head gasket on block.

The cylinder liners must protrude evenly from the top of the cylinder block to the specified amount to provide adequate clamping force on firing ring of each cylinder.

The cap screws must be proper length, made of proper material, and be tightened to the proper torque in order to provide an adequate clamp load between other joint components.

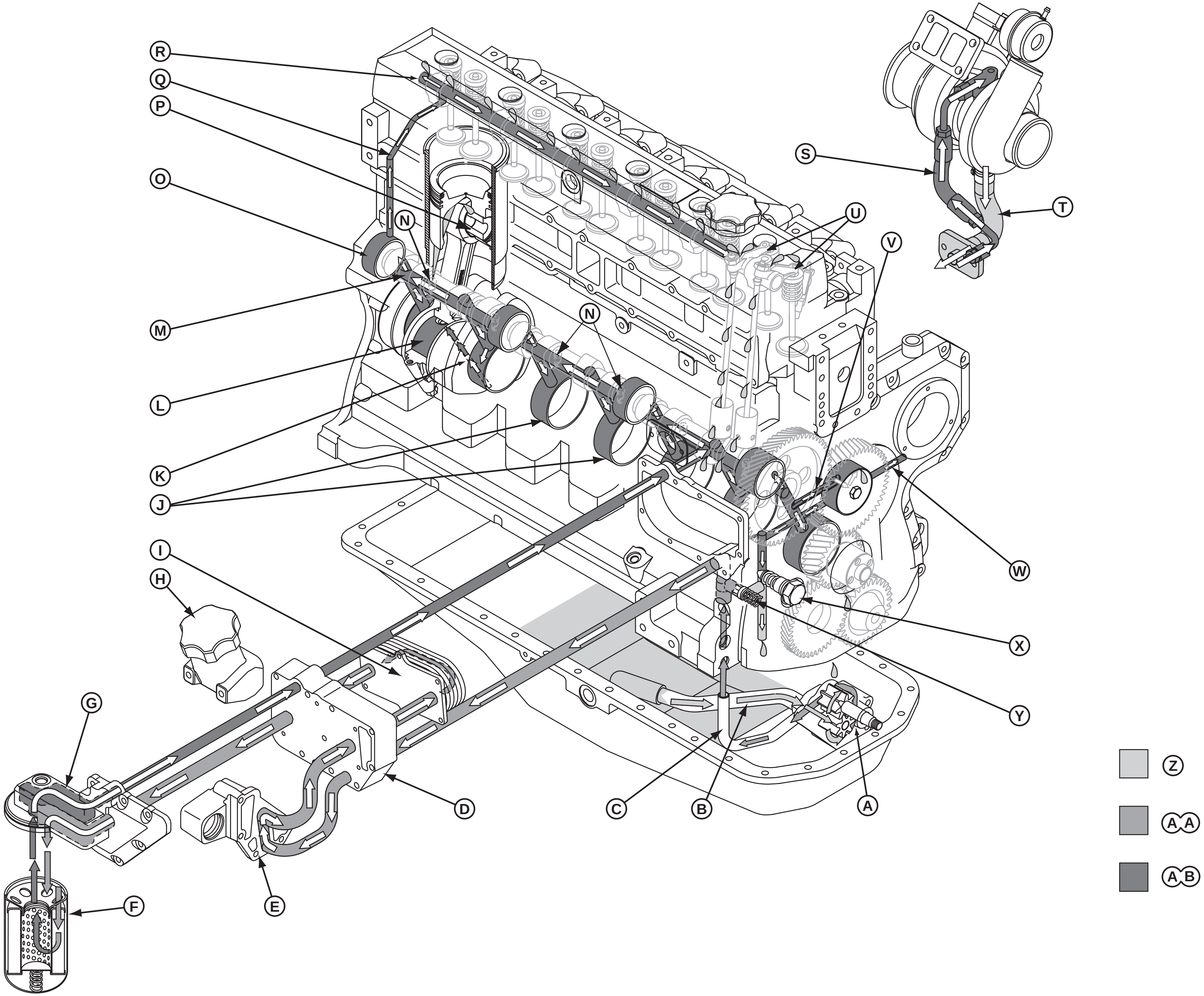
Each of the above components contributes to the integrity of the head gasket joint. If any of these components do not conform to specifications, gasket joint may fail resulting in combustion leaks, coolant leaks, or oil leaks.

Failure of head gasket and mating parts may occur when coolant and oil temperatures become excessive, or when abnormally high combustion temperatures and pressures persist.

RG,RG34710,3024 –19–15JUL96–2/2

Lubrication System Operation on a 6068 CNG Engine

RG9255 –UN–14JUN99



A—Oil Pump
B—Oil Suction Line
C—Oil Outlet Tube
D—Oil Cooler Housing
E—Coolant Passage Adapter
F—Oil Filter
G—Oil Filter Header/Adapter
H—Oil Fill Tube
I—Oil Cooler
J—Main Bearing Bushings
K—Crankshaft Drilled Cross Passages
L—Connecting Rod Bearings
M—Main Oil Gallery
N—Drilled Oil Passage
O—Camshaft Bushings
P—Piston Cooling Orifice
Q—Oil Passage-to-Cylinder Head
R—Rocker Arm Shaft
S—Turbocharger Oil Supply Line
T—Turbocharger Drain Line
U—Rocker Arms
V—Machined Groove
W—Cross-Drillings
X—Oil Pressure Regulating Valve
Y—Oil ByPass Valve
Z—Unfiltered, Pressure-Free Oil
AA—Unfiltered, Pressurized Oil
AB—Filtered, Pressurized Oil

RG,RG34710,3025 –19–15JUL96–2/2

Lubrication System Operation on a 6068 CNG Engine—Continued

The engine lubrication system consists of a crank-driven oil pump (A), oil cooler (I), oil filter (F), oil bypass valve (Y), and oil pressure regulating valve (X).

Oil is drawn up from the sump through the oil pump and on to the oil cooler. If a high restriction is sensed, the oil cooler and oil filter will be bypassed when the oil bypass valve closes off the passage to those areas. Oil proceeds through the oil cooler where it exchanges heat with the engine coolant. Oil then moves through the oil filter. After passing through the filter, a certain amount of oil is routed into the turbocharger oil supply line (S) to give oil to the turbocharger. The rest of the oil is sent back to the engine block.

The oil then moves to the oil pressure regulator, which regulates the oil pressure of the main oil gallery (M) and permits excess to be returned to the sump. After flowing past the regulating valve, cooled, clean pressurized oil is supplied to the main oil gallery then distributed to the crankshaft main bearings (J) and piston cooling orifices (P) through drilled passages in the cylinder block.

The main bearings work to send oil to the camshaft bushings (O) while passages in the crankshaft allow pressurized oil to also lubricate the connecting rod bearings (L). The piston cooling orifices direct oil onto the piston crown and piston/wrist pin assembly.

Oil from the camshaft bushing travels through drilled passages in the camshaft nose to lubricate the camshaft thrust washer and front drive train.

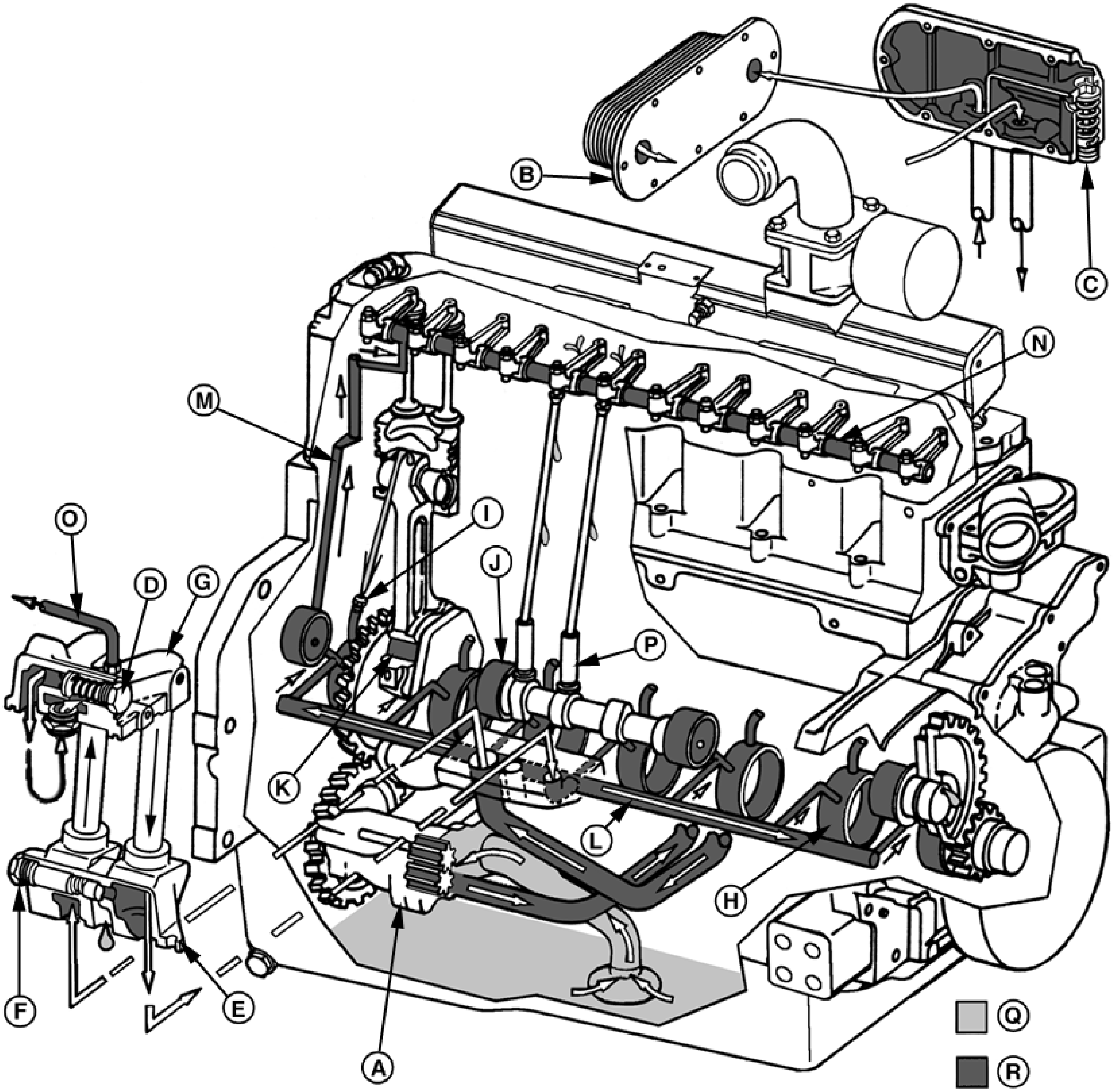
Oil from the rear camshaft bushing feeds through drilled passages (Q) in the cylinder block and cylinder head into passages in the rocker arm shaft (R), which in turn provide oil to the other valve train components as well as the camshaft followers.

Some oil is routed from the top of the oil filter base through an external line (S) to the turbocharger and is returned to the cylinder block crankcase through another external line (T).

The air compressor is pressure lubed by way of an external line which taps into the main oil gallery.

DPSG,RG34710,90 –19–22JUL99–1/1

Lubrication System Operation on a 6081 CNG Engine



A—Oil Pump
B—Oil Cooler
C—Oil Cooler Bypass Valve
D—Oil Filter Bypass Valve
E—Oil Pressure Regulating Valve Housing
F—Oil Pressure Regulating Valve
G—Oil Filter Base
H—Crankshaft Main Bearing
I—Piston Cooling Orifices
J—Camshaft Bushings
K—Connecting Rod Bearings
L—Main Oil Gallery
M—Drill Oil Passage
N—Rocker Arm Shaft
O—Turbocharger Lube Line
P—Camshaft Followers
Q—Return Oil
R—Pressurized Oil

RG,RG34710,3025 –19–15JUL96–1/1

Lubrication System Operation on a 6081 CNG Engine—Continued

The engine lubrication system consists of a crank-driven oil pump (A), oil cooler (B), oil filter, oil cooler bypass valve (C), oil filter bypass valve (D) and oil pressure regulating valve (F).

Oil is drawn up from the sump through the oil pump and on to the oil cooler by way of the oil cooler cover which houses the oil cooler bypass valve. Oil proceeds through the oil cooler where it exchanges heat with the engine coolant, unless high restriction is sensed in which case the oil cooler is bypassed. Oil goes to the oil filter base (G) which houses the oil filter bypass valve. Oil passes through the oil filter, unless high restriction is sensed in which case the oil filter is bypassed.

The oil then moves to the oil pressure regulating valve housing (E) where the regulating valve regulates the main oil gallery (L) pressure and permits excess to be returned to the sump. After flowing past the regulating valve, cooled, clean pressurized oil is supplied to the main oil gallery then distributed to the crankshaft main bearings (H) and piston cooling orifices (I) through drilled passages in the cylinder block.

The main bearings work to send oil to the camshaft bushings (J) while passages in the crankshaft allow pressurized oil to also lubricate the connecting rod bearings (K). The piston cooling orifices direct oil onto the piston crown and piston/wrist pin assembly.

Oil from the camshaft bushing travels through drilled passages in the camshaft nose to lubricate the camshaft thrust washer and front drive train.

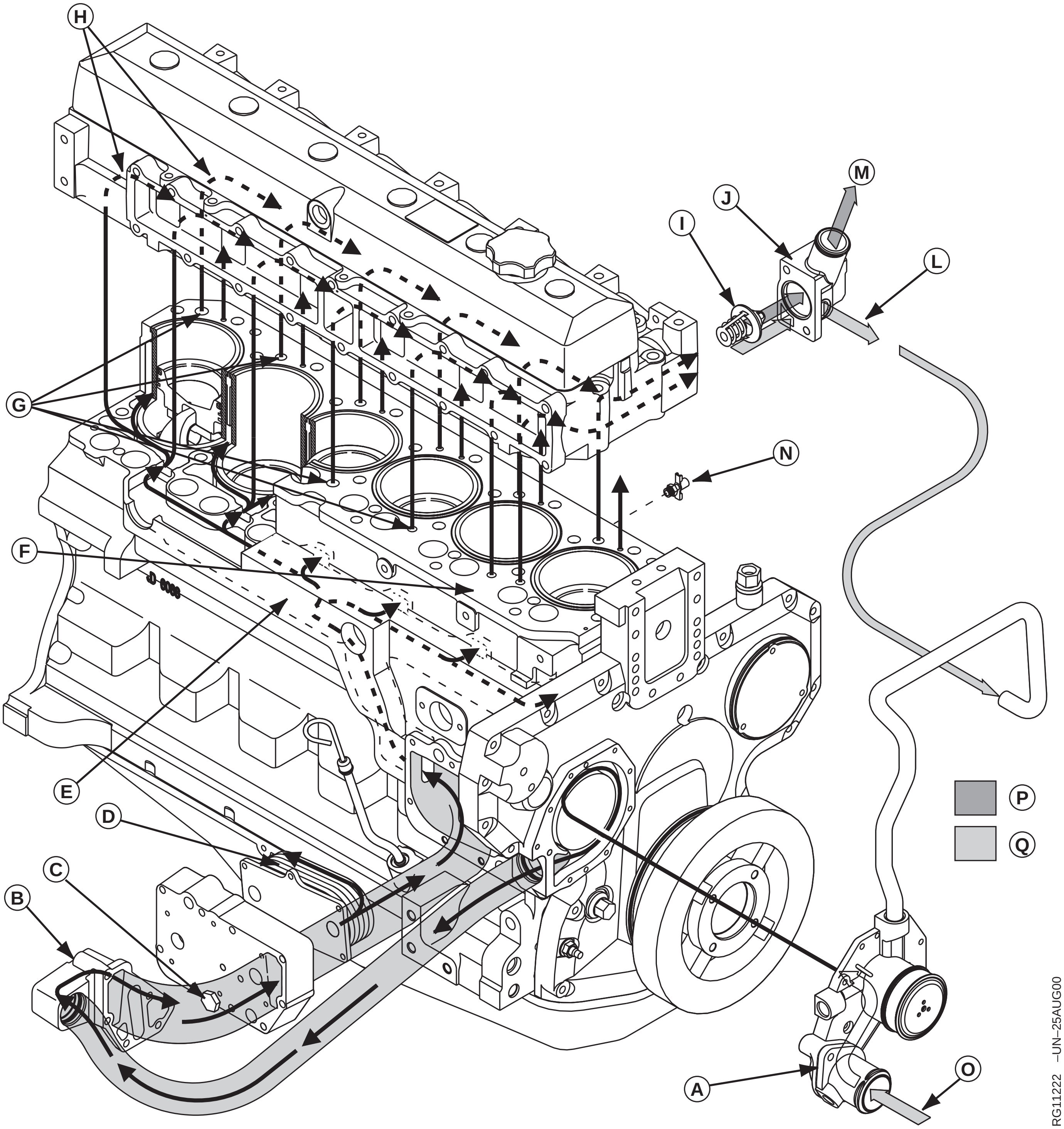
Oil from the rear camshaft bushing feeds through drilled passages (M) in the cylinder block and cylinder head into passages in the rocker arm shaft (N), which in turn provide oil to the other valve train components as well as the camshaft followers (P).

Some oil is routed from the top of the oil filter base through an external line (O) to the turbocharger and is returned to the cylinder block crankcase through another external line.

The air compressor is pressure lubed by way of an external line which taps into the main oil gallery.

DPSG,RG34710,91 –19–22JUL99–1/1

Cooling System Operation on a 6068 CNG Engine



A—Water Pump
B—Coolant Passage Adapter
C—Oil Cooler Drain Plug
D—Oil Cooler Plates
E—Main Coolant Gallery
F—Coolant Jacket
G—Block Deck Passages
H—Passages
I—Thermostat
J—Water Manifold/Thermostat Housing
L—Bypass Circuit
M—To Radiator Top Tank
N—Drain Valve
O—Suction Side of Water Pump
P—High Temperature Coolant
Q—Low Temperature Coolant

RG,RG34710,3027 –19–15JUL96–1/1

Cooling System Operation on a 6068 CNG Engine—Continued

The cooling system includes the radiator, water pump (A), and thermostat (I).

Coolant is circulated from the water pump into the coolant passage adapter (B) and circulates around the oil cooler plates (D). From the oil cooler, coolant flows into the main coolant gallery (E). From the gallery coolant flows into the coolant jacket (F), around the cylinder liners, up through the block deck passages (G), and into the cylinder head. In the cylinder head the coolant flows through passages (H) around the intake and exhaust ports, valve seats, and the injection nozzles. Coolant flows toward the front end of the cylinder head and exits through the water manifold/thermostat housing (J).

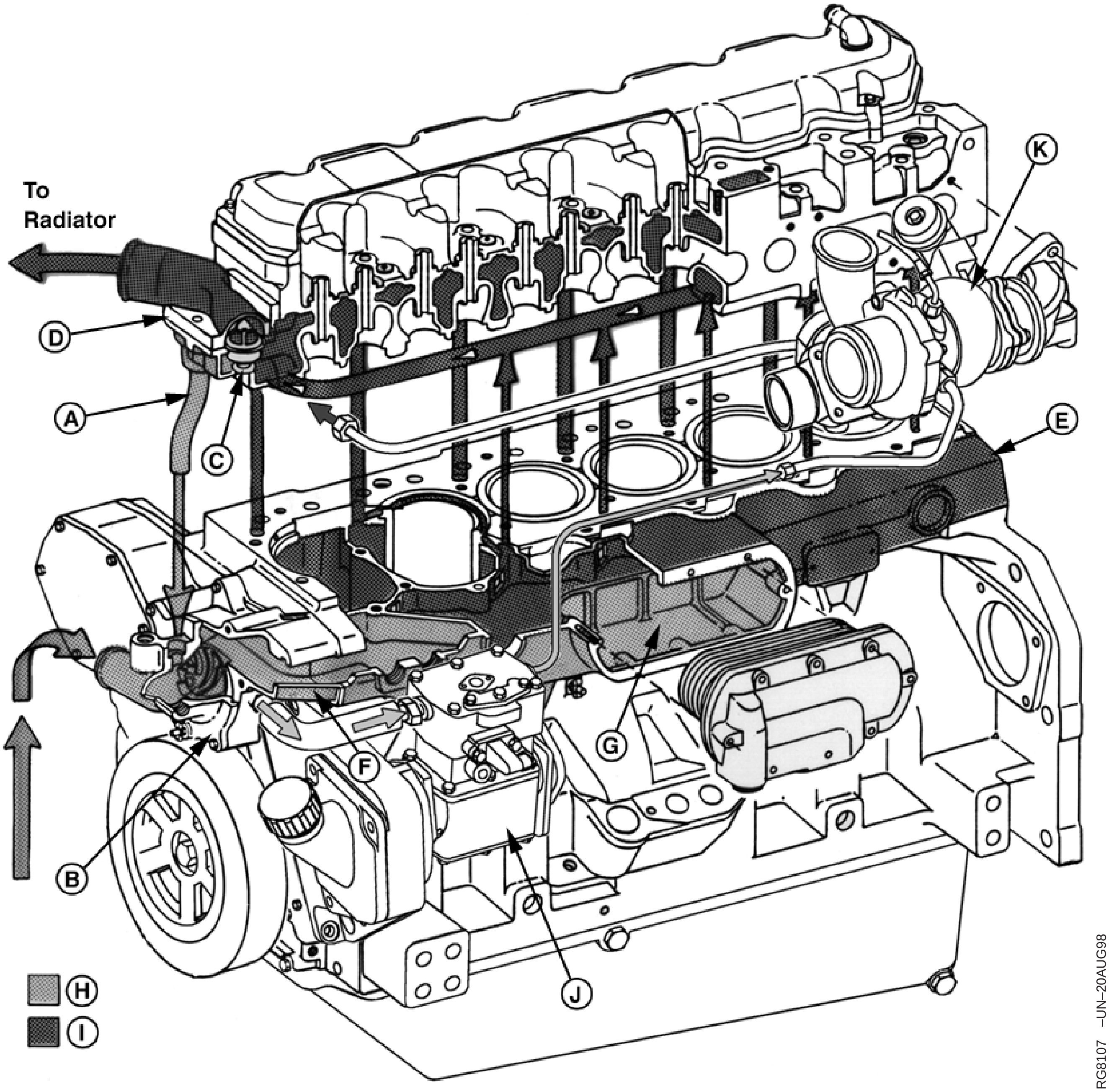
Coolant also travels to the turbocharger, air compressor, and fuel pressure regulator.

During the warm-up period, the thermostat (I) is closed and coolant is directed through a bypass circuit (L) into suction side of water pump. The coolant continues circulating through the cylinder block, cylinder head, and water pump to provide a uniform and fast warm-up period.

Once the engine has reached operating temperature, the thermostat opens and allows coolant to flow through the upper radiator hose to the radiator top tank (M). Coolant circulates through the radiator, dissipates heat, and then flows out of the radiator through the lower hose and into the suction side (O) of the water pump. Coolant continues flowing through the engine and radiator circuit until the coolant temperature drops below the thermostat opening temperature.

DPSG,RG34710,93 –19–22JUL99–1/1

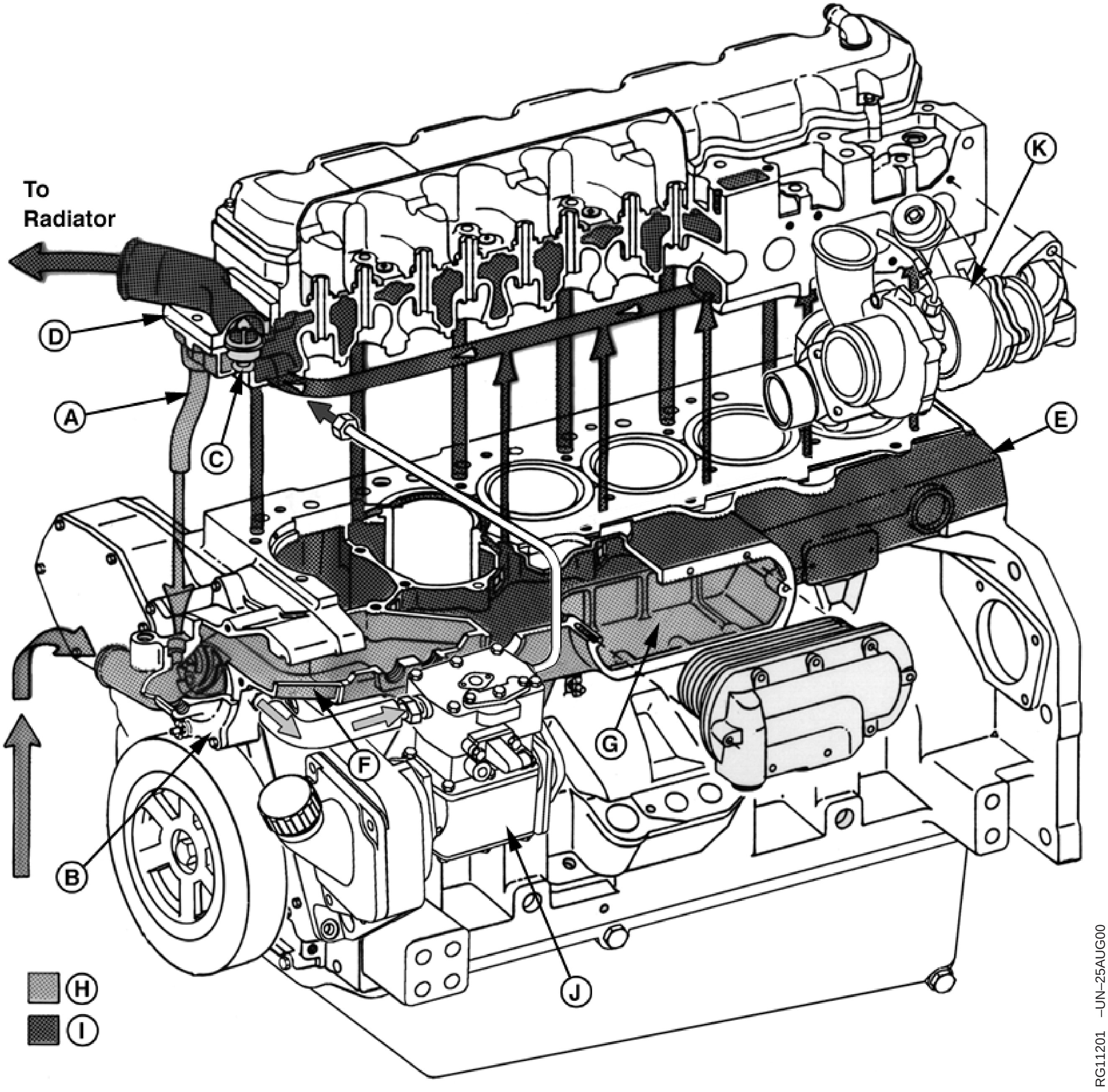
Cooling System Operation on a 6081 HFN01/HFN03 CNG Engines **With Water Cooled Turbo**



A—Coolant Bypass Tube
B—Water Pump
C—Thermostats (2 used)
D—Thermostat Housing
E—Coolant Manifold
F—Inlet Manifold
G—Engine Oil Cooler
H—Low Temperature
I—High Temperature Engine Coolant
J—Air Compressor
K—Turbocharger

RG,RG34710,3027 –19–15JUL96–1/1

Cooling System Operation on a 6081 HFN02 CNG Engines



A—Coolant Bypass Tube
B—Water Pump
C—Thermostats (2 used)
D—Thermostat Housing
E—Coolant Manifold
F—Inlet Manifold
G—Engine Oil Cooler
H—Low Temperature
I—High Temperature Engine Coolant
J—Air Compressor
K—Turbocharger

RG,RG34710,3027 –19–15JUL96–1/1

Cooling System Operation on a 6081 CNG Engines—Continued

The cooling system consists of a conventional radiator, cooling fan, water pump (B), thermostats (C), thermostat housing (D), and cylinder block with coolant cavities.

The pump draws coolant from the bottom of the radiator and discharges it through the lower inlet manifold (F) on the left-hand side of the engine block. The inlet directs coolant to the engine oil cooler (G) and provides the cooling capability from the coolant flow around it. Coolant passes through the oil cooler cavity and enters the upper coolant manifold. At this time, the coolant flow will move in one of four directions. Each cylinder is unitized and has a separate flow circuit.

The main coolant passage flows through a rectangular port and around the cylinder liner, then exists the block through a vertical passage into the right-hand side of the cylinder head.

The second circuit involves flowing coolant from the upper coolant manifold through a small vertical passage onto the left-hand side of the cylinder head.

The third circuit is called the “directed cooling” system. Coolant flows through a small port and into a groove at the top of the cylinder liner. Coolant passes around a groove in the liner, and exists into the vertical passage of the main circuit, then into the right-hand side of the cylinder head.

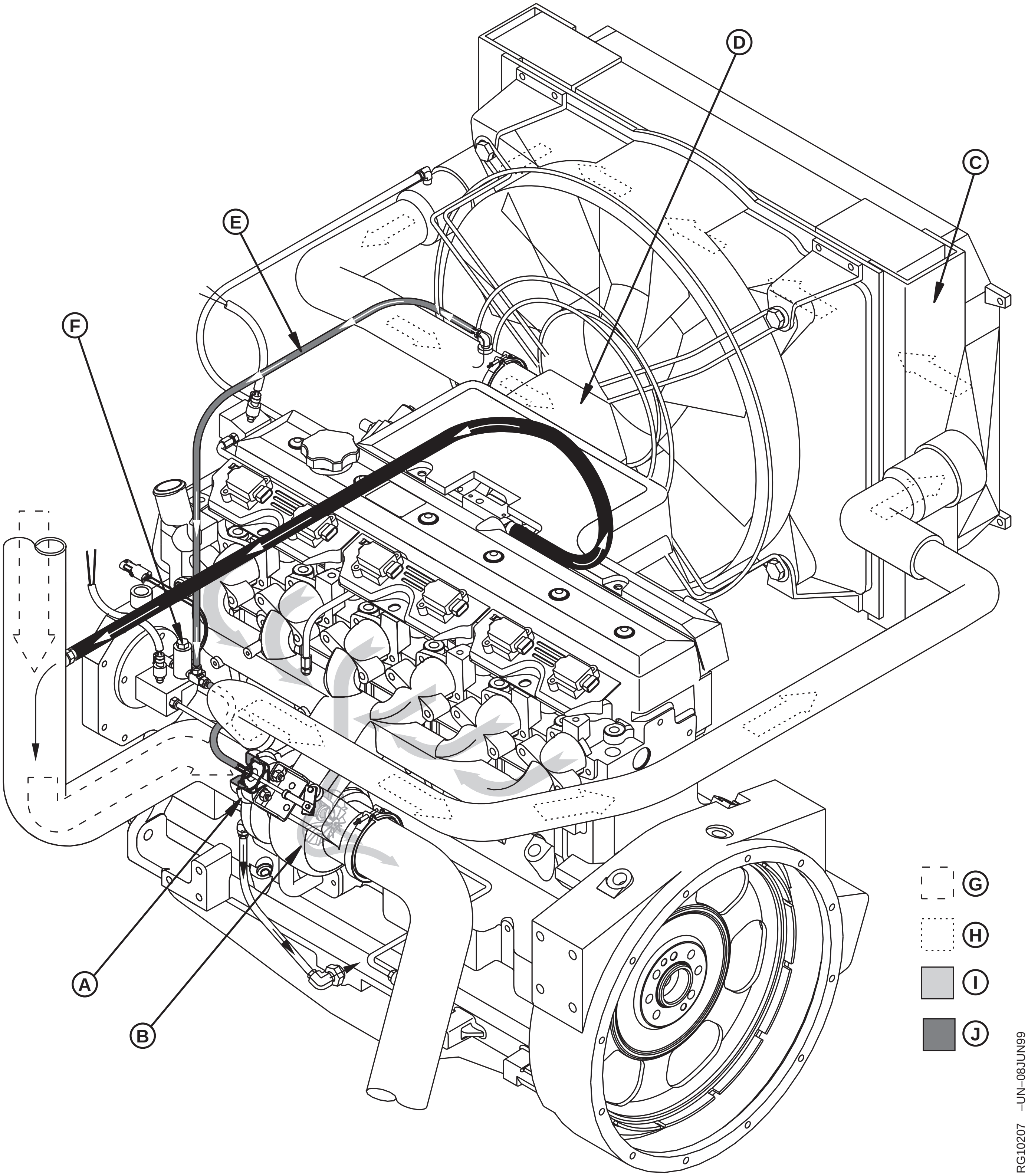
The fourth circuit flows coolant from the water manifold, into the air compressor (J), from the compressor, into the turbo, and from the turbocharger (K) to the thermostat housing. Coolant also runs to the fuel pressure regulator, which in some applications is removed from engine.

Once the coolant is in the cylinder head, all flow is towards the front. Coolant passes onto the thermostat housing, past the two open thermostats (engine at normal operating temperature), and then returns to the radiator.

If the thermostats are closed (as during warm-up periods), coolant is directed back to the pump through the bypass tube (A) to be recirculated. This provides a faster and more uniform warm-up. Some coolant passes through the bypass tube even while the thermostats are open.

DPSG,RG34710,92 –19–22JUL99–1/1

Intake and Exhaust Systems Operation



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A—Wastegate
B—Turbocharger
C—Air-to-Air Aftercooler
D—Air/fuel Mixing Elbow
E—Intake Air routed to operate Wastegate
F—Wastegate Actuator
G—Clean Air
H—Charged Air
I—Exhaust Air
J—Cooled, Charged Air

NOTE: The drawing is for an air system of a 6068 CNG engine. The air system of a 6081 CNG engine is similar.

RG,RG34710,3028 –19–15JUL96–2/2

Intake and Exhaust Systems Operation—Continued

Engine suction draws dust-laden outside air through an air inlet stack into the air cleaner. Air is filtered through dry-type primary and secondary filter elements in the air cleaner canister. Clean air (G) travels through the intake air hose to the turbocharger (B), this charged air (H) goes through the air-to-air aftercooler (C), through the air/fuel mixing elbow (D), and into the intake manifold.

Exhaust (I), as it is expelled out of the exhaust manifold, drives the turbocharger to deliver a larger quantity of air to meet the engine requirements than what could be delivered under naturally aspirated (non-turbocharged) conditions.

The air-to-air aftercooler cools the turbocharger compressor discharge air by routing in through a heat exchanger before it enters the engine. The heat exchanger uses no coolant but relies on air flow to cool the charge air. Excessive crankcase pressure is released through a breather tube, and it runs into the intake air pipe before the turbocharger.

Prior to the mixing elbow, cool, charged air (J) is routed to control the wastegate (A). When the wastegate actuator (F) is not powered, this air is routed to open the wastegate, allowing exhaust air to bypass the turbine wheel in the turbocharger. This limits the turbocharger's shaft speed which controls the boost pressure. When the wastegate actuator is powered, this air is routed out the vent. The valve allows the system to develop peak charge-air pressures for maximum engine boost response while eliminating the chance of excessive manifold pressure (over-boost) at high speeds or loads.

DPSG,RG34710,94 –19–22JUL99–1/1

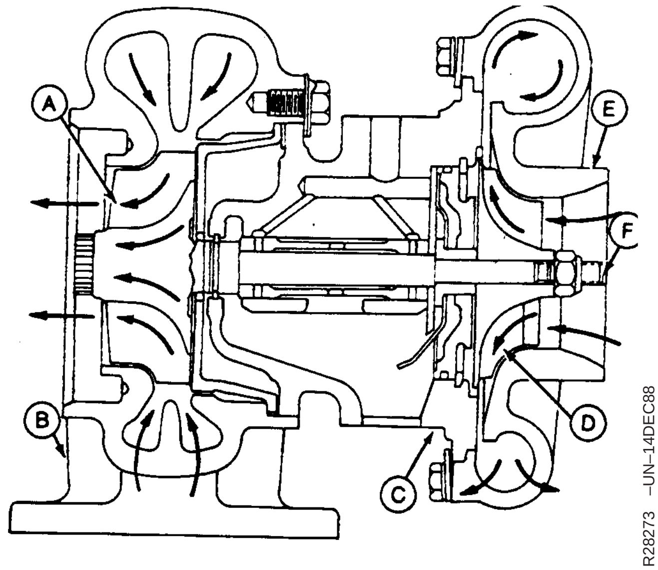
How the Turbocharger Works

The turbocharger, which is basically an air pump that is driven by exhaust gases, allows the engine to produce added power without increasing displacement.

Exhaust gases from the engine pass through the turbine housing (B) causing the turbine wheel (A) to rotate before it is discarded into the atmosphere. The turbine wheels are mounted on the shaft (F) to drive the compressor wheel (D) which is also mounted on the shaft.

As the compressor wheel rotates in the compressor housing (E), an increased volume of (compressed) inlet air is drawn into the housing and delivered to the air-to-air aftercooler.

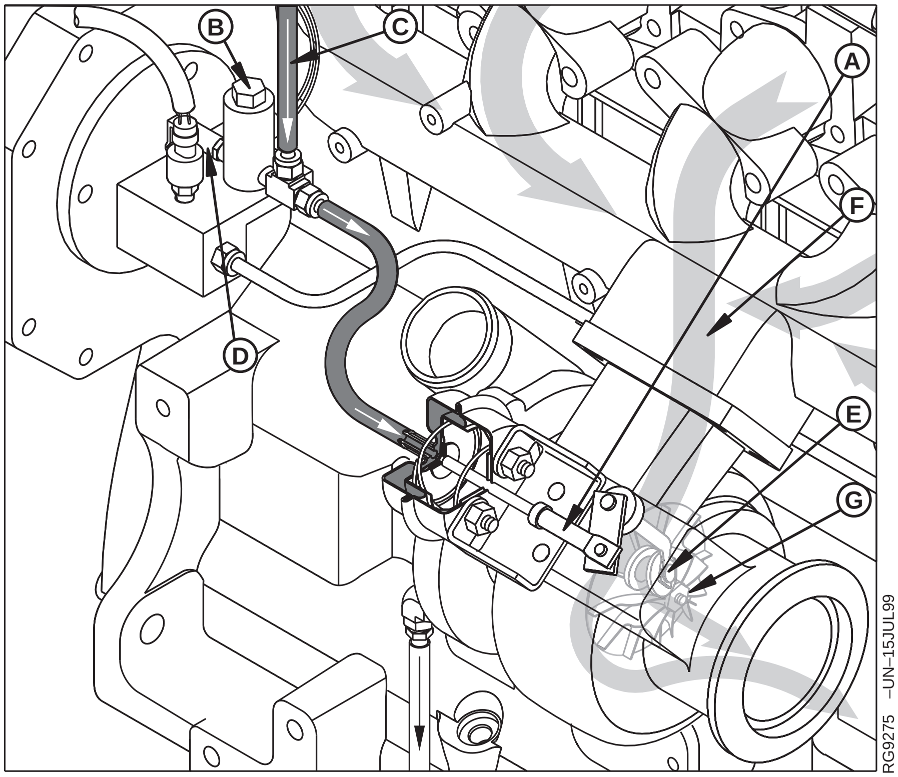
All rotating components of the turbocharger are lubricated within the center housing (C).



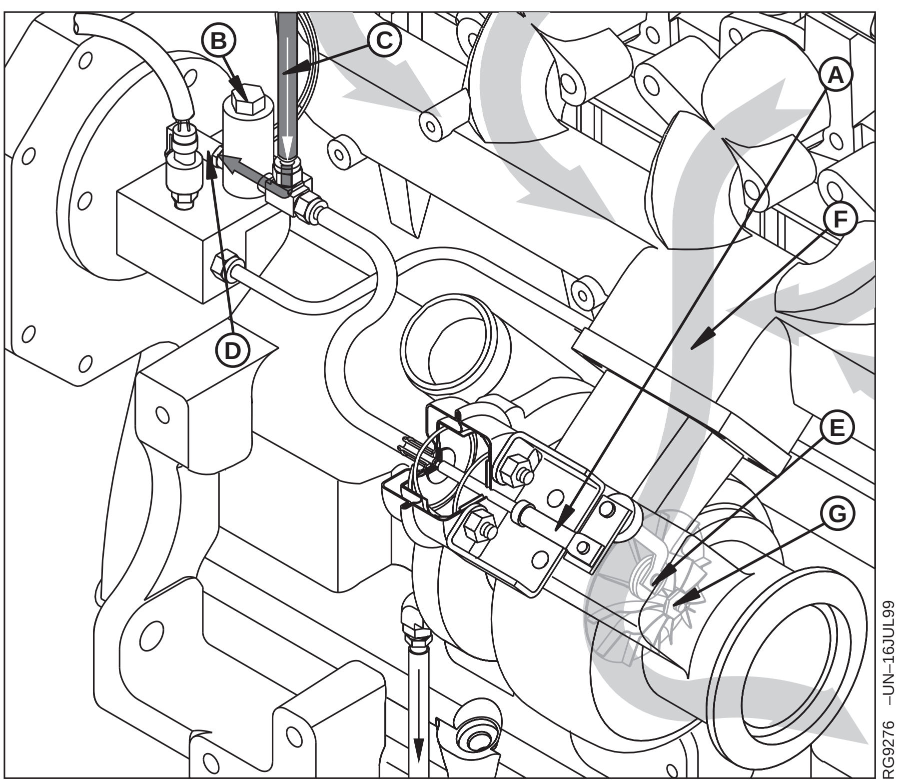
A—Turbine Wheel
B—Turbine Housing
C—Center Housing
D—Compressor Wheel
E—Compressor Housing
F—Shaft

RG,RG34710,3029 –19–15JUL96–1/1

How the Wastegate Works



Wastegate Open on a 6068 CNG



Wastegate Closed on 6068 CNG

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DPSG,RG40854,266 –19–13JUL99–1/2

A—Wastegate Actuator
B—Wastegate Control Solenoid
C—Pre-throttle Air Pressure
D—Vent
E—Turbocharger Turbine Wheel
F—Exhaust Air
G—Wastegate Valve

NOTE: The drawing is for a wastegate of a 6068 CNG engine. The 6081 CNG engine has a different location for the wastegate, but there is no difference in its function and components involved.

The opening and closing of the wastegate actuator (A) is indirectly controlled by the wastegate control solenoid (B). The wastegate control solenoid is controlled by the ECU. The ECU reads MAP, engine speed, and foot pedal position with respect to one another. If the MAP is too high with respect to the commanded value sent by the foot pedal for a certain engine speed, the ECU will then cut electrical power to the wastegate control solenoid which will reduce boost.

When the wastegate solenoid is energized, pre-throttle intake air pressure (C) is allowed to exit out of the vent (D). Because the pressure is released through the vent, the wastegate actuator keeps the wastegate valve (G) closed and maximum boost can be developed.

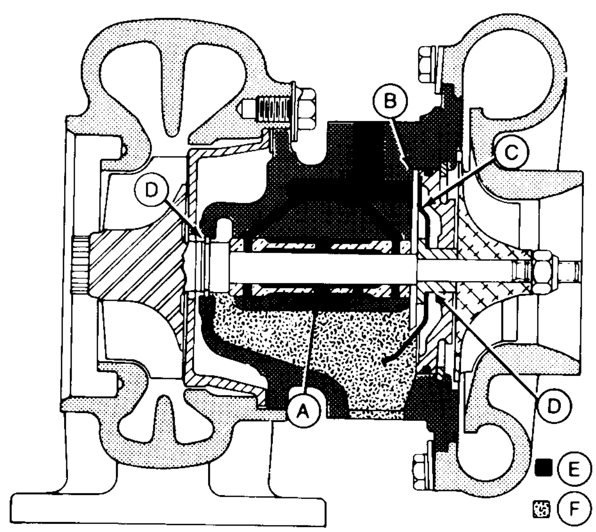
When the wastegate solenoid is not powered, pre-throttle intake air pressure is not allowed to exit out of the vent. Because of this, all of the pressure exerts force onto the wastegate actuator. This actuator moves the wastegate control valve which allows some exhaust air (F) to bypass the turbine wheel (E) of the turbocharger. This reduces boost by reducing turbine speed.

DPSG,RG40854,266 –19–13JUL99–2/2

How the Turbocharger is Lubricated

Engine oil under pressure from the lubrication system is pumped through a passage in the bearing housing and is directed to the bearing (A), thrust plate (B), and thrust sleeve (C). Oil is sealed from the compressor and turbine by a piston ring (D) at both ends of bearing housing.

The turbocharger contains a single floating bearing. This bearing has a clearance between the bearing OD and the housing wall as well as clearance between the bearing ID and the shaft OD. These clearances are lubricated by the oil supply and the bearings are protected by a cushion of oil. Discharge oil drains by gravity from the bearing housing to the engine crankcase.



RG4646 –UN–29AUG94

A—Bearing
B—Thrust Plate
C—Thrust Sleeve
D—Piston Ring
E—Pressure Oil
F—Discharge Oil

RG,RG34710,3030 –19–15JUL96–1/1

Theory of Lean-Burn Engines

A stoichiometric combustion engine burns an air/fuel mixture which contains just enough air to theoretically burn all of the fuel. A lean-burn combustion engine burns an air/fuel mixture which contains more air than is theoretically needed to completely burn the fuel.

The excess air in lean-burn combustion results in a more complete combustion than what is achievable in a stoichiometric engine. This complete combustion yields lower emissions of hydrocarbon (HC) and carbon monoxide (CO) and decreases fuel consumption. In addition, lean air/fuel mixtures burn at a lower temperature resulting in less formation of oxides of nitrogen (NOx) emissions.

The lower temperature combustion of a lean-burn engine results in less thermal energy loss through the cylinder walls, yielding a greater thermal efficiency. A lower combustion temperature also reduces the thermal stress on components exposed to combustion such as the exhaust valves.

The amount of energy in a lean mixture is less than the amount of energy in the same volume of a stoichiometric mixture. However, both the 6068 CNG and 6081 CNG have a turbocharger and aftercooler that increases the density of the air/fuel mixture and allows the engine to develop a high power output.

Lean air/fuel mixtures don’t ignite as readily as stoichiometric mixtures; therefore, a lean-burn engine ignition system must be powerful, and the air and fuel must be mixed thoroughly. Both the 6068 CNG and 6081 CNG thoroughly mix the air and fuel in a mixing elbow, upstream of the throttle. Ignition is accomplished using a high power inductive ignition system with one coil per cylinder to provide a high energy, long duration spark.

Accurate control of the air/fuel ratio in a lean-burn engine is extremely important. If the mixture is too rich, the advantages of lean-burn will be lost. If the mixture is too lean, the mixture will not ignite and a misfire will result. Both the 6068 CNG and 6081 CNG accurately control the air/fuel ratio using a closed loop, adaptive learn, electronic fuel injection system to deliver a precise amount of natural gas to the engine.

RG,RG34710,3031 –19–15JUL96–1/1

High Pressure Fuel Supply System Storage and Routing

The Compressed Natural Gas (CNG) fuel for the 6068 HFN and 6081 HFN engines is stored in high strength aluminum, fiberglass reinforced tanks (A). CNG is stored in the tanks up to 3600 psi.

Each tank includes a manual shut-off valve containing a pressure relief valve (B) designed to vent at either high pressure or high temperature. Each tanks' relief valve is plumbed into a common vent pipe (C) that routes out of the vehicle.

CNG flows out of the individual tanks, and into a high pressure rated, stainless steel common fuel line (D). The fuel lines are joined by high pressure rated stainless steel compression fittings. Any tank with its shut off valve open feeds fuel into the common fuel line. With its shut off valve closed, the tank doesn't feed the common line, but the valve's tee is exposed to common line high pressure.

The common fuel line flows into a high pressure lock-off (E) and a coalescing filter (F). From there, fuel flows to the fuel pressure regulator. The pressure regulator drops fuel pressure to approximately 130 psia (115 psig). From the regulator, fuel flows to the fuel metering block containing a low pressure lock-off solenoid activated by the ignition switch, the engine Electronic Control Unit (ECU), and the fire suppression system.

During refilling, fuel is routed through a filter then back flows into the common fuel line and into any tank with an open shut off valve. A pressure gauge (G) plumbed into the filler assembly measures common fuel line pressure.

A 1/4-turn shut-off valve (H) near the filler assembly shuts off fuel flow to the common fuel line.

The fuel gauge on the dash of the vehicle is operated by the engine ECU. The ECU measures fuel pressure on the fuel pressure regulator with the Natural Gas Tank Pressure (NGTP) sensor and fuel temperature with the Natural Gas Tank Temperature (NGTT) sensor on the common fuel line, then calculates CNG fuel volume and operates the fuel gauge accordingly. The ECU won't sense any CNG in a tank with a closed shut off valve.

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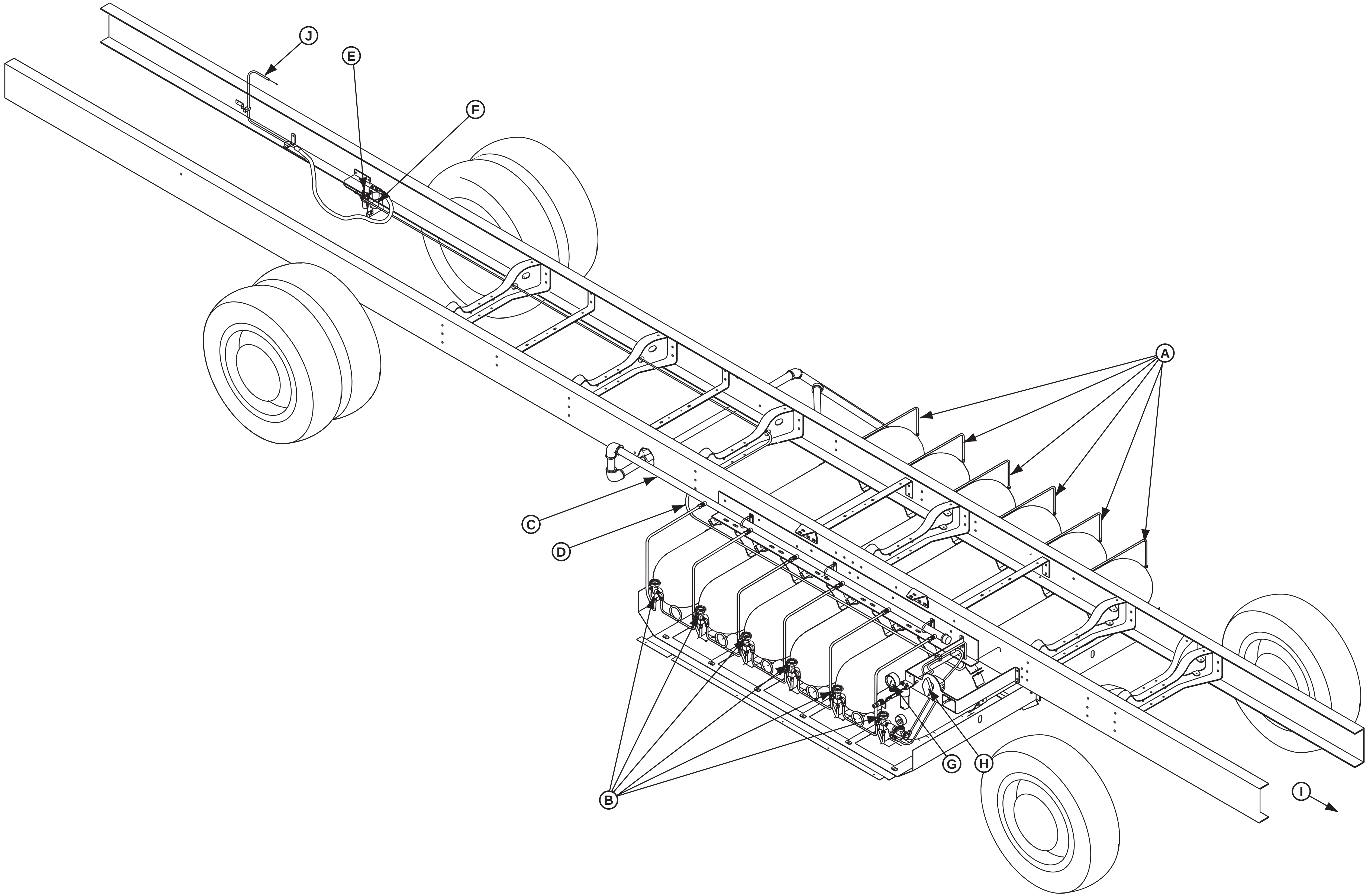
RG8108 –UN–01JUL99



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RG,RG34710,3032 –19–15JUL96–2/5

A—Compressed Natural Gas Tanks
B—Pressure Relief Valve
C—Common Vent Pipe
D—Common Fuel Line
E—High Pressure Lock-off
F—Coalescing Filter
G—Pressure Gauge
H—1/4-Turn Shut-off Valve

NOTE: Some buses with 6068 CNG and 6081 CNG engines may have the fuel regulator located away from the engine. Not all applications will have the same configuration for fuel tanks.

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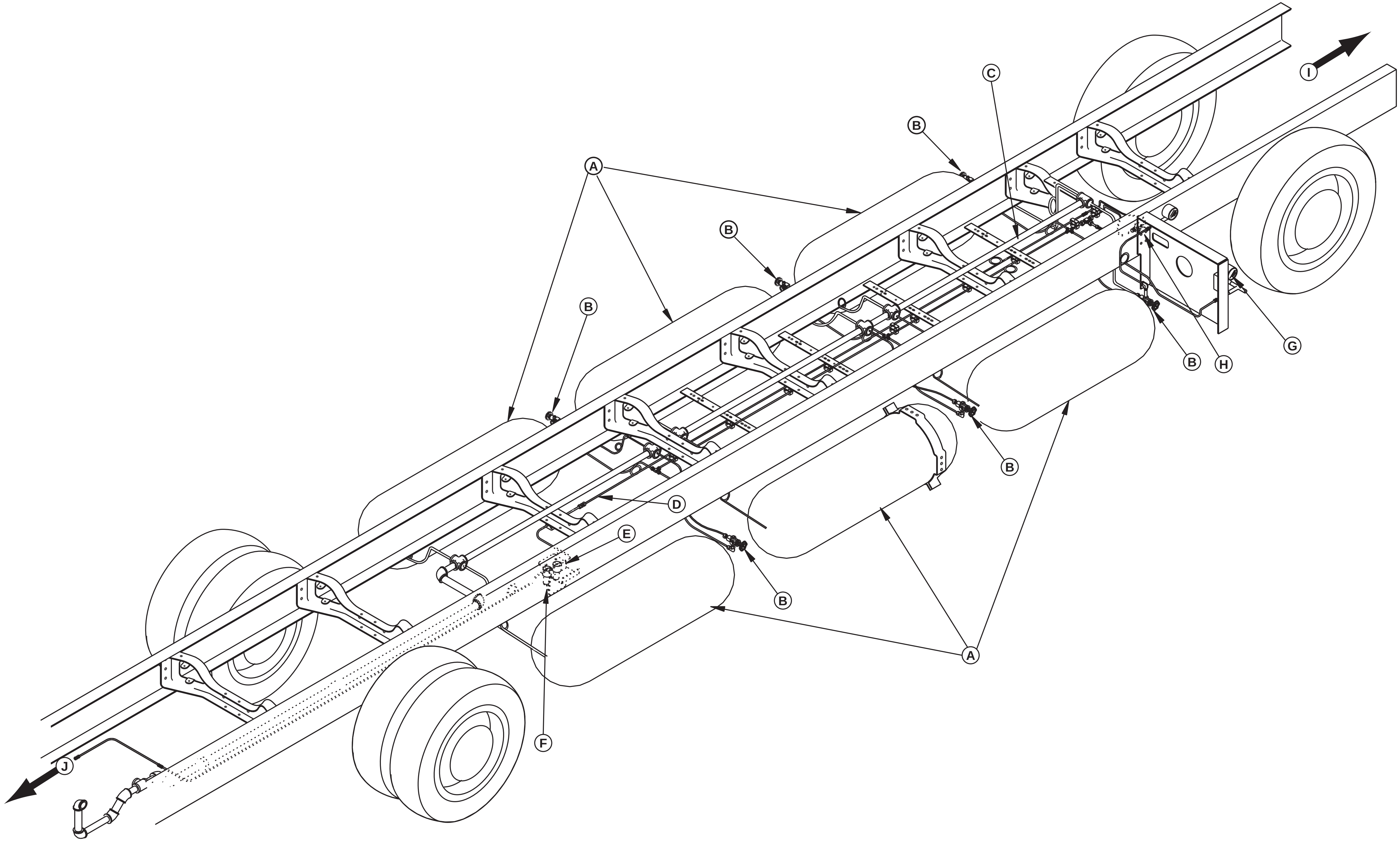
RG8109 –UN–08JUN99



A—Compressed Natural Gas Tanks
B—Pressure Relief Valve
C—Common Vent Pipe
D—Common Fuel Line
E—High Pressure Lock-off
F—Coalescing Filter
G—Pressure Gauge
H—1/4-Turn Shut-off Valve

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RG,RG34710,3032 –19–15JUL96–4/5

NOTE: Some buses with 6068 CNG and 6081 CNG engines may have the fuel regulator located away from the engine. Not all applications will have the same configuration for fuel tanks.

RG,RG34710,3032 –19–15JUL96–5/5

Electronic Engine Controls Theory of Operation

DEFINITION OF TERMS

5VESA	Five volt external supply from the ECU to the sensors. Channel A is pins A2 and A3 on the ECU.
5VESB	Five volt external supply from the ECU to the sensors. Channel B is pin J2 on the ECU.
ACT	Air Charge Temperature. The temperature of the air flowing into the intake manifold.
Actuator	A device controlled by the ECU to perform a certain function.
Adaptive Learn	Adaptive learn is a function of the control system that helps to optimize engine operation by acting as a fuel correction memory. When the ECU commands a fuel quantity that is successful in achieving the desired air/fuel ratio, (measured with the UEGO sensor) the adaptive learn function “remembers” that fuel quantity and uses it in the future.
AL_Mult	Adaptive learn multiplier. The adaptive learn multiplier is a correction to the fuel delivery which is expressed as a percentage (%) and stored in the ECU’s memory.
Analog	Signal which has a continuous range of possible voltages. Usually 0 to 5 or 0 to 12 volt signals.
Batt	Battery voltage.
Boost	Pressure in the intake tract just before the throttle body.
BP	Barometric pressure. The pressure of the outside air.
CAM	Camshaft Position Sensor
Closed Loop	The control system has two operating modes: open loop and closed loop. During closed loop mode, the ECU uses the UEGO sensor to determine the air/fuel ratio, then adjusts the amount of fuel delivered to the engine until the desired air/fuel ratio is achieved.
CL_Mult	Closed loop multiplier. The closed loop multiplier is a fast acting adjustment to the fuel delivery based on feedback from the UEGO. The closed loop multiplier is expressed as a percentage (%) and is not stored in the ECU’s memory.
CEL	"Check Engine" Light.
Clocks	An internal timing function of the ECU.
CNG	Compressed Natural Gas.
COP	An internal self-check of the ECU.
DTC	Diagnostic Trouble Code. A code which is stored in the ECU’s memory when the ECU detects a problem in the electronic engine control system.
DST	Diagnostic Scan Tool. The tool used to read and clear DTCs, read sensor and actuator data, and perform special tests.
Digital	A signal which consists of only two-volt levels — usually 0 volts and +5 volts.
EBP	Exhaust Back Pressure (sensor). Measures the pressure in the exhaust system downstream of the turbocharger.
ECT	Engine Coolant Temperature (sensor). Measures the temperature of the engine coolant.
ECU	Electronic Control Unit. The computer which controls the fuel, air, and ignition systems on the engine.

Continued on next page

RG,RG34710,3033 –19–15JUL96–1/3

DEFINITION OF TERMS

EEPROM	Electrically Erasable Programable Read Only Memory. The EEPROM is the memory where vehicle specific information such as RSG (Road Speed Governor), fuel gauge calibration, and ECU update information is stored.
Execution	An internal function of the ECU.
Flash	Flash Memory. An internal re-programmable memory module which contains the calibration information for the engine control system.
FPP1	Foot Pedal Position 1 (Sensor 1). Measures the position of the operator’s foot pedal.
FPP2	Foot Pedal Position 2 (Sensor 2). Measures the position of the operator’s foot pedal.
HFN01	Early 6081, some of the current 6081, and current 6068 engines.
HFN02	Current 6081 with 280 Hp engine.
HFN03	Some of the current 6081 engine.
IVS	Idle Validation Switch. Switch to validate that no force is applied to the foot pedal.
ICU	Ignition Control Unit.
IMON	Ignition Monitor. A monitor in the ICU that sends a signal to the ECU to determine if the primary coil is operating normally.
Inj	Fuel Injector
Interrupt	An internal function of the ECU.
Index	The signal sent by the ECU to the ICU that identifies cylinder number 1.
J1708	An SAE digital communication standard for electronic components of heavy-duty vehicles.
J1708 Rx	J1708 Receive Circuit
J1708 Tx	J1708 Transmit Circuit
MAP	Manifold Absolute Pressure (sensor). Measures the pressure of the air in the intake manifold.
MAT	Manifold Air Temperature (sensor). Measures the temperature of the air in the intake manifold.
NGP	Natural Gas Pressure (sensor). Measures the pressure of the natural gas in the metering block.
NGT	Natural Gas Temperature (sensor). Measures the temperature of the natural gas in the metering block.
NGTP	Natural Gas Tank Pressure (sensor). Measures the pressure of the natural gas in the fuel storage tanks. The NGTP sensor is located on the fuel pressure regulator.
NGTT	Natural Gas Tank Temperature (sensor). Measures the temperature of the natural gas in the fuel storage tanks.
Open Loop	The control system has two operating modes: open loop and closed loop. Before the engine is up to operating temperature and during several other special conditions, the control system operates in open loop mode. During open loop mode, the ECU commands fuel delivery based on engine data and information from several sensors.
PROM	Programmable, Read-Only Memory. The computer chip which contains the calibration information for the engine control system.

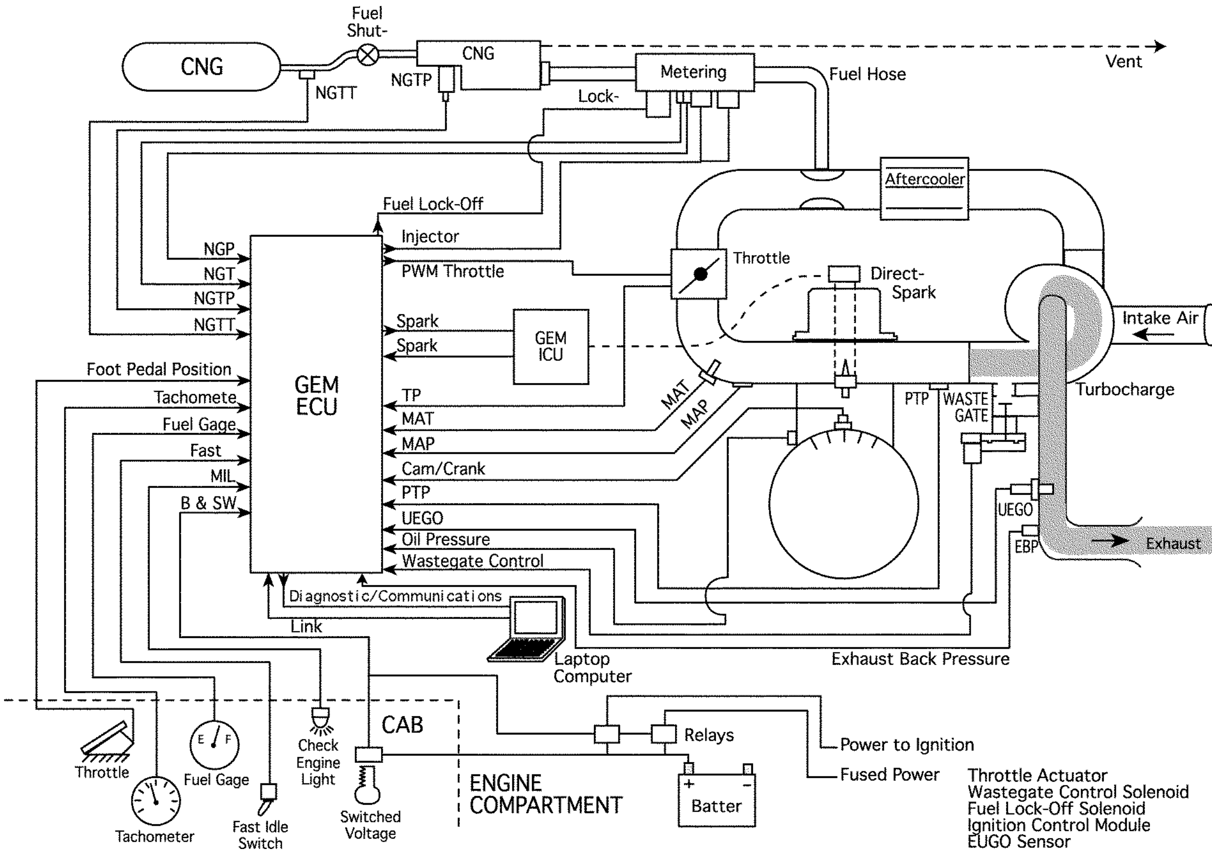
Continued on next page RG,RG34710,3033 –19–15JUL96–2/3

DEFINITION OF TERMS

PTP	Pre-Turbine Pressure (sensor). Measures the pressure in the exhaust manifold between the engine and the turbocharger turbine.
PWM	Pulse Width Modulation. A digital signal (not analog) which consists of a pulse generated at a fixed frequency. When an actuator is controlled by a PWM signal, the on time of the signal is increased or decreased (modulated) to increase or decrease the output of the actuator.
RAM	Random Access Memory. The portion of computer memory within the ECU which changes as the engine is running and is stored while the engine is off.
Raw	Type of variable that has not been scaled by the ECU.
RSG	Road Speed Governor. A governor function that limits the maximum vehicle speed.
Sensor	Devices used by the ECU to monitor various engine parameters.
Stack	An internal function of the ECU.
Thr Inhibit	Throttle inhibit. A safety switch, that when activated, will not allow the engine to rise above idle regardless of the FPP.
TPS	Throttle Position Sensor. Located inside the Woodward FloTech throttle. The throttle position sensor measures the opening of the throttle.
Trigger	The signal which is sent by the camshaft position sensor that indicates when each cylinder is at top-dead-center at the end of the compression stroke.
UEGO	Universal Exhaust Gas Oxygen (sensor). The UEGO sensor determines the air-fuel ratio of the engine by measuring the oxygen content of the exhaust gas.
UEGOH	UEGO Heater. A component of the UEGO sensor.
UEGOP	UEGO Pump cell. A component of the UEGO sensor.
UEGOR	UEGO Calibration Resistor. A component of the UEGO sensor.
UEGOS	UEGO Sense cell. A component of the UEGO sensor.
VREF	Internal ECU 5 volt reference and supply.
WG PWM	Wastegate pulse width modulated control signal.

RG,RG34710,3033 –19–15JUL96–3/3

HFN01/HFN03 Electronic Engine Control System Overview

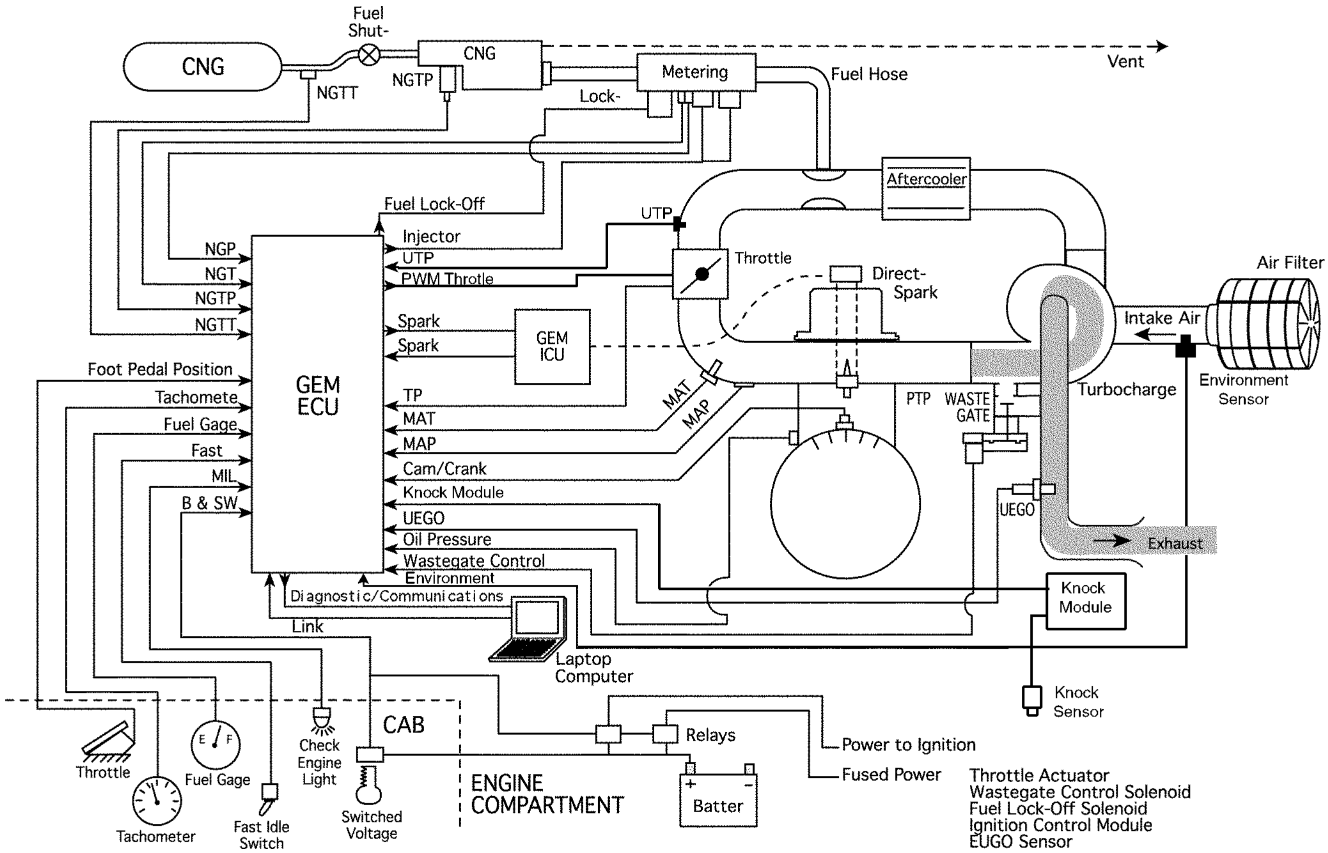


RG9282 –19–20AUG98

The John Deere 6068 CNG and 6081 CNG engines use the JDNG (John Deere Natural Gas) control system to optimize exhaust emissions, driveability, and fuel economy. The system controls engine airflow, engine fuel delivery and ignition spark timing and provides self-diagnosis capabilities. In order to determine the optimum airflow, fuel delivery and spark timing, the system uses sensors to monitor performance characteristics such as manifold air pressure, engine coolant temperature, exhaust back pressure etc. The system ECU makes decisions based on the monitored parameters and controls the pulse width modulated (PWM) Throttle, the electrically pulsed fuel injectors and the ignition control unit.

RG,RG34710,3034 –19–15JUL96–1/1

HFN02 Electronic Engine Control System Overview

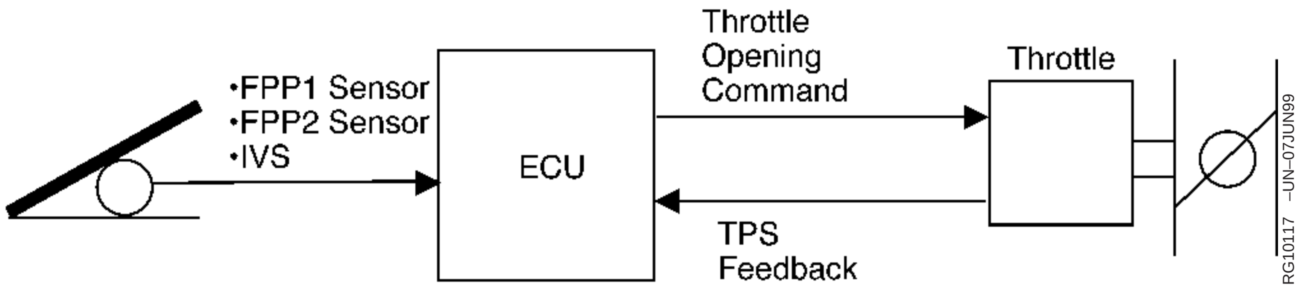


RG11202 –UN–25AUG00

The John Deere 6068 CNG and 6081 CNG engines use the JDNG (John Deere Natural Gas) control system to optimize exhaust emissions, driveability, and fuel economy. The system controls engine airflow, engine fuel delivery and ignition spark timing and provides self-diagnosis capabilities. In order to determine the optimum airflow, fuel delivery and spark timing, the system uses sensors to monitor performance characteristics such as manifold air pressure, engine coolant temperature, upstream throttle pressure, etc. The system ECU makes decisions based on the monitored parameters and controls the pulse width modulated (PWM) Throttle, the electrically pulsed fuel injectors and the ignition control unit.

RG,RG34710,3034 –19–15JUL96–1/1

Throttle Operation



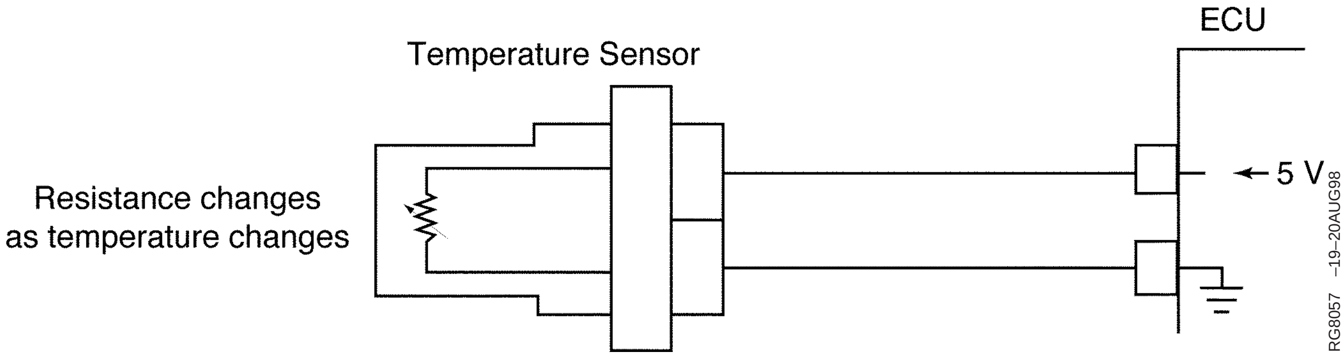
As the foot pedal is depressed, a foot pedal position (FPP) sensor sends a signal to the ECU. The ECU uses this signal to communicate to the throttle for throttle position. The throttle has a throttle position sensor (TPS) that reads the input from the ECU and opens the throttle to the commanded position. TPS send a signal (TPS feedback) back to the ECU verifying that the throttle has opened to the commanded position.

IMPORTANT: If the throttle is determined to be faulty through diagnostics, use the following when ordering throttle.

- Order Digital Throttle
  - Engine uses the early ECU (smaller control box).
  - Harness connector to throttle uses flat 6 pin connector.
  - There is NOT a jumper harness between main wiring harness and throttle.
- Order Analog Thottle and jumper harness.
  - Engine has had ECU replaced with the latest version (larger control box).
  - Jumper harness does NOT currently exist between the main harness and the throttle.
- Order Analog Throttle
  - Engine uses the latest ECU (larger control box).
  - Harness connector to throttle is square 6 pin connector OR
  - There is a jumper harness between the main harness and the throttle.

RG41221,000005D –19–17OCT00–1/1

Temperature Sensors



The temperature sensors used are temperature sensitive variable resistors. The sensor's resistance changes predictably as it's temperature changes. Even small changes in temperature can be determined by monitoring the resistance of the sensor. As sensor temperature increases, the resistance decreases. The ECU sends a 5 volt supply signal to the sensor, monitors the voltage drop across the sensor, then compares the sensor voltage to preprogrammed values to determine the temperature. The system has temperature sensors to measure:

- **Engine Coolant Temperature (ECT)**

ECT is monitored so that the ECU can determine when to enable certain features and is used in engine airflow calculations.

- **Manifold Air Temperature (MAT)**

MAT is monitored in order to help the ECU determine the mass of air flowing into the engine.

- **Natural Gas Temperature (NGT)**

NGT is monitored in order to allow the ECU to determine the density of natural gas at the injectors. The ECU uses this information as it determines injector on-time.

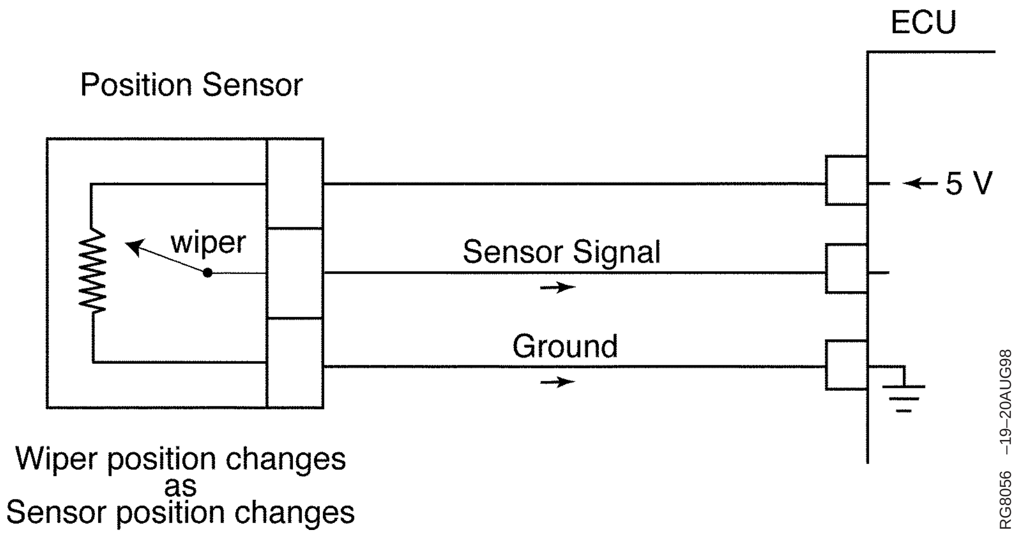
- **Natural Gas Tank Temperature (NGTT)**

NOTE: The NGTT sensor is not used on the 6081 CNG HFN02 Engines.

The ECU uses the NGTT sensor in conjunction with the natural gas tank pressure (NGTP) sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash.

RG,RG34710,3036 –19–15JUL96–1/1

Position Sensors



The throttle position sensor (TPS) and the foot pedal position 1 (FPP1) and foot pedal position 2 (FPP2) sensors are variable resistors (potentiometers). The resistance of these sensors varies depending on sensor position. A moveable center contact (wiper) slides along a wire-wound resistor as sensor position is changed. The ECU sends a 5 V reference voltage into the sensor, the voltage value returning to the ECU on the sensor signal wire varies depending on sensor position. The ECU monitors the voltage on the sensor signal wire and translates this voltage reading to sensor position. The idle validation switch helps to validate that the FPP1 and FPP2 sensors are accurate.

- **Throttle Position Sensor (TPS)**

The TPS is located inside the throttle and is used to determine if the throttle is opening as commanded.

- **Foot Pedal Position 1 (FPP1)**

The FPP1 sensor is used in order for the ECU to determine the operators desired engine load.

- **Foot Pedal Position 2 (FPP2)**

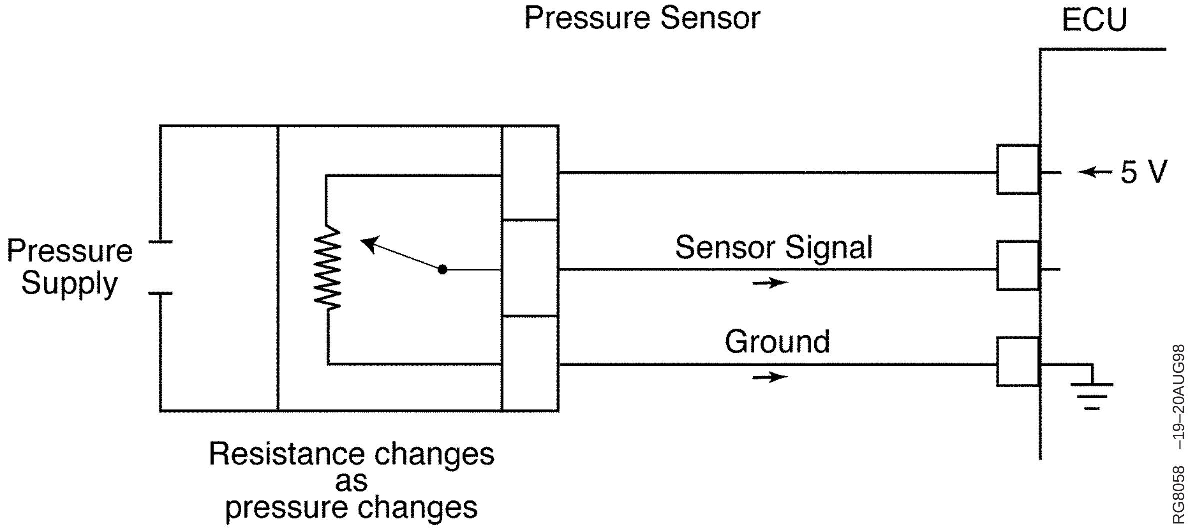
The FPP2 sensor is used in order for the ECU to determine the operator's desired engine load in the event that FPP1 sensor goes bad.

- **Idle Validation Switch (IVS)**

The IVS is used to determine whether engine is at idle when it should or should not be according to the positions shown by both FPP1 and FPP2.

RG,RG34710,3037 –19–15JUL96–1/1

Pressure Sensors



The system's pressure sensors are pressure sensitive variable resistors. As the pressure changes, sensor resistance changes. The ECU sends a 5 V reference voltage to the sensor, then monitors the voltage returning on the sensor signal wire. The ECU then translates this voltage to a pressure value. The system uses pressure sensors to measure:

- **Manifold Absolute Pressure (MAP)**

The MAP sensor is used in conjunction with several other sensors to determine the amount of airflow into the engine. The MAP sensor gives the ECU a direct measurement of turbo boost.

- **Preturbine Pressure (PTP)**

NOTE: The PTP sensor is not used on the 6081 CNG HFN02 Engines.

The PTP is used in conjunction with several other sensors to determine engine airflow and to enhance turbocharger wastegate control.

- **Exhaust back pressure (EBP)**

NOTE: The EBP sensor is not used on the 6081 CNG HFN02 Engines.

EBP is monitored in order to aid the ECU in determining air density, closed loop fuel correction and to enhance turbocharger wastegate control. During certain operating conditions, the EBP sensor is used to measure barometric pressure.

- **Natural Gas Pressure (NGP)**

NGP is monitored in order to allow the ECU to determine the density of natural gas at the injectors. The ECU utilizes this information as it determines injector on-time.

- **Natural Gas Tank Pressure (NGTP)**

NOTE: The NGTP sensor is not used on the 6081 CNG HFN02 Engines.

The ECU uses the NGTP sensor in conjunction with the natural gas tank temperature (NGTT) sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash.

- **Upstream Throttle Pressure (UTP)**

NOTE: The UTP sensor is ONLY used on the 6081 CNG HFN02 Engines.

The ECU uses the UTP sensor to measure air pressure above the throttle plate. The ECU uses the UTP with the MAP and the TPS to control boost levels.

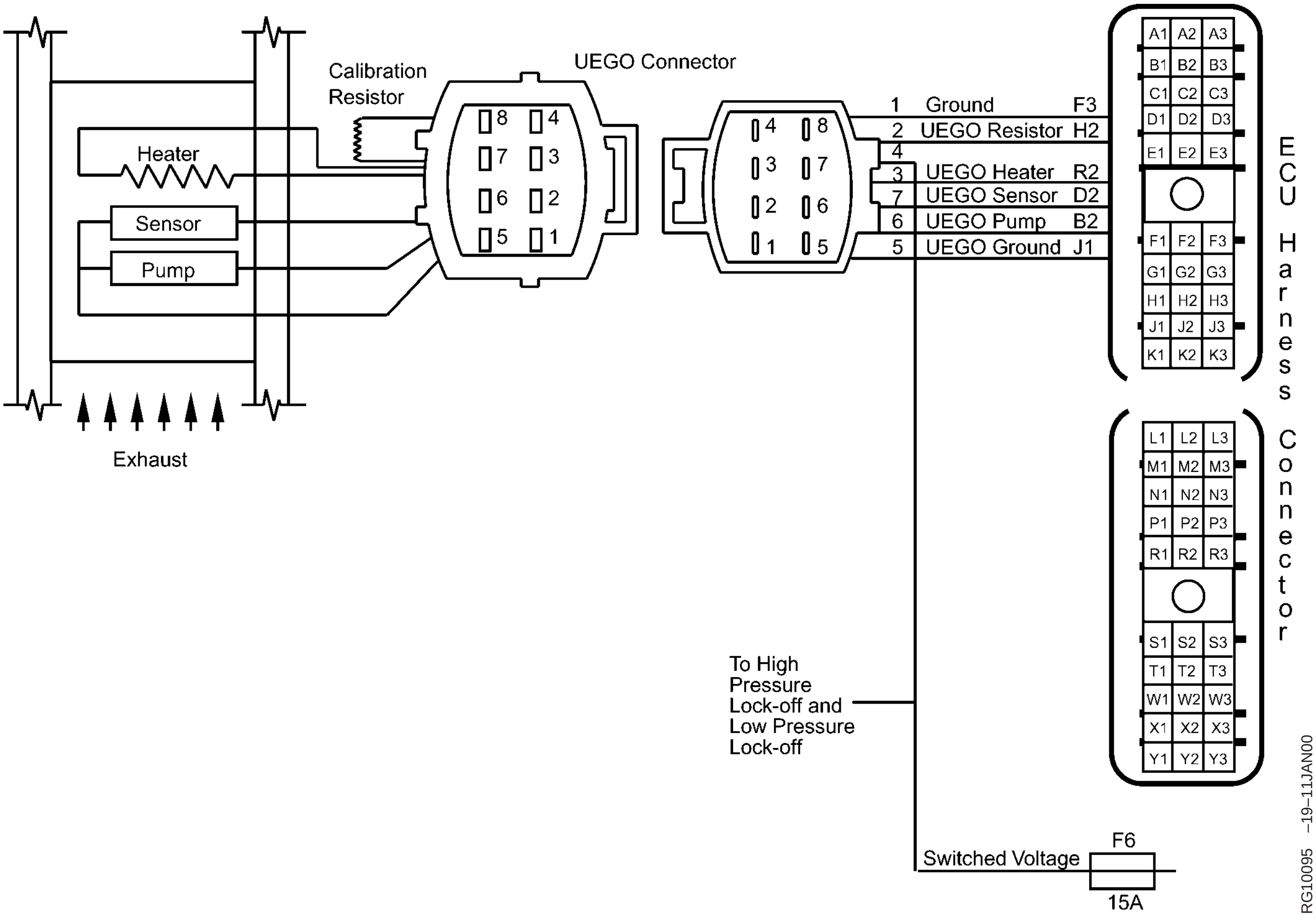
RG,RG34710,3038 –19–15JUL96–1/1

Engine Airflow Measurement

The system determines engine airflow using the speed-density strategy. Base airflow is calculated using engine speed, manifold absolute pressure (MAP), and engine volumetric efficiency. Engine volumetric efficiency is calibrated for the engine, then corrected for varying manifold air temperature (MAT), engine coolant temperature (ECT), and pre-turbine pressure (PTP).

RG,RG34710,3039 –19–15JUL96–1/1

Air/Fuel Ratio Measurement — UEGO Sensor

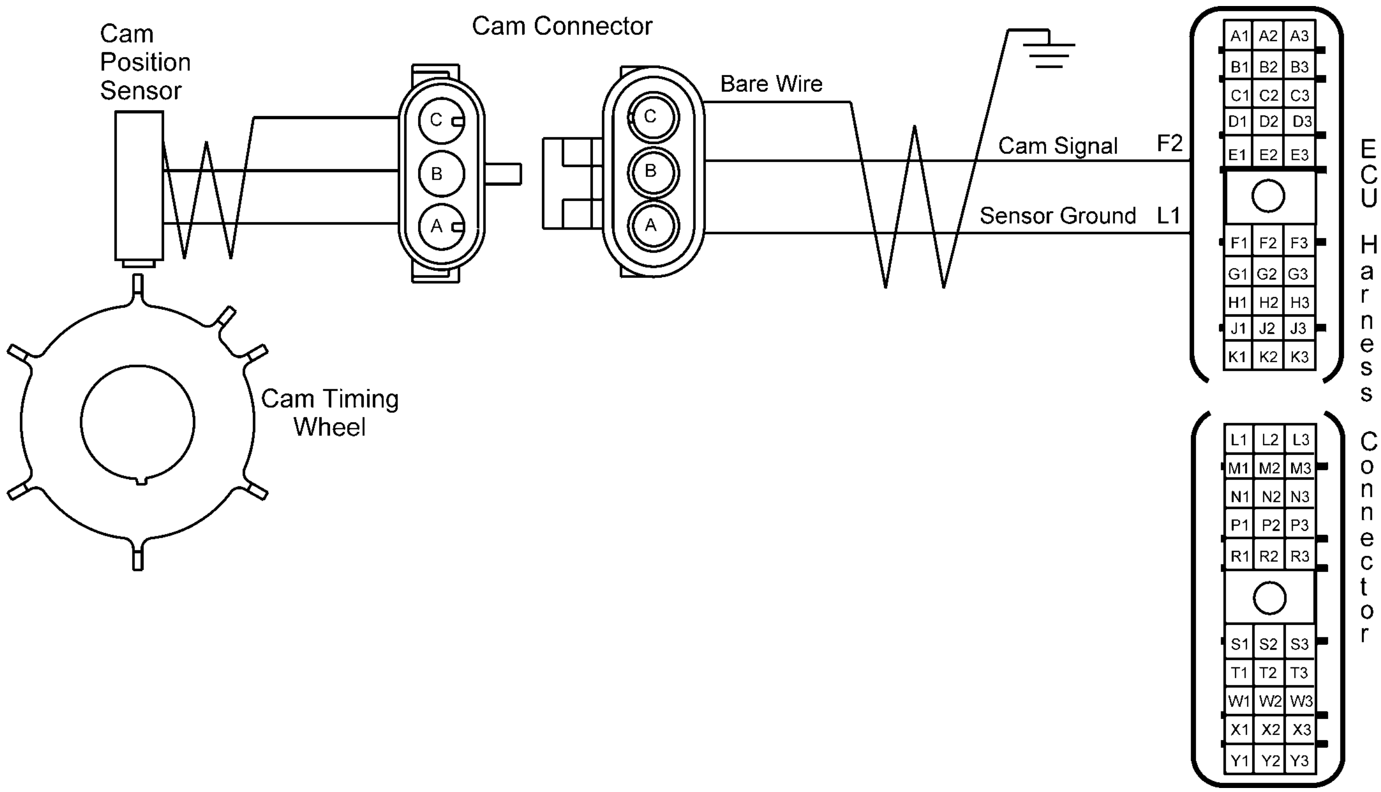


When the engine is operating in closed loop, the Universal Exhaust Gas Oxygen sensor measures the amount of oxygen in the exhaust gas. The amount of free oxygen in the exhaust is directly related to the air/fuel ratio. A rich mixture results in little free oxygen; most of it is consumed during combustion. A lean mixture results in considerable free oxygen because all of the oxygen is not consumed during combustion. The ECU uses the oxygen measurement to determine the correct amount of fuel delivery. The UEGO sensor is composed of a pump cell, a sense cell, a heater and a calibration resistor. The sense cell works similar to a standard automotive oxygen sensor where little sensed oxygen (rich condition) causes a relative high voltage (above 450 millivolts).

Higher concentrations of oxygen (lean condition) cause a relative low voltage (below 450 millivolts). The pump cell works like a standard oxygen sensor backwards; voltage creates oxygen. The ECU monitors the amount of voltage required by the pump cell to create the desired reading on the sense cell. The ECU then uses the sense voltage and pump voltage in combination to determine the amount of oxygen in the exhaust gas and to generate the UEGO voltage. The UEGO heater creates the heat that is required for the sense and pump cells to operate correctly. The UEGO calibration resistor allows the ECU to “fine tune” it’s oxygen measurement calibration when a UEGO sensor is changed.

RG,RG34710,3040 –19–15JUL96–1/1

Camshaft Position Sensor



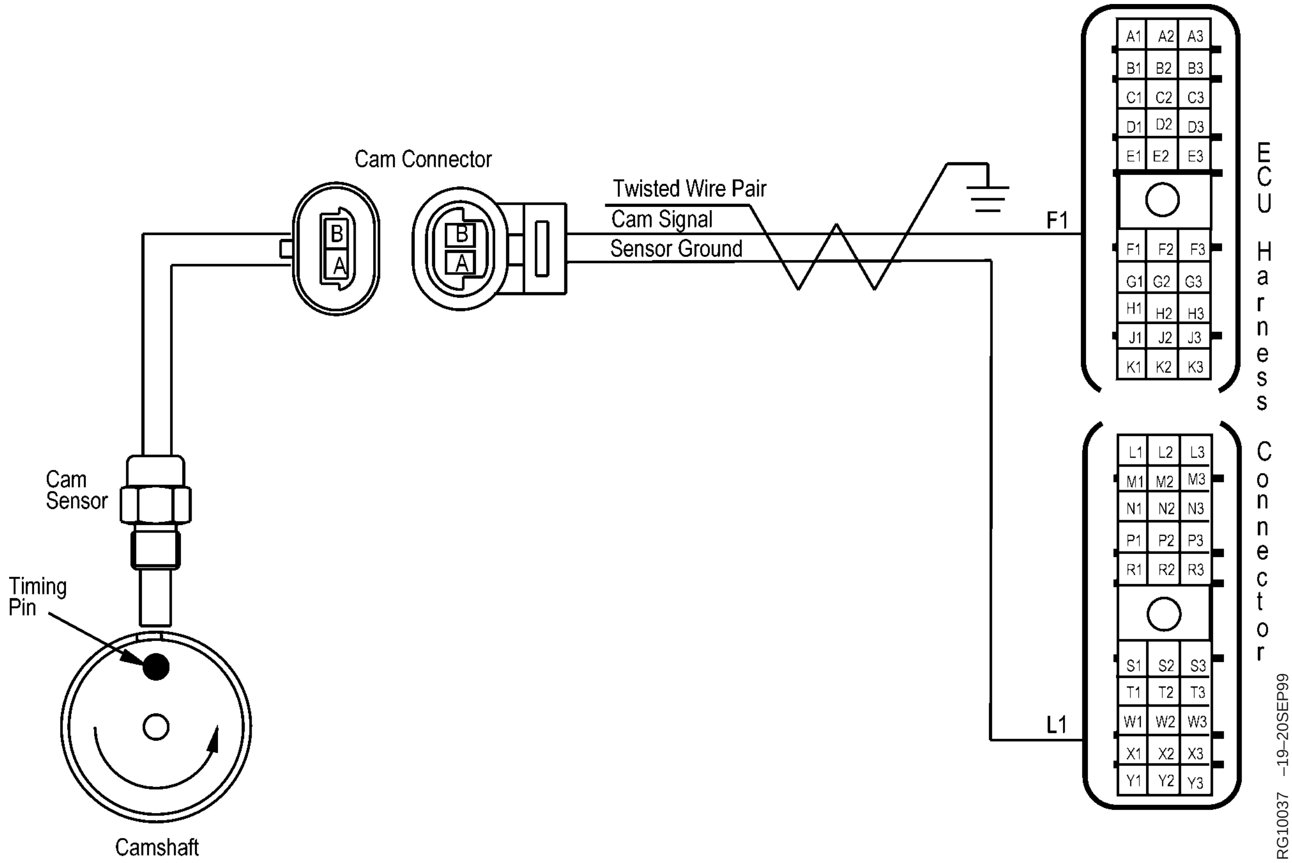
RG10071 –19–24MAY99

Camshaft position sensor (6081 CNG Engines ONLY)

The ECU uses the camshaft position sensor to determine engine speed, and to determine when each cylinder is at TDC at the end of the compression stroke. The ECU needs this information in order to fire the correct coil at the correct time. The ECU monitors the voltage that is created by the cam position sensor when a tooth on the camshaft trigger wheel passes under it. The camshaft trigger wheel has 6 evenly spaced teeth (one for each cylinder) and one extra closely spaced tooth to the number one tooth.

When this extra tooth passes under the cam position sensor, the ECU then “knows” that number 1 cylinder is at TDC at the end of the compression stroke. The next tooth will then indicate when the next cylinder in the firing order (cylinder number 5) is at TDC at the end of compression.

Continued on next page RG,RG34710,3041 –19–15JUL96–1/2

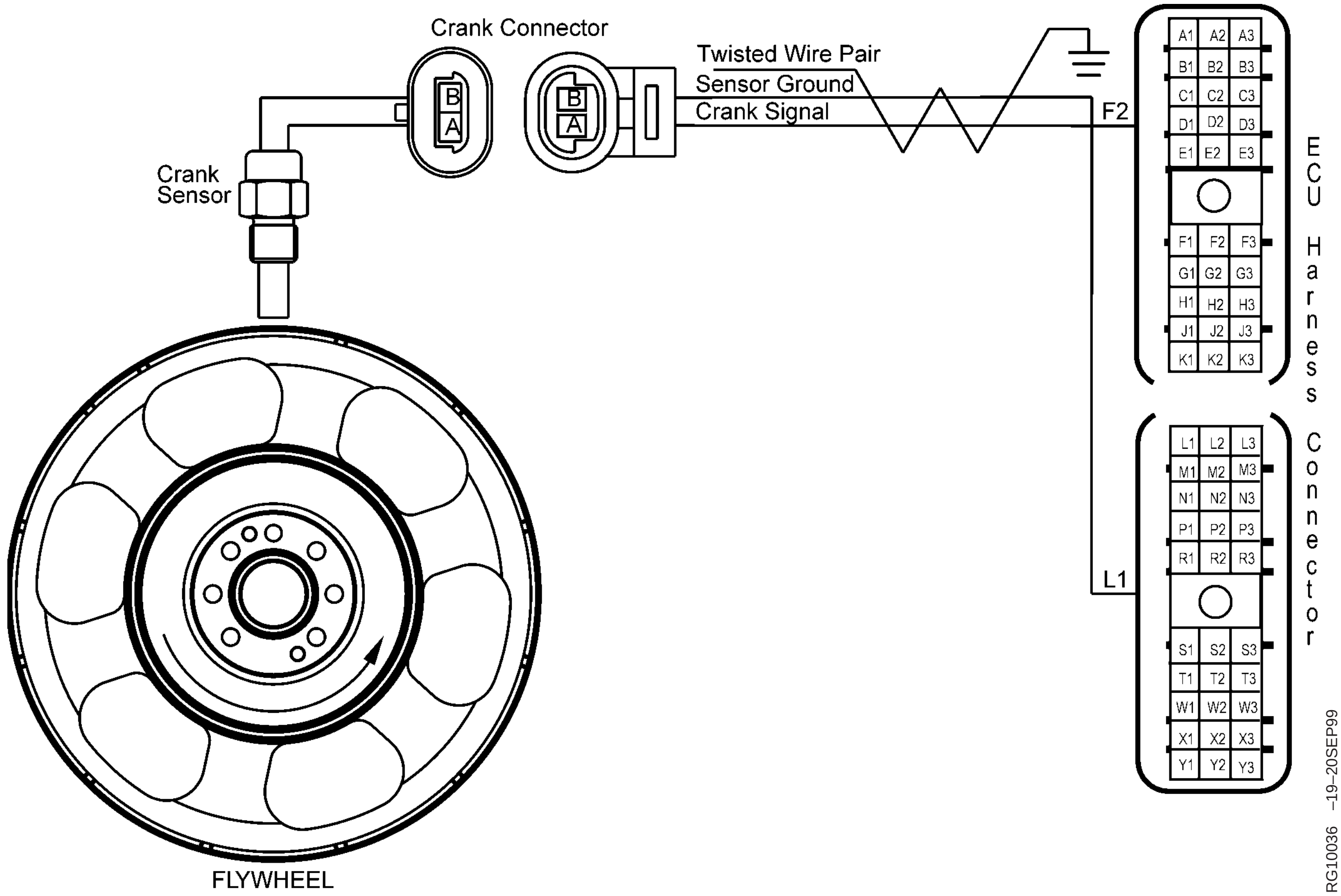


Camshaft position sensor (6068 CNG Engines ONLY)

The camshaft position sensor is an inductive-type pickup sensor that detects a pin on the end of the camshaft. The pin passes under the camshaft position sensor 14 degrees before cylinder number 1 reaches top dead center (TDC) at the same time that the longer gap of the crankshaft position sensor occurs. The ECU uses information from the camshaft position to synchronize the ignition system.

RG,RG34710,3041 –19–15JUL96–2/2

Crankshaft Position Sensor



Crankshaft position sensor (6068 CNG Engines ONLY)

The crankshaft position sensor is an inductive-type position sensor that detects 12 notches into the engine flywheel. Eleven of the notches are evenly spaced with the twelfth notch advanced 15 degrees. This advance results in a longer gap between notches 12 and 1. Every other rotation of the engine, the camshaft position sensor detects the pin on the camshaft during this longer gap. The ECU uses the crankshaft position sensor for measuring engine RPM and for determining when each cylinder is at TDC firing in order to control the engine’s ignition system.

DPSG,RG40854,75 –19–10MAY99–1/1

ECU

IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

The electronic control unit (ECU) is the “brains” of the control system. The ECU performs the following functions:

- Converts the electrical signals from all the various sensors into digital signals
- Makes decisions on the best airflow, fuel flow and ignition timing based on information from the various sensors
- Performs “self diagnosis” on the control system
- Stores fault codes in its memory

The ECU is divided into the following subsystems:

Analog/Digital Converters

This part of the ECU converts the electrical signals from the various sensors into digital signals that the central processing unit (CPU) can use.

Central Processing Unit

The central processing unit (CPU) performs the mathematical computations and logical functions that are necessary in controlling air, fuel, and ignition. The CPU commands closed loop operation and controls the “self diagnostic” system.

Memory

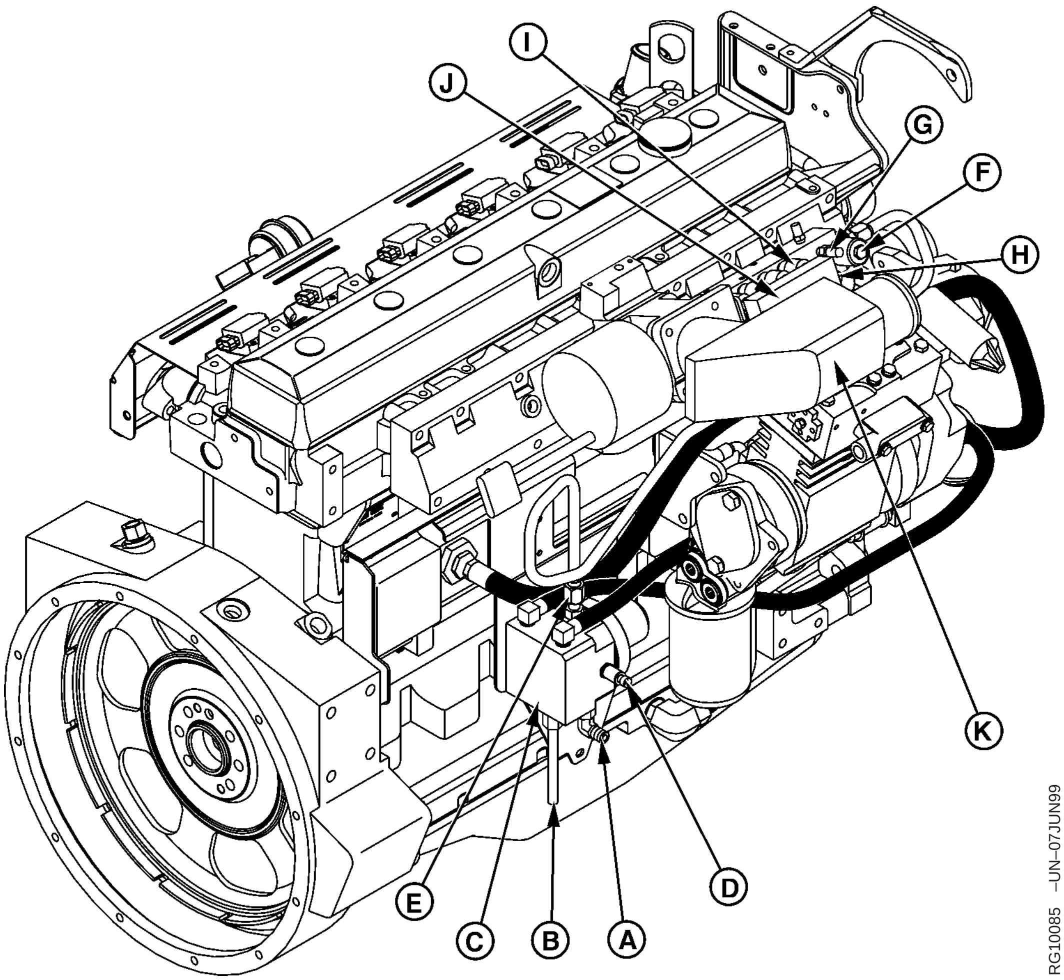
Random Access Memory - RAM: The RAM is like the working desk top of the ECU. Data from the various sensors and the results of various calculations are temporarily stored in RAM. Information in RAM is lost when battery voltage to the ECU is removed.

Read Only Memory - ROM: The ROM contains programmed information. Information in ROM can only be read, not changed. ROM information is retained when battery voltage is removed.

Programmable Read Only Memory - PROM: The PROM contains information programmed in at the factory including engine calibration data, transmission information and axle ratio. Information in the PROM is retained when battery voltage is removed.

RG,RG34710,3042 –19–15JUL96–1/1

Fuel Control on a 6068 CNG Engine



A—Fuel Regulator Inlet
B—Regulator Pressure Relief Vent
C—Fuel Pressure Regulator
D—Natural Gas Tank Pressure (NGTP) Sensor
E—Fuel Regulator Outlet
F—Fuel Lock-off Solenoid
G—Natural Gas Temperature (NGT) Sensor
H—Natural Gas Pressure (NGP) Sensor
I—Fuel Injectors
J—Fuel Metering Block
K—Fuel/Air Mixer

NOTE: On some applications the fuel pressure regulator is located away from the engine.

CNG fuel is supplied to the regulator inlet (A) at pressures up to 3600 psi. Fuel is then reduced by the two-stage, diaphragm design pressure regulator (C) to approximately 130 psia. A regulator pressure relief vent (B), which is connected to the vehicle vent, protects against over-pressure problems. The fuel is then delivered to the engine by eight (four pairs of two) electrically pulsed injectors (I) located on the fuel metering block (J). The ECU controls the “on” time (pulse width) of each pair of injectors to deliver the correct amount of fuel to the engine. A common outlet port from the metering valve provides fuel to a fuel/air mixer (K) located upstream of the throttle body.

Natural gas pressure (NGP) (H) and natural gas temperature (NGT) (G) are measured at the metering valve so the ECU can adjust the injector pulse width to compensate for variations in natural gas density. Also located on the fuel metering block is an ECU controlled lock off solenoid (F) that will stop the flow of fuel upstream of the injectors. The lock off solenoid controls a normally closed valve that opens when the ECU energizes it. The lock off solenoid will be closed anytime the ignition is OFF or is ON but hasn’t been in the crank position for 3-4 seconds.

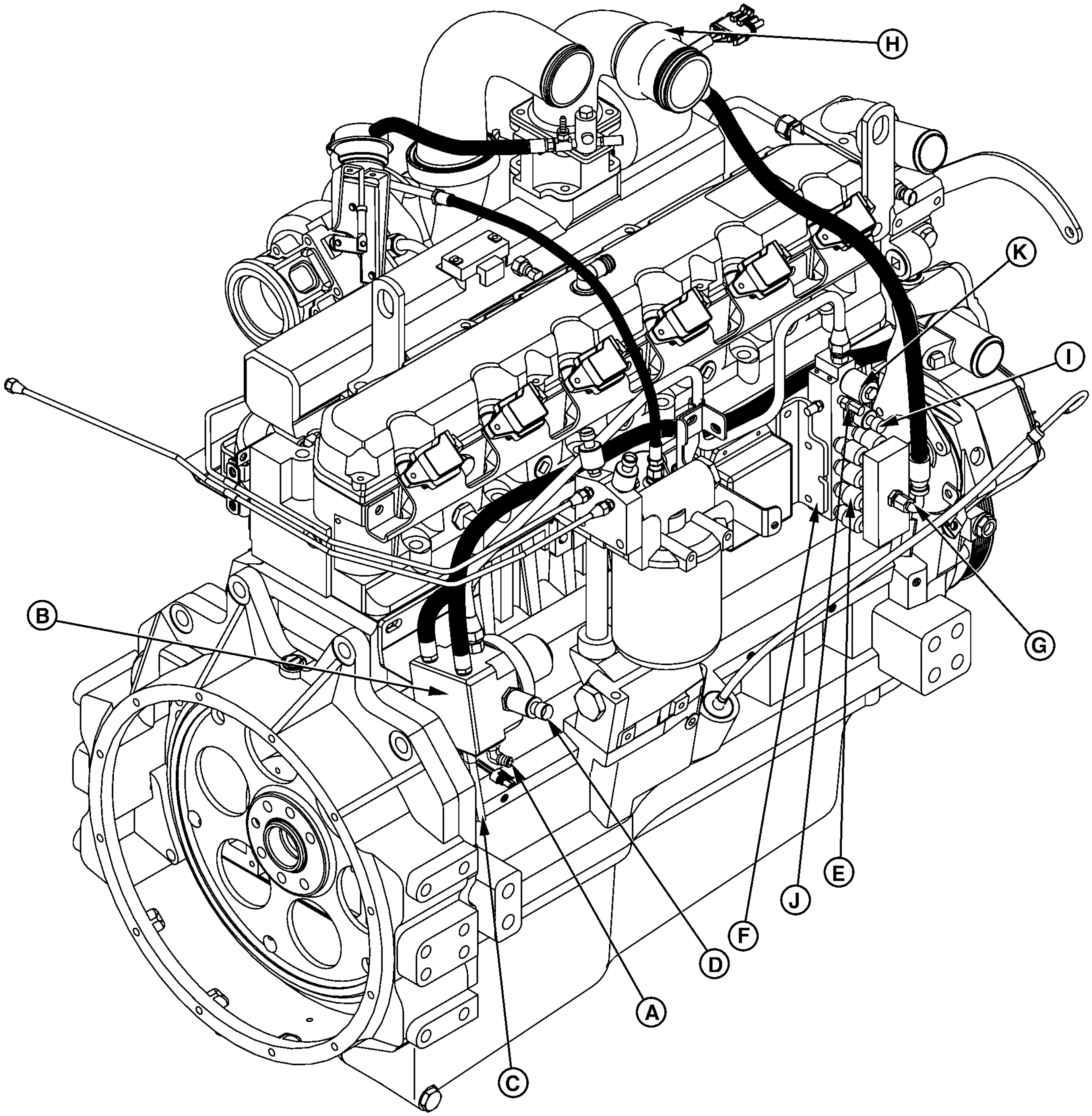
Continued on next page

RG,RG34710,3043 –19–15JUL96–1/2

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

RG,RG34710,3043 –19–15JUL96–2/2

Fuel Control on a 6081 HFN01/HFN03 CNG Engine

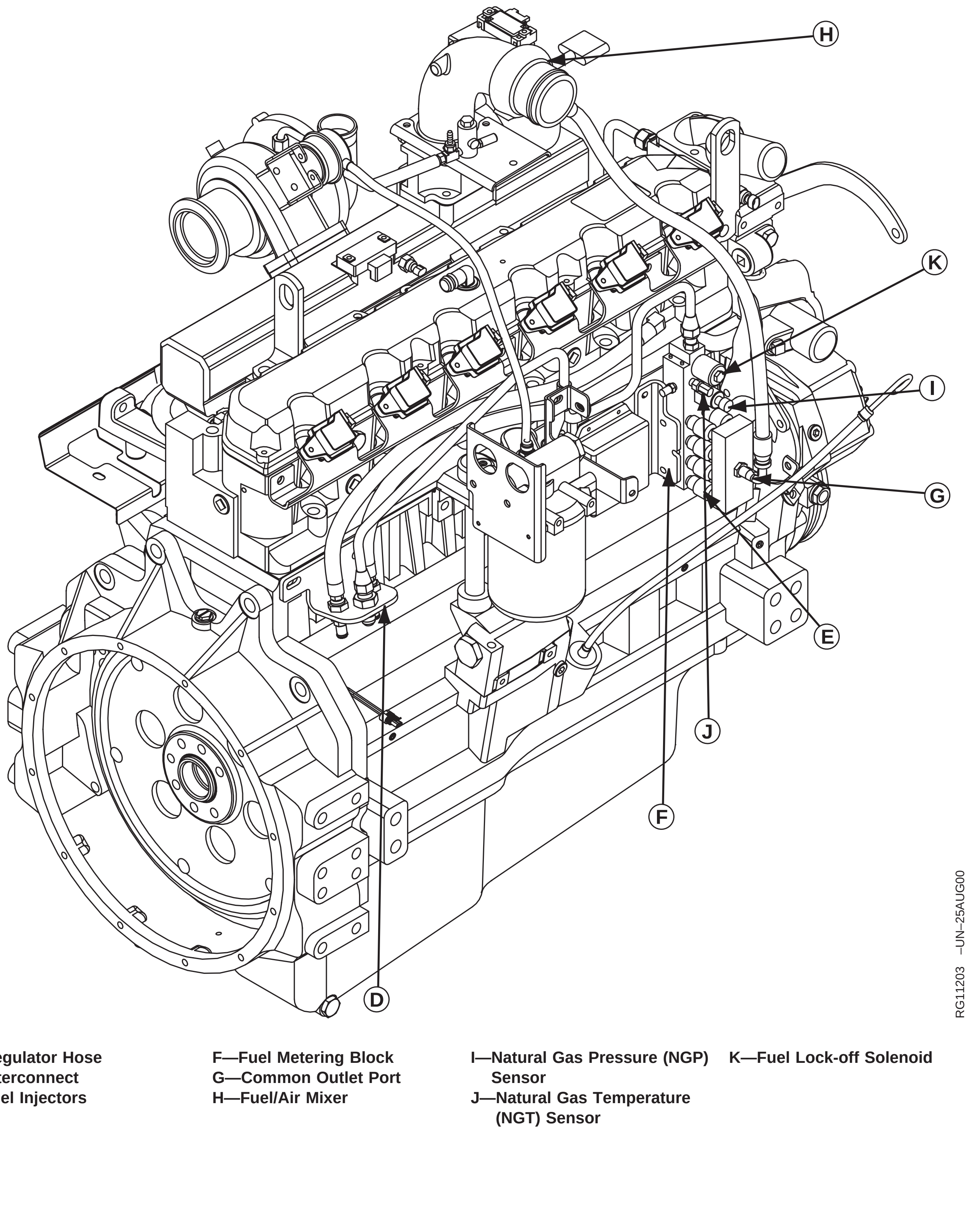


RG10097 –UN–07JUN99

A—Fuel Injection Regulator Inlet
B—Fuel Pressure Regulator
C—Regulator Pressure Relief Vent
D—Natural Gas Tank Pressure (NGTP) Sensor
E—Fuel Injectors
F—Fuel Metering Block
G—Common Outlet Port
H—Fuel/Air Mixer
I—Natural Gas Pressure (NGP) Sensor
J—Natural Gas Temperature (NGT) Sensor
K—Fuel Lock-off Solenoid

RG,RG34710,3043 –19–15JUL96–1/1

Fuel Control on a 6081 HFN02 CNG Engine



D—Regulator Hose Interconnect
E—Fuel Injectors
F—Fuel Metering Block
G—Common Outlet Port
H—Fuel/Air Mixer
I—Natural Gas Pressure (NGP) Sensor
J—Natural Gas Temperature (NGT) Sensor
K—Fuel Lock-off Solenoid

RG,RG34710,3043 –19–15JUL96–1/1

Fuel Control on a 6081 CNG Engine—Continued

NOTE: The 6081 HFN02 Engine and some of the HFN01 and HFN03 engines have a remote mounted Fuel Pressure Regulator. It operates identical to the engine mounted regulator used on the HFN01/HFN03.

CNG fuel is supplied to the regulator inlet (A) at pressures up to 3600 psi. Fuel is then reduced by the two-stage (early engines), or single stage (current engines) diaphragm design pressure regulator (B) to approximately 130 psia. The regulator is heated by engine coolant and a regulator pressure relief vent (C) is connected to the vehicle vent to protect against over-pressure problems. The fuel is then delivered to the engine by eight (four pairs of two) electrically pulsed injectors (E) located on the fuel metering block (F). The ECU controls the “on” time (pulse width) of each pair of injectors to deliver the correct amount of fuel to the engine. A common outlet port (G) from the metering valve provides fuel to a fuel/air mixer (H) located upstream of the throttle body.

Natural gas pressure (NGP) (I) and natural gas temperature (NGT) (J) are measured at the metering valve so the ECU can adjust the injector pulse width to compensate for variations in natural gas density. Also located on the fuel metering block is an ECU controlled lock-off solenoid (K). The lock-off solenoid will stop the flow of fuel upstream of the injectors. The lock off solenoid controls a normally closed valve that opens when the ECU energizes it. The lock off solenoid will be closed anytime the ignition is OFF or is ON but hasn’t been in the crank position for 3-4 seconds.

NOTE: When the ignition is in the “ON” position without having been in the “START” position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won’t be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

DPSG,RG34710,95 –19–22JUL99–1/1

Fuel Control Modes

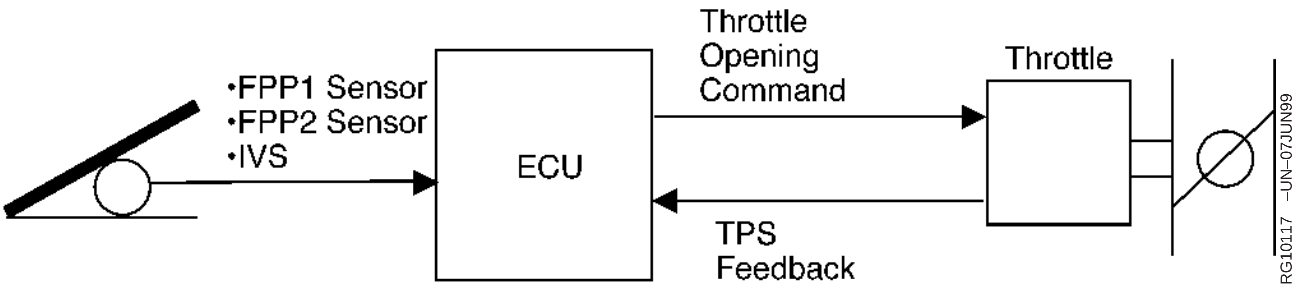
After the engine is first started, for the first 30-60 seconds of run time, the ECU operates in open loop. During open loop fuel control, fueling rate is determined by ECU calibration based on measurements of MAP, RPM, MAT, ECT, and PTP. This is speed density fuel control.

Fuel delivery accuracy is improved when the system operates in closed loop. After the engine has been running for about 30-60 sec, the ECU changes from open loop fuel control to closed loop fuel control. Closed loop provides the ability for the ECU to correct for gas composition variation and for changing operating conditions. Using a universal exhaust gas oxygen (UEGO) sensor, the ECU is able to measure the amount of oxygen in the exhaust. From the oxygen measurement, the ECU can determine the air/fuel ratio, then adjust the amount of fuel delivered until the optimum air/fuel ratio is achieved. The closed loop multiplier number is the percent increase or decrease from the base mass fuel flow the ECU delivered in order to achieve the optimum air/fuel ratio. Typical corrections under normal operating conditions will be +/- 10%.

The adaptive learn acts as a fuel correction memory. The adaptive learn is enabled when the engine reaches operating temperature and is in closed loop fueling control. The adaptive learn function maintains a table where each cell of the table represents a different combination of engine speed (RPM) and engine load (MAP). Each time the closed loop correction is “successful” in achieving the optimum air/fuel ratio for a certain engine speed and MAP, the adaptive learn stores that fuel correction in a cell. The next time the engine operates at that same engine speed and MAP, the fuel correction stored in that cell is used. If the engine tends toward a slightly lean condition, the adaptive learn multiplier number will be positive. If the engine has a tendency to run slightly rich, the adaptive learn multiplier number will be negative. Under normal operating conditions, the system will operate in closed loop + adaptive fuel control mode.

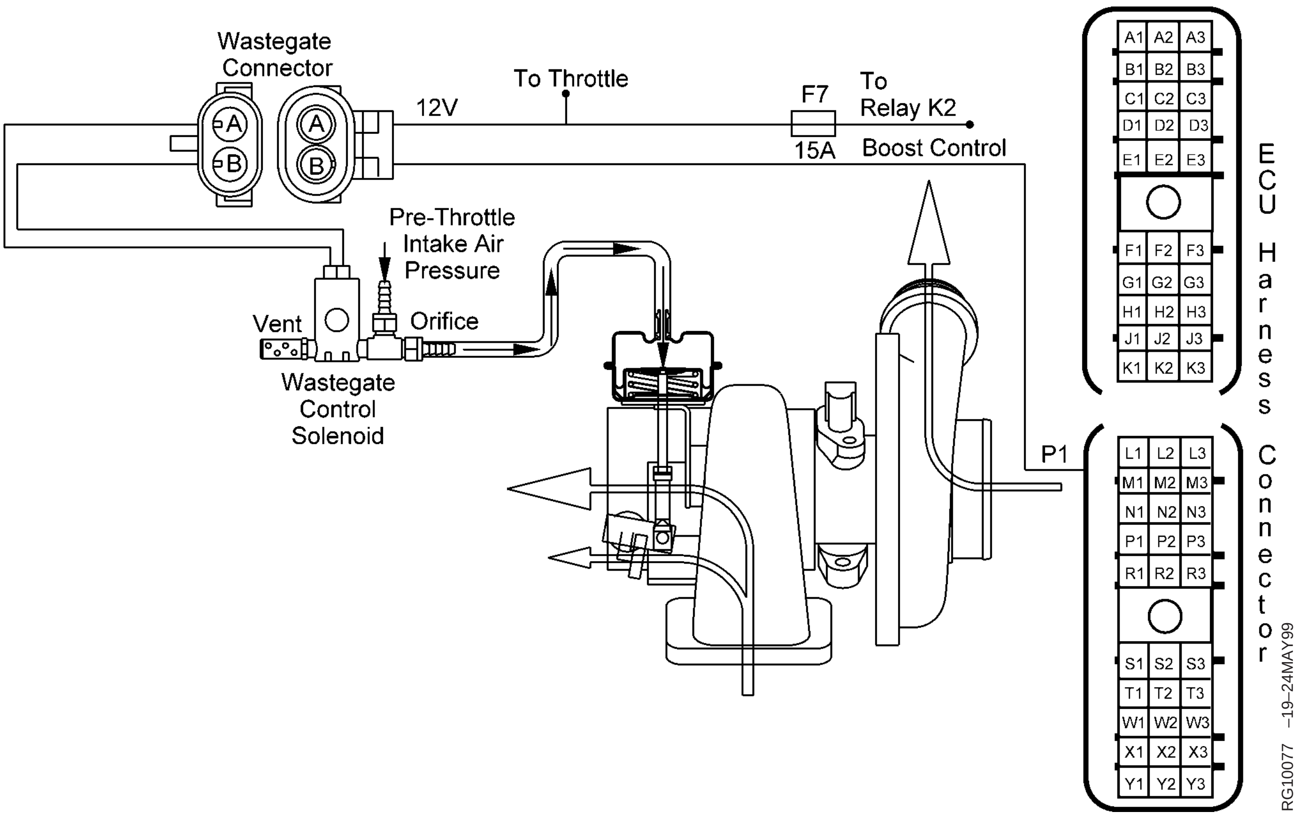
RG,RG34710,3044 –19–15JUL96–1/1

Air Control



Power output of a spark ignited natural gas engine is controlled by varying the airflow to the engine. More airflow results in more power. The ECU controls engine airflow by commanding both throttle opening and turbocharger boost level. Some applications have a throttle that is a drive-by wire electronically controlled throttle/actuator. The ECU provides a pulse width modulated (PWM) signal to command throttle opening based on the foot pedal position (FPP) input from the driver. The throttle is configured for min/max governing, and is designed so that no separate idle-air bypass is needed. A switch on the dash is provided for fast idle operation.

Continued on next page RG,RG34710,3045 –19–15JUL96–1/2

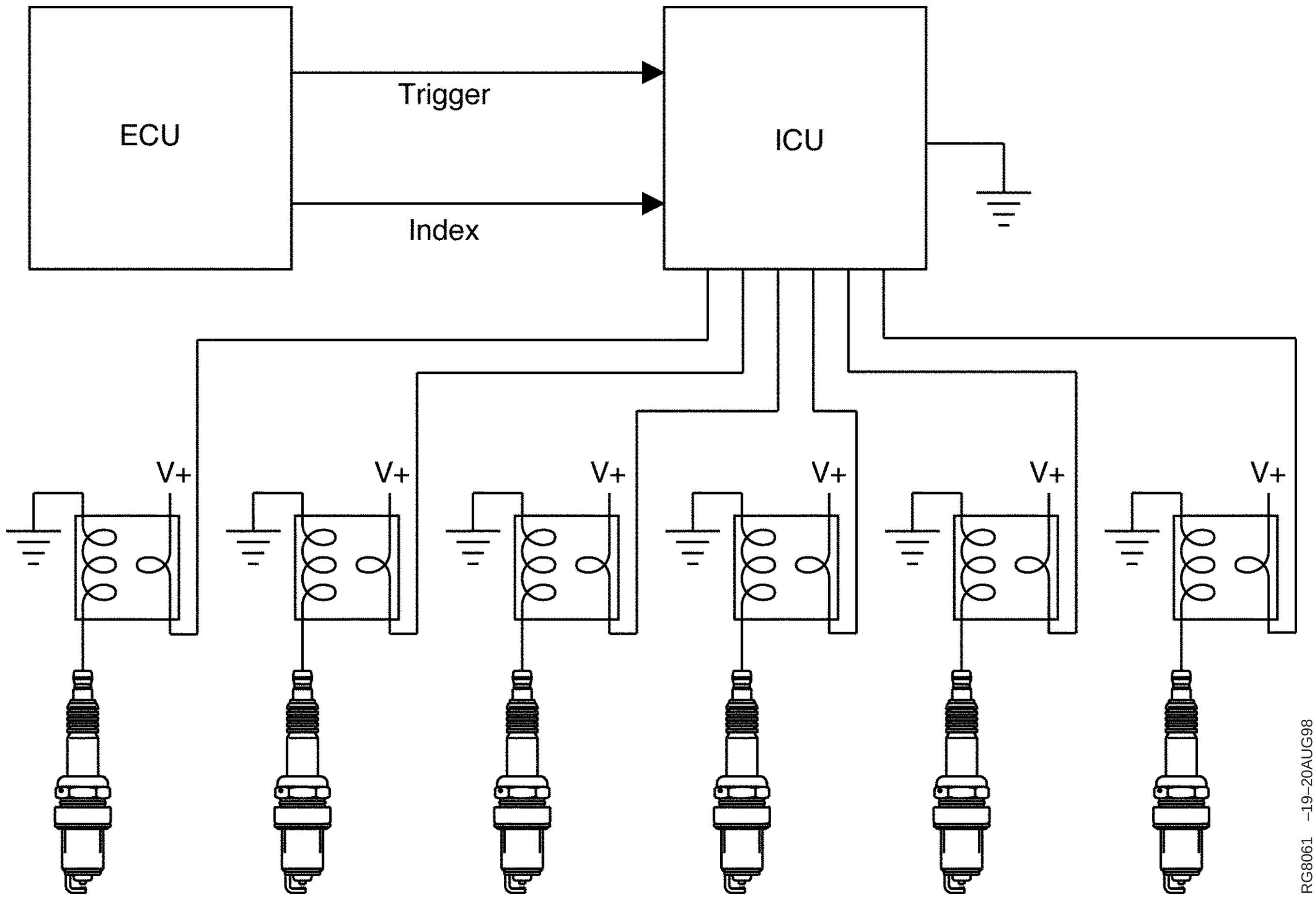


Turbocharger boost control is achieved by using a turbo with a conventional diaphragm wastegate actuator and a pulse width modulated (PWM) wastegate control solenoid. The ECU controls the amount of boost that the turbocharger is allowed to generate by sending a PWM signal to the wastegate solenoid. The wastegate control solenoid routes pre-throttle intake air pressure to either the wastegate diaphragm or to a vent.

When the solenoid is energized, pressure is routed to the vent, spring force holds the wastegate closed and the turbo generates maximum boost. When the solenoid is not energized, pressure is routed to the wastegate diaphragm, overcoming spring force, opening the wastegate, causing the turbo to generate minimum boost. A foot pedal position (FPP)/engine speed table is used to control the boost at each condition.

RG,RG34710,3045 –19–15JUL96–2/2

Ignition Control



The JDNG Ignition Control system uses a direct-fire, one coil-per-cylinder, coil-on-plug inductive ignition system. The non-adjustable spark timing is controlled by the ECU based on engine speed, MAP and ECT. The ECU monitors the cam position sensor input to determine engine speed and engine position, determines the desired timing advance, then outputs a trigger signal to the ignition control unit (ICU) when a coil should be fired. A synchronization pulse (index) is also sent by the ECU to the ICU so that the ICU fires the correct coil.

RG,RG34710,3047 –19–15JUL96–1/1

Diagnosing Head Gasket Joint Failures

Head gasket failures generally fall into three categories:

- Combustion seal leakage.
- Coolant seal leakage.
- Oil seal leakage.

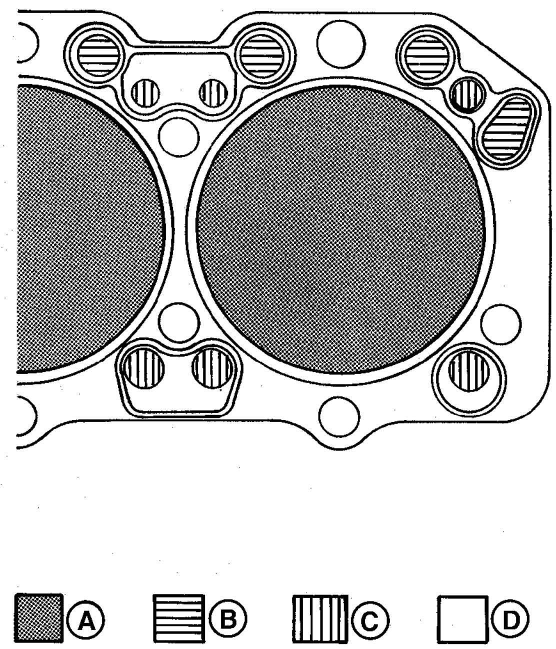
Combustion seal leakage failures occur when combustion gases escape between cylinder head and head gasket combustion flange, or between combustion flange and cylinder liner. Leaking combustion gases may vent to an adjacent cylinder, to a coolant of oil passage, or externally.

Coolant or oil seal leakage failures occur when oil or coolant escapes between cylinder head and gasket body, or between cylinder block and gasket body. The oil or coolant may leak to an adjacent coolant or oil passage, or externally. Since oil and coolant passages are primarily on right hand (camshaft) side of engine, fluid leaks are most likely to occur in that area.

Follow these diagnostic procedures when a head gasket joint failure occurs, or is suspected.

1. Before starting of disassembling engine, conduct a visual inspection of vehicle, and note any of the following:

   - Oil or coolant in head gasket seam, or on adjacent surfaces. Especially right rear corner of gasket joint.
   - Displacement of gasket from normal position.
   - Discoloration from combustion gas leakage.
   - Leaking radiator, overflow tank, or hoses.
   - Leaking coolant from water pump weep hole.
   - Damaged or incorrect radiator, fan, or shroud.
   - Obstructed air flow or coolant flow.
   - Worn or slipping belts.
   - Damaged or incorrect pressure cap.
   - Presence of oil in coolant.
   - Low coolant levels.
   - Improper coolant.
   - Unusually high or low oil levels.
   - Oil degradation, dilution, or contamination.
   - Unburned fuel or coolant in exhaust system.



RG6449 –UN–26NOV97

A—Combustion Sealing Areas
B—Oil Sealing Areas (Push Rod)
C—Coolant Sealing Areas
D—Cylinder Head Cap Screws

Continued on next page

2. Obtain coolant and oil samples for further analysis.

3. Start and warm up engine if it can be safely operated. Examine all potential leakage areas again as outlined previously. Using appropriate test and measurement equipment, check for the following:

   - Excessive raw fuel, or moisture in exhaust system.
   - Rough, irregular exhaust sound, or misfiring.
   - Air bubbles, gas entrapment in radiator or overflow tank.
   - Loss of coolant from overflow.
   - Excessive cooling system pressure.
   - Coolant overheating.
   - Low coolant flow.

4. Shut engine down. Recheck crankcase, radiator, and overflow tank for any significant differences in fluid levels, viscosity, or appearance.

5. Compare your observations from above steps with the following diagnostic charts. If diagnostic evaluations and observations provide conclusive evidence of combustion gas, coolant, or oil leakage from head gasket joint, the cylinder head must be removed for inspection and repair of gasket joint components.

Combustion Seal Leakage

Symptoms:

- Exhaust from head gasket crevice
- Air bubbles in radiator/overflow tank
- Coolant discharge from overflow tube
- Engine overheating
- Power loss
- Engine runs rough
- White exhaust smoke
- Gasket section dislodged, missing (blown)
- Coolant in cylinder
- Coolant in crankcase oil
- Low coolant level

Possible Causes:

- Insufficient liner standout
- Excessive liner standout differential between cylinders

Continued on next page

- Low head bolt clamping loads
- Rough/damaged liner flange surface
- Cracked/deformed gasket combustion flange
- Out-of-flat/damaged/rough cylinder head surface
- Missing/mislocated gasket fire ring
- Block cracked in liner support area
- Hydraulic or mechanical disturbance of combustion seal

NOTE: Cracked cylinder head or liners may also allow combustion gas leakage into coolant.

Coolant Seal Leakage

Symptoms:

- Coolant discharge from head gasket crevice
- Coolant in crankcase oil
- Low coolant level
- High oil level
- Coolant discharge from crankcase vent

Possible Causes:

- Excessive liner standout
- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damaged/voids in elastomer beading

NOTE: Cracked cylinder head, liners, liner packings, defective oil cooler or aftercooler may also allow coolant leakage into crankcase.

Oil Seal Leakage

Symptoms:

- Oil discharge from head gasket crevice
- Oil in coolant
- Low crankcase oil level
- Reduced oil to rocker arms (noisy)

Possible Causes:

- Excessive liner standout

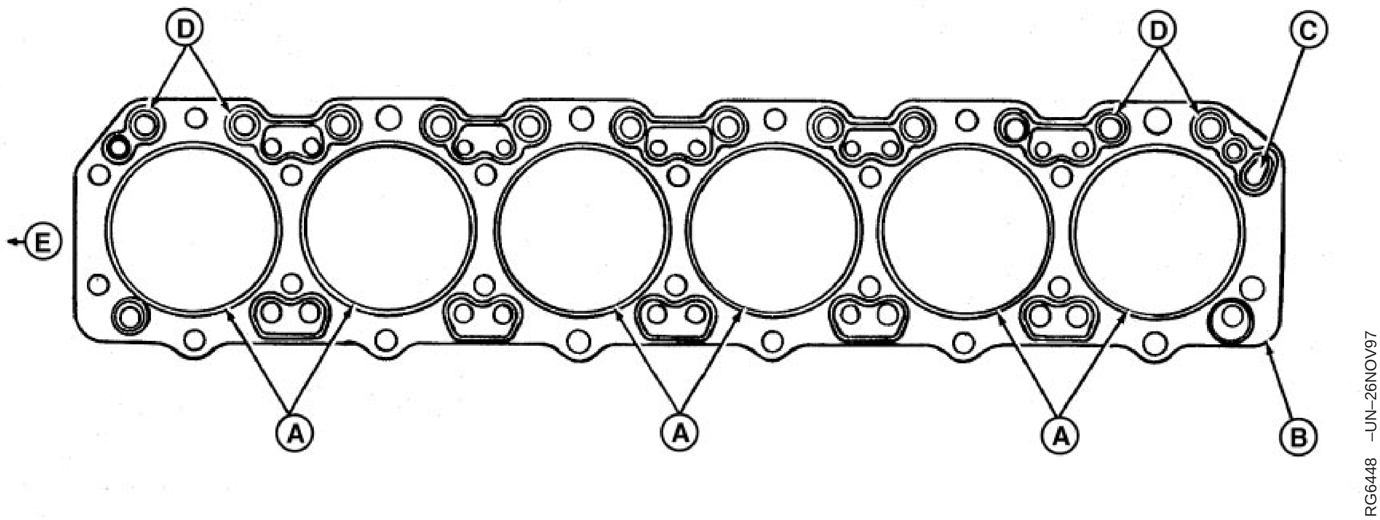
Continued on next page

- Excessive liner standout differential between cylinders
- Low head bolt clamping loads
- Out-of-flat/damaged/rough block surface
- Out-of-flat/damaged/rough cylinder head surface
- Oil or coolant overheating
- Cracks/creases in gasket body surfaces
- Damage/voids in elastomer beading
- Damaged/missing O-ring seal at oil port to rocker arms

NOTE: Defective oil cooler may also allow oil leakage into coolant.

RG,RG34710,3048 –19–15JUL96–4/4

Head Gasket Inspection and Repair Sequence



A—Combustion Seals (Flanges) **B—Gasket Body** **C—Rocker Arm Oil Port** **D—Elastomer Beading Strips** **E—Front of Engine**

NOTE: The drawing for Head Gasket Inspection and Repair Sequence represent a 6081 CNG engine.

The following inspection procedures are recommended whenever a head gasket joint failure occurs, or when joint disassembly takes place.

1. Review historical data relating to machine operation, maintenance and repair, along with diagnostic observations. Note all areas requiring further inspection and analysis.

2. Remove rocker arm cover and check for presence of coolant in the oil.

3. Record head cap screws torques prior to removal. Upon removal, check cap screw length differences.

4. Remove cylinder head using appropriate lifting devices to prevent handling damage to head gasket. See REMOVE CYLINDER HEAD in Group 05 of CTM87 for 6081 CNG engines or REMOVE CYLINDER HEAD in Group 05 of CTM146 for 6068 CNG engines.

5. Observe surfaces of removed head gasket.

   - Examine combustion seals (A) for the following:
     – Flange severed/expanded/cracked/deformed.
     – Adjacent body area burned/eroded.
     – Fire ring severed/displaced/missing.
     – Flange sealing pattern eccentric/contains voids.
     – Discoloration of flange and adjacent body areas.
     – Flange surfaces rough/abraded/channelled.
   - Examine gasket body (B) for the following:
     – Combustion gas erosion paths or soot deposits originating at combustion seals.
     – Extreme discoloration/hardening/embrittlement in localized areas.
     – O-ring seal missing/damaged in port area (C).
     – Elastomer missing/damaged in port areas (D).
     – Oil or coolant paths from port areas.
     – Localized areas of low compression.

6. Before cleaning components, inspect head, block, and liners for evidence of combustion gas and fluid leakage. Inspect cylinder and valve ports for unusual deposits.

Continued on next page

7. Clean block, head, liners, and cap screws. (See INSPECT AND CLEAN CYLINDER HEAD in Group 05 of CTM87 for 6081 CNG engines or INSPECT AND CLEAN CYLINDER HEAD in Group 05 of CTM146 for 6068 CNG engines.)

8. Proceed with the following dimensional checks and visual inspections:

   - Cylinder Head (See INSPECT AND CLEAN CYLINDER HEAD in Group 05 of CTM87 for 6081 CNG engines or INSPECT AND CLEAN CYLINDER HEAD in Group 05 of CTM146 for 6068 CNG engines.)
     – Check surface flatness/finish.
     – Inspect for surface damage.
     – Check cylinder head thickness, if resurfacing.
   - Cylinder Block and Liners (assembled and clamped) (See MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK) in Group 10 in CTM87 for 6081 CNG engines or MEASURE CYLINDER LINER STANDOUT (HEIGHT ABOVE BLOCK) in Group 10 of CTM146 for 6068 CNG engines.)
     – Check liner standout at four places on each liner.
     – Check liner standout difference between cylinders.
   - Cylinder Block (See INSPECT AND CLEAN CYLINDER BLOCK in Group 10 of CTM87 for 6081 CNG engines or INSPECT AND CLEAN CYLINDER BLOCK in Group 10 of CTM146 for 6068 CNG engines.)
     – Check surface flatness/finish.
     – Inspect for surface damage.
     – Check liner counterbore depth (if liner is removed).
     – Check top deck to crankshaft centerline dimension.
     – Inspect cap screw bosses, must be clean/intact.
   - Cylinder Liner (See VISUALLY INSPECT CYLINDER LINERS in Group 10 of CTM87 for 6081 CNG engines or VISUALLY INSPECT CYLINDER LINERS in Group 10 of CTM146 for 6068 CNG engines.)
     – Check liner flange flatness/finish.
     – Check liner flange thickness (if liner is removed).
     – Inspect flange for damage.
   - Cylinder Head Cap Screws (See CTM87 for 6081 CNG engines or CTM146 for 6068 CNG engines.)
     – Inspect for corrosion damage.
     – Inspect condition of threads.
     – Inspect for straitness.
     – Check length.

9. When inspections and measurements have been completed, determine most probable causes of joint failure. Make all necessary repairs to joint components and cooling system.

10. Reassemble the engine according to procedures and specifications in COMPLETE FINAL ASSEMBLY of Group 10 and other Groups of CTM87 for 6081 CNG engines or in COMPLETE FINAL ASSEMBLY of Group 10 and other Groups of CTM146 for 6068 CNG engines.

RG,RG34710,3049 –19–15JUL96–2/2

Diagnosing Lubrication System Malfunctions

Low Oil Pressure

- Low oil level.
- Clogged cooler or filter.
- Excessive oil temperature.
- Incorrect oil.
- Oil pressure regulating valve failure.
- Excessive main or rod bearing clearance.
- Clogged oil pump screen.
- Excessive clearance between oil pump gears and cover.
- Piston cooling orifice not installed.

High Oil Pressure

- Improper oil classification.
- Clogged oil lines.
- Oil pressure regulating valve failure.

Oil Sludge and Dilution

- Improper operation and servicing.
- Coolant leakage into lubrication system.
- Incomplete combustion.
- Excessive oil consumption.

Low Oil Pressure at Slow Idle

- Bypass oil check valve failure.

RG,RG34710,3050 –19–15JUL96–1/1

Diagnosing Cooling System Malfunctions

Engine Overheats

- Loose or broken fan belt.
- Dirty radiator.
- Low coolant level.
- Engine overloaded.
- Defective head gasket.
- Faulty thermostats.
- Faulty water pump.
- Corroded coolant passages.

Low Coolant Level

- Improper maintenance.
- Improper operation.
- Damaged radiator.
- Water pump seal leakage.
- Leakage.
- Faulty radiator cap.

Water Pump Leaking

- Seal ring or pump shaft worn.

RG,RG34710,3051 –19–15JUL96–1/1

Test Engine Compression Pressure

IMPORTANT: Compression pressures are affected by the cranking speed of the engine. Before beginning test, insure that batteries are fully charged and spark plug area is thoroughly cleaned.

1. Start engine and run at rated speed until it warms up to normal operating temperature. (From a cold start, operate engine 10-15 minutes.)

2. Shut off engine. Disconnect the 6-way electrical connection (A) between the Electronic Control Unit (ECU) and Ignition Control Unit (ICU).

3. Disconnect the 2-way electrical connection to the low-pressure lock off solenoid (B).

4. Remove all spark plugs. (See REMOVE AND INSTALL SPARK PLUGS in Group 45 of CTM87 for 6081 CNG engines or REMOVE AND INSTALL SPARK PLUGS in Group 45 of CTM146 for 6068 CNG engines.)

IMPORTANT: Inspect O-ring on JDG814 Compression Test Adapter (C) before measuring compression on each cylinder. Replace O-ring as needed.

5. Install JDG814 Compression Test Adapter (C) into the spark plug bore. Tighten to 7 N•m (5 lb-ft).

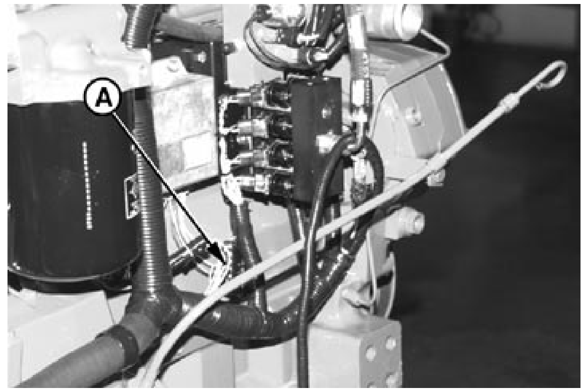
6. Connect JT01682 Gauge and Hose Assembly (D) to adapter.

7. Turn the ignition to the “ON” position.

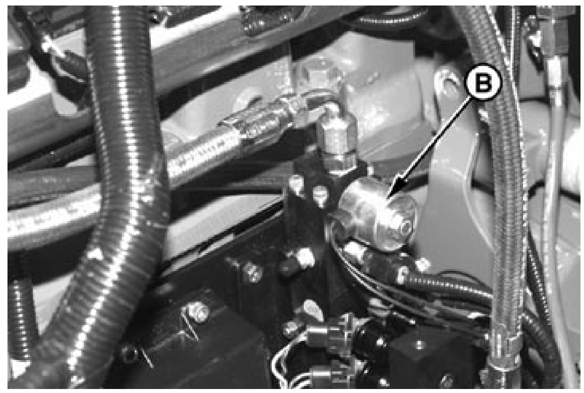
8. Connect JT07267 ECU Communication Kit. (See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115) and execute the JDNG diagnostic software.

9. Select Throttle Test from the DST main menu.

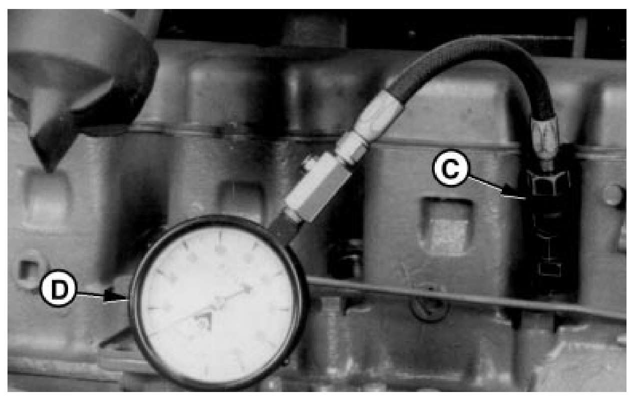
10. Press the accelerator pedal all the way to the floor and crank engine over at 275-325 rpm cranking speed and record compression readings.



RG8141 –UN–20AUG98



RG8075 –UN–20AUG98



RG11221 –UN–25AUG00

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RG,RG34710,3052 –19–15JUL96–1/2

Specification

Compression Pressure (Wide Open Throttle)—6081 CNG (10.5:1 C/R) .... 1069–1276 kPa (10.7–12.8 bar) (155–185 psi)
6068 CNG (11.0:1 C/R) .... 1242-1518 kPa (12.4-15.2 bar) (180-220 psi)

NOTE: Specified pressure was taken at 183 m (600 ft) above sea level. A 3.6 percent reduction in gauge pressure will result for each additional 300 m (1000 ft) rise in altitude.

11. If pressure is much lower than shown, remove gauge and apply oil to ring area of piston through spark plug bore. Do not use too much oil and do not get oil on the valves.

12. Crank engine over and record compression readings again.

    If pressure is higher than 1276 kPa (12.8 bar) (185 psi) for a 6081 CNG engine or 1518 kPa (15.2 bar) (220 psi) for a 6068 CNG engine, worn or stuck rings are indicated. Either replace piston rings or install new piston and liner sets as needed. Refer to CTM87 for 6081 CNG engines or CTM146 for 6068 CNG engines.

    If pressure is below 1069 kPa (10.7 bar) (155 psi) for 6081 CNG engines or 1242 kPa (12.4 bar) (180 psi) for 6068 CNG engines, it is possible that valves are worn or sticking. Recondition cylinder as needed. Refer to CTM87 for 6081 CNG engines or CTM146 for 6068 CNG engines.

13. Measure compression pressure in all remaining cylinders and compare readings. Recondition cylinders and valves, or replace rings and liners, as required.

RG,RG34710,3052 –19–15JUL96–2/2

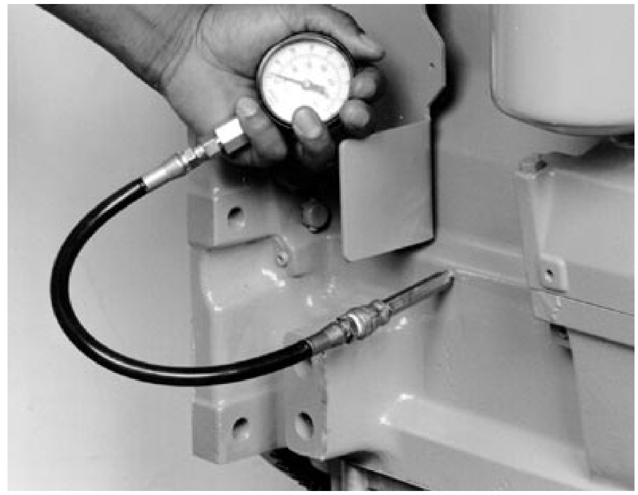
Check Engine Oil Pressure

1. Remove pipe plug from main oil galley using JDG782 Oil Galley Plug Tool.

2. Install No. 0070 (D1) Fitting, No. 2106 (19-HP) Hose, and JT05472[1] Gauge (or equivalent).

IMPORTANT: To achieve an accurate oil pressure reading, warm up engine to 105°C (220°F).

3. Start engine, run at speeds given below, measure oil pressure, and compare readings.



RG7067 –UN–20AUG98

Item	Measurement	Specification
Minimum No Load at 850 rpm (Idle)	Oil Pressure for 6081 CNG engine Oil Pressure for 6068 CNG engine	138 kPa (1.4 bar) (20 psi) 100 kPa (1.0 bar) (14 psi)
Maximum Full Load at 2200 rpm (Rated Speed)	Oil Pressure for 6081 CNG engine Oil Pressure for 6068 CNG engine	400 kPa (4.0 bar) (58 psi) 275 kPa (2.75 bar) (40 psi)

NOTE: The oil pressure regulating valve is designed so that adjustment of oil pressure should not be required.

[1] *Part of JT05470 (D15027NU) Universal Pressure Test Kit*

RG,RG34710,3053 –19–15JUL96–1/1

Diagnosing Turbocharger Malfunctions

Before replacing the turbocharger, determine what caused the failure of the defective unit, and correct the condition. This will prevent an immediate repeat failure of the replacement unit.

Noise or Vibration[1]

- Bearings not lubricated (insufficient oil pressure).
- Air leak in engine intake or exhaust manifold.
- Improper clearance between turbine wheel and turbine housing.
- Broken blades (or other wheel failures).

Engine Will Not Deliver Rated Power

- Clogged manifold system.
- Foreign material lodged in compressor, impeller, or turbine.
- Excessive dirt build-up in compressor.
- Leak in engine intake and exhaust manifold.
- Rotating assembly bearing failure.
- Damaged compressor or turbine blades.

Oil on Compressor Wheel or in Compressor Housing (Oil Being Pushed or Pulled Through Center Housing)

- Excessive crankcase pressure.
- Air intake restriction.
- Drain tube restriction.

Oil in Manifold or Dripping from Housing

- Excessive crankcase pressure.
- Air intake restriction.
- Drain be restriction.
- Damaged or worn journal bearings.
- Unbalance of rotating assembly.
- Damage to turbine or compressor wheel or blade.
- Dirt or carbon build-up on wheel or blade.
- Bearing wear.
- Oil starvation or insufficient lubrication.
- Shaft seals worn.

Turbine Wheel Drag

- Carbon build-up behind turbine wheel caused by cooked oil or combustion deposits.
- Dirt build-up behind compressor wheel caused by air intake leaks.
- Bearing seizure or dirty, worn bearings caused by excessive temperatures, unbalanced wheel, dirty oil, oil starvation, or insufficient lubrication.

[1] *Do not confuse the whine heard during run down with noise which indicates a bearing failure.*

RG,RG34710,3054 –19–15JUL96–1/1

Starting and Charging Systems Handling Precaution

CAUTION: Battery gas can explode. Keep sparks and flames away from batteries. Use a flashlight to check battery electrolyte level.

Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.

Always remove grounded (-) battery clamp first and replace it last.

DPSG,RG34710,97 –19–11AUG99–1/1

Starting and Charging Systems Diagnostics

Symptom	Problem	Solution
Low Battery Charge	Excessive engine idling	Idle engine only when necessary.
	Lights or accessories left on	Be sure all electrical switches are off before leaving vehicle.
	Continuous drain on battery	Check for current leakage on dirty battery top.
		Check for excessive parasitic drain on the battery by measuring current draw with ignition and all accessories off. If excessive draw is measured, remove fuses in fuse panel one at a time until circuit with excessive draw is located.
		See “Low Charging System Voltage Output” below.
	Faulty charging system output	Replace battery.
	Defective battery	Replace battery.
Low Charging System Voltage Output	Slipping drive belt	Adjust belt tension.
	Faulty voltage regulator	Replace voltage regulator.
	Defective diodes	Replace diodes.
	Defective electrical windings in alternator	Repair or replace alternator windings.
	Excessively worn or sticking brushes	Repair or replace alternator brushes.
High Charging System Voltage Output	Faulty voltage regulator	Replace voltage regulator.

Continued on next page RG,RG34710,3055 –19–15JUL96–1/2

Symptom	Problem	Solution
Noisy Alternator	Defective or badly worn drive belt.	Replace drive belt.
	Worn or defective bearings	Replace alternator bearings.
	Loose mounting or loose pulley drive	Tighten mounting and pulley.
	Misaligned drive belt or pulley	Check pulley condition, align if necessary.
Sluggish Starter Operation	Low battery charge	Recharge battery. If battery does not respond to charging, install a new one.
	Dirty battery cable connection(s)	Inspect all battery cable connections, and clean if necessary.
	Defective starter	Replace starter.
	Extremely cold weather	Warm-up battery before starting engine.
	Too-high engine oil viscosity	Drain oil and replace with recommended viscosity oil.
Starter Will Not Operate	Low battery charge	Recharge battery. If battery does not respond to charging, install a new one.
	Defective or nonfunctional neutral safety switch	Repair problem with neutral safety switch.
	Dirty battery cable connection(s)	Inspect all battery cable connections, and clean if necessary.
	Faulty starter	Repair or replace starter.

RG,RG34710,3055 –19–15JUL96–2/2

About This Section of the Manual

This section of the manual contains necessary information to diagnose the electronic engine control system portion of the engine. Use this information in conjunction with the 6081 CNG ENGINE REPAIR manual (CTM87) and 6068 CNG ENGINE REPAIR manual (CTM146).

See the 6081 CNG ENGINE REPAIR manual or 6068 CNG ENGINE REPAIR manual for:

- Removal of components
- Repair procedures
- Disassembly
- Inspection
- Assembly

Parts such as sensors, actuators, connectors, and wiring harnesses are serviceable and available.

To help diagnose electronic engine control problems, SPECIFICATIONS in Group 198 contains useful information, such as: ECU terminal identification, system wiring schematic, and component location.

IMPORTANT: Not under any circumstances, should the Electronic Control Unit (ECU) be opened.

DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

RG,RG34710,3056 –19–15JUL96–1/1

Physical Differences Between Early HFN01, Current HFN01/HFN03, and HFN02 Wiring Harnesses

Current Harness vs. Early Harness

Early Harness HFN01

- **Used on:**6081 CNG engines prior to April 14, 1997.
- **Characteristics:**
  - 6 Fuses and 2 Relays mounted “ON” engine
  - Wires that have 2 colors
  - Foot pedal wiring that runs wires through Vehicle Interconnect X-3 and Vehicle Interconnect X-10.

Current Harness HFN01/HFN03

- **Used on:**
  - 6081 CNG engines starting April 14, 1997.
- **Characteristics:**
  - 7 Fuses and 2 Relays located in a Fuse/Relay box mounted “Away” from engine.
  - Wires that have one solid color and a wire number
  - Foot pedal wiring that runs all wires through Vehicle Interconnects X-3 and X-4.

Current Harness HFN02

- **Used on:**
  - All 6081 CNG engines with 280 Hp
- **Characteristics:**
  - 7 Fuses and 2 Relays located in a Fuse/Relay box mounted “Away” from engine.
  - Wires that have one solid color and a wire number
  - Foot pedal wiring that runs all wires through Vehicle Interconnects X13.
  - Throttle uses a 6 pin Deutsch connector.

Differences in Current Harness between 6068, 6081, and 6081 with 280 Hp CNG engines

6068 CNG engine has:

- A crank sensor.
- A two pin cam sensor connector.
- A cam sensor that is located on the rear of the engine.
- Cam sensor wiring that uses a different ECU pin number and different wire numbers than the cam sensor on the 6081 CNG engine.

Continued on next page

- EBP, PTP, NGTT, and NGTP sensors
- 2 - 10 way MetriPack interconnect connectors

6081 CNG engine has:

- A three pin cam sensor connector.
- A cam sensor that is located on the front of the engine.
- Cam sensor wiring that uses a different ECU pin number and different wire numbers than the cam sensor on the 6068 CNG engine.
- EBP, PTP, NGTT, and NGTP sensors
- 2 - 10 way MetriPack interconnect connectors

6081 280 Hp CNG engine has:

- A three pin cam sensor connector.
- A cam sensor that is located on the front of the engine.
- Cam sensor wiring that uses a different ECU pin number and different wire numbers than the cam sensor on the 6068 CNG engine.
- UTP sensor and Environment sensor to replace sensors listed above
- Knock sensor and Knock module
- 1 - 23 way Deutsch interconnect connector

Support in this manual to help to distinguish these areas:

- Schematics for trouble codes have tables to help show the wire color and numbers for the current and early wiring harnesses.
- These schematics for ALL DTCs represent the “Current Wiring Harness”, so it is important to pay attention to notes which will point out differences.
- Four electrical schematics in Group 198 later in this manual:

1. 6081 CNG Engine with “Early Wiring Harness” (HFN01)
2. 6081 CNG Engine with “Current Wiring Harness”(HFN01/HFN03)
3. 6068 CNG Engine (HFN51)
4. 6081 CNG Engine with 280 Hp (HFN02)

DPSG,RG40854,79 –19–09JUN99–2/2

Electrical Concepts

Tests will include making measurements of voltage and resistance and making checks for open circuits and short circuits. An understanding of the following concepts is required to use the diagnostic procedures:

- Voltage (volts)
- Current (amps)
- Resistance (ohms)
- Open Circuit
- Short Circuit

RG,RG34710,3057 –19–15JUL96–1/1

Using a Digital Multimeter

RW11274 –UN–12DEC88

It is recommended that a digital multimeter (JT05791 or equivalent with an analog display) be used to make the required measurements in the diagnostic procedures. A knowledge of the operation of the particular meter used is assumed.

Instructions for measuring voltages take the following form:

Measure voltage from Point A (+) to Point B (-)

In this example, the positive test lead from the volt-ohm input of the meter should be connected to Point A and the negative test lead from the common input of the meter should be connected to Point B.

Unless otherwise stated, all voltage measurements are direct current (D.C.).

In making a resistance measurement, be careful to use the correct resistance range on the meter. Disconnect appropriate connectors or turn off key switch, as directed by diagnostic procedures later in this group.

Operation of JT05791 Digital Multimeter

Digital Display—The digital display reads values of variables measured. It is updated 2-1/2 times a second. In normal operation the meter selects the range which will show the most accurate reading. When the value being measured is too large for the meter to display, an “OL” (overload) will be shown. Position of decimal point will change, depending upon range in use. The display also verifies the type and size of measurement being made.

Analog Display—This is a bar graph located below the digital display. The analog display is updated 25 times per second. It is more responsive to help see trends developing in variable readings. The polarity indicator is also part of this display. The full bar graph indicates the maximum reading for a scale. The arrowhead indicates OL.

Continued on next page

RG,RG34710,3058 –19–15JUL96–1/2

Selector—The selector is the rotary switch which allows the operator to select the type of variable to be measured. For amperage readings, the red (+) contact must also be moved to the desired terminal.

Diode Test—The “diode test” position can be used to test diodes. A single tone will sound in the forward bias direction along with a display of forward voltage drop. The meter also can be used to test continuity. If the circuit is open, there will be no tone. If the circuit has continuity (less than 150 ohms) a continuous tone will sound.

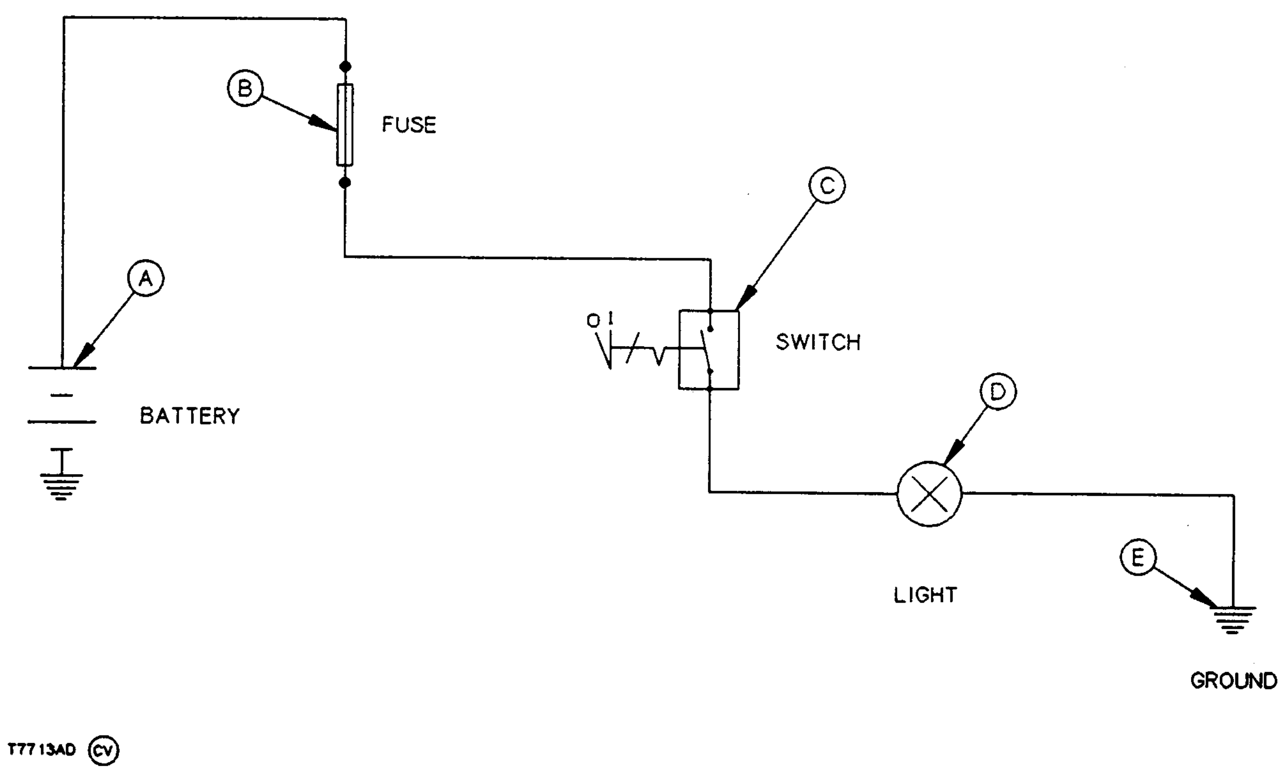
Autoranging—The meter powers up in the autorange mode. Range is selected automatically. The digital display indicates the range.

Manual Ranging—when the violet button in the middle of the selector knob is pressed with the meter on, the range is selected manually. You can “dial” through ranges by repeatedly depressing the button. As in the autorange mode, range in use will be shown in the digital display. To return to autorange mode, press range button for 1 second. Meter will “chirp” once and return to autorange mode.

Touch Hold—If the violet button in the selector is depressed and held down while the meter is being turned on, and held until the display reaches full brightness the meter is in the “touch hold” mode. In touch hold, any reading which is constant for a minimum of 1/2 second and differs from the previous reading by at least one bar of the analog display will be “captured” by the meter. A tone (beep) will sound when the reading has been held. The operator can then remove the probes and the reading will be retained. Touch hold is always in autorange mode. Turn the selector switch to “OFF” to deactivate touch hold.

RG,RG34710,3058 –19–15JUL96–2/2

Electrical System Basic Information



T7713AD –19–27FEB92

A—Battery
B—Fuse
C—Switch
D—Light
E—Ground

Electrical Circuit Malfunctions

1. There are four common circuit malfunctions

   - High-Resistance Circuit
   - Open Circuit
   - Grounded Circuit
   - Shorted Circuit

2. Three sections in a simple circuit where these malfunctions can occur;

   - Before the controlling switch (C).
   - Between the controlling switch and before the component, light (D).
   - After the component.

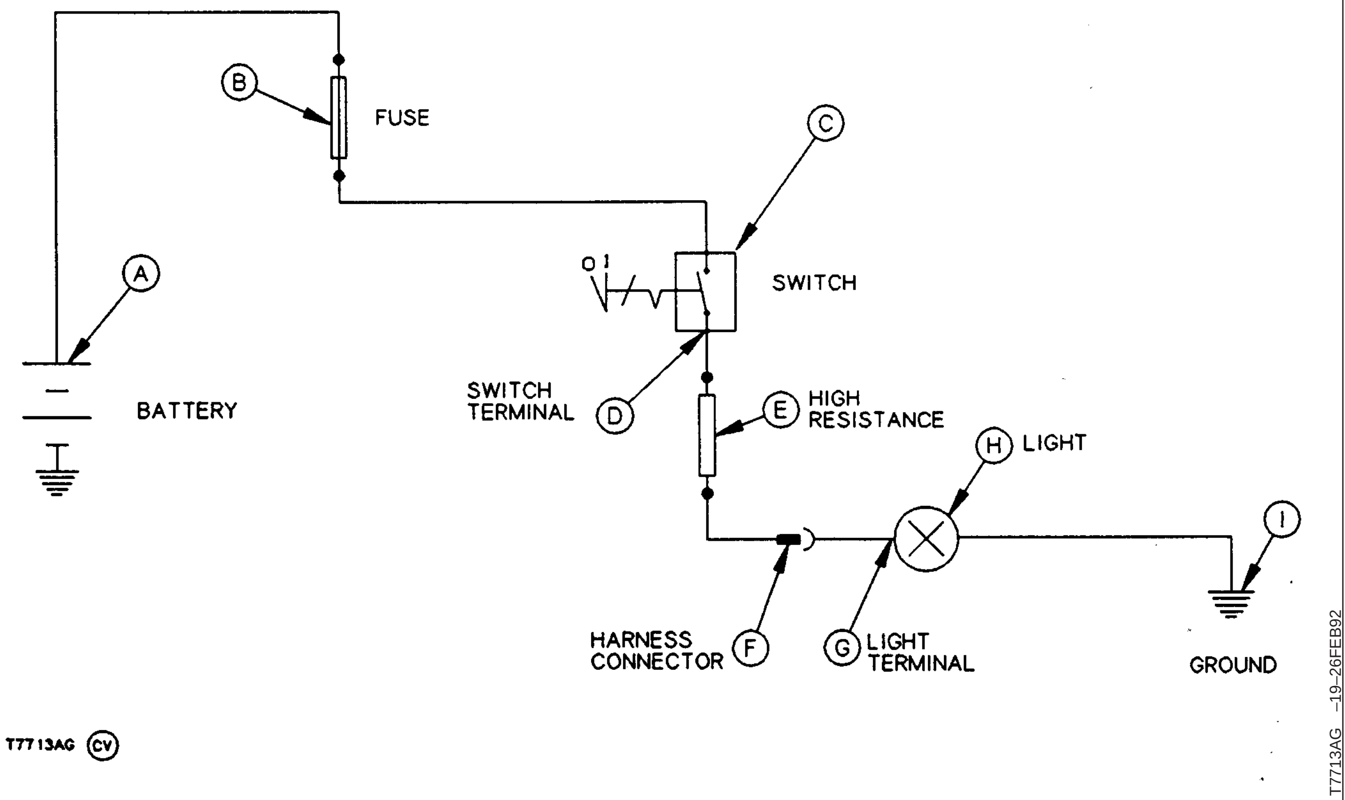
Component malfunctions can easily be confused with circuit malfunctions. Therefore, care must be exercised when isolating the cause of the problem.

Example: Light does not operate or is dim when switch is turned ON, until switch connector is disconnected and reconnected.

Reason: High resistance caused by a dirty switch connector, caused a voltage drop which prevented the proper amount of current from flowing to the light.

RG,RG34710,3059 –19–15JUL96–1/1

High Resistance Circuit



A—Battery
B—Fuse
C—Switch
D—Switch Terminal High Resistance
F—Harness Connector
G—Light Terminal
H—Light
I—Ground

A high resistance circuit can result in slow, dim or no component operation.

Examples: Loose, corroded, dirty or oily terminals. Wire size too small. Strands broken inside the wire. Poor ground connection to frame.

To locate the cause of high resistance.

With switch (C) ON, check for battery voltage between switch and ground (I) at an easily accessible location, like harness connector (F).

If less than battery voltage is measured, check again closer to switch.

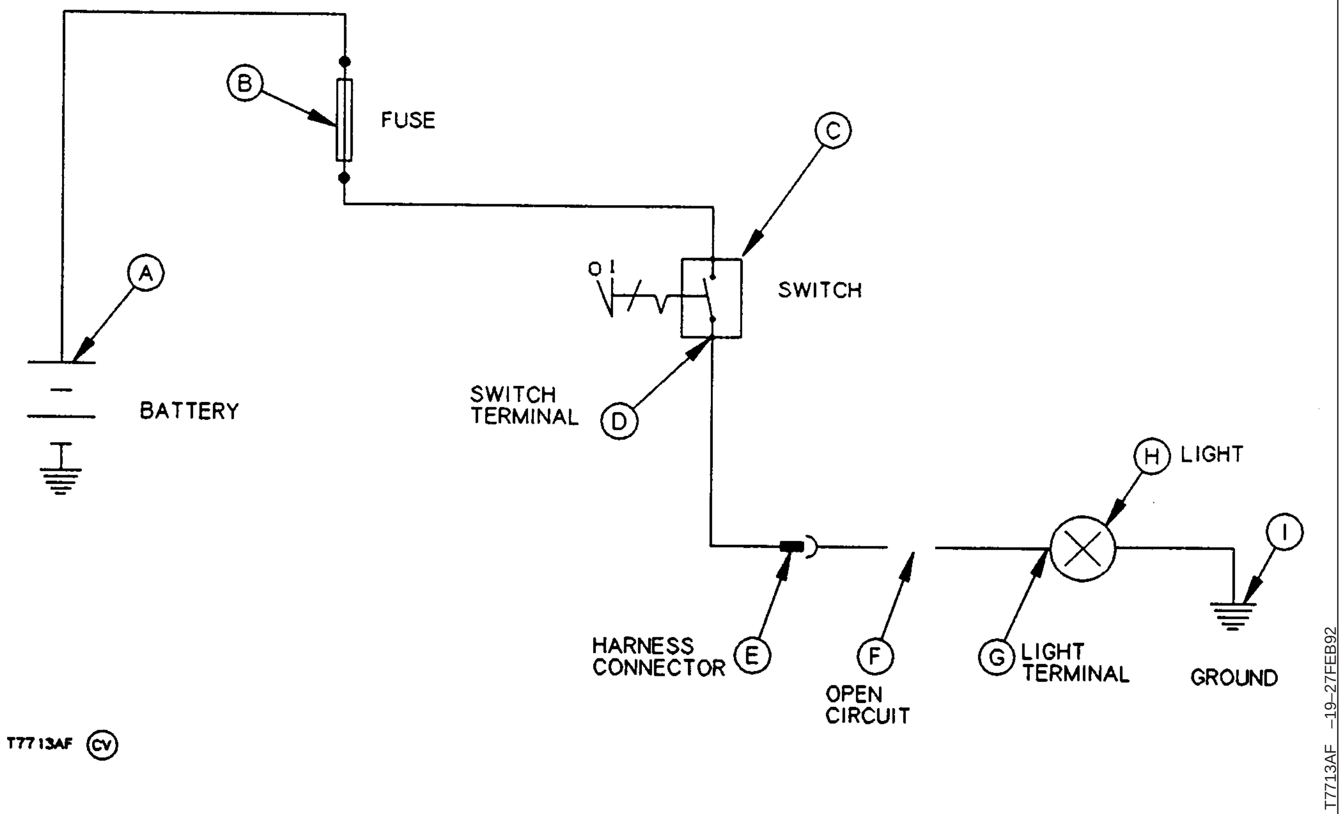
If battery voltage is measured, check closer to ground to locate point of voltage drop. The example shows high resistance (E) between switch and harness connector.

Repair circuit as required. In the example, strands were broken inside the wire, replace that section of wire.

Repeat check-out procedure after repair.

RG,RG34710,3060 –19–15JUL96–1/1

Open Circuit



A—Battery
B—Fuse
C—Switch
D—Switch Terminal
E—Harness Connector
F—Open Circuit
G—Light Terminal
H—Light
I—Ground

An open circuit will result in no components operating. Fuse may or may not be blown.

Example: Broken wire, disconnected component terminal, pins inside a connector not making contact, blown fuse, open circuit breaker, failed switch or component, or a disconnected ground wire.

To locate a open circuit:

Check fuse. If blown, replace and operate circuit. If fuse blows a second time, continue check.

With switch (C) ON, check for battery voltage at switch terminal (D).

If no voltage is measured, check switch, fuse, and wiring to battery.

If battery voltage is measured, check for voltage closer to ground at harness connector (E).

If no voltage is measured, wire may be broken between switch and connector.

If battery voltage is measured, inspect connector pins. If pins are OK check for voltage at light terminal (G).

In the example, zero voltage will be measured at light terminal, indicating a broken wire between harness connector and light terminal.

If battery voltage had been measured, the next check for voltage would be at ground connection (I).

Normal measured voltage at a ground connection should be 0.0 to 0.5 volts.

Continued on next page

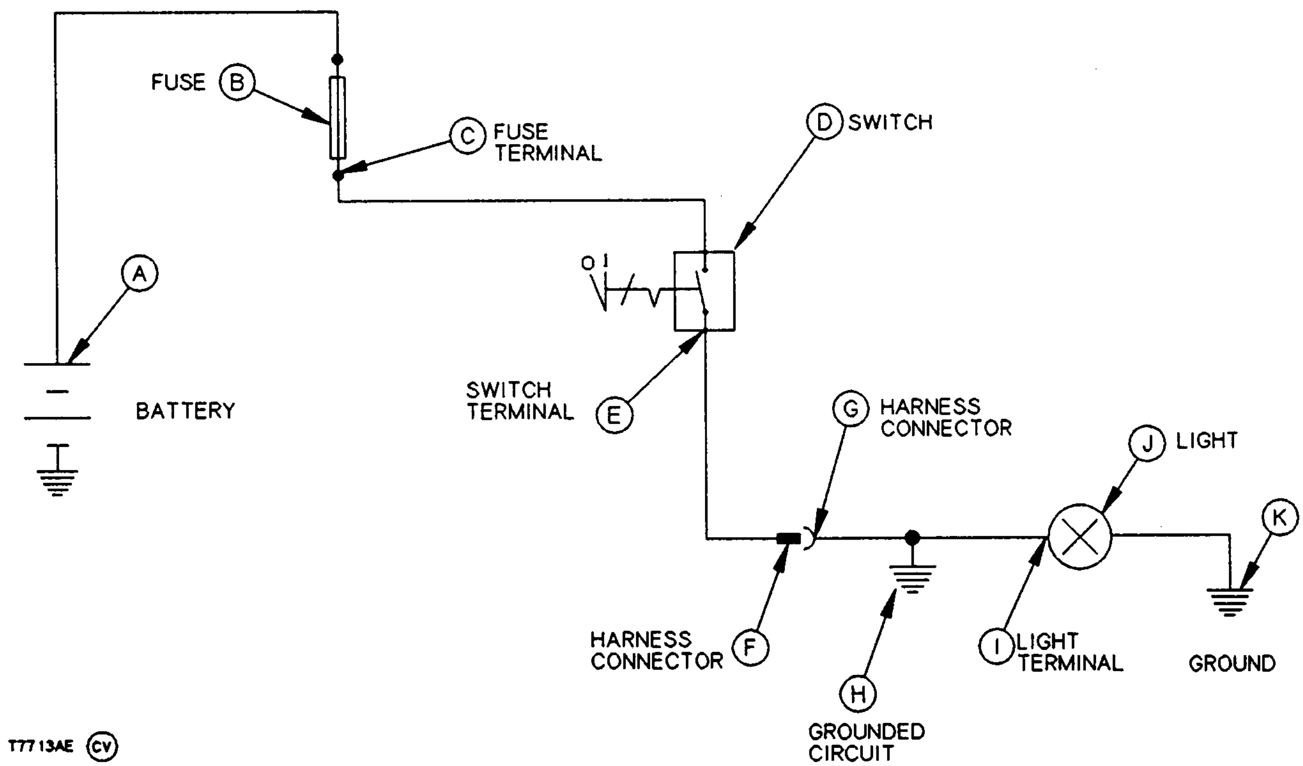
RG,RG34710,3061 –19–15JUL96–1/2

If battery voltage is measured, poor connection to frame or broken wire is indicated.

When problem is located, repair as needed then repeat last check.

RG,RG34710,3061 –19–15JUL96–2/2

Grounded Circuit



T7713AE –19–27FEB92

A—Battery
B—Fuse
C—Fuse Terminal
D—Switch
E—Switch Terminal
F—Harness Connector
G—Harness Connector
H—Grounded Circuit
I—Light Terminal
J—Light
K—Ground

If no component operates, the fuse is blown and replacement fuses blow immediately or the circuit breaker is open and reopens when reset, a grounded circuit exists. (Example: power wire contacting frame or other metal component). A wire may be pinched or insulation may be worn from a wire.

To isolate the location of a grounded circuit:

If circuit is grounded between battery and fuse, wire will be burned and circuit will be open, fuse will not be blown.

If fuse is blown, remove fuse from circuit, disconnect circuit near its center, such as harness connector (F), turn switch (D) ON, check for continuity to ground at harness connector (F). This will check harness from harness connector to fuse.

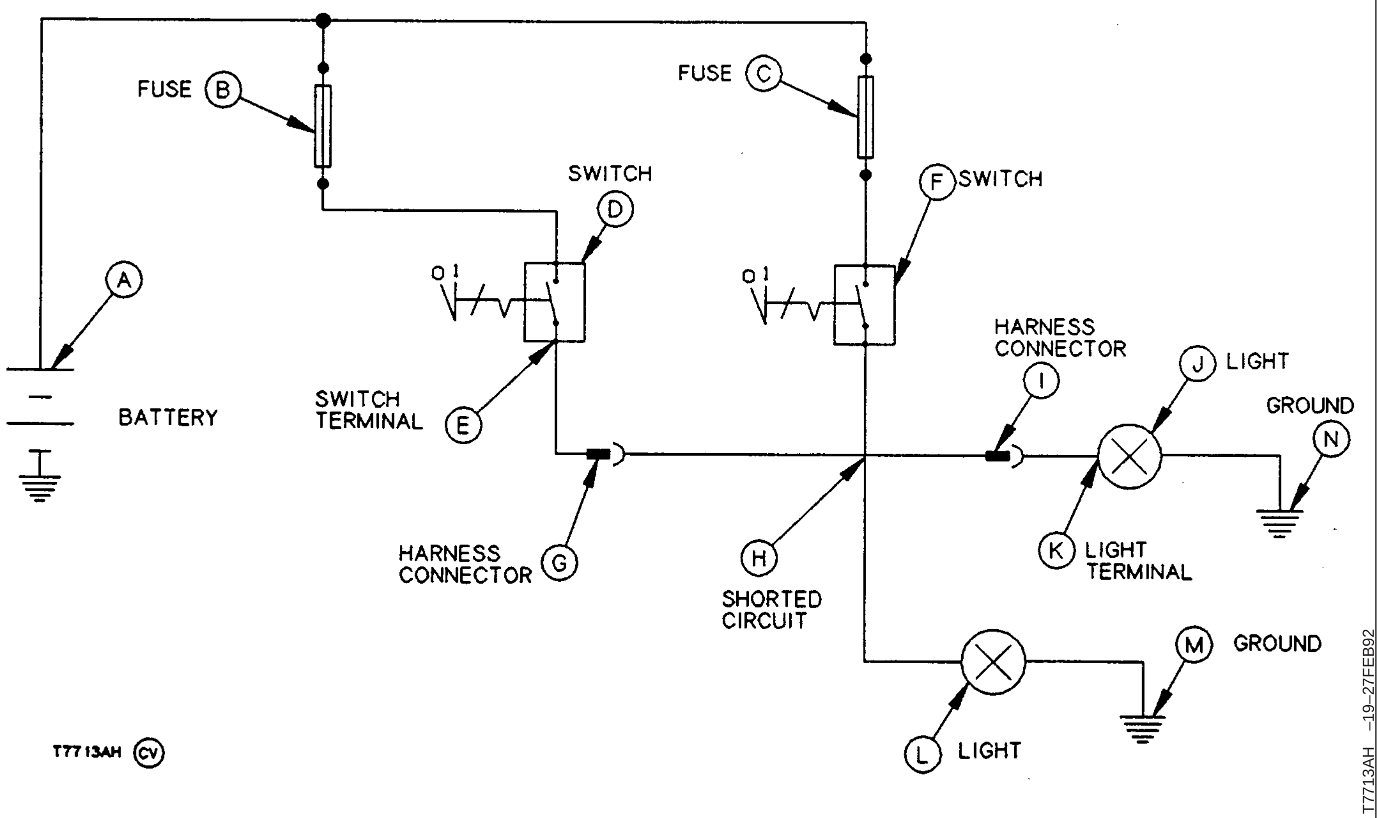
If continuity to ground is measured, there is a pinched or bare wire between fuse (B) and harness connector (F).

If continuity to ground does not exist, disconnect ground (K) from frame. Measure continuity to ground at harness connector (G). This checks harness from harness connector to ground terminal. In the example continuity to ground will exist because circuit is grounded (wire is pinched) at (H).

If continuity exists, disconnect circuit at light terminal (I) and measure continuity to ground on light terminal. This checks harness from light to ground terminal. In the example continuity will not exist, indicating a grounded circuit between the light and harness connector (G). Repeat check-out procedure after repair.

RG,RG34710,3062 –19–15JUL96–1/1

Shorted Circuit



A—Battery
B—Fuse
C—Fuse
D—Switch
E—Switch Terminal
F—Switch
G—Harness Connector
H—Shorted Circuit
I—Harness Connector
J—Light
K—Light Terminal
L—Light
M—Ground
N—Ground

A shorted circuit causes components in separate circuits to operate when a switch in either circuit is turned ON. (Example: two harnesses rubbing together until insulation is worn through allowing bare wires to touch). Components can also become shorted. However, shorted components will usually blow the fuse.

To locate a shorted circuit:

Turn switch (F) ON then OFF, turn switch (D) ON then OFF, both lights (J and L) will be ON when either switch (D or F) is ON.

Turn switch (F) ON. Both lights (J and L) will be ON, only light (L) should be ON.

Disconnect wire from switch component that should not be ON. In the example, disconnect wire from terminal (E) at switch (D). Light (J) remains ON.

Disconnect circuit at convenient places like harness connectors (G), (I) and light terminal (K) until light (J) goes OFF.

The shorted circuit will be between the last two places the circuit was disconnected. In the example, it is between harness connectors (G and I). Light (J) will go OFF when harness connector (I) is disconnected. Inspect harness between connectors (G and I).

Continued on next page

Repair or replace wires and harnesses as needed. Install tie bands and clamps on harnesses as required to prevent future failures.

Repeat check-out procedure after repair.

RG,RG34710,3063 –19–15JUL96–2/2

Using the Diagnostic Scan Tool (DST)

NOTE: All codes in the DST are identified as “Fault Codes” and not “Trouble Codes. Please note that Fault codes are the same as Trouble codes.

The Diagnostic Scan Tool (DST) allows DTCs to be read and cleared, the ability to view sensor and actuator voltage values and calculated values, and the ability to perform special tests.

Loading the Diagnostic Software

Before using the DST, the diagnostic software must be loaded into the computer. To load the diagnostic software into the computer, proceed as follows:

1. Turn the computer “on”.

2. After the computer has finished booting up, it will display **C:** .

3. Insert the diagnostic software disk into the floppy drive

4. Type **copy a:*.* c:** then press “ENTER”.

5. The diagnostic software will be copied onto the computer hard drive

Connecting and Starting the DST

1. Connect the diagnostic cable to the RS232 port on the back of the computer.

2. Connect the diagnostic cable to the diagnostic connector on the vehicle. There are two diagnostic connectors on the vehicle, one is located under the dash, and one is located near the control panel in the engine compartment

3. Turn the computer ON.

4. After the computer has finished booting up, it will display **C:** .

Continued on next page RG,RG34710,3064 –19–15JUL96–1/9

NOTE: If using Windows 95 or 98 as operating platform, it should load now.

5. Place the vehicle ignition in the “ON” position

6. Type **JDNG** then press “ENTER”.

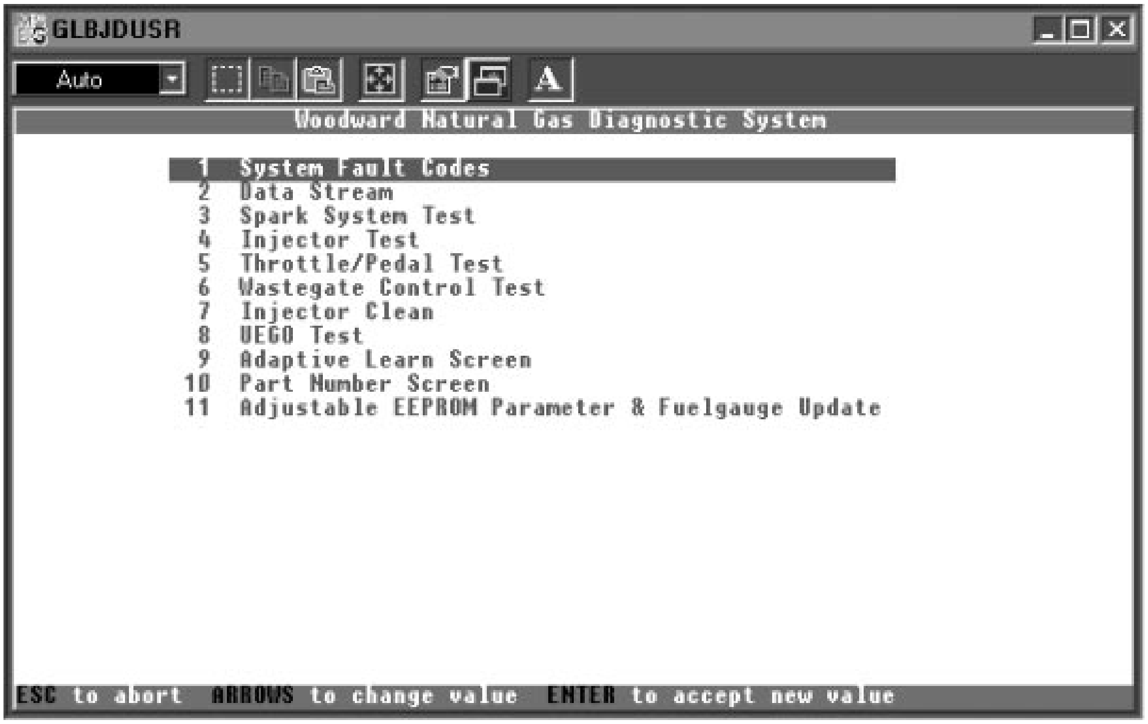
7. The John Deere Natural Gas Diagnostic System main menu should now appear

NOTE: If using Windows 95 or 98 as operating platform, depress the “Windows Start” button and select “Run” from the menu. At the dialog box, type a: JDNG and then press the “OK” button.

8. To Exit the diagnostic software, press “ESC”.

NOTE: If the message “Unable to establish connection to the JDNG control system!” is displayed, ensure the ignition is in the “ON” position and the communication cable is connected tightly, then retry Step 6 above.

Continued on next page RG,RG34710,3064 –19–15JUL96–2/9



RG11301 –19–11OCT00

RG11302 –19–11OCT00

Main Menu

The main menu is the starting point from which the diagnostic screens and special tests are accessed. Depending on the ECU, there are two possible menus.

The first menu is for engines using the 1.1 controller and the 1.2 controllers on non HFN02 engines. The second menu is for the 1.2 controller on HFN02 engines. The selections, as displayed on the screen, are shown above.

Continued on next page

RG,RG34710,3064 –19–15JUL96–3/9

To choose one of the selections, use the arrow keys to highlight the desired selection and press “ENTER”. The DST will then go to the screen or mode that has been selected. Modes 1, 2, 3, 4, 5, 8, 9, 10, 11, and 12 can be accessed with the ignition ON and the engine either stopped or running. Modes 6 and 7 can only be accessed with the ignition ON and the engine stopped. Modes 3, 4, 5, 6, and 7 have a 10 minute time limit from the time of the test mode entry. Running one of these tests longer than 10 minutes will result in the DST terminating the test and reverting back to the main menu.

Function Keys

ESC - Pressing the “ESC” key will cause the DST to exit the current screen. Pressing the “ESC” key twice will Exit the program.

ENTER - The “ENTER” key is used to clear DTCs.

SPACE BAR - Pressing the “SPACE BAR” will cause the DST to pause. When the DST is paused, pressing any key will resume normal DST operation.

PGUP/PGDN - Pressing either the “PGUP” or “PGDN” keys while in the System Fault Code, Data Stream, or the special test screens will cause the DST to return to the main menu. At the main menu pressing the “PGUP” key will cause the highlight to move to the number 1 menu option; pressing the “PGDN” key will cause the highlight to move to the last menu option.

F2 - The “F2” key can be used to save the current screen to the computer’s memory. This function can be used for storing screens of information for later reference. After pressing the “F2”, you will be asked to assign a name to the saved screen of information. The name can be up to eight (8) characters long, and can have NO spaces in it. The name should be followed by “.dat”, again with NO spaces. For example, a saved screen name could be “test1.dat”. The saved screens could then be viewed using a text editing program such as Write or Notepad.

T & P - The “T” and “P” keys are used to graph data. Graphing the values and voltages can be a very useful tool in doing intermittent fault diagnosis. The diagnostic software includes graphing and data logging capability. These features enhance the ability to diagnose and repair possible problems. The graphing feature allows sensor inputs and select control output variables to be plotted in real-time while the engine is running.

To plot a variable you must first TAG the variable you wish to plot. To do this, use the up-down-left-right arrow keys to highlight the variable, then press the “T” key. The “T” key is used as a toggle switch to highlight and un-highlight the variable. Up to six (6) variables can be plotted at a given time.

Next press the “P” key to invoke the plotting feature. You will first be prompted for the desired time interval for each display screen. The default is 10 seconds. This can be increased or decreased as necessary to display the desired results. Next you must decide whether you want to save the displayed data to a file. If so, you must define a file name where the data will be stored. The name can be up to eight (8) characters long, and can have NO spaces in it. The name should be followed by “.dat”, again with NO spaces. It is best to use descriptive names such as “Test1.dat” or “idle_MAP.dat” that can be easily identified later. The saved file could then be viewed using a text editing program such as Write or Notepad. Data logging starts when plotting starts and is recorded for the duration of one display screen.

You are now ready to plot. Simply press the “ENTER” key to observe the plotted variables. The plot sweeps across the screen from left to right. To pause the display screen press the “SPACE BAR” at any time during plotting. To continue plotting simply press the “SPACE BAR” again. To escape the plotting feature and return to the Data Stream screen, press the “ESC” key.

Continued on next page

The range of each variable is listed along the left side of the display and the line style is listed along the bottom of the screen. For best visual results use a color monitor. To determine the calculated value of a variable, simply note the percent scale of the plotted variable along the vertical axis and multiply it by the range of the variable. For example, if the exhaust back pressure (EBP) parameter is displayed at 33% of full scale and the EBP sensor range is 0 to 30 psia, the EBP value is 33% x 30 psia = 10 psia.

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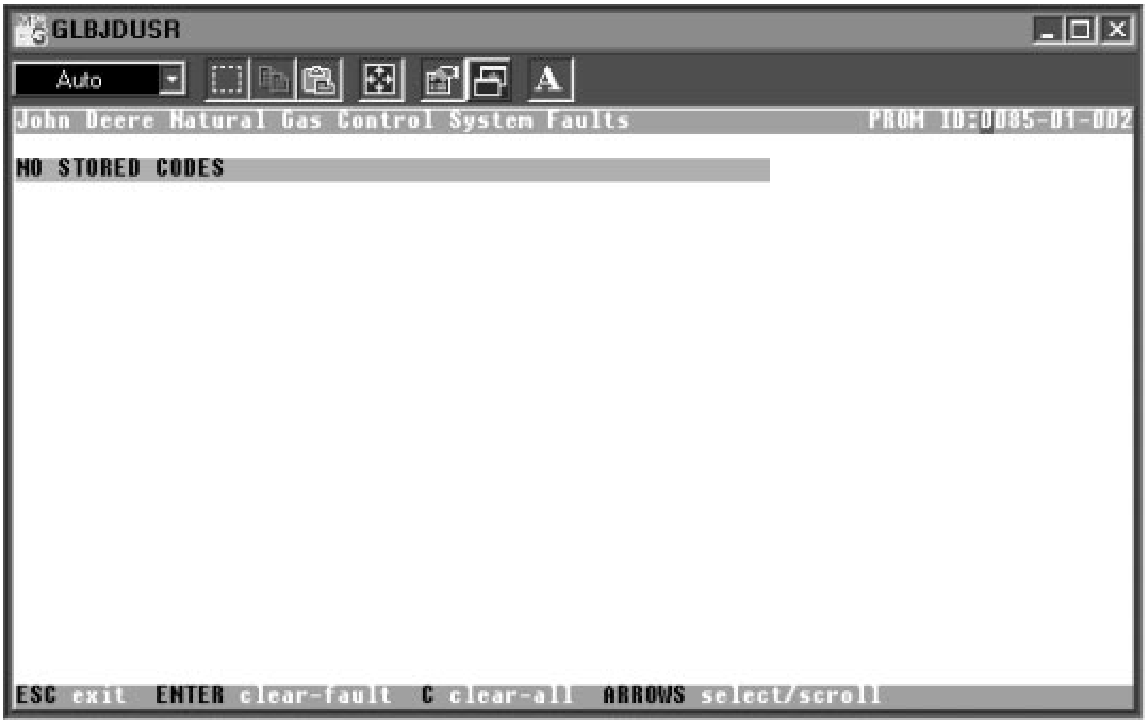
RG,RG34710,3064 –19–15JUL96–5/9



RG11303 –19–11OCT00

System Fault Codes

NOTE: System fault codes are the same as diagnostic trouble codes.

The System Fault Code screen is used to view and clear DTCs which have been stored in the ECU's memory.

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DST in Group 115 for instructions on using the DST.

Checking Fault Codes

NOTE: Fault codes are the same as diagnostic trouble codes.

The System Fault Code screen contains a listing of all of the DTCs that have been set and stored in the ECU's memory. The DTC can either be an active or stored code. An active code means that it can not be cleared until the present problem that set the code is repaired. A stored code has already been repaired and can be cleared.

Clearing Fault Codes

NOTE: Fault codes are the same as trouble codes.

NOTE: Record faults before erasing them for reference during diagnostics.

To clear a DTC from memory use the arrow keys to move the cursor until the word "FAULT" is highlighted. Press the "ENTER" key to clear the fault from the ECU's memory. If the code reappears, there is an active code. Go to the corresponding diagnostic chart.

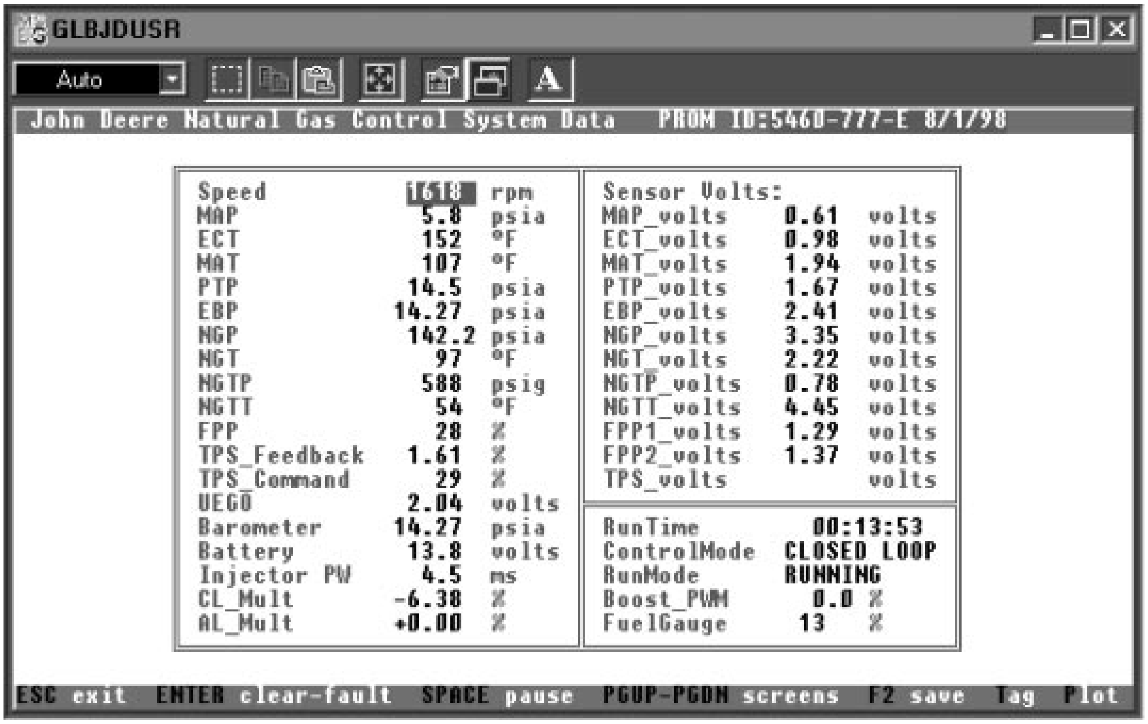
Continued on next page

RG,RG34710,3064 –19–15JUL96–6/9

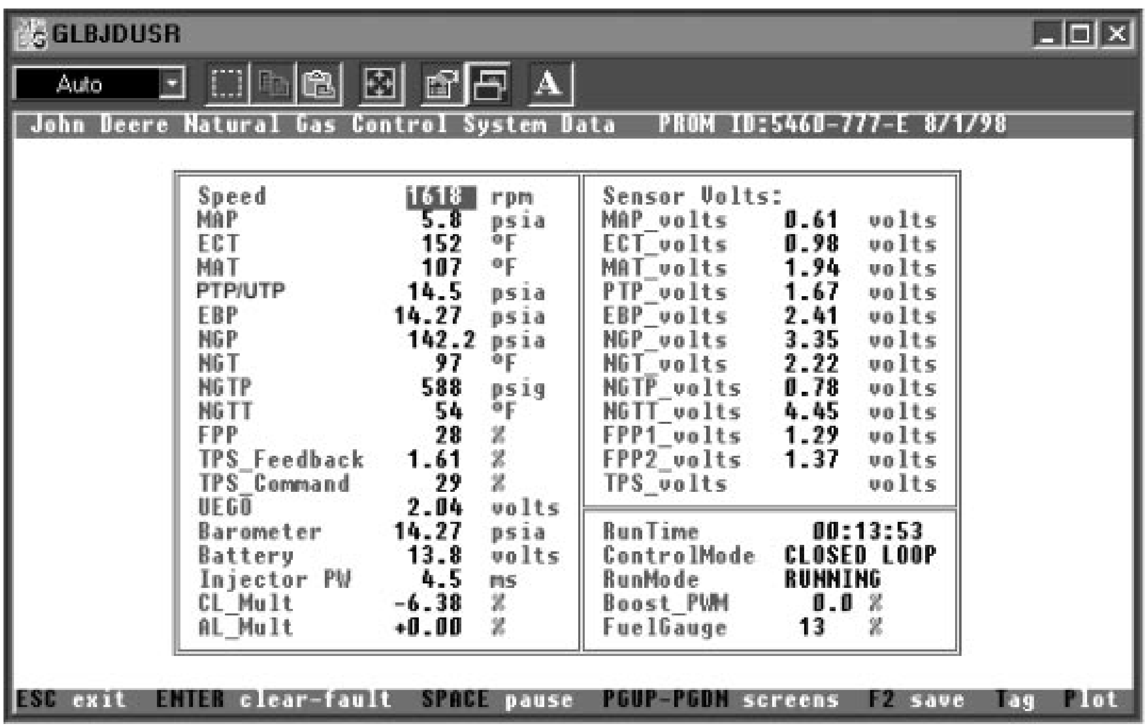
Reading the PROM ID and Date Code

The PROM ID and Date Code are located in the upper right hand corner of the diagnostic screen. This information is used to track the exact version of the PROM installed in the ECU. It is used to verify that the correct PROM is installed and to check the installation of any software updates.

Continued on next page RG,RG34710,3064 –19–15JUL96–7/9



RG11304 –19–06OCT00



RG11400 –19–06OCT00

Data Stream

Data Stream information is sensor and actuator voltage values and sensor calculated values the ECU is using as it controls fuel, air, and ignition. There are two possible screens that will display this information. The first screen is used for engines using the 1.1 controller and the 1.2 controller on non 280 Hp engines. The second screen displays the information for the 1.2 controller on 280 Hp engines.

Continued on next page

RG,RG34710,3064 –19–15JUL96–8/9

Reading Sensor and Actuator Values

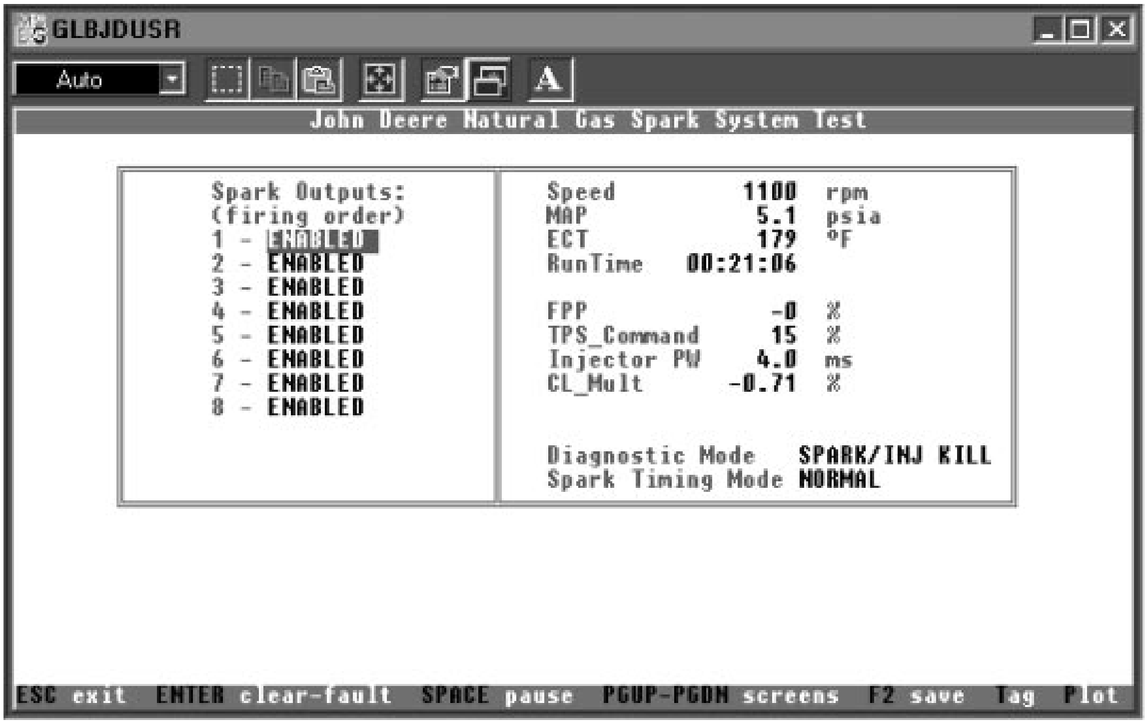
Most applicable sensor and actuator values are displayed on the Data Stream screen. The display shows the voltage the ECU is reading and, for sensors, the sensor calculated value.

NOTE: The latest Data Stream screen includes parameters for several engine platforms. Some of the parameters share lines of data, so it is important to know what engine type is present.

NOTE: If a DTC for a sensor is active, the calculated value for that sensor may be a default, "limp home" value and the voltage value will be the actual sensor voltage. Use the voltage value when performing diagnostics unless directed to do otherwise by the diagnostic chart

RG,RG34710,3064 –19–15JUL96–9/9

Spark System Test



RG11305 –19–06OCT00

The Spark System Test allows the spark system on individual cylinders to be disabled, which allows the spark system for individual cylinders to be evaluated.

If the Spark System Test is selected with the engine running below 1000 RPM, the minimum throttle command will lock into the position it was in when the test mode was entered. If the Spark System Test is selected with the engine running above 1000 RPM, the throttle will continue to operate normally.

Disabling Spark Outputs

To disable the ignition system for an individual cylinder, use the up and down arrow keys to highlight the desired spark output. Then press the “ENTER” key. The word ENABLED will change to DISABLED and the selected spark output will be disabled. The spark output can be re-enabled by pressing “ENTER” again. If the engine is running below 1000 RPM, the spark output will stay disabled for 15 seconds and then reset. If the engine is running above 1000 RPM, the spark output will stay disabled for 5 seconds and then reset. This test mode has a time limit of 10 minutes.

NOTE: *The spark outputs are arranged by firing order, not by cylinder number. For example, number 2 is NOT cylinder number 2, it is the second cylinder in the firing order. The 6081 CNG and 6068 CNG engine firing order is 1-5-3-6-2-4.*

Performing the Spark System Test

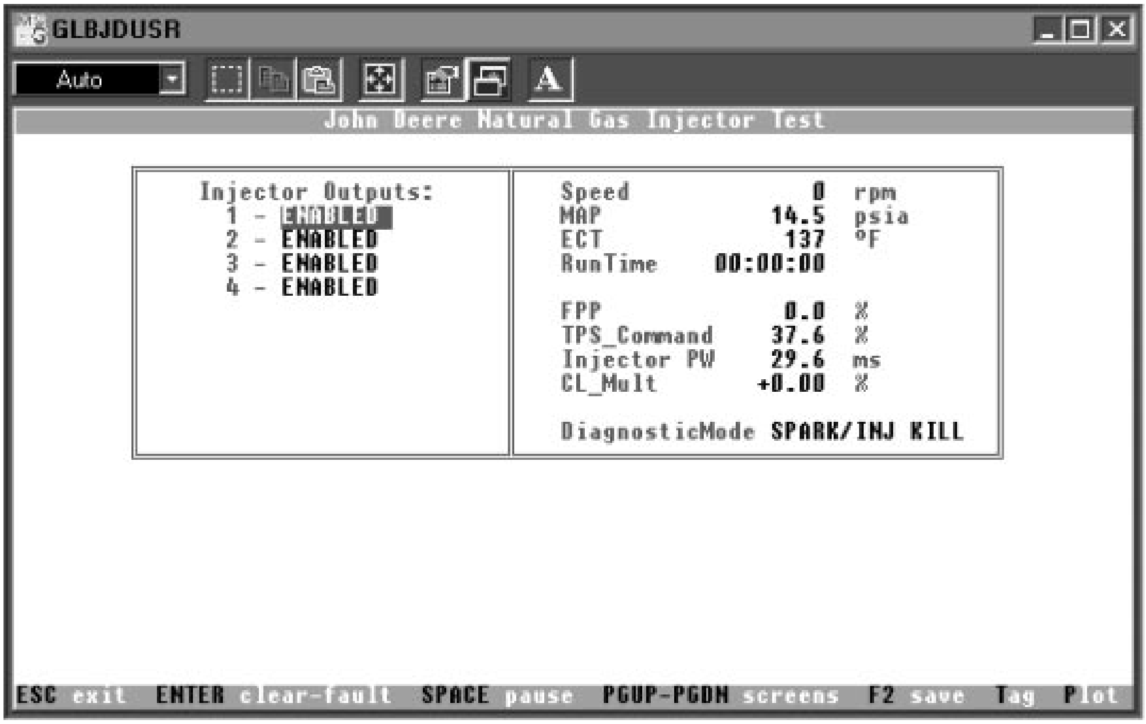
To perform the Spark System Test, disable each cylinder one-at-a-time while watching the engine speed. The engine speed should drop equally for each cylinder when it is disabled.

Data Logging

When in the Spark System Test mode, the data logging feature of the software can be used as described in the description of the DATA Stream mode earlier in this Group.

RG,RG34710,3065 –19–15JUL96–1/1

Injector Test



RG11307 –19–11OCT00

The Injector Test is used to disable individual injector drivers. Each driver operates a pair of fuel injectors. Disabling a pair of injectors allows each pair to be evaluated.

If the Injector Test mode is selected with the engine running below 1000 RPM, the minimum throttle command will lock into the position it was in when the test mode was entered. If the Injector Test mode is selected with the engine running above 1000 RPM, the throttle will continue to operate normally.

Disabling Injector Drivers

To disable an injector driver, use the up and down arrow keys to highlight the desired injector driver. Then press the "ENTER" key. The word ENABLED will change to DISABLED and the selected injector driver will be disabled. The injector driver can be re-enabled by pressing "ENTER" again. If the engine is running below 1000 RPM, the injector driver will stay disabled for 15 seconds and then reset. If the engine is running above 1000 RPM, the injector driver will stay disabled for 5 seconds and then reset.

Performing the Injector Test

To perform the Injector Test, disable each pair of injectors one-at-a-time while watching the engine speed and closed loop multiplier during the first 3-4 seconds after the pair is disabled. When a pair is disabled, the engine speed and closed loop multiplier should change equally for each pair.

To determine the driver number for each pair of injectors on the fuel metering block, use the chart below.

Continued on next page RG,RG34710,3066 –19–15JUL96–1/2

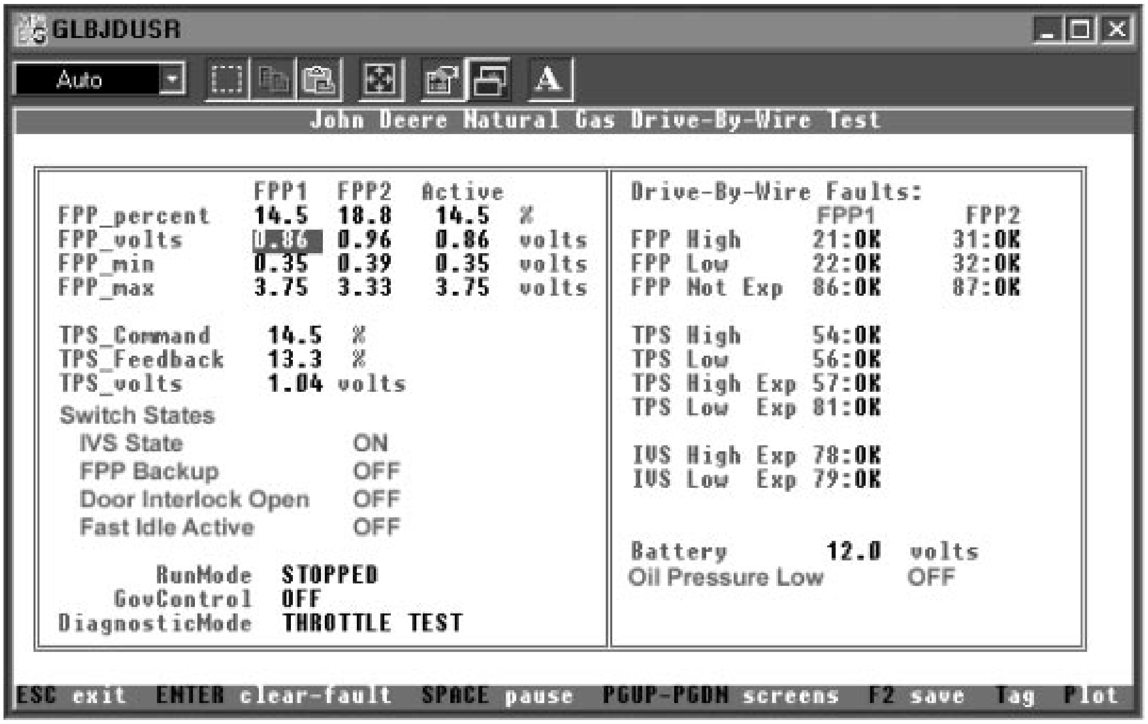
ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
Y3	A	1 Orange	Orange/Lt. Blue	Inj. 1 High
W1	B	2 Brown	Brown/Lt. Blue	Inj. 1 Low
X2	A	3 Orange	Orange/Lt. Green	Inj. 2 High
W2	B	4 Brown	Brown/Lt. Green	Inj. 2 Low
Y1	A	5 Orange	Orange/White	Inj. 3 High
T1	B	6 Brown	Brown/White	Inj. 3 Low
Y2	A	7 Orange	Orange/Yellow	Inj. 4 High
X1	B	8 Brown	Brown/Yellow	Inj. 4 Low

Data Logging

When in the Injector Test mode, the data logging feature of the software can be used as described in the description of the DATA Stream mode earlier in this Group.

RG,RG34710,3066 –19–15JUL96–2/2

Throttle/Pedal Test



RG11308 –19–06OCT00

The Throttle/Pedal Test mode allows the throttle to be controlled directly with the foot pedal and is used during the diagnostic charts specified for FPP and TPS related faults.

To execute the Throttle/Pedal Test, the ignition must be ON and the engine must be OFF.

FPP displays the current position of the foot pedal as a percentage. FPP_volts displays the voltage which the ECU is reading from both the FPP1 and FPP2 sensors. FPP min shows the lowest value FPP_volts has reached in the current cycle. The active column refers to the primary FPP sensor that the ECU selects.

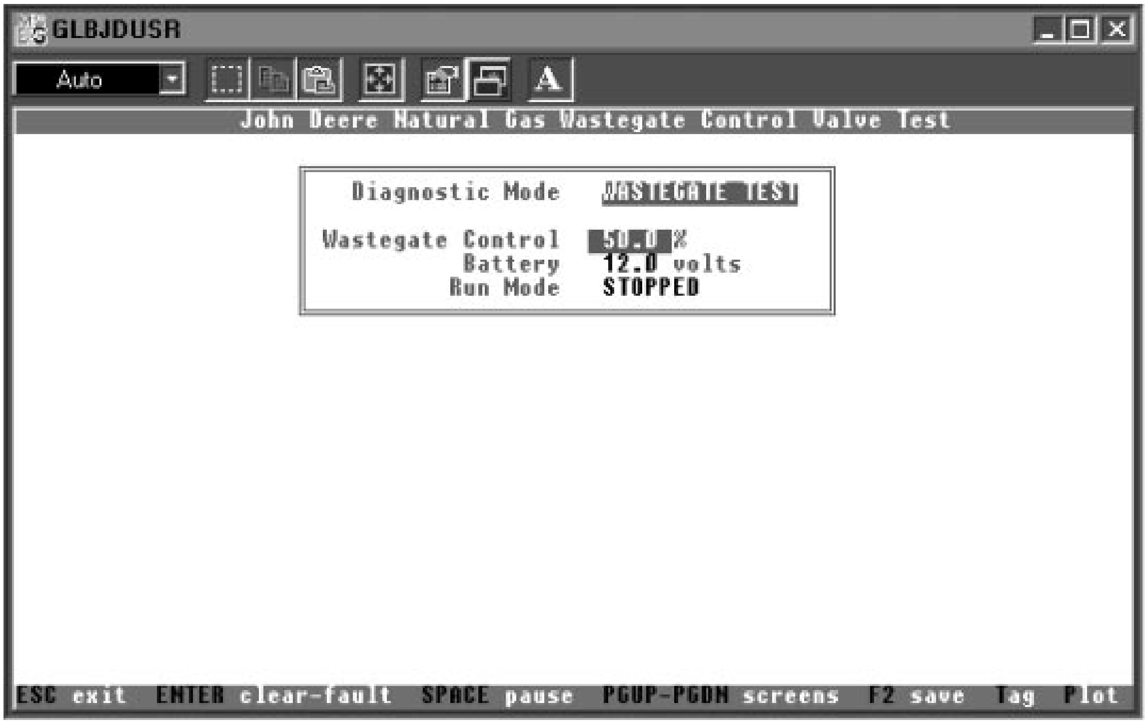
TPS Command displays the commanded throttle position, expressed as a percentage, which is being sent to the throttle. TPS_Feedback is the actual percent of throttle opening being sent to the ECU from the throttle. TPS_volts displays the actual TPS signal voltage the ECU is receiving from the throttle.

Data Logging

When in the Throttle/Pedal Test mode, the data logging feature of the software can be used as described in the description of the DATA Stream mode earlier in this Group.

RG,RG34710,3067 –19–15JUL96–1/1

Wastegate Control Test



RG11309 –19–11OCT00

During the Wastegate Control Test, the ECU sends a fixed wastegate control signal to the wastegate control solenoid. It is used during the diagnostic routines specified for faults associated with wastegate control.

The diagnostic software will not let this test mode be selected while the engine is running. To select this test mode the ignition must be ON and the engine must be OFF.

When Wastegate Control Test is selected, a 30 Hz, pulse width modulated (PWM) signal is sent to the wastegate control solenoid. The duty cycle of the signal is displayed on the screen.

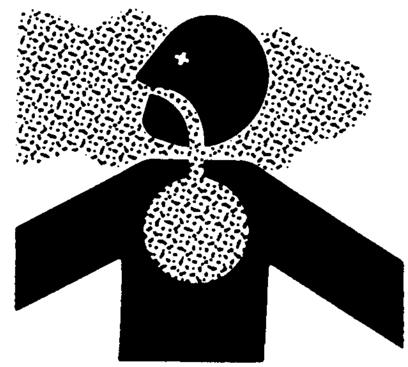
Performing the Wastegate Control Test

If the ECU is able to control the wastegate solenoid correctly, a high speed clicking noise is audible while running the test.

RG,RG34710,3068 –19–15JUL96–1/1

Injector Cleaning

Handle Compressed Natural Gas (CNG) Safely



TS220 –UN–23AUG88

CAUTION: Handle Compressed Natural Gas (CNG) safely. CNG is methane (natural gas) stored at high pressure. It spreads into air quickly.

Natural gas fumes can cause sickness or death. Always work in a well ventilated area.

Do not smoke when refueling or working on or around natural gas vehicles or equipment.

Keep natural gas vehicles away from sparks, flames, and electrical devices in operation, especially if you suspect a natural gas leak.

DPSG,RG41221,72 –19–26JUL00–1/10

Service Compressed Natural Gas (CNG) Systems Safely

TS227 –UN–23AUG88

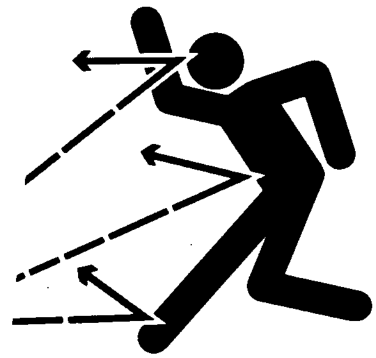
CAUTION: Service Compressed Natural Gas (CNG) systems safely. Improper installation, service, or operation of CNG storage and delivery components can result in fire, explosion, and/or serious injury.

Relieve CNG fuel system pressure before working on the system. Properly tighten connections and check for leaks before pressurizing the CNG fuel system.

Continued on next page

DPSG,RG41221,72 –19–26JUL00–2/10

Protect Against High Pressures



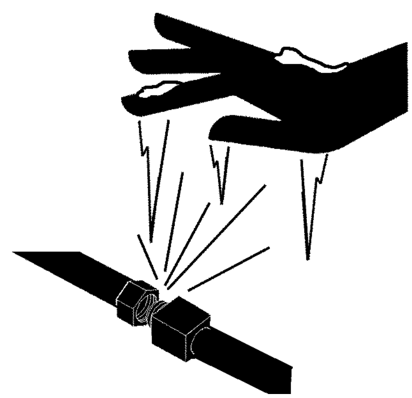
TS265 –UN–23AUG88

CAUTION: Protect against high pressure. CNG fuel systems operate at high pressures. DO NOT disassemble or remove any CNG fuel system components under pressure. Explosive separation of components, and the escaping natural gas can cause serious injury.

Relieve CNG fuel system pressure before disconnecting any fuel system component.

DPSG,RG41221,72 –19–26JUL00–3/10

Protect Against Extremely Cold CNG Leakage



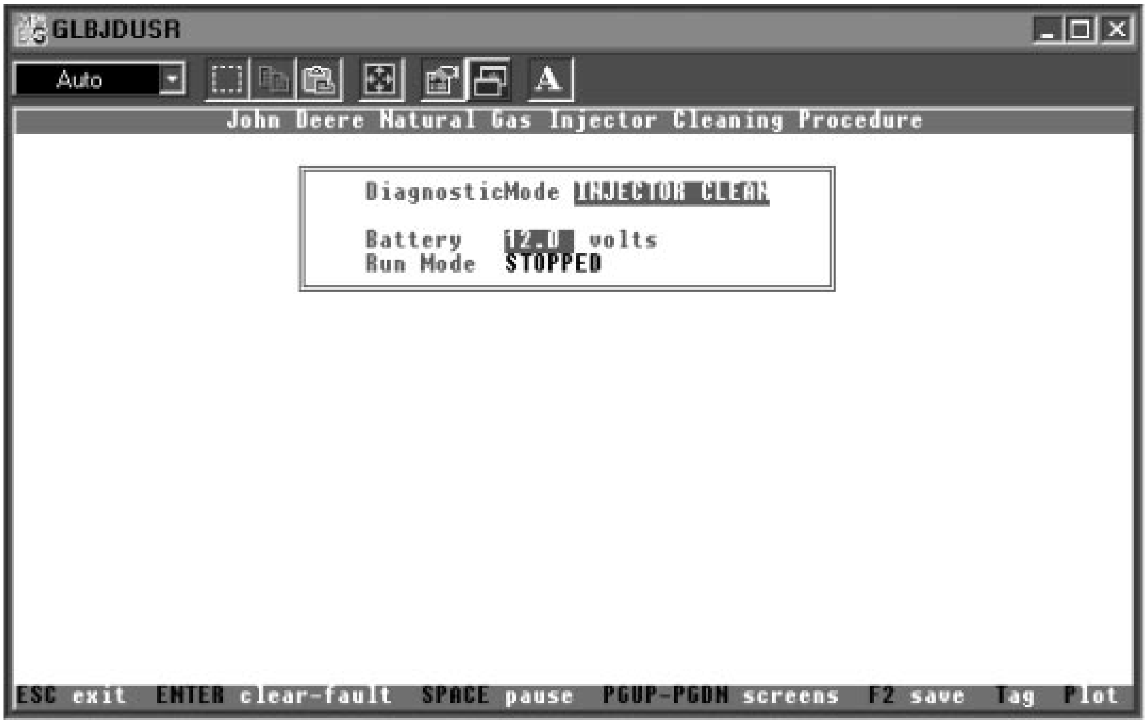
RG8110 –UN–20AUG98

CAUTION: Protect against extremely cold CNG leakage. Gas escaping from the CNG fuel system is very cold. Frostbite and skin damage can occur for contact with cold escaping gas or surrounding components.

Inspect for leaks by spraying a soap and water solution on joints, fittings, and other areas. Look for bubbles that indicate leakage from the system.

Continued on next page

DPSG,RG41221,72 –19–26JUL00–4/10



RG11315 –19–11OCT00

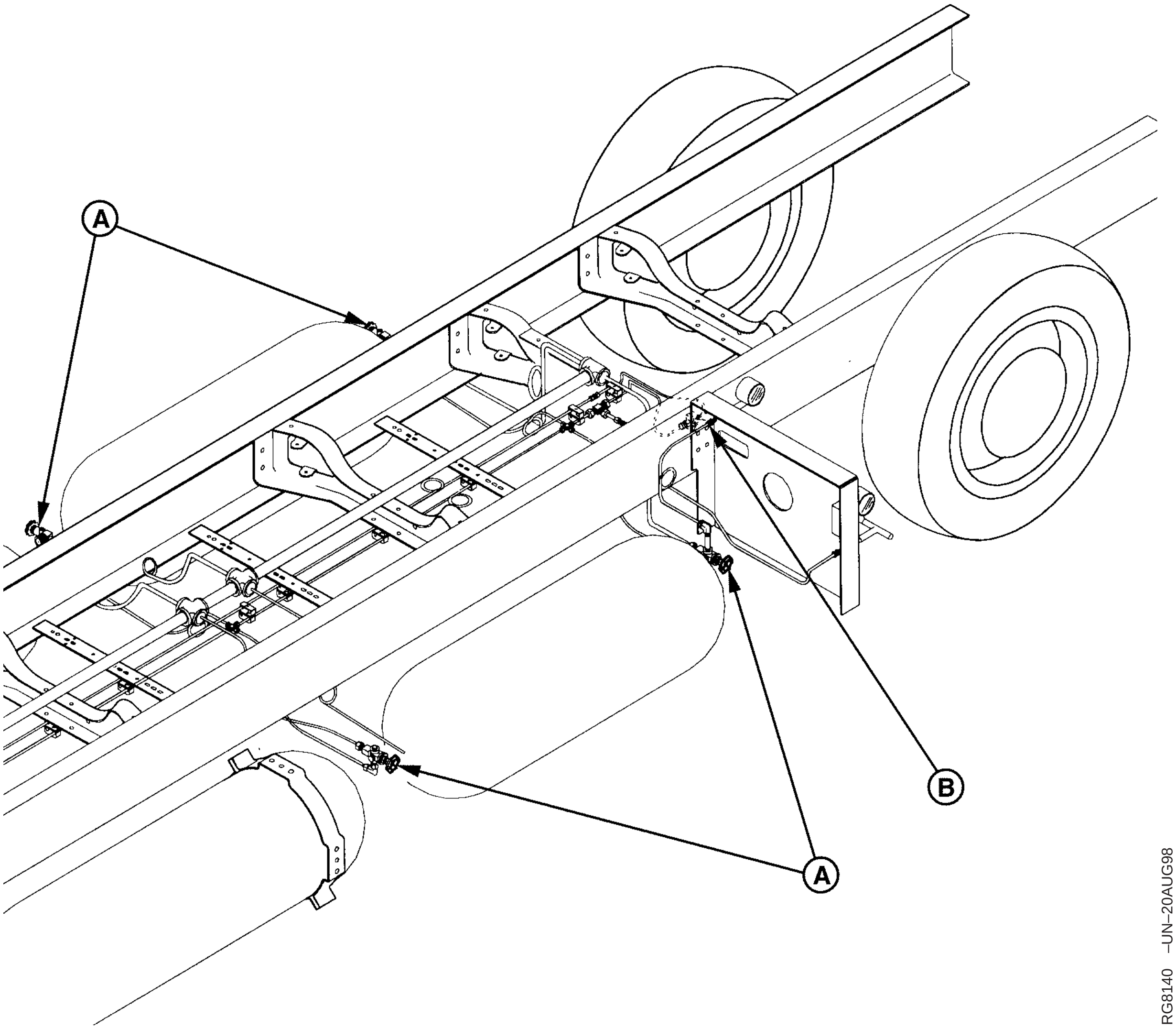
The Injector Clean mode causes the injectors to be pulsed continuously for the purpose of cleaning the fuel injectors. The fuel injector cleaning procedure should be performed when a diagnostic chart recommends doing so.

The diagnostic software will not let this mode be selected while the engine is running. To select this mode the ignition must be ON and the engine must be OFF.

To clean the fuel injectors, perform the procedure on the following pages.

Continued on next page

DPSG,RG41221,72 –19–26JUL00–5/10



NOTE: The illustration above is a typical application and does not show all of the shutoff valves. Refer to vehicle operator's manual to help locate all fuel cylinder shutoff valves.

IMPORTANT: Always relieve the natural gas pressure by closing each fuel cylinder manual shutoff valve (A). DO NOT relieve the natural gas pressure by closing the 1/4-turn valve (B).

NOTE: The valve is closed when turned fully clockwise viewed from the top, and open when turned counterclockwise viewed from the top.

1. Close **ALL** fuel cylinder manual shutoff valves (A). Proceed to step 2 **OR** step 3.

2. If the engine **WILL** start, let it run until it dies from running out of fuel. Make sure pressure is completely relieved by attempting to start engine several more times. Proceed to step 4.

Continued on next page DPSG,RG41221,72 –19–26JUL00–6/10

3. If the engine **WILL NOT** start and run, make sure the vehicle is outside, away from heat, flames, or sparks. Slowly loosen the hose from the fuel metering block inlet fitting (A) just until escaping gas is heard. Let fuel escape until fuel pressure is completely relieved. Proceed to step 4.

4. Disconnect the fuel hose (A) from the inlet of the metering block.

5. Inspect the O-ring on the fuel metering block inlet fitting for nicks or other damage. Replace if necessary with O-ring included in part number JT07281 Injector Cleaner Accessory Kit.

6. Apply a thin coating of O-ring lubricant or lithium-based grease to the O-ring on the fuel metering block inlet fitting.

7. Install cap from part number JT07281 Injector Cleaner Accessory Kit on the fuel metering block inlet fitting. Torque to 20 lb-ft. Proceed to step 8 for 8.1 L engines and step 9 for 6.8 L engines.

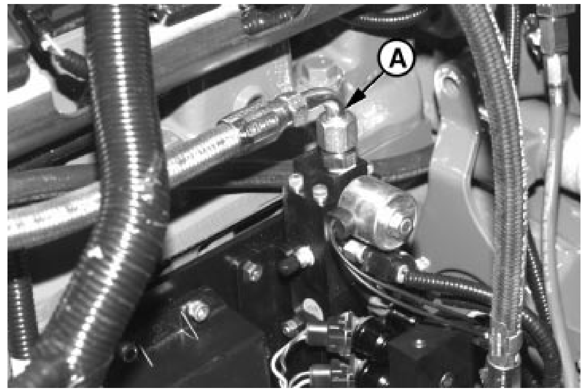
8. Disconnect the hose from the mixing elbow at (B) on 8.1 L engines then proceed to step 12.

9. Remove black gas system cover (2 flange nuts) on 6.8 L engines.

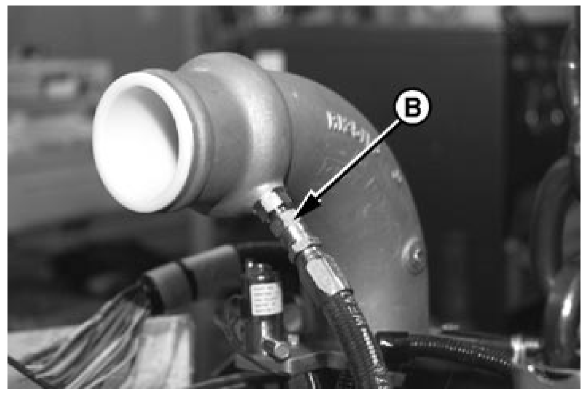
10. Remove 3 cap screws (C) and 2 flange nuts (D) from mixing elbow. Carefully remove mixing elbow from throttle at point (E) and discard mixing elbow gasket.

11. Apply a thin coating of O-ring lubricant or lithium grease to the metering block fitting at point (E). Connect a 5/8” I.D. hose to metering block fitting (E).

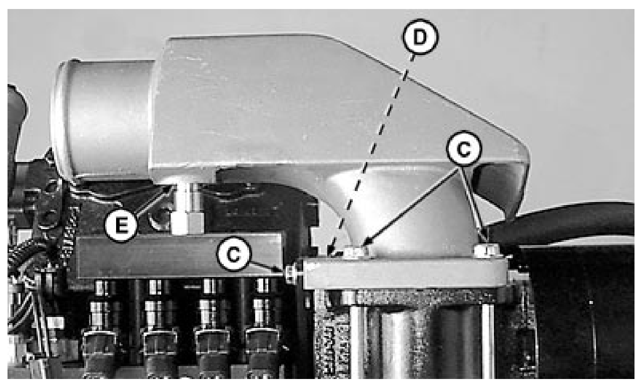
12. Direct end of hose into a suitable container (F).



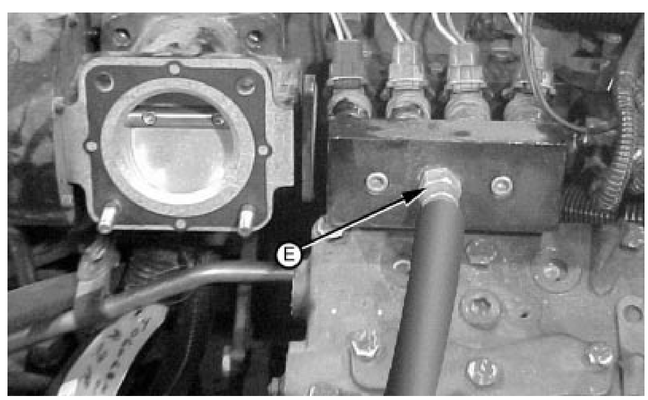
RG11219 –UN–25AUG00



RG8073 –UN–20AUG98



RG11205 –UN–25AUG00



RG11206A –UN–29SEP00

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DPSG,RG41221,72 –19–26JUL00–7/10

13. Connect the cable in part number JT07267 ECU Communications Kit.

14. Using the Schrader valve adapter from part number JT07281 Injector Cleaner Accessory Kit, connect part number JT07282 Fuel Injector Cleaner to the Schrader valve (G) located on the fuel metering block according to the instructions included with the Fuel Injector Cleaner Kit.

15. Adjust the canister pressure regulator (H) to 20-25 psi.

16. Open the valve (I) on the bottom of the canister.

17. Turn the ignition to the "ON" position and execute the JDNG diagnostic software. See USING THE DIAGNOSTIC SCAN TOOL (DST) earlier in this Group for instructions on using the DST.

18. Select Fuel Injector Clean mode on the DST.

19. After all of the cleaning fluid has passed through the metering valve, stop the DST by pressing ESC. Adjust the canister pressure regulator to 70 psi. Restart the DST in the Fuel Injector Clean mode and allow air to flow through the valve for an additional 10 minutes to remove any remaining cleaning fluid.

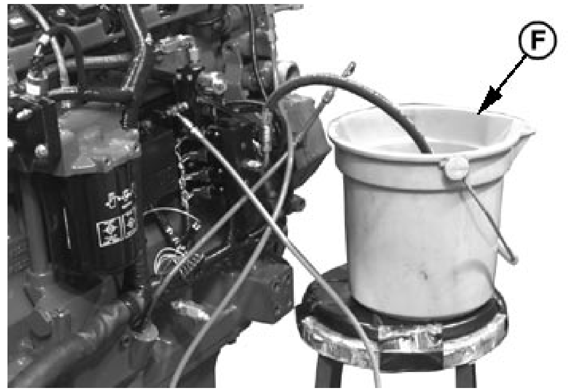
20. Turn the ignition to the "OFF" position.

21. Disconnect the injector cleaning equipment from the Schrader valve according to the instructions included with the injector cleaning equipment.

22. Replace the Schrader valve cap.

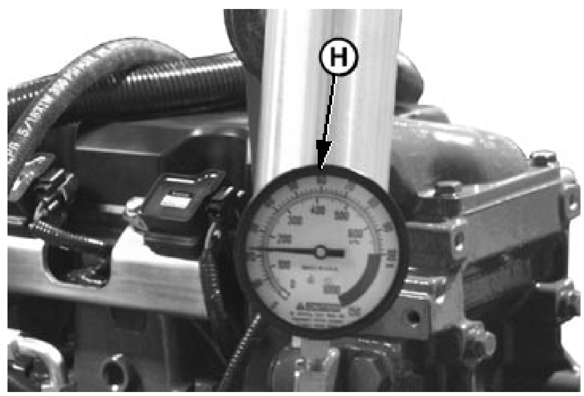
23. Disconnect the diagnostic cable. For 8.1 L engines proceed to step 24. For 6.8 L engine proceed to step 27.

24. Inspect the O-ring on the mixing elbow fitting for nicks or other damage. Replace if necessary with O-ring included in part number JT07281 Injector Cleaner Accessory Kit.

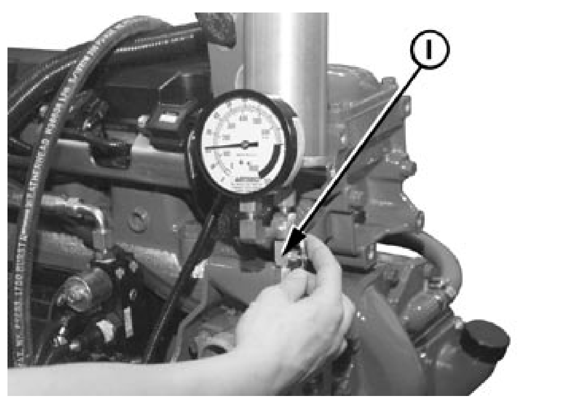


RG11220 –UN–25AUG00

RG11226 –UN–25AUG00



RG11227 –UN–25AUG00



RG11228 –UN–25AUG00

Continued on next page

DPSG,RG41221,72 –19–26JUL00–8/10

25. Apply a thin coating of O-ring lubricant or lithium-based grease to the O-ring on the mixing elbow fitting.

26. Reconnect the hose to the mixing elbow. Torque to 20 lb-ft. Proceed to step 31.

27. Remove hose from fitting.

28. Replace mixing elbow gasket with new gasket.

29. Inspect the O-ring inside the mixing elbow for nicks or other damage. Replace O-ring if necessary.

NOTE: The O-ring in the mixing elbow is **NOT** *included in part number JT07281 Injector Cleaner Accessory Kit.*

30. Reassemble mixing elbow to the throttle. Torque 3 screws (C) and 2 flange nuts (D) to 27N•m (20lb-ft).

31. Remove the cap from the metering valve inlet fitting.

32. Inspect the O-ring on the metering valve inlet fitting for nicks or other damage. Replace if necessary with O-ring included in part number JT07281 Injector Cleaner Accessory Kit.

33. Apply a thin coating of O-ring lubricant or lithium-based grease to the O-ring on the metering valve inlet fitting.

34. Reconnect the hose to the metering valve inlet. Torque to 20 lb-ft.

35. Open fuel cylinder manual shutoff valves.

36. Start engine.

37. With the engine idling, use a non-ammonia soap solution and wet the fitting and hose inlet to the mixing elbow and the fitting and hose at the inlet of the fuel metering block. If bubbles form, the fuel line or fitting is leaking.

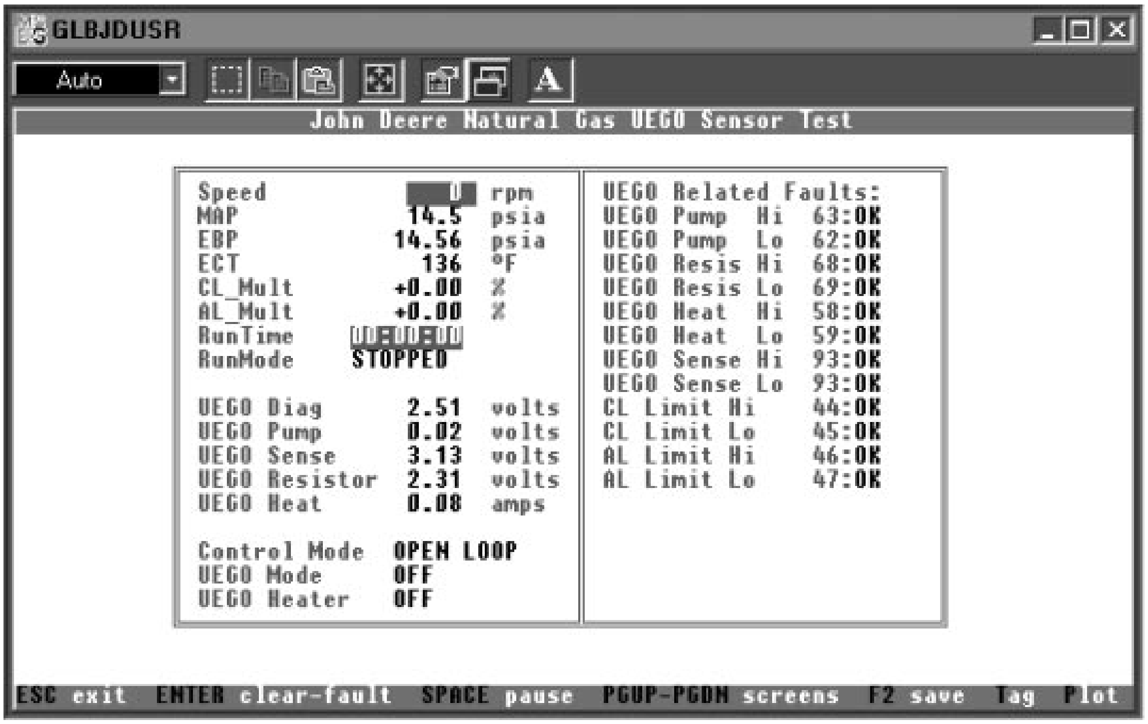
38. If a leak is detected, inspect lines and fittings for damage. Check also for damaged or missing O-ring.

Continued on next page

39. Repair and repeat procedure until no leaks are detected.

DPSG,RG41221,72 –19–26JUL00–10/10

UEGO Test



RG11306 –19–11OCT00

The UEGO Test mode displays all variables related to the UEGO sensor, and is used during the diagnostic routines specified for faults associated with the UEGO sensor.

UEGO Voltage is an internal voltage generated within the ECU. UEGOH is the current of the UEGO heater circuit. UEGOS is the voltage of the UEGO sense cell. UEGOP is the voltage of the UEGO pump cell. UEGOR is the voltage read from the UEGO calibration resistor.

When the engine is off and UEGO Test is selected, the UEGO heater can be turned on and off from this screen.

NOTE: The UEGO heater should only be turned ON or OFF when directed to do so by a diagnostic chart.

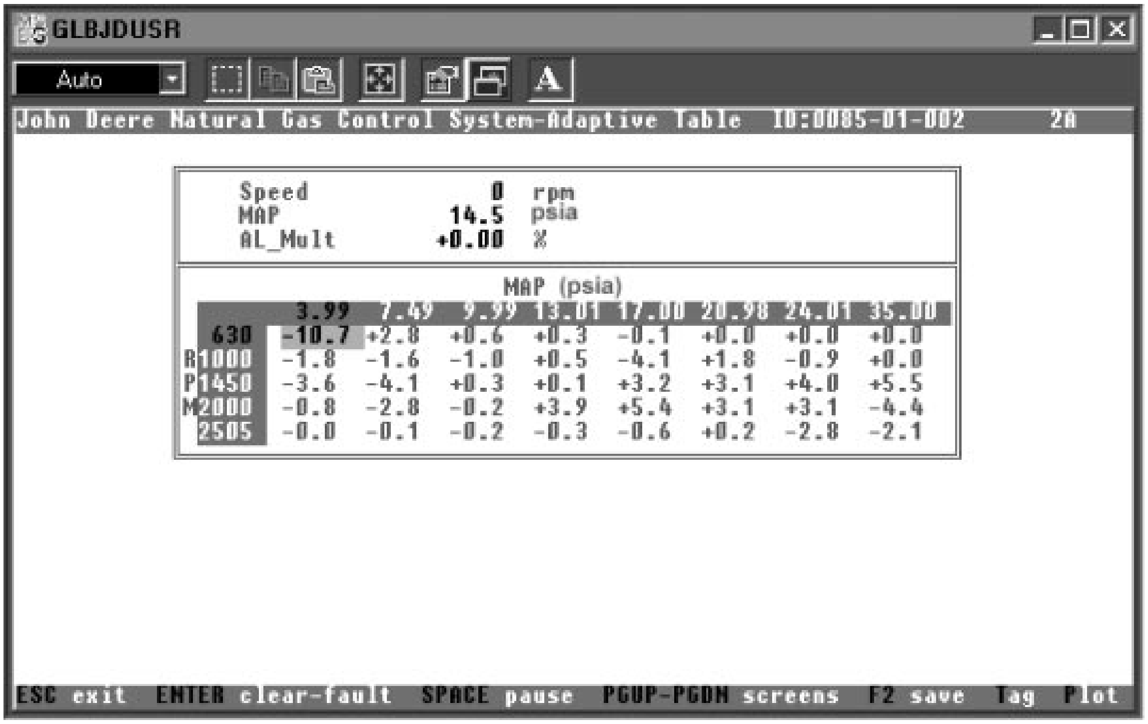
To turn the heater on, use the up and down arrow keys to highlight the UEGO heater. Then press the “ENTER” key. The word “OFF” will change to “ON” and the heater will be turned on. Pressing “ENTER” again will turn the heater OFF. The heater switch will be ignored if the engine is running.

Data Logging

When in the UEGO Test mode, the data logging feature of the software can be used as described in the description of the DATA Stream mode earlier in this Group.

RG,RG34710,3069 –19–15JUL96–1/1

Adaptive Learn Screen

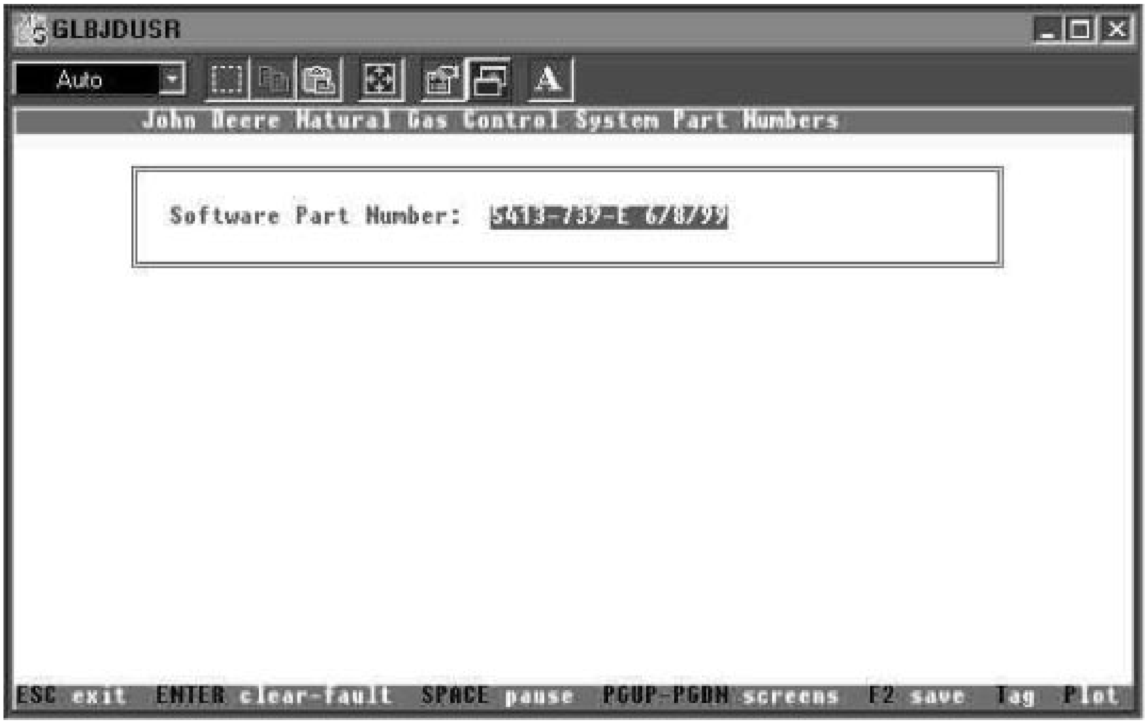


RG11310 –19–11OCT00

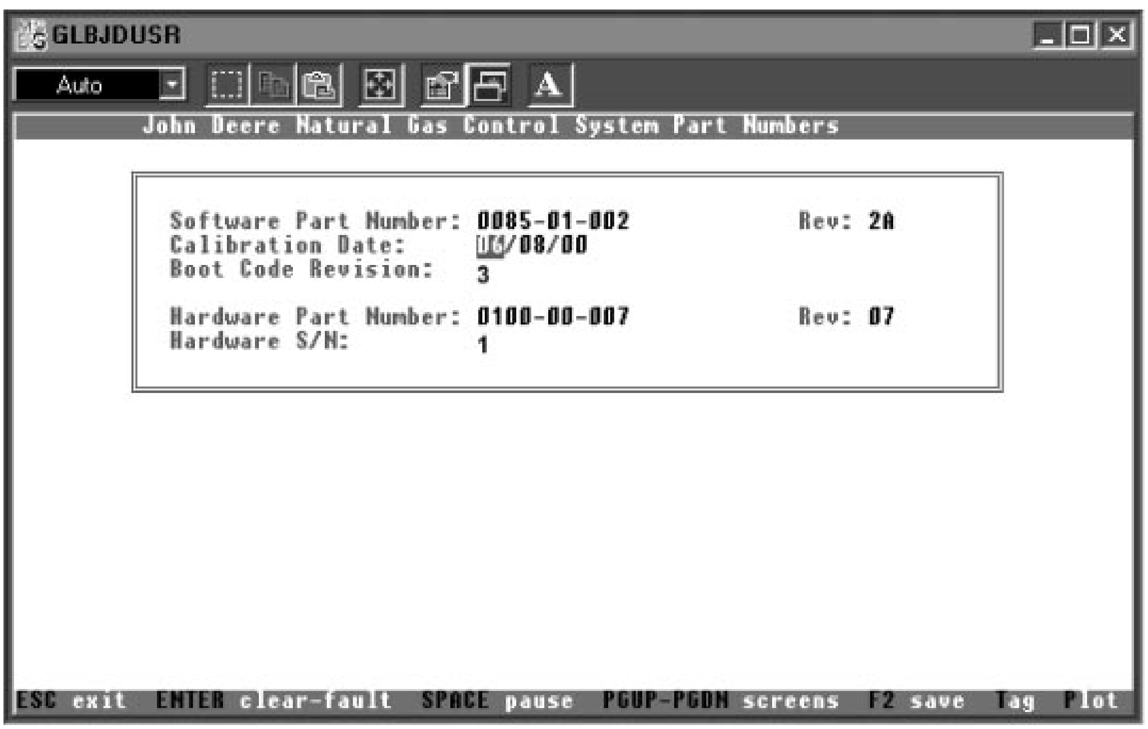
The Adaptive Learn Screen allows the technician to view the adaptive learn table. The table displays the actual adaptive learn at each MAP vs. RPM point.

DPSG,RG41221,53 –19–29JUN00–1/1

System Part Number Screen



RG11311 –19–11OCT00



RG11312 –19–11OCT00

The part number screen is useful to determine both the ECU hardware and software part numbers.

Continued on next page

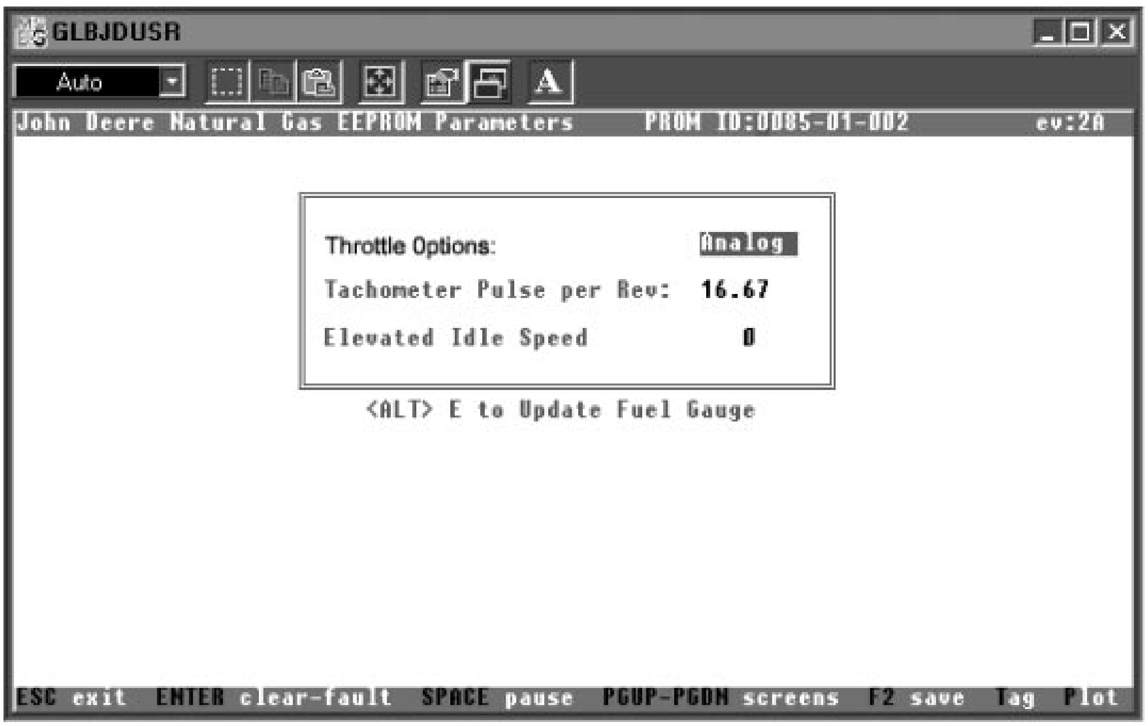
DPSG,RG41221,54 –19–29JUN00–1/2

NOTE: The early controllers will only display the software part number.

The boot code is a special function of the software used to recover the ECU in the event of a download failure. When a software update is provided, it may be necessary to update the boot code as well. This can be determined by comparing the revision of the new boot code versus what is currently in the ECU.

DPSG,RG41221,54 –19–29JUN00–2/2

Adjustable EEPROM Parameter & Fuelgauge Update



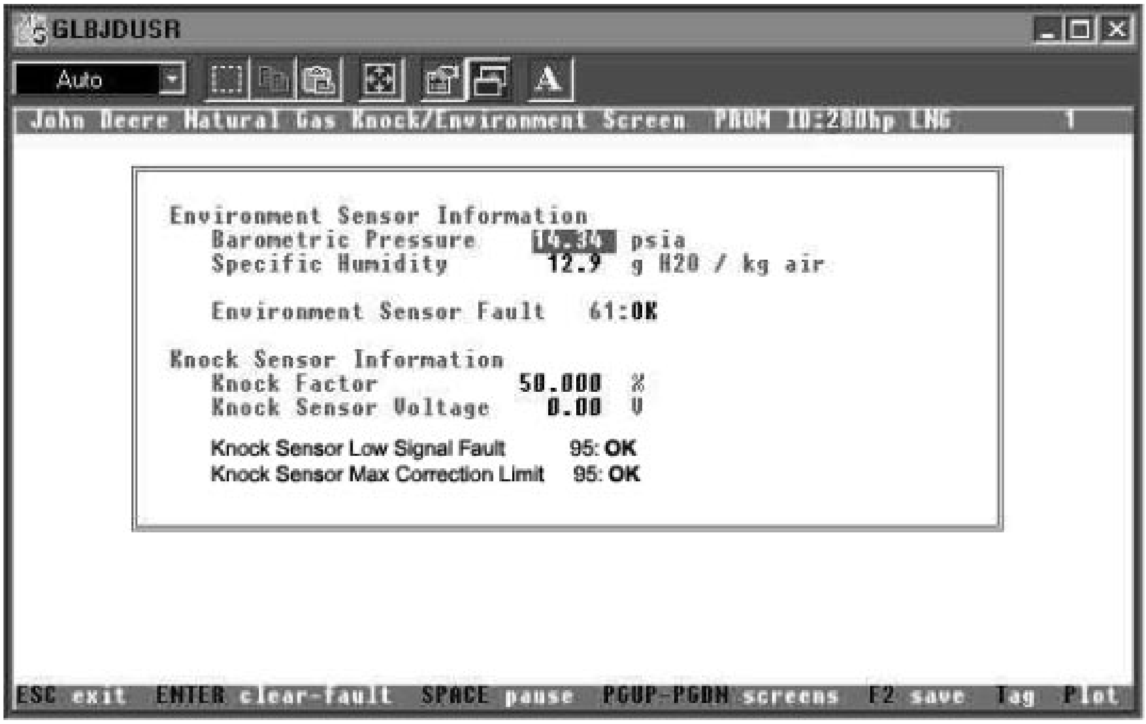
RG11313 –19–06DEC00

The EEPROM are special parameters that are permanently stored in the ECU. These special parameters can be changed by the operator with the PC tool. Four items can be modified by this method:

1. The FloTech throttle can be selected to match the ECU setting for optimum engine performance.
2. ECU tachometer output pulse per engine revolution.
3. Evaluated idle speed (only available in 280 Hp configuration).
4. Pressing <ALTE will bring up the fuel gauge download software to update the ECU fuel gauge calibration to match the dash gauge.

DPSG,RG41221,55 –19–29JUN00–1/1

Knock/Environment Screen



RG11314 –19–06DEC00

NOTE: This screen is ONLY used with the HFN02 6081 engines.

The Knock/Environment screen displays parameters associated with the current status of the Knock sensor and the Environment sensor.

DPSG,RG41221,7 –19–29AUG00–1/1

Procedure to Program an ECU With New Calibration File

1. Connect PC to ECU with the proper communication cable.
2. Determine the S19 file (calibration file) name that you would like to download.
3. Make sure the ECU to be programmed is connected and the ignition is on.
4. Start the user diagnostic tool.

NOTE: The easiest approach is to place the diagnostic program in the same directory as the new S19 file. Thereby you will have all programs in one location.

5. Enter the data screen press <ALT D for normal download or <ALT B for download with boot. Enter the requested password, supplied be John Deere. The PC will then prompt you for a file name (and path if it is stored in a different directory).
6. Download will now occur. At the bottom of the screen you can watch the download packet number increase.
7. Wait until complete. If the download stops for any reason and fails to restart, escape out of the PC program, turn ignition off, and pull the 2 - 20 amp fuses (current engines) or 1 - 35 amp fuse (early engines) from the ECU. Reinstall the fuse, turn on the key and restart the PC diagnostic program. Then repeat step 3.

Continued on next page DPSG,RG41221,56 –19–29JUN00–1/2

NOTE: If power is interrupted during the flash process, the ECU will not be able to operate the engine. The CEL lamp will flash at approximately 1 Hz. The PC tool will go straight to a flash download procedure when connected to an ECU that is not properly programmed. Once the proper program is flashed into the ECU, the ECU will operate normally.

NOTE: If a message appears stating checksum for software does not match, ALWAYS reattempt the flash. If a second try fails, reattempt again and disconnect the PC from the ECU and cycle battery power on the ECU before the flash process is done. If the download is not re-attempted, the ECU may be left brain dead. By disconnecting the PC during the download process, the ECU will be left operating the boot code so that the ECU can be flashed with a file without the checksum problems.

8. The ECU/Engine is now ready to operate with the new S19 file.
9. The operator can now verify the download by checking the part number and revision loaded into ECU.
10. Start the vehicle and check proper operation.

DPSG,RG41221,56 –19–29JUN00–2/2

Diagnostic System

The John Deere natural gas engine control system has self-diagnostic capabilities. Most problems that affect emissions or driveability of the vehicle will set a Diagnostic Trouble Code (DTC). The ECU will store that DTC in memory and illuminate the “Check Engine” Light (CEL) located on the dash of the vehicle.

“Check Engine” Light (CEL)

The CEL has the following functions:

It notifies the driver of a problem in the fuel system, air system, or ignition control system so the driver can arrange for service as soon as possible.

It will display DTCs that have been stored in memory due to a system malfunction.

The light should be on when the ignition is ON and the engine is OFF. This feature verifies that the light is in proper working order.

NOTE: If the light is not on with the key on, engine off, See B1 - “CHECK ENGINE” LIGHT (CEL) DOES NOT ILLUMINATE, later in this Group.

Once the engine is in the “start” or “run” mode, the CEL should go off. If the light illuminates while the engine is in the “start” or “run” mode, the Electronic Control Unit (ECU) has detected a fault and will store the DTC in memory.

Diagnostic Trouble Codes (DTCs)

Diagnostic Trouble Codes (DTCs) indicate that the ECU has detected a problem in some area of the electronic engine control system, and are numbered in order of importance. For example, DTC 13 and 44, both concerning the oxygen sensor, could be set at the same time. By repairing DTC 13 first, the problem causing DTC 44 may also corrected.

DTCs can be read by using either the “Check Engine” Light (CEL) or the Diagnostic Scan Tool (DST).

If a sensor or wiring fails and a DTC is active for that sensor, the ECU will use a substitute “limp home” value in its calculations to continue engine operation.

NOTE: If the DST is used to read a sensor voltage and calculated value, and there is a current DTC for that sensor, the calculated value for that sensor will be the “limp home” value and the voltage will be the actual sensor voltage. Use the voltage during diagnostics unless otherwise directed by a diagnostic chart.

Some failures that set DTCs are “intermittent” failures. These could be problems such as a bad connection or a wire intermittently shorting to ground. Some intermittent DTCs will cause the CEL to turn on then turn off after about 15 seconds when the DTC “goes away”. Other intermittent failures that could seriously affect engine operation will cause the CEL to be on and remain on until the ignition is shut off even though the problem may have “gone away”. In either case the DTC will be stored in memory.

Other failures are “hard” failures. During this type of failure a DTC will be set, the CEL will be on and remain on until the problem is fixed.

RG,RG34710,3071 –19–15JUL96–1/1

Listing of DTCs

Following is a list of DTCs that can occur in the electronic engine control system.

DTC	Definition
13	Universal Exhaust Gas Oxygen (UEGO) sense cell failure
14	Natural Gas Temperature (NGT) input voltage too high
15	Natural Gas Temperature (NGT) input voltage too low
16	5 volt sensor supply voltage error
17	Exhaust Back Pressure (EBP) input voltage too high
18	Exhaust Back Pressure (EBP) input voltage too low
19	Exhaust Back Pressure (EBP) input voltage higher than expected
21	Foot Pedal Position 1 (FPP1) input voltage too high
22	Foot Pedal Position 1 (FPP1) input voltage too low
23	Manifold Air Temperature (MAT) input voltage too high
24	Manifold Air Temperature (MAT) input voltage higher than expected
25	Manifold Air Temperature (MAT) input voltage too low
26	Engine Coolant Temperature (ECT) input voltage too high
27	Engine Coolant Temperature (ECT) input voltage too low
28	Engine Coolant Temperature (ECT) input voltage higher than expected
29	Exhaust Back Pressure (EBP) input voltage lower than expected
31	Foot Pedal Position 2 (FPP2) input voltage too high
32	Foot Pedal Position 2 (FPP2) input voltage too low
33	Manifold Absolute Pressure (MAP) input voltage too high
34	Manifold Absolute Pressure (MAP) input voltage too low
35	Barometric Pressure (BP) input voltage higher than expected
36	Barometric Pressure (BP) input voltage lower than expected
37	Pre-Turbine Pressure (PTP) input voltage too high
38	Natural Gas Pressure (NGP) input voltage too high
39	Natural Gas Pressure (NGP) input voltage too low
41	Natural Gas Pressure (NGP) higher than expected
42	Camshaft position sensor error (6081 CNG ONLY)
42	Camshaft position sensor error (6068 CNG ONLY)
43	Natural Gas Pressure (NGP) lower than expected
44	Closed loop multiplier high limit reached
45	Closed loop multiplier low limit reached
46	Adaptive learn multiplier high limit reached
47	Adaptive learn multiplier low limit reached
48	Pre-Turbine Pressure (PTP) input voltage too low

RG,RG34710,3072 –19–15JUL96–1/1

Listing of DTCs — Continued

49	**Pre-Turbine Pressure (PTP) not active**
DTC	**Definition**
51	RAM error
52	Battery voltage too low
53	Battery voltage too high
54	Throttle Position Sensor (TPS) input voltage too high
55	Electronic Control Unit (ECU) error
56	Throttle Position Sensor (TPS) input voltage too low
57	Throttle Position Sensor (TPS) input voltage higher than expected
58	Universal Exhaust Gas Oxygen (UEGO) heater current too high
59	Universal Exhaust Gas Oxygen (UEGO) heater current too low
61	Environment sensor internal error
62	Universal Exhaust Gas Oxygen (UEGO) pump voltage too low
63	Universal Exhaust Gas Oxygen (UEGO) pump voltage too high
64	Natural Gas Tank Temperature (NGTT) voltage too high
65	Natural Gas Tank Temperature (NGTT) voltage too low
66	Natural Gas Tank Pressure (NGTP) input voltage too high
67	Natural Gas Tank Pressure (NGTP) input voltage too low
68	Universal Exhaust Gas Oxygen (UEGO) calibration resistor voltage too high
69	Universal Exhaust Gas Oxygen (UEGO) calibration resistor voltage too low
71	Boost higher than expected
72	Boost lower than expected
73	Overboost
74	Oil pressure switch input voltage low
75	Injector duty cycle too high
77	Natural Gas Temperature (NGT) voltage lower than expected
78	IVS Status OFF Unexpected
79	IVS Status ON Unexpected
81	Throttle Position Sensor (TPS) input voltage lower than expected
82	Crankshaft position sensor error (6068 CNG ONLY)
83	Natural Gas Tank Pressure (NGTP) input voltage higher than expected
84	Vehicle network transmit fault
85	Vehicle network receive fault
86	Foot Pedal Position 1 (FPP1) different than expected
87	Foot Pedal Position 2 (FPP2) different than expected
94	ECU internal voltage error
95	Knock sensor voltage too low
96	Natural Gas Pressure (NGP) voltage excessively high

RG,RG34710,3072 –19–15JUL96–1/1

Diagnostic Procedure

Diagnosis of the electronic engine control system should be performed according to the following procedure:

1. Make sure all engine mechanical and other systems not related to the electronic control system are operating properly.

2. Read and record DTC(s).

3. Go to the diagnostic chart that corresponds to the DTC(s) present.

NOTE: If more than one DTC is present, go to the chart corresponding to the lowest number DTC and diagnose that problem to correction unless directed to do otherwise.

4. If no DTC(s) are present, proceed to the B1-B6 symptom diagnostic chart, later in this Group, that is appropriate.

5. After any repairs are made, recheck to make sure all DTCs have been eliminated.

NOTE: After using the DST, always replace the dust cover on the diagnostic connector.

IMPORTANT: Care should be used during diagnostic procedures to avoid damaging the terminals of connectors, sensors, and actuators. Probes should not be poked into or around the terminals or damage will result. Probes should only be touched against the terminals to make measurements.

IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

Reading DTCs

The CEL can be used to read DTCs.

1. Turn the ignition OFF

2. Locate one of the flat four pin diagnostic connectors. One is located under the dash, near the operator's left knee, and one near the control panel in the engine compartment.

Continued on next page RG,RG34710,3073 –19–15JUL96–1/2

3. Install a jumper wire between the outer two terminals (terminals A and D) in the diagnostic connector.

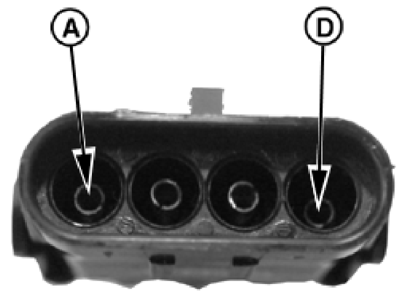
4. Turn the ignition ON

5. The CEL will begin to flash a code number. For example, “flash”...short pause “flash”, “flash”...long pause. This example is code 12.

6. The ECU will flash each fault code that is stored in its memory three times in numerical order.

7. Code 12 will always be flashed first. This code means that the self diagnosis system is working correctly. If this is the only code flashed, all systems are working correctly.

8. To exit the diagnostic mode, turn the ignition OFF and remove the jumper wire.



RG7773 –UN–20AUG98

The preferred diagnostic interface is the Diagnostic Scan Tool (DST). The DST consists of an IBM compatible computer, diagnostic software and a diagnostic interface cable. See USING THE DIAGNOSTIC SCAN TOOL (DST), earlier in this Group for detailed instructions.

Clearing DTCs

DTCs may be erased from memory by either using the DST or by turning the ignition OFF and removing the ECU main power fuses (F3) and (F4) for 15 seconds. If engine has Early Wiring harness, (F3) is the only power fuse to the ECU.

RG,RG34710,3073 –19–15JUL96–2/2

Intermittent Fault Diagnostics

Intermittent faults are problems that periodically "go away". A problem such as a terminal that intermittently doesn't make contact can cause an intermittent fault. Other intermittent faults may be set only under certain operating conditions such as heavy load, extended idle etc. When diagnosing intermittent faults, take special note of the condition of wiring and connectors since a high percentage of intermittent problems originate here. Check for loose, dirty or disconnected connectors. Inspect the wiring routing looking for possible shorts caused by contact with external parts (for example, rubbing against sharp sheet metal edges). Inspect the connector vicinity looking for wires that have pulled out of connector terminals, damaged connectors, poorly positioned terminals, and corroded or damaged terminals. Look for broken wires, damaged splices, and wire-to-wire shorts. Use good judgement if component replacement is thought to be required.

NOTE: The ECU is the component LEAST likely to fail.

To Diagnose Intermittent Faults:

1. Read and record DTCs.

2. If diagnostic chart indicates that the problem is intermittent, try to reproduce the conditions that set the DTC.

3. If a faulty connection is suspected to be the cause of the intermittent problem, check the connection by wiggling the connection with the engine idling.

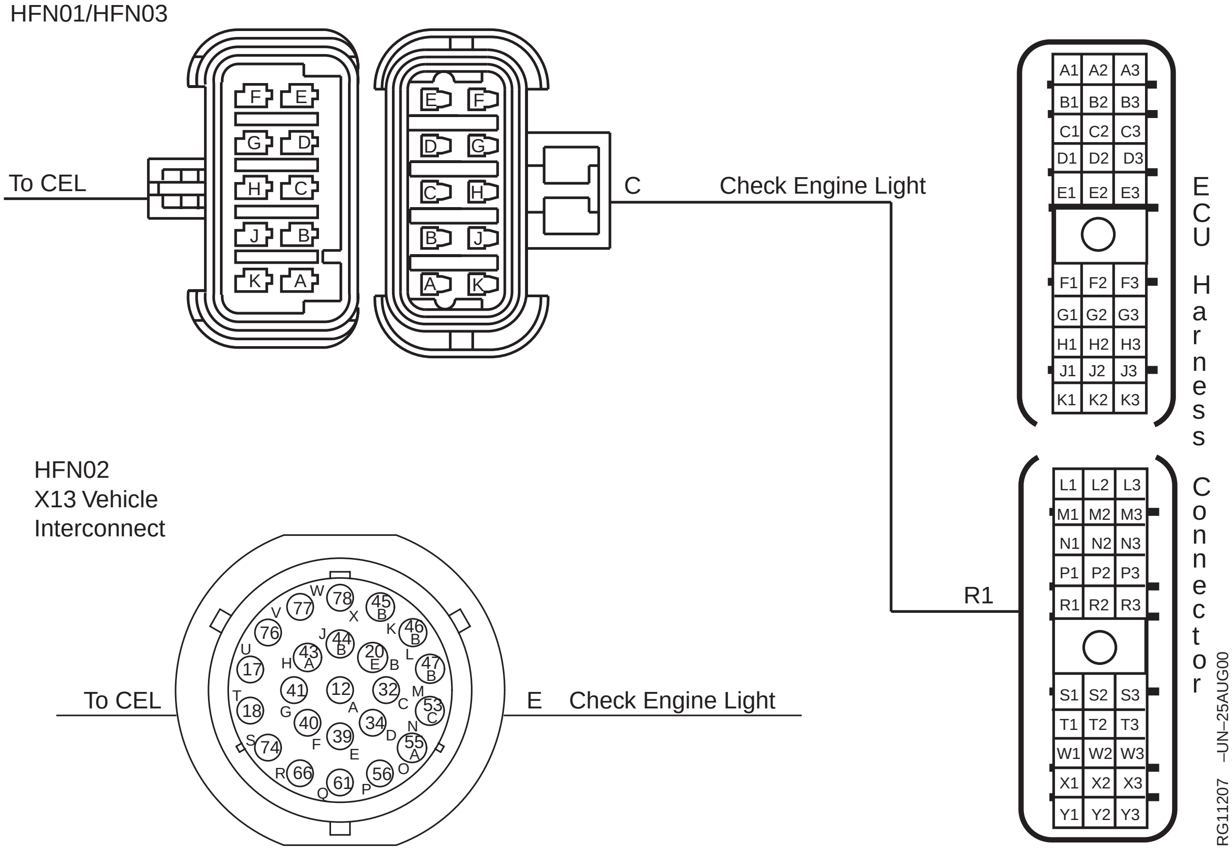
4. To check the connection between the harness and a sensor or the harness and the ECU, use JT07328 Connector Adapter Test Kit. Insert the male end of the appropriate test adapter into the female end of the ECU or sensor connector terminal. There should be moderate resistance when the test adapter is inserted into the terminal. If the connection is loose, replace the female terminal.

Possible Causes Of Intermittent Faults:

- Faulty connection between sensor or actuator and harness.
- Faulty contact between terminals in connector.
- Faulty terminal/wire connection.
- An intermittent short to ground in ECU controlled CEL circuit will cause the CEL to illuminate even though no DTC is present.
- Electromagnetic interference (EMI) from an improperly installed 2-way radio, from a faulty ignition system component, etc. can cause faulty signals to be sent to the ECU.

RG,RG34710,3074 –19–15JUL96–1/1

B1 - “Check Engine” Light (CEL) Does Not Illuminate



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
R1	C (E)	39 Lt. Blue	Lt. Blue/Black	Check Engine Light

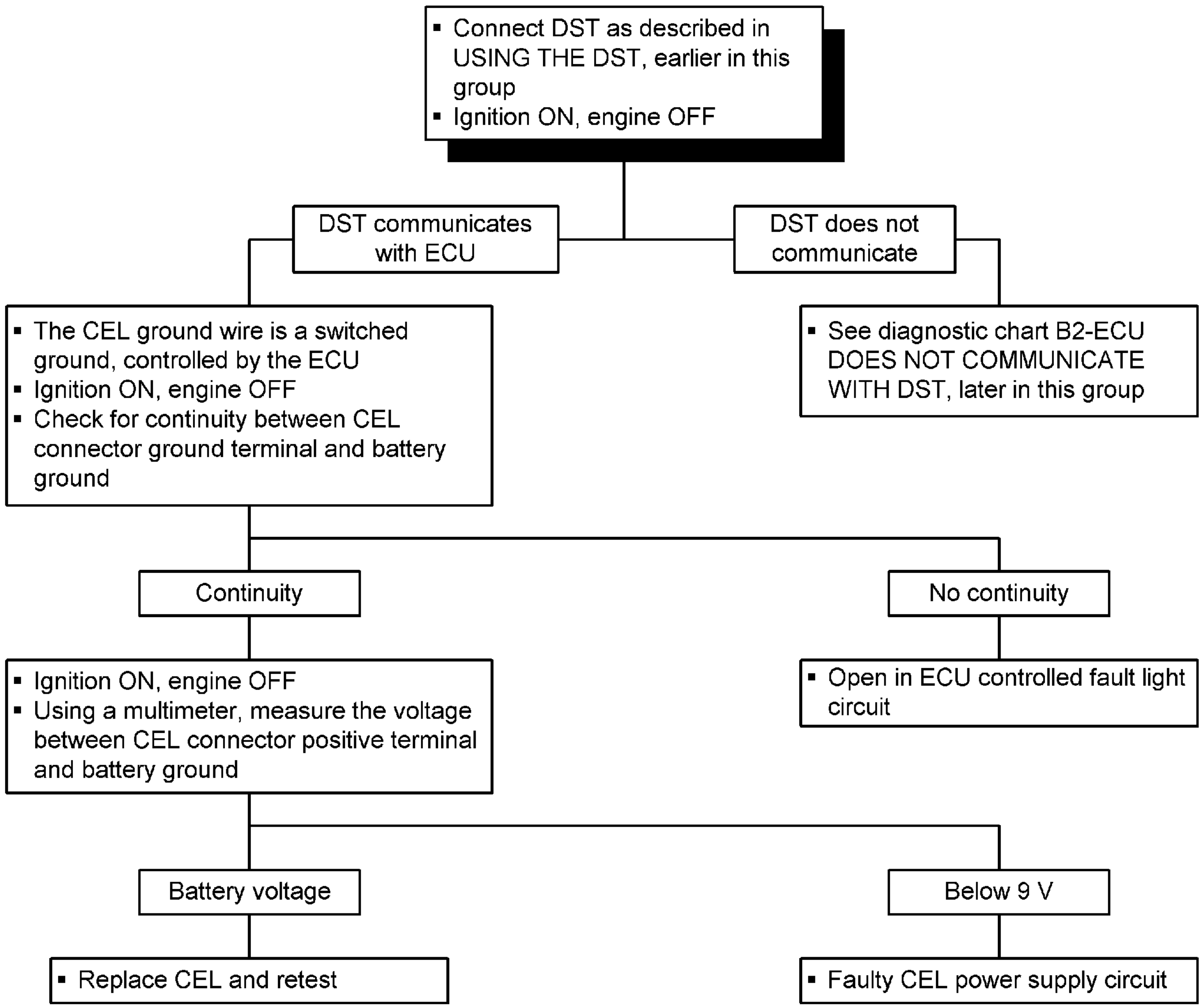
This diagnostic chart should be used if the “Check Engine” Light (CEL) does not illuminate when the ignition is ON and the engine is OFF. The CEL turned ON under these conditions verifies that the CEL is in proper working order.

The CEL positive circuit is connected to battery power. The ground circuit is a switched ground, controlled by the ECU. When the ECU detects a Diagnostic Trouble Code (DTC), it completes the CEL ground circuit and the light turns ON. The ground circuit runs from the ECU, through the vehicle interconnect and to the CEL.

OM60113,80A –19–25APR97–1/1

B1 - "Check Engine" Light (CEL) Does Not Illuminate - Continued

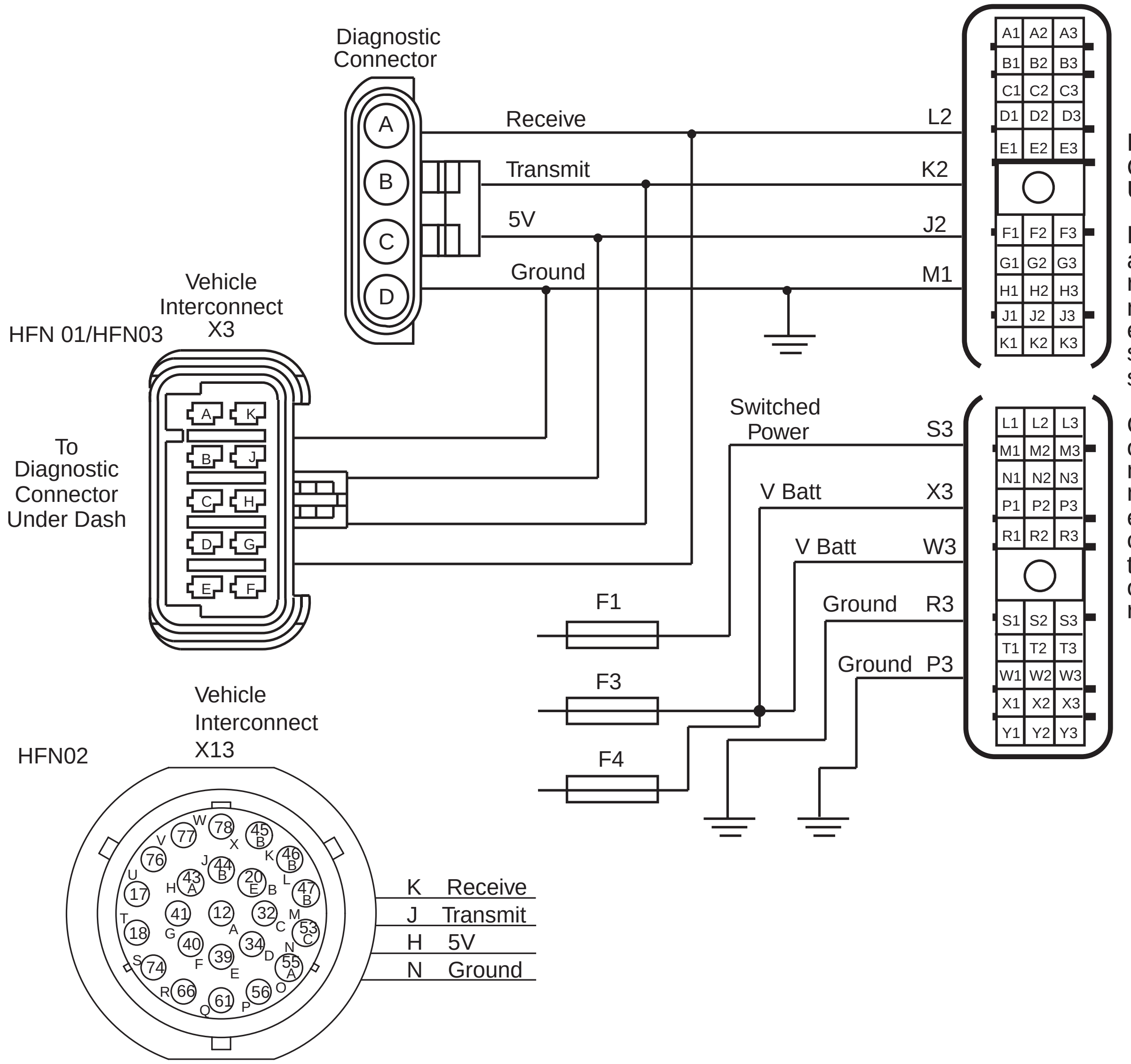
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10120 –19–16AUG00

DPSG,RG40854,84 –19–10JUN99–1/1

B2 - ECU Does Not Communicate With DST



RG11208 –UN–25AUG00

Continued on next page

OM60113,80A –19–25APR97–1/2

NOTE: In early wiring harnesses, fuse F3 is the only fuse used for ECU pin's X3 and W3.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
M1	D (Diag. Conn. and X-3 V.I.) (N)	53B White	White	Ground
J2	C (Diag. Conn. and X-3 V.I.) (H)	43Gray	Gray/Red	5V Supply
K2	B (Diag. Conn. and X-3 V.I.) (J)	44Dk. Green	Dk. Green	Transmission
L2	A (Diag. Conn. and X-3 V.I.) (K)	45 Orange	Orange	Receive
S3	X-4 VI	61 Pink	Pink	Vehicle Switched Power
X3	N.A.	49 Red	Red/Tan	VBAT 1
W3	N.A.	50 Red	Red/Tan	VBAT 2
R3	N.A.	51 White	White	Ground
P3	N.A.	52 Lt. Blue	White	Ground

This diagnostic chart should be used if Diagnostic Scan Tool (DST) will not communicate with the ECU.

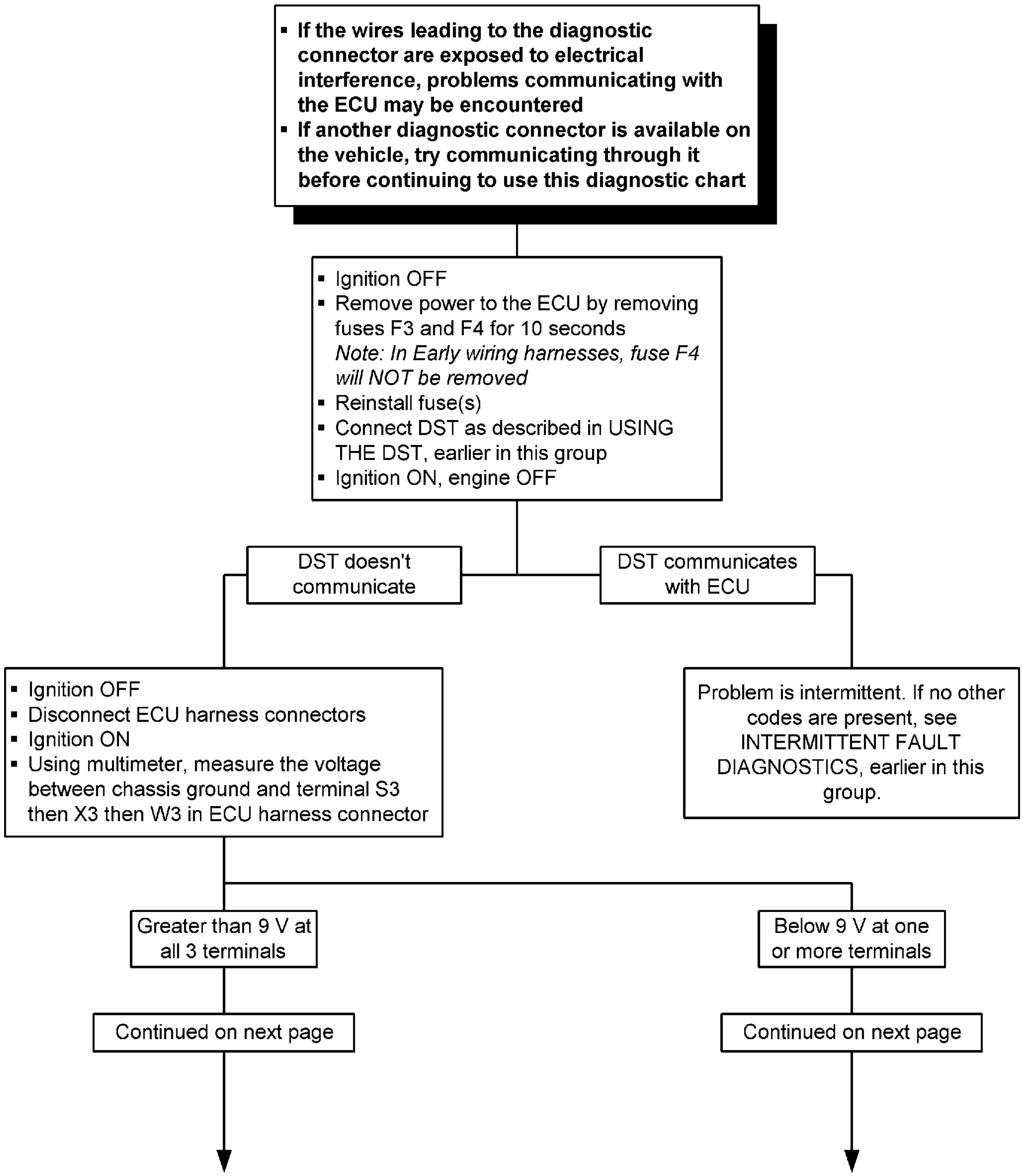
The Electronic Control Unit (ECU) communicates with the Diagnostic Scan Tool (DST) through one of two diagnostic connectors.

IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

OM60113,80A –19–25APR97–2/2

B2 - ECU Does Not Communicate With DST - Continued

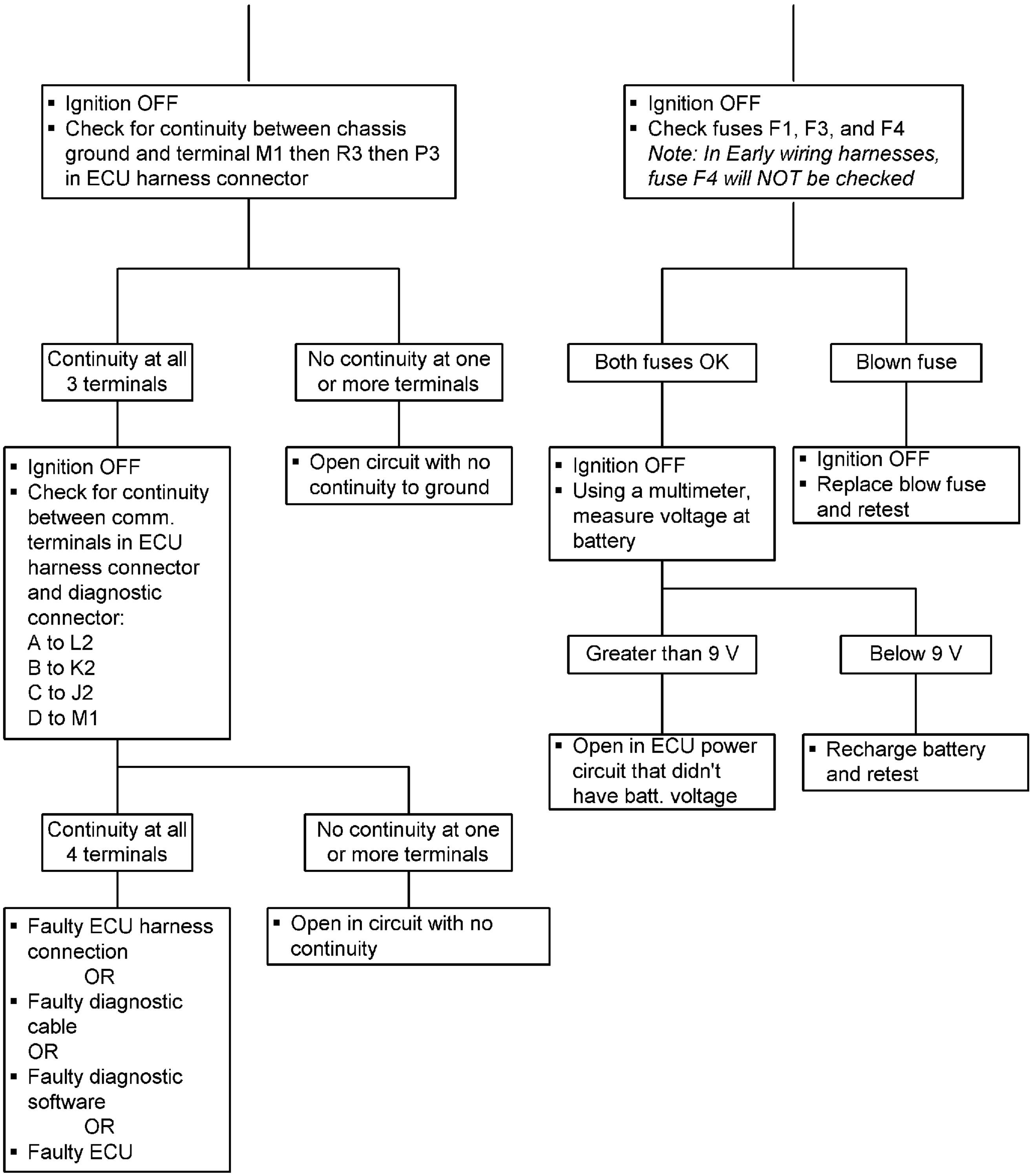
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Diagnostic connector, and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10121 –19–16AUG00

DPSG,RG40854,85 –19–10JUN99–1/1

B2 - ECU Does Not Communicate With DST - Continued



RG10122 –19–16AUG00

DPSG,RG40854,85 –19–10JUN99–1/1

B3 - Engine Cranks/Won't Start

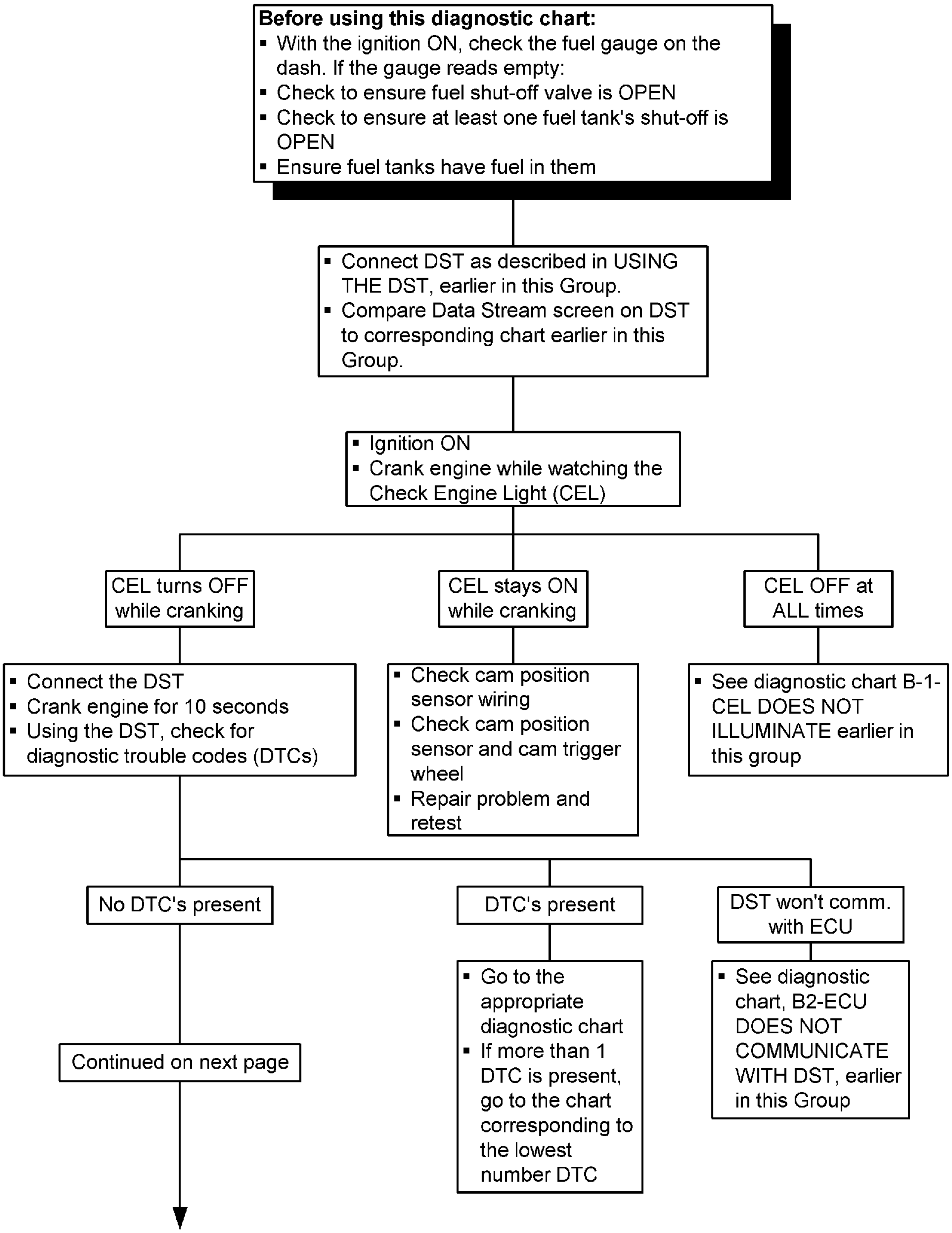
This diagnostic chart should be used if the engine cranks OK, but it will not start. If the engine will not crank correctly, See STARTING AND CHARGING SYSTEM DIAGNOSTICS, in Group 110.

IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

RG,RG34710,3075 –19–15JUL96–1/1

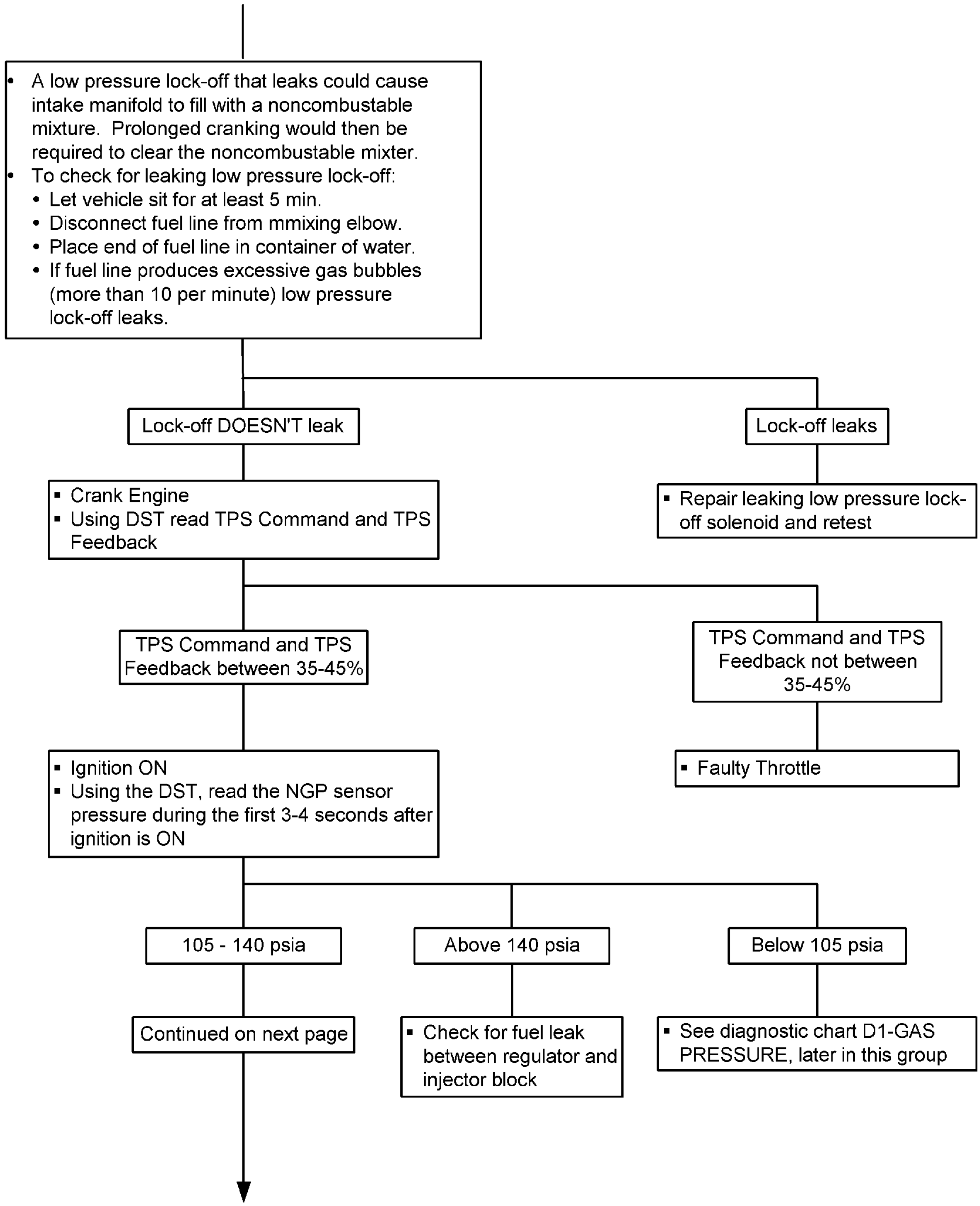
B3 - Engine Cranks/Won't Start - Continued



RG10123 –19–16AUG00

DPSG,RG40854,86 –19–10JUN99–1/1

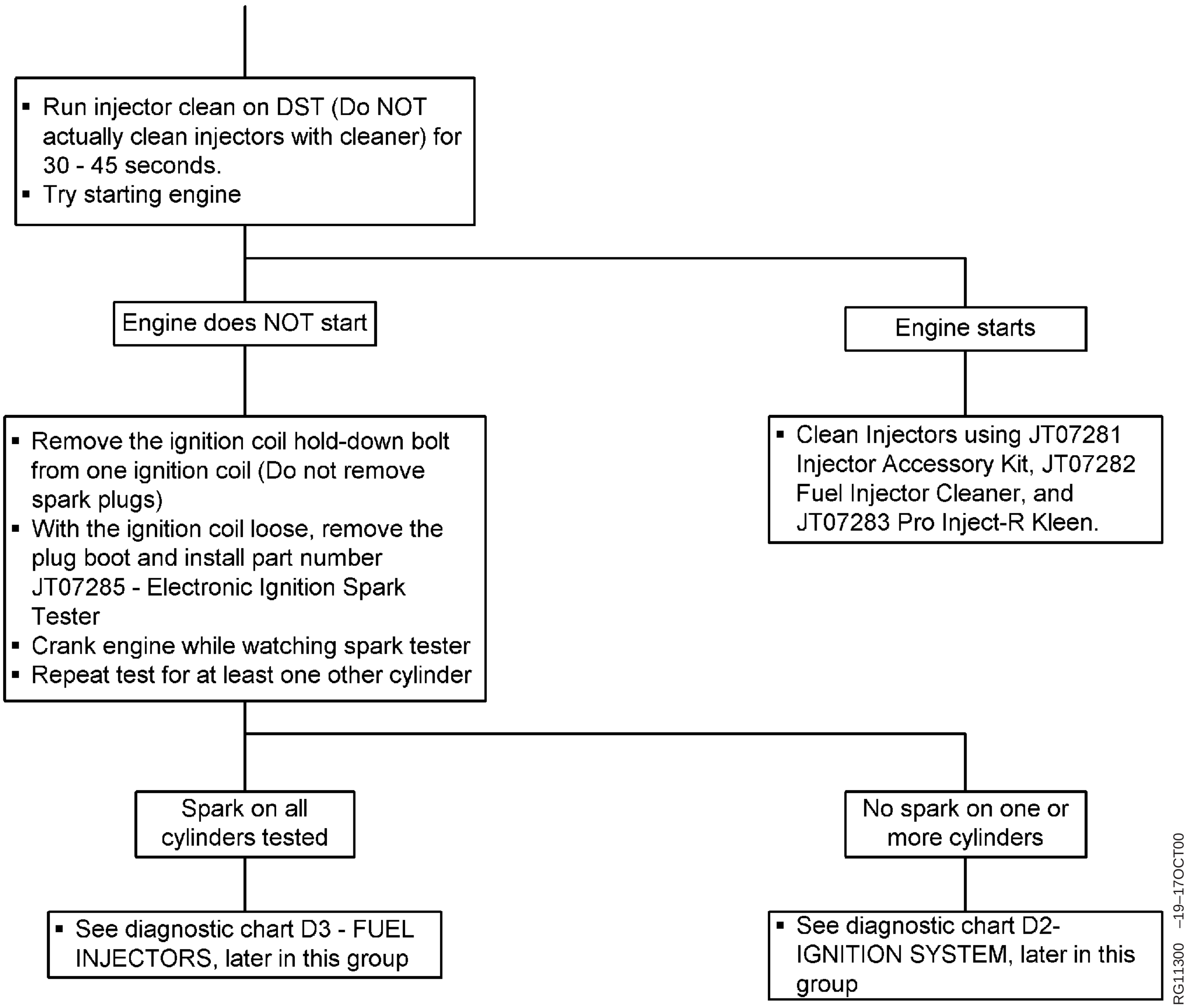
B3 - Engine Cranks/Won’t Start - Continued



RG10124 –19–17OCT00

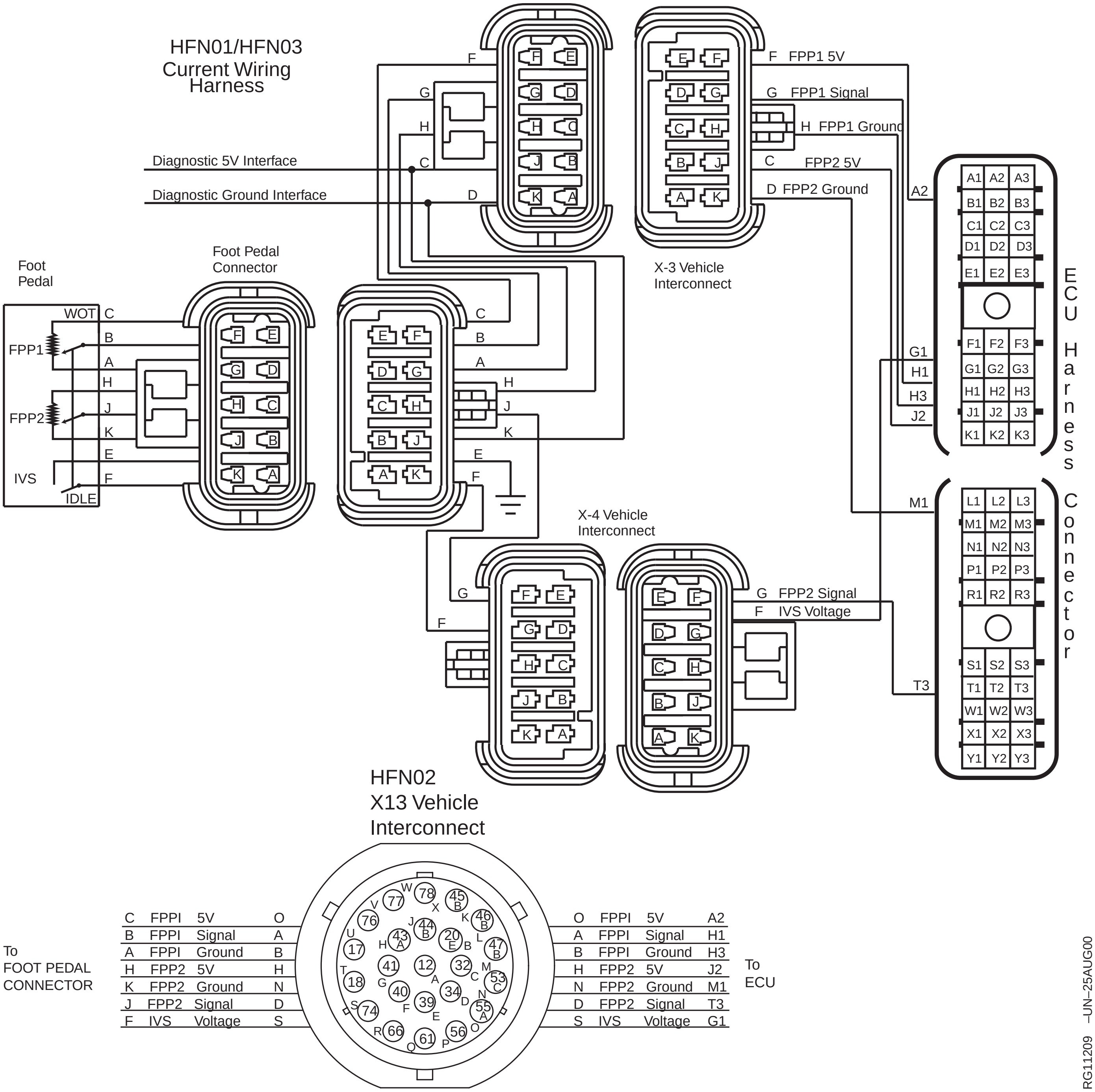
DPSG,RG40854,86 –19–10JUN99–1/1

B3 - Engine Cranks/Won’t Start - Continued



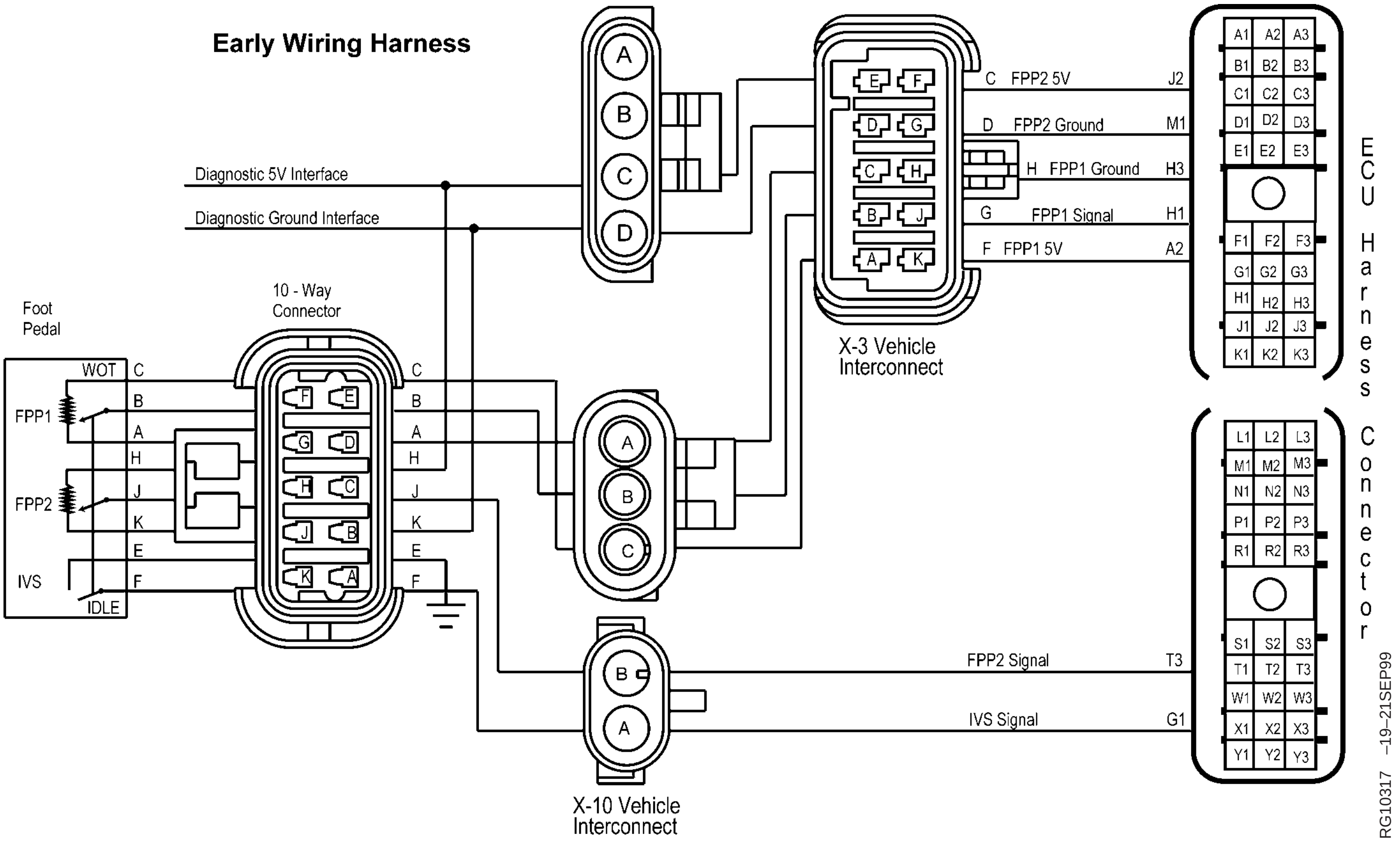
DPSG,RG41221,4 –19–16AUG00–1/1

B4 - Engine Won't Idle (Not Missing or Running Rough)



Continued on next page

RG,RG34710,3076 –19–15JUL96–1/2



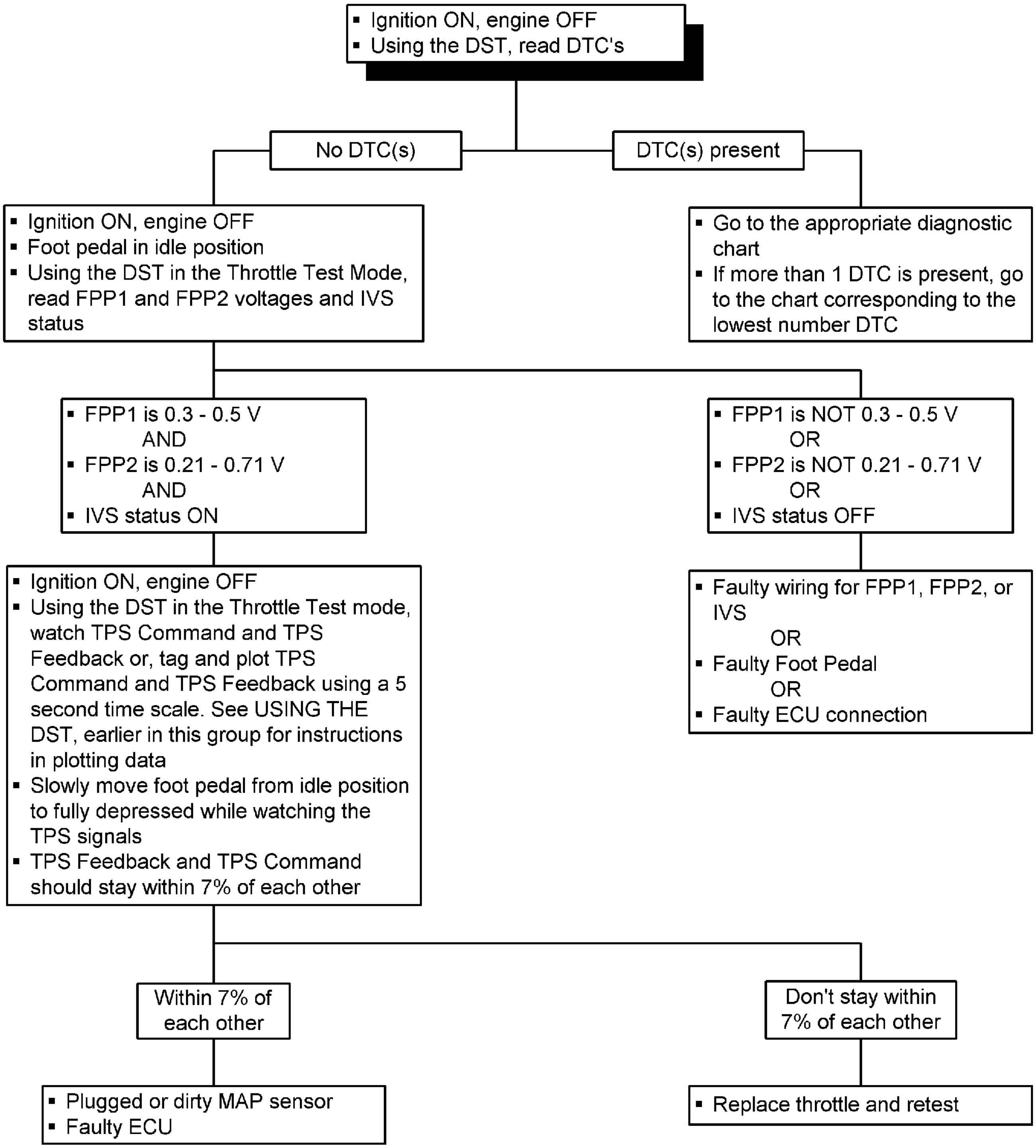
ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.)(D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

This diagnostic chart should be used if the engine starts, but will not idle without pressing on the foot pedal. If the engine won’t start, See diagnostic chart B3 - ENGINE CRANKS/WON’T START, earlier in this Group.

RG,RG34710,3076 –19–15JUL96–2/2

B4 - Engine Won't Idle - Continued

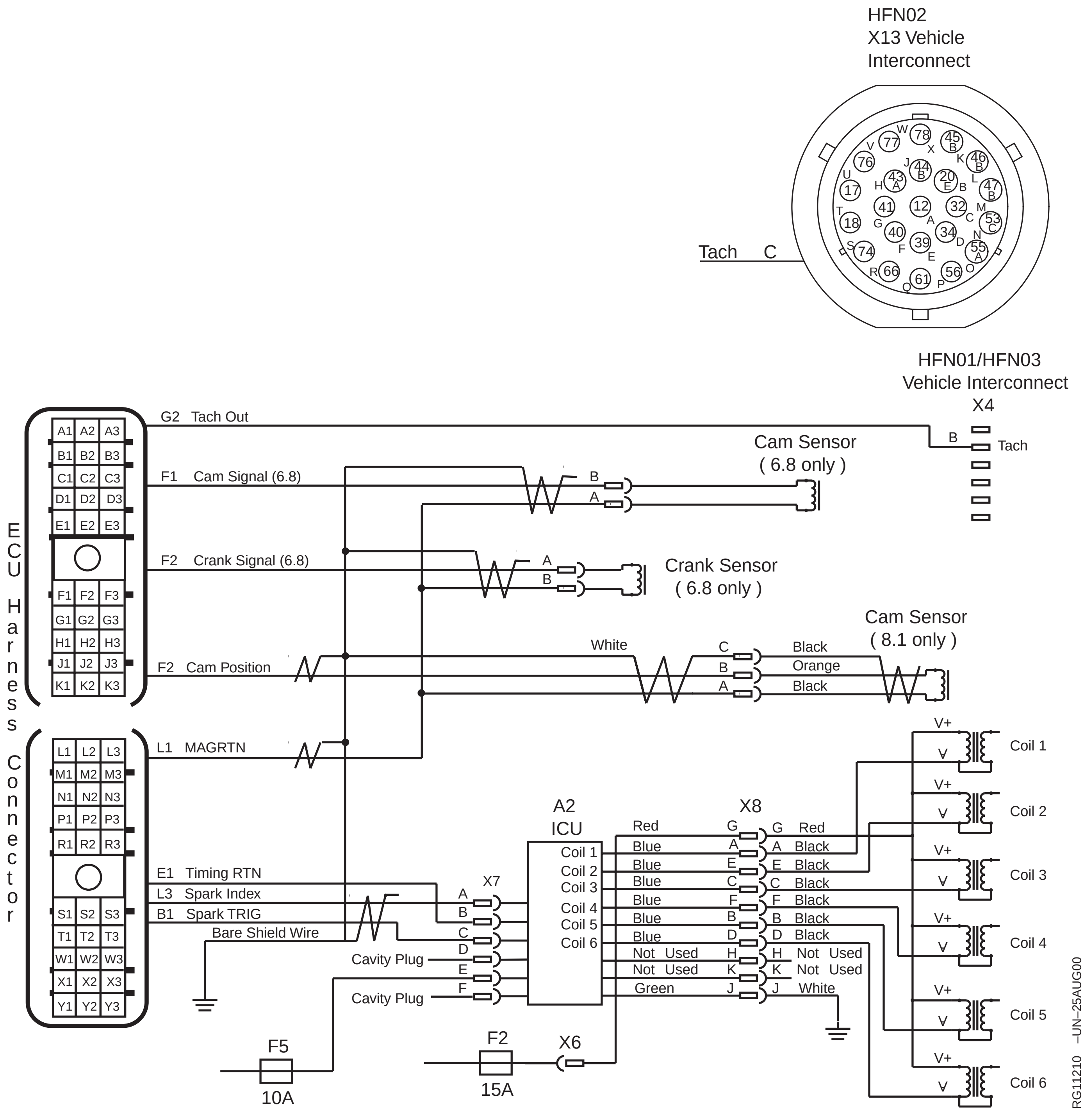
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connectors looking for dirty, damaged, or poorly positioned terminals.



RG10125 –19–31AUG00

DPSG,RG40854,87 –19–10JUN99–1/1

B5 - Engine Miss/Runs Rough



Continued on next page RG,RG34710,3077 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F6 is used in the location of fuse F5 shown in the electrical schematic below.

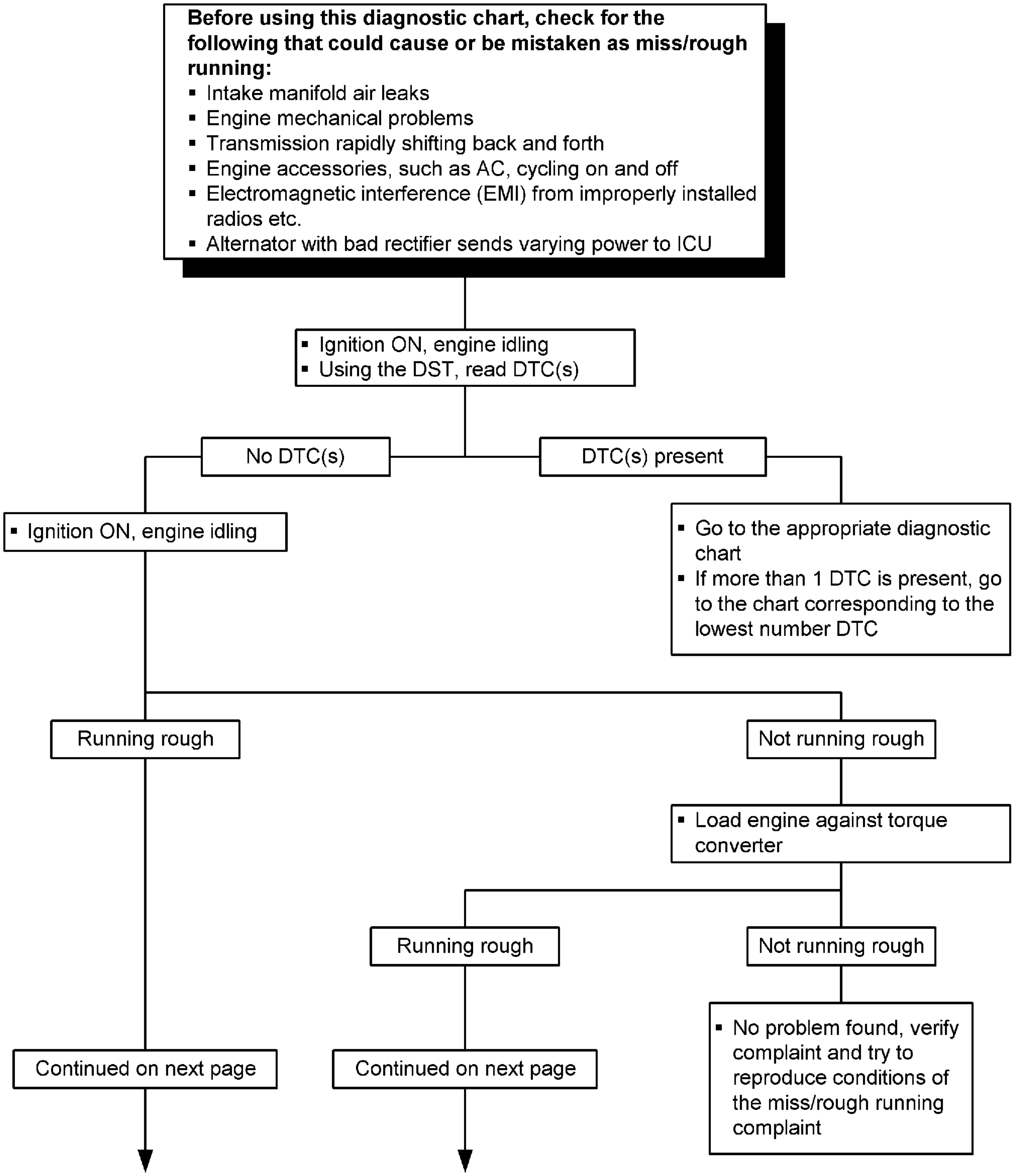
ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F2	A	31 White	N.A.	Crank Signal
F2	B	31 Lt. Blue	Lt. Blue/Dk. Green	Cam Signal (8.1)
F1	B	73 White	N.A.	Cam Signal (6.8)
L1	A	33B Black	N.A.	MAGRTN (6.8 Cam)
L1	A	33 Black	Black Gray	MAGRTHN (8.1 Cam)
L1	B	33A Black	N.A.	MAGRTN (6.8 Crank)
G2	B (X-4 V.I.) (C)	Lt. Blue 32	Lt. Blue/Red	Tach. Out
E1	B	30 Gray	Gray/Brown	Timing RTN
L3	A	28 Purple	Purple/White	Spark Index
B1	C	29 White	White/Purple	Spark Trig
N.A.	E	62 Pink	Pink	VBAT

This diagnostic chart should be used if the engine demonstrates a symptom of varying power or does not seem to be operating on all cylinders.

RG,RG34710,3077 –19–15JUL96–2/2

B5 - Engine Miss/Runs Rough - Continued

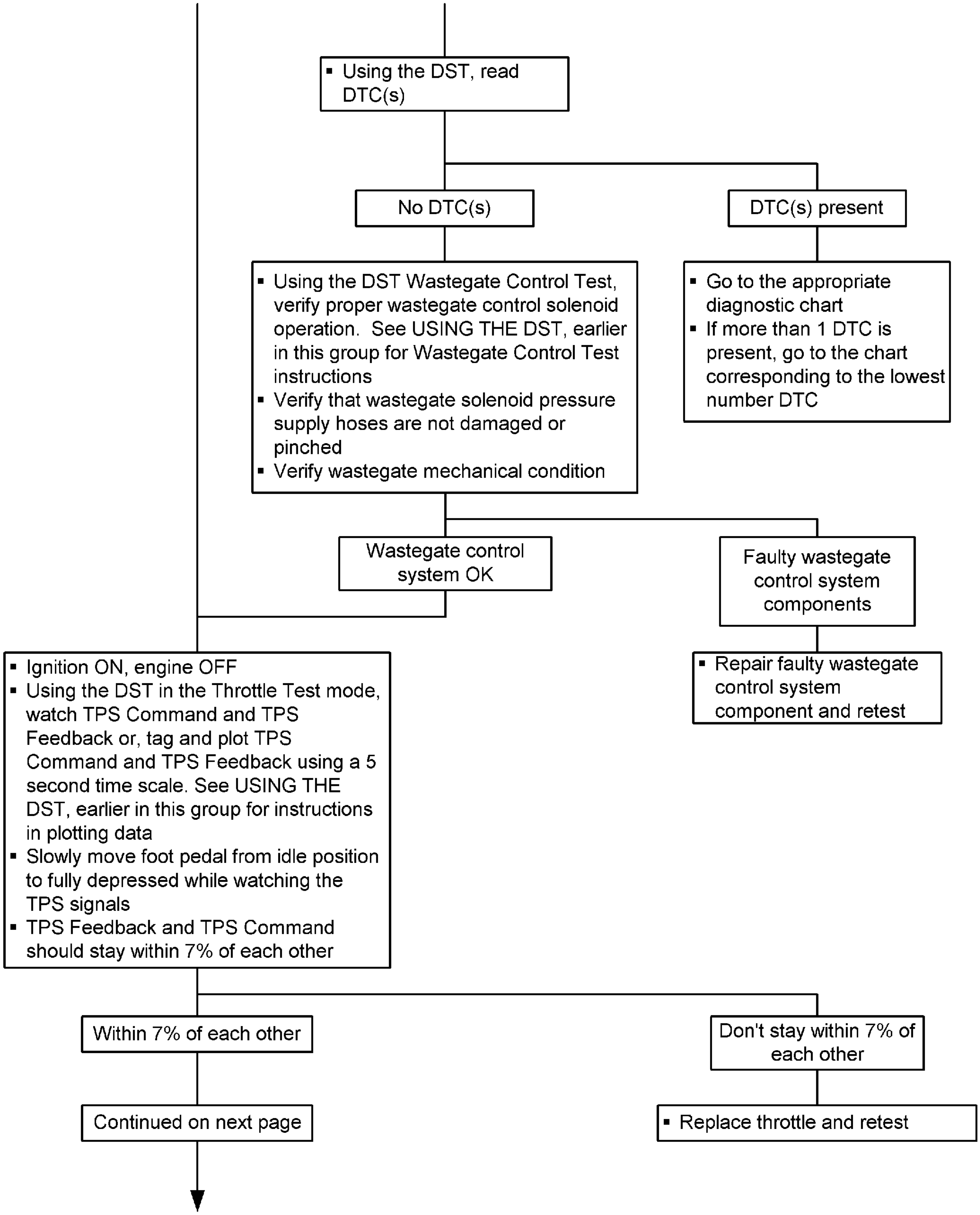
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, ICU connector, and all of the relating sensor connectors looking for dirty, damaged, or poorly positioned terminals.



RG10126 –19–16AUG00

DPSG,RG40854,88 –19–10JUN99–1/1

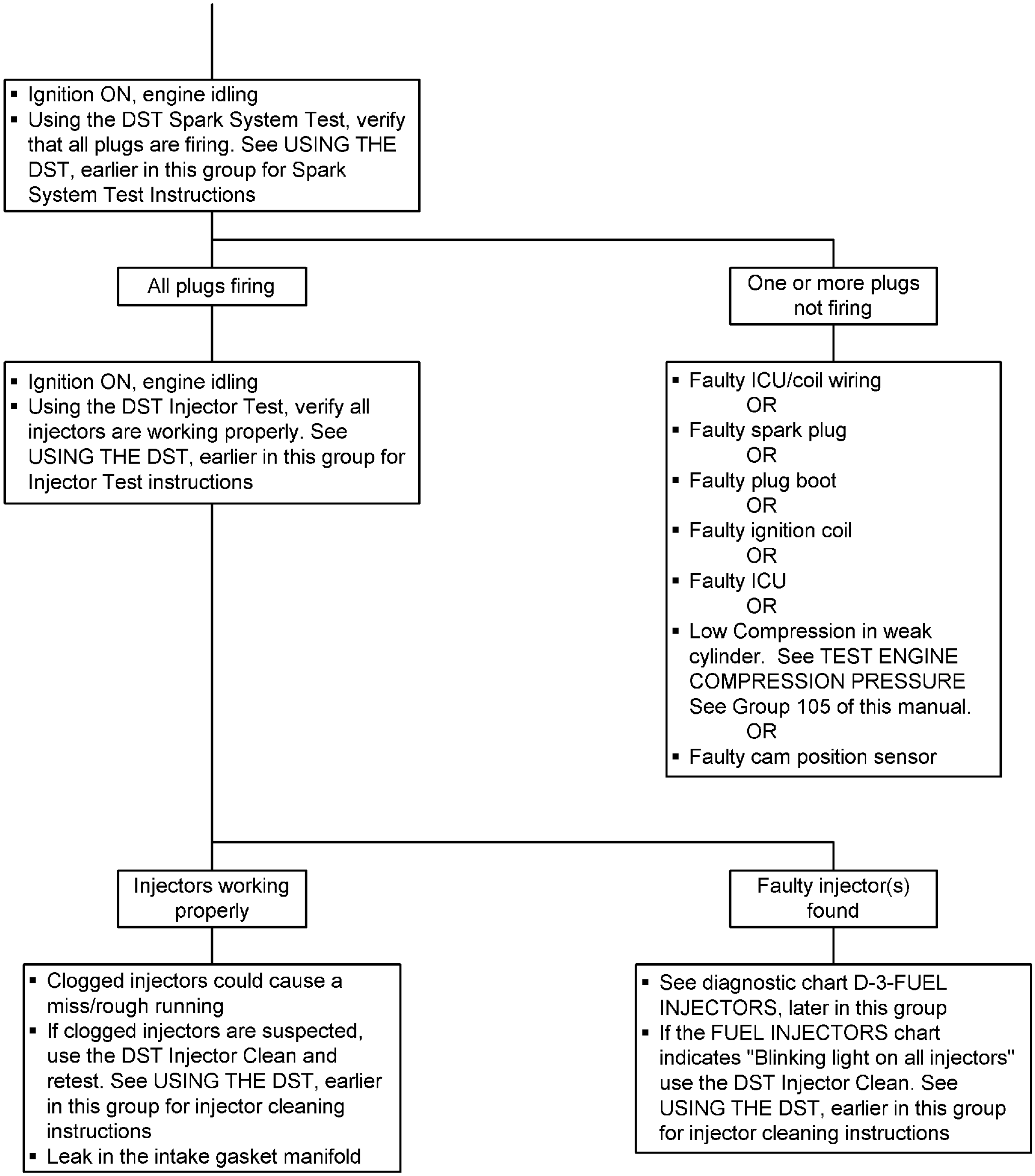
B5 - Engine Miss/Runs Rough - Continued



RG10127 –19–31AUG00

DPSG,RG40854,88 –19–10JUN99–1/1

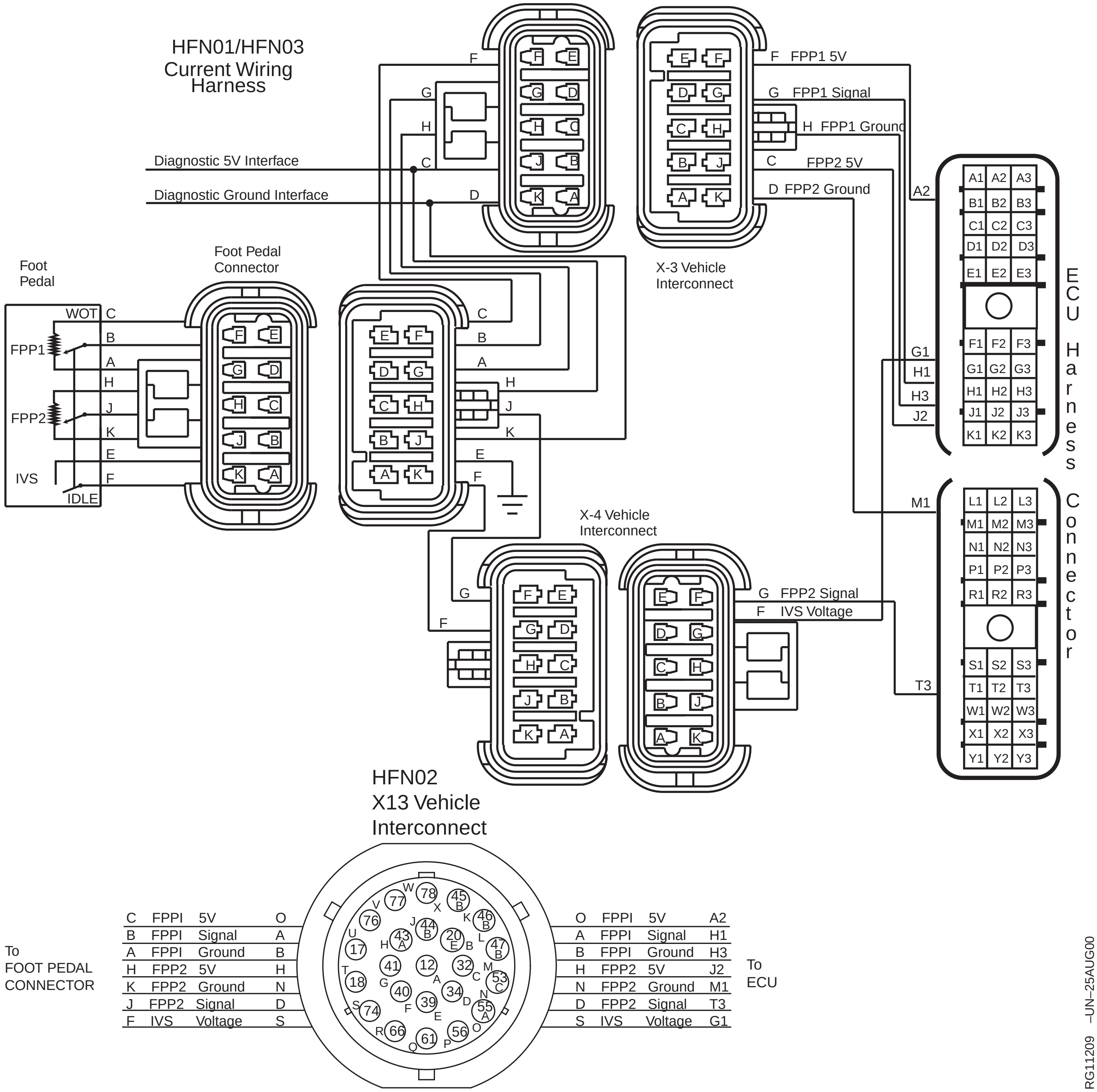
B5 - Engine Miss/Runs Rough - Continued



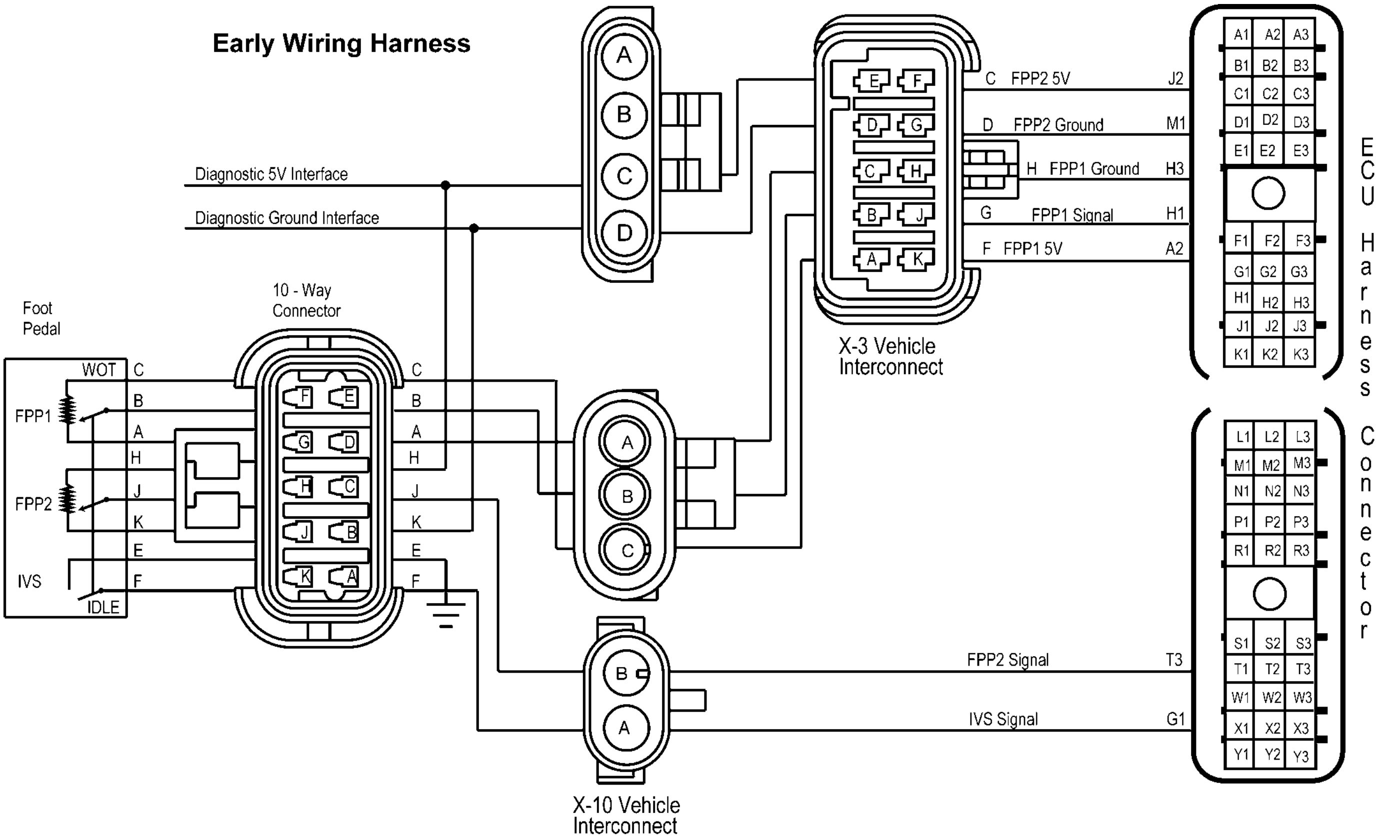
RG10128 –19–31AUG00

DPSG,RG40854,88 –19–10JUN99–1/1

B6 - Low Power



Continued on next page RG,RG34710,3078 –19–15JUL96–1/2



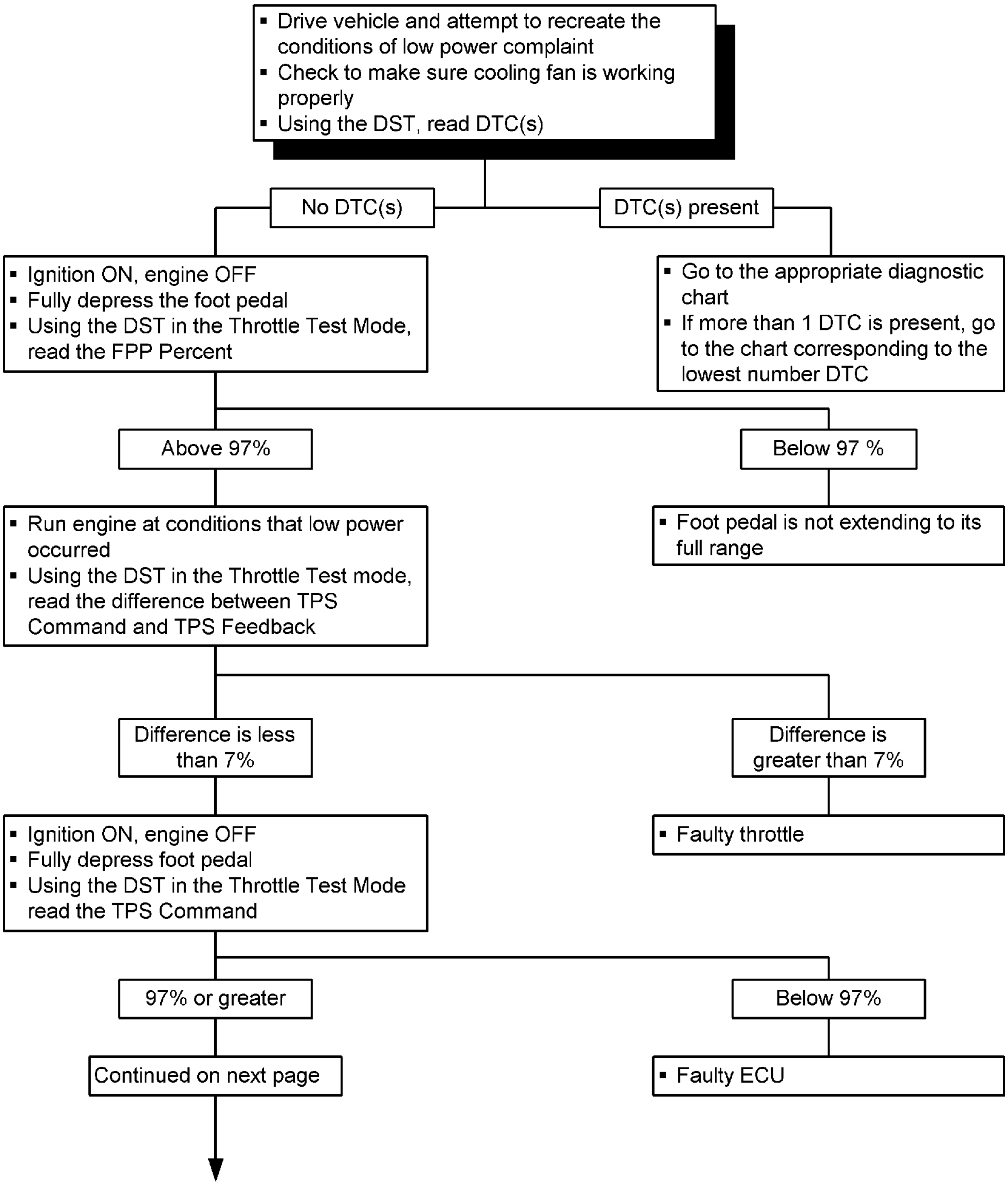
ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.)(D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

This diagnostic chart should be used if the engine delivers less power than expected. If the engine misses or runs rough, use diagnostic chart B5 - ENGINE MISS/RUNS ROUGH, earlier in this Group. **Before using this diagnostic chart, ensure that there are no problems with the transmission or the engine mechanical systems, and there isn't excessive load on the vehicle.**

RG,RG34710,3078 –19–15JUL96–2/2

B6 - Low Power - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10129 –19–16AUG00

DPSG,RG40854,89 –19–10JUN99–1/1

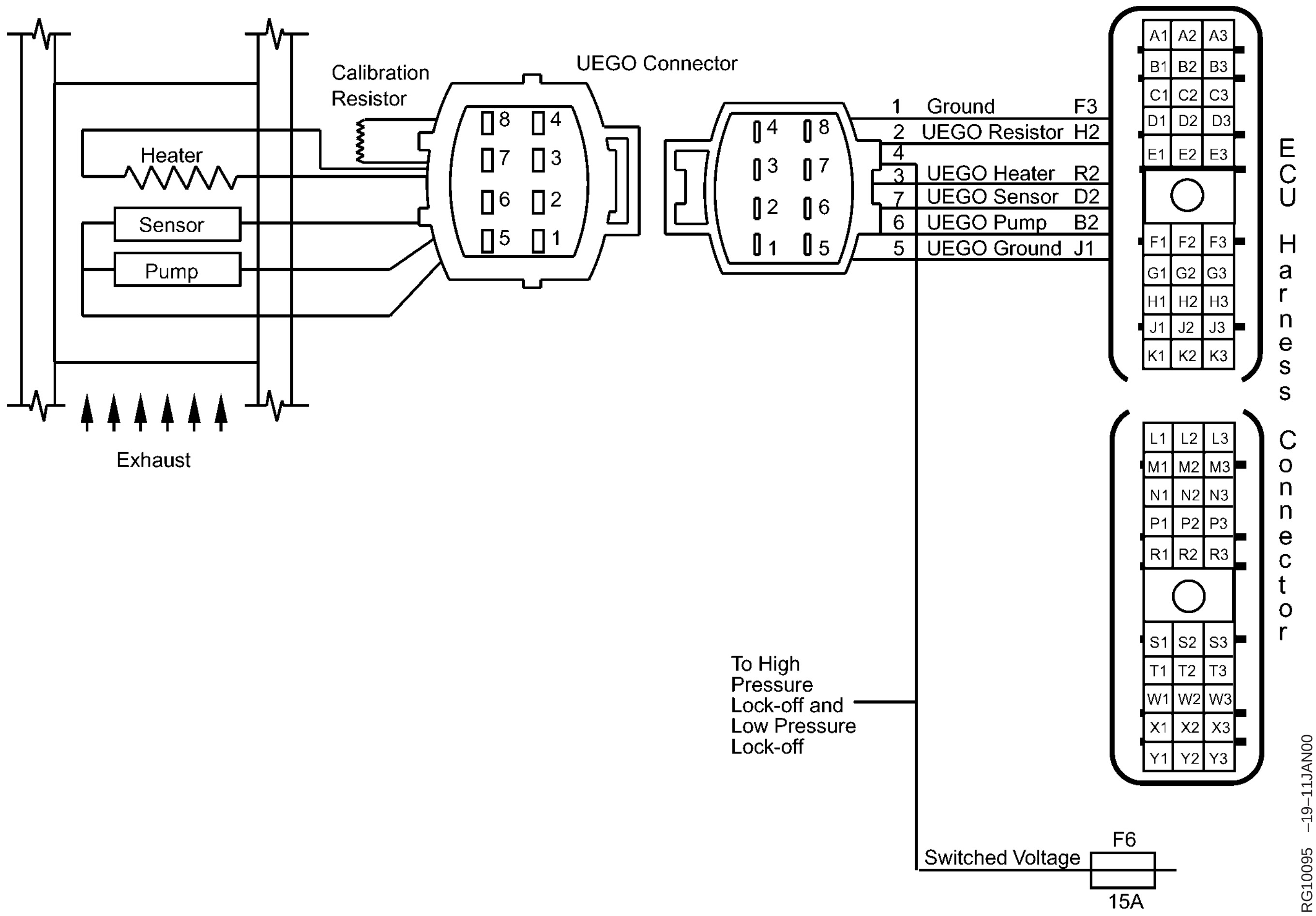
B6 - Low Power - Continued

- Use the DST Spark System Test to verify ignition system integrity. See USING THE DST, earlier in this group for Spark System Test instructions
- Faulty ICU/coil wiring - Check for loose or damaged wires
- Faulty ignition coil - Check for faulty coil.
- Faulty spark plug boot - Check for loose or torn boots
- Faulty spark plugs - Check that all spark plugs are in good condition and are gapped to specification
- Faulty ICU - Check for faulty ICU
- Faulty ECU - Check for faulty ECU

RG11296 –19–16AUG00

DPSG,RG41221,2 –19–14AUG00–1/1

DTC 13 UEGO Sense Cell Failure



Continued on next page RG,RG34710,3079 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO sense cell is used in conjunction with the pump cell to measure exhaust oxygen content.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO sensor to correct fuel delivery with the Closed Loop multiplier and the Adaptive Learn multiplier.

DTC 13 will set if:

- The UEGO sense voltage exceeds 1.10 volts at anytime the system is operating in closed loop mode
- **OR** The UEGO sense voltage exceeds 1.10 volts after the engine has been running for 60 seconds

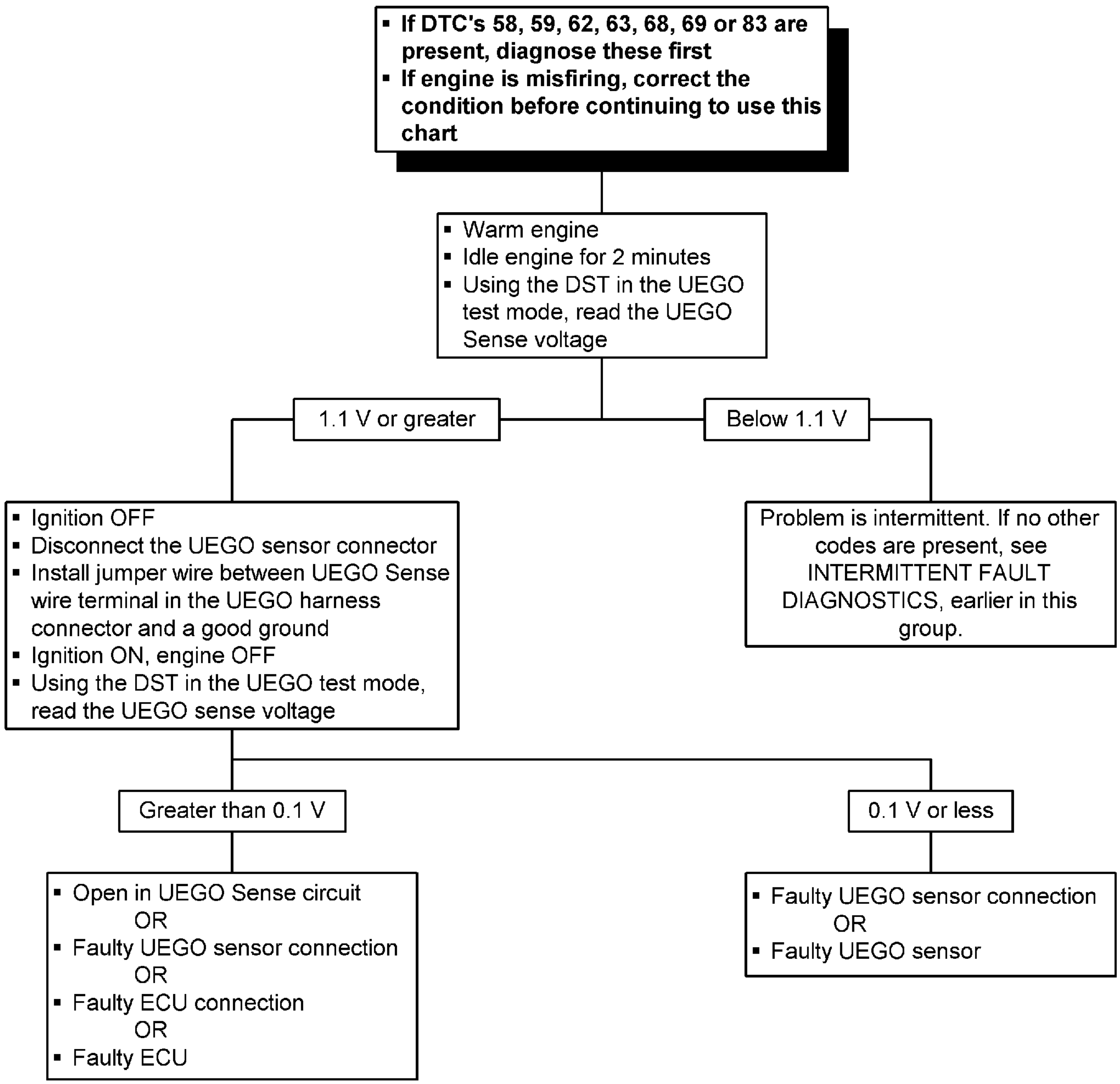
If DTC 13 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3079 –19–15JUL96–2/2

DTC 13 UEGO Sense Cell Failure - Continued

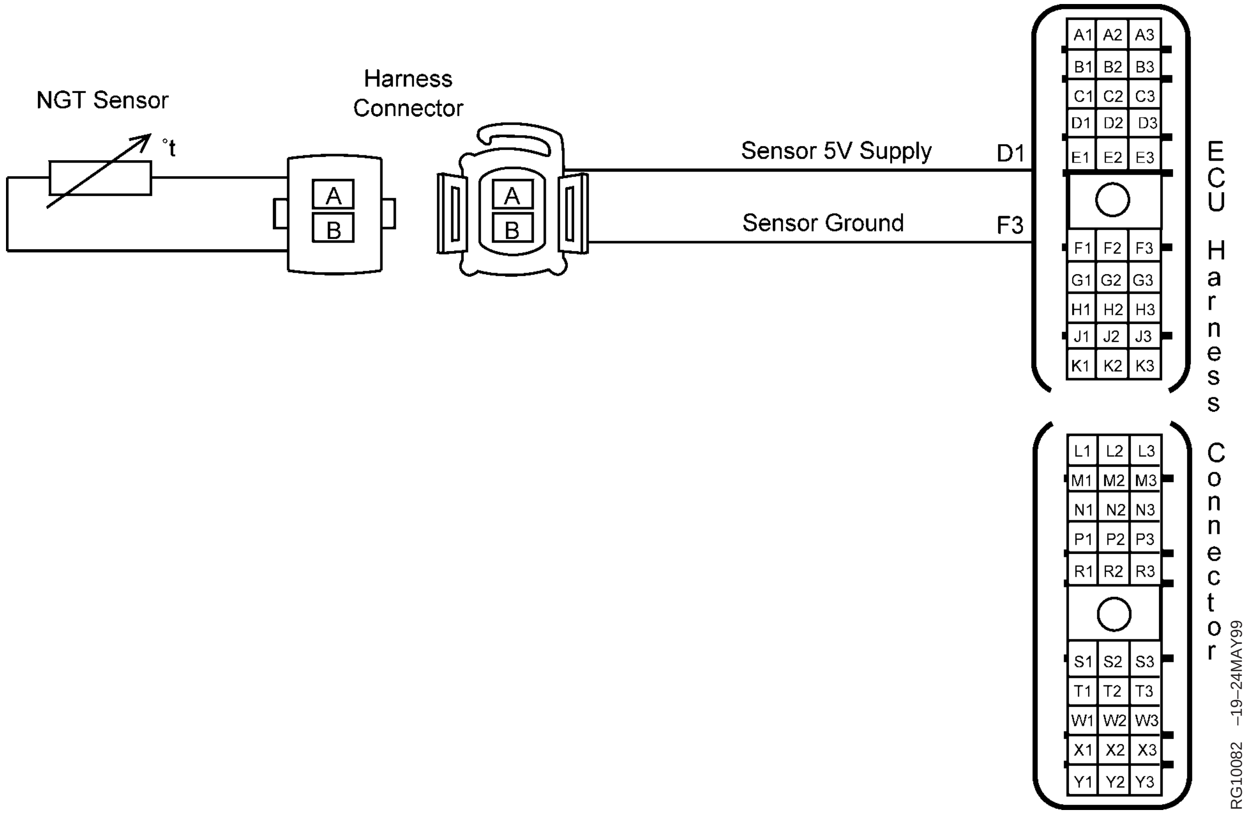
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10131 –19–16AUG00

DPSG,RG40854,91 –19–10JUN99–1/1

DTC 14 NGT Voltage High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
D1	A	14 White	White/Lt. Green	NGT 5V Supply
F3	B	21A Black	Black/Yellow	Sensor Ground

NGT - Natural Gas Temperature sensor

The NGT sensor is a thermistor (temperature sensitive variable resistor) located in the fuel metering valve. It is used to measure the temperature of the fuel prior to injection. The NGT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the NGT sensor measurement:

In conjunction with the NGP sensor to determine fuel density at the injectors.

DTC 14 will set if:

The NGT voltage exceeds 4.95 volts anytime the engine is cranking or running.

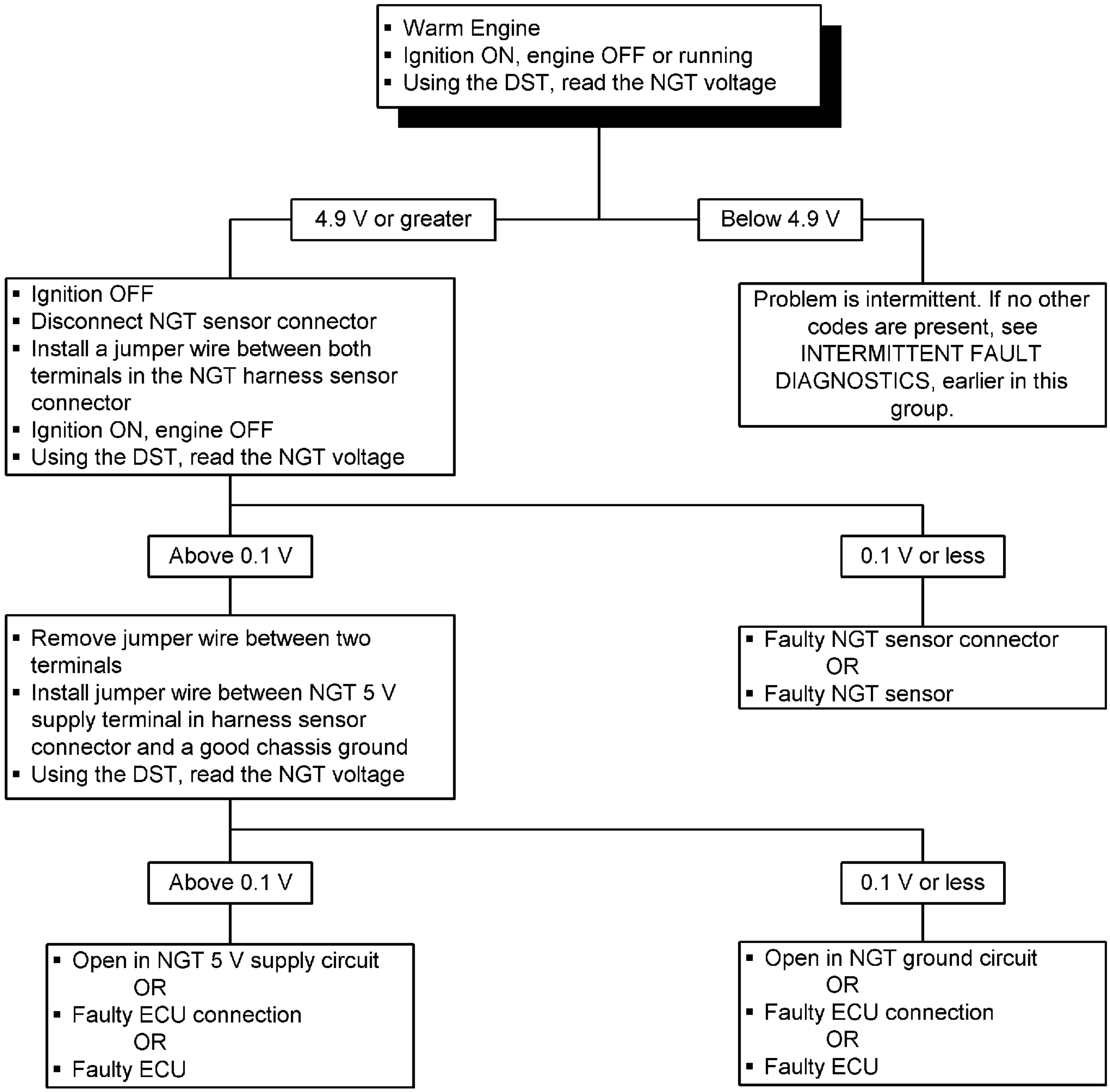
If DTC 14 sets, the following will occur:

- Adaptive learn disabled
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- ECU will use a default “limp home” NGT value
- CEL turned on and stays on for 20 seconds after active fault

RG,RG34710,3081 –19–15JUL96–1/1

DTC 14 NGT Voltage High - Continued

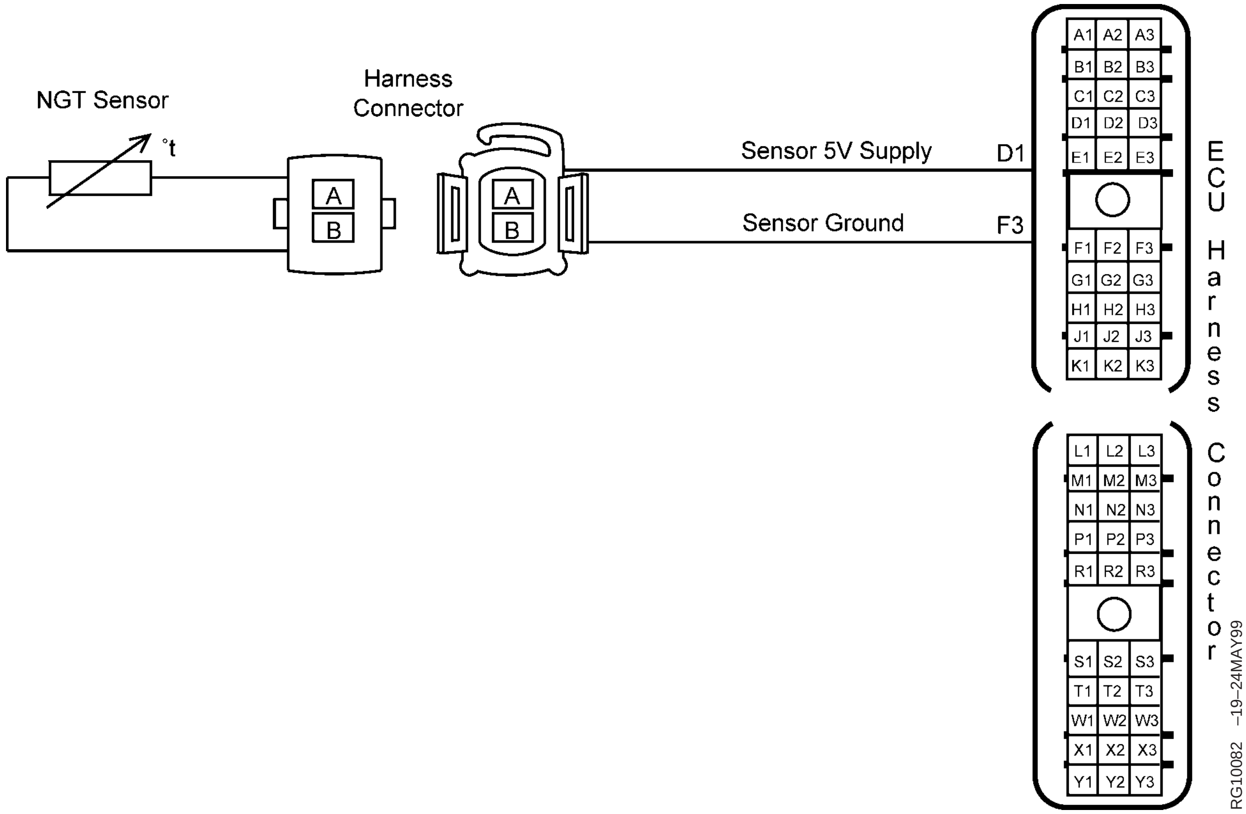
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10132 –19–16AUG00

DPSG,RG40854,92 –19–10JUN99–1/1

DTC 15 NGT Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
D1	A	14 White	White/Lt. Green	NGT 5V Supply
F3	B	21A Black	Black/Yellow	Sensor Ground

NGT - Natural Gas Temperature sensor

The NGT sensor is a thermistor (temperature sensitive variable resistor) located in the fuel metering valve. It is used to measure the temperature of the fuel prior to injection. The NGT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the NGT sensor measurement:

In conjunction with the NGP sensor to determine fuel density at the injectors.

DTC 15 - will set if:

The NGT voltage drops below 0.05 volts anytime the engine is cranking or running.

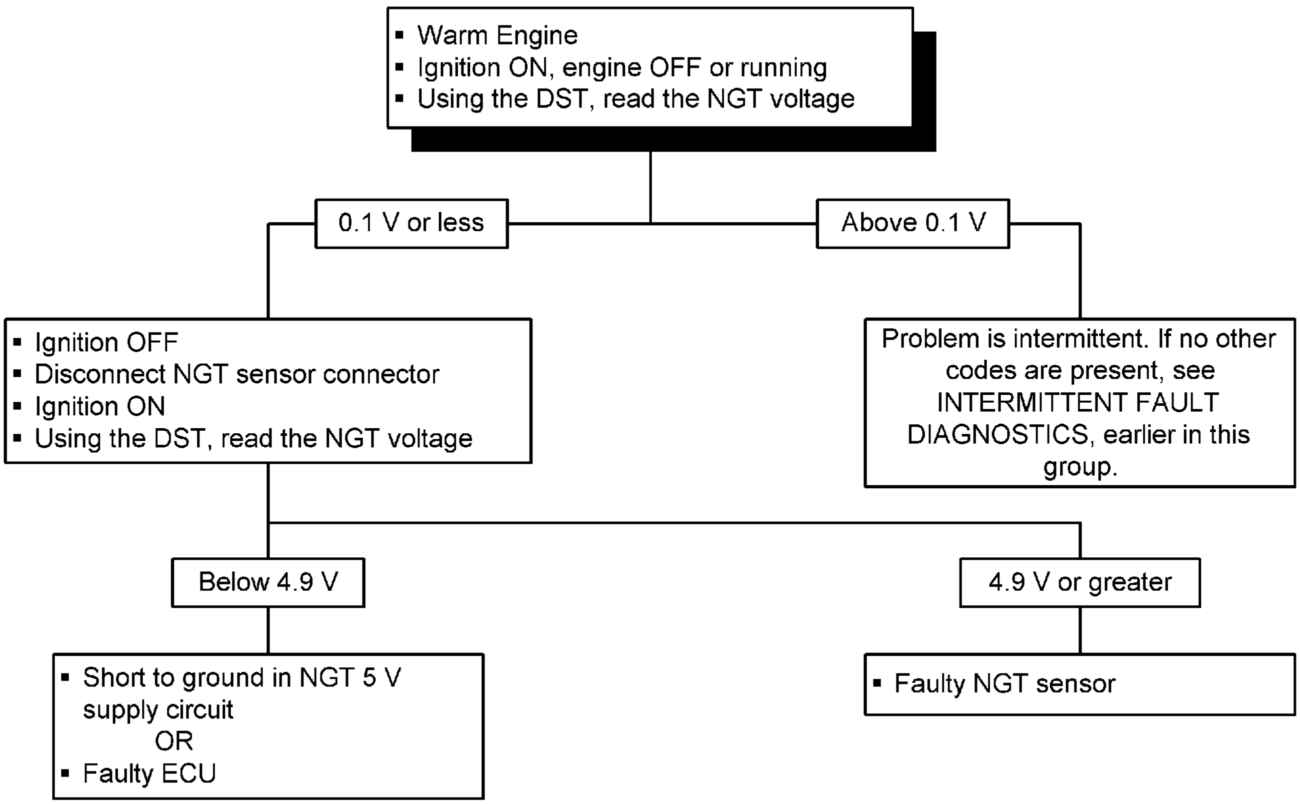
If DTC 15 sets, the following will occur:

- Adaptive learn disabled
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- ECU will use a default “limp home” NGT value
- CEL turned on and stays on 15 seconds after a fault becomes inactive.

RG,RG34710,3083 –19–15JUL96–1/1

DTC 15 NGT Voltage Low - Continued

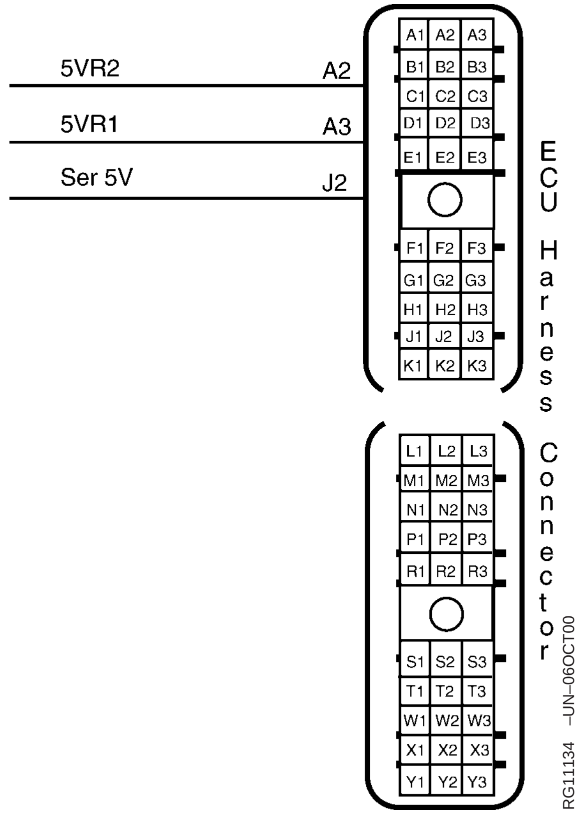
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10133 –19–16AUG00

DPSG,RG40854,93 –19–10JUN99–1/1

DTC 16 External 5 Volt Supply Error



ECU Pin #	‘Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	55 Lt Green	Lt Green/Red	Sensor 5V Supply A	
A3	54A Yellow	Yellow/Red	Sensor 5V Supply A	
J2	43 Gray	Gray/Red	Sensor 5V Supply B	

5 Volt Supply

All of the sensors and some other components in the system voltages are supplied by an external 5 volt supply. Due to the importance of the 5 volt supply accuracy, the ECU monitors the voltage. If the ECU detects an overload, shorted, or out of specification high or low on the 5 volt supply line, this code sets.

The ECU uses the External 5 Volt Supply to:

Supply all of the sensors with power.

DTC 16 - will set if:

- 5 Volt Supply A exceeds 5.3 Volts
- 5 Volt Supply B exceeds 5.3 Volts
- 5 Volt Supply A is below 4.7 Volts
- 5 Volt Supply B is below 4.7 Volts

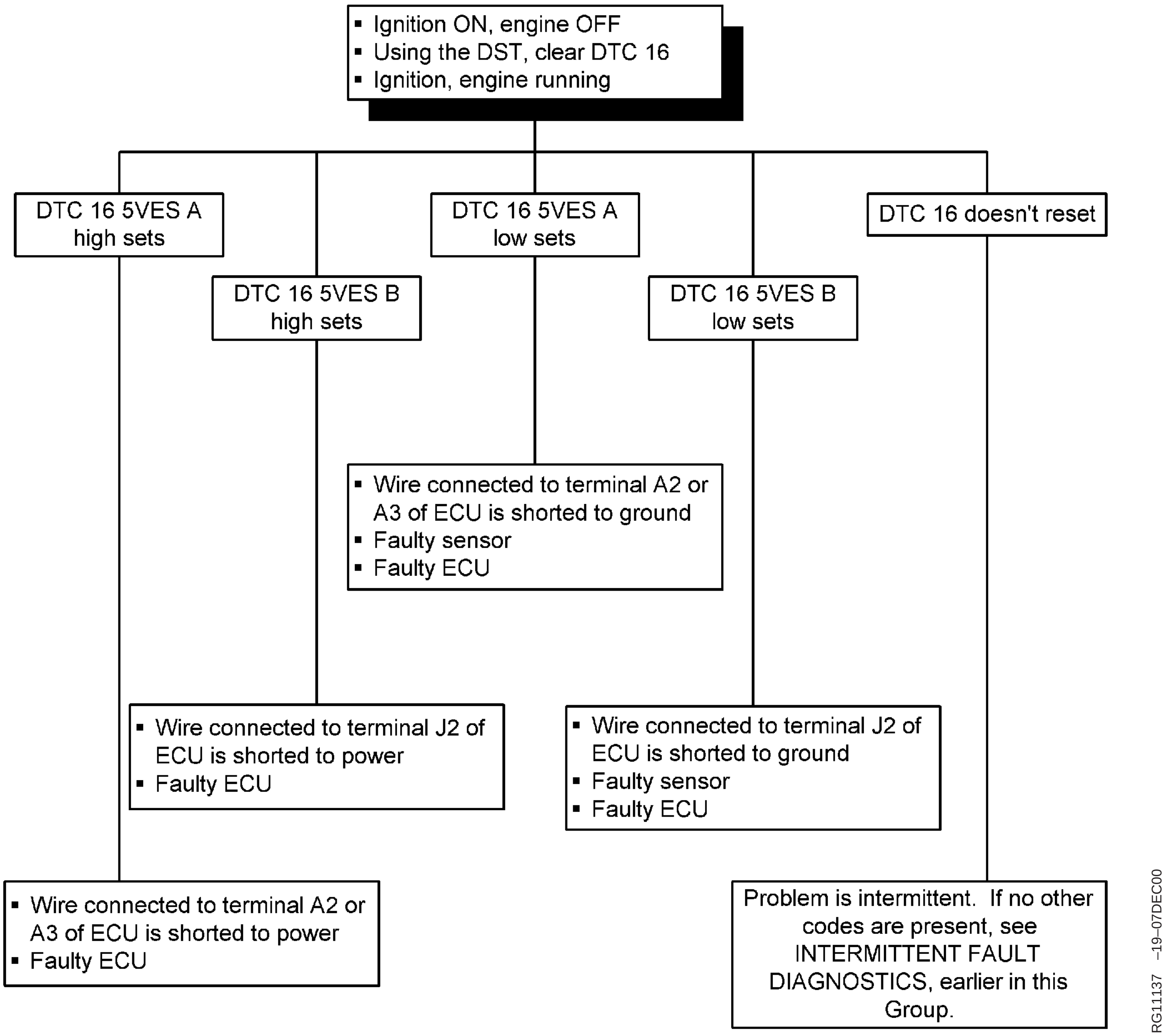
If DTC 16 sets, the following will occur:

- Adaptive Learn disabled
- CEL on for remainder of key on cycle
- Closed loop multiplier allowed to stay at its limit if needed (Closed loop limit fault will set)
- Boost pressure is limited to 10 psig maximum for remainder of key on cycle

DPSG,RG41221,58 –19–10JUL00–1/1

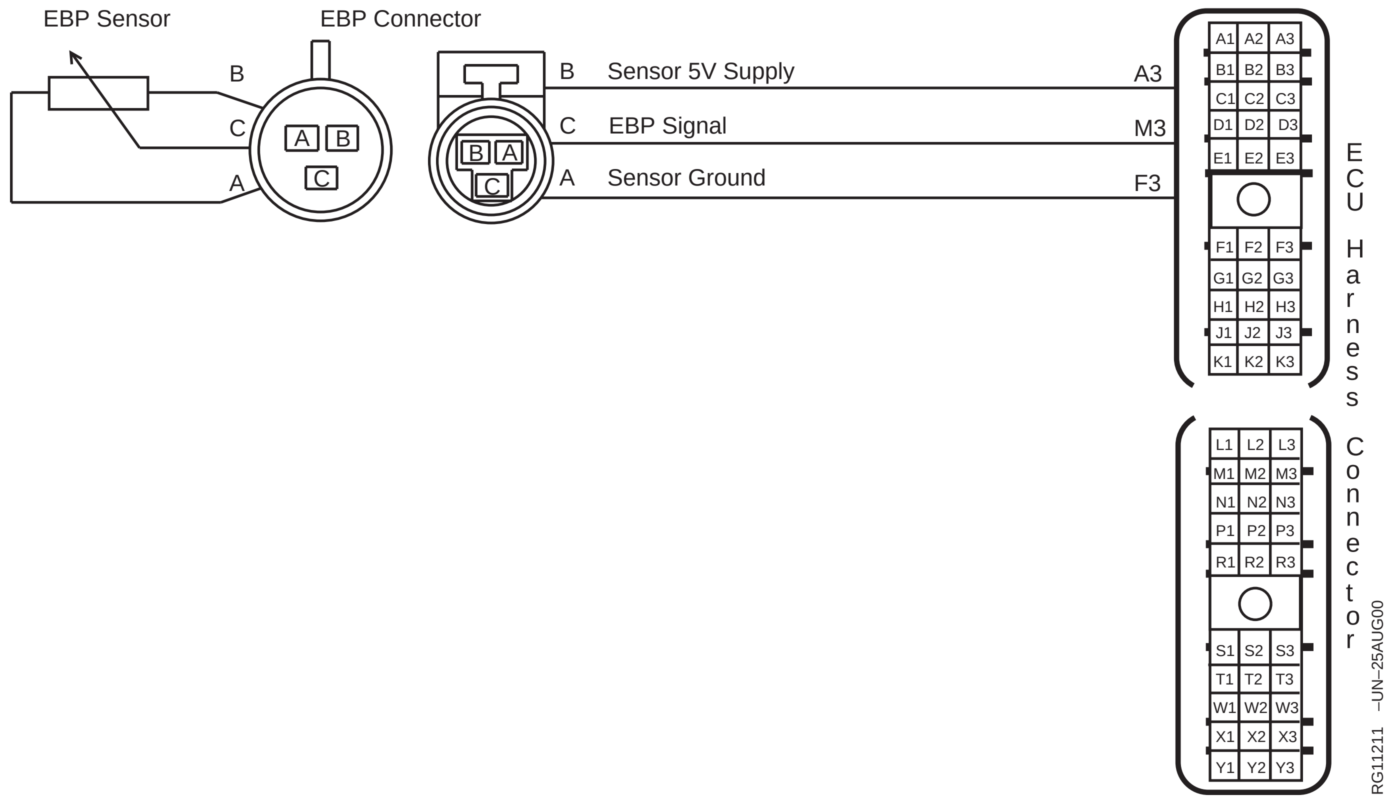
DTC 16 External 5 Volt Supply Error - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors looking for dirty, damaged, or poorly positioned terminals.



DPSG,RG41221,59 –19–10JUL00–1/1

DTC 17 EBP Voltage High



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54A Yellow	Yellow/Red	Sensor 5V Supply
M3	C	9 Dk. Green	Dk. Green/White	EBP Signal
F3	A	21C Black	Black/Yellow	Sensor Ground

EBP - Exhaust Back Pressure sensor

The EBP sensor is a pressure transducer mounted in the exhaust, downstream of the turbocharger. The EBP signal voltage varies as exhaust pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the EBP sensor signal for:

- Air density calculations
- Turbocharger wastegate control
- Closed loop fuel delivery correction

DTC 17 will set if:

The EBP sensor output is above 3.0 volts anytime the key is on

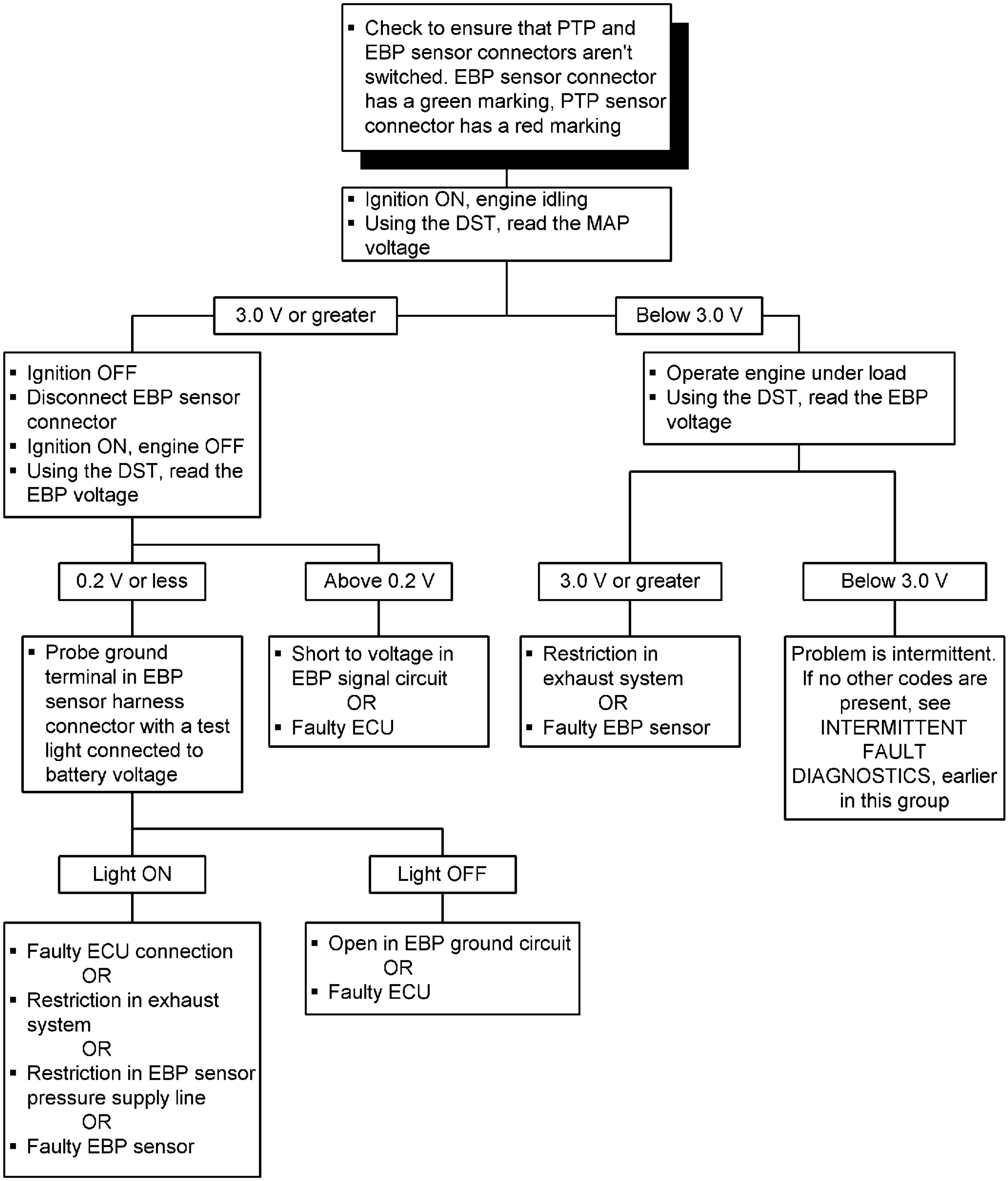
If DTC 17 sets, the following will occur:

- Boost is limited to 10 psig maximum
- Adaptive learn disabled for remainder of key-on cycle
- ECU will use a default “limp home” EBP value
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3085 –19–15JUL96–1/1

DTC 17 EBP Voltage High - Continued

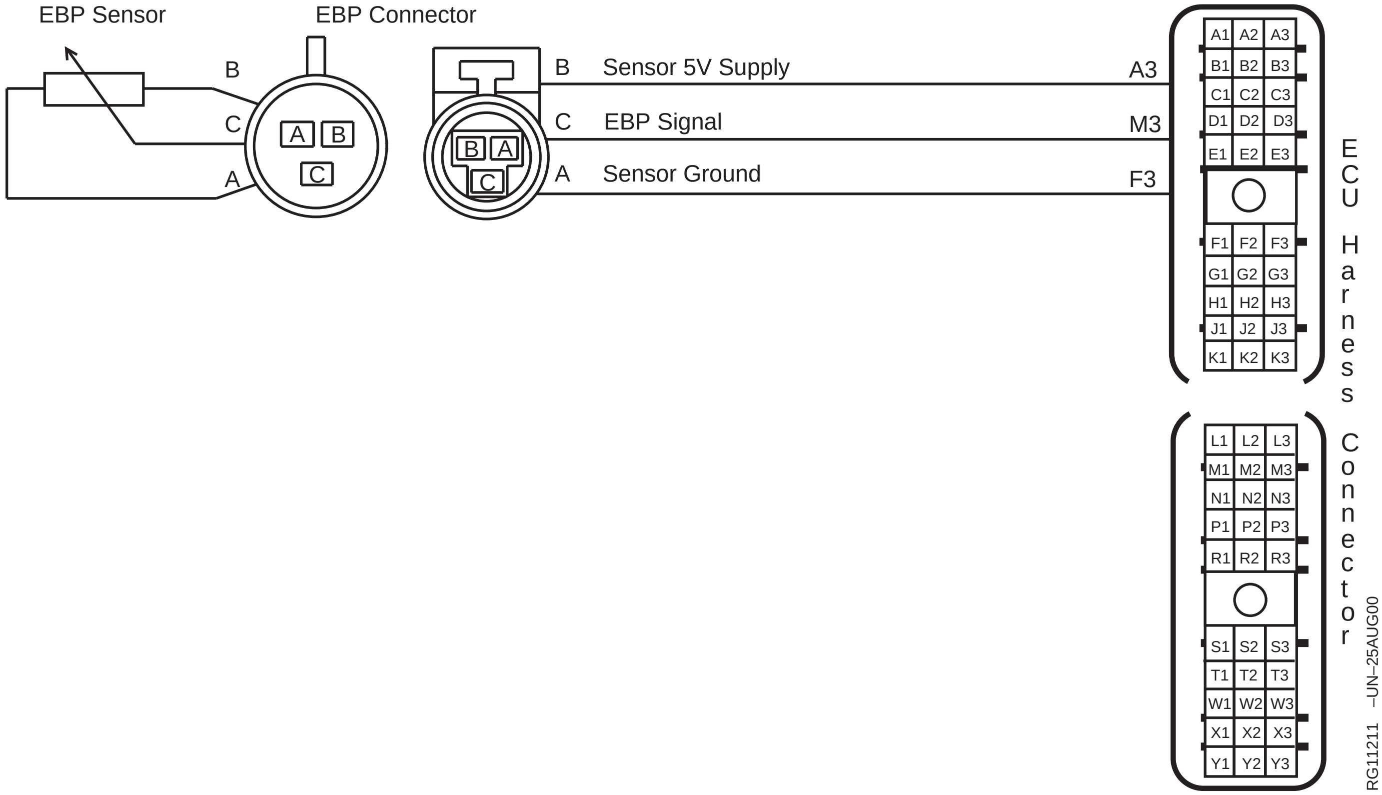
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Exhaust Back Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10134 –19–16AUG00

DPSG,RG40854,83 –19–10JUN99–1/1

DTC 18 EBP Voltage Low



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54A Yellow	Yellow/Red	Sensor 5V Supply
M3	C	9 Dk. Green	Dk. Green/White	EBP Signal
F3	A	21C Black	Black/Yellow	Sensor Ground

EBP - Exhaust Back Pressure sensor

The EBP sensor is a pressure transducer mounted in the exhaust, downstream of the turbocharger. The EBP signal voltage varies as exhaust pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the EBP sensor signal for:

- Air density calculations
- Turbocharger wastegate control
- Closed loop fuel delivery correction

DTC 18 will set if:

The EBP sensor output is less than 1.5 volts anytime the key is on

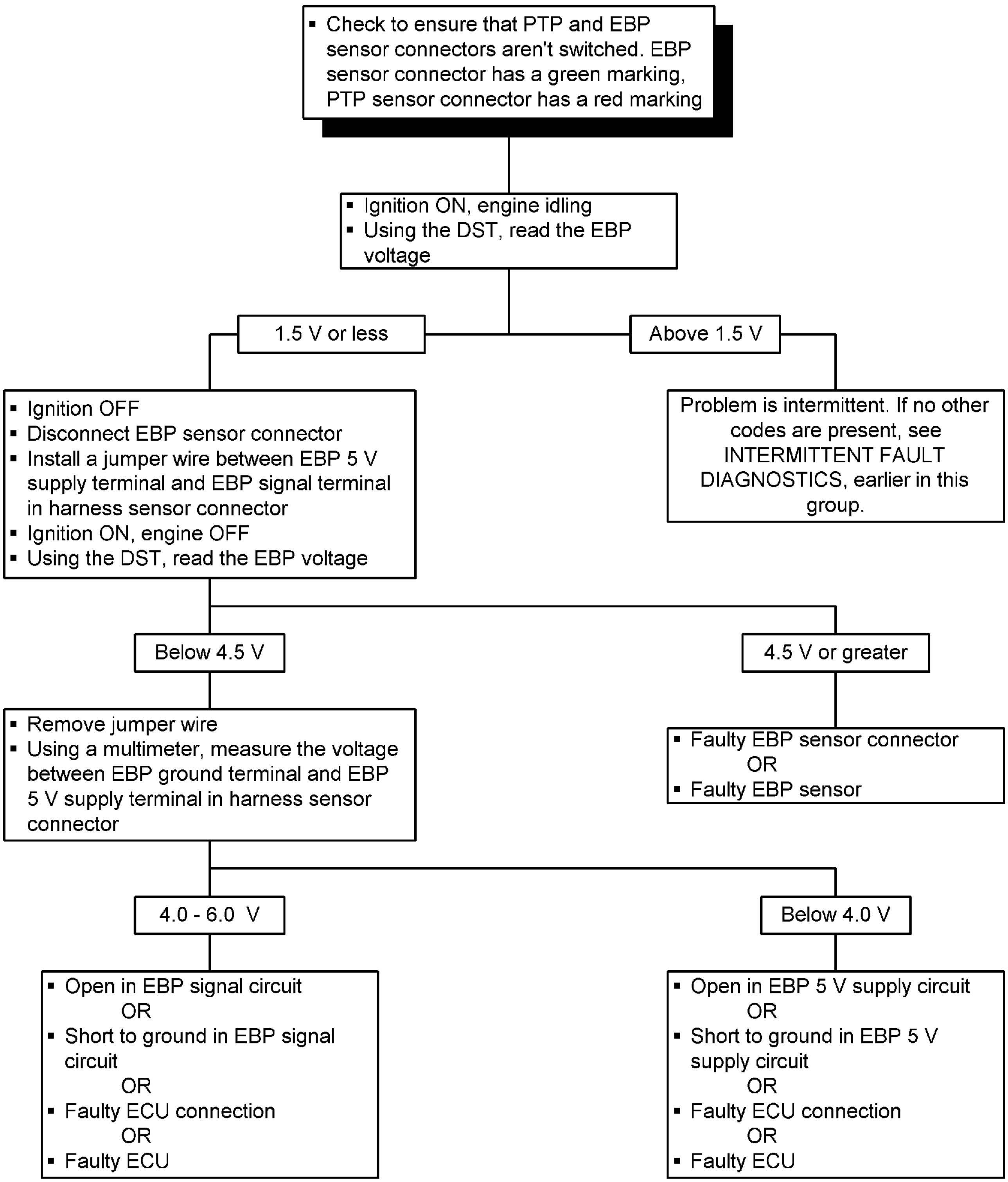
If DTC 18 sets, the following will occur:

- Boost is limited to 10 psig maximum
- Adaptive learn disabled for remainder of key-on cycle
- ECU will use a default “limp home” EBP value
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3087 –19–15JUL96–1/1

DTC 18 EBP Voltage Low - Continued

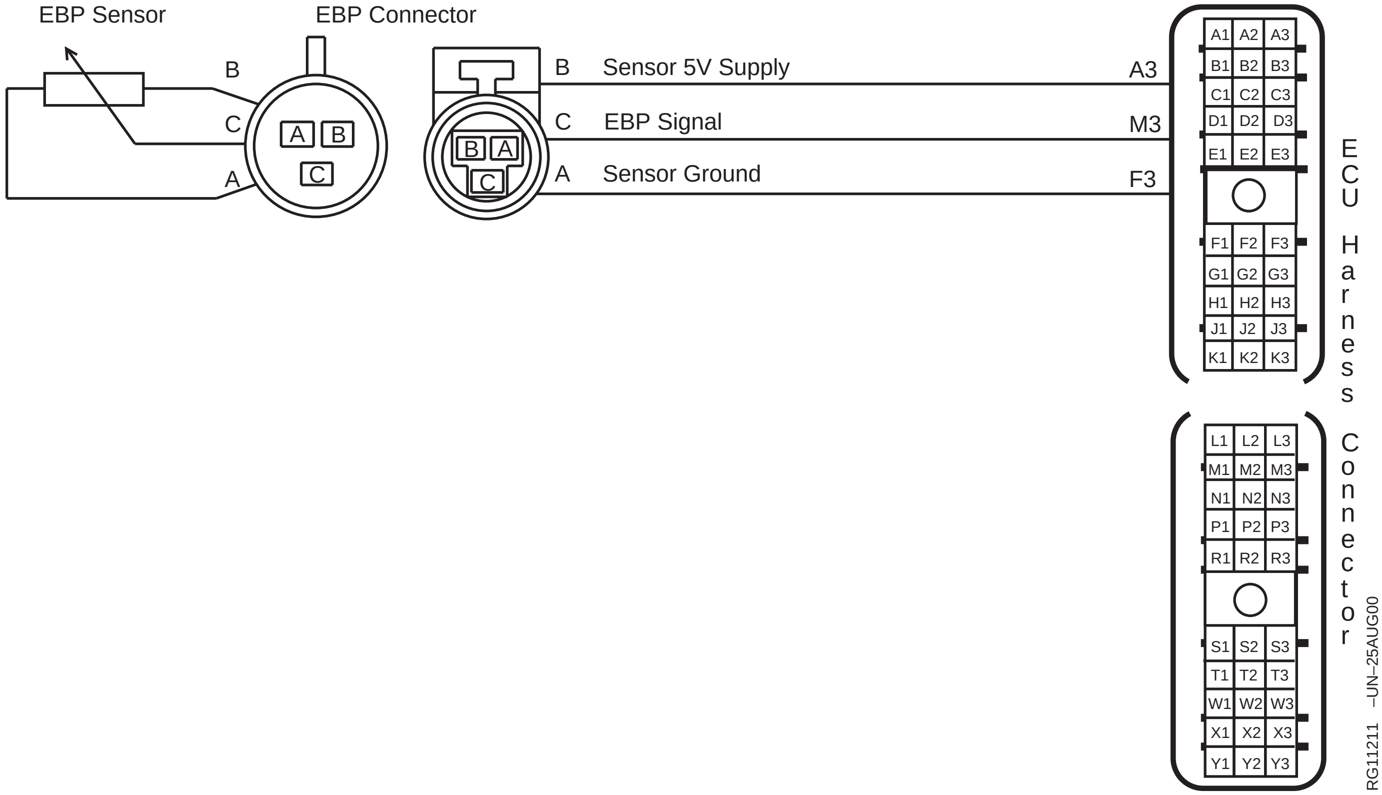
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Exhaust Back Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10135 –19–16AUG00

DPSG,RG40854,94 –19–10JUN99–1/1

DTC 19 EBP Higher Than Expected



NOTE: *This code is not used on the HFN02 6081 engines.*

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54A Yellow	Yellow/Red	Sensor 5V Supply
M3	C	9 Dk. Green 9	Dk. Green/White	EBP Signal
F3	A	21C Black	Black/Yellow	Sensor Ground

EBP - Exhaust Back Pressure sensor

The EBP sensor is a pressure transducer mounted in the exhaust, downstream of the turbocharger. The EBP signal voltage varies as exhaust pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the EBP sensor signal for:

- Air density calculations
- Turbocharger wastegate control
- Closed loop fuel delivery correction

DTC 19 will set if:

The EBP signal voltage is out of range compared to the maximum value expected for the sensor based on the current barometric pressure, MAP, and engine speed.

If DTC 19 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3089 –19–15JUL96–1/1

DTC 19 EBP Higher Than Expected - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Exhaust Back Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.

- Check to ensure that PTP and EBP sensor connectors aren't switched. EBP sensor connector has a green marking, PTP sensor connector has a red marking

- Ignition ON, engine OFF
- Using the DST, clear DTC 19
- Ignition ON, engine running

DTC 19 resets

- Ignition OFF
- Disconnect EBP sensor connector
- Ignition ON, engine OFF
- Using the DST, read the EBP voltage

Below 0.2 V

- Probe EBP ground terminal in harness sensor connector with a test light connected to battery voltage

Light ON

- Exhaust restriction - An exhaust flow restriction will cause the pressure in the exhaust system to increase above normal levels. Check for damaged components and for restricted flow in the muffler.
- Faulty EBP sensor - If no other problems are found, replace the EBP sensor and retest.

Light OFF

- Open in EBP sensor ground circuit
  OR
- Faulty ECU

0.2 V or greater

- Short to voltage in EBP signal circuit
  OR
- Faulty ECU

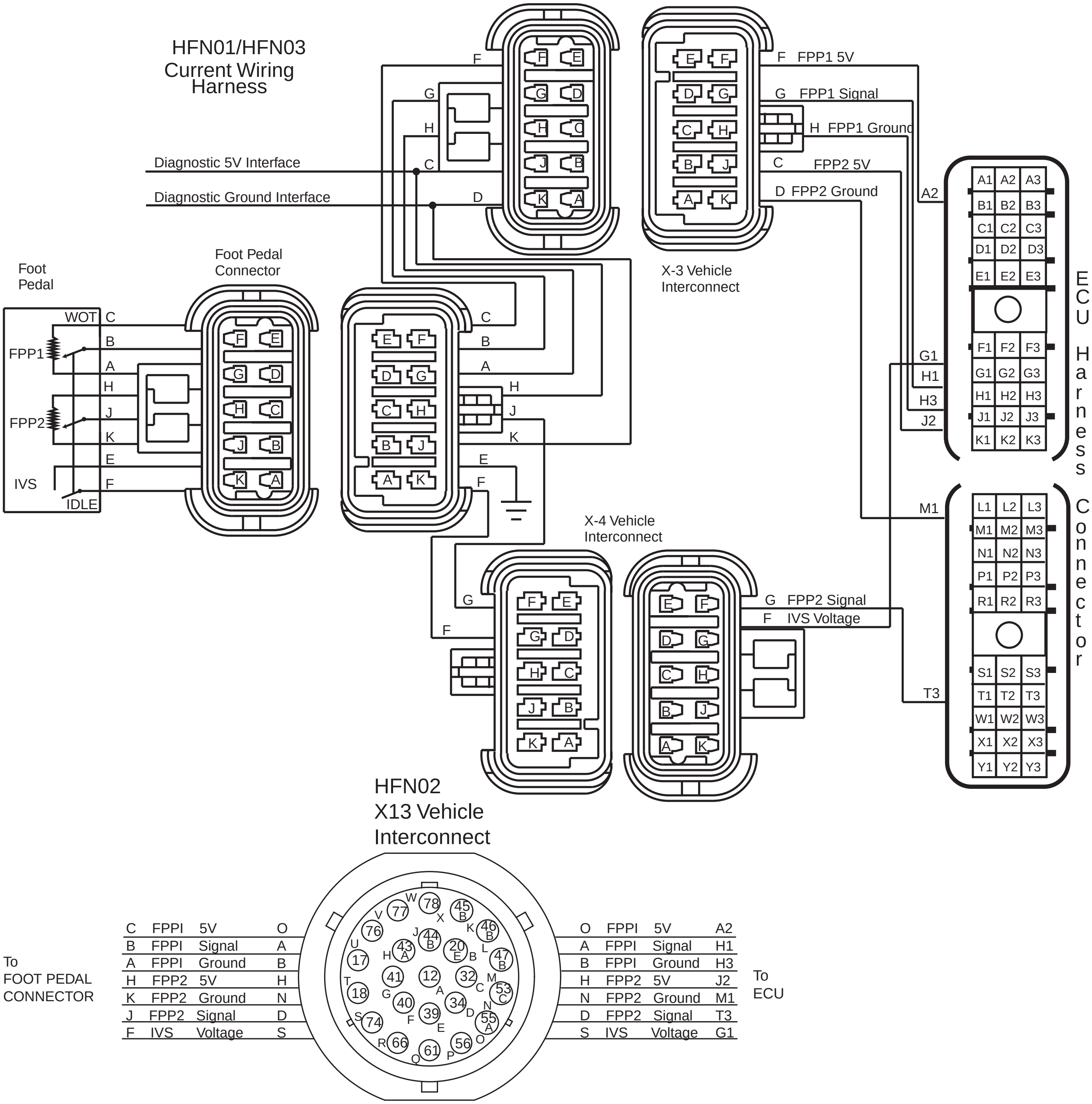
DTC 19 doesn't reset

Problem is intermittent. If no other codes are present, see INTERMITTENT FAULT DIAGNOSTICS, earlier in this group.

RG10136 –19–16AUG00

DPSG,RG40854,95 –19–10JUN99–1/1

DTC 21 FPP1 Voltage High



RG11209 –UN–25AUG00

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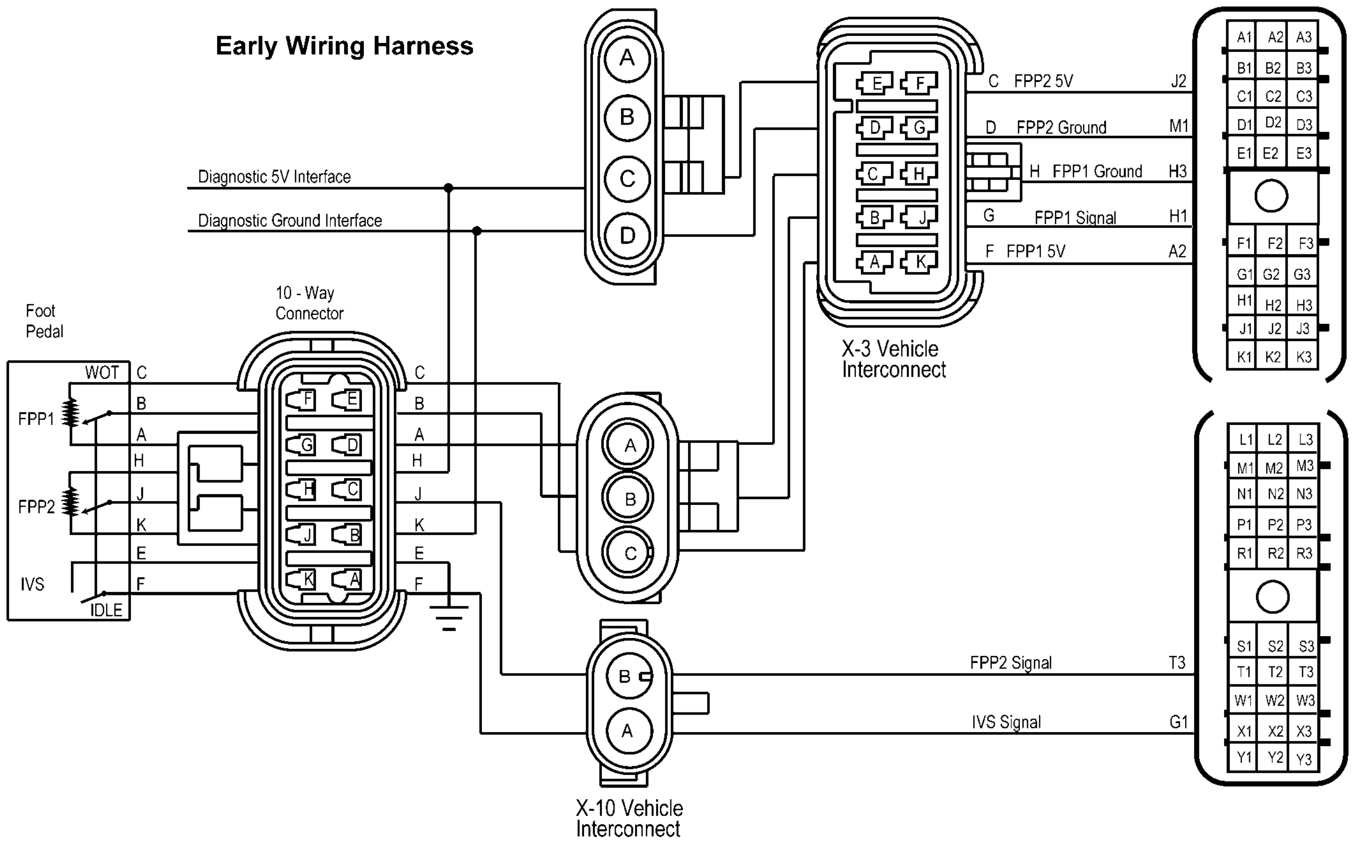
RG,RG34710,3091 –19–15JUL96–1/3



RG10317 –19–21SEP99

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

FPP1 - Foot Pedal Position 1 sensor

The foot pedal assembly contains two independent FPP sensors and an Idle Validation Switch (IVS). The FPP sensors are variable resistors (potentiometers) used to measure the position of the foot pedal. The FPP signal voltages vary as the foot pedal is depressed and released. Less depression of the pedal results in lower signal voltages; greater depression results in higher signal voltages. The two FPP signals are compared to each other and to the IVS status to determine each signal's validity. If the ECU determines that the FPP1 signal is invalid, it will set a fault code and use the FPP2 and IVS signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the FPP sensor signal:

As a redundant input to FPP2; to give the ECU a command of the operator's desired engine load

DTC 21 will set if:

Continued on next page

The FPP1 sensor signal voltage exceeds 4.8 volts any time the key is on

If DTC 21 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

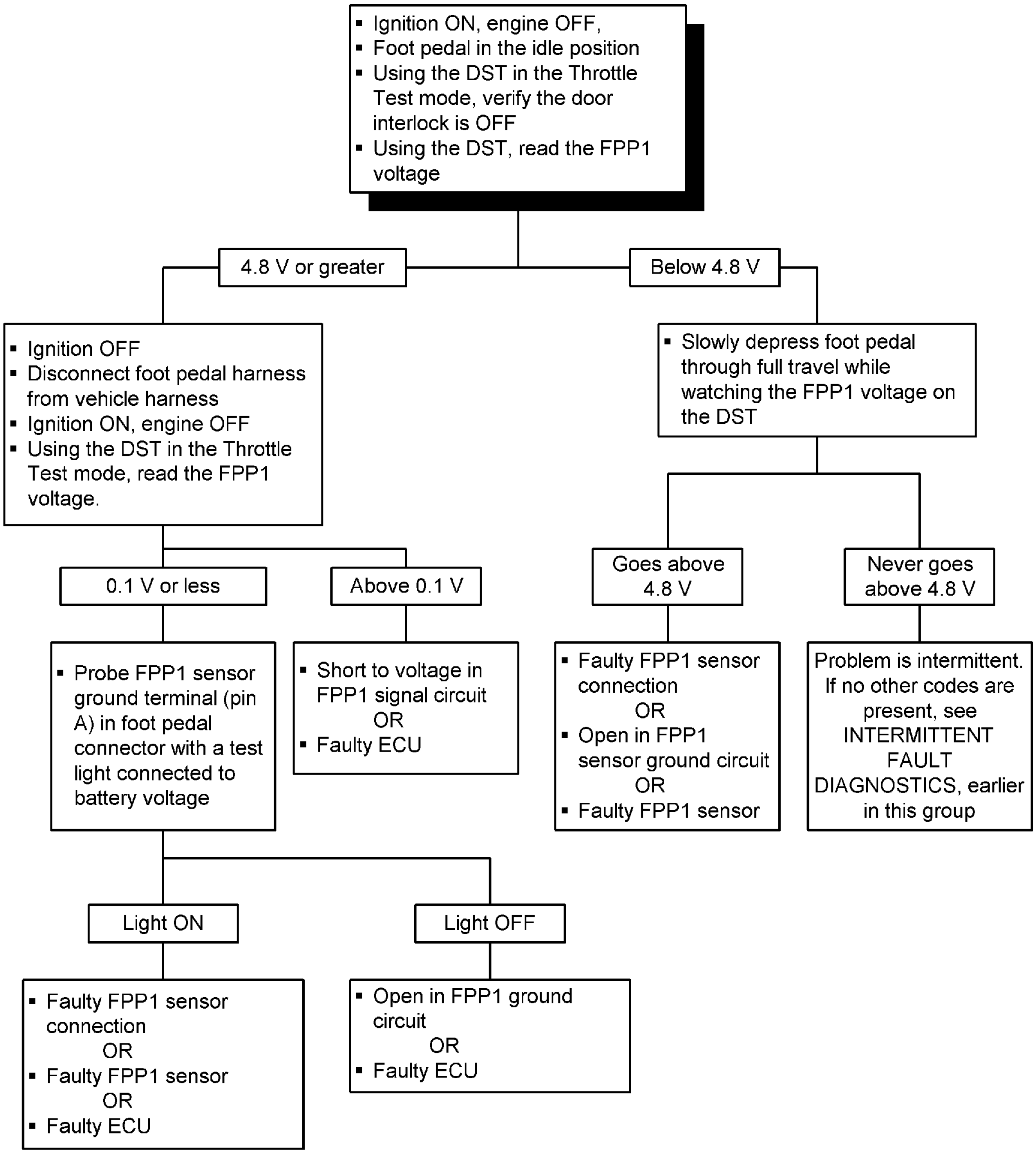
- No change in driveability
- Reduced engine power and degraded driveability
- Step power changes between idle and approximately 50% engine power as the pedal is depressed

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3091 –19–15JUL96–3/3

DTC 21 FPP1 Voltage High - Continued

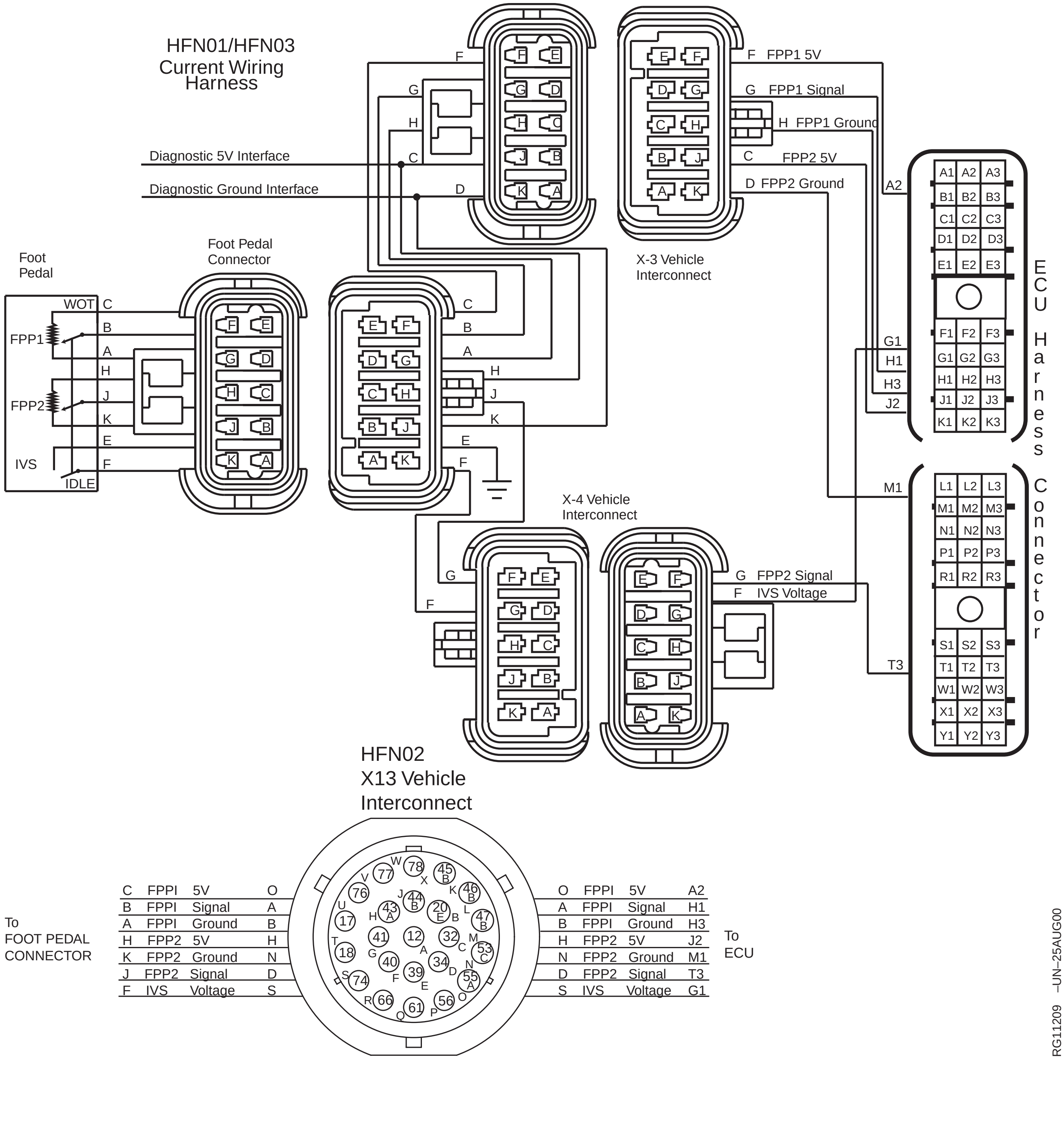
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and the Vehicle Interconnect connectors looking for dirty, damaged, or poorly positioned terminals.



RG10137 –19–16AUG00

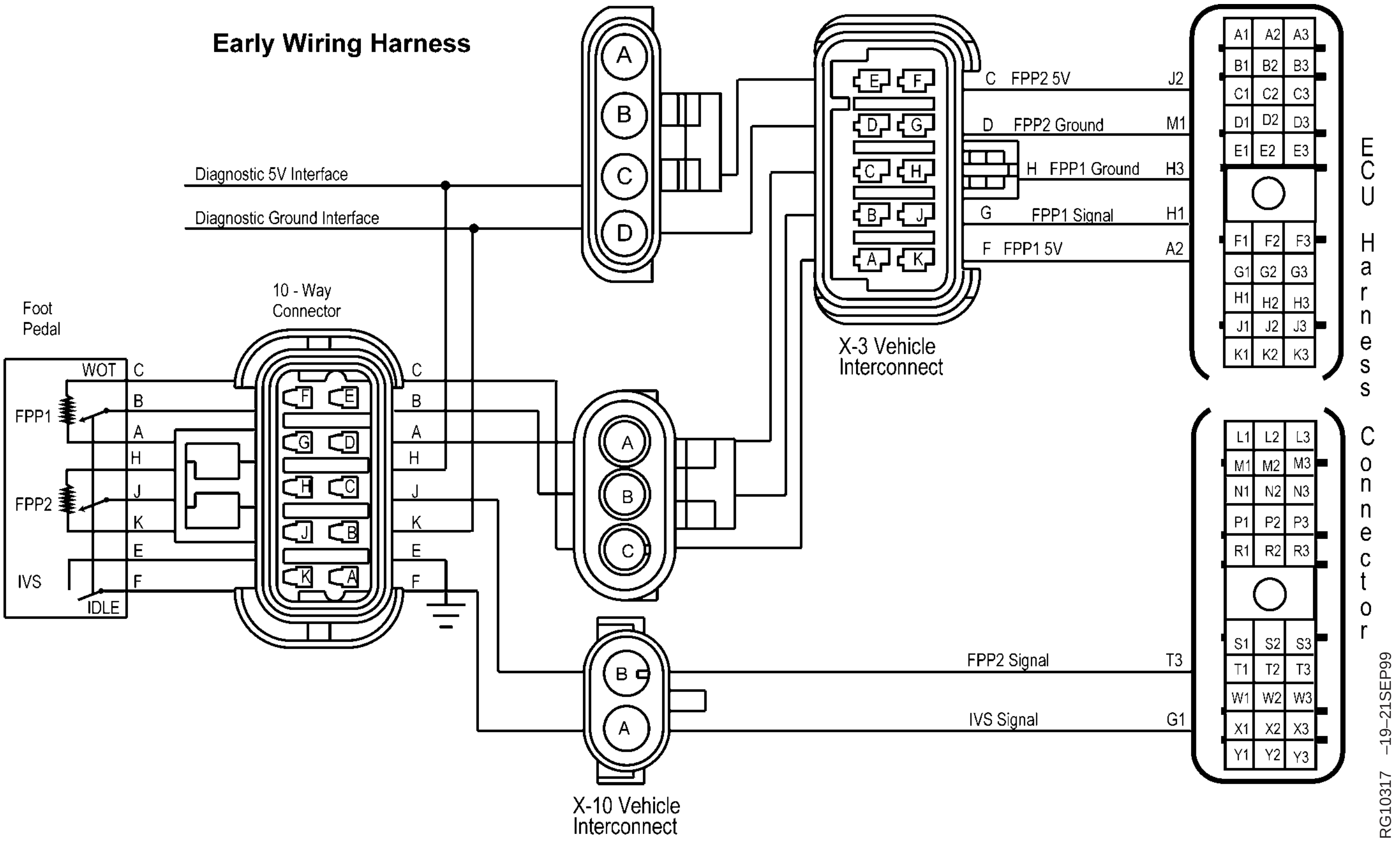
DPSG,RG40854,96 –19–10JUN99–1/1

DTC 22 FPP1 Voltage Low



Continued on next page

RG,RG34710,3093 –19–15JUL96–1/3



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.)(S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

FPP1 - Foot Pedal Position 1 sensor

The foot pedal assembly contains two independent FPP sensors and an Idle Validation Switch (IVS). The FPP sensors are variable resistors (potentiometers) used to measure the position of the foot pedal. The FPP signal voltages vary as the foot pedal is depressed and released. Less depression of the pedal results in lower signal voltages; greater depression results in higher signal voltages. The two FPP signals are compared to each other and to the IVS status to determine each signal's validity. If the ECU determines that the FPP1 signal is invalid, it will set a fault code and use the FPP2 and IVS signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the FPP1 sensor signal:

As a redundant input to FPP2; to give the ECU a command of the operator's desired engine load

DTC 22 will set if:

Continued on next page RG,RG34710,3093 –19–15JUL96–2/3

The FPP1 sensor signal voltage drops below 0.15 volts any time the key is on

If DTC 22 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

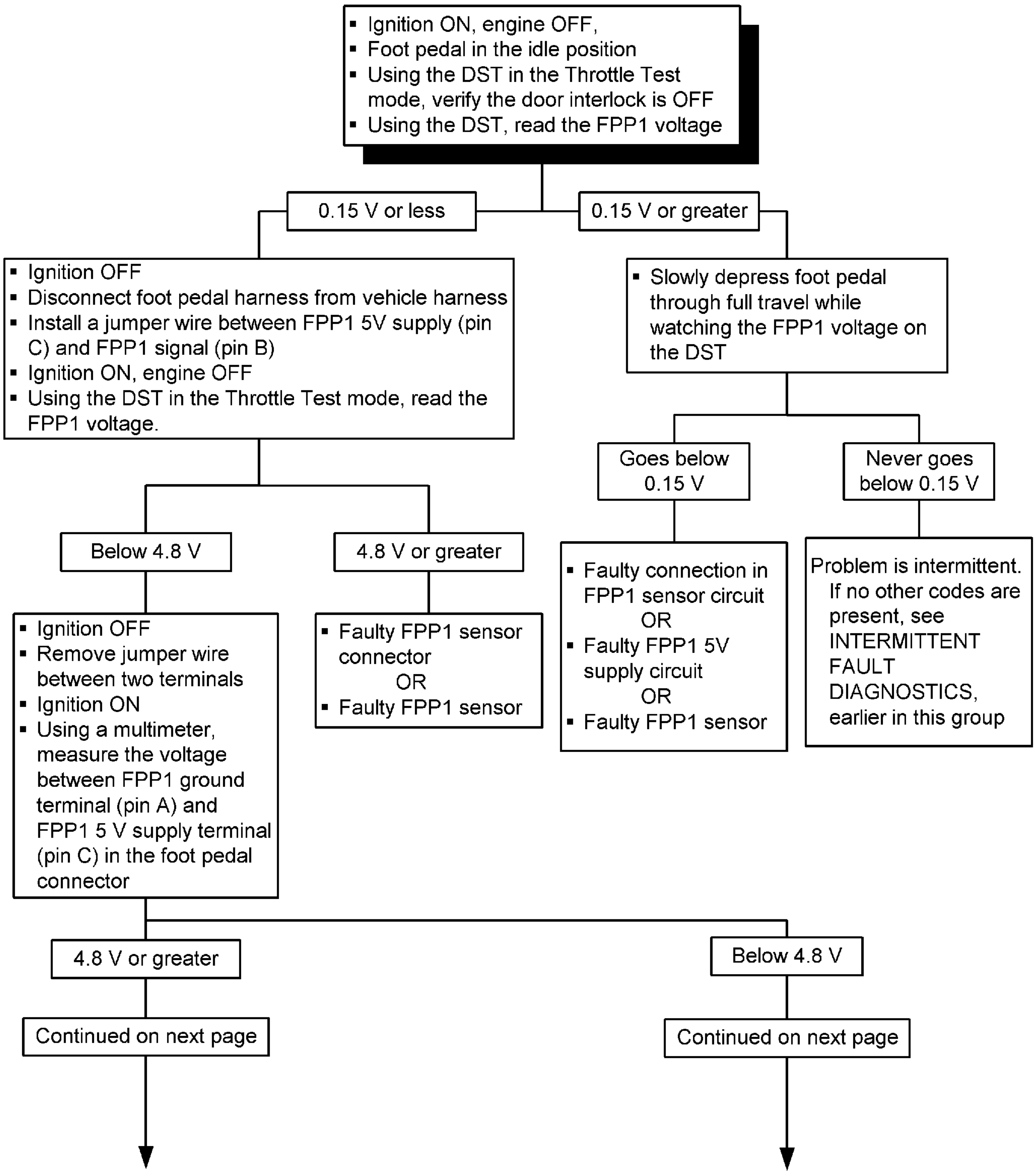
- No change in driveability
- Reduced engine power and degraded driveability
- Step power changes between idle and approximately 50% engine power as the pedal is depressed

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3093 –19–15JUL96–3/3

DTC 22 FPP1 Voltage Low - Continued

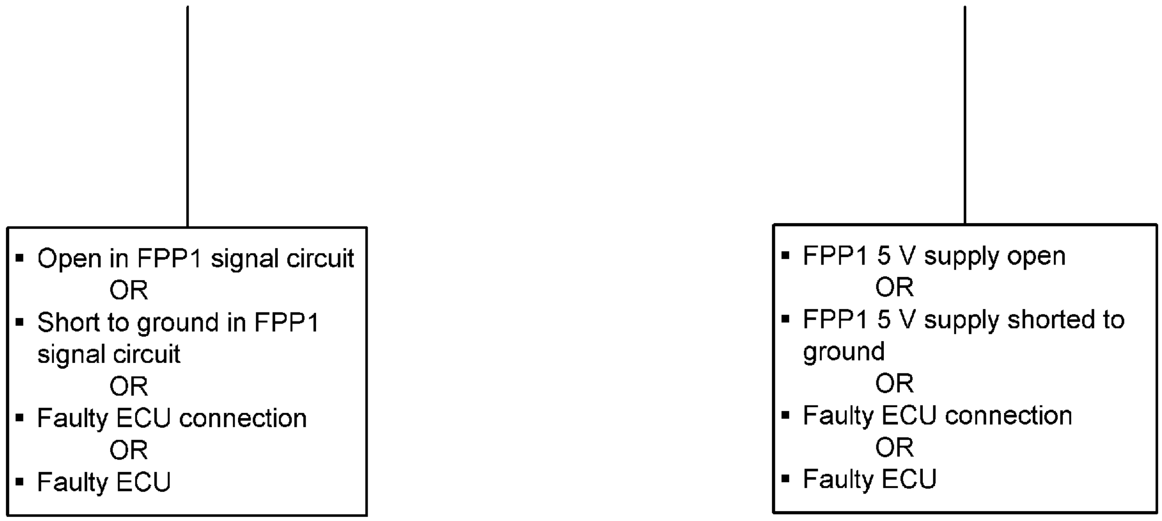
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and the Vehicle Interconnect connectors looking for dirty, damaged, or poorly positioned terminals.



RG10138 –19–16AUG00

DPSG,RG40854,97 –19–10JUN99–1/1

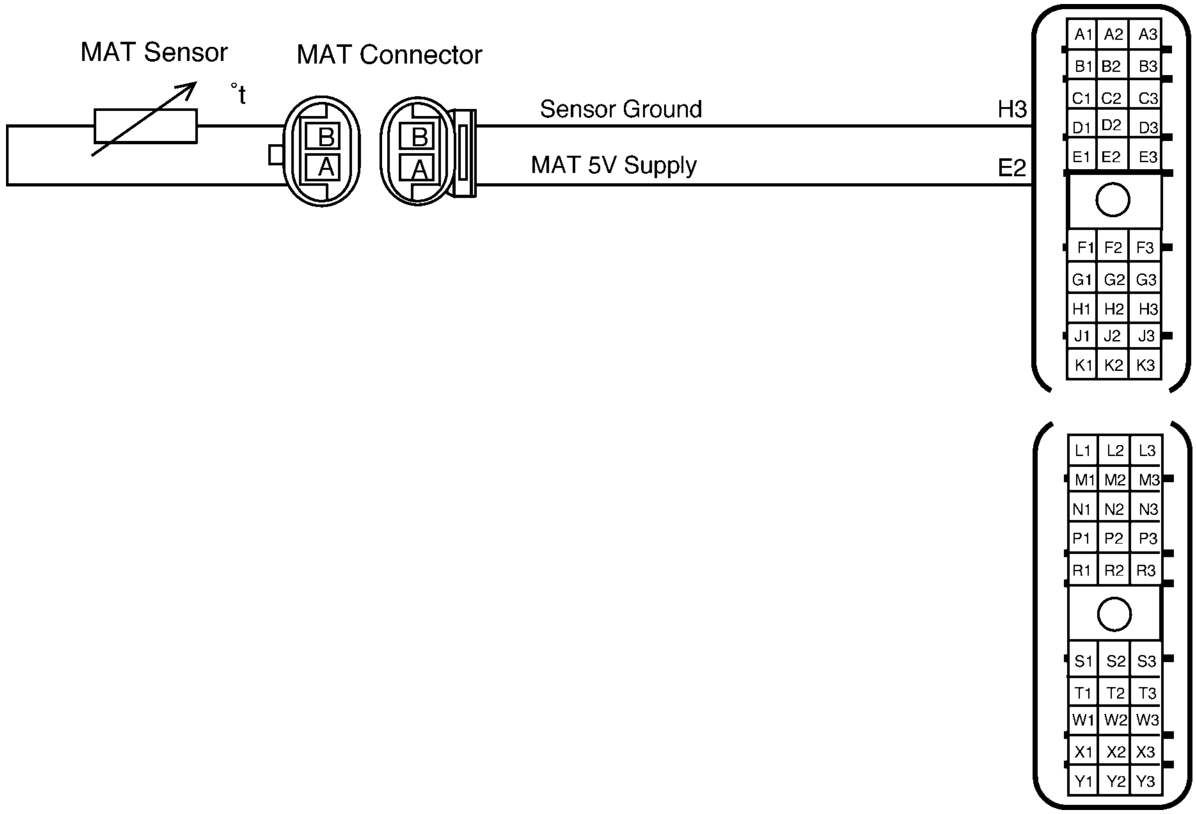
DTC 22 FPP1 Voltage Low - Continued



RG11298 –19–16AUG00

DPSG,RG41221,1 –19–14AUG00–1/1

DTC 23 MAT Voltage High



RG10065 –19–21SEP99

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
E2	A	13 Tan	Tan	MAT 5V Supply
H3	B	20C Black	Black/Tan	Sensor Ground

MAT - Manifold Air Temperature sensor

The MAT sensor is a thermistor (temperature sensitive resistor) located in the intake manifold. It is used to measure the temperature of the intake air. The MAT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the MAT sensor measurement:

In conjunction with several other sensors to determine engine airflow

DTC 23 will set if:

The MAT voltage exceeds 4.95 volts anytime the engine is cranking or running

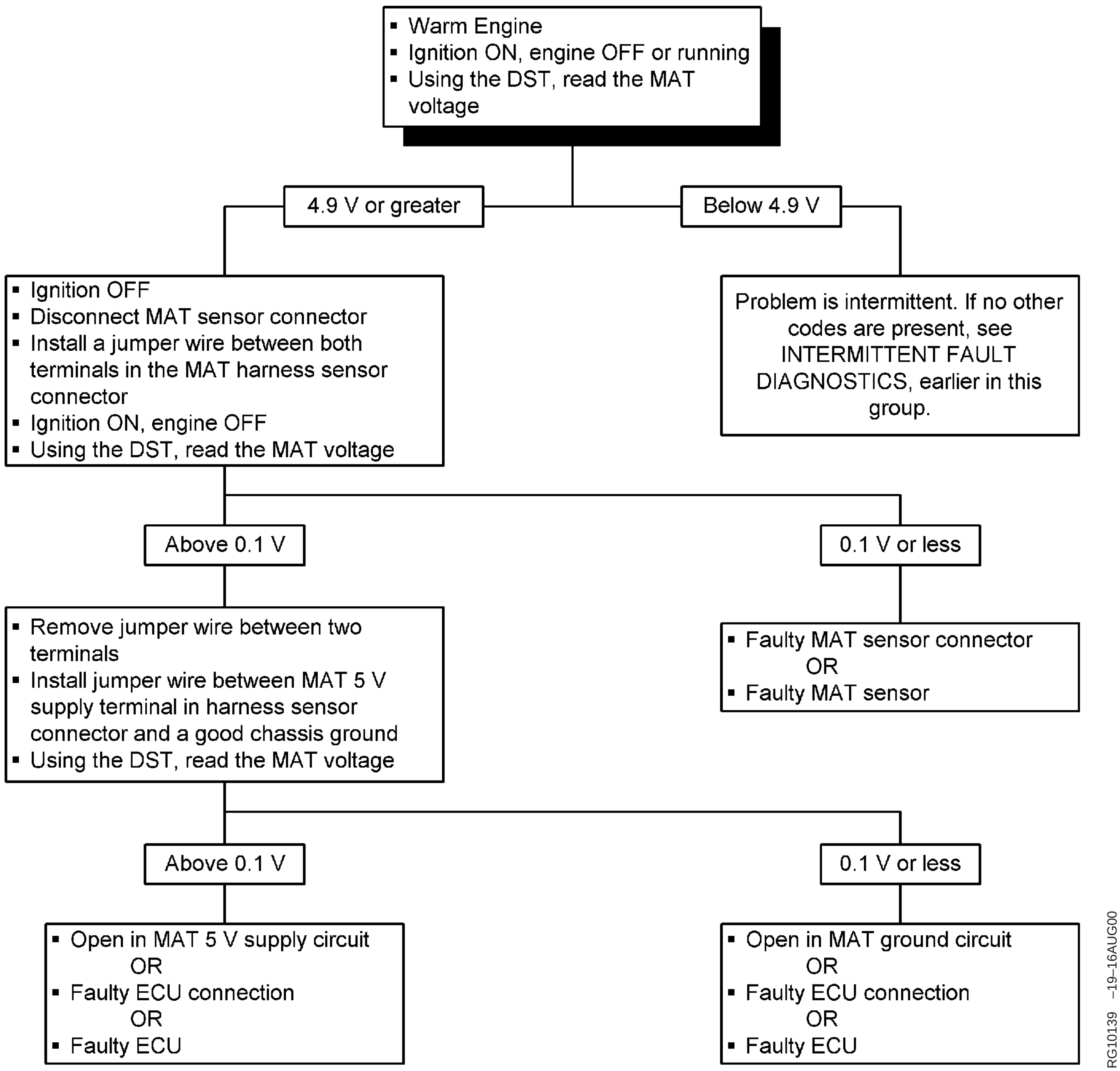
If DTC 23 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- ECU will use a default “limp home” MAT value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3095 –19–15JUL96–1/1

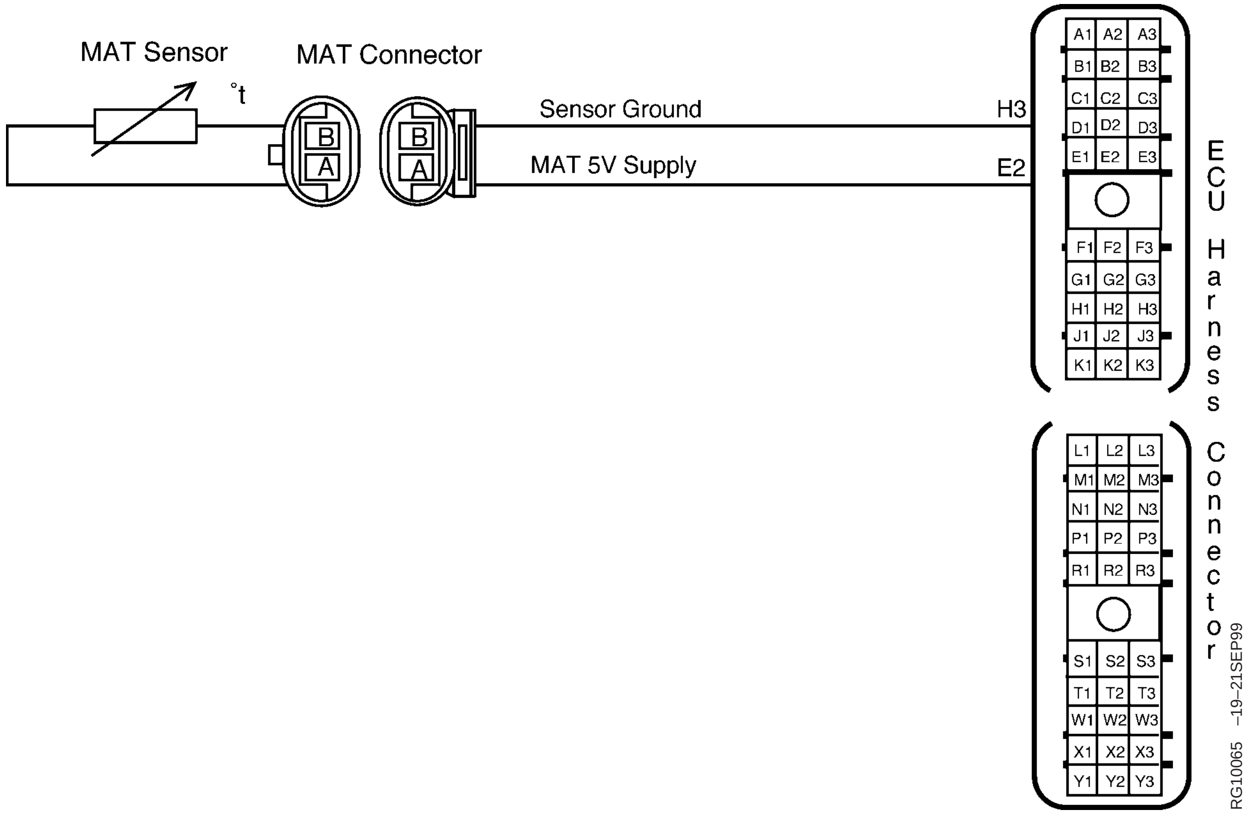
DTC 23 MAT Voltage High - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Manifold Air Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



DPSG,RG40854,98 –19–10JUN99–1/1

DTC 24 MAT Higher Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
E2	A	13 Tan	Tan	MAT 5V Supply
H3	B	20C Black	Black/Tan	Sensor Ground

MAT - Manifold Air Temperature sensor

The MAT sensor is a thermistor (temperature sensitive resistor) located in the intake manifold. It is used to measure the temperature of the intake air. The MAT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result higher voltages.

The ECU uses the MAT sensor measurement:

In conjunction with several other sensors to determine engine airflow

DTC 24 will set if:

The MAT sensor measures an intake air temperature that might become dangerous to the engine. The MAT must read a temperature above 170° F for a minimum of one minute while the engine speed is above 1000 RPM and the MAP reading is above 20 psia.

If DTC 24 sets, the following will occur:

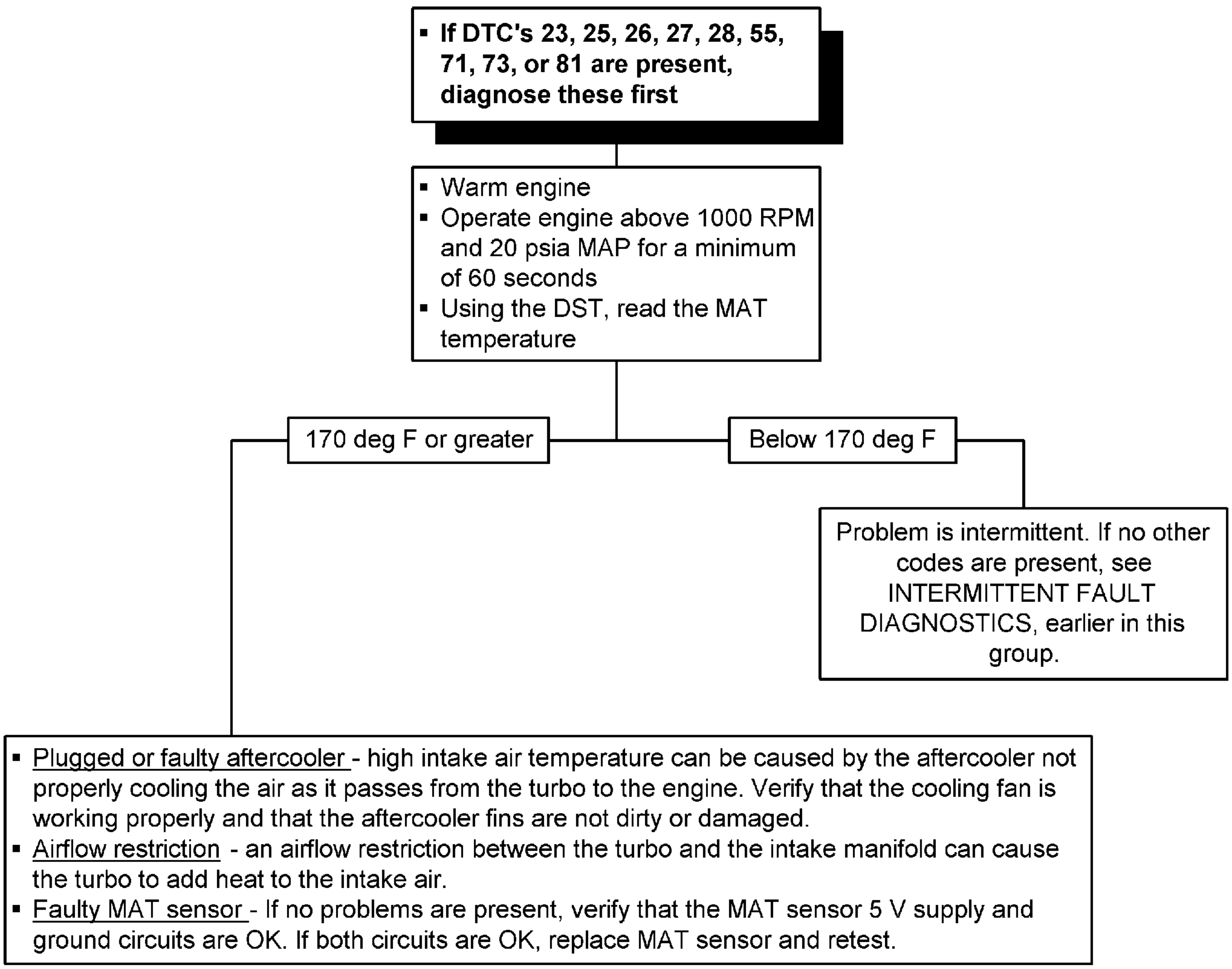
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

NOTE: When MAT exceeds 150°F, boost will be frozen and power will start to decrease. However, the CEL will not illuminate until MAT exceeds 170°F.

RG,RG34710,3097 –19–15JUL96–1/1

DTC 24 MAT Higher Than Expected - Continued

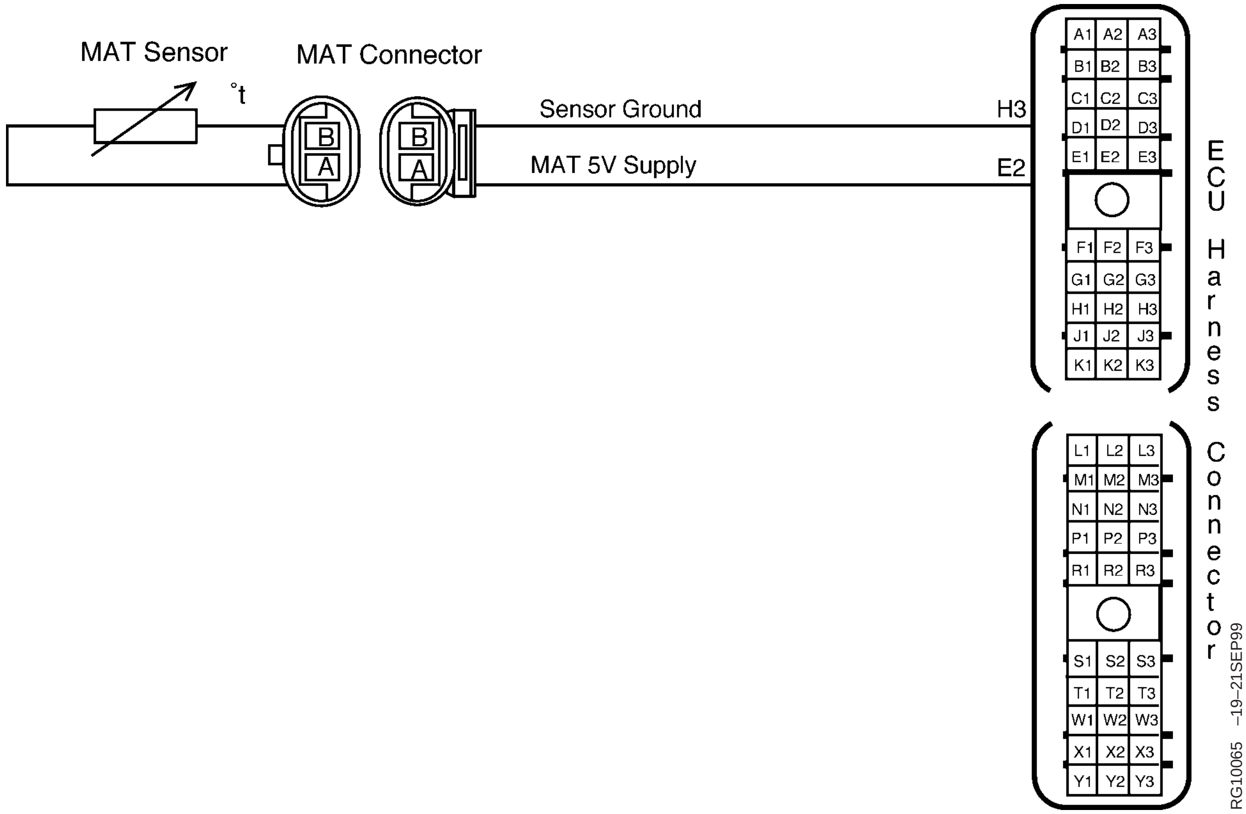
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Manifold Air Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10140 –19–16AUG00

DPSG,RG40854,99 –19–10JUN99–1/1

DTC 25 MAT Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
E2	A	13 Tan	Tan	MAT 5V Supply
H3	B	20C Black	Black/Tan	Sensor Ground

MAT - Manifold Air Temperature sensor

The MAT sensor is a thermistor (temperature sensitive resistor) located in the intake manifold. It is used to measure the temperature of the intake air. The MAT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the MAT sensor measurement:

In conjunction with several other sensors to determine engine airflow

DTC 25 will set if:

The MAT voltage drops below 0.05 volts anytime the engine is cranking or running

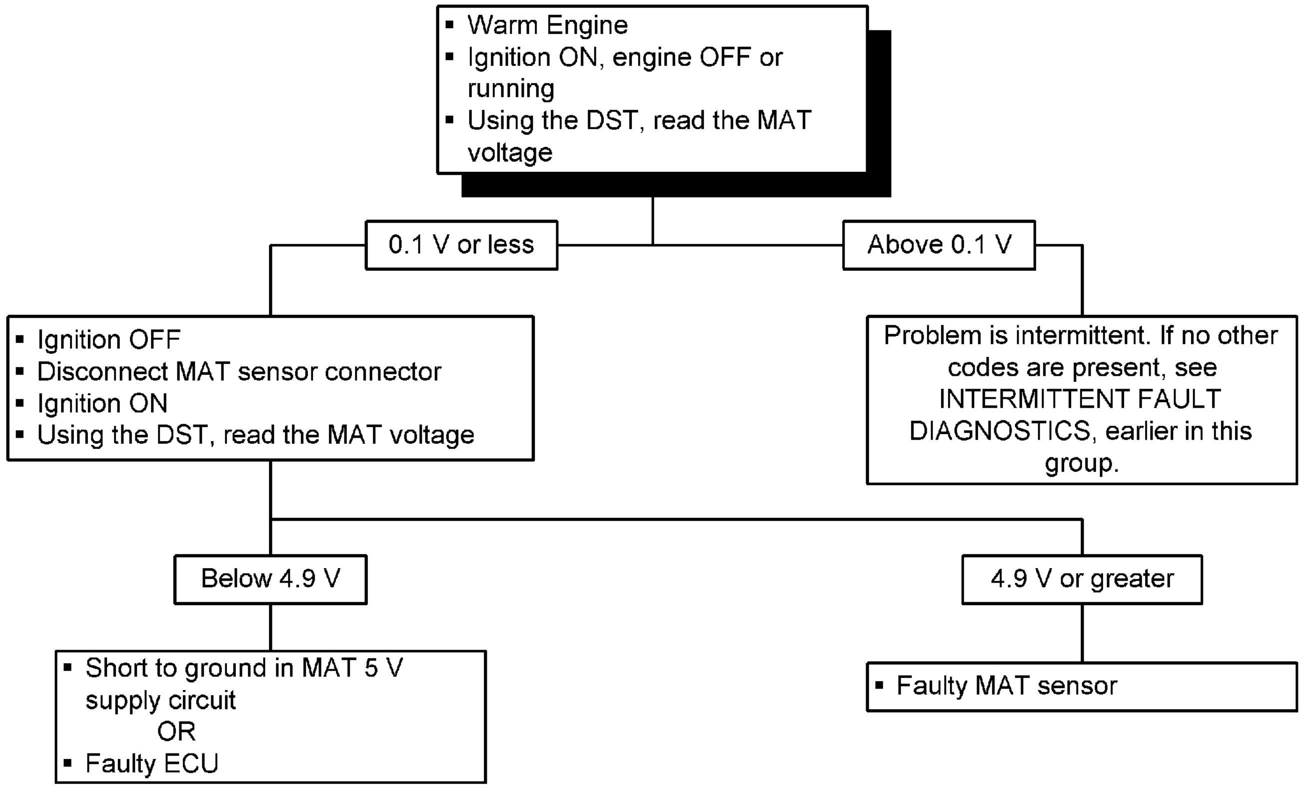
If DTC 25 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- ECU will use a default “limp home” MAT value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3099 –19–15JUL96–1/1

DTC 25 MAT Voltage Low - Continued

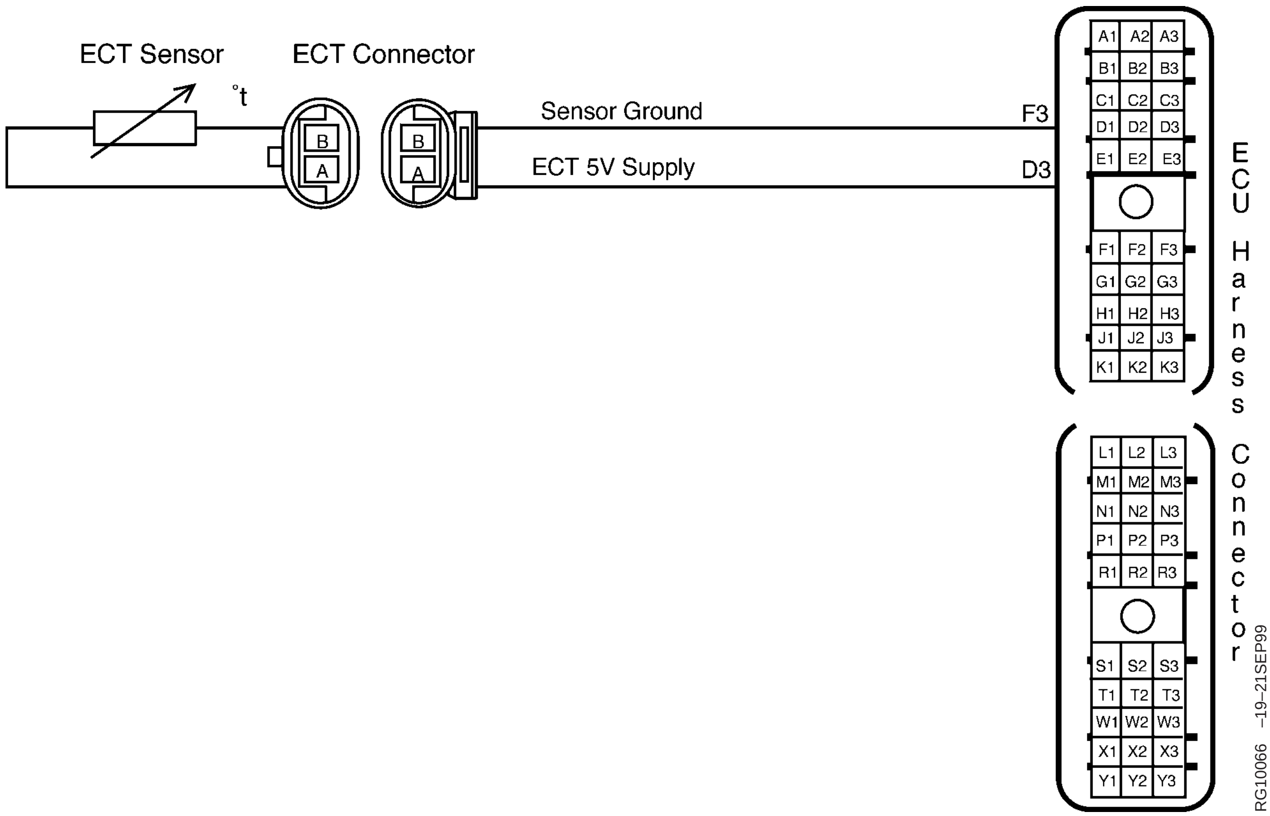
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Manifold Air Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10141 –19–16AUG00

DPSG,RG40854,100 –19–10JUN99–1/1

DTC 26 ECT Voltage High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
D3	A	16Yellow	Yellow/Gray	ECT 5V Supply
F3	B	21B Black	Black/Yellow	Sensor Ground

ECT - Engine Coolant Temperature sensor

The ECT sensor is a thermistor (temperature sensitive resistor) exposed to engine coolant. It is used to measure the temperature of the coolant. The ECT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the ECT sensor measurement:

- In engine airflow calculations
- To monitor engine temperature

DTC 26 will set if:

The ECT voltage exceeds 4.95 volts anytime the engine is cranking or running

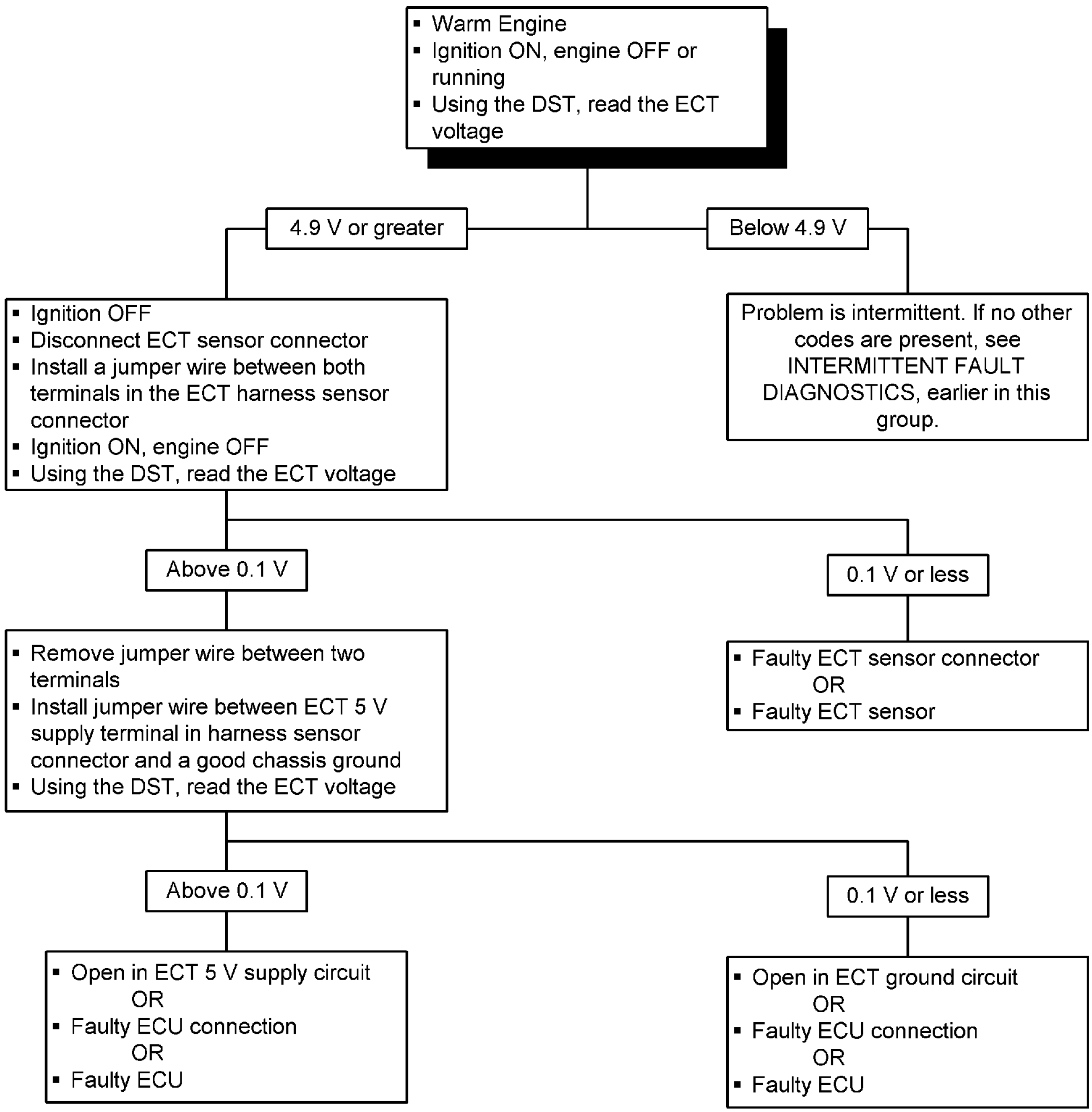
If DTC 26 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- ECU will use a default “limp home” ECT value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3101 –19–15JUL96–1/1

DTC 26 ECT Voltage High - Continued

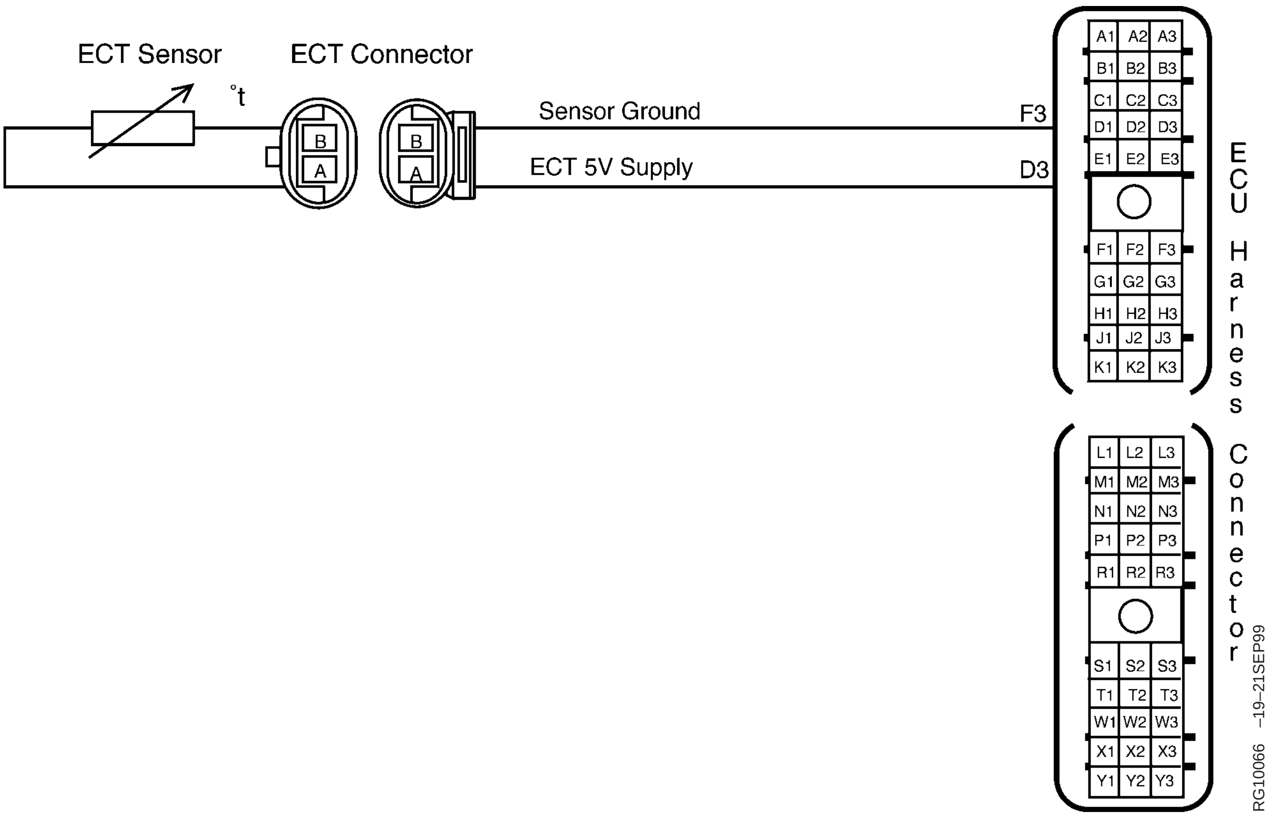
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Engine Coolant Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10143 –19–16AUG00

DPSG,RG40854,101 –19–10JUN99–1/1

DTC 27 ECT Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
D3	A	16 Yellow	Yellow/Gray	ECT 5V Supply
F3	B	21B Black	Black/Yellow	Sensor Ground

ECT - Engine Coolant Temperature sensor

The ECT sensor is a thermistor (temperature sensitive resistor) exposed to engine coolant. It is used to measure the temperature of the coolant. The ECT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the ECT sensor measurement:

- In engine airflow calculations
- To monitor engine temperature

DTC 27 will set if:

The ECT voltage drops below 0.05 volts anytime the engine is cranking or running

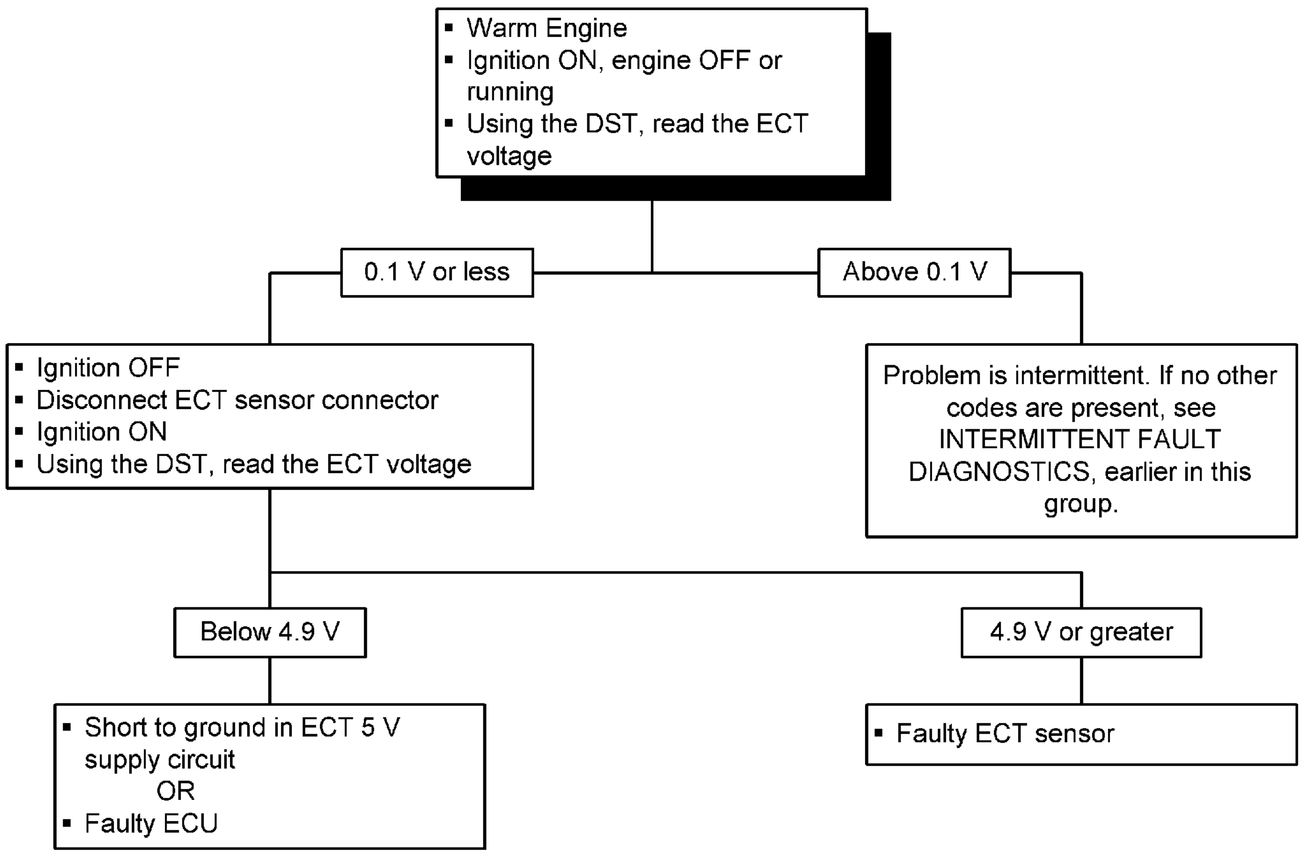
If DTC 27 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- ECU will use a default “limp home” ECT value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3103 –19–15JUL96–1/1

DTC 27 ECT Voltage Low - Continued

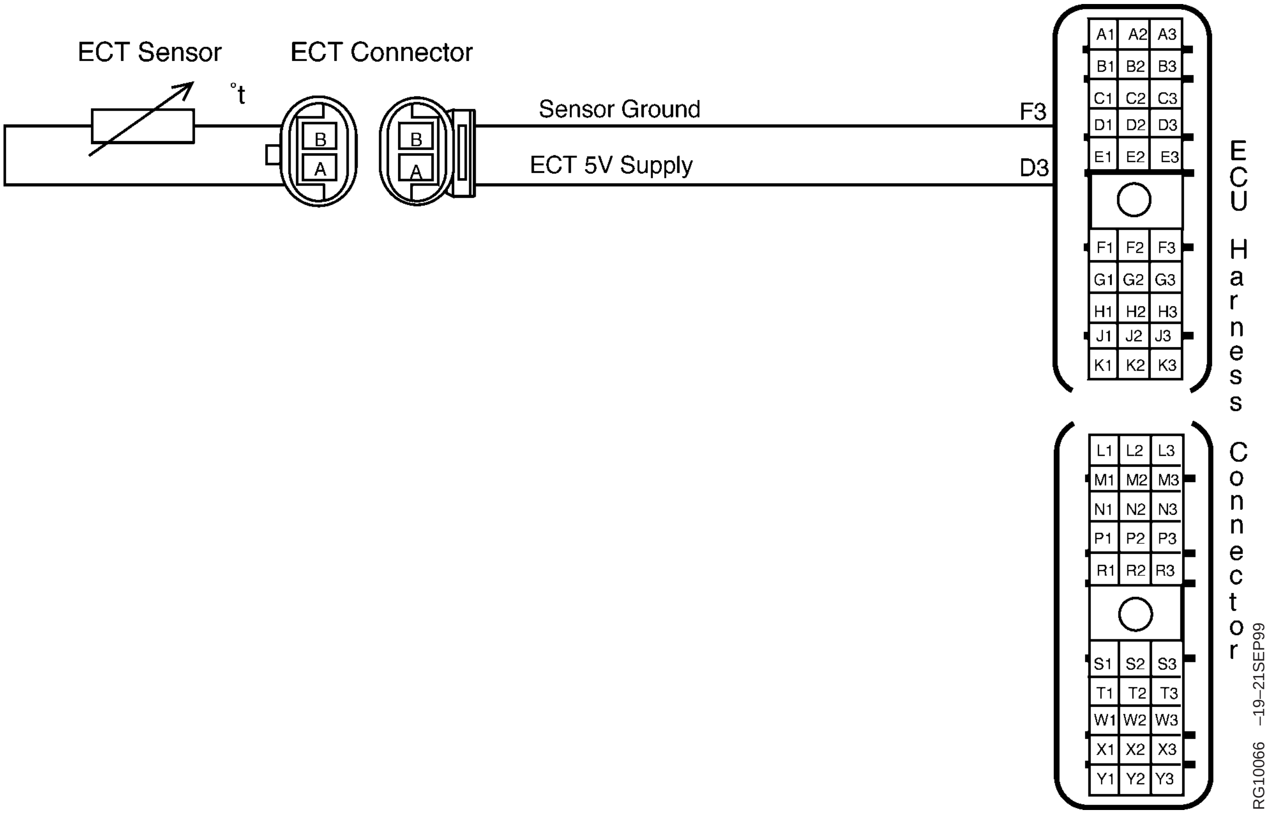
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Engine Coolant Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10144 –19–16AUG00

DPSG,RG40854,102 –19–10JUN99–1/1

DTC 28 ECT Higher Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
D3	A	16 Yellow	Yellow/Gray	ECT 5V Supply
F3	B	21B Black	Black/Yellow	Sensor Ground

ECT - Engine Coolant Temperature sensor

The ECT sensor is a thermistor (temperature sensitive resistor) exposed to engine coolant. It is used to measure the temperature of the coolant. The ECT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the ECT sensor measurement:

- In engine airflow calculations
- To monitor engine temperature

DTC 28 will set if:

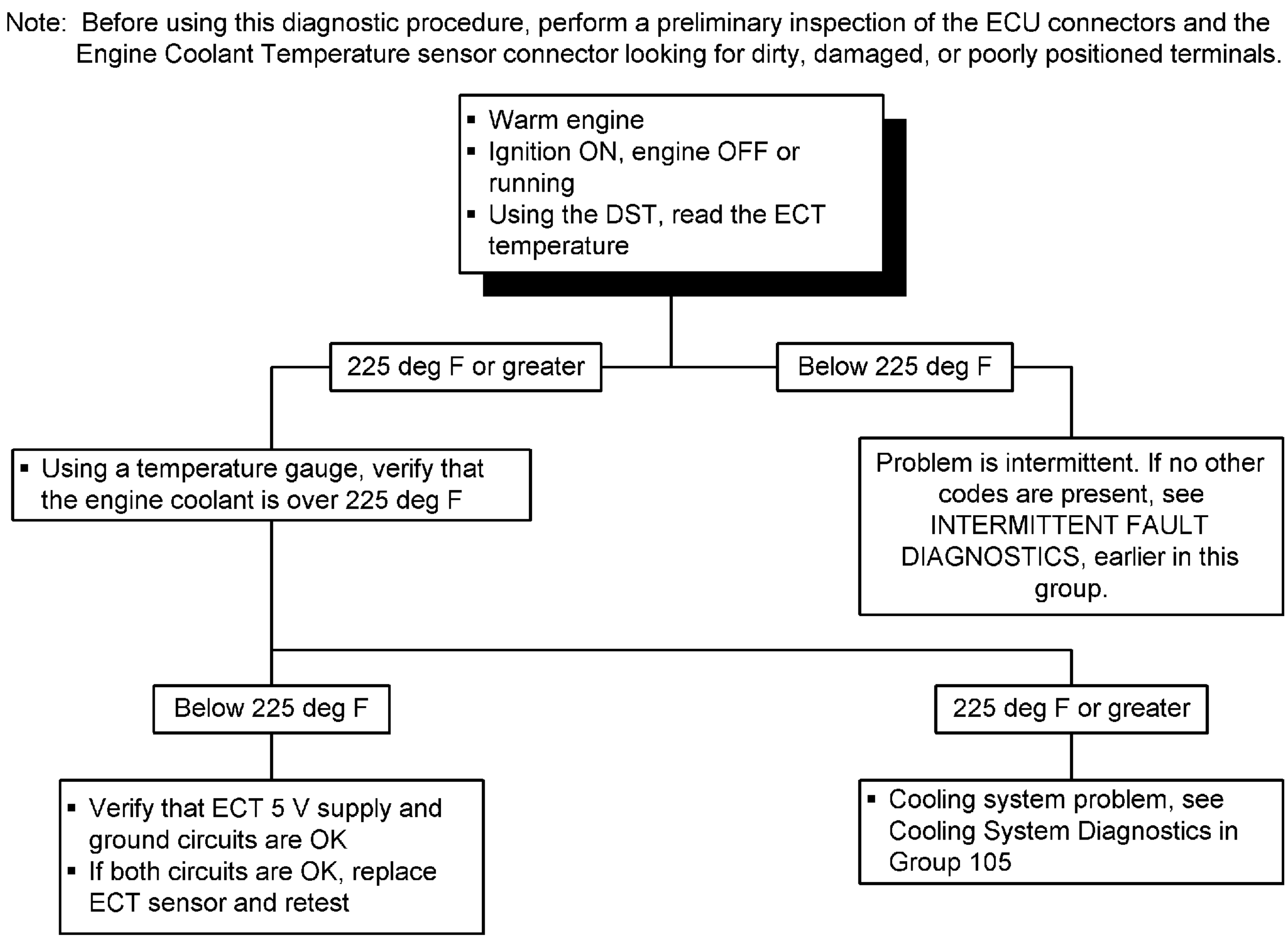
- Engine speed is greater than 1000 RPM
- **AND** the ECT sensor measures a coolant temperature that exceeds 225° F for 60 seconds

If DTC 28 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Engine power output is limited proportional to the over temperature amount by opening turbo wastegate and closing throttle.
  – If ECT exceeds 225° F, boost will gradually be reduced and there will be a noticeable power decrease.
  – If ECT exceeds 240° F, boost will be limited to 0 psig.
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3105 –19–15JUL96–1/1

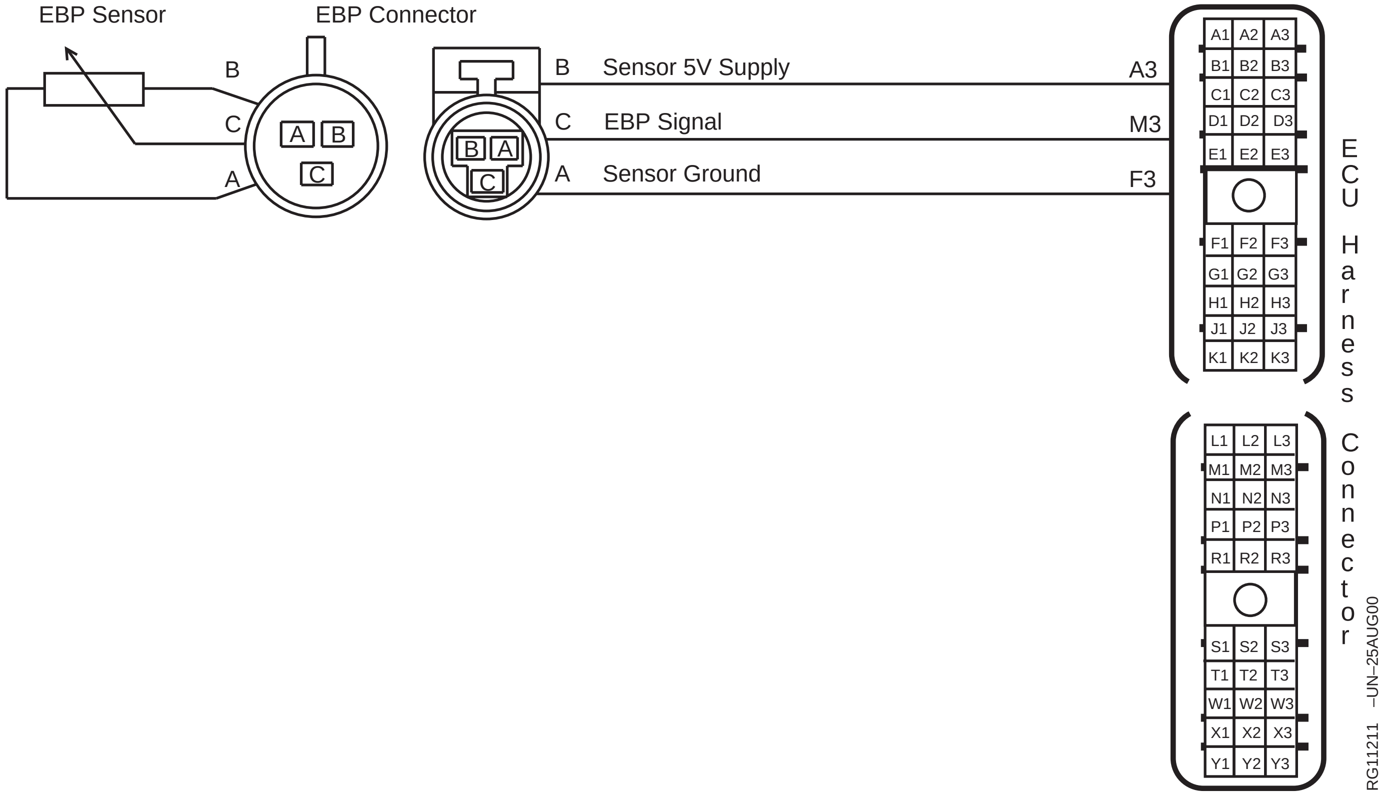
DTC 28 ECT Higher Than Expected - Continued



RG10145 –19–16AUG00

DPSG,RG40854,103 –19–10JUN99–1/1

DTC 29 EBP Lower than Expected



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54A Yellow	Yellow/Red	Sensor 5V Supply
M3	C	9 Dk. Green	Dk. Green/White	EBP Signal
F3	A	21C Black	Black/Yellow	Sensor Ground

EBP - Exhaust Back Pressure sensor

The EBP sensor is a pressure transducer mounted in the exhaust, downstream of the turbocharger. The EBP signal voltage varies as exhaust pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the EBP sensor signal for:

- Air density calculations
- Turbocharger wastegate control
- Closed loop fuel delivery correction

DTC 29 will set if:

The EBP signal voltage is out of range compared to the minimum value expected for the sensor based on the current barometric pressure, MAP, and engine speed

If DTC 29 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3107 –19–15JUL96–1/1

DTC 29 EBP Lower than Expected - Continued

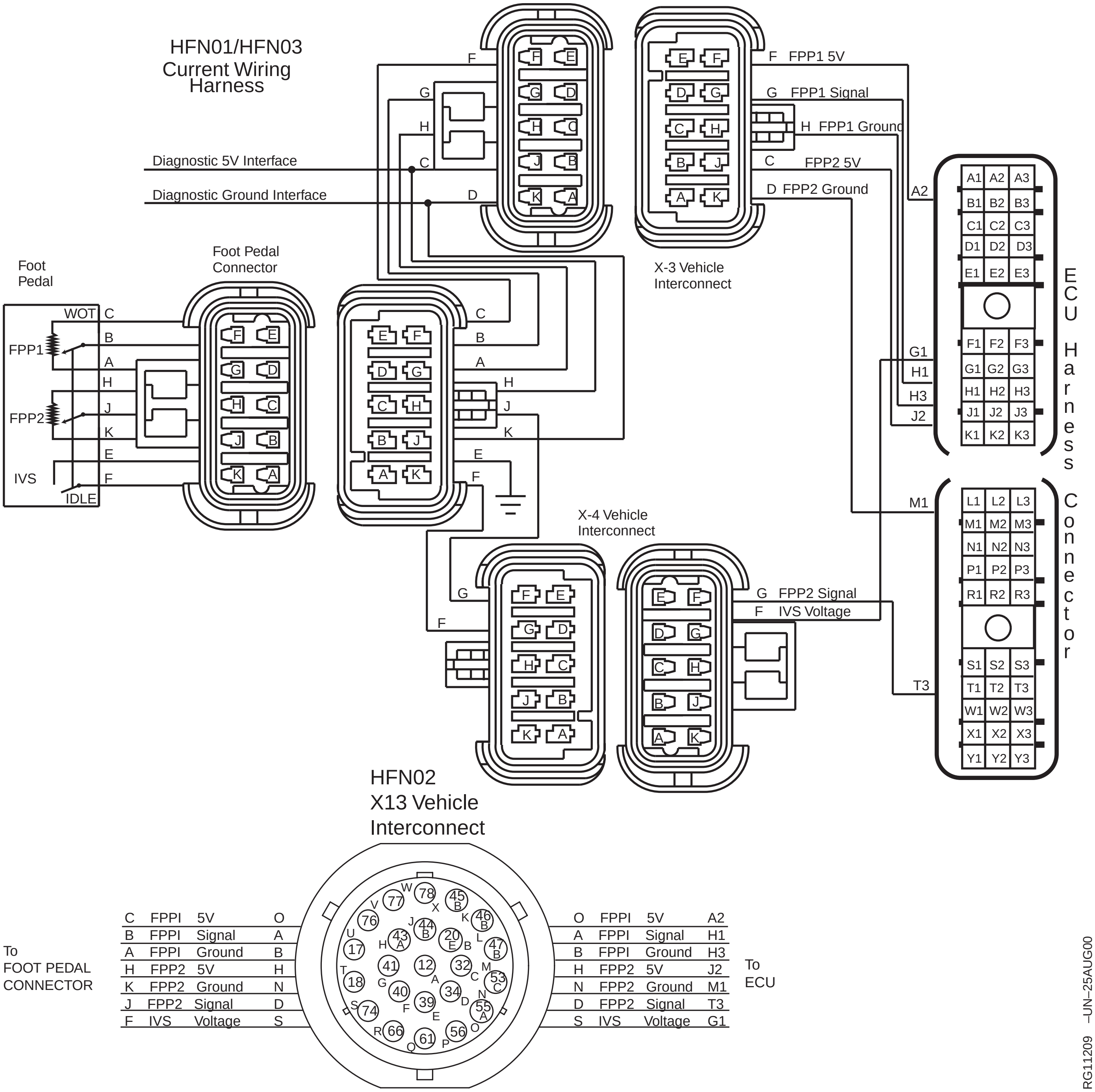
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Exhaust Back Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.

- EBP sensor pressure supply leak - A leak in the EBP sensor line that connects the sensor to the exhaust can cause DTC 29 to set under moderate to high load conditions, repair any leaks and retest.
- Exhaust leak or removed muffler - An exhaust leak or removed muffler will lower exhaust back pressure, causing DTC 29.
- EBP sensor supply pressure supply restricted - A restriction in the EBP pressure supply can cause DTC 29. Check for soot plugging pressure supply line.
- Faulty EBP sensor - If no other problems are found, replace the EBP sensor and retest.

RG10146 –19–16AUG00

DPSG,RG40854,104 –19–10JUN99–1/1

DTC 31 FPP2 Voltage High



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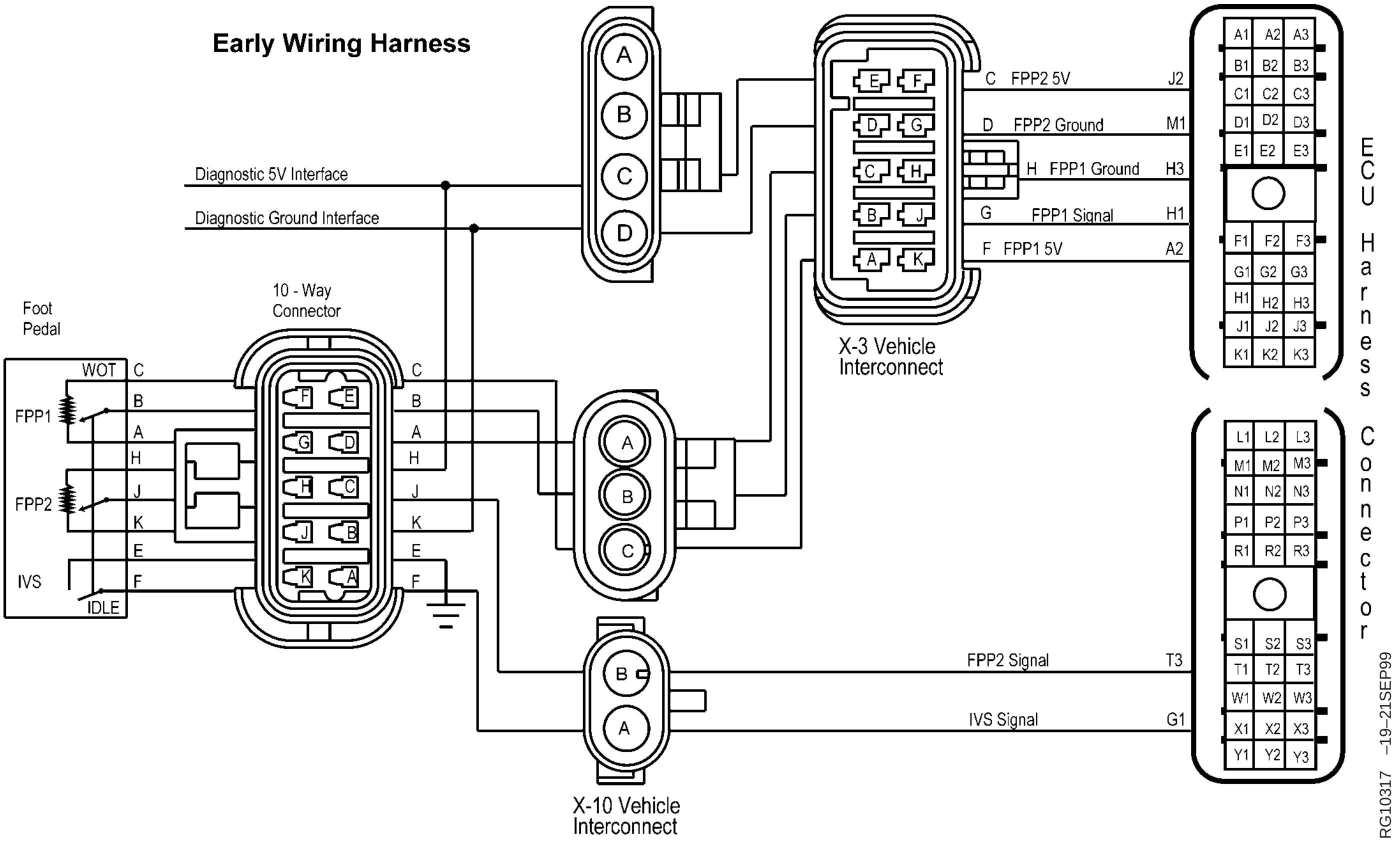
RG,RG34710,3109 –19–15JUL96–1/3



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

FPP2 - Foot Pedal Position 2 sensor

The foot pedal assembly contains two independent FPP sensors and an Idle Validation Switch (IVS). The FPP sensors are variable resistors (potentiometers) used to measure the position of the foot pedal. The FPP signal voltages vary as the foot pedal is depressed and released. Less depression of the pedal results in lower signal voltages; greater depression results in higher signal voltages. The two FPP signals are compared to each other and to the IVS status to determine each signal's validity. If the ECU determines that the FPP2 signal is invalid, it will set a fault code and use the FPP1 and IVS signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the FPP2 sensor signal:

As a redundant input to FPP1; to give the ECU a command of the operator's desired engine load

DTC 31 will set if:

Continued on next page

RG,RG34710,3109 –19–15JUL96–2/3

The FPP2 sensor signal voltage exceeds 4.5 volts any time the key is on

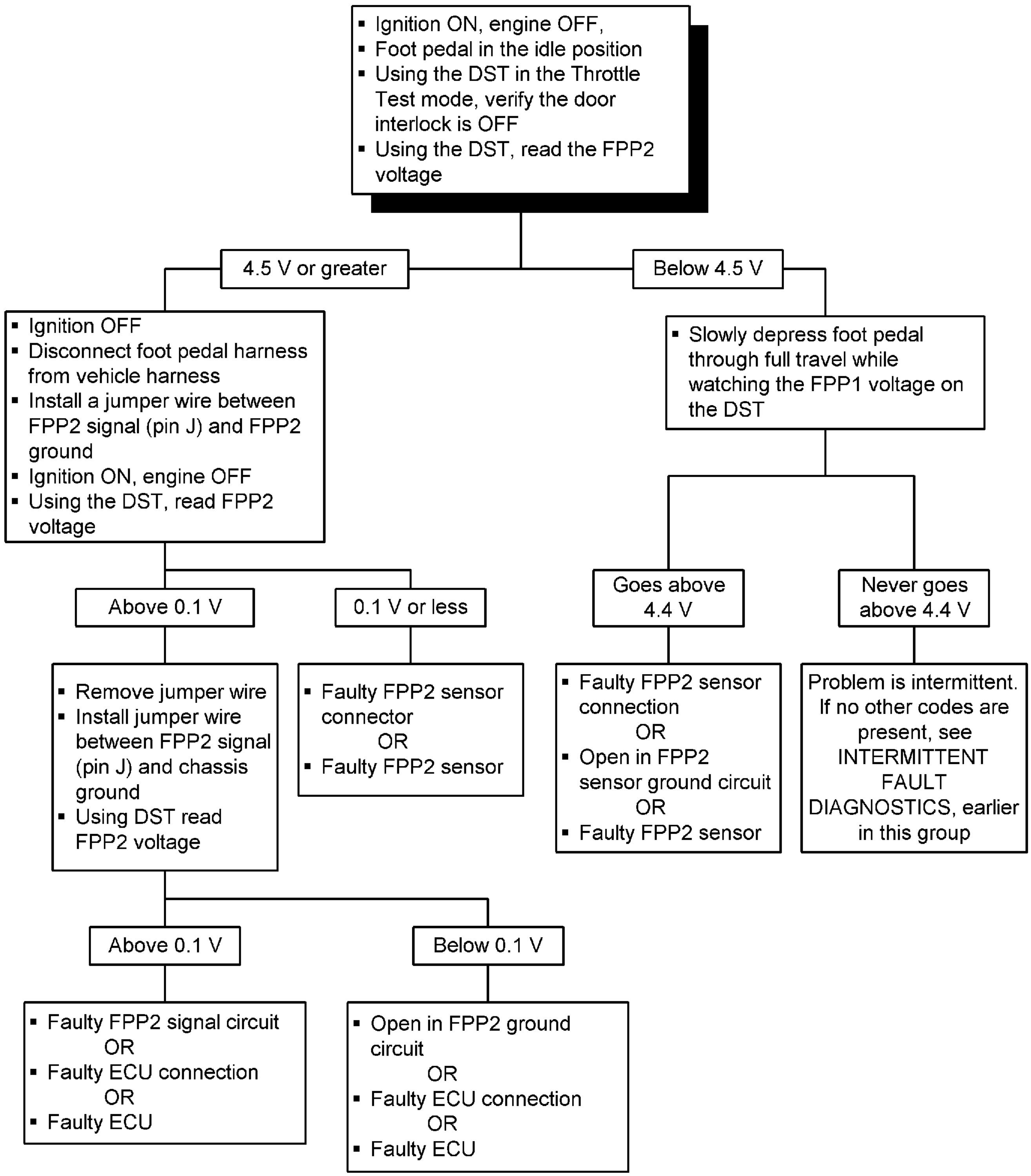
If DTC 31 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Depending on whether or not there are other fault codes, one of the following will occur:
- No change in driveability
- Reduced engine power and degraded driveability
- Step power changes between idle and approximately 50% engine power as the pedal is depressed
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3109 –19–15JUL96–3/3

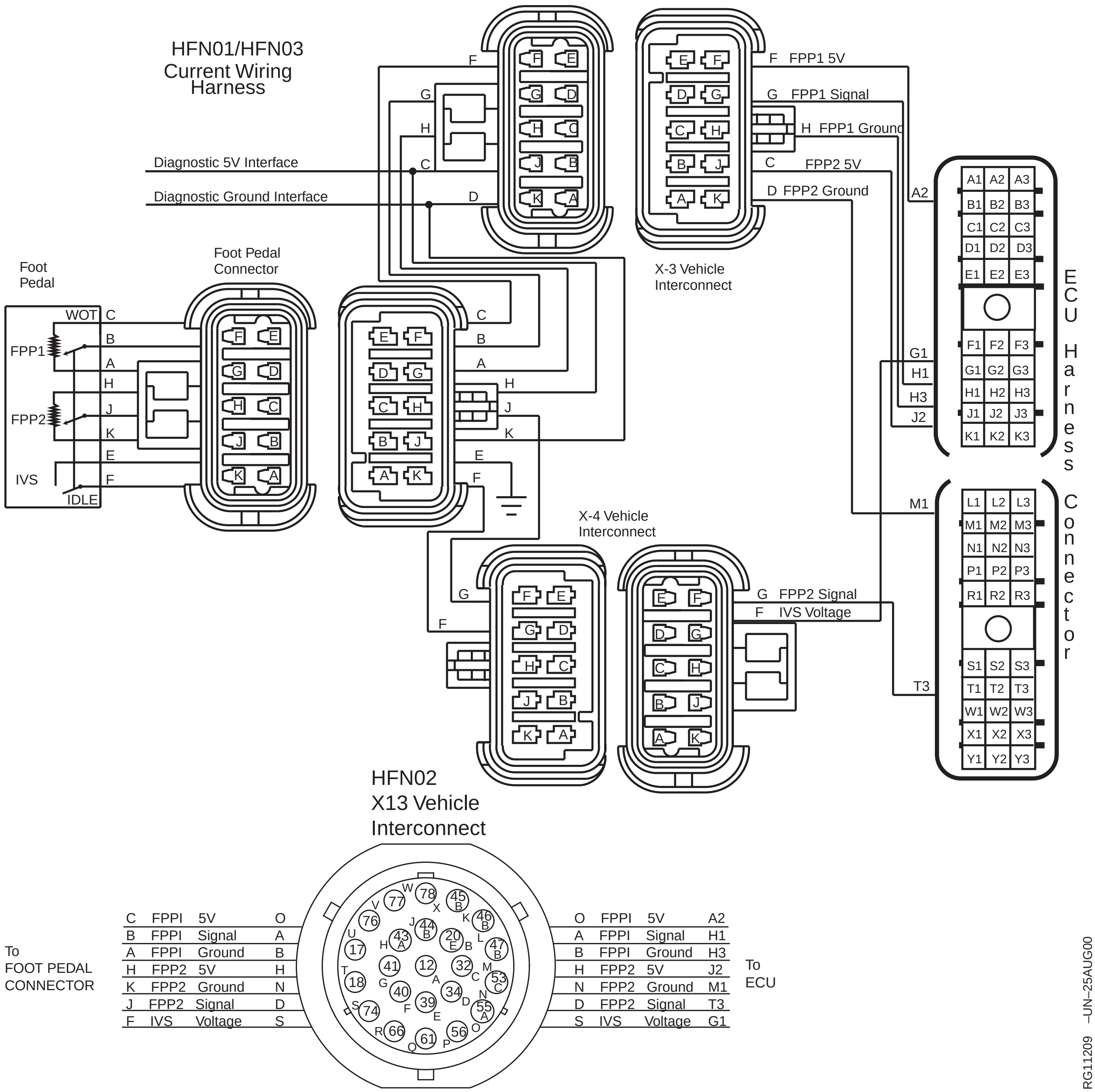
DTC 31 FPP2 Voltage High - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connectors looking for dirty, damaged, or poorly positioned terminals.



RG10147 –19–16AUG00

DTC 32 FPP2 Voltage Low



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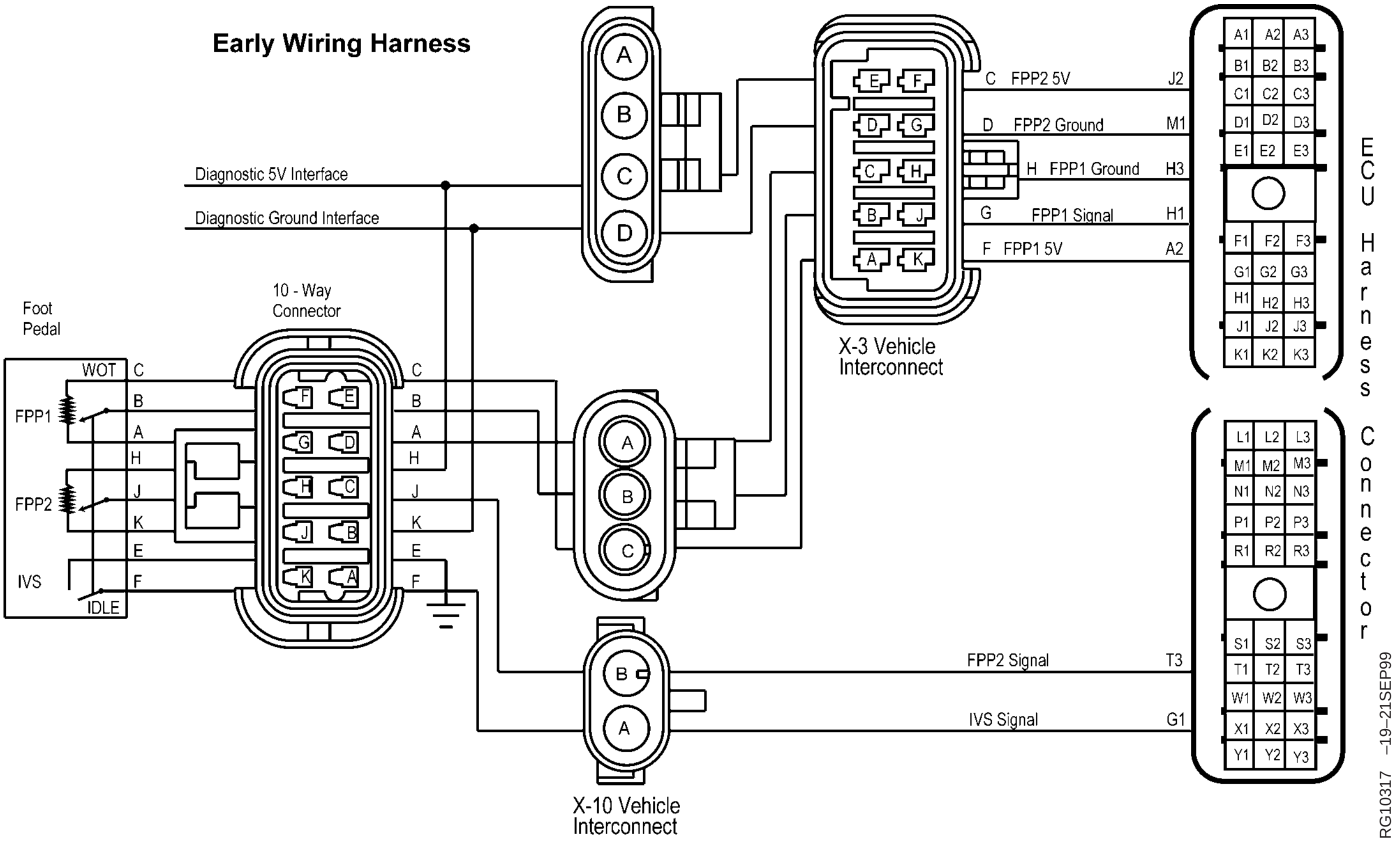
RG,RG34710,3111 –19–15JUL96–1/3



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

FPP2 - Foot Pedal Position 2 sensor

The foot pedal assembly contains two independent FPP sensors and an Idle Validation Switch (IVS). The FPP sensors are variable resistors (potentiometers) used to measure the position of the foot pedal. The FPP signal voltages vary as the foot pedal is depressed and released. Less depression of the pedal results in lower signal voltages; greater depression results in higher signal voltages. The two FPP signals are compared to each other and to the IVS status to determine each signal's validity. If the ECU determines that the FPP2 signal is invalid, it will set a fault code and use the FPP1 and IVS signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the FPP2 sensor signal:

As a redundant input to FPP1; to give the ECU a command of the operator's desired engine load

DTC 32 will set if:

Continued on next page

RG,RG34710,3111 –19–15JUL96–2/3

The FPP2 sensor signal voltage drops below 0.15 volts any time the key is on

If DTC 32 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

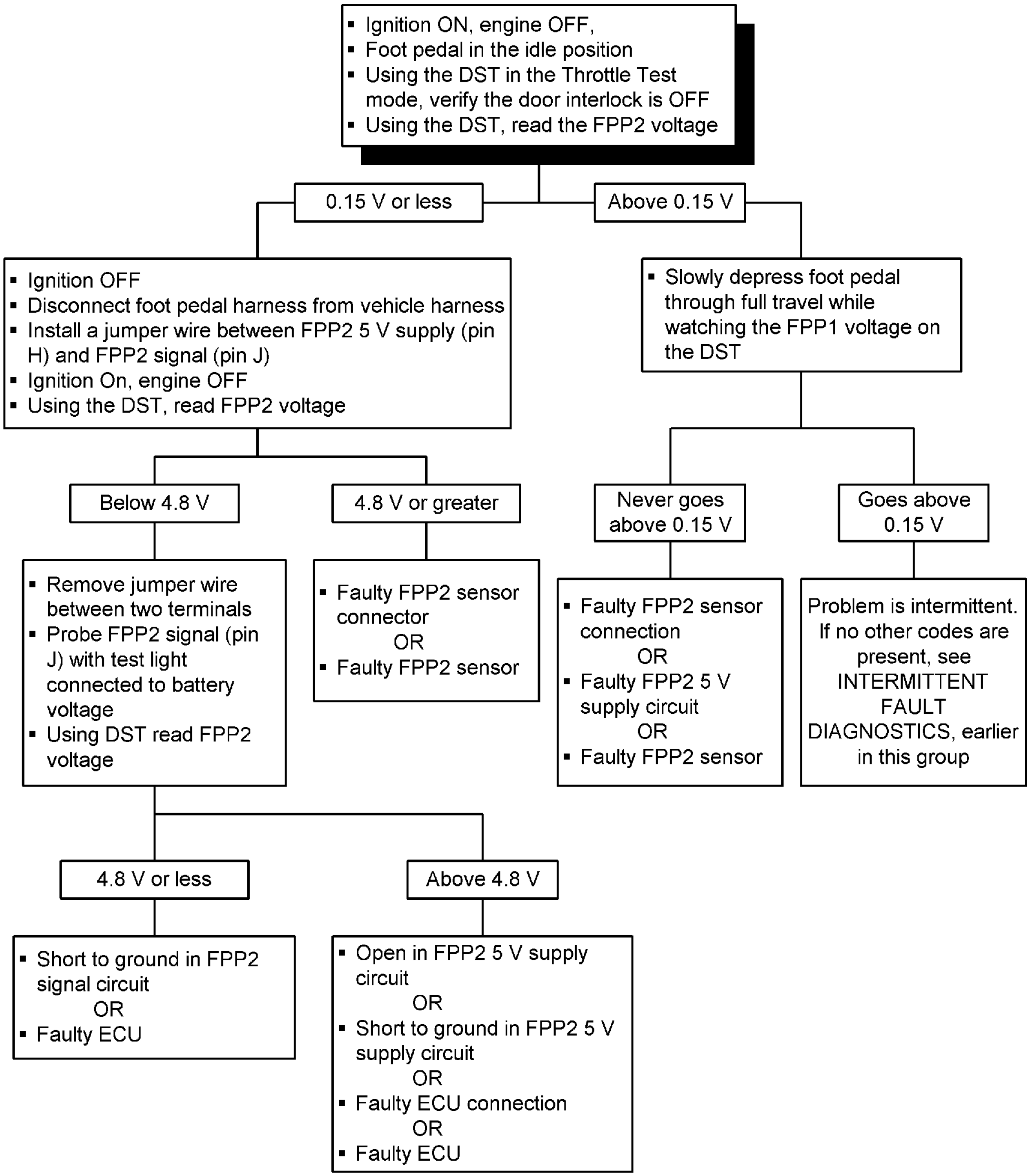
- No change in driveability
- Reduced engine power and degraded driveability
- Step power changes between idle and approximately 50% engine power as the pedal is depressed

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3111 –19–15JUL96–3/3

DTC 32 FPP2 Voltage Low - Continued

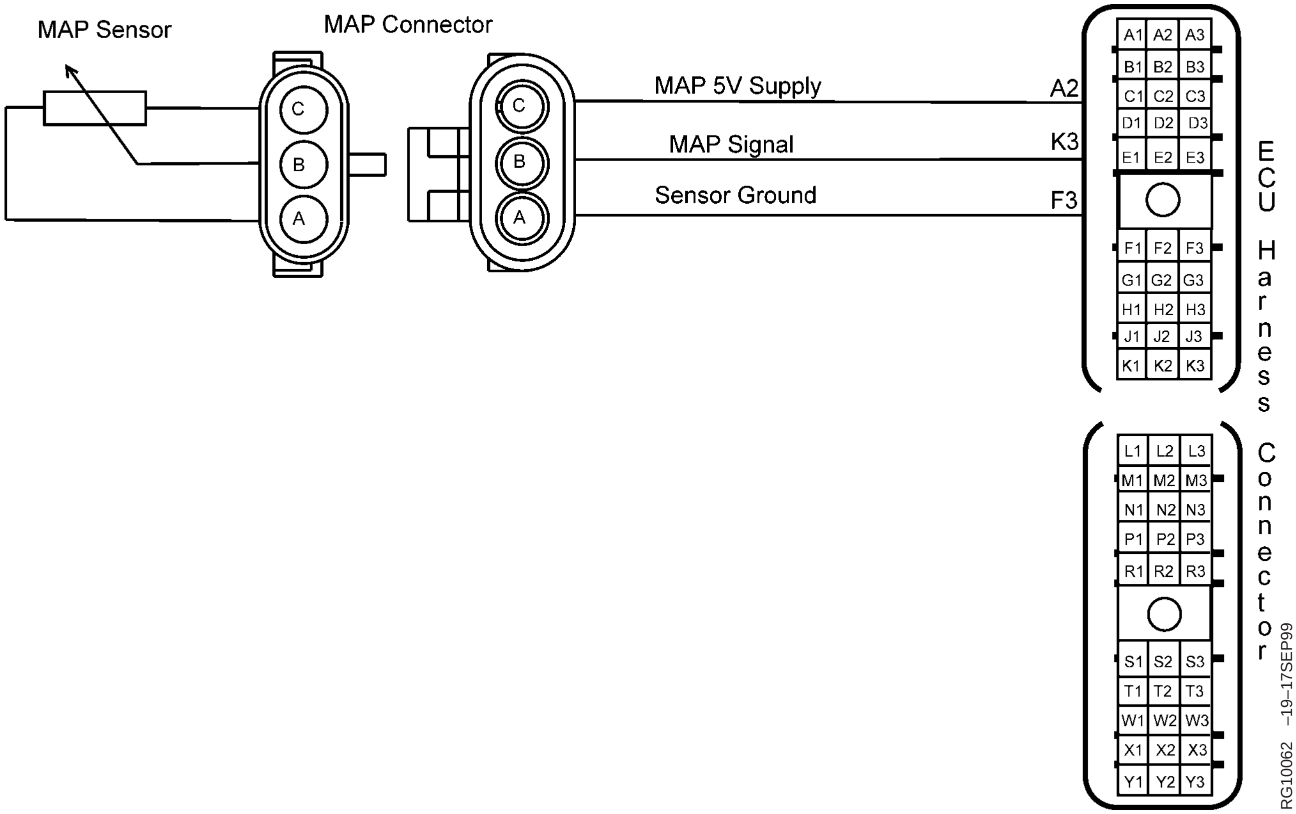
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connectors looking for dirty, damaged, or poorly positioned terminals.



RG10148 –19–16AUG00

DPSG,RG40854,106 –19–10JUN99–1/1

DTC 33 MAP Voltage High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
K3	B	11 Lt. Green	Lt. Green	MAP Signal
F3	A	21E Black	Black/Lt. Green	Sensor Ground
A2	C	55C Lt. Green	Lt. Green/Red	Sensor 5V Supply

MAP - Manifold Absolute Pressure sensor

The MAP sensor is a pressure transducer connected to intake manifold pressure. It is used to measure the air pressure in the intake manifold. The MAP signal voltage varies as intake manifold pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the MAP sensor signal:

In conjunction with several other sensors to determine the airflow rate to the engine

DTC 33 will set if:

- Engine speed is greater than 500 RPM
- **AND** Throttle command is less than 12.5% (1.0 V)
- **AND** MAP and TPS readings are steady
- **AND** PTP is less than 18 psia
- **AND** MAP value exceeds 1.3 V

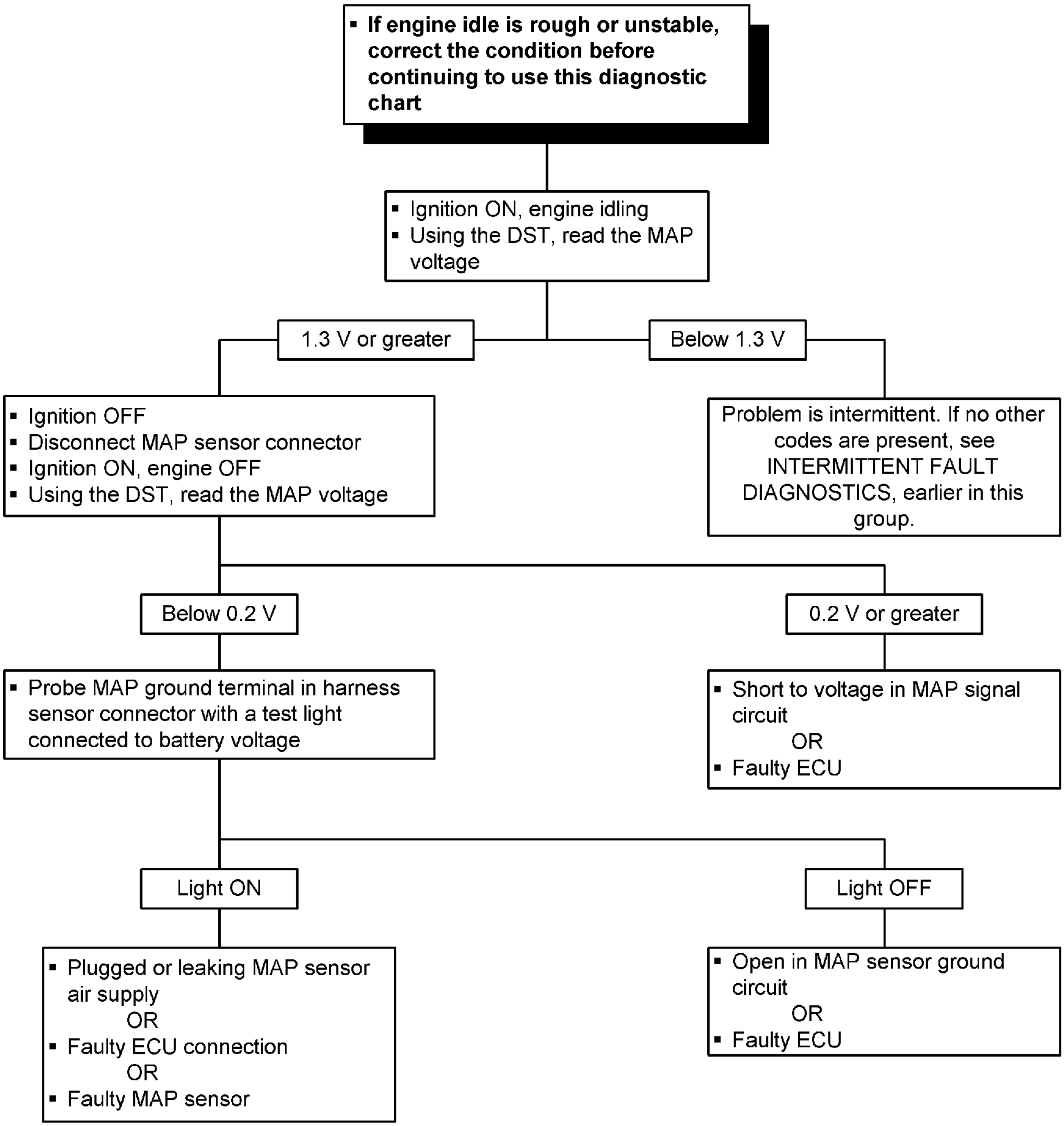
If DTC 33 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop disabled for remainder of key-on cycle
- No boost will be allowed until fault is no longer active
- Fuel delivery based on engine speed and TPS
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3113 –19–15JUL96–1/1

DTC 33 MAP Voltage High - Continued

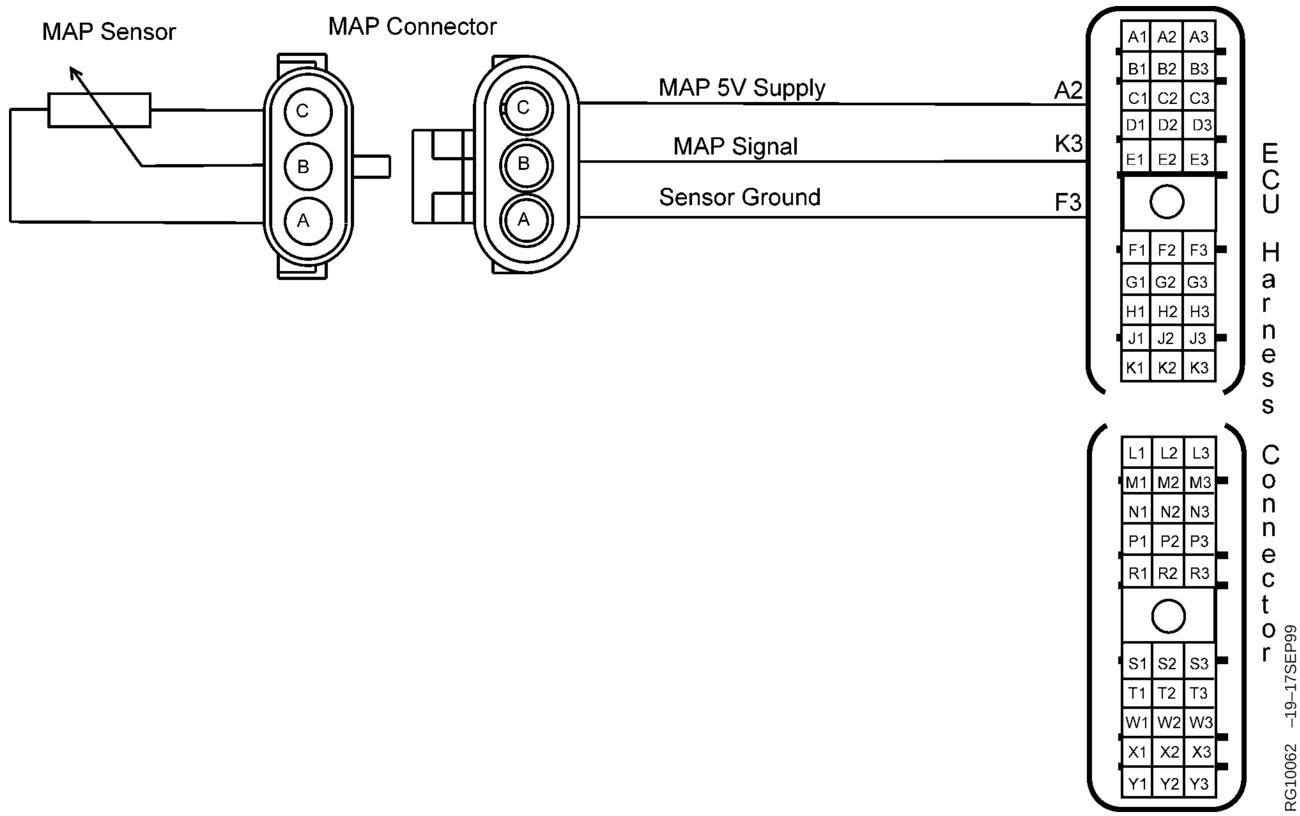
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Manifold Absolute Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10149 –19–16AUG00

DPSG,RG40854,107 –19–10JUN99–1/1

DTC 34 MAP Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
K3	B	11 Lt. Green	Lt. Green	MAP Signal
F3	A	21E Black	Black/Lt. Green	Sensor Ground
A2	C	55C Lt. Green	Lt. Green/Red	Sensor 5V Supply

MAP - Manifold Absolute Pressure sensor

The MAP sensor is a pressure transducer connected to intake manifold pressure. It is used to measure the air pressure in the intake manifold. The MAP signal voltage varies as intake manifold pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the MAP sensor signal:

In conjunction with several other sensors to determine engine airflow

DTC 34 will set if:

MAP voltage drops below 0.05 volts anytime the engine is cranking or running

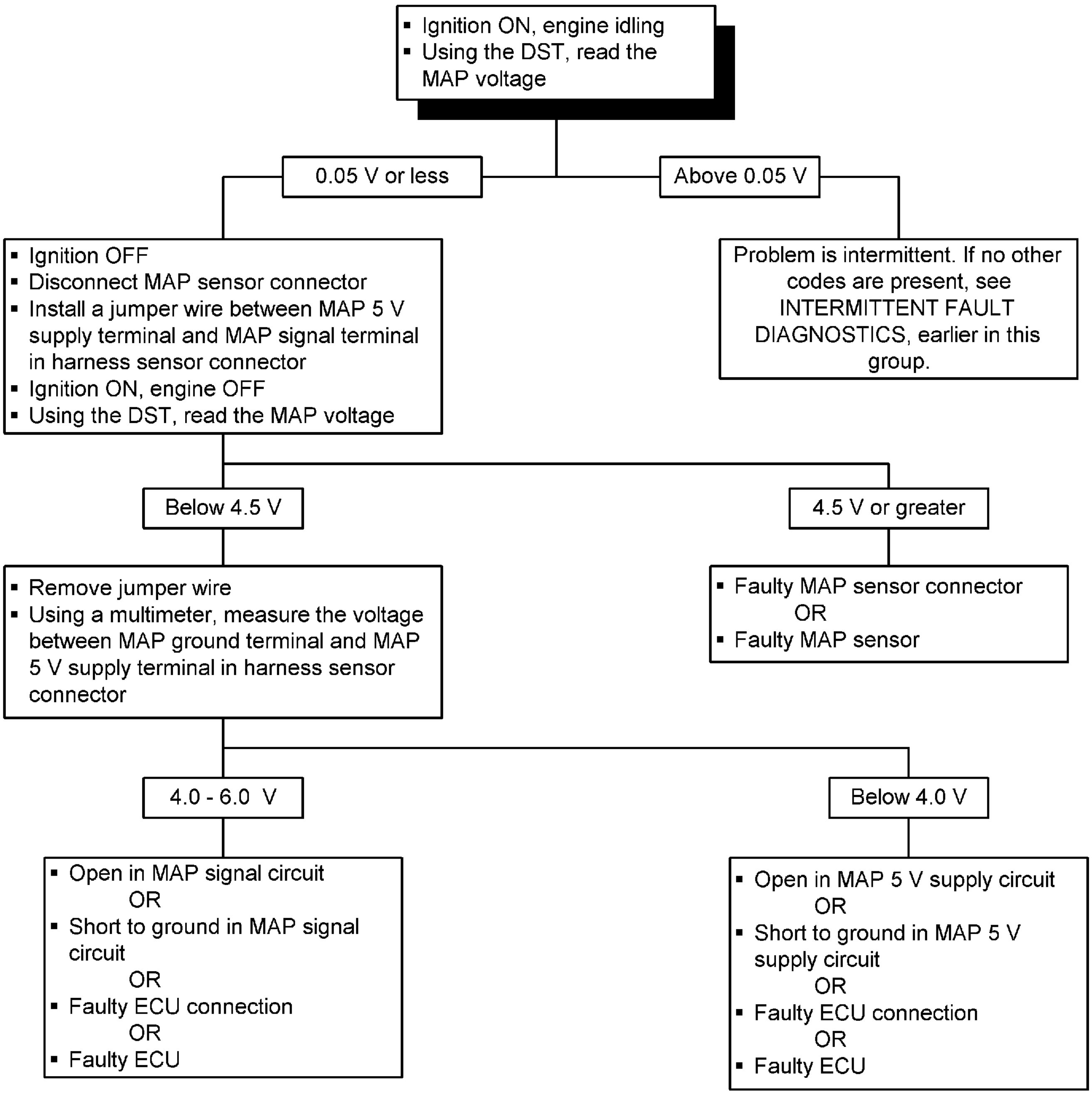
If DTC 34 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop disabled for remainder of key-on cycle
- No boost will be allowed until fault is no longer active
- Amount of fuel delivered to the engine based on engine speed and TPS
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3115 –19–15JUL96–1/1

DTC 34 MAP Voltage Low - Continued

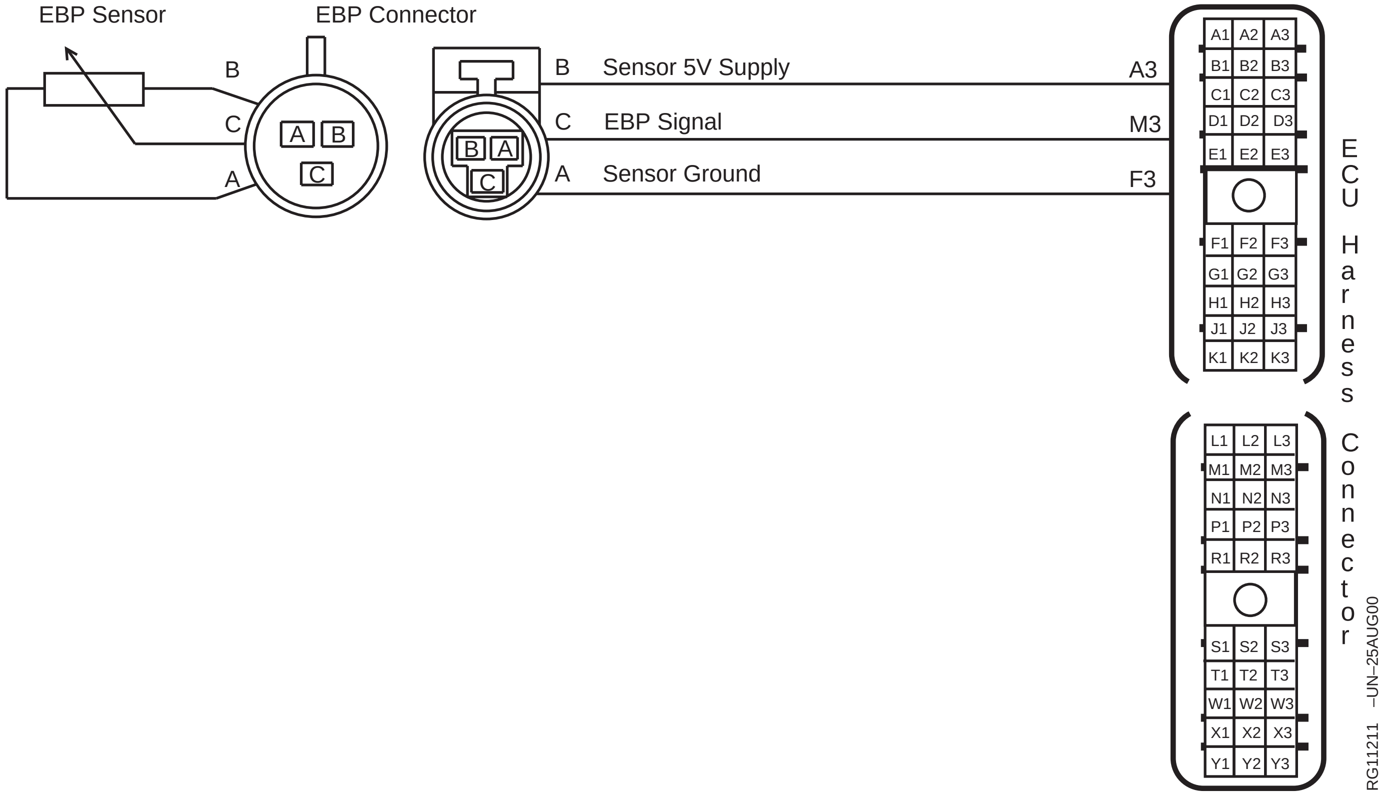
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Manifold Absolute Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10150 –19–12SEP00

DPSG,RG40854,108 –19–10JUN99–1/1

DTC 35 BP Higher than Expected



NOTE: This code is not used in the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54A Yellow	Yellow/Red	Sensor 5V Supply
M3	C	9 Dk. Green	Dk. Green/White	EBP Signal
F3	A	21C Black	Black/Yellow	Sensor Ground

BP - Barometric Pressure

Barometric pressure is measured with the Exhaust Back Pressure (EBP) sensor when engine speed is less than 900 RPM, MAP reading is less than 8.0 psia, and MAP and TPS readings are steady. The EBP sensor is a pressure transducer mounted in the exhaust, downstream of the turbocharger. The EBP signal voltage varies as pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the BP measurement for:

- Driveability enhancement
- Turbocharger overspeed protection

DTC 35 will set if:

- Engine speed is less than 900 RPM
- **AND** MAP reading is less than 8.0 psia
- **AND** MAP and TPS readings are steady
- **AND** EBP voltage exceeds 2.6 volts

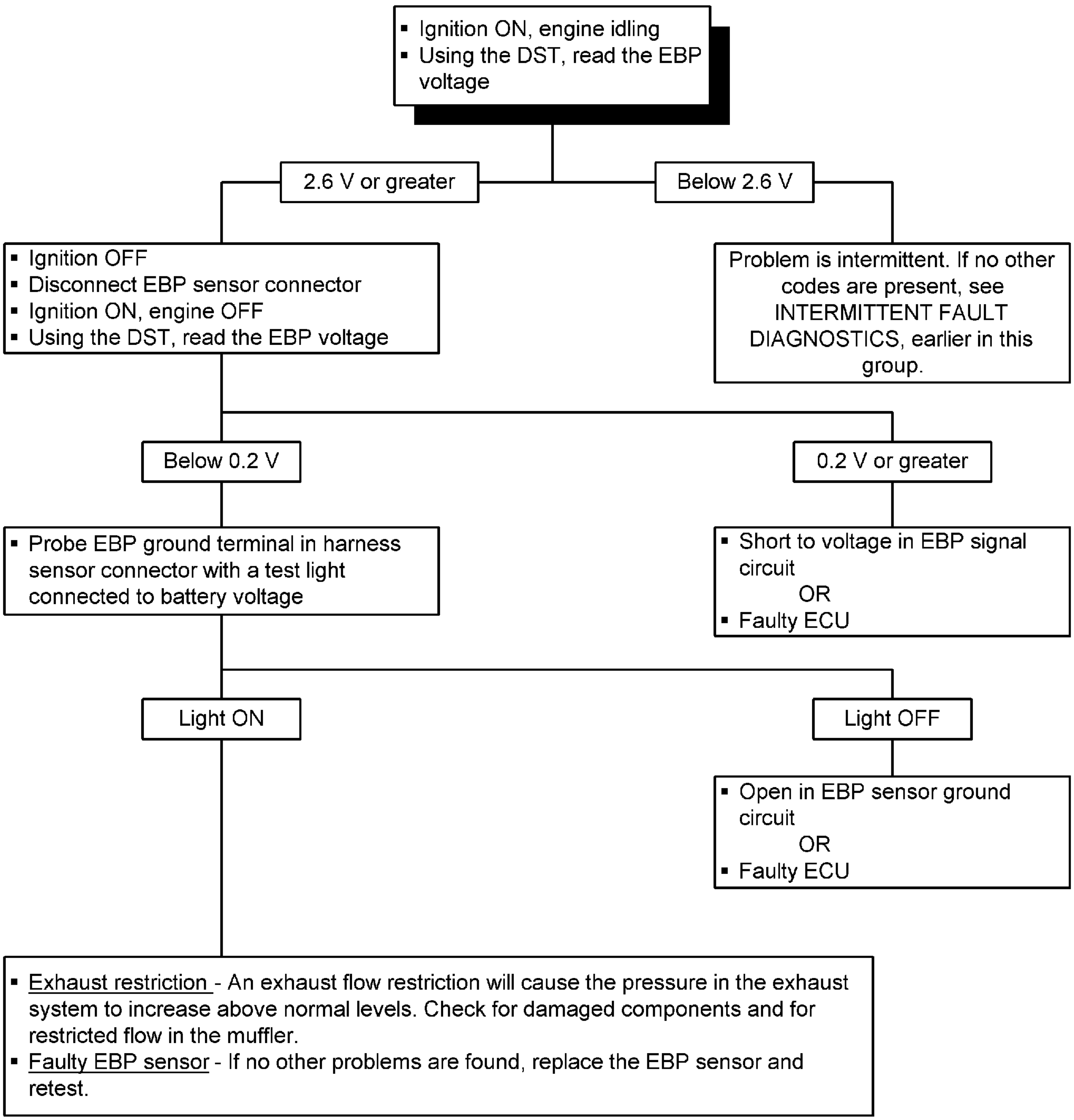
If DTC 35 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3117 –19–15JUL96–1/1

DTC 35 BP Higher than Expected - Continued

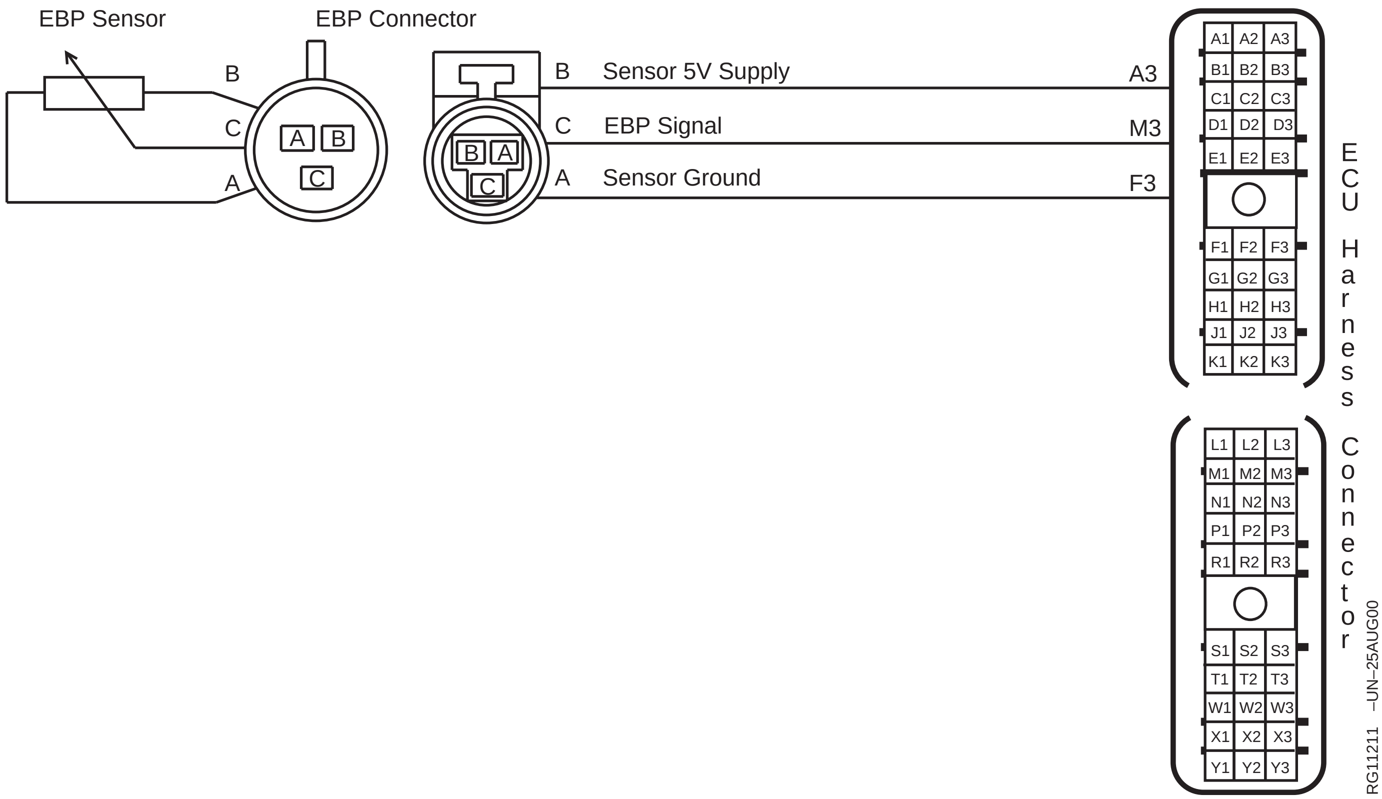
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Exhaust Back Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10151 –19–16AUG00

DPSG,RG40854,109 –19–10JUN99–1/1

DTC 36 BP Lower Than Expected



NOTE: This code is not used in the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54A Yellow	Yellow/Red	Sensor 5V Supply
M3	C	9 Dk. Green	Dk. Green/White	EBP Signal
F3	A	21C Black	Black/Yellow	Sensor Ground

BP - Barometric Pressure

Barometric pressure is measured with the Exhaust Back Pressure (EBP) sensor when engine speed is less than 900 RPM, MAP reading is less than 8.0 psia, and MAP and TPS readings are steady. The EBP sensor is a pressure transducer mounted in the exhaust, downstream of the turbocharger. The EBP signal voltage varies as pressure varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the BP measurement for:

- Driveability enhancement
- Turbocharger overspeed protection

DTC 36 will set if:

- Engine speed is less than 900 RPM
- **AND** MAP reading is less than 8.0 psia
- **AND** MAP and TPS readings are steady
- **AND** EBP voltage drops below 1.6 volts

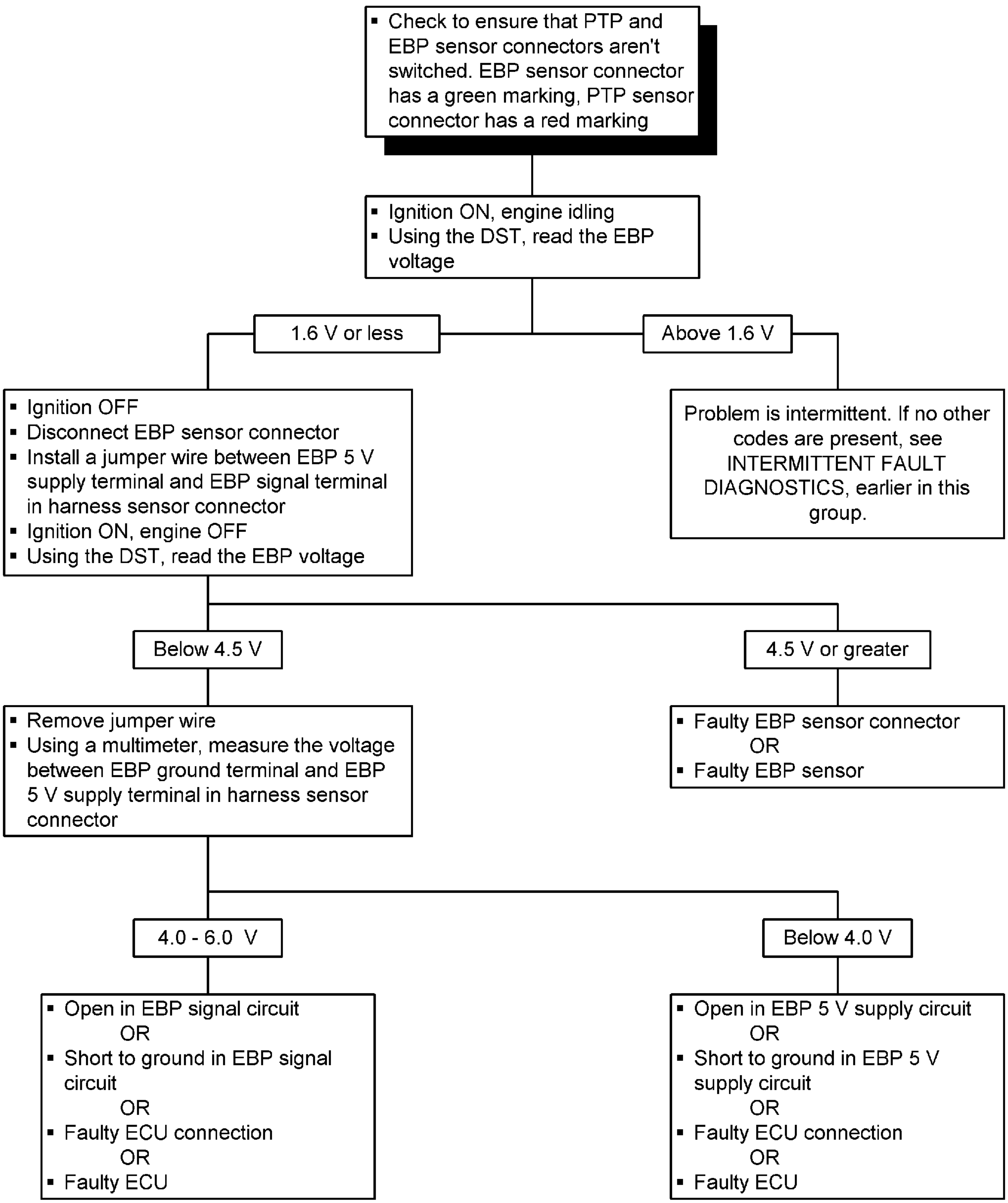
If DTC 36 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3119 –19–15JUL96–1/1

DTC 36 BP Lower Than Expected - Continued

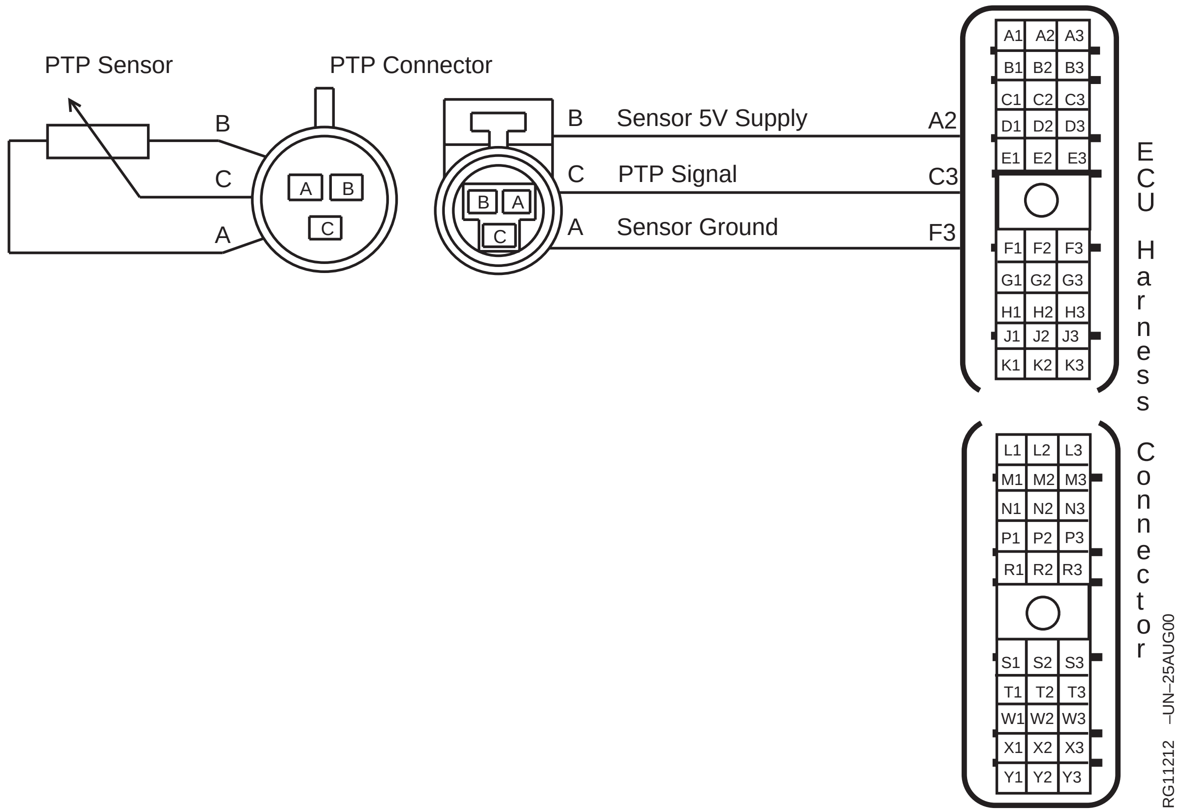
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Exhaust Back Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10152 –19–16AUG00

DPSG,RG40854,110 –19–10JUN99–1/1

DTC 37 PTP Voltage High



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	B	55A Lt. Green	Lt. Green/Red	Sensor 5V Supply
C3	C	10 Lt. Blue	Lt. Blue/Dk. Blue	PTP Signal
F3	A	21F Black	Black/Lt. Green	Sensor Ground

PTP - Pre-Turbine Pressure sensor

The PTP sensor is a pressure transducer connected to exhaust manifold pressure. It is used to measure the pressure in the exhaust manifold in front of the turbocharger. The PTP signal voltage varies as pressure in the exhaust manifold varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the PTP sensor signal:

- In conjunction with several other sensors to determine engine airflow
- To enhance turbocharger wastegate control

DTC 37 will set if:

- MAP reads less than 12 psia
- **AND** MAP and TPS readings are steady
- **AND** PTP voltage exceeds 2.5 volts anytime the engine is running

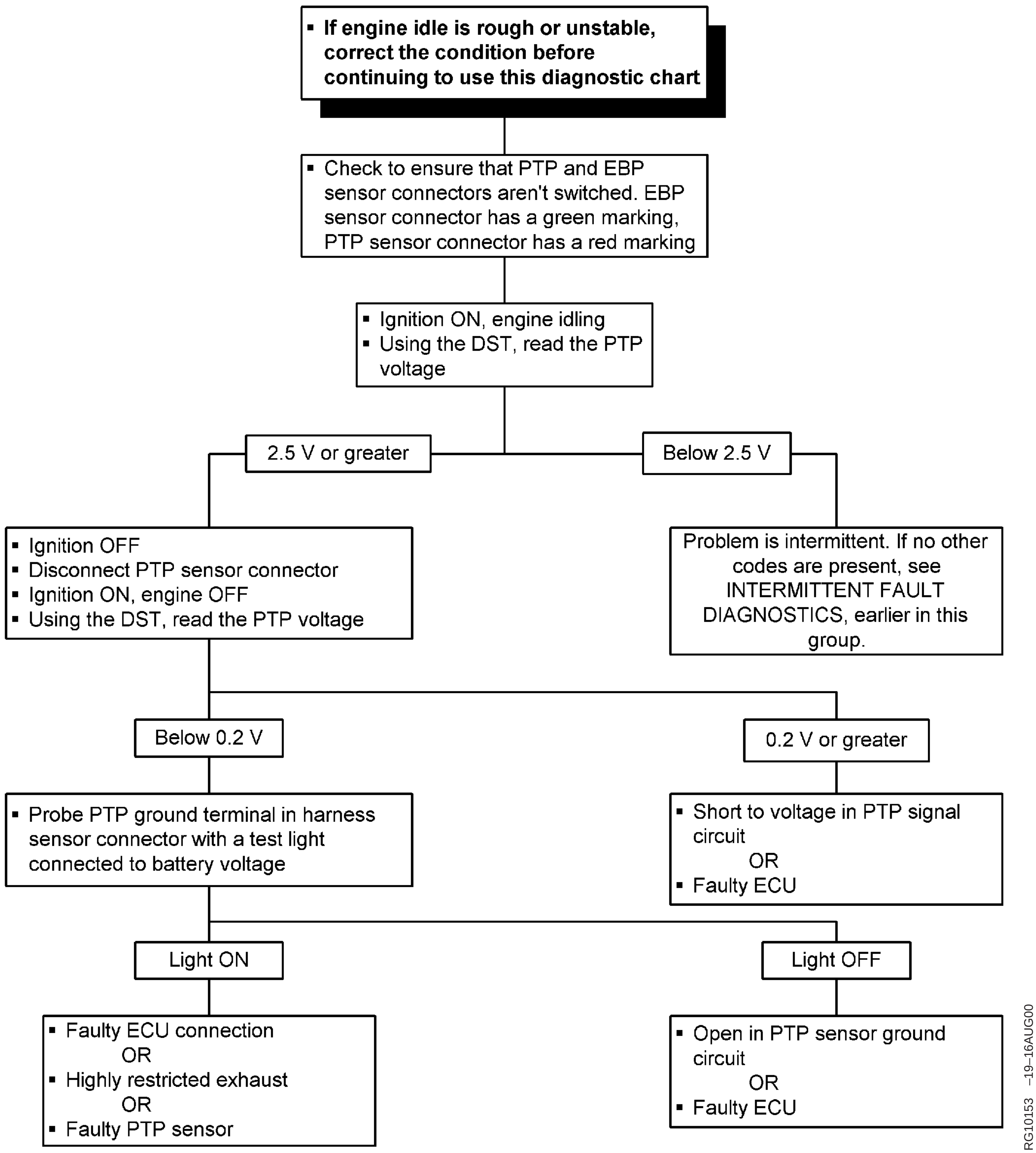
If DTC 37 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- ECU will use default “limp home” PTP value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3121 –19–15JUL96–1/1

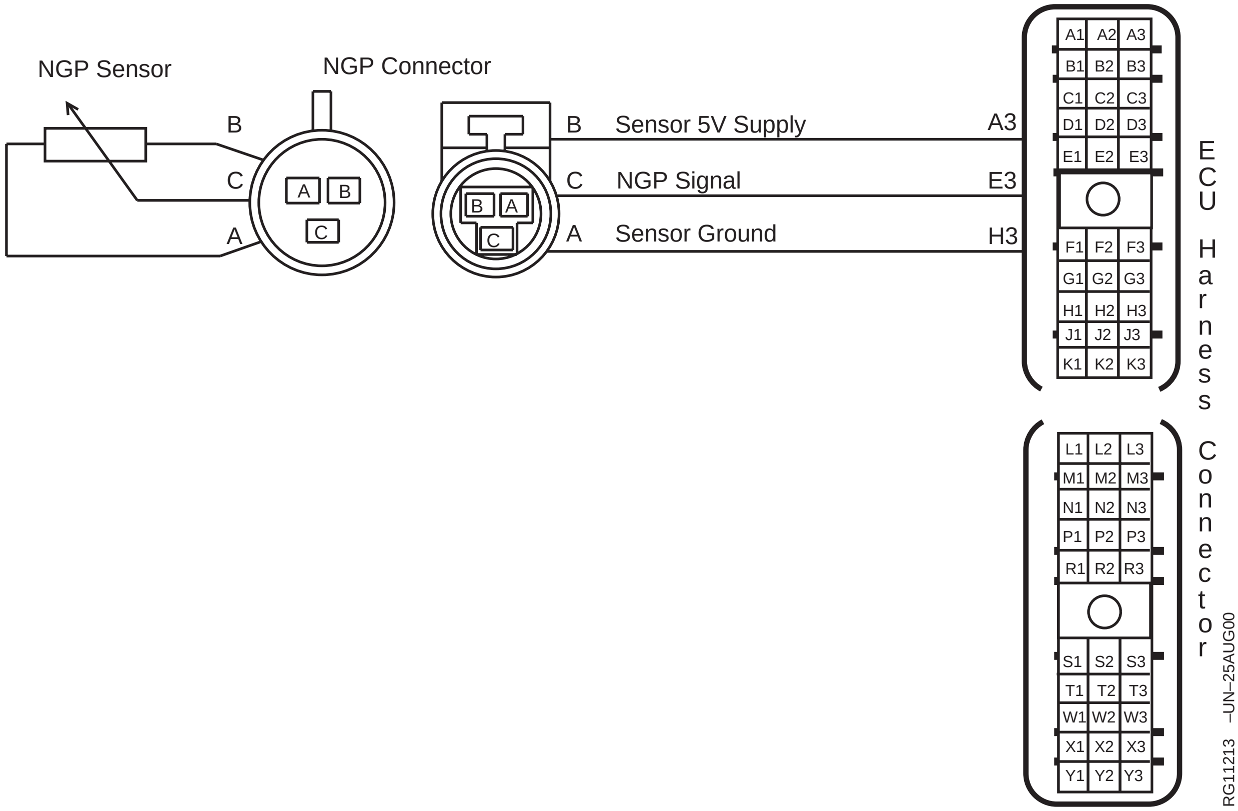
DTC 37 PTP Voltage High - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Pre-Turbine Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



DPSG,RG40854,111 –19–10JUN99–1/1

DTC 38 NGP Voltage High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54B Yellow	Yellow/Red	Sensor 5V Supply
E3	C	15 Yellow	Yellow	NGP Signal
H3	A	20D Black	Black/Yellow	Sensor Ground

NGP - Natural Gas Pressure sensor

The NGP sensor is a pressure transducer mounted in the fuel metering valve. It is used to measure the regulated gas pressure prior to injection. The NGP signal voltage varies as fuel pressure in the metering valve varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGP sensor signal:

In conjunction with the NGT sensor value to calculate fuel density at the injectors

DTC 38 will set if:

The NGP voltage exceeds 4.8 volts anytime the engine is running

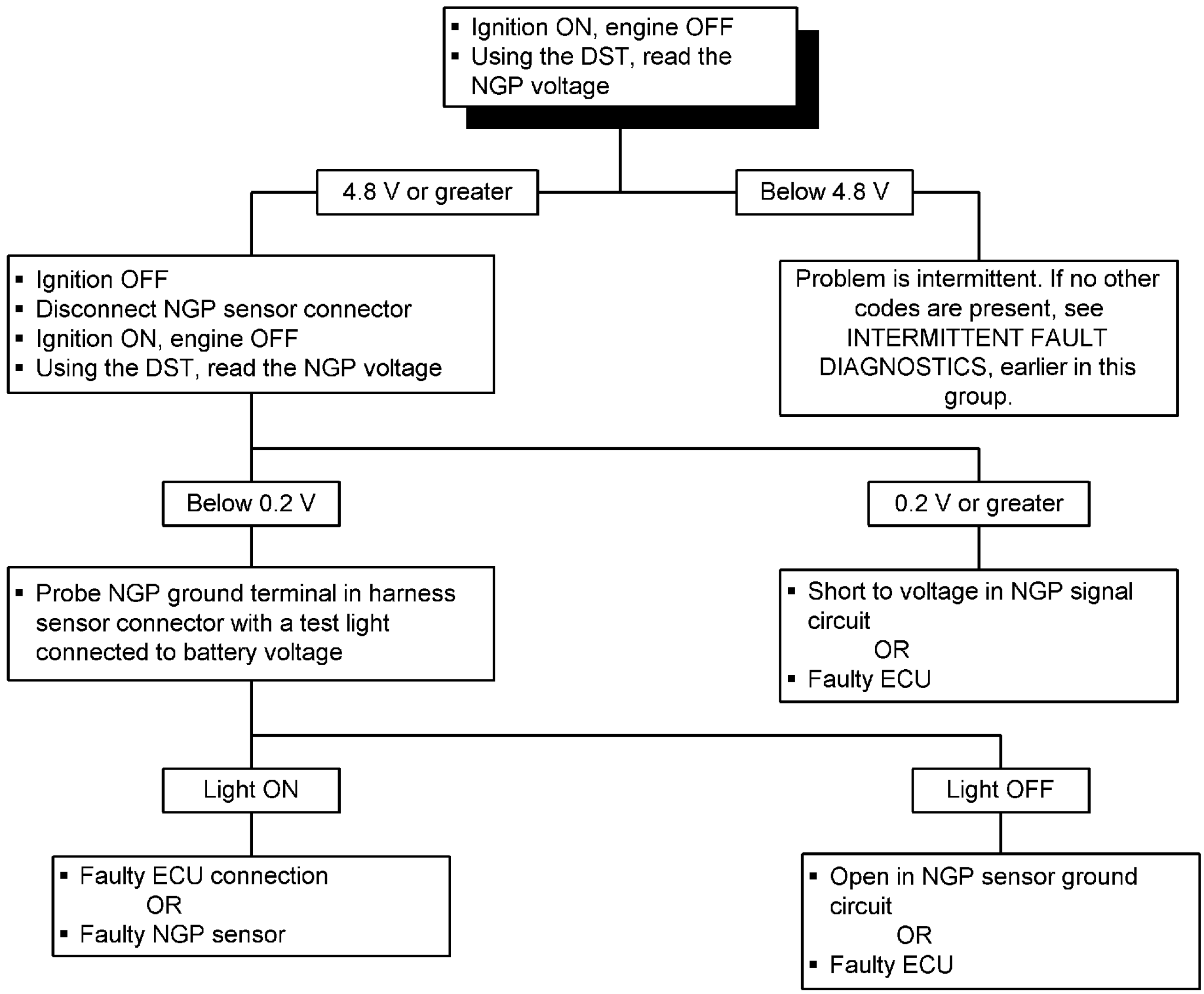
If DTC 38 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- ECU will use a default “limp home” NGP value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3123 –19–15JUL96–1/1

DTC 38 NGP Voltage High - Continued

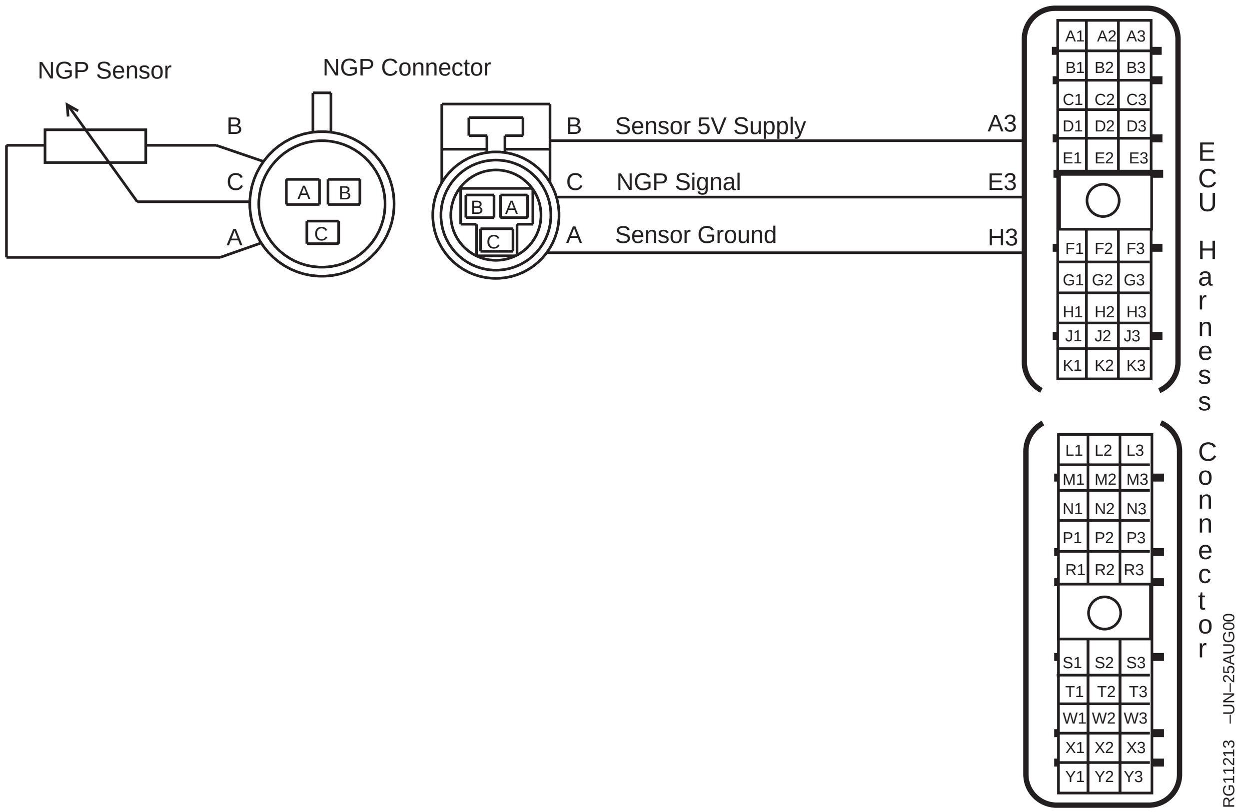
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10154 –19–16AUG00

DPSG,RG40854,112 –19–10JUN99–1/1

DTC 39 NGP Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54B Yellow	Yellow/Red	Sensor 5V Supply
E3	C	15 Yellow	Yellow	NGP Signal
H3	A	20D Black	Black/Yellow	Sensor Ground

NGP - Natural Gas Pressure sensor

The NGP sensor is a pressure transducer mounted in the fuel metering valve. It is used to measure the regulated gas pressure prior to injection. The NGP signal voltage varies as fuel pressure in the metering valve varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGP sensor signal:

In conjunction with the NGT sensor value to calculate fuel density at the injectors

DTC 39 will set if:

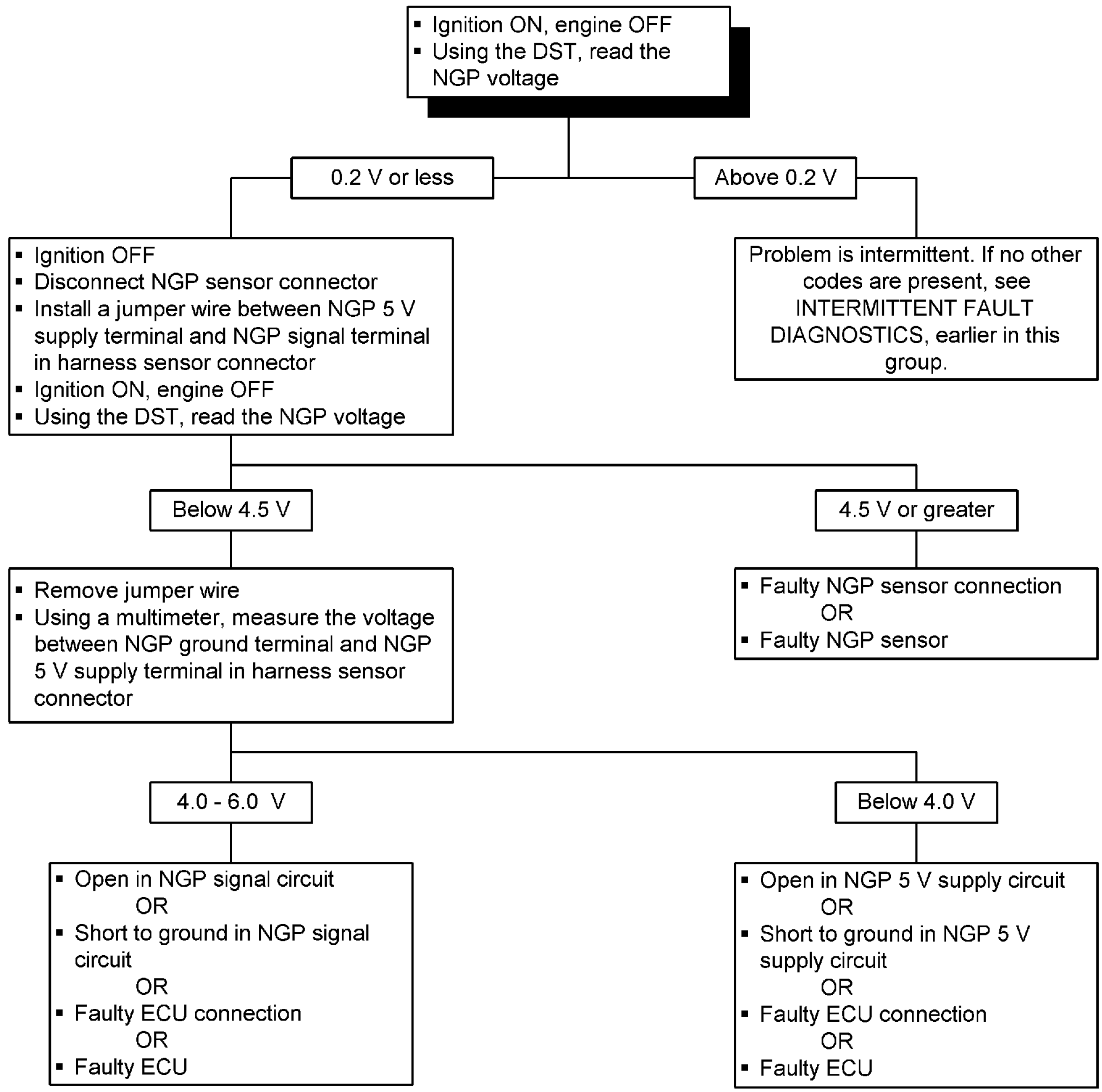
The NGP voltage drops below 0.2 volts anytime the engine is running

If DTC 39 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- ECU will use default “limp home” NGP value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

DTC 39 NGP Voltage Low - Continued

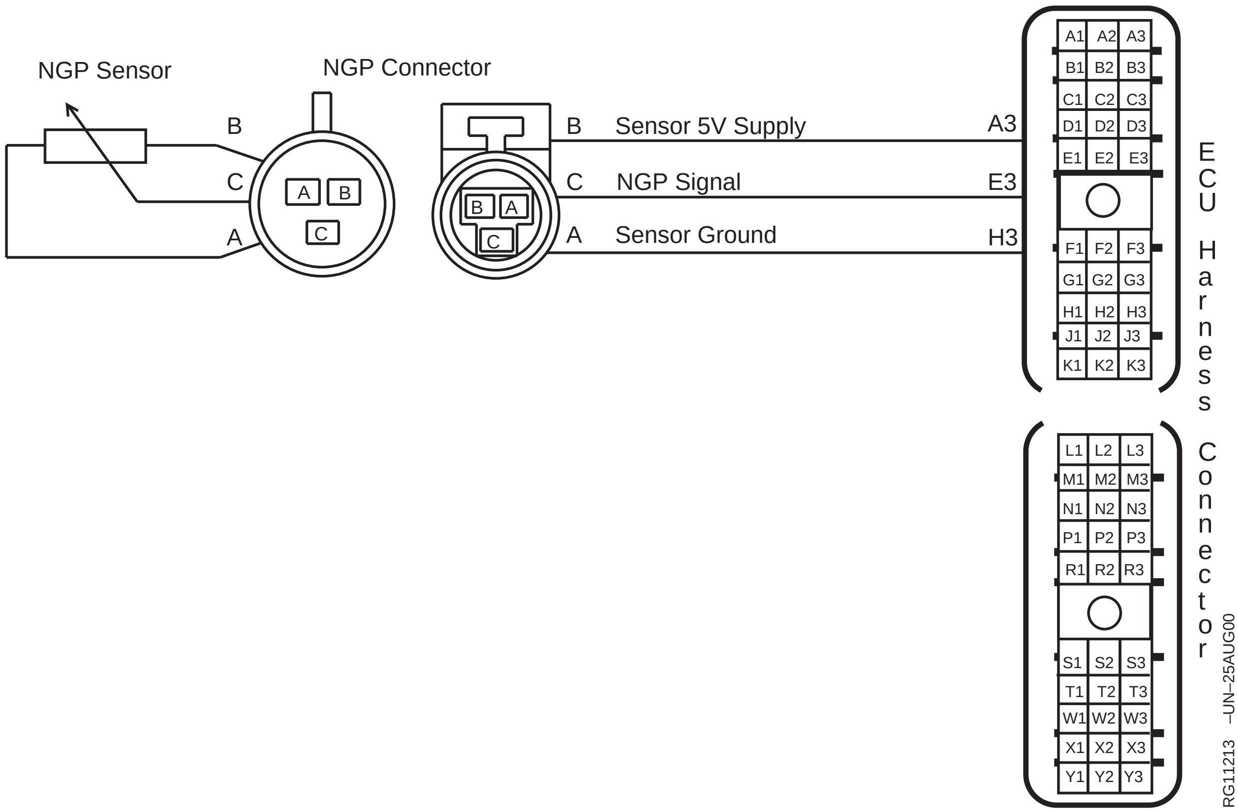
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10155 –19–16AUG00

DPSG,RG40854,113 –19–10JUN99–1/1

DTC 41 NGP Higher Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54B Yellow	Yellow/Red	Sensor 5V Supply
E3	C	15 Yellow	Yellow	NGP Signal
H3	A	20D Black	Black/Yellow	Sensor Ground

NGP - Natural Gas Pressure sensor

The NGP sensor is a pressure transducer mounted in the fuel metering valve. It is used to measure the regulated gas pressure prior to injection. The NGP signal voltage varies as fuel pressure in the metering valve varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGP sensor signal:

In conjunction with the NGT sensor value to calculate fuel density at the injectors

DTC 41 will set if:

The NGP reading exceeds 160 psia while engine is running

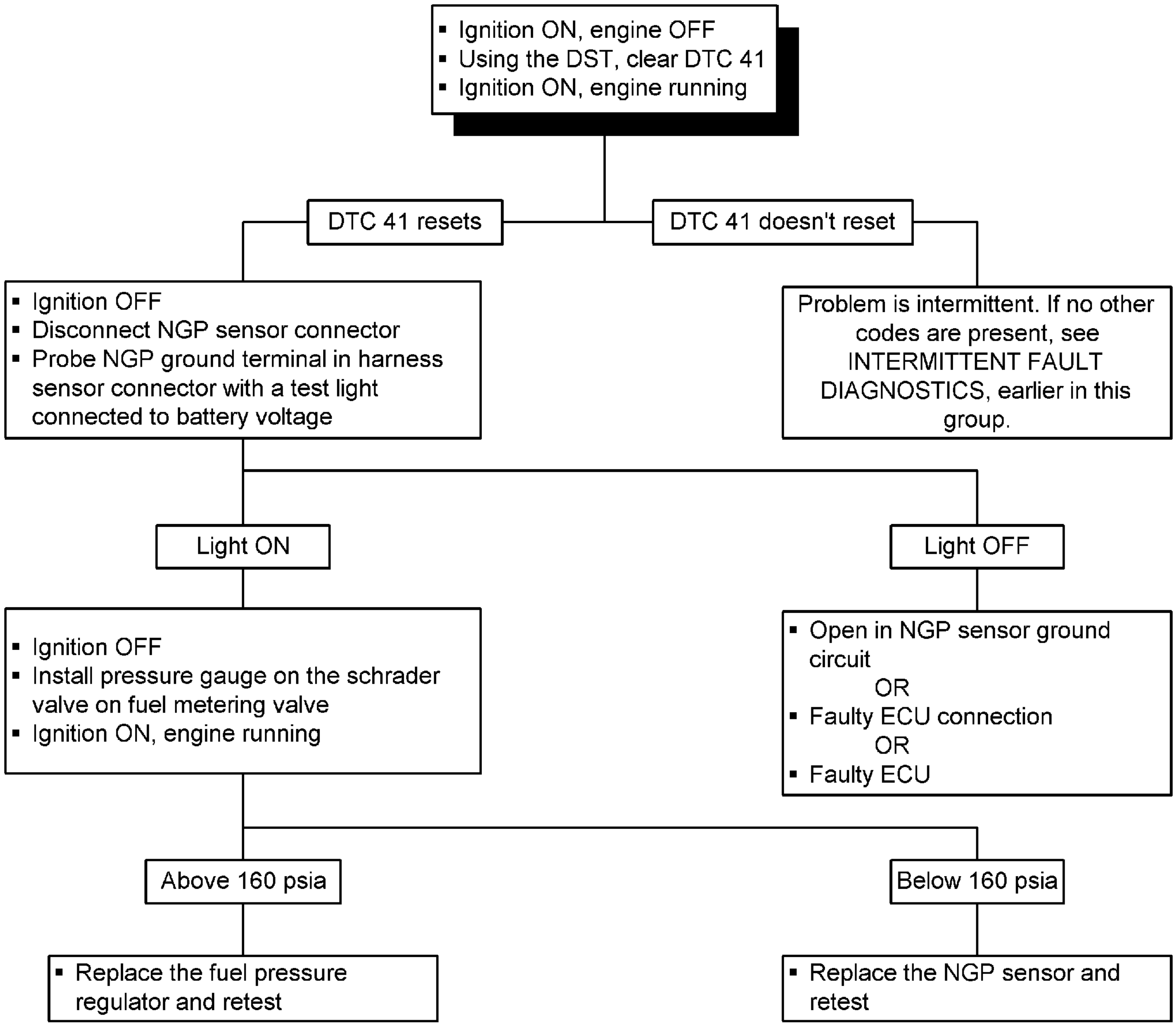
If DTC 41 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3127 –19–15JUL96–1/1

DTC 41 NGP Higher Than Expected - Continued

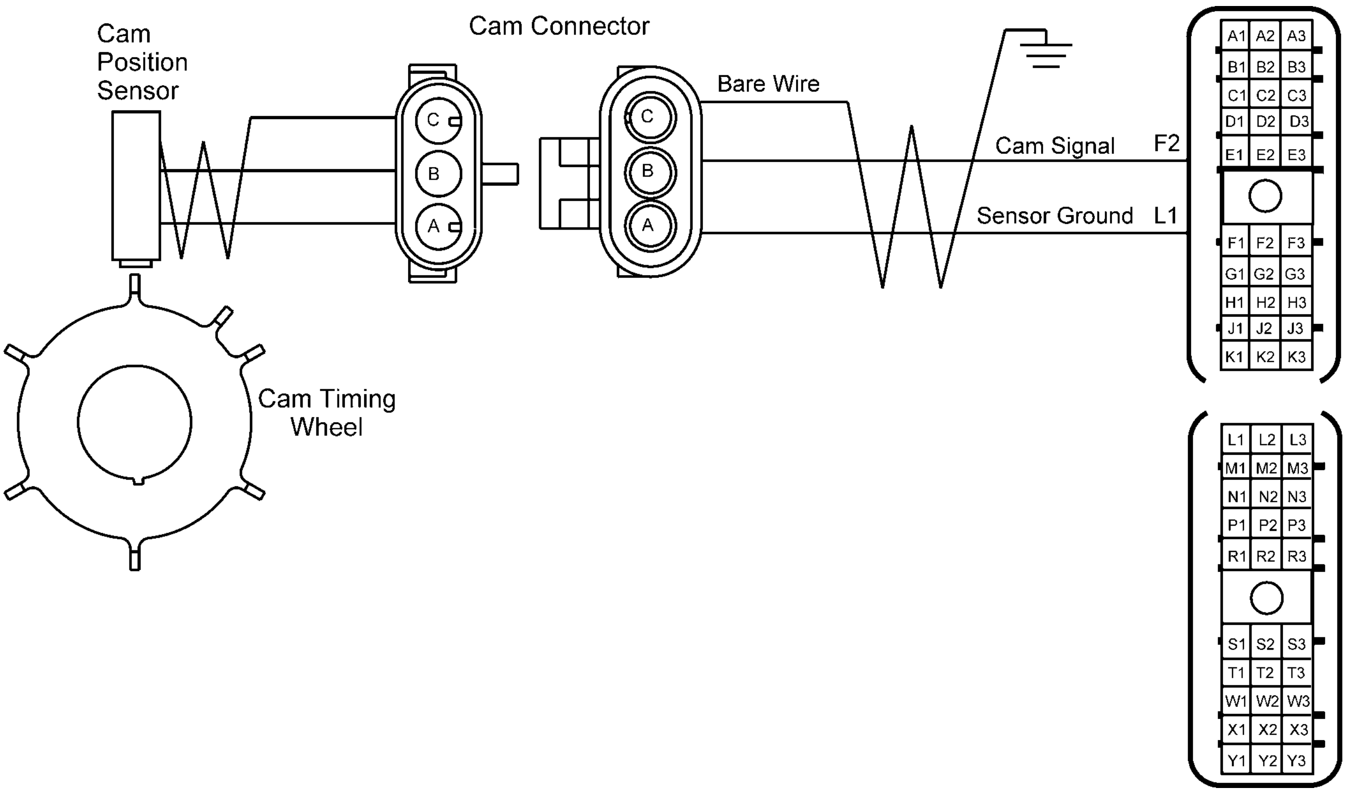
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10156 –19–17OCT00

DPSG,RG40854,114 –19–10JUN99–1/1

DTC 42 Camshaft Position Sensor Error (6081 CNG Only)



RG10071 –19–24MAY99

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F2	B	31 Lt. Blue	Lt. Blue/Dk. Green	Cam Signal
L1	A	Black 33A	Black/Gray	Sensor Ground
	C	White 51	White	Ground for Bare Wire

Camshaft position sensor

The camshaft position sensor is used for measuring engine RPM and for determining when each cylinder is at TDC firing. The camshaft trigger wheel has 6 evenly spaced teeth (one for each cylinder) and one extra closely spaced tooth to the number one tooth. This extra tooth “tells” the ECU when number 1 cylinder is at TDC at the end of the compression stroke.

DTC 42 will set if:

The ECU detects unexpected high frequency pulses from the camshaft position sensor anytime the engine is running

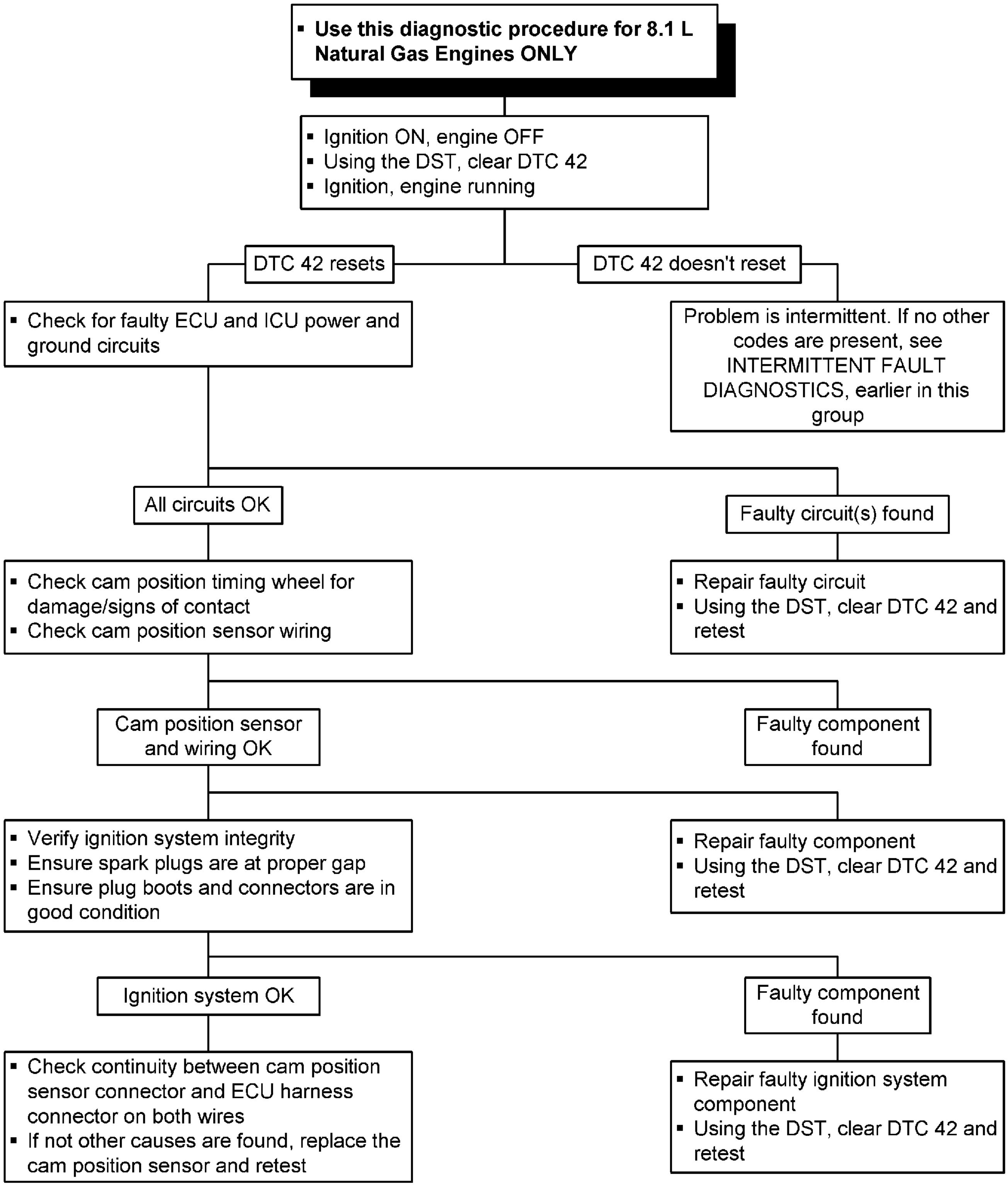
If DTC 42 sets the following will occur:

CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3129 –19–15JUL96–1/1

DTC 42 Camshaft Position Sensor Error (6081 CNG Only) - Continued

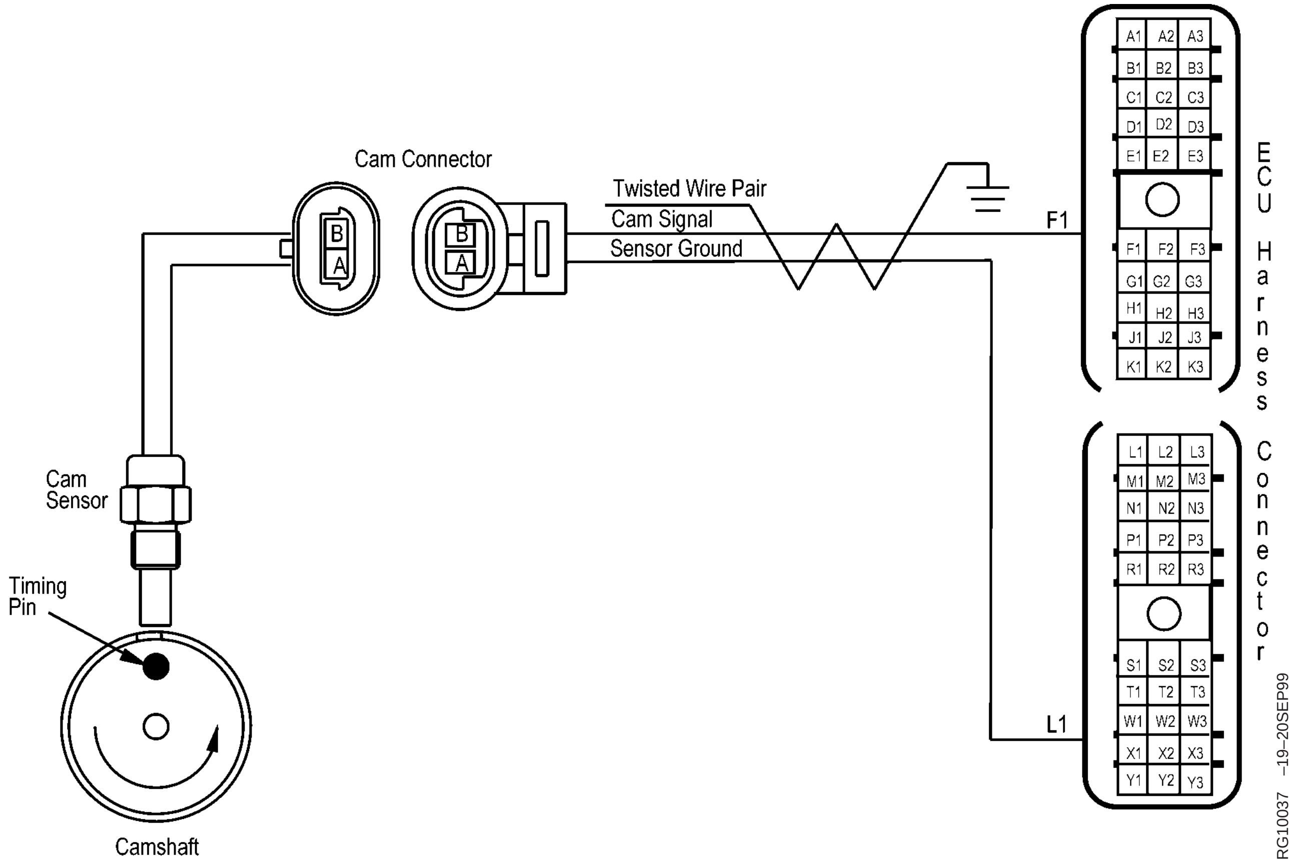
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Camshaft Position sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10157 –19–16AUG00

DPSG,RG40854,115 –19–10JUN99–1/1

DTC 42 Camshaft Position Sensor Error (6068 CNG Only)



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F1	B	73 White	N.A.	Cam Signal
L1	A	33B Black	N.A.	Sensor Ground

Camshaft position sensor

The camshaft position sensor is an inductive-type pickup sensor that detects a pin on the end of the camshaft. The pin passes under the camshaft position sensor 14 degrees before cylinder number 1 reaches top dead center (TDC) at the same time that the wider 45 degree gap of the flywheel is seen by the crankshaft sensor. The ECU uses this information from the camshaft position to synchronize the ignition system.

DTC 42 will set if:

The ECU loses the signal coming from the camshaft position sensor or if the ECU detects unexpected high frequency pulses from the sensor anytime the engine is cranking or running.

If DTC 42 sets, the following will occur:

If the fault occurs while the engine is running, the engine will continue to run until the ignition switch is turned off using only the signal coming from the crankshaft position sensor.

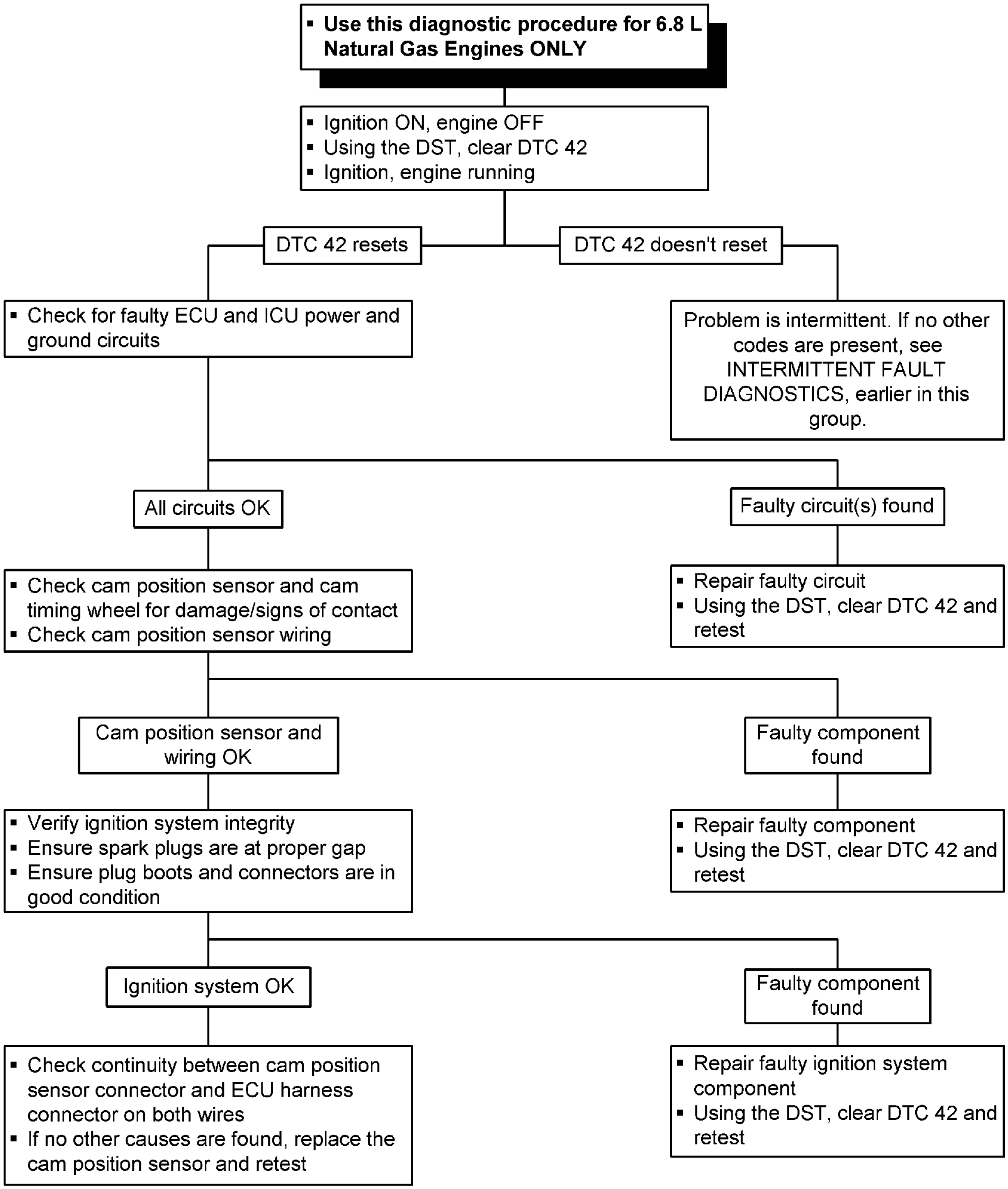
If the fault occurs while the engine is cranking, the engine will not start.

CEL turned on and stays on for 15 seconds after fault becomes inactive.

DPSG,RG40854,73 –19–30APR99–1/1

DTC 42 Camshaft Position Sensor Error (6068 CNG Only) - Continued

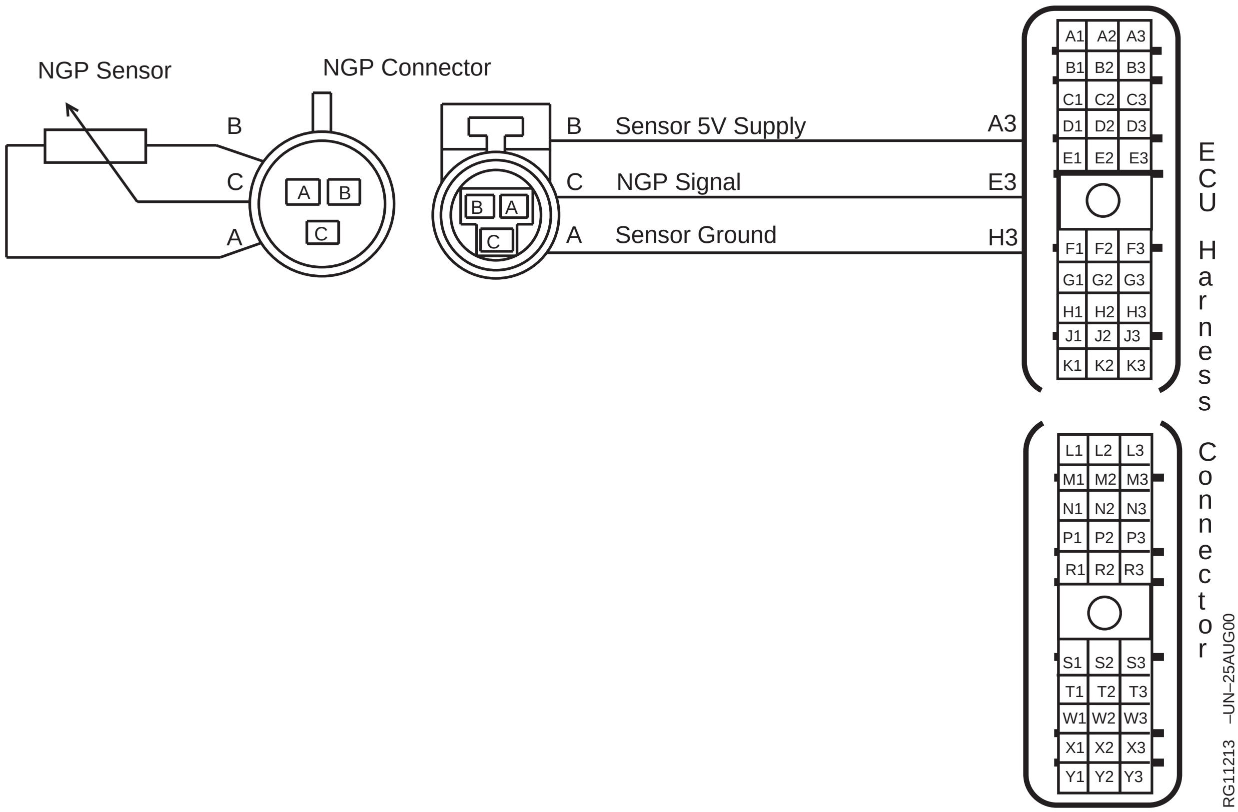
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Camshaft Postion sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10158 –19–16AUG00

DPSG,RG40854,116 –19–10JUN99–1/1

DTC 43 NGP Lower Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54B Yellow	Yellow/Red	Sensor 5V Supply
E3	C	15 Yellow	Yellow	NGP Signal
H3	A	20 D Black	Black/Yellow	Sensor Ground

NGP - Natural Gas Pressure sensor

The NGP sensor is a pressure transducer mounted in the fuel metering valve. It is used to measure the regulated gas pressure prior to injection. The NGP signal voltage varies as fuel pressure in the metering valve varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGP sensor signal:

In conjunction with the NGT sensor value to calculate fuel density at the injectors

DTC 43 will set if:

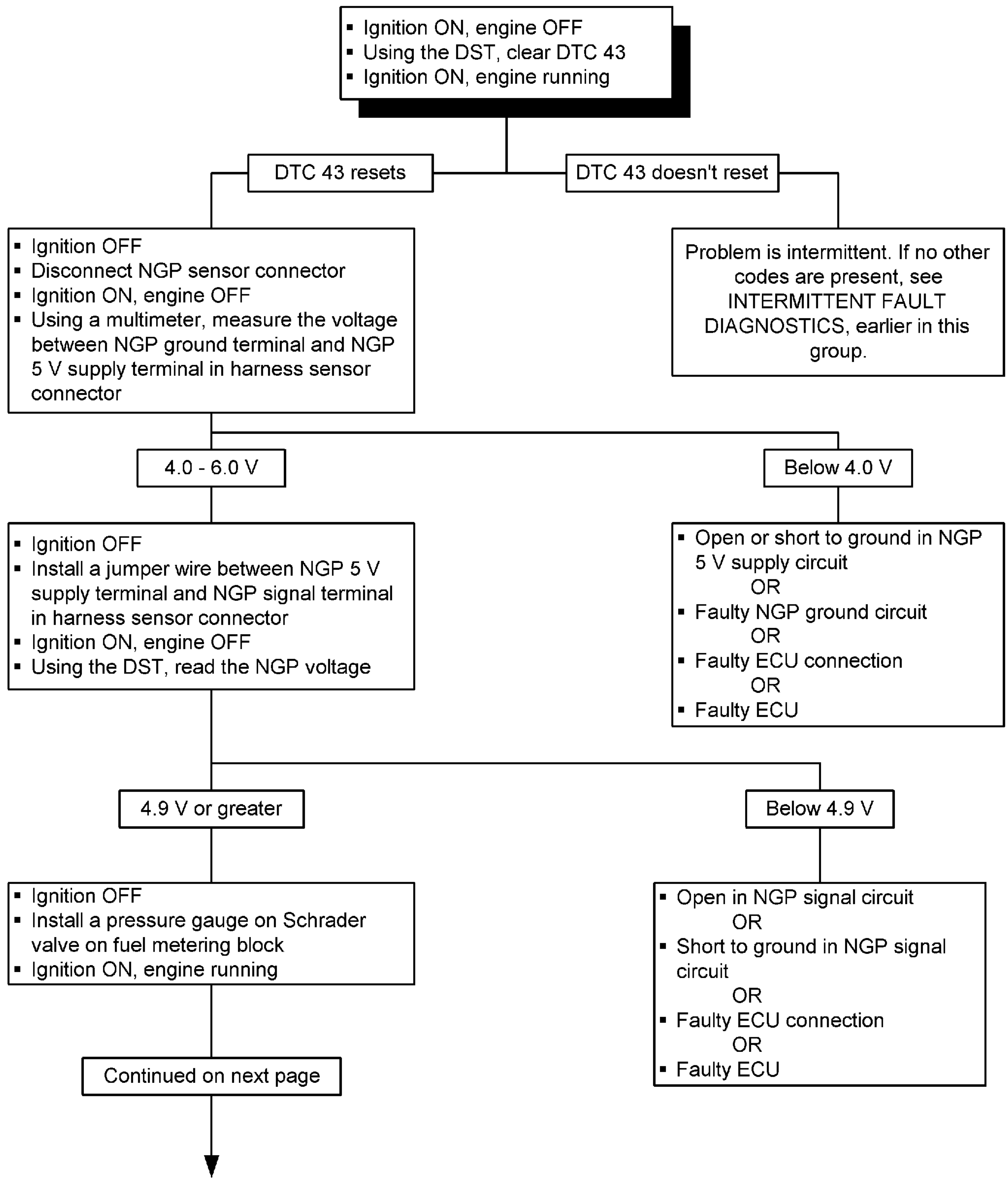
The NGP reading is less than 105 psia while engine is running

If DTC 43 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

DTC 43 NGP Lower Than Expected - Continued

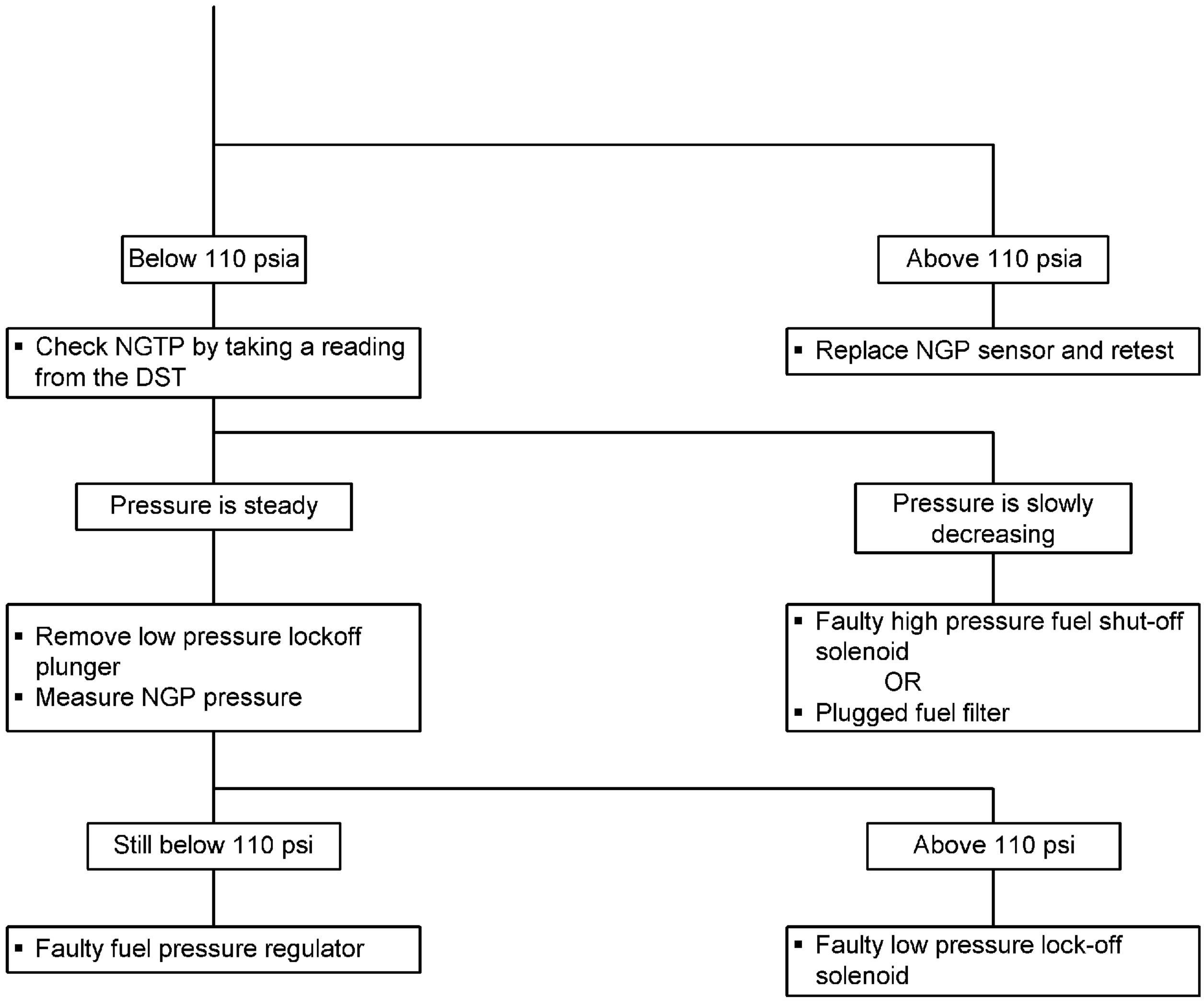
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10159 –19–16AUG00

DPSG,RG40854,117 –19–10JUN99–1/1

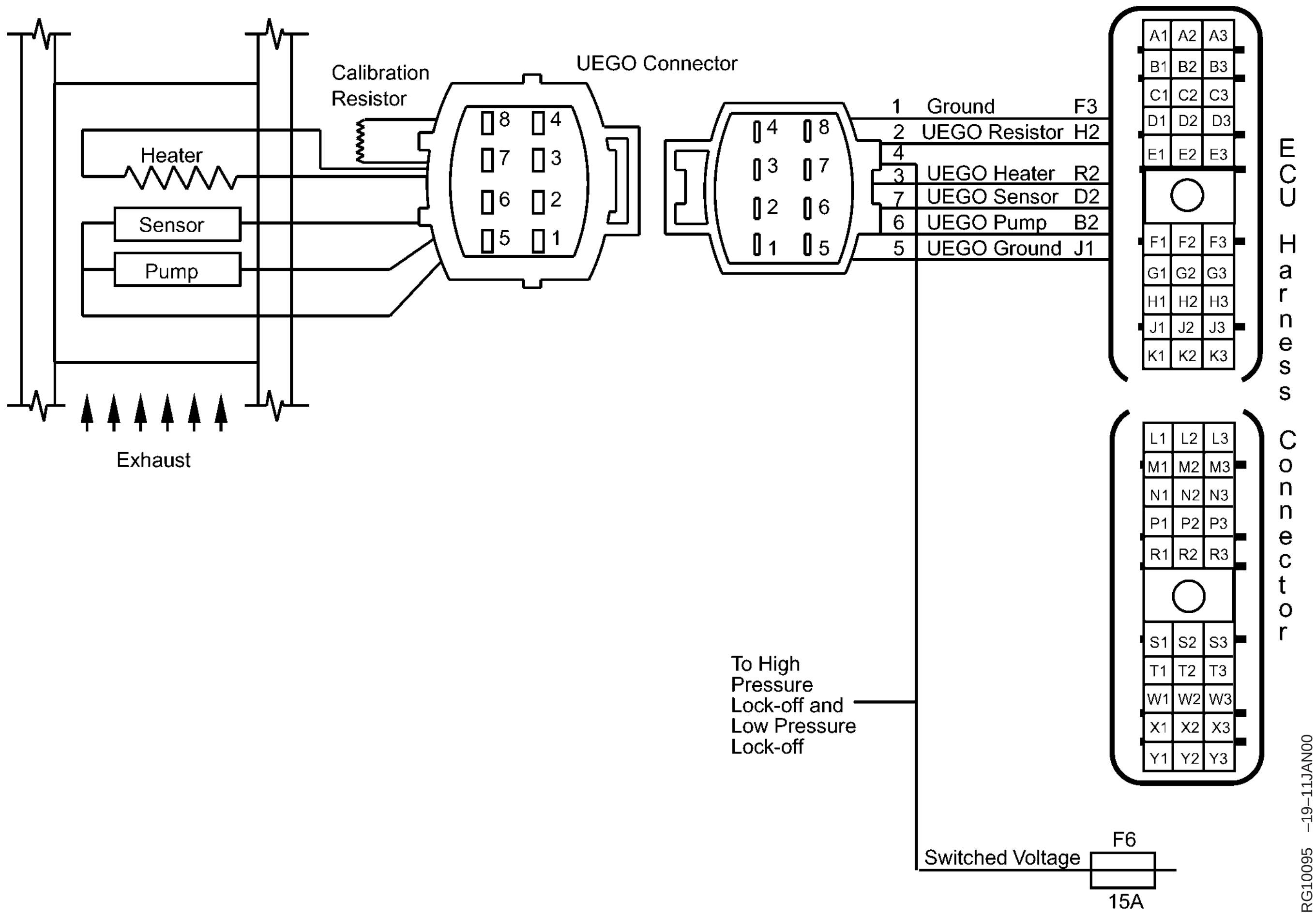
DTC 43 NGP Lower Than Expected - Continued



RG10160 –19–16AUG00

DPSG,RG40854,118 –19–10JUN99–1/1

DTC 44 Closed Loop Multiplier Limit High



Continued on next page RG,RG34710,3134 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

Closed Loop Multiplier

When the system is operating in closed loop, the UEGO sensor is used to determine the air/fuel ratio. When a lean condition is measured, the ECU will increase the amount of fuel delivered; when a rich condition is measured, the ECU will decrease the amount of fuel delivered. The closed loop multiplier is the percent increase or decrease in mass fuel flow that the ECU commanded in order to richen or lean the air/fuel mixture. DTC 44 indicates that the ECU has been measuring a lean exhaust condition, has been increasing the amount of fuel delivered by increasing the closed loop multiplier, and has reached the high limit of normal operation.

DTC 44 will set if:

- The system is operating in closed loop mode
- **AND** the closed loop multiplier exceeds 35% when MAP is ABOVE atmospheric pressure **OR** exceeds 45% when MAP is BELOW atmospheric pressure.

If DTC 44 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

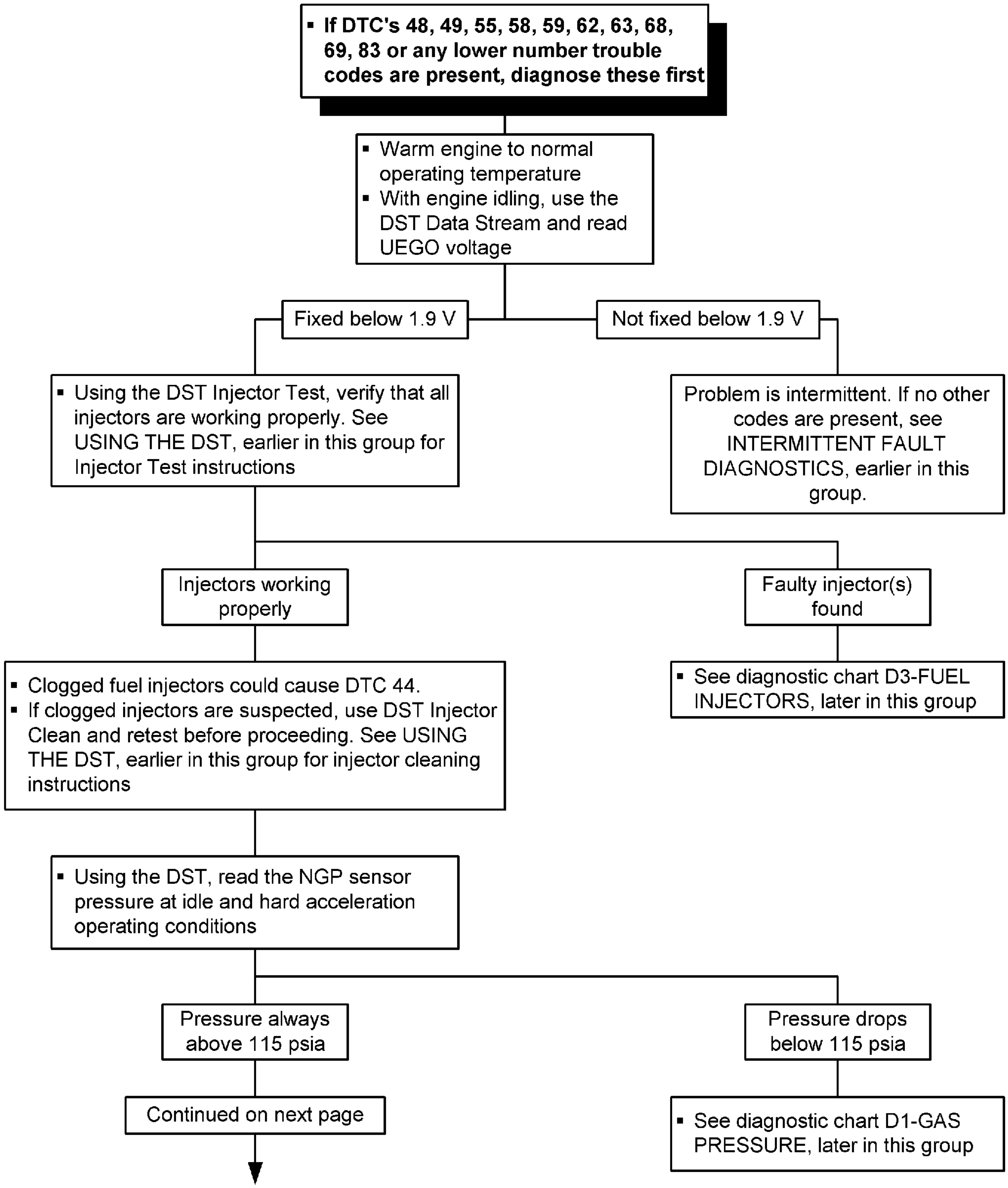
Possible Failures

- **Faulty fuel injector(s)** - A lean condition could result if an injector or an injector driver fails. Use the DST Injector Test to determine if injector(s) is faulty.
- **Clogged injectors** - Injectors that are partially clogged could cause a lean condition. Use the DST Injector Clean, then retest.
- **Inadequate gas pressure** - A lean condition could result if there isn’t adequate gas pressure at the injectors. See Gas Pressure diagnostic chart.
- **Large intake manifold air leak** - An intake manifold air leak could cause the system to be lean under light load conditions because air will be drawn in through the leak. Determine if there is an intake manifold air leak, if there is repair it and retest.
- **Exhaust leak** - If there is an exhaust leak near the UEGO sensor; under certain conditions, fresh air could be drawn across the UEGO sensor causing a false lean condition. Determine if there is an exhaust leak, if there is repair it and retest.
- **Faulty UEGO sensor** - A faulty UEGO sensor could send the ECU a faulty lean condition. If no other problems are found, replace the UEGO sensor and retest.

RG,RG34710,3134 –19–15JUL96–2/2

DTC 44 Closed Loop Multiplier Limit High - Continued

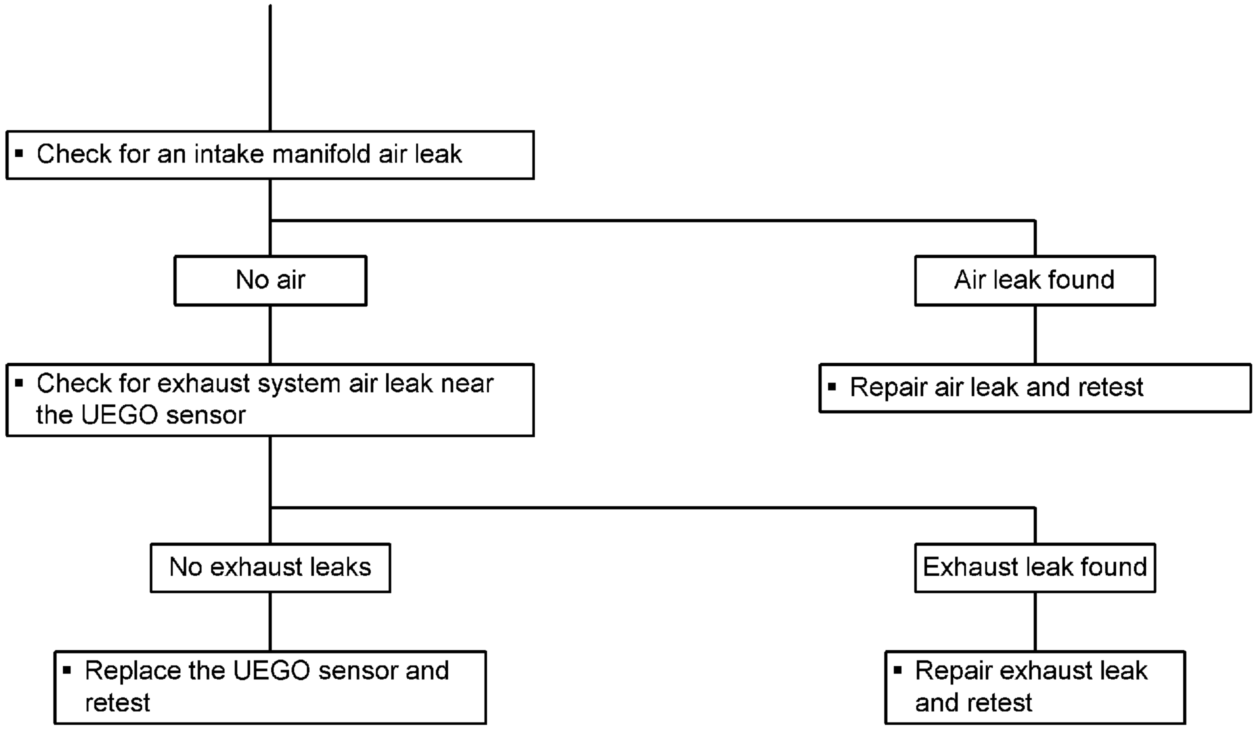
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10161 –19–16AUG00

DPSG,RG40854,119 –19–10JUN99–1/1

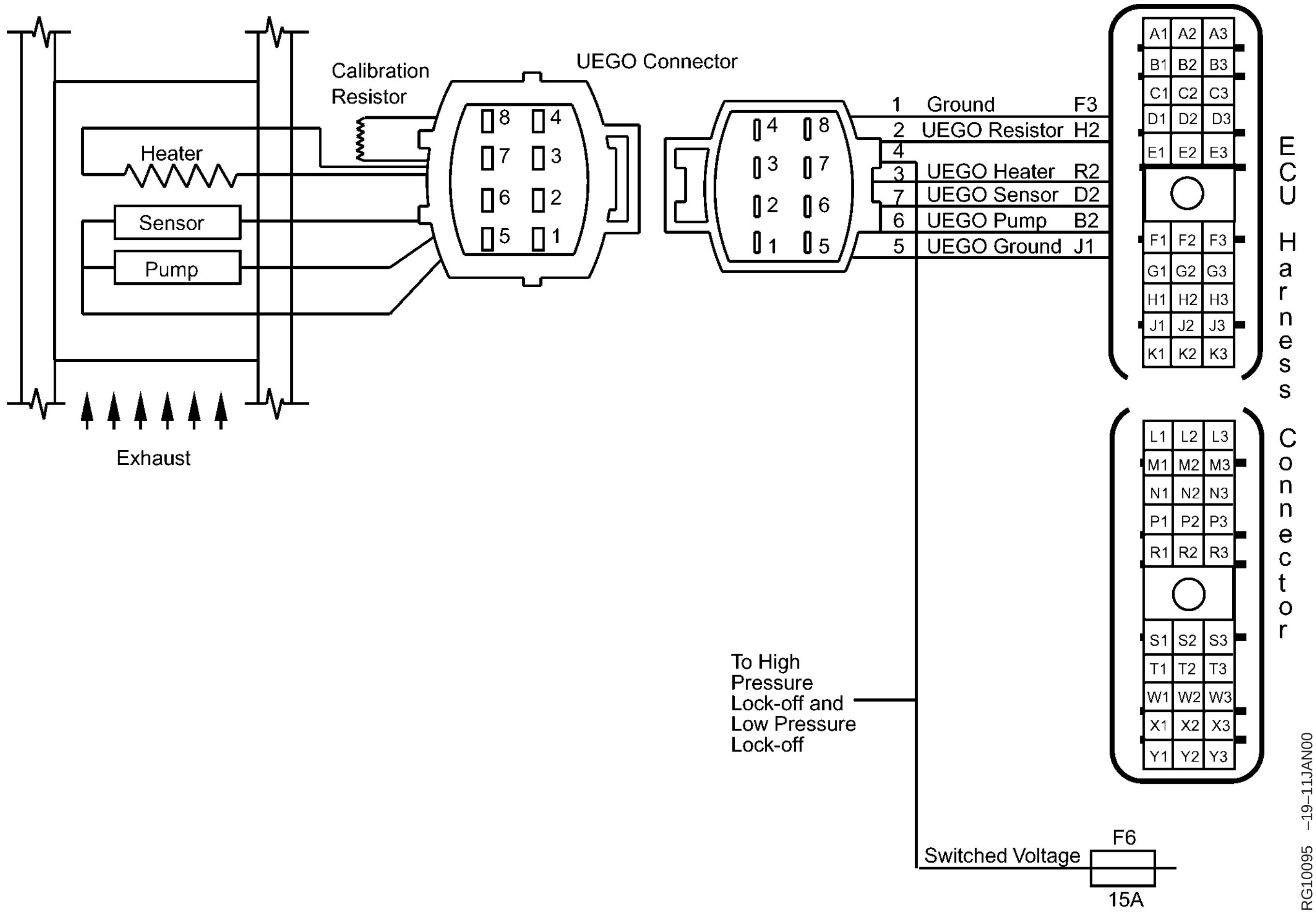
DTC 44 Closed Loop Multiplier Limit High - Continued



RG10162 –19–16AUG00

DPSG,RG40854,120 –19–10JUN99–1/1

DTC 45 Closed Loop Multiplier Limit Low



Continued on next page RG,RG34710,3137 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

Closed Loop Multiplier

When the system is operating in closed loop, the UEGO sensor is used to determine the air/fuel ratio. When a lean condition is measured, the ECU will increase the amount of fuel delivered; when a rich condition is measured, the ECU will decrease the amount of fuel delivered. The closed loop multiplier is the percent increase or decrease in mass fuel flow that the ECU commanded in order to richen or lean the air/fuel mixture. DTC 45 indicates that the ECU has been measuring a rich exhaust condition, has been trying to decrease the amount of fuel delivered by decreasing the closed loop multiplier, and has reached the high limit of normal operation.

DTC 45 will set if:

- The system is operating in closed loop mode
- **AND** the closed loop multiplier drops below -35% when MAP is ABOVE atmospheric pressure **OR** drops below -45% when MAP is BELOW atmospheric pressure.

If DTC 45 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- Closed loop disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

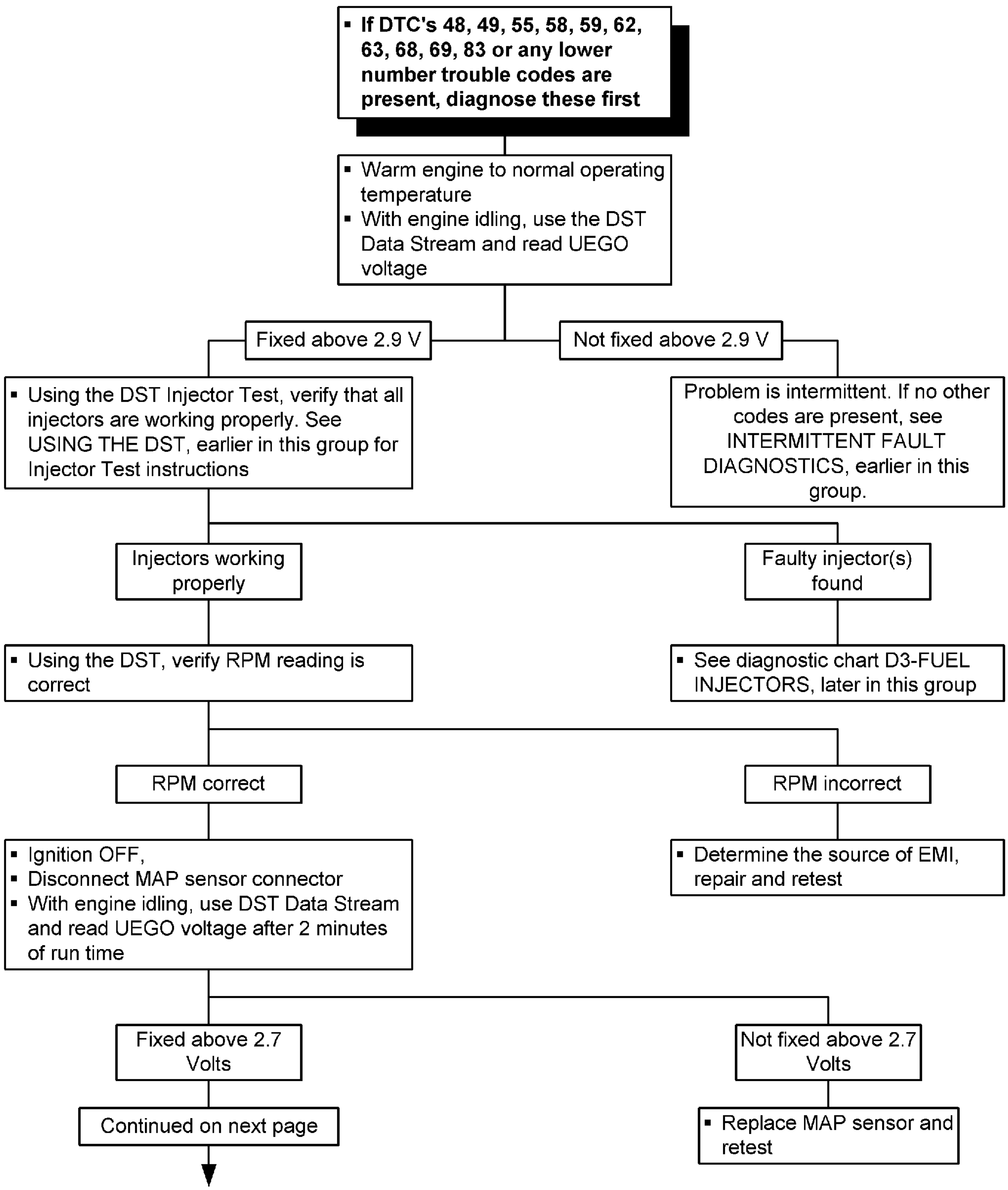
Possible Failures

- **Faulty fuel injector(s)** - A rich condition could result if an injector fails stuck open. Use the DST Injector Test to determine if the fuel injectors are all functioning properly.
- **EMI (electromagnetic interference)** - An open ground circuit in the ignition system, a faulty cam position sensor, or a faulty ECU ground circuit can cause EMI.
  The ECU could mistake EMI as ignition pulses causing the sensed RPM to be higher than actual engine speed. In this case the ECU will deliver too much fuel, causing the rich condition. Using the DST, verify that the engine speed is correct.
- **Faulty MAP sensor** - A faulty MAP sensor that reads higher than actual manifold pressure will cause the ECU to deliver too much fuel, causing a rich condition. Disconnect the MAP sensor and determine if the rich condition goes away. If it does replace the MAP sensor.
- **Faulty TP sensor** - A faulty TPS that reads more than actual throttle opening will cause the ECU to deliver too much fuel which will cause a rich condition. Determine if TPS is working properly using the DST Throttle Test.
- **Faulty MAT sensor** - A faulty MAT sensor that reads lower than actual intake air temperature will cause the ECU to deliver too much fuel which will cause a rich condition. Using the DST, determine if the MAT sensor is reading correctly.
- **Faulty UEGO sensor** - A faulty UEGO sensor could send the ECU a faulty rich condition. If no other problems are found, replace the UEGO sensor and retest.

RG,RG34710,3137 –19–15JUL96–2/2

DTC 45 Closed Loop Multiplier Limit Low - Continued

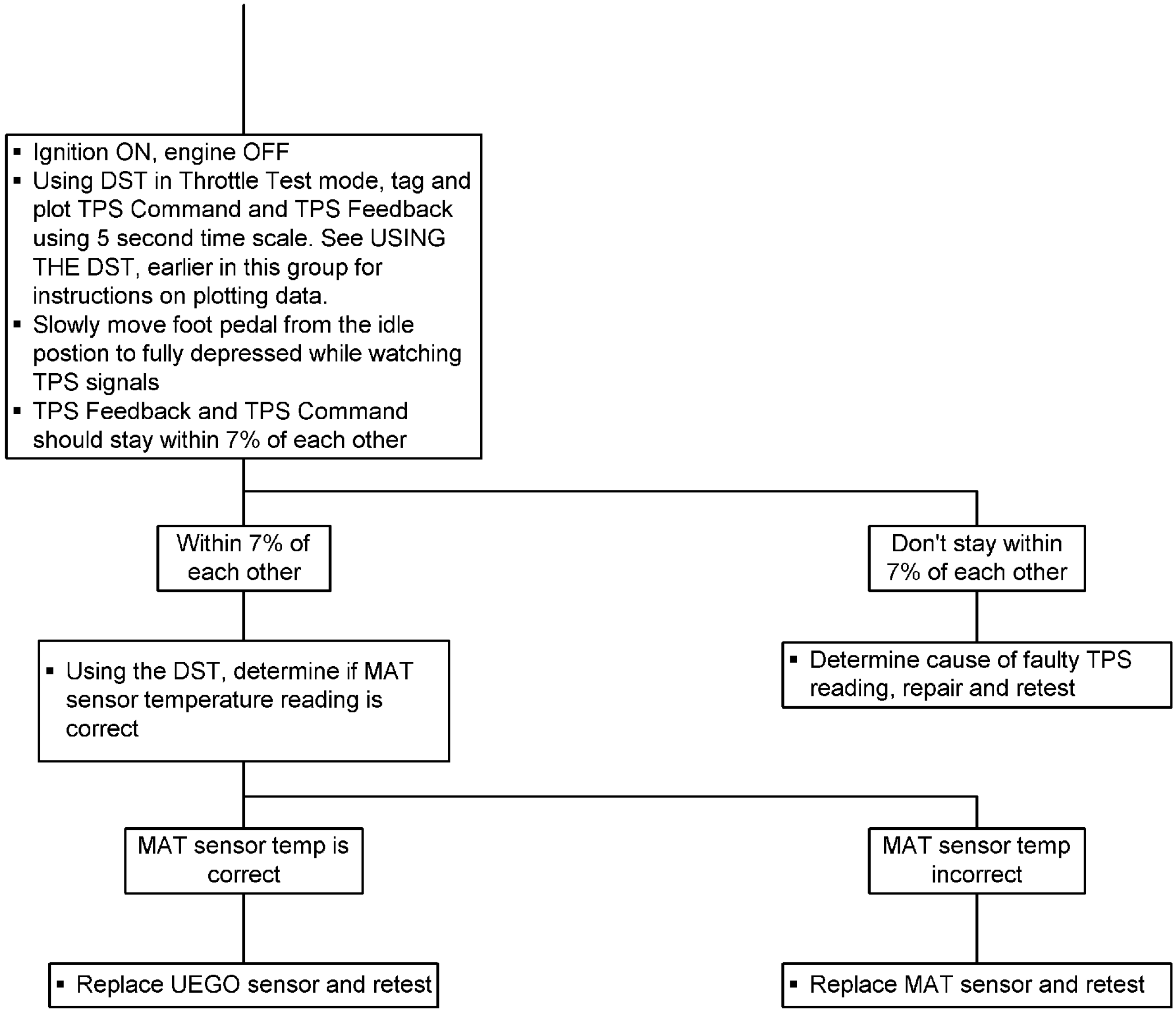
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10163 –19–16AUG00

DPSG,RG40854,121 –19–10JUN99–1/1

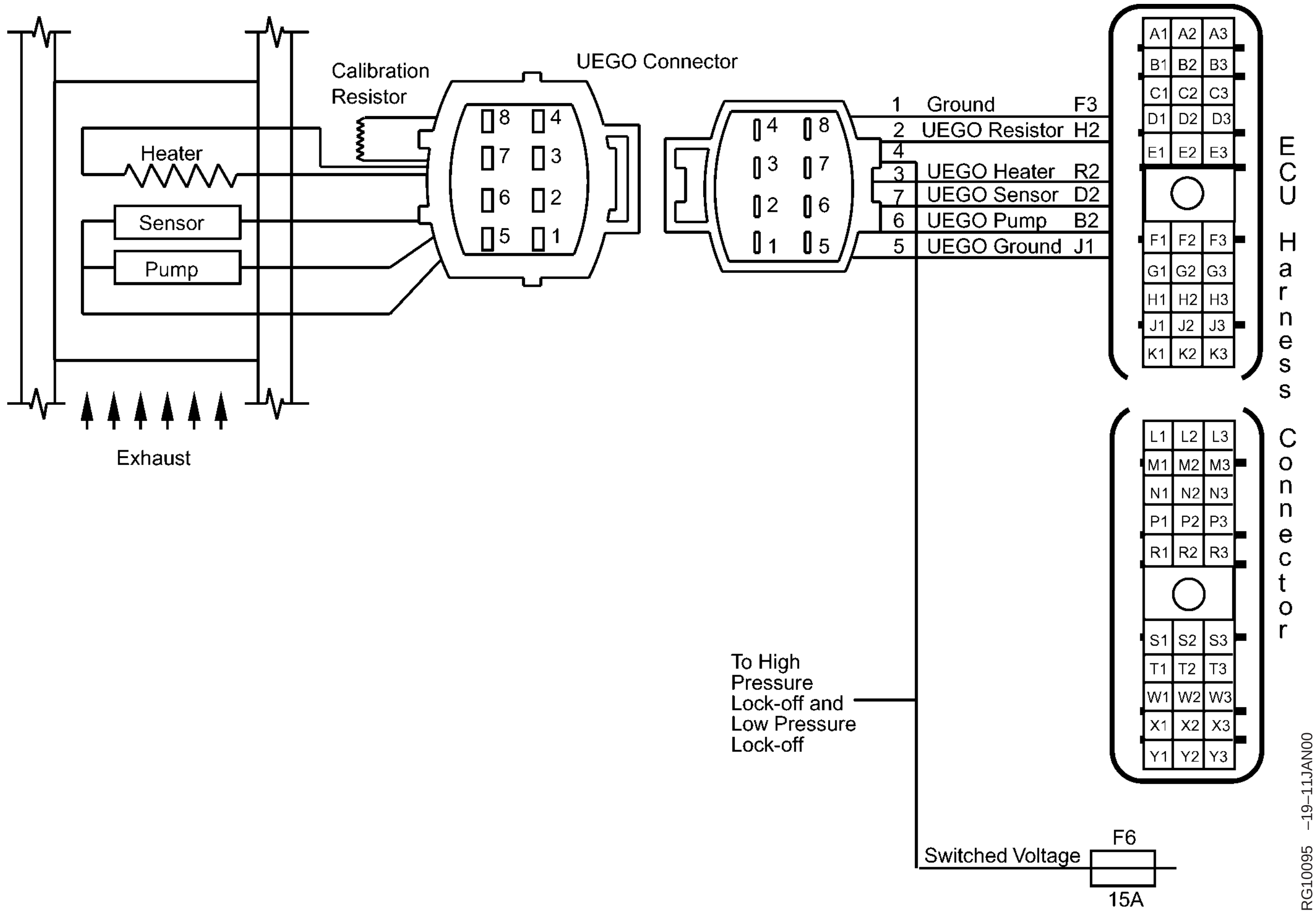
DTC 45 Closed Loop Multiplier Limit Low - Continued



RG10164 –19–16AUG00

DPSG,RG40854,122 –19–10JUN99–1/1

DTC 46 Adaptive Learn Multiplier Limit High



Continued on next page RG,RG34710,3140 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

Adaptive Learn Multiplier High

The adaptive learn acts as a fuel correction memory. Each time the closed loop correction is “successful” in achieving the optimum air/fuel ratio, the adaptive learn “remembers” that fuel correction and uses it in the future. The adaptive learn multiplier is the percent increase or decrease in mass fuel flow that the ECU commanded in order to richen or lean the air/fuel mixture. DTC 46 indicates that over time the ECU has been measuring a lean exhaust condition, has been increasing the amount of fuel delivered by increasing the adaptive learn multiplier, and has reached the high limit of normal operation.

DTC 46 will set if:

The adaptive learn multiplier exceeds 30% when MAP is ABOVE atmospheric pressure **OR** exceeds 40% when MAP is BELOW atmospheric pressure.

If DTC 46 sets, the following will occur:

CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

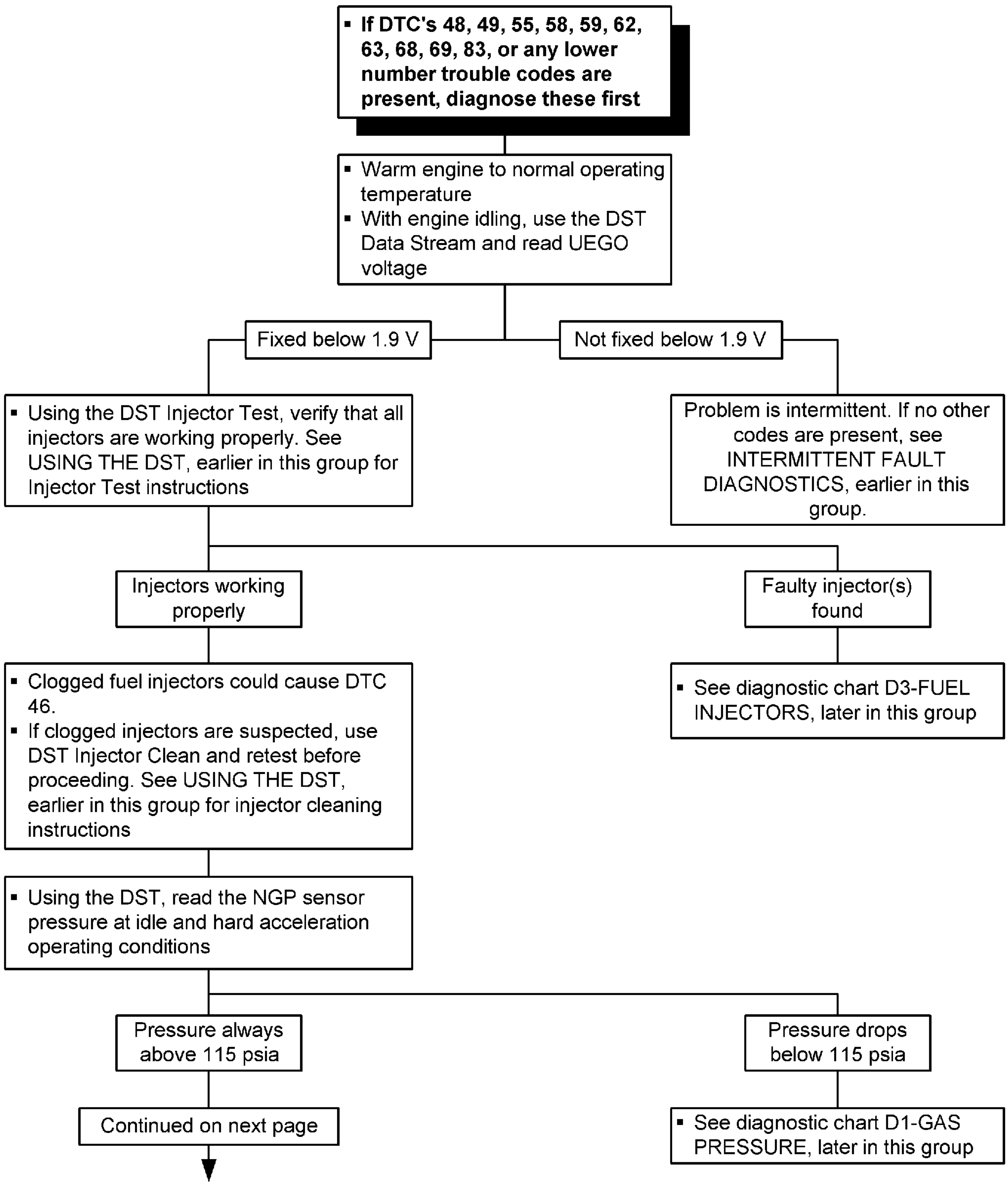
Possible Failures

- **Faulty fuel injector(s)** - A lean condition could result if an injector or an injector driver fails. Use the DST Injector Test to determine if injector(s) is faulty.
- **Clogged injectors** - Injectors that are partially clogged could cause a lean condition. Use the DST Injector Clean, then retest.
- **Inadequate gas pressure** - A lean condition could result if there isn’t adequate gas pressure at the injectors. See Gas Pressure diagnostic chart.
- **Large intake manifold air leak** - An intake manifold air leak could cause the system to be lean under light load conditions because air will be drawn in through the leak. Determine if there is an intake manifold air leak, if there is repair it and retest.
- **Exhaust leak** - If there is an exhaust leak near the UEGO sensor; under certain conditions, fresh air could be drawn across the UEGO sensor causing a false lean condition. Determine if there is an exhaust leak, if there is repair it and retest.
- **Faulty UEGO sensor** - A faulty UEGO sensor could send the ECU a faulty lean condition. If no other problems are found, replace the UEGO sensor and retest.

RG,RG34710,3140 –19–15JUL96–2/2

DTC 46 Adaptive Learn Multiplier Limit High - Continued

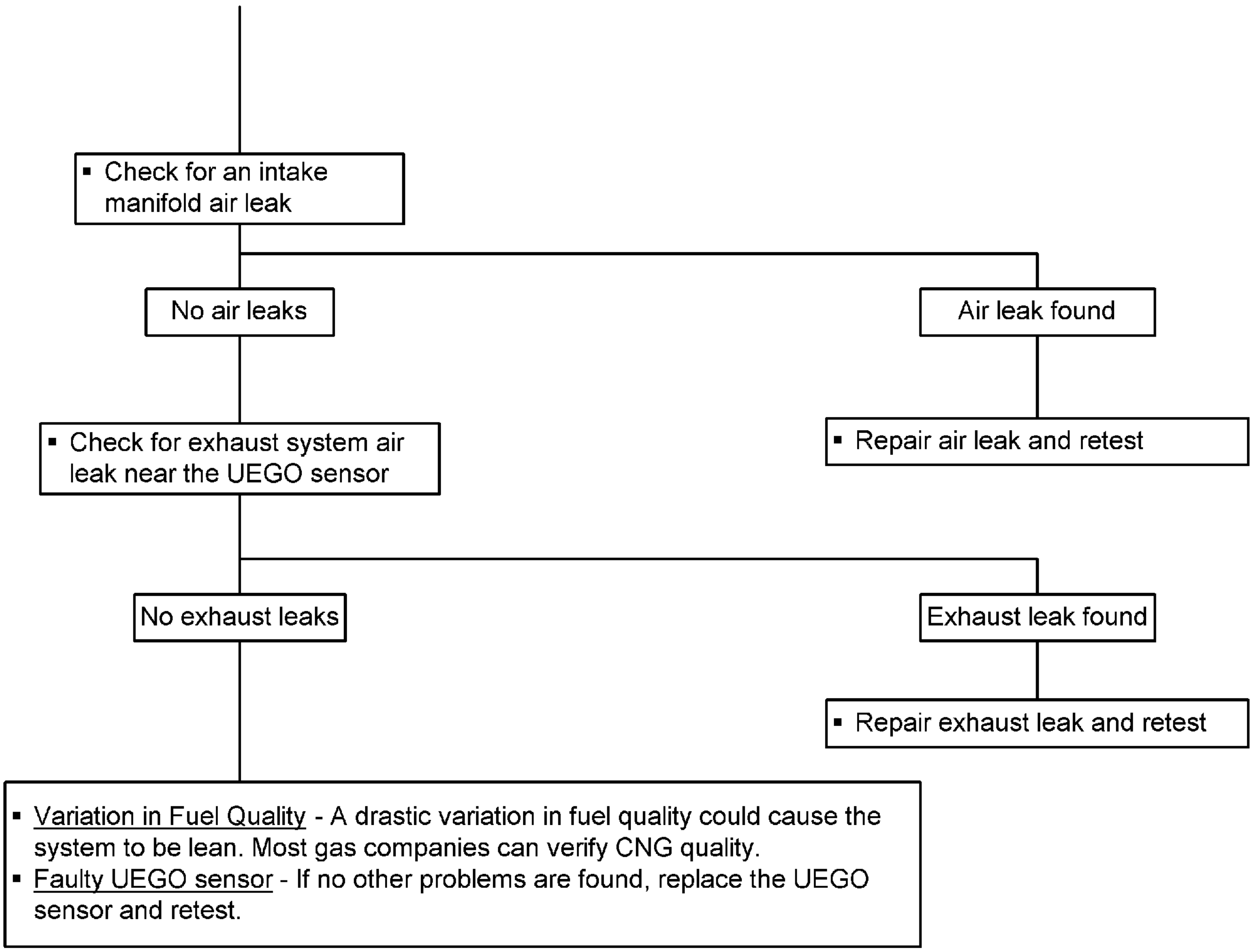
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10165 –19–16AUG00

DPSG,RG40854,123 –19–10JUN99–1/1

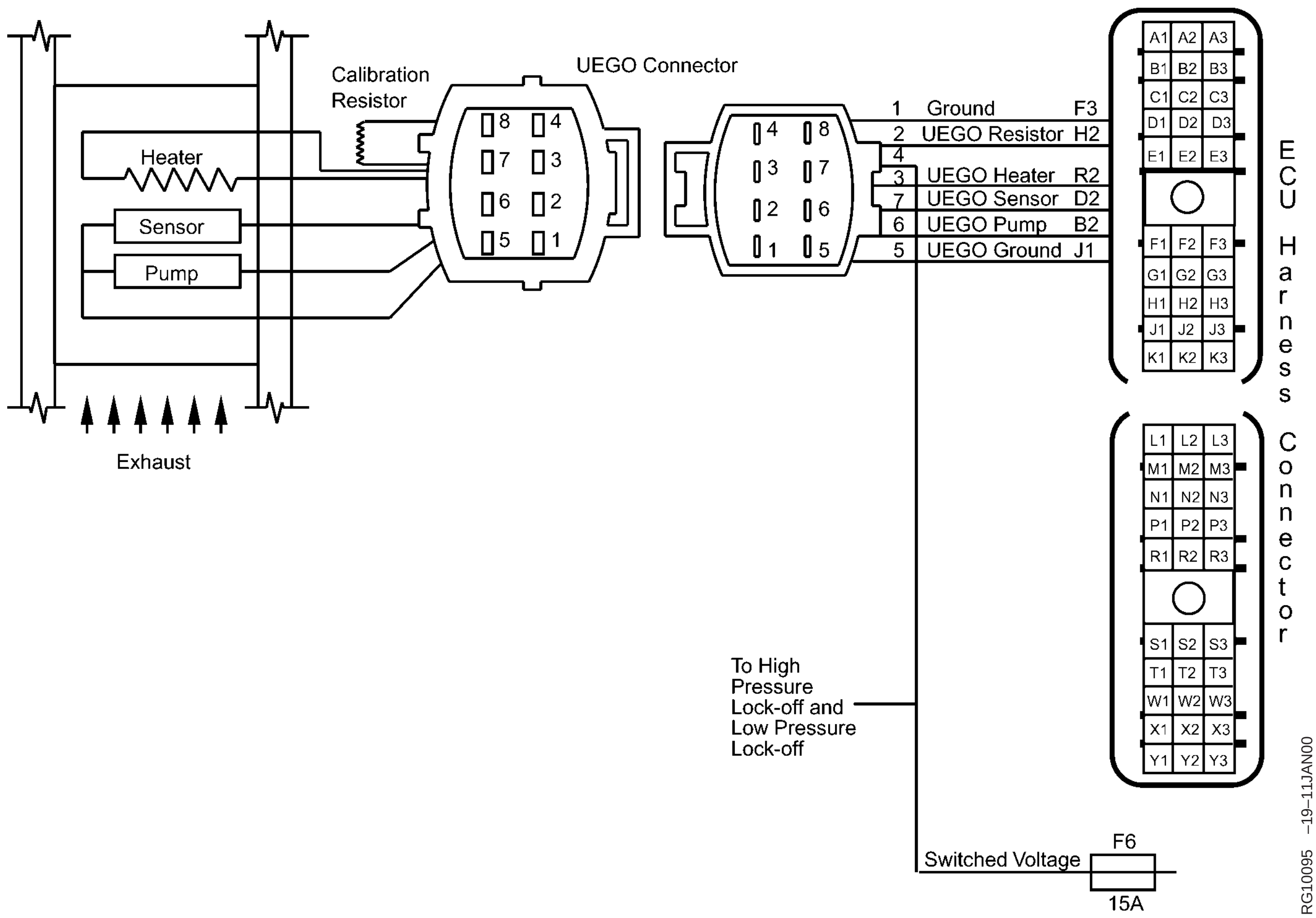
DTC 46 Adaptive Learn Multiplier Limit High - Continued



RG10166 –19–16AUG00

DPSG,RG40854,124 –19–10JUN99–1/1

DTC 47 Adaptive Learn Multiplier Limit Low



Continued on next page

RG,RG34710,3142 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

Adaptive Learn Multiplier High

The adaptive learn acts as a fuel correction memory. Each time the closed loop correction is “successful” in achieving the optimum air/fuel ratio, the adaptive learn “remembers” that fuel correction and uses it in the future. The adaptive learn multiplier is the percent increase or decrease in mass fuel flow that the ECU commanded in order to richen or lean the air/fuel mixture. DTC 47 indicates that over time the ECU has been measuring a rich exhaust condition, has been decreasing the amount of fuel delivered by decreasing the adaptive learn multiplier, and has reached the low limit of normal operation.

DTC 47 will set if:

The adaptive learn multiplier drops below - 30% when MAP is ABOVE atmospheric pressure **OR** drops below -40% when MAP is BELOW atmospheric pressure.

If DTC 47 sets, the following will occur:

CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

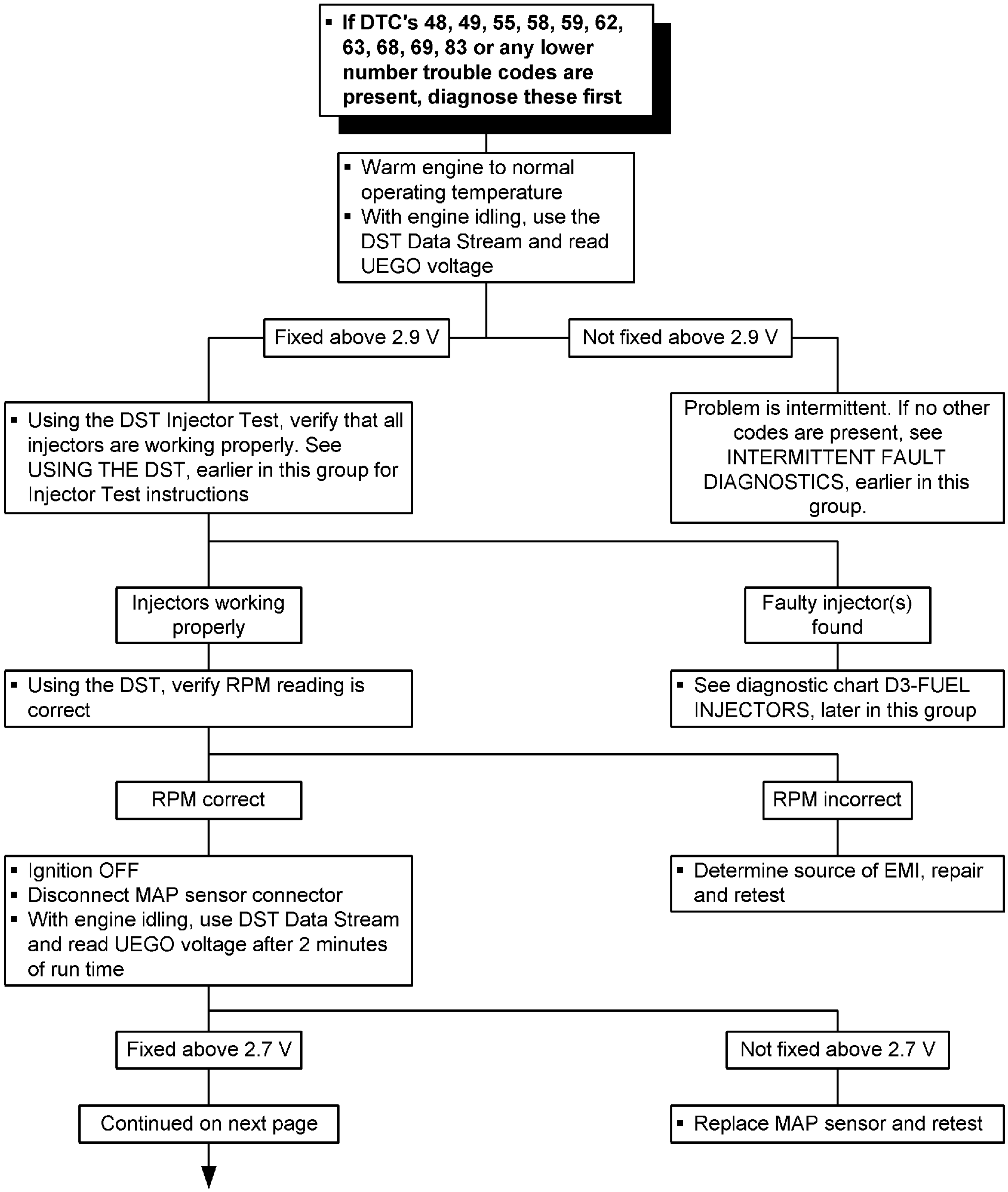
Possible Failures

- **Faulty fuel injector(s)** - A rich condition could result if an injector fails stuck open. Use the DST Injector Test to determine if the fuel injectors are all functioning properly.
- **EMI (electromagnetic interference)** - An open ground circuit in the ignition system, a faulty cam position sensor, or a faulty ECU ground circuit can cause EMI. The ECU could mistake EMI as ignition pulses causing the sensed RPM to be higher than actual engine speed. In this case the ECU will deliver too much fuel, causing the rich condition. Using the DST, verify that the engine speed is correct.
- **Faulty MAP sensor -** A faulty MAP sensor that reads higher than actual manifold pressure will cause the ECU to deliver too much fuel, causing a rich condition. Disconnect the MAP sensor and determine if the rich condition goes away. If it does replace the MAP sensor.
- **Faulty TP sensor -** A faulty TPS that reads more than actual throttle opening will cause the ECU to deliver too much fuel which will cause a rich condition. Determine if TPS is working properly using the DST Throttle Test.
- **Faulty MAT sensor -** A faulty MAT sensor that reads lower than actual intake air temperature will cause the ECU to deliver too much fuel which will cause a rich condition. Using the DST, determine if the MAT sensor is reading correctly.
- **Faulty UEGO sensor** - A faulty UEGO sensor could send the ECU a faulty rich condition. If no other problems are found, replace the UEGO sensor and retest.

RG,RG34710,3142 –19–15JUL96–2/2

DTC 47 Adaptive Learn Multiplier Limit Low - Continued

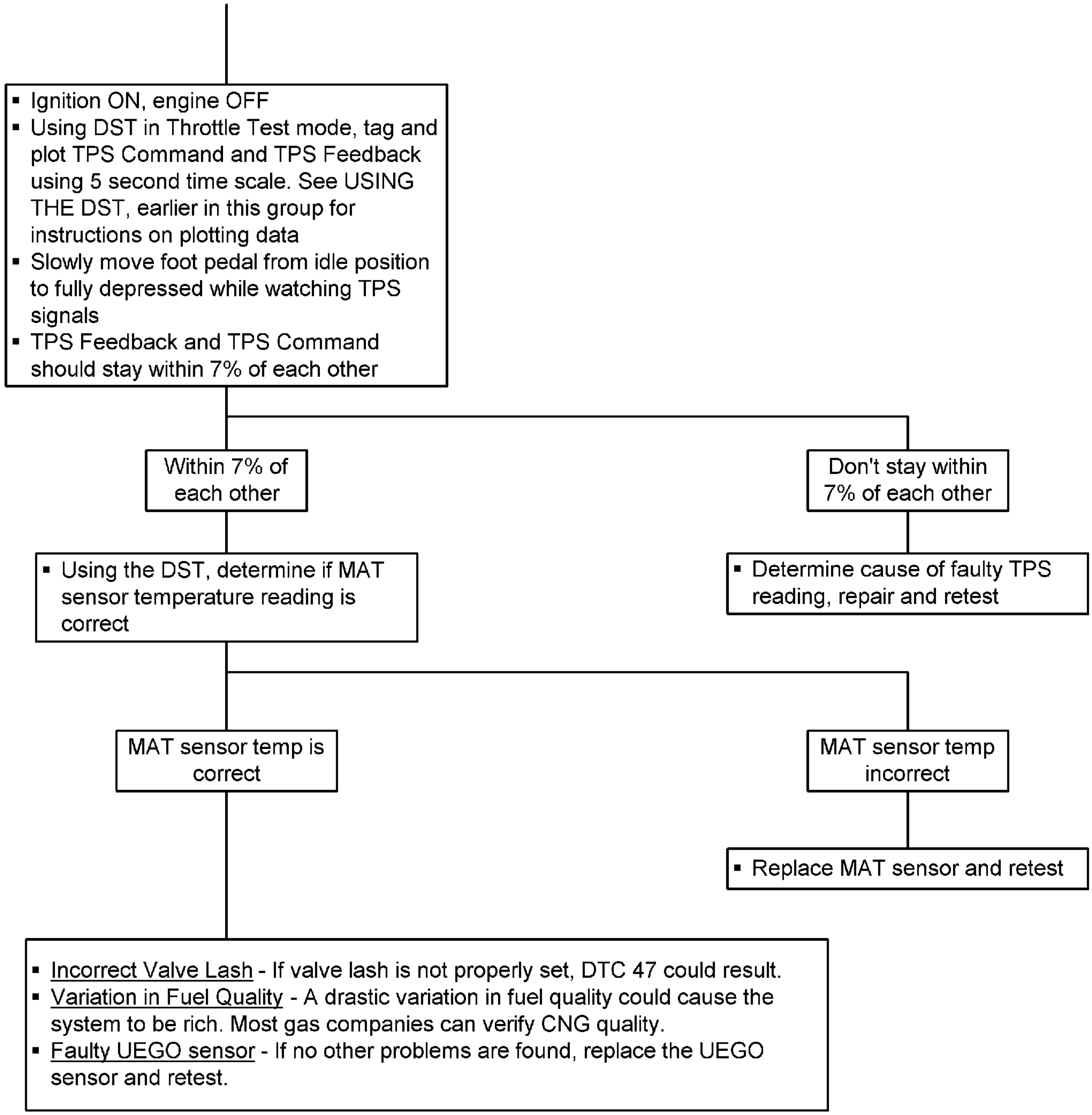
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10167 –19–16AUG00

DPSG,RG40854,125 –19–10JUN99–1/1

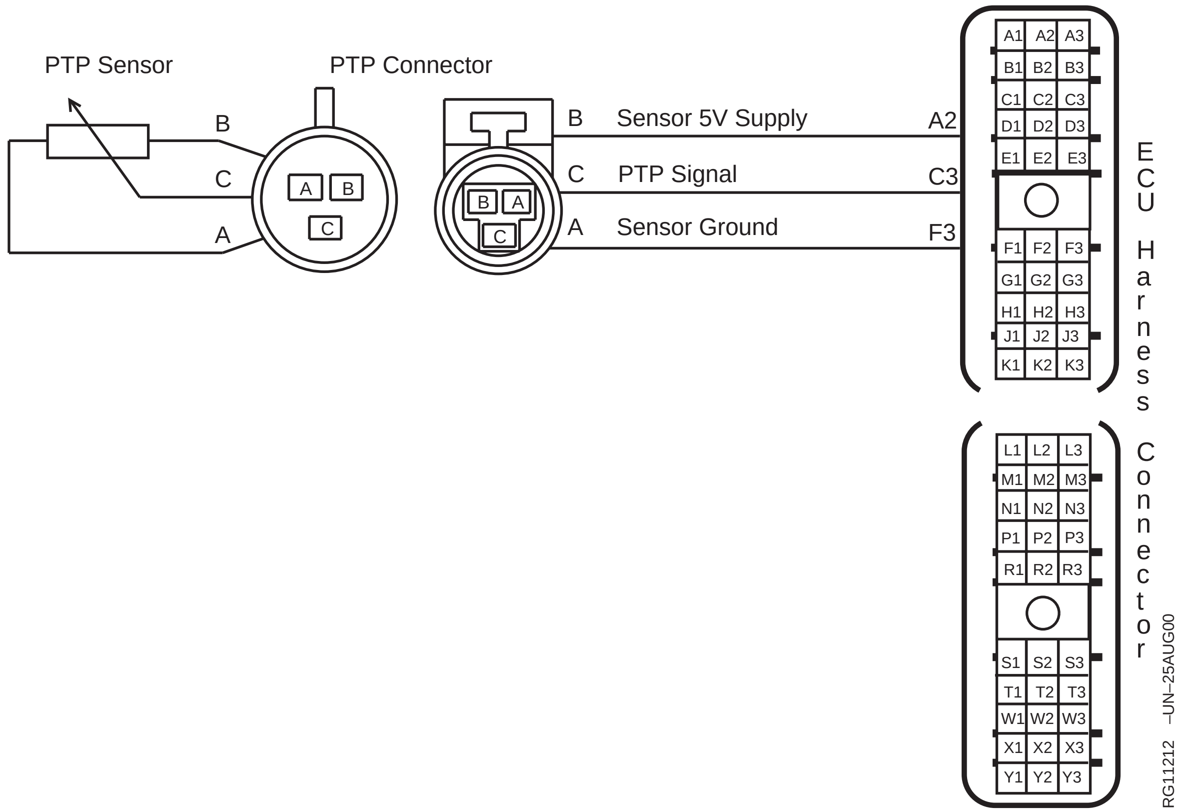
DTC 47 Adaptive Learn Multiplier Limit Low - Continued



RG10168 –19–16AUG00

DPSG,RG40854,126 –19–10JUN99–1/1

DTC 48 PTP Voltage Low



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	B	55A Lt. Green	Lt. Green/Red	Sensor 5V Supply
C3	C	10 Lt. Blue	Lt. Blue/Dk. Blue	PTP Signal
F3	A	21F Black	Black/Lt. Green	Sensor Ground

PTP - Pre-Turbine Pressure sensor

The PTP sensor is a pressure transducer connected to exhaust manifold pressure. It is used to measure the pressure in the exhaust manifold in front of the turbocharger. The PTP signal voltage varies as pressure in the exhaust manifold varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the PTP sensor signal:

- In conjunction with several other sensors to determine engine airflow
- To enhance turbocharger wastegate control

DTC 48 will set if:

The PTP voltage drops below 0.1 volts anytime the engine is cranking or running

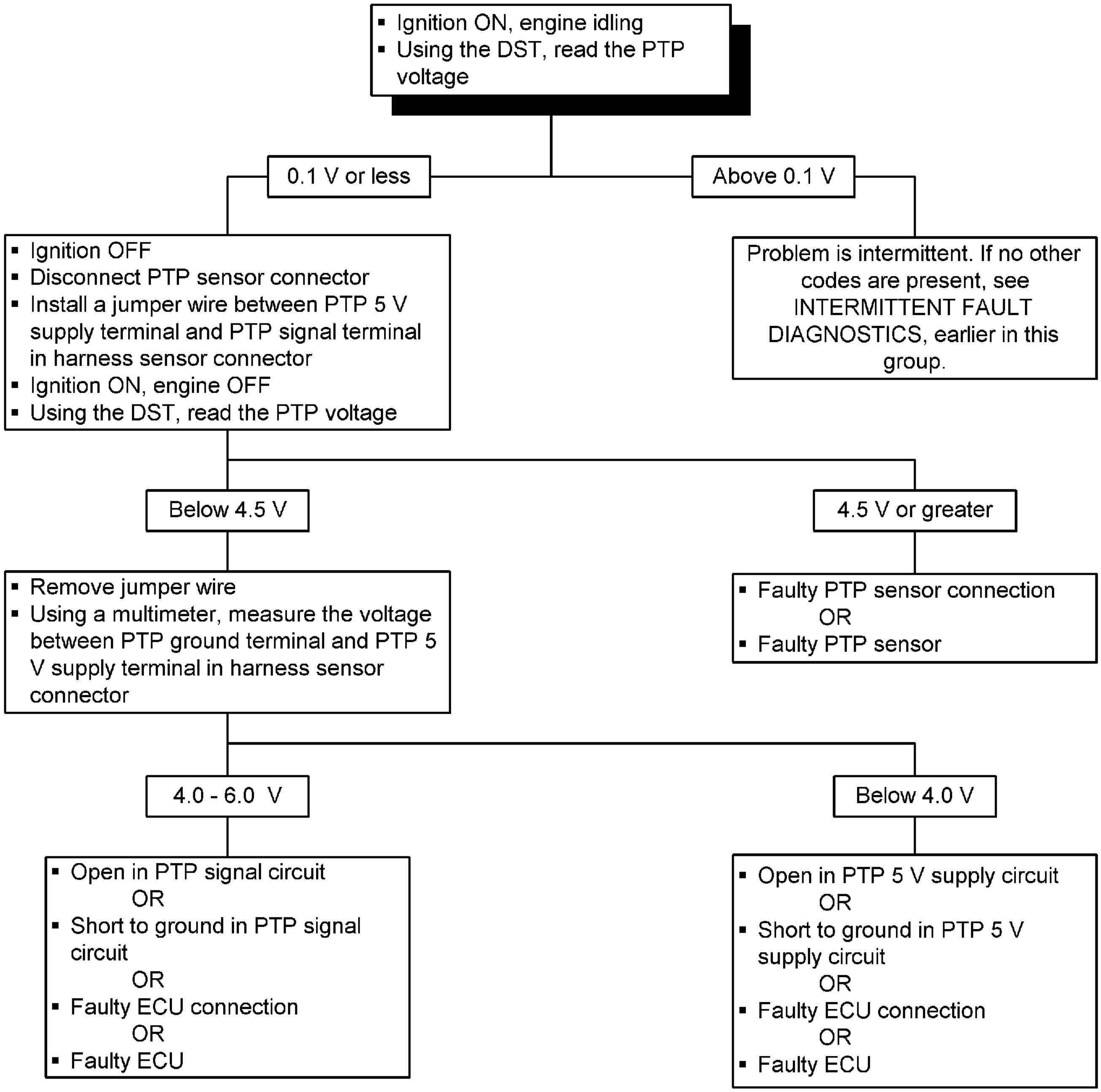
If DTC 48 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- ECU will use default “limp home” PTP value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3145 –19–15JUL96–1/1

DTC 48 PTP Voltage Low - Continued

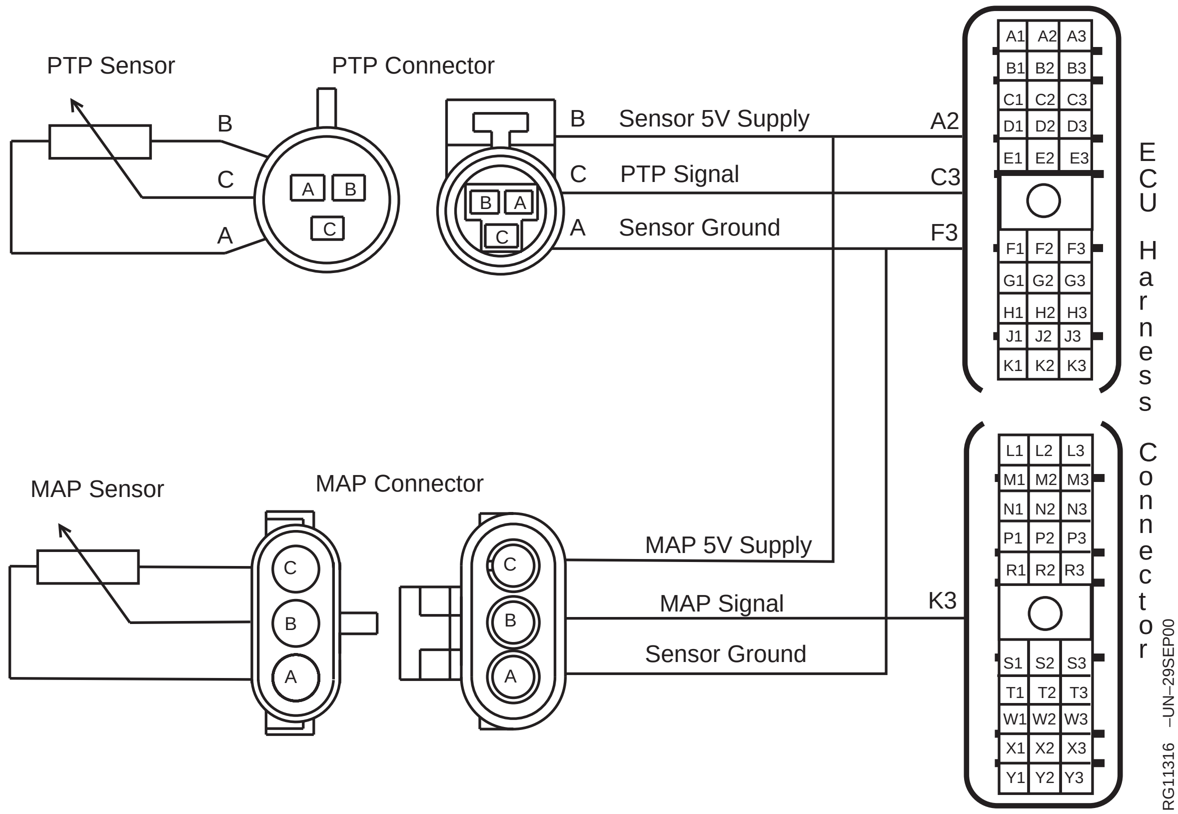
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Pre-Turbine Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10169 –19–16AUG00

DPSG,RG40854,127 –19–10JUN99–1/1

DTC 49 PTP Not Active



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	B	55A Lt. Green	Lt. Green/Red	Sensor 5V Supply
C3	C	10 Lt. Blue	Lt. Blue/Dk. Blue	PTP Signal
F3	A	21F Black	Black/Lt. Green	Sensor Ground

PTP - Pre-Turbine Pressure sensor

The PTP sensor is a pressure transducer connected to exhaust manifold pressure. It is used to measure the pressure in the exhaust manifold in front of the turbocharger. The PTP signal voltage varies as pressure in the exhaust manifold varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the PTP sensor signal:

- In conjunction with several other sensors to determine engine airflow
- To enhance turbocharger wastegate control

DTC 49 will set if:

- MAP reads greater than 28 psia
- **AND** PTP voltage drops below 1.8 volts anytime the engine is running or cranking.

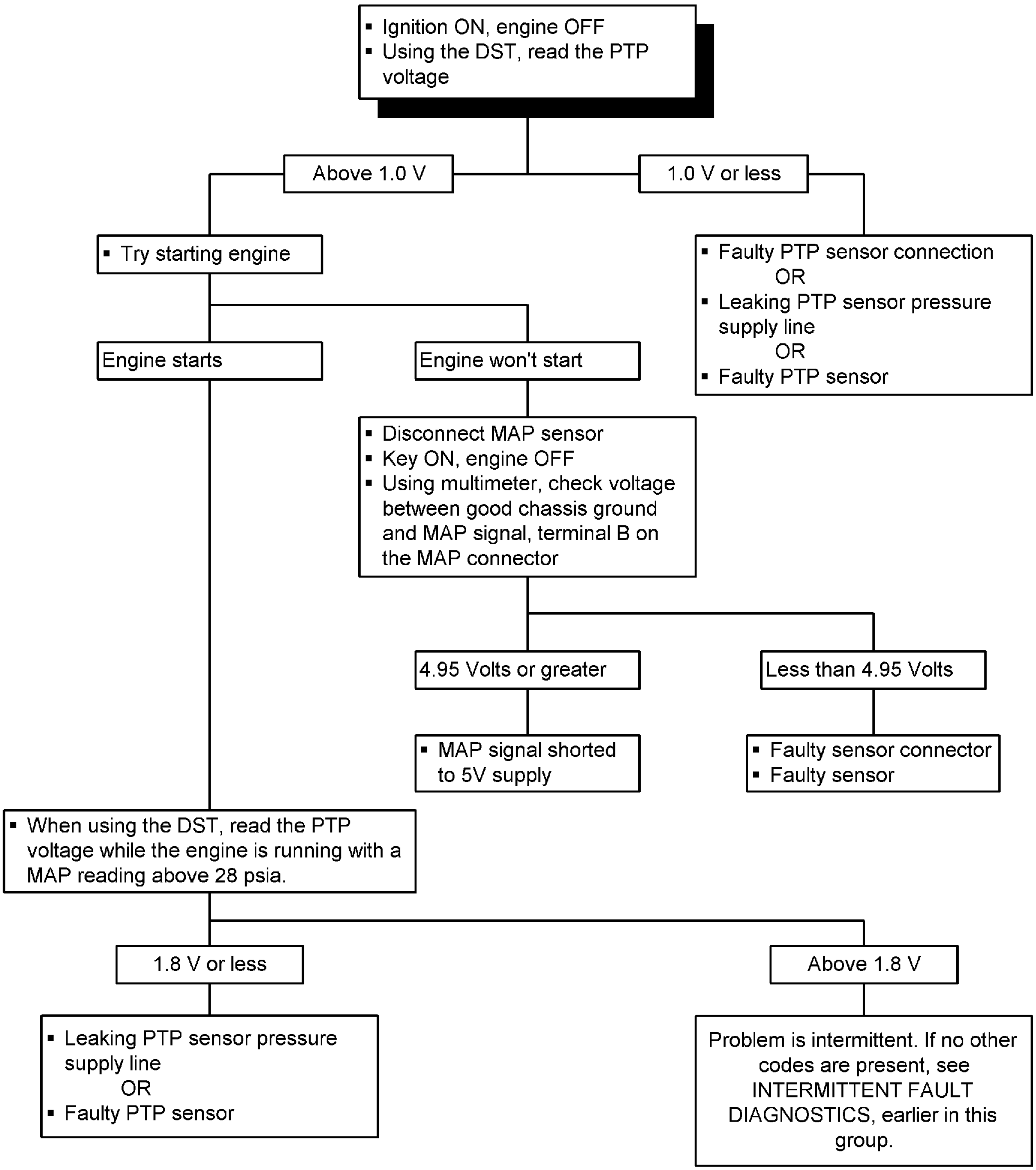
If DTC 49 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3147 –19–15JUL96–1/1

DTC 49 PTP Not Active - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Pre-Turbine Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10170 –19–31AUG00

DPSG,RG40854,128 –19–10JUN99–1/1

DTC 51 RAM Error

RAM - Random Access Memory

RAM is memory located within the ECU and can be read from or written to at anytime. DTCs and the adaptive learn multiplier table are stored in RAM. This code will not self erase, it must be erased using the DST or by removing power to the ECU

DTC 51 will set if:

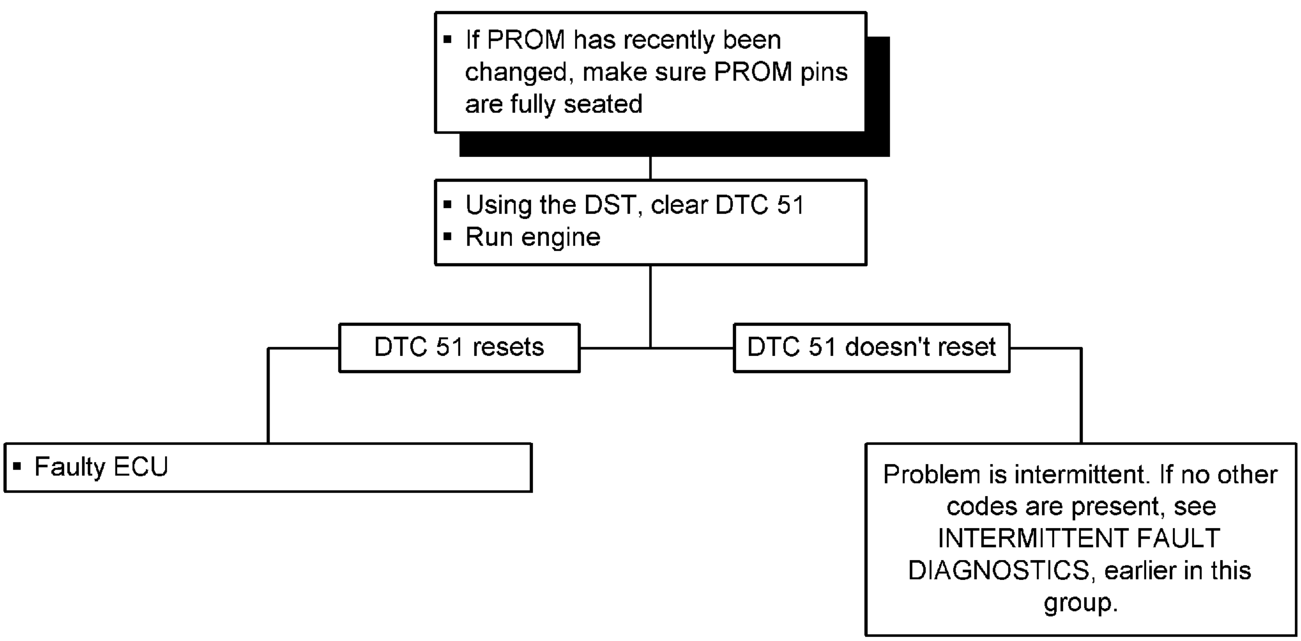
The ECU detects an internal problem with RAM

If DTC 51 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle and reset to zero
- Boost limited to 10 psig maximum
- CEL turned on and stays on until code is cleared using a DST or by removing battery power to the ECU

RG,RG34710,3149 –19–15JUL96–1/1

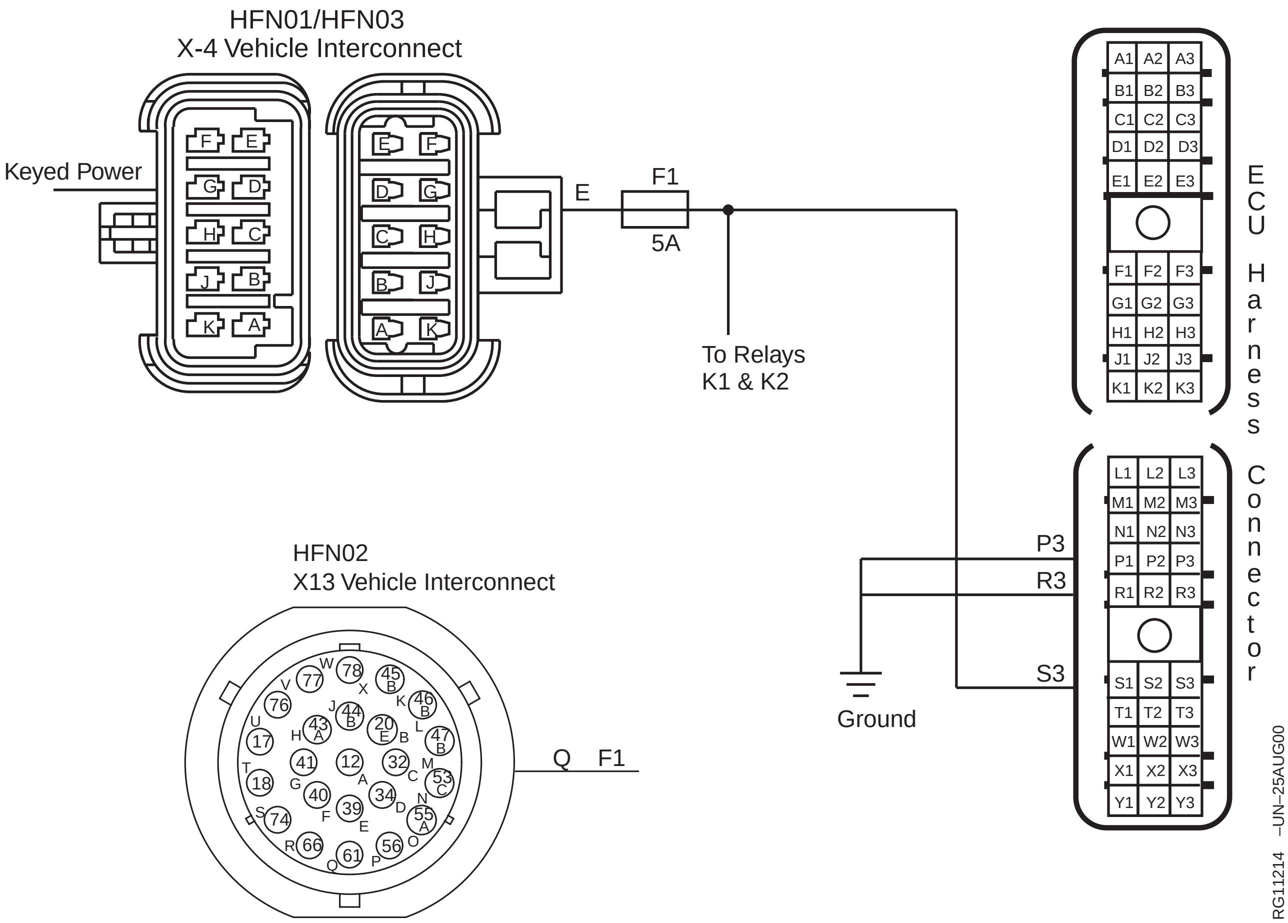
DTC 51 RAM Error - Continued



RG10171 –19–16AUG00

DPSG,RG40854,129 –19–10JUN99–1/1

DTC 52 Battery Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
P3	N.A.	52 White	White	Ground
R3	N.A.	51 White	White	Ground
S3	E (X-4 V.I.) (Q)	48 Pink	Pink/Tan	Keyed Power and Relays

System voltage to ECU

Battery voltage powers the ECU and is measured so that the ECU can compensate for variations in battery voltage as it controls the output device drivers. The adaptive learn multiplier is disabled when this fault is active due to the inability of the ECU to correctly time fuel injector opening

DTC 52 will set if:

- Engine speed greater than 1200 RPM
- **AND** the ECU detects a voltage less than 9.5 volts for 1.5 seconds on the ECU switched voltage wire

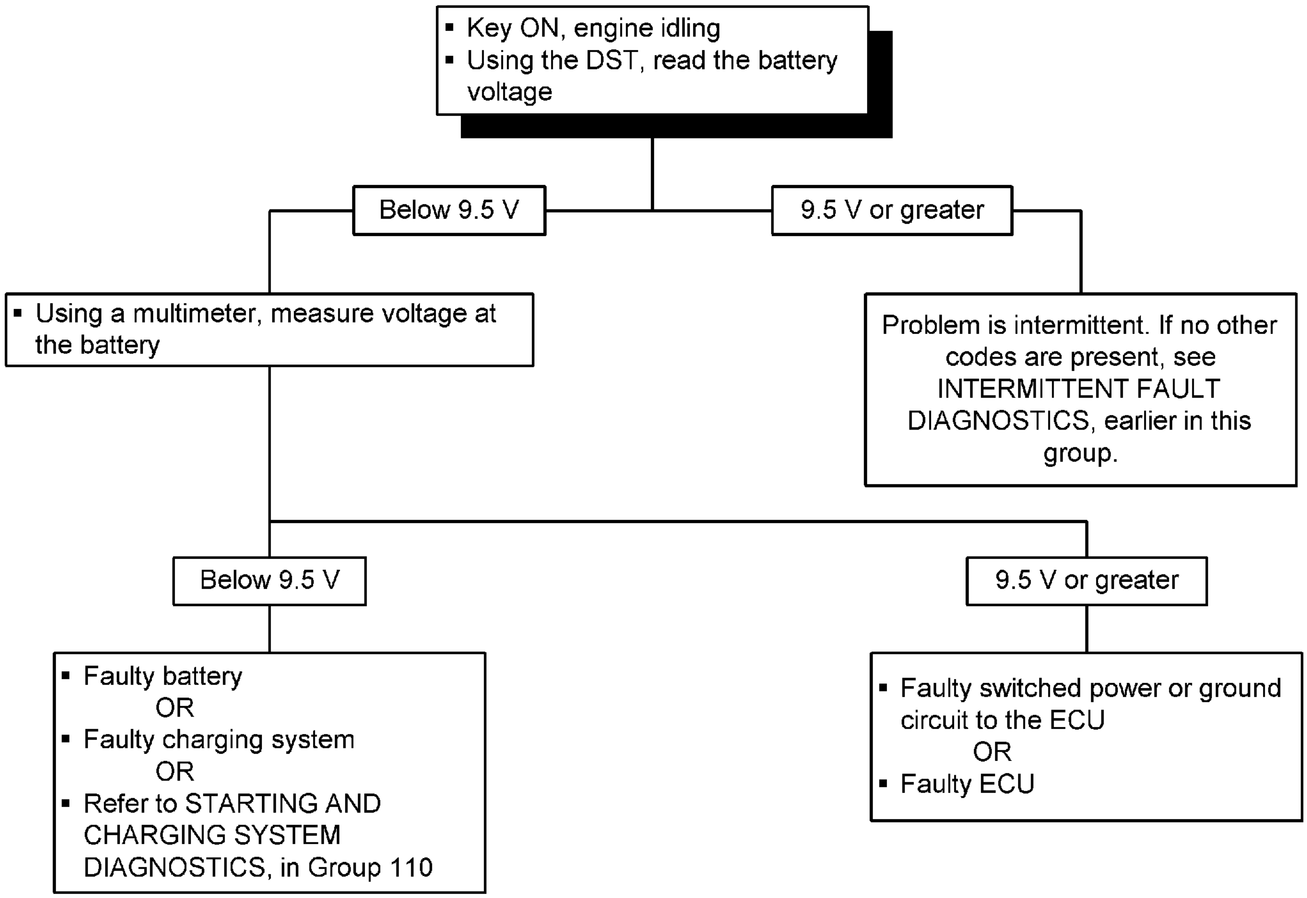
If DTC 52 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3151 –19–15JUL96–1/1

DTC 52 Battery Voltage Low - Continued

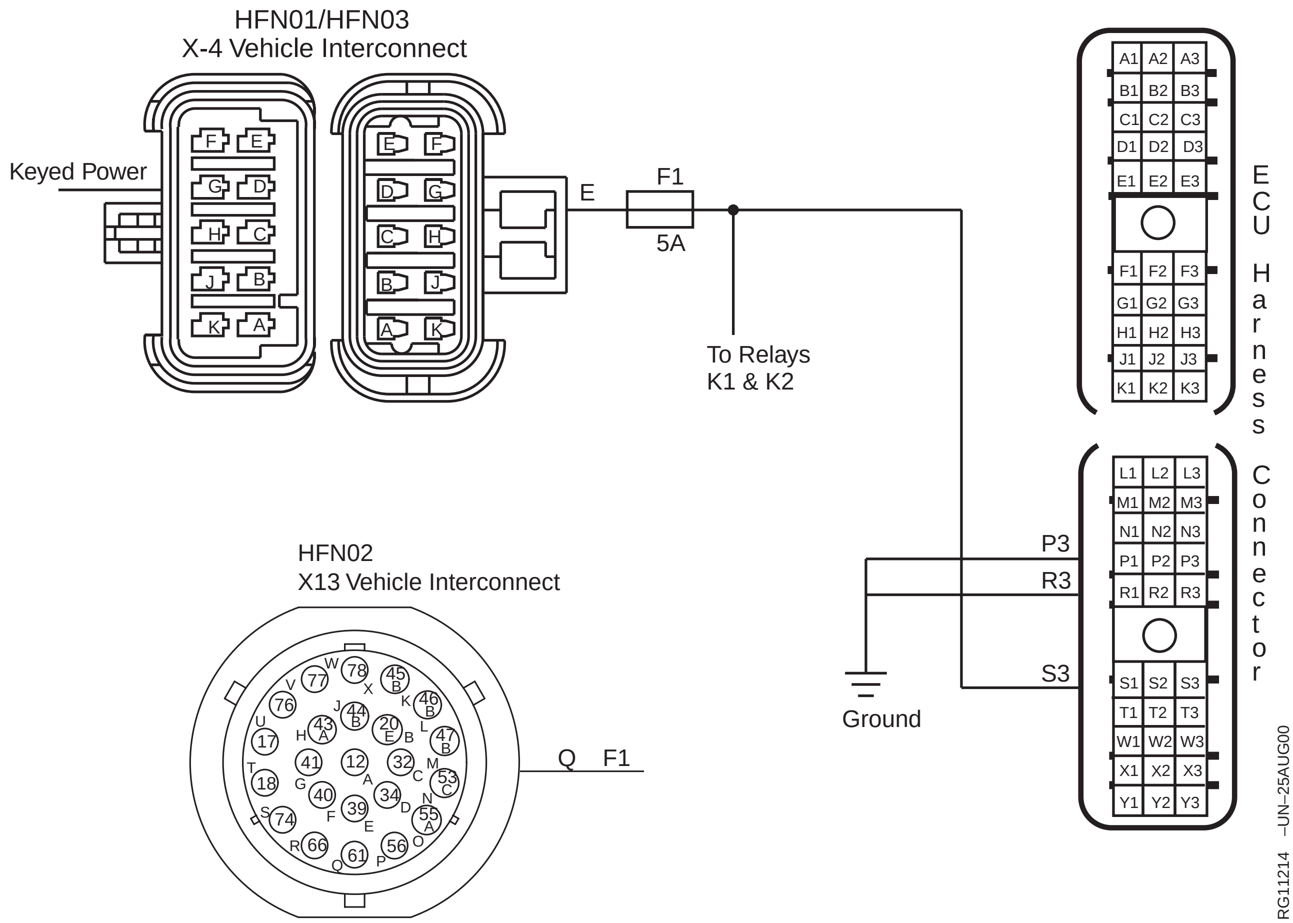
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10172 –19–16AUG00

DPSG,RG40854,130 –19–10JUN99–1/1

DTC 53 Battery Voltage High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
P3	N.A.	52 White	White	Ground
R3	N.A.	51 White	White	Ground
S3	E (X-4 V.I.) (Q)	48 Pink	Pink/Tan	Keyed Power and Relays

System voltage to ECU

Battery voltage powers the ECU and is measured so that the ECU can compensate for variations in battery voltage as it controls the output device drivers. The adaptive learn multiplier is disabled when this fault is active due to the inability of the ECU to correctly time fuel injector opening. Extended periods of operation with a system voltage above 17 volts can damage system components

DTC 53 will set if:

The ECU detects a voltage greater than 17.1 volts for 1.5 seconds on the ECU switched voltage wire anytime the engine is cranking or running

If DTC 53 sets, the following will occur:

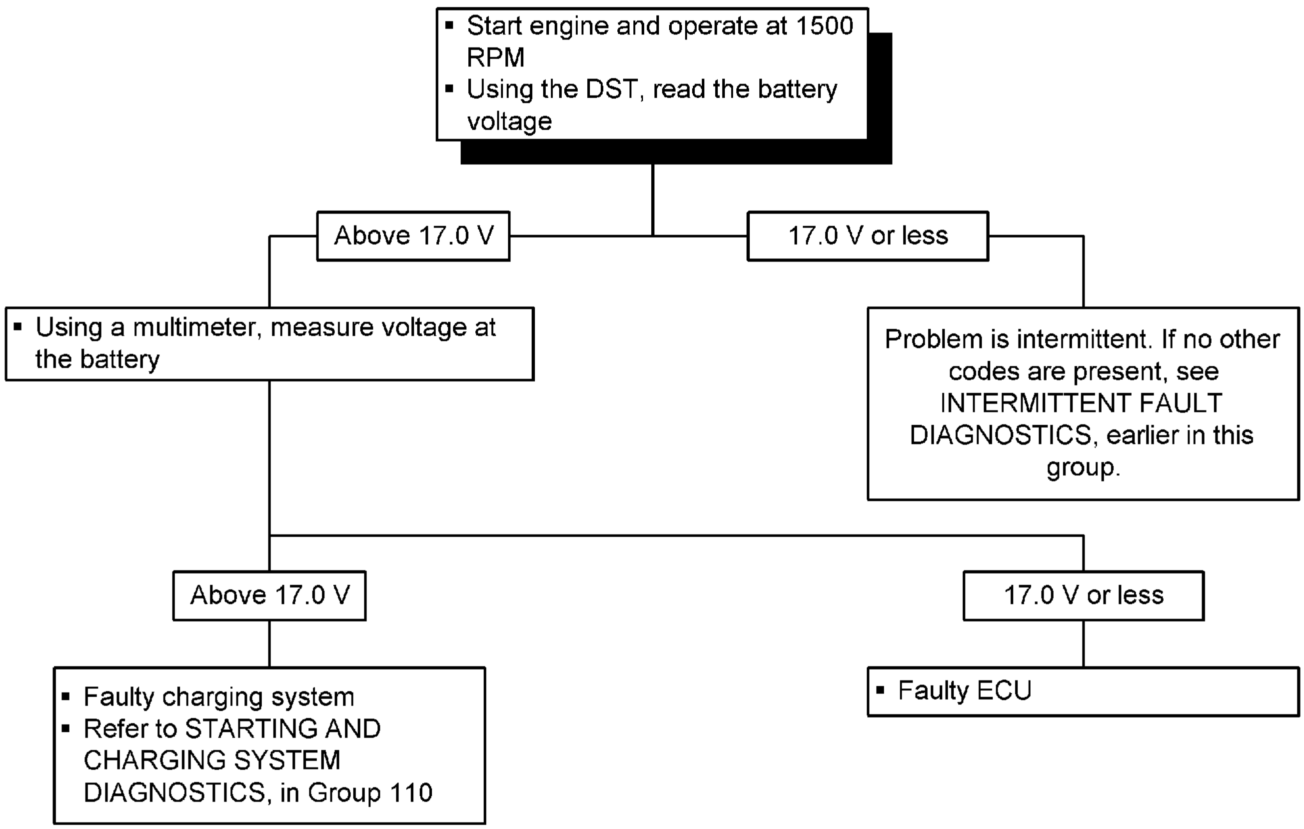
- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

RG,RG34710,3153 –19–15JUL96–1/1

DTC 53 Battery Voltage High - Continued

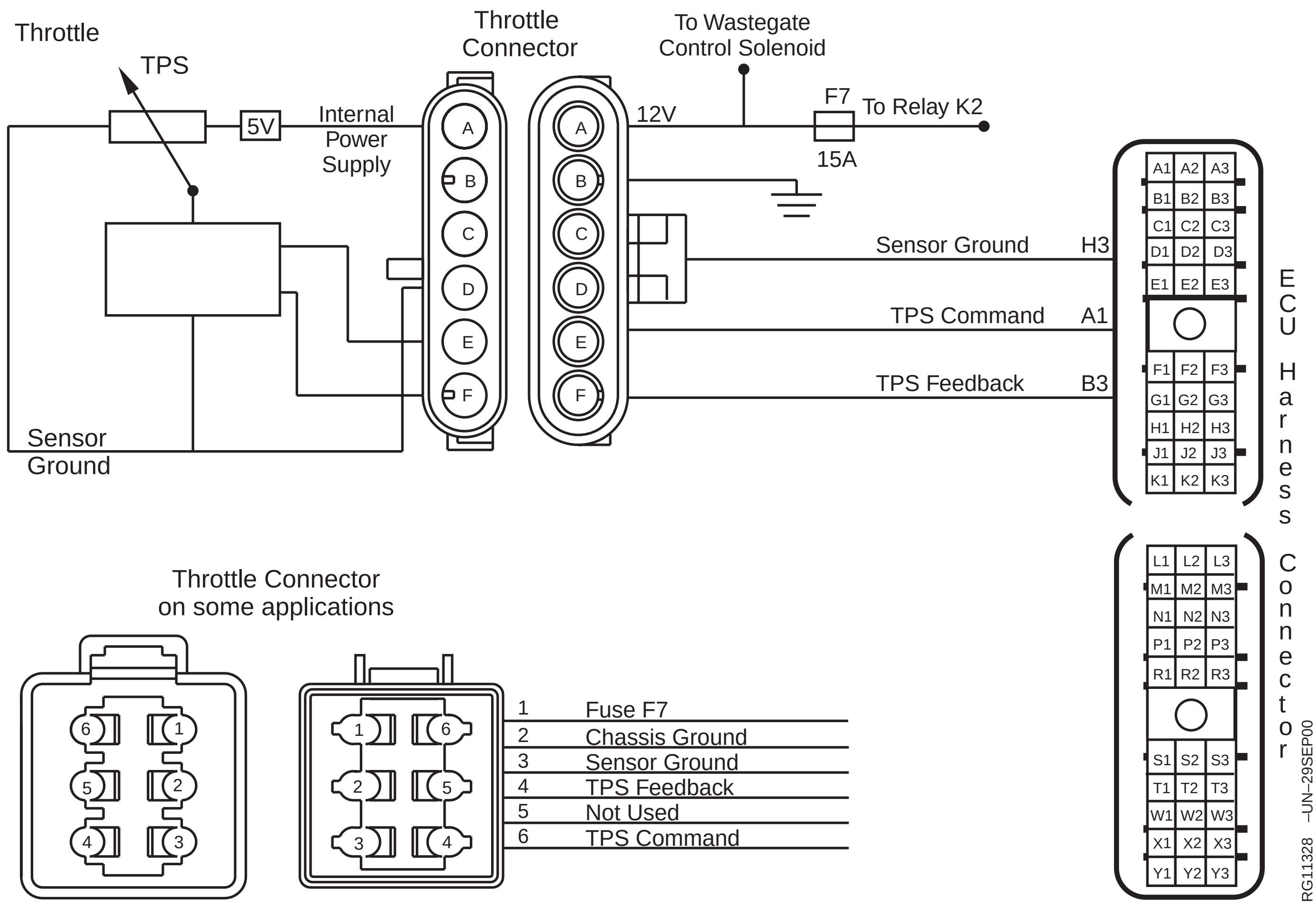
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10173 –19–16AUG00

DPSG,RG40854,131 –19–10JUN99–1/1

DTC 54 TPS Voltage High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A1	E (6)	35 Lt. Green	Lt. Green/Brown	TPS Command
B3	F (4)	19 Purple	White/Purple	TPS Feedback
H3	D (3)	20C Black	Black/Tan	Sensor Ground
	A (1)	65 Pink	Pink/Yellow	VBAT
	B (2)	58A White	White	Ground

IMPORTANT: If the throttle is determined to be faulty through diagnostics, see THROTTLE OPERATION in Group 100 earlier in this manual.

TPS - Throttle Position Sensor

The TPS is a variable resistor (potentiometer) used to measure throttle opening. The TPS is located in the throttle. The TPS Feedback voltage varies with throttle position. Less throttle opening results in lower feedback voltage; greater throttle opening results in higher feedback voltage. If the throttle detects an internal problem, it will output a TPS Feedback voltage greater than 4.8 V.

The ECU uses the TPS Feedback to:

Determine if the throttle is opening as commanded

DTC 54 will set if:

- The TPS Feedback voltage exceeds 4.8 volts anytime the engine is cranking or running
- **OR** if the throttle detects an internal problem

Continued on next page

RG,RG34710,3155 –19–15JUL96–1/2

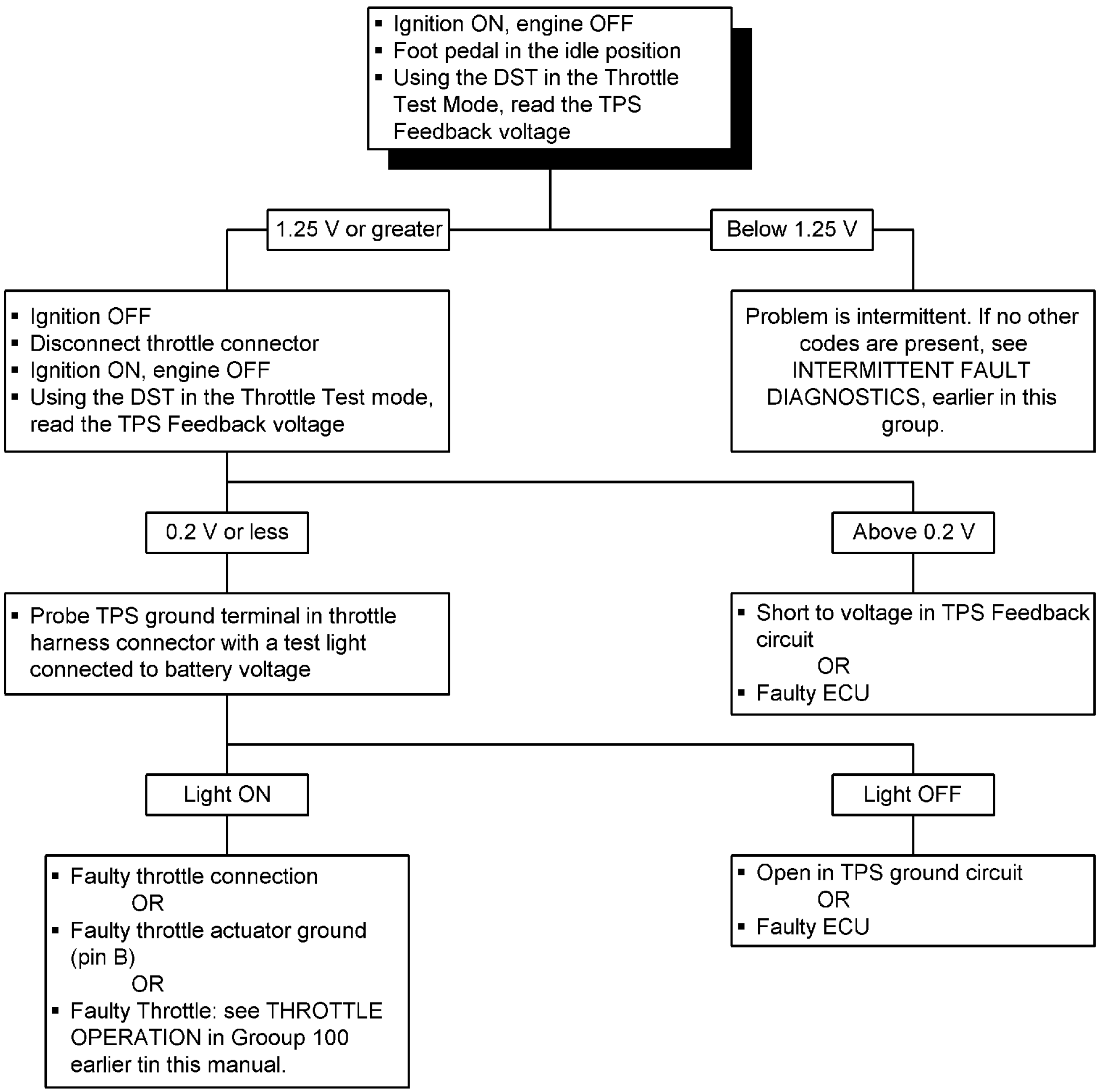
If DTC 54 sets, the following will occur:

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.
- ECU will use a default “limp home” value of 1400 rpm with fuel cut.

RG,RG34710,3155 –19–15JUL96–2/2

DTC 54 TPS Voltage High - Continued

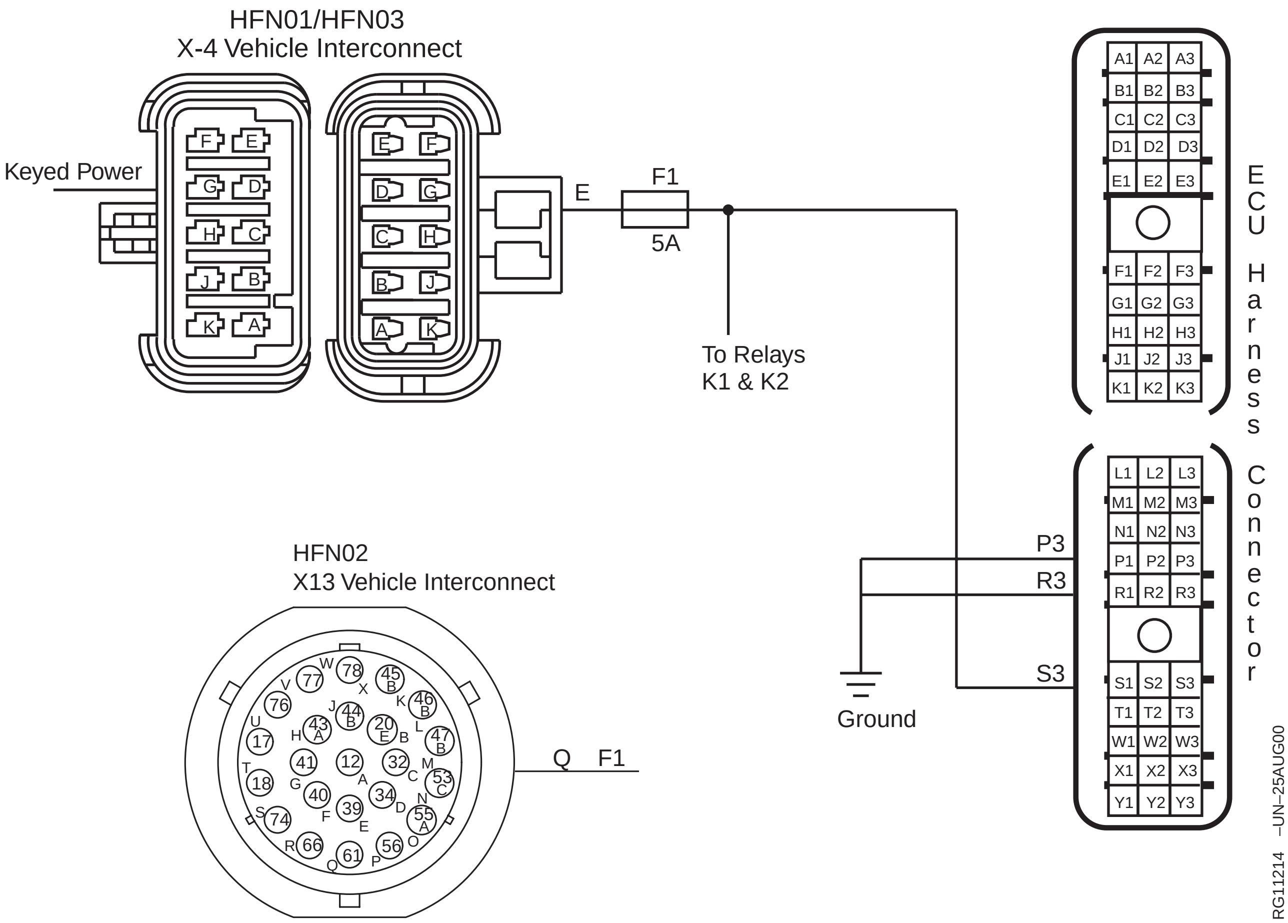
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Throttle Position sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11323 –19–17OCT00

DPSG,RG40854,132 –19–10JUN99–1/1

DTC 55 ECU Error



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
P3	N.A.	52 White	White	Ground
R3	N.A.	51 White	White	Ground
S3	E (X-4 V.I.) (Q)	48 Pink	Pink/Tan	Keyed Power and Relays

ECU internal problem

The ECU performs internal checks that must be satisfied each time an instruction is executed. There are several different failures within the ECU that will set a DTC 55. This code will not self erase, it should be erased by removing power to the ECU

DTC 55 will set if:

The ECU detects an internal error

If DTC 55 sets, the following will occur:

- Depending on severity of ECU internal failure, the closed loop multiplier will either remain enabled or will be disabled for remainder of key on cycle.
- Depending on severity of ECU internal failure, the adaptive learn multiplier will either remain enabled or will be disabled for remainder of key on cycle and reset to zero
- Depending on severity of ECU internal failure, boost will either not be affected or will be limited to 10 psig maximum
- CEL turned on and stays on until code is cleared using the DST or by removing battery power to the ECU

Possible Failures

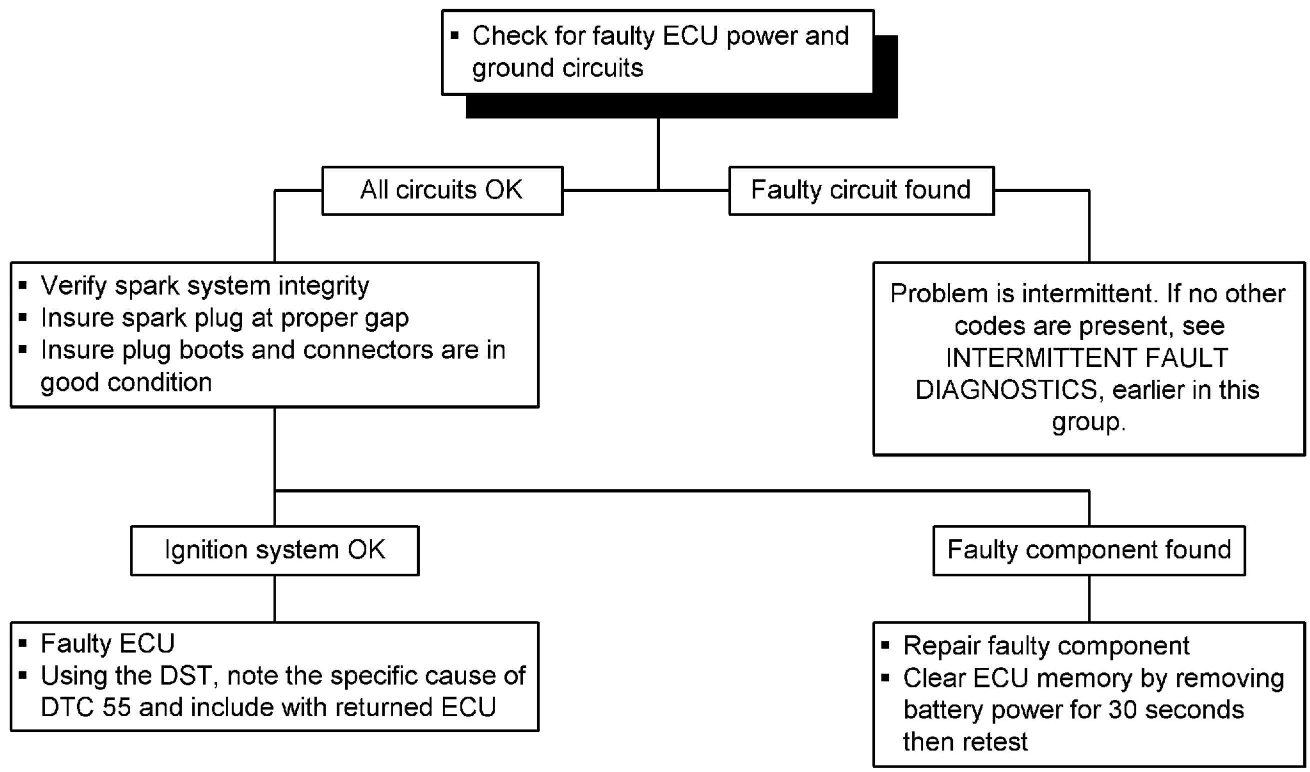
Continued on next page

- **Faulty power and ground circuits** - Check to ensure that all ECU power and ground circuits are OK. If faulty circuits are found, repair circuits then clear ECU memory by removing battery power to the ECU for 30 seconds then retest.
- **EMI (Electromagnetic interference)** - If components in the engine's ignition system are faulty, EMI from the faulty component can cause DTC 55. Insure spark plugs are at proper gap, insure plug boots and connectors are in good condition. If faulty components are found, repair components then clear ECU memory by removing battery power to the ECU for 30 seconds then retest.

RG,RG34710,3157 –19–15JUL96–2/2

DTC 55 ECU Error - Continued

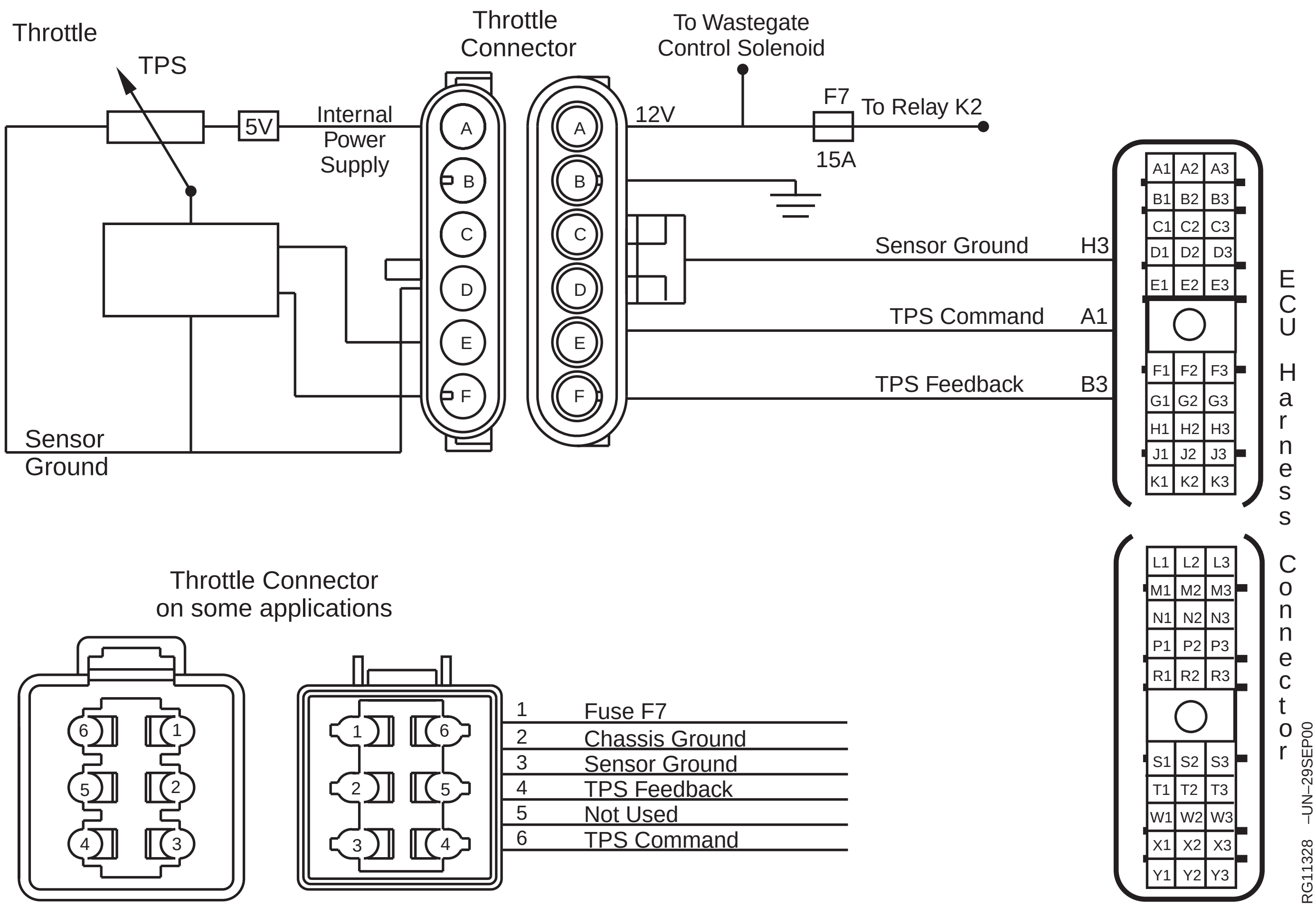
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10175 –19–16AUG00

DPSG,RG40854,133 –19–10JUN99–1/1

DTC 56 TPS Voltage Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A1	E (6)	35 Lt. Green	Lt. Green/Brown	TPS Command
B3	F (4)	19 Purple	White/Purple	TPS Feedback
H3	D (3)	20C Black	Black/Tan	Sensor Ground
	A (1)	65 Pink	Pink/Yellow	VBAT
	B (2)	58A White	White	Ground

IMPORTANT: If the throttle is determined to be faulty through diagnostics, see THROTTLE OPERATION in Group 100 earlier in this manual.

TPS - Throttle Position Sensor

The TPS is a variable resistor (potentiometer) used to measure throttle opening. The TPS is located in the throttle. The TPS Feedback voltage varies with throttle position. Less throttle opening results in lower feedback voltage; greater throttle opening results in higher feedback voltage.

The ECU uses the TPS Feedback to:

Determine if the throttle is opening as commanded

DTC 56 will set if:

The TPS Feedback voltage drops below 0.2 volts anytime the engine is cranking or running

If DTC 56 sets, the following will occur:

Continued on next page

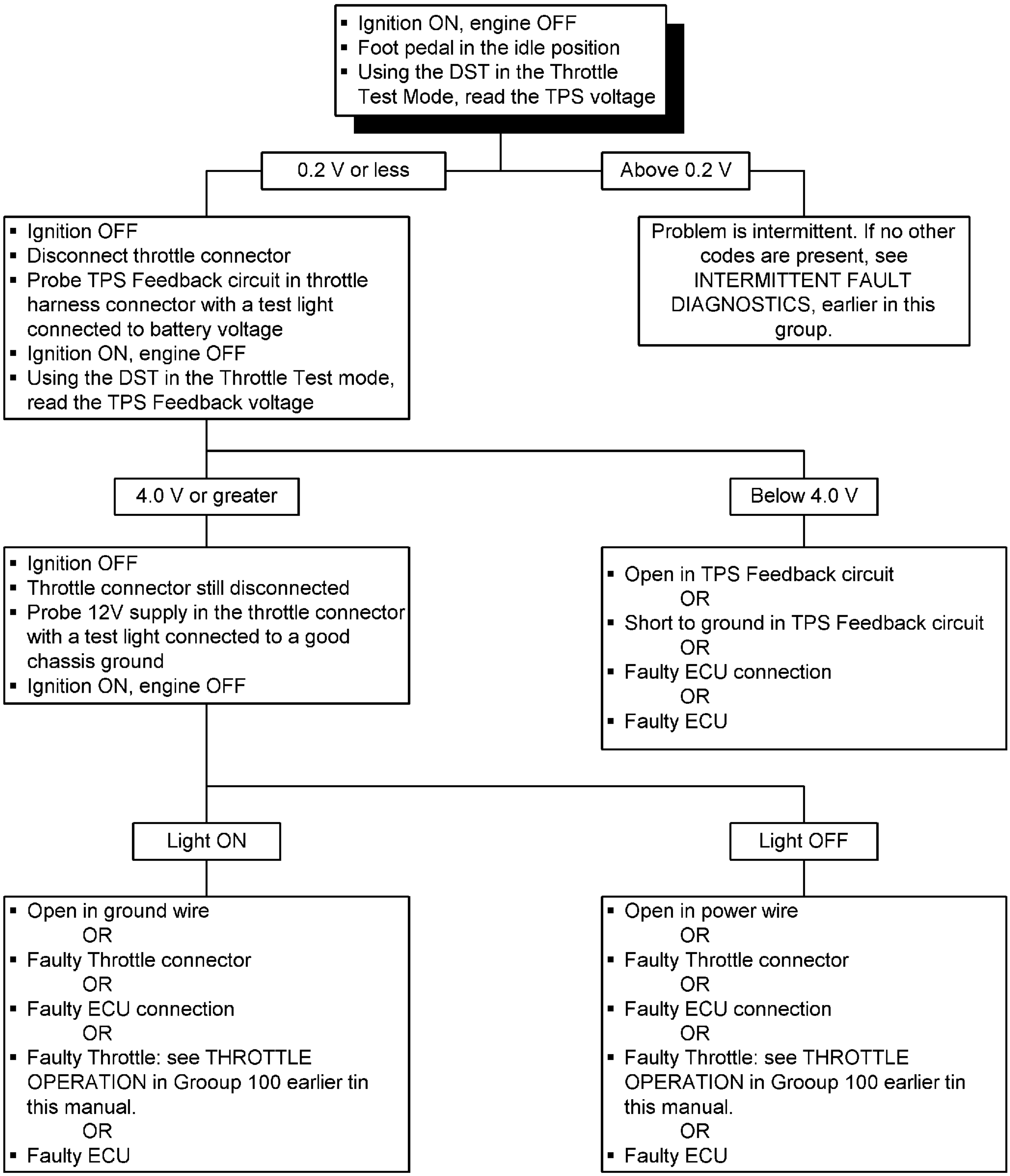
RG,RG34710,3159 –19–15JUL96–1/2

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.
- ECU will use a default “limp home” value of 1400 rpm with fuel cut.

RG,RG34710,3159 –19–15JUL96–2/2

DTC 56 TPS Voltage Low - Continued

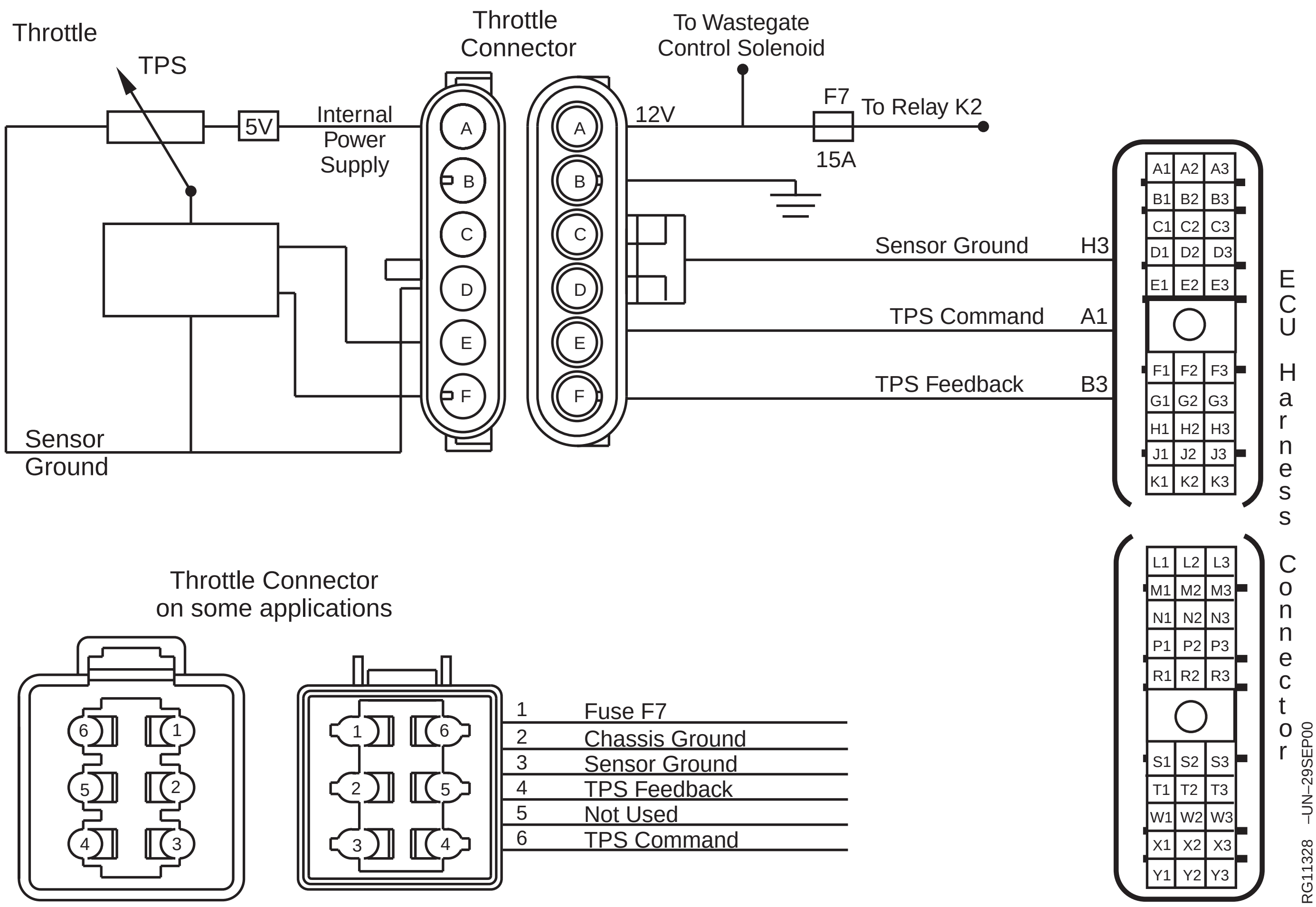
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Throttle Position sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11324 –19–17OCT00

DPSG,RG40854,134 –19–10JUN99–1/1

DTC 57 TPS Higher Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A1	E (6)	35 Lt. Green	Lt. Green/Brown	TPS Command
B3	F (4)	19 Purple	White/Purple	TPS Feedback
H3	D (3)	20C Black	Black/Tan	Sensor Ground
	A (1)	65 Pink	Pink/Yellow	VBAT
	B (2)	58A White	White	Ground

IMPORTANT: If the throttle is determined to be faulty through diagnostics, see THROTTLE OPERATION in Group 100 earlier in this manual.

TPS - Throttle Position Sensor

The TPS is a variable resistor (potentiometer) used to measure throttle opening. The TPS is located in the throttle. The TPS Feedback voltage varies with throttle position. Less throttle opening results in lower feedback voltage; greater throttle opening results in higher feedback voltage

The ECU uses the TPS Feedback to:

Determine if the throttle is opening as commanded

DTC 57 will set if:

The TPS Feedback voltage exceeds 3.0 volts (50%) when the commanded position should be less than 38%

If DTC 57 sets, the following will occur:

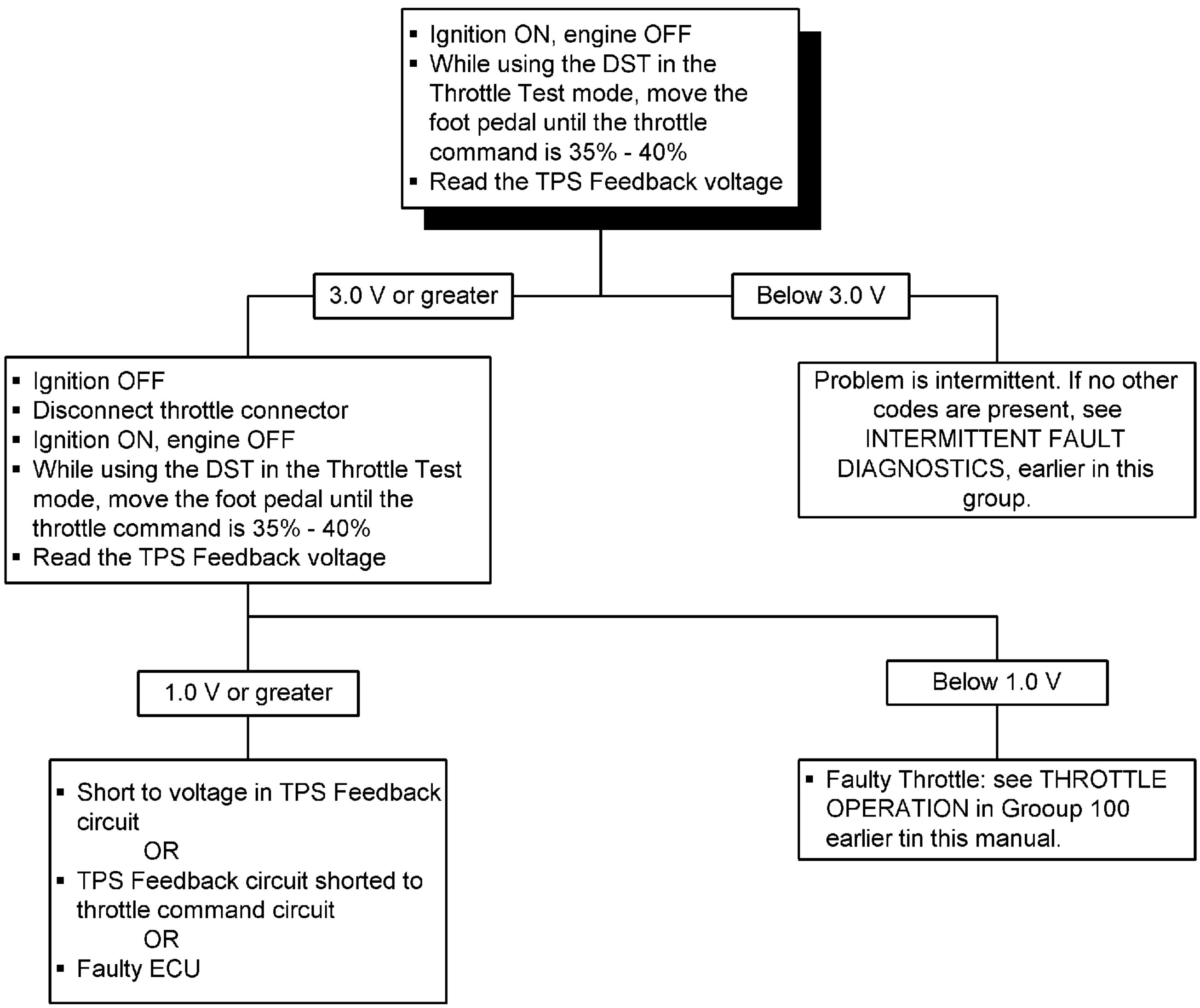
Continued on next page

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.
- ECU will use a default “limp home” value of 1400 rpm with fuel cut.

RG,RG34710,3160 –19–15JUL96–2/2

DTC 57 TPS Higher Than Expected - Continued

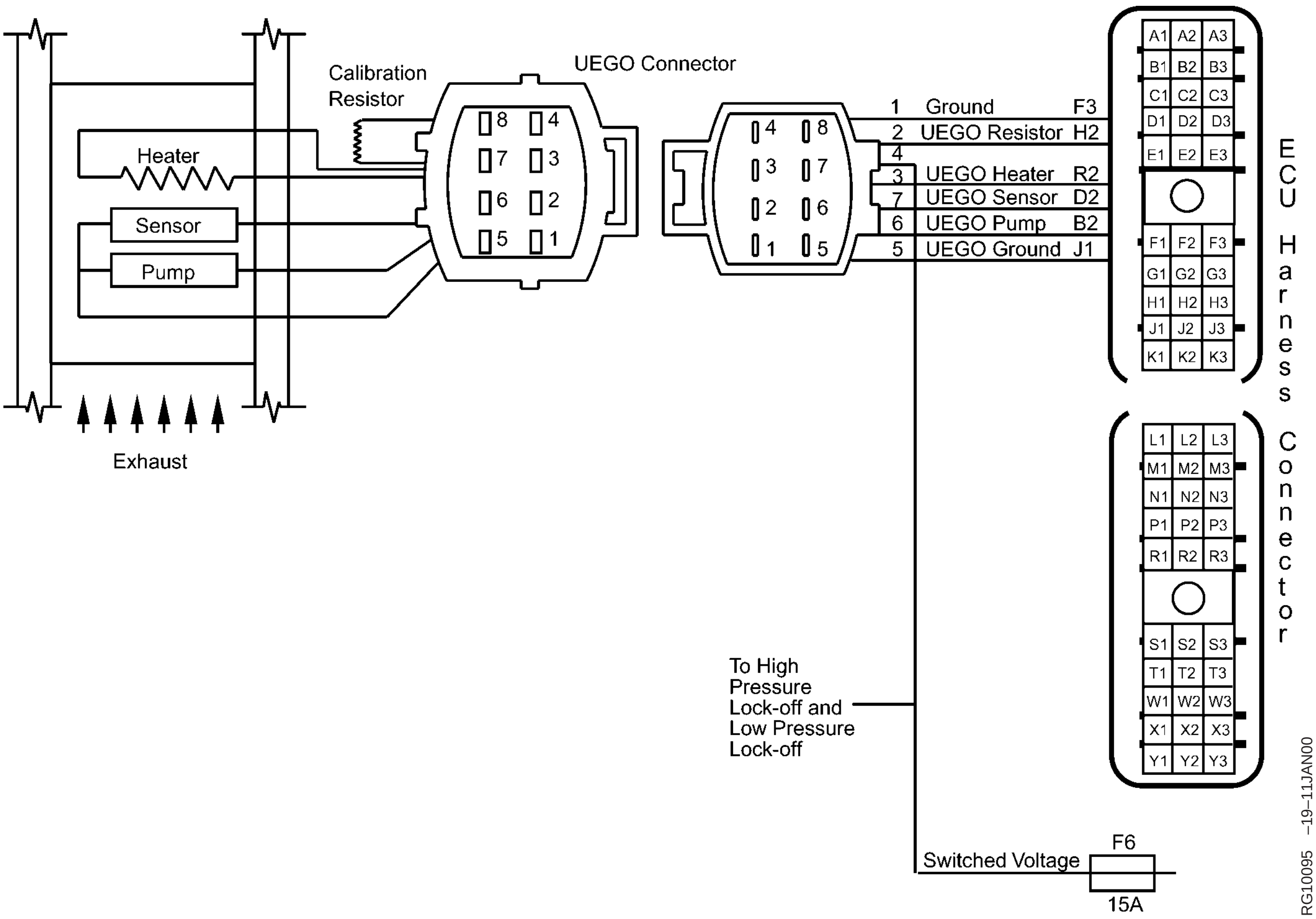
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Throttle Position sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11325 –19–17OCT00

DPSG,RG40854,135 –19–10JUN99–1/1

DTC 58 UEGO Heater Current High



Continued on next page RG,RG34710,3162 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO heater provides adequate sensor temperature required for normal operation.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO to correct fuel delivery with the Closed Loop multiplier and the Adaptive learn multiplier.

DTC 58 will set if:

UEGO heater circuit current exceeds 6.0 amps anytime the key is on

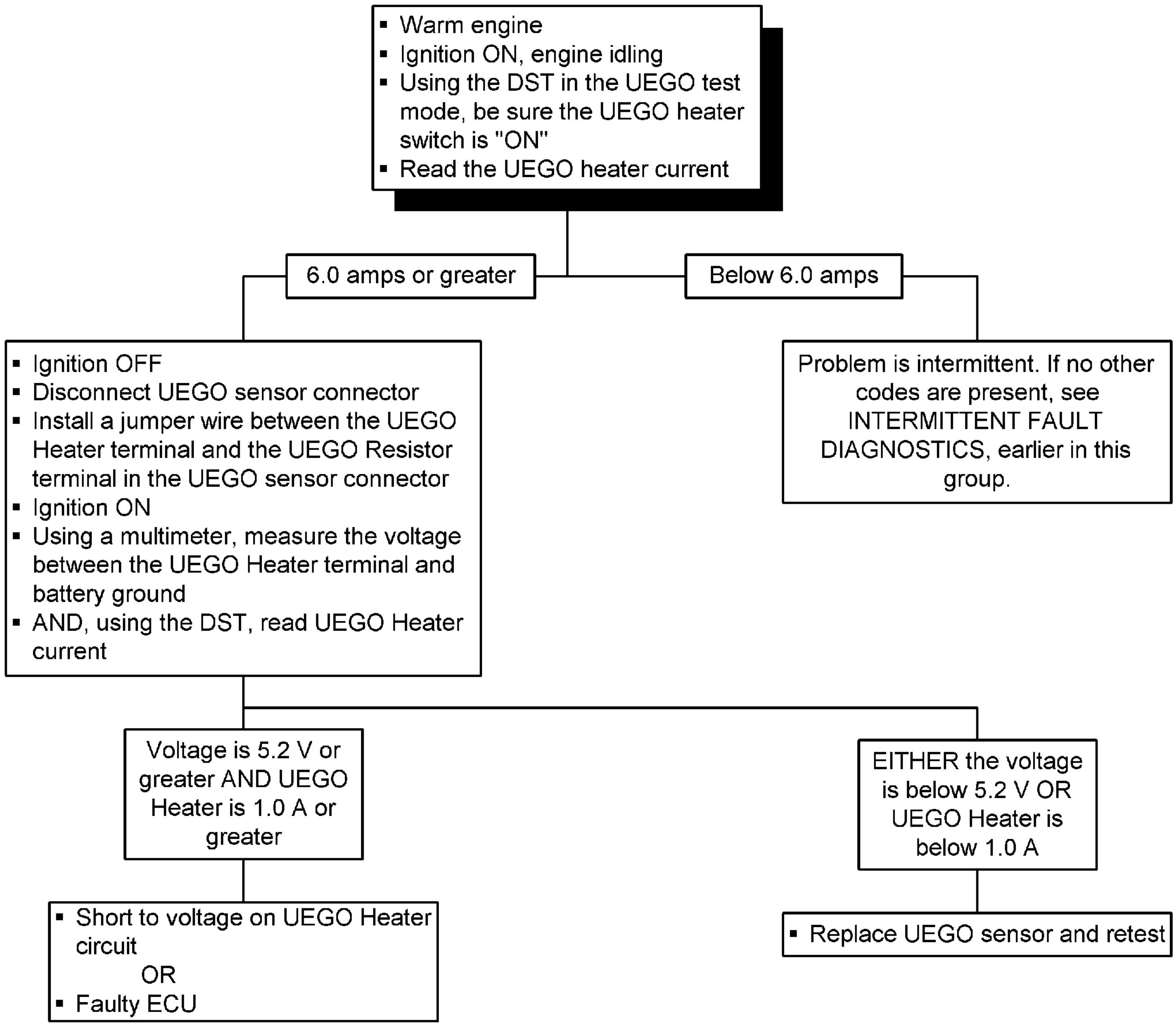
If DTC 58 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3162 –19–15JUL96–2/2

DTC 58 UEGO Heater Current High - Continued

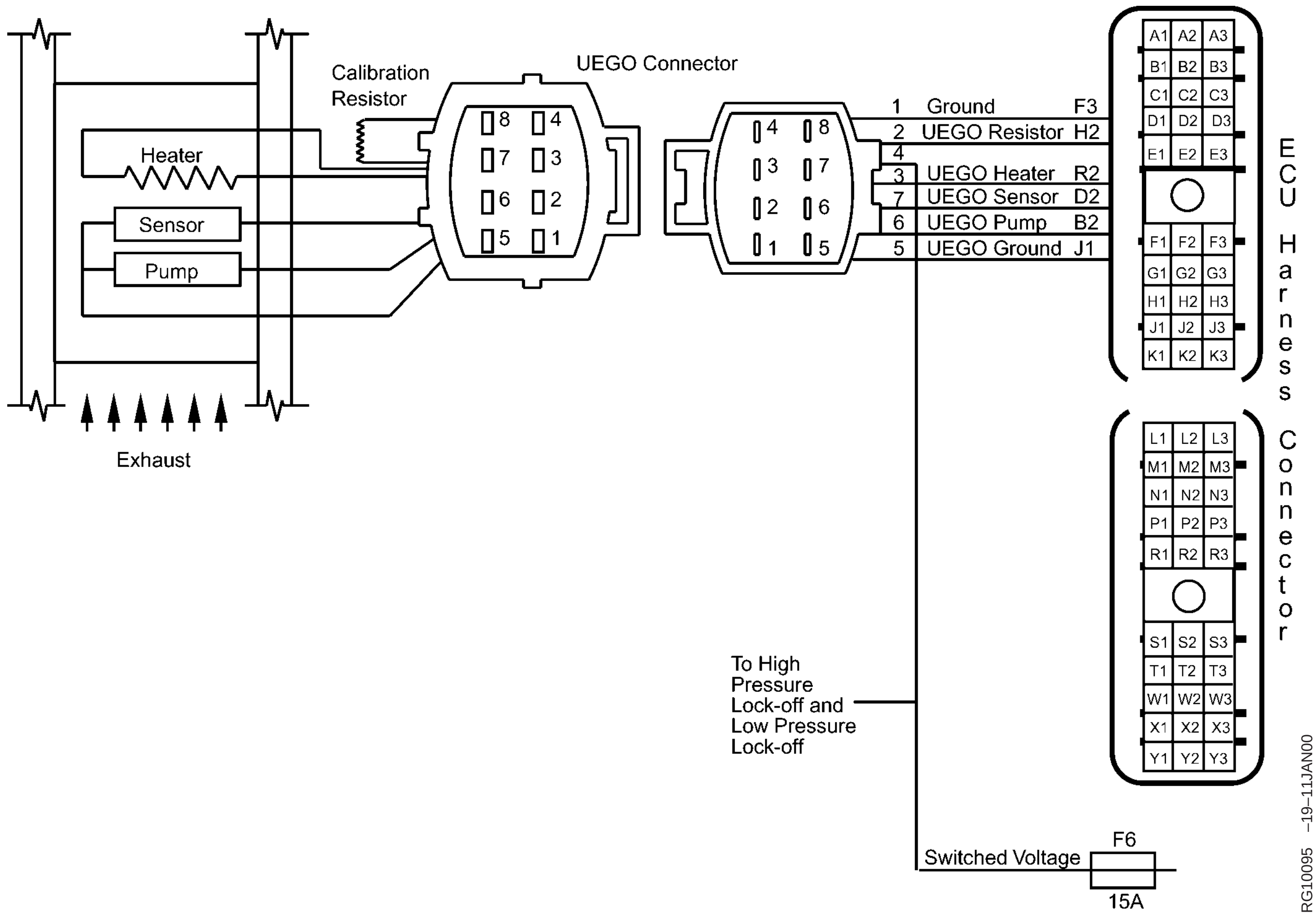
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10178 –19–16AUG00

DPSG,RG40854,136 –19–10JUN99–1/1

DTC 59 UEGO Heater Current Low



Continued on next page RG,RG34710,3164 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO heater provides adequate sensor temperature required for normal operation.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO to correct fuel delivery with the Closed Loop multiplier and the Adaptive learn multiplier

DTC 59 will set if:

UEGO heater circuit current drops below 0.2 amps anytime the key is on

If DTC 59 sets, the following will occur:

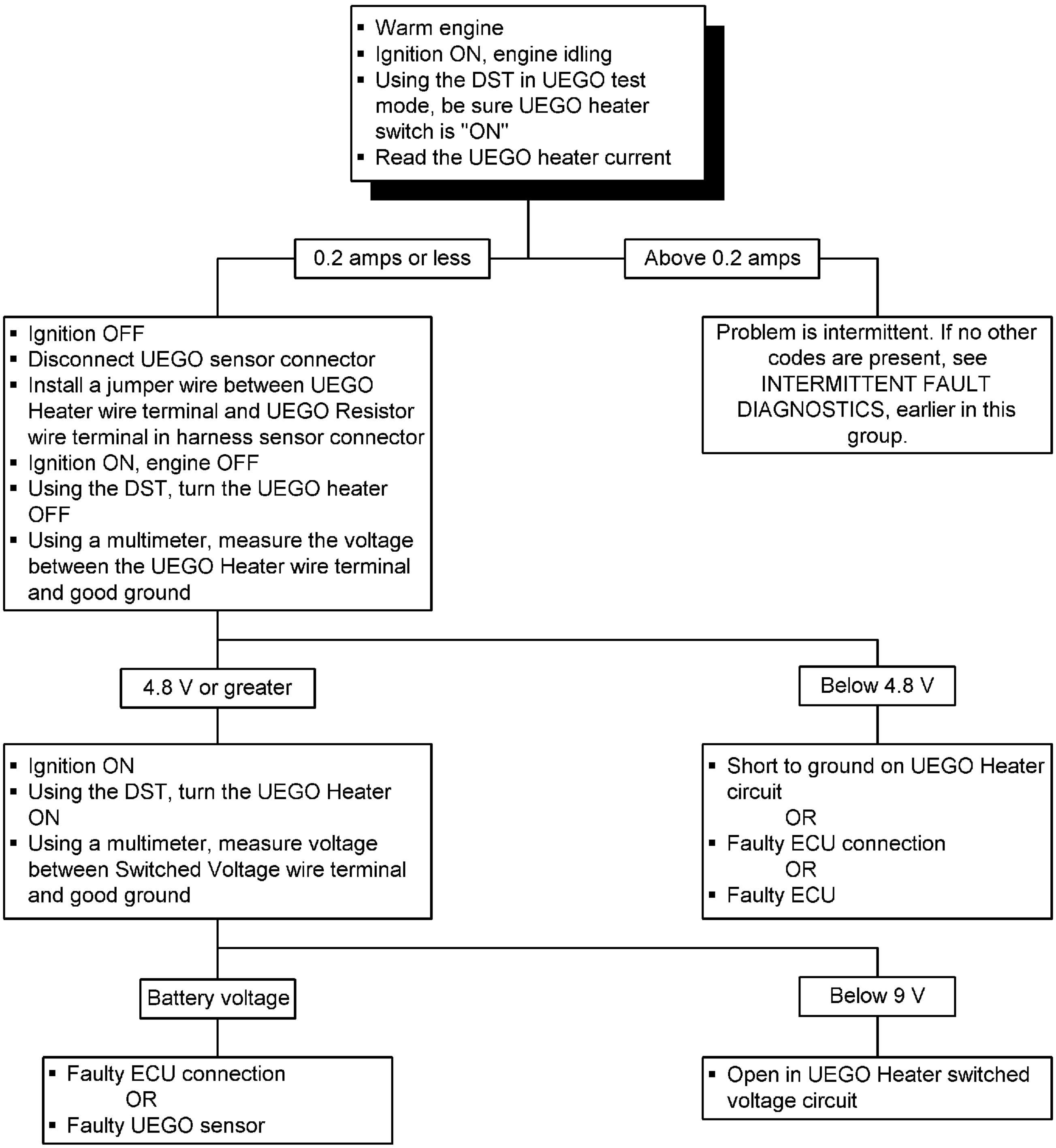
- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

NOTE: When the ignition is in the “ON” position without having been in the “START” position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won’t be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

RG,RG34710,3164 –19–15JUL96–2/2

DTC 59 UEGO Heater Current Low - Continued

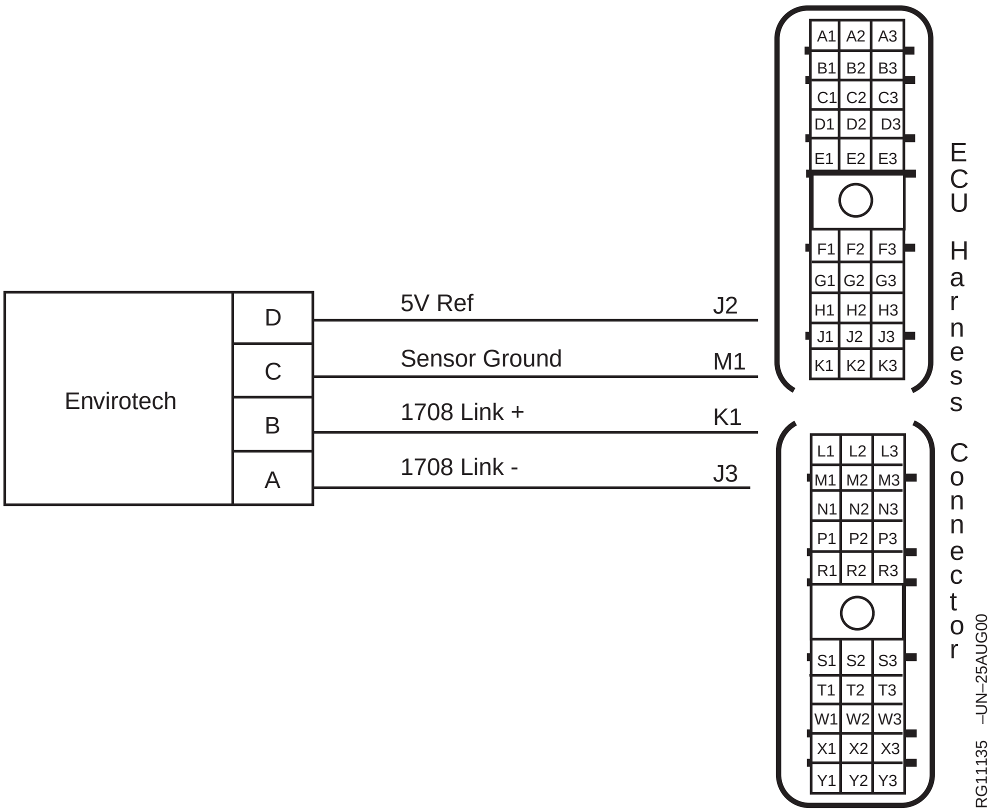
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10179 –19–16AUG00

DPSG,RG40854,137 –19–10JUN99–1/1

DTC 61 Environment Sensor Error



NOTE: This code is ONLY used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
J2	D	43 Gray	Gray/Red	Sensor 5V Supply
J3	A	47 Purple	Purple	1708 Link -
K1	B	46 Dk Blue	Dk Blue/Pink	1708 Link +
M1	C	53 Gray	White	Sensor Ground

Environment Sensor

The Environment Sensor is a microprocessor-controlled device with three different internal sensors. It send air temperature, pressure, and humidity information to the ECU. The ECU uses this information for altitude power correction, turbocharger overspeed protection, and UEGO reading corrections.

The ECU uses the Environment sensor:

To make altitude power corrections, protect against turbocharger over-speeds, and UEGO reading corrections.

DTC 61 - will set if:

- An internal diagnostic error is detected by the Environment sensor.

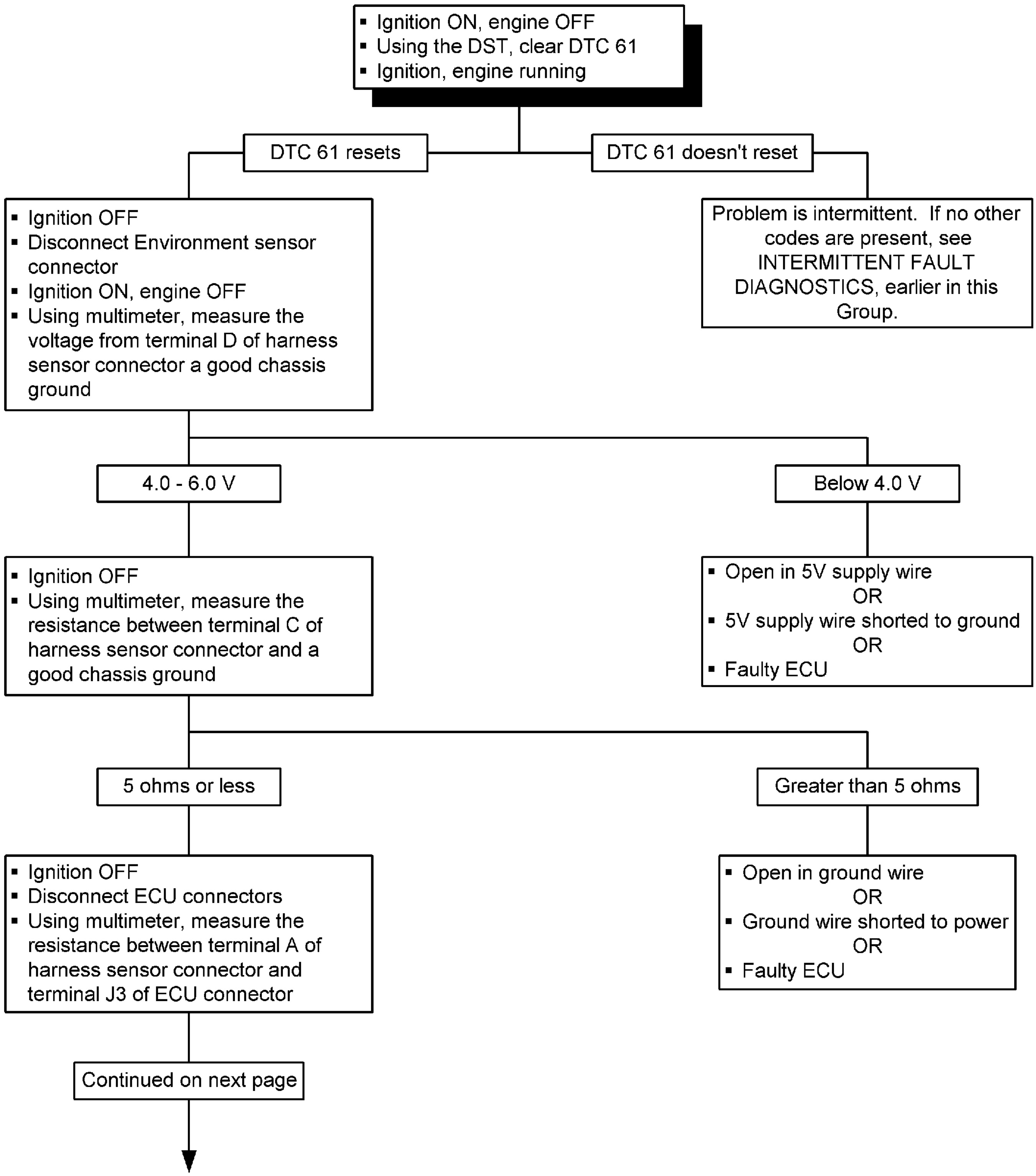
If DTC 61 sets, the following will occur:

- Adaptive Learn disabled
- CEL on during active fault and for 15 seconds after active fault
- Closed loop multiplier allowed to stay at its limit if needed
- Boost pressure is limited to 10 psig maximum

DPSG,RG41221,60 –19–10JUL00–1/1

DTC 61 Environment Sensor Error - Continued

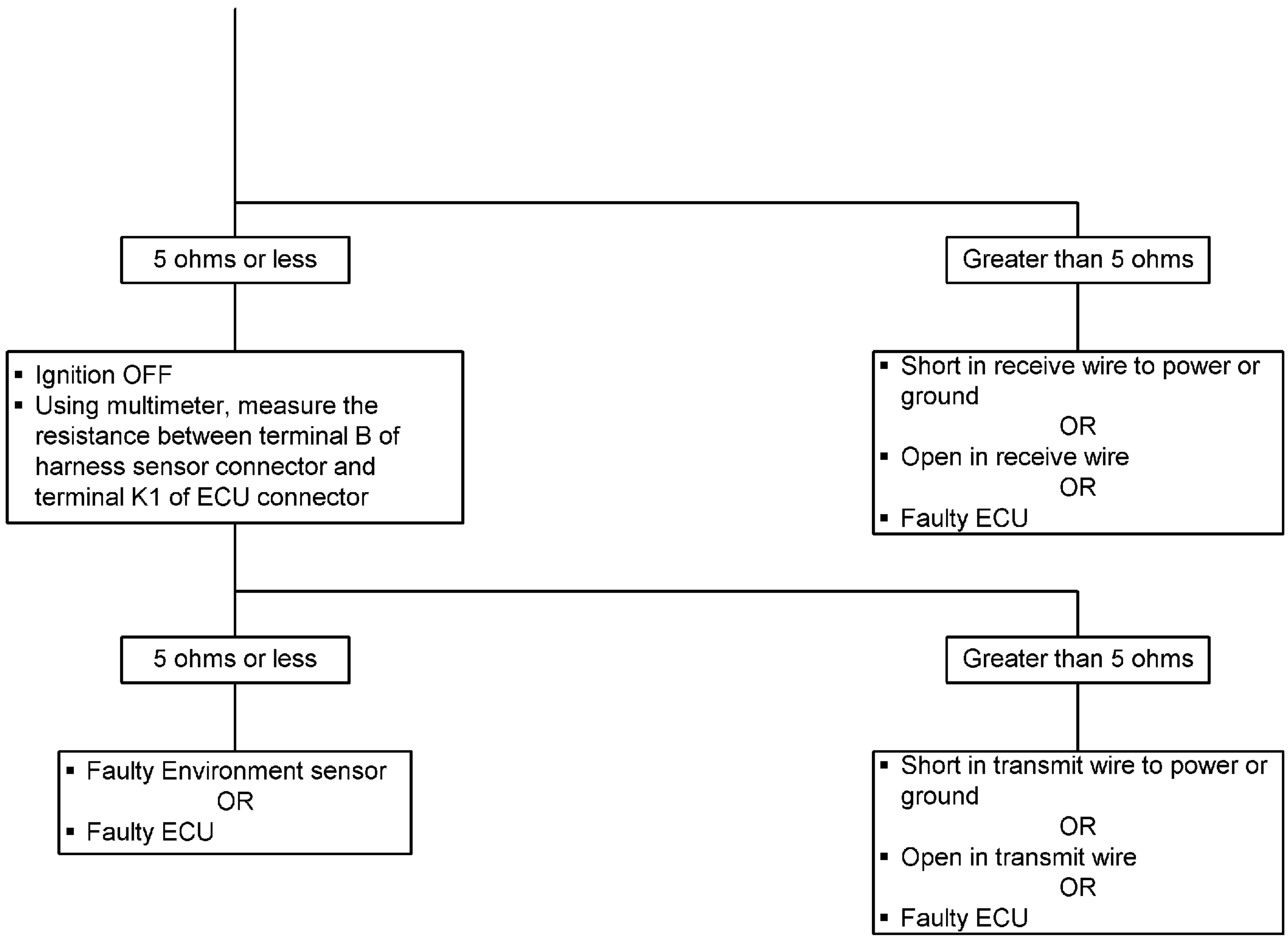
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Environment sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11138 –19–16AUG00

DPSG,RG41221,61 –19–10JUL00–1/1

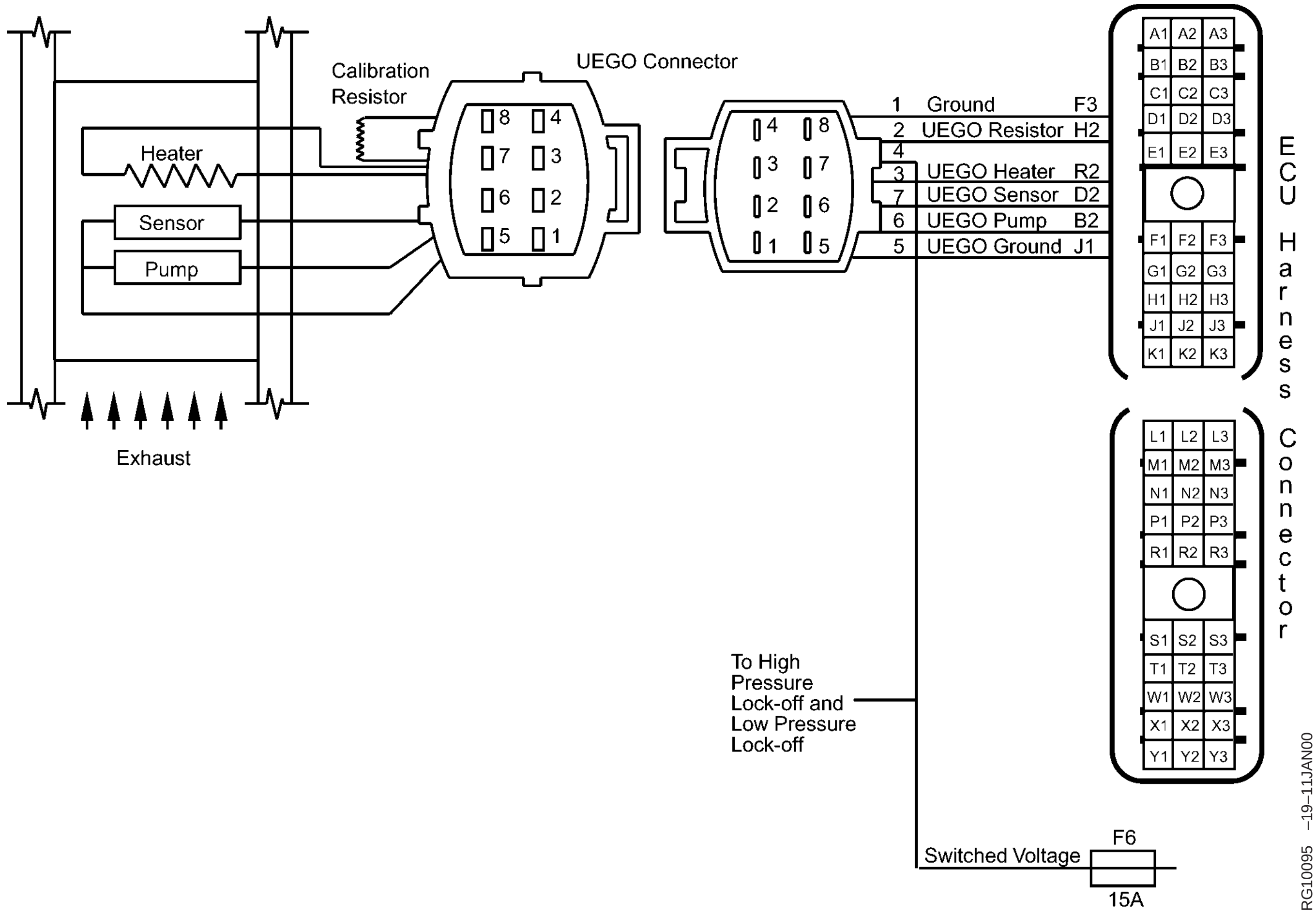
DTC 61 Environment Sensor Error - Continued



RG11200 –19–16AUG00

DPSG,RG41221,70 –19–21JUL00–1/1

DTC 62 UEGO Pump Cell Voltage Low



Continued on next page RG,RG34710,3166 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO pump cell is used in conjunction with the sense cell to measure oxygen content.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO to correct fuel delivery with the Closed Loop multiplier and the Adaptive learn multiplier.

DTC 62 will set if:

- The system is operating in closed loop
- **AND** the UEGO pump cell voltage drops below 0.5 volts

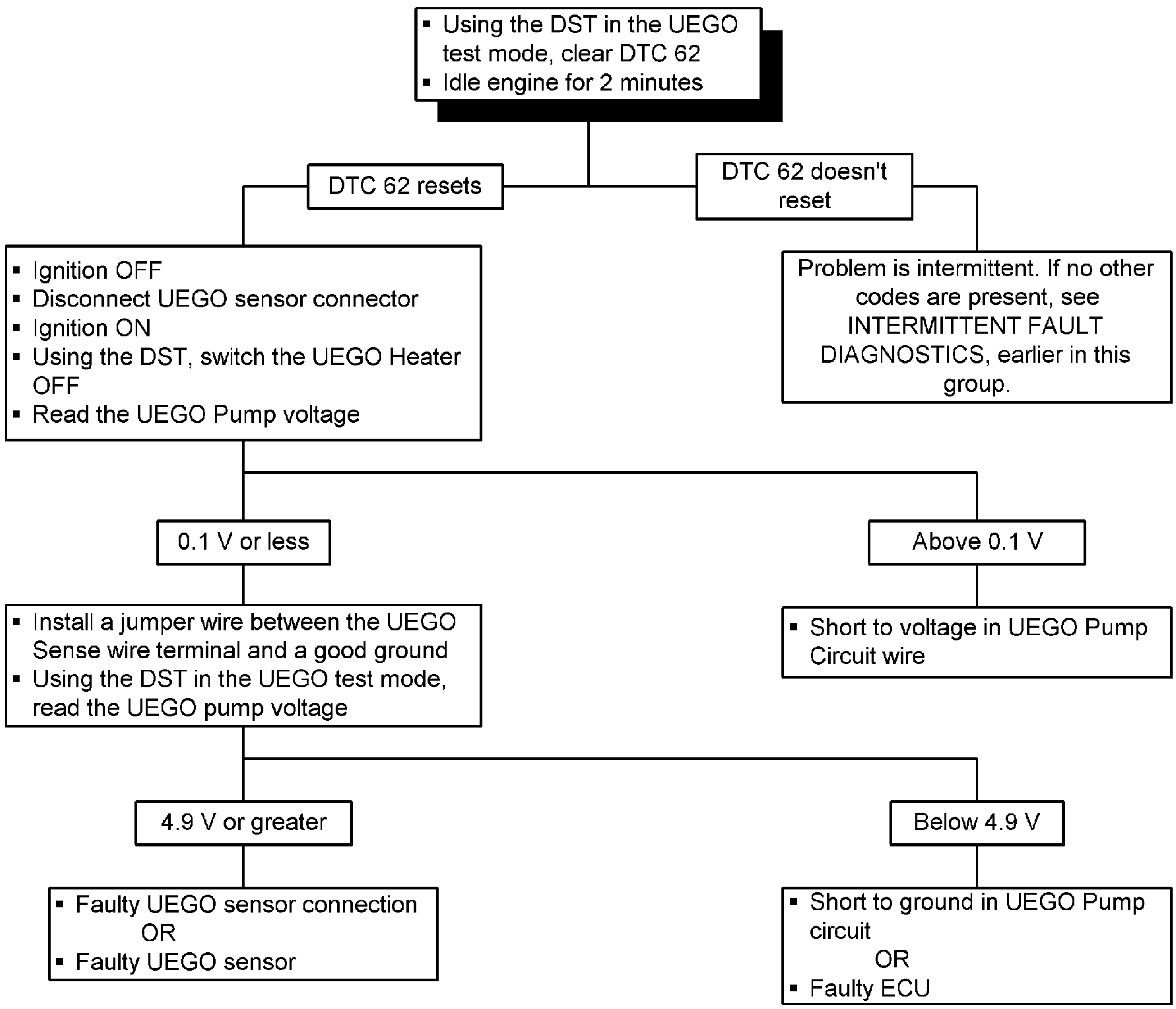
If DTC 62 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3166 –19–15JUL96–2/2

DTC 62 UEGO Pump Cell Voltage Low - Continued

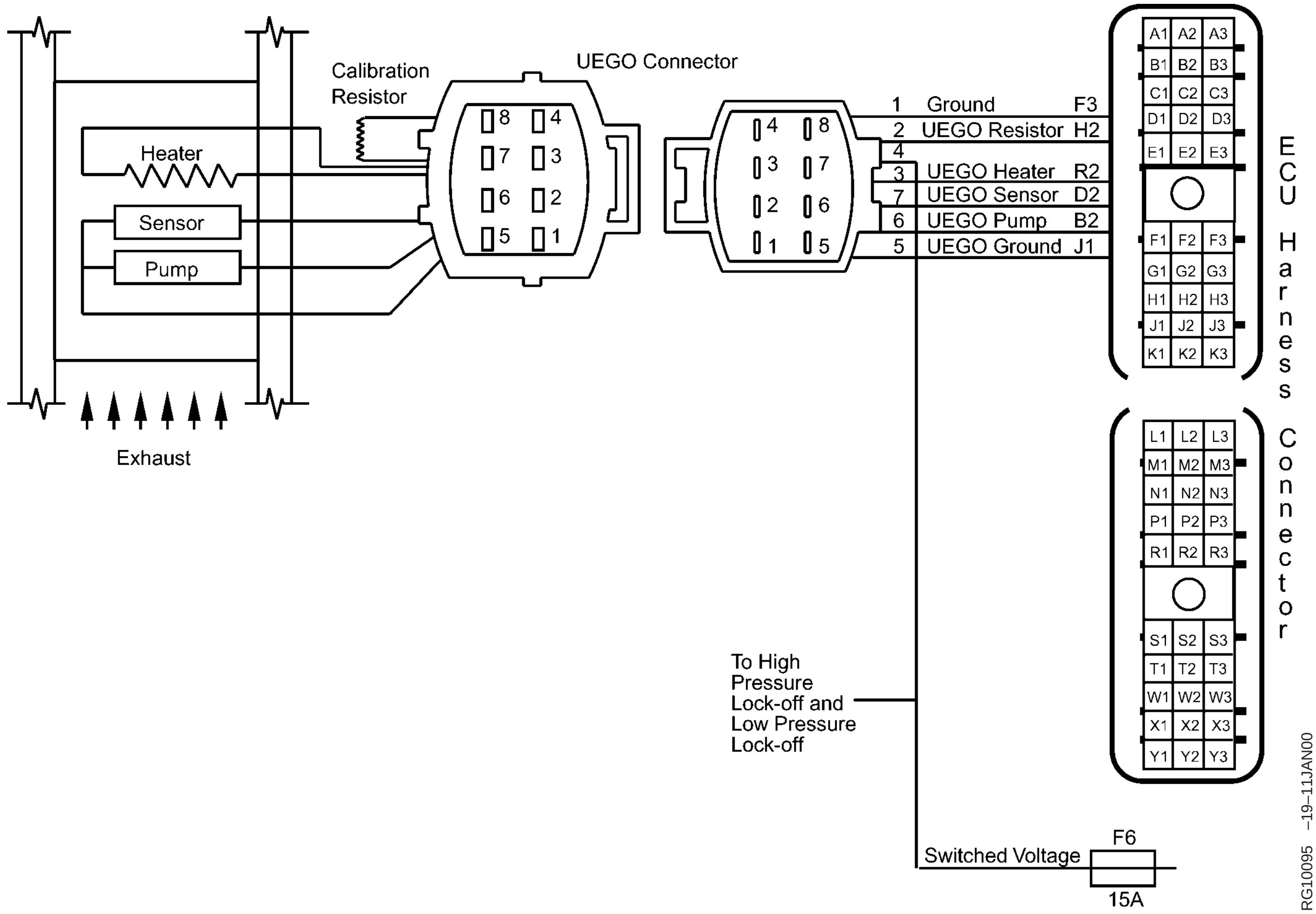
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10180 –19–16AUG00

DPSG,RG40854,138 –19–10JUN99–1/1

DTC 63 UEGO Pump Cell Voltage High



Continued on next page RG,RG34710,3168 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO pump cell is used in conjunction with the sense cell to measure oxygen content.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO to correct fuel delivery with the Closed Loop multiplier and the Adaptive learn multiplier.

DTC 63 will set if:

- The system is operating in closed loop
- **AND** the UEGO pump cell voltage exceeds 4.5 volts

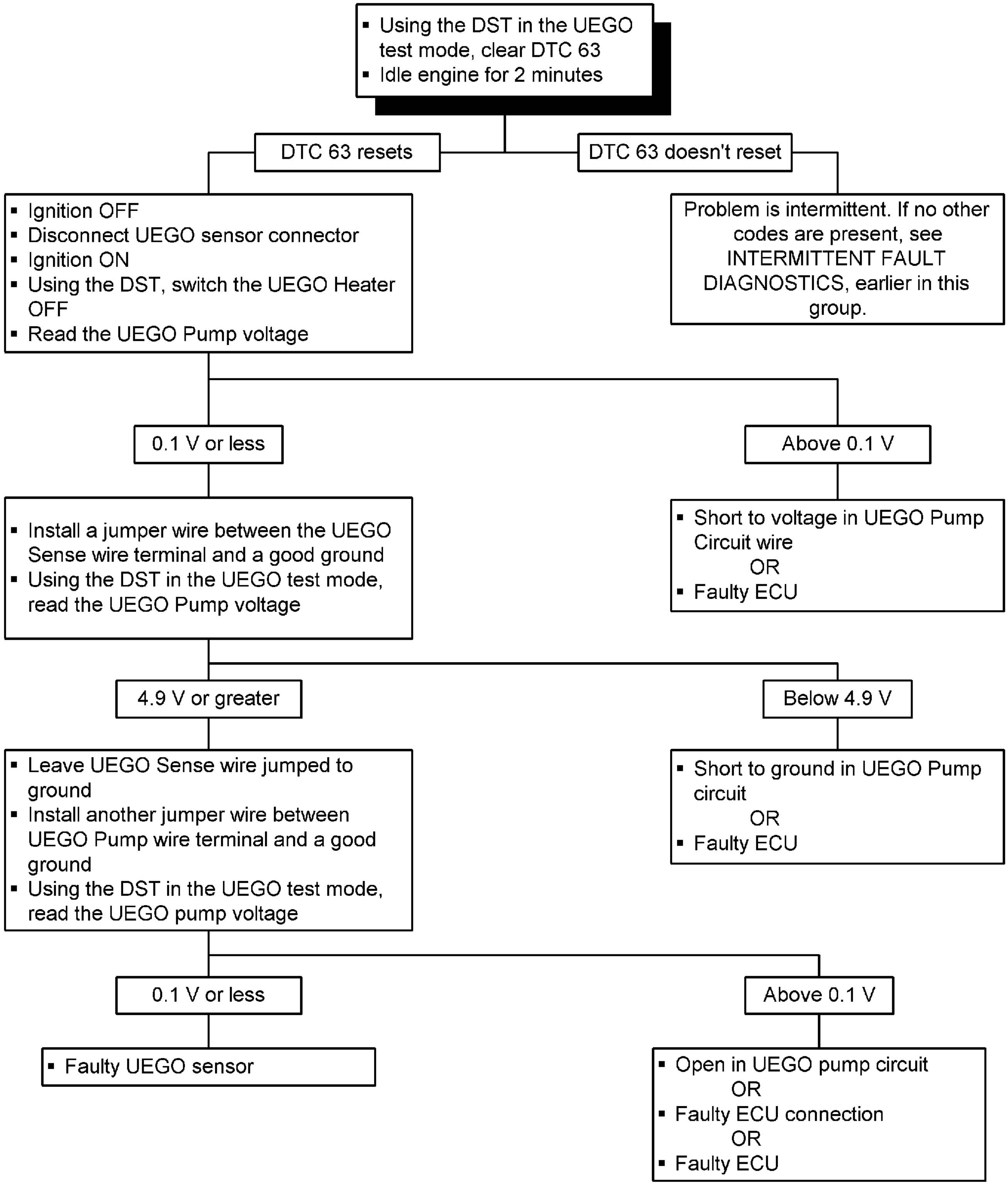
If DTC 63 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3168 –19–15JUL96–2/2

DTC 63 UEGO Pump Cell Voltage High - Continued

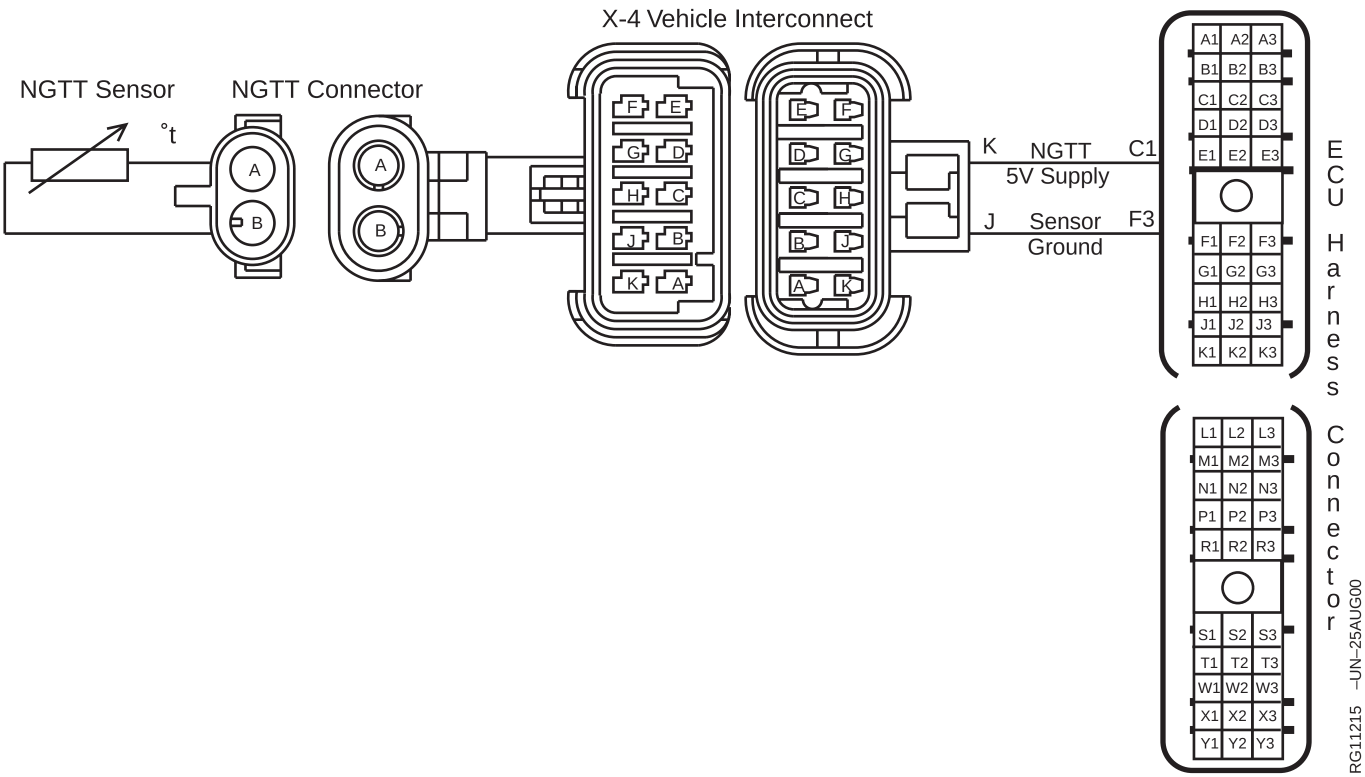
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10181 –19–16AUG00

DPSG,RG40854,139 –19–10JUN99–1/1

DTC 64 NGTT Voltage High



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
C1	K (X-4 V.I.)	18 Yellow	Yellow/Dk. Blue	NGTT 5V Supply
F3	J (X-4 V.I.)	21H Black	Black/Lt. Green	Sensor Ground

NGTT - Natural Gas Tank Temperature sensor

The NGTT sensor is thermistor (temperature sensitive resistor) tape wrapped around the fuel supply line. It is used to measure the temperature of the fuel in the storage tanks. The NGTT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the NGTT sensor:

In conjunction with the NGTP sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash

DTC 64 will set if:

The NGTT voltage exceeds 4.95 volts anytime the engine is cranking or running

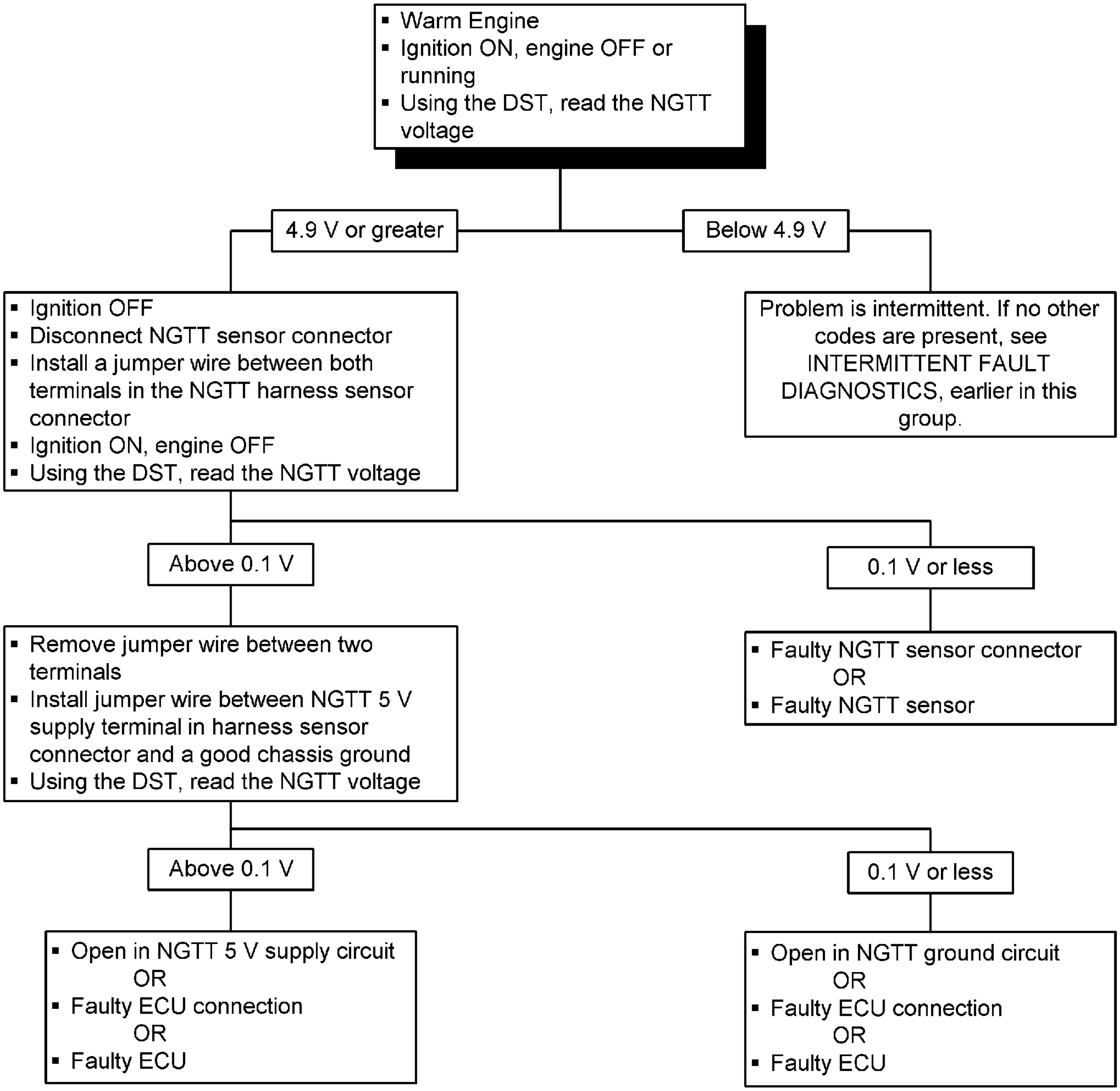
If DTC 64 sets, the following will occur:

- ECU will use a default “limp home” NGTT value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3170 –19–15JUL96–1/1

DTC 64 NGTT Voltage High - Continued

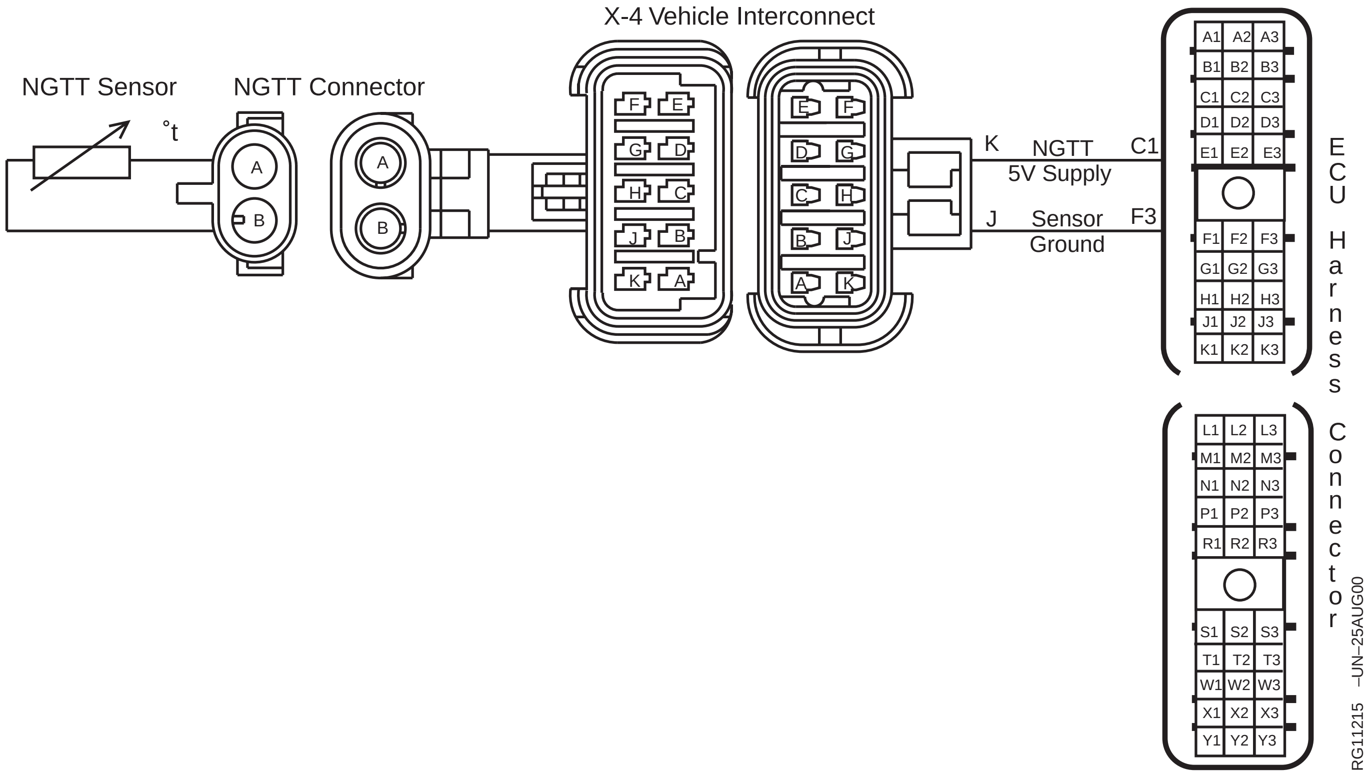
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Tank Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10182 –19–16AUG00

DPSG,RG40854,140 –19–10JUN99–1/1

DTC 65 NGTT Voltage Low



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
C1	K (X-4 V.I.)	18 Yellow	Yellow/Dk. Blue	NGTT 5V Supply
F3	J (X-4 V.I.)	21H Black	Black/Lt. Green	Sensor Ground

NGTT - Natural Gas Tank Temperature sensor

The NGTT sensor is thermistor (temperature sensitive resistor) tape wrapped around the fuel supply line. It is used to measure the temperature of the fuel in the storage tanks. The NGTT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU; lower temperatures result in higher voltages.

The ECU uses the NGTT sensor:

In conjunction with the NGTP sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash.

DTC 65 will set if:

The NGTT voltage drops below 0.05 volts anytime the engine is cranking or running

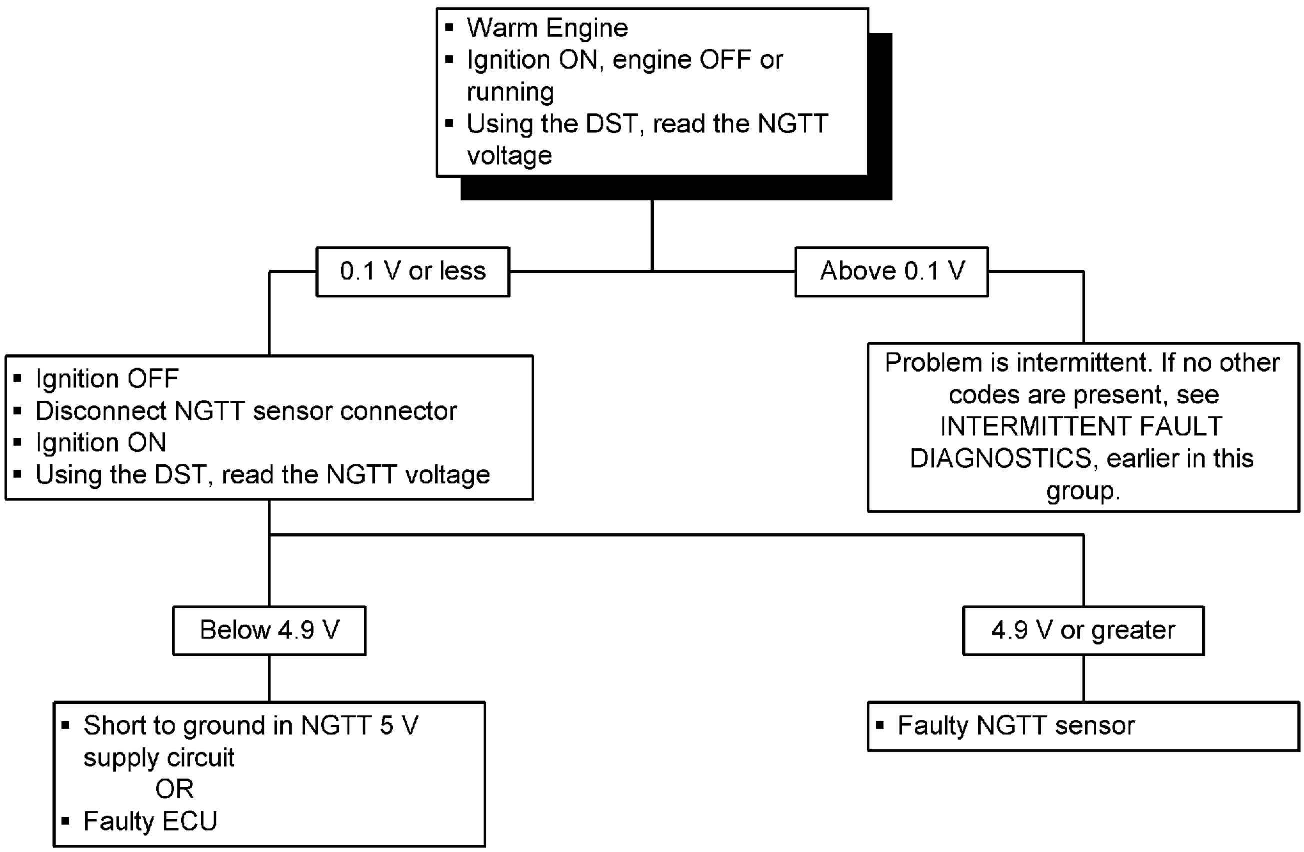
If DTC 65 sets, the following will occur:

- ECU will use a default “limp home” NGTT value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3172 –19–15JUL96–1/1

DTC 65 NGTT Voltage Low - Continued

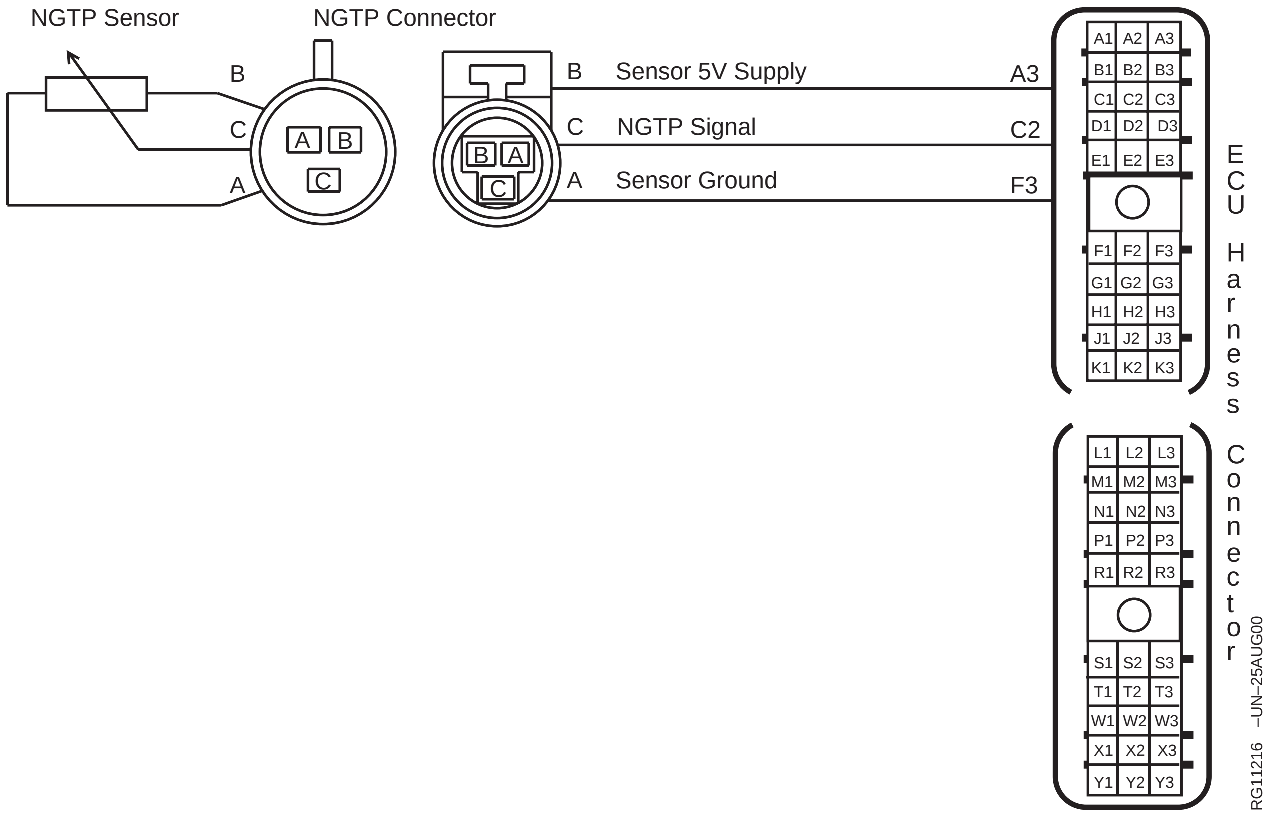
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Tank Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10183 –19–16AUG00

DPSG,RG40854,141 –19–10JUN99–1/1

DTC 66 NGTP Voltage High



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54C Yellow	Purple/Red	Sensor 5V Supply
C2	C	17 Dk. Blue	Dk. Blue/White	NGTP Signal
F3	A	21G Black	Black/Lt. Green	Sensor Ground

NGTP - Natural Gas Tank Pressure sensor

The NGTP sensor is a pressure transducer mounted on the pressure regulator. The NGTP sensor measures gas pressure prior to regulation. The NGTP signal voltage varies as fuel pressure in the storage tanks varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGTP sensor:

In conjunction with the NGTT sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash

DTC 66 will set if:

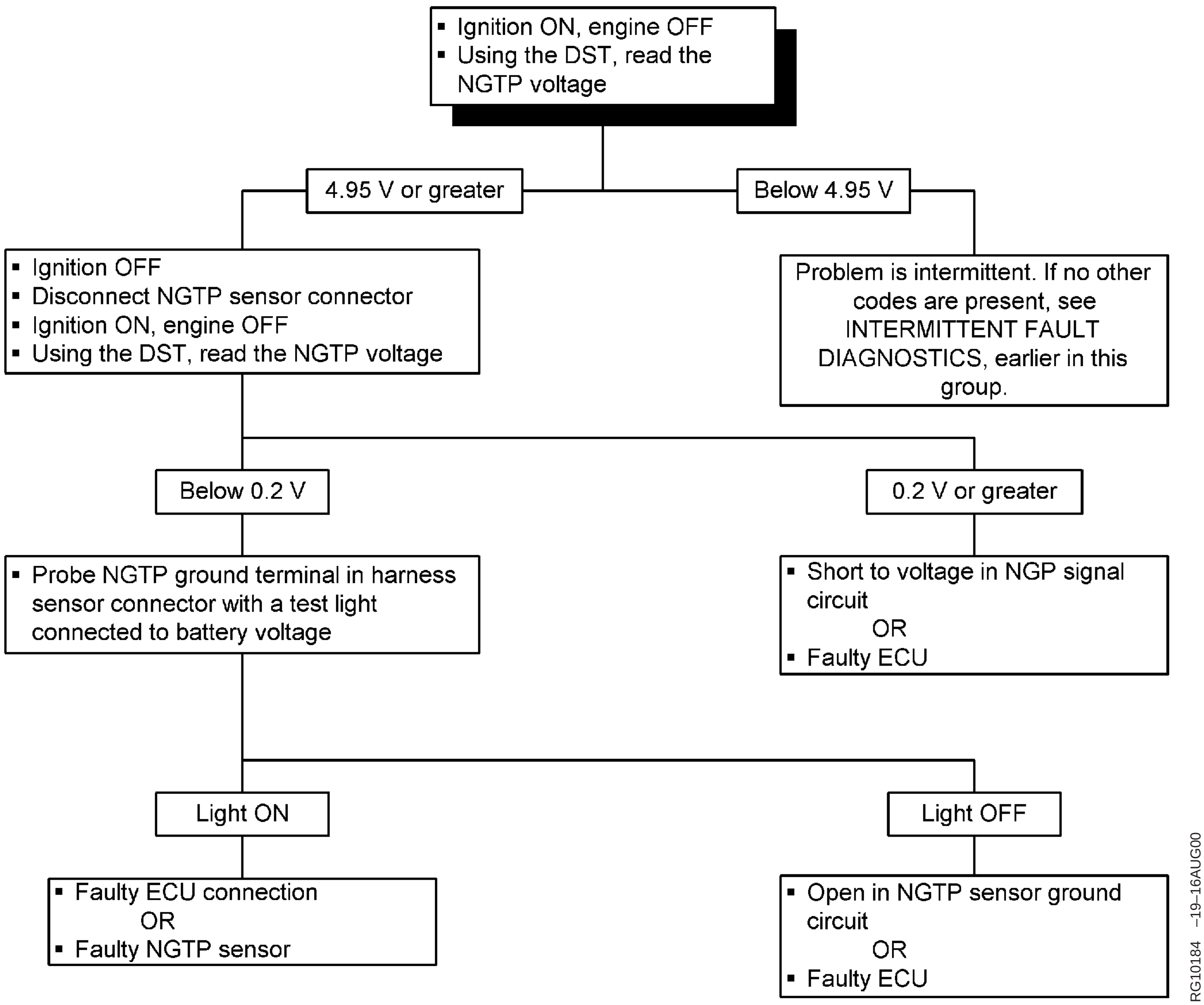
The NGTP voltage exceeds 4.95 volts anytime the engine is cranking or running

If DTC 66 sets, the following will occur:

- ECU will use a default “limp home” NGTP value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

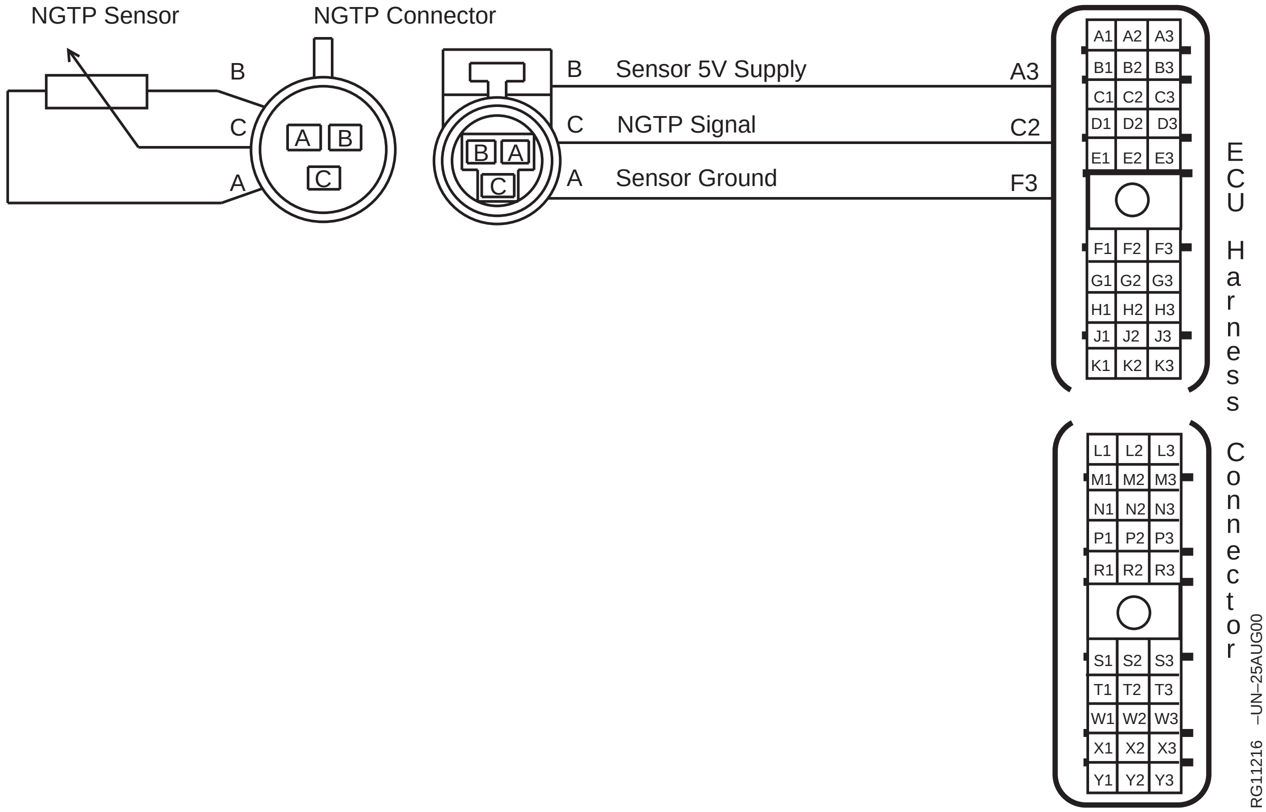
DTC 66 NGTP Voltage High - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Tank Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



DPSG,RG40854,142 –19–10JUN99–1/1

DTC 67 NGTP Voltage Low



NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54 Yellow	Purple/Red	Sensor 5V Supply
C2	C	17 Dk. Blue	Dk. Blue/White	NGTP Signal
F3	A	21G Black	Black/Lt. Green	Sensor Ground

NGTP - Natural Gas Tank Pressure sensor

The NGTP sensor is a pressure transducer mounted on the pressure regulator. The NGTP sensor measures gas pressure prior to regulation. The NGTP signal voltage varies as fuel pressure in the storage tanks varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGTP sensor:

In conjunction with the NGTT sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash.

DTC 67 will set if:

The NGTP voltage drops below 0.05 volts anytime the engine is cranking or running

If DTC 67 sets, the following will occur:

- ECU will use a default “limp home” NGTP value
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

DTC 67 NGTP Voltage Low - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Tank Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.

- Ignition ON, engine OFF
- Using the DST, read the NGTP voltage

0.1 V or less

- Ignition OFF
- Disconnect NGTP sensor connector
- Install a jumper wire between NGTP 5 V supply terminal and NGTP signal terminal in harness sensor connector
- Ignition ON, engine OFF
- Using the DST, read the NGTP voltage

Below 4.5 V

- Remove jumper wire
- Using a multimeter, measure the voltage between NGTP ground terminal and NGTP 5 V supply terminal in the harness sensor connector

4.0 - 6.0 V

- Open in NGTP signal circuit
  OR
- Short to ground in NGTP signal circuit
  OR
- Faulty ECU connection
  OR
- Faulty ECU

Below 4.0 V

- Open in NGTP 5 V supply circuit
  OR
- Short to ground in NGTP 5 V supply circuit
  OR
- Faulty ECU connection
  OR
- Faulty ECU

4.5 V or greater

- Faulty NGTP sensor connection
  OR
- Faulty NGTP sensor

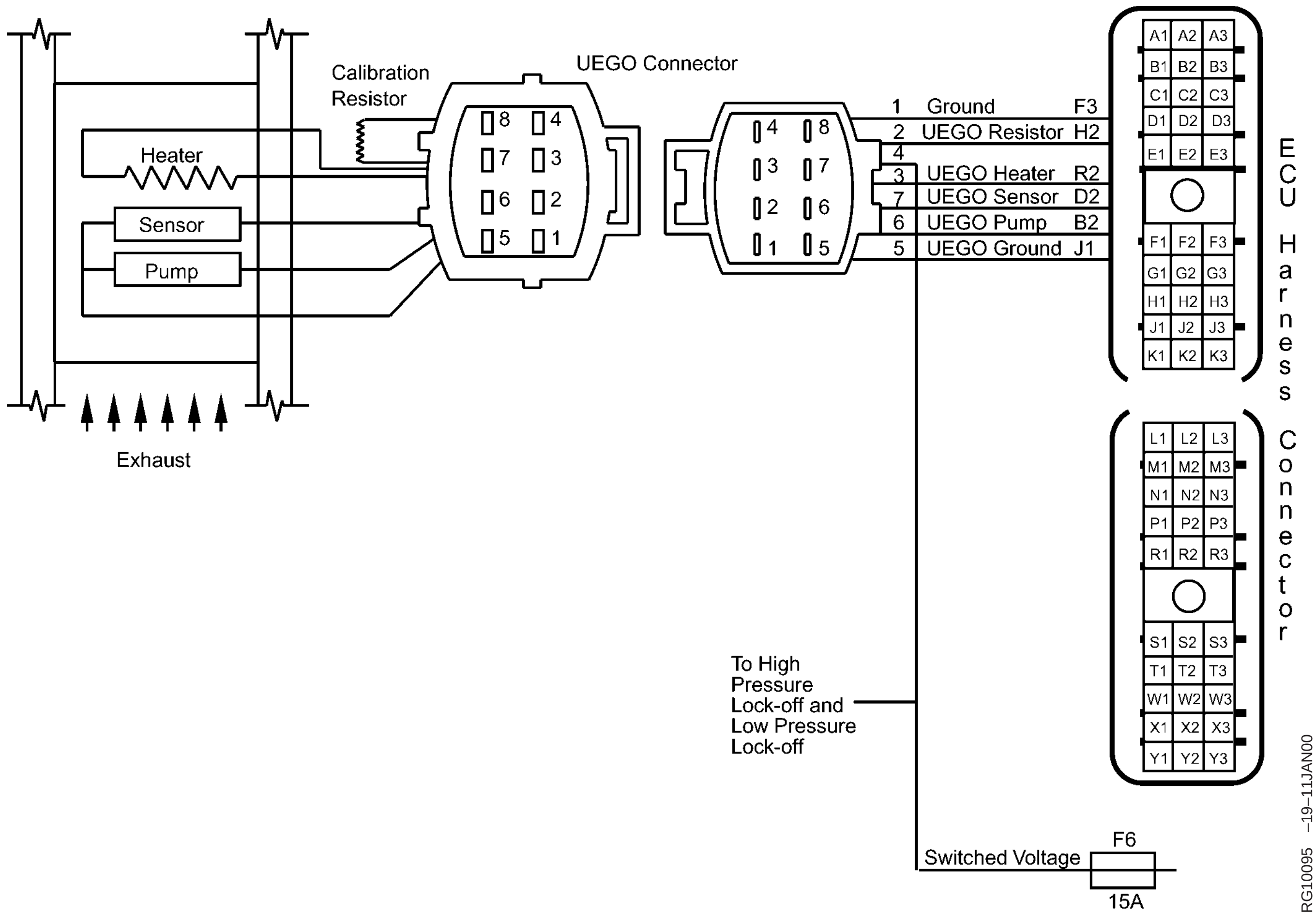
Above 0.1 V

Problem is intermittent. If not other codes are present, see INTERMITTENT FAULT DIAGNOSTICS, earlier in this group

RG10185 –19–16AUG00

DPSG,RG40854,143 –19–10JUN99–1/1

DTC 68 UEGO Calibration Resistor Voltage High



Continued on next page RG,RG34710,3178 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO calibration resistor is used to allow for interchange ability of UEGO sensors.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO to correct fuel delivery with the Closed Loop multiplier and the Adaptive learn multiplier.

DTC 68 will set if:

The UEGO calibration resistor voltage exceeds 4.9 volts

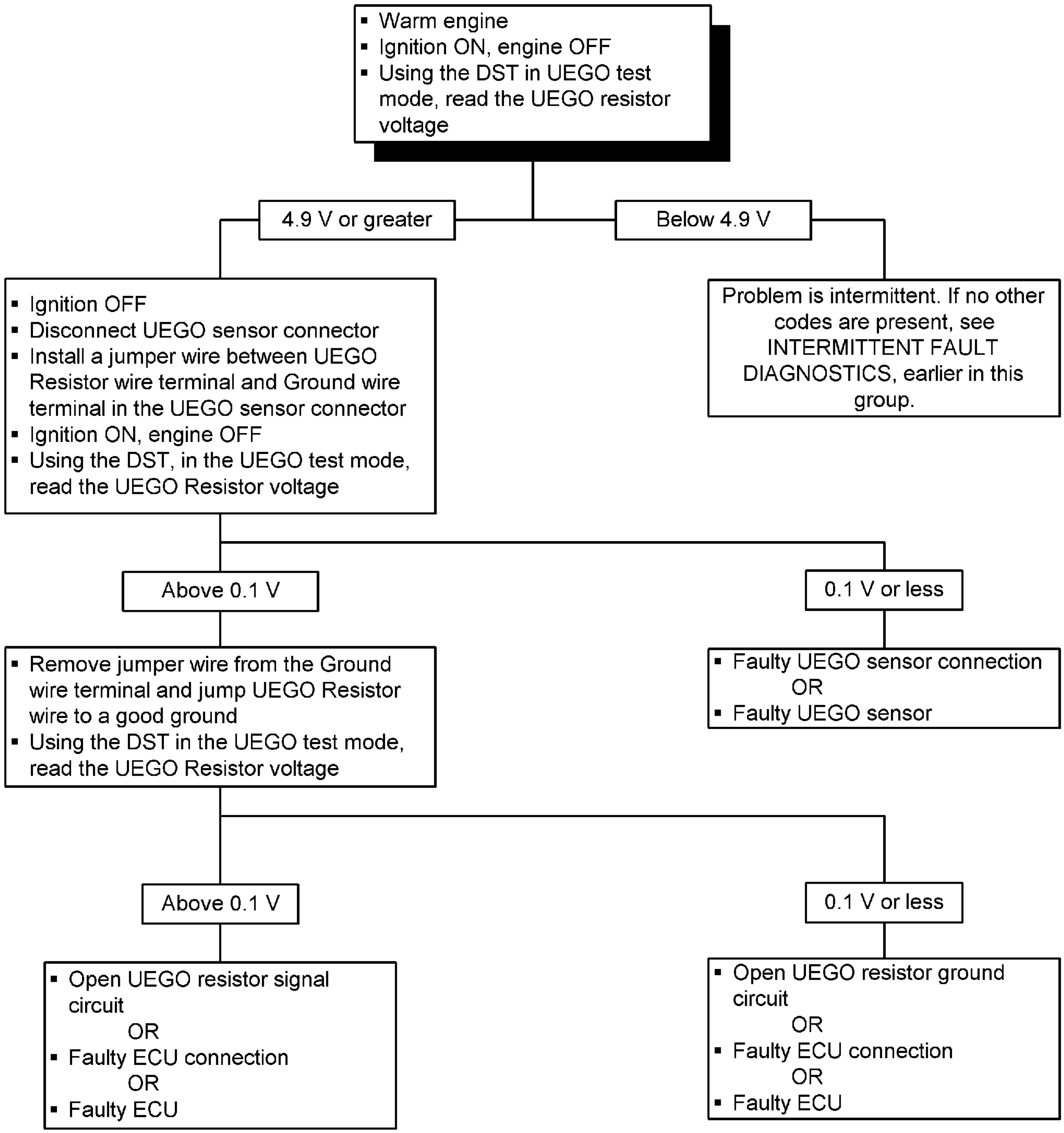
If DTC 68 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3178 –19–15JUL96–2/2

DTC 68 UEGO Calibration Resistor Voltage High - Continued

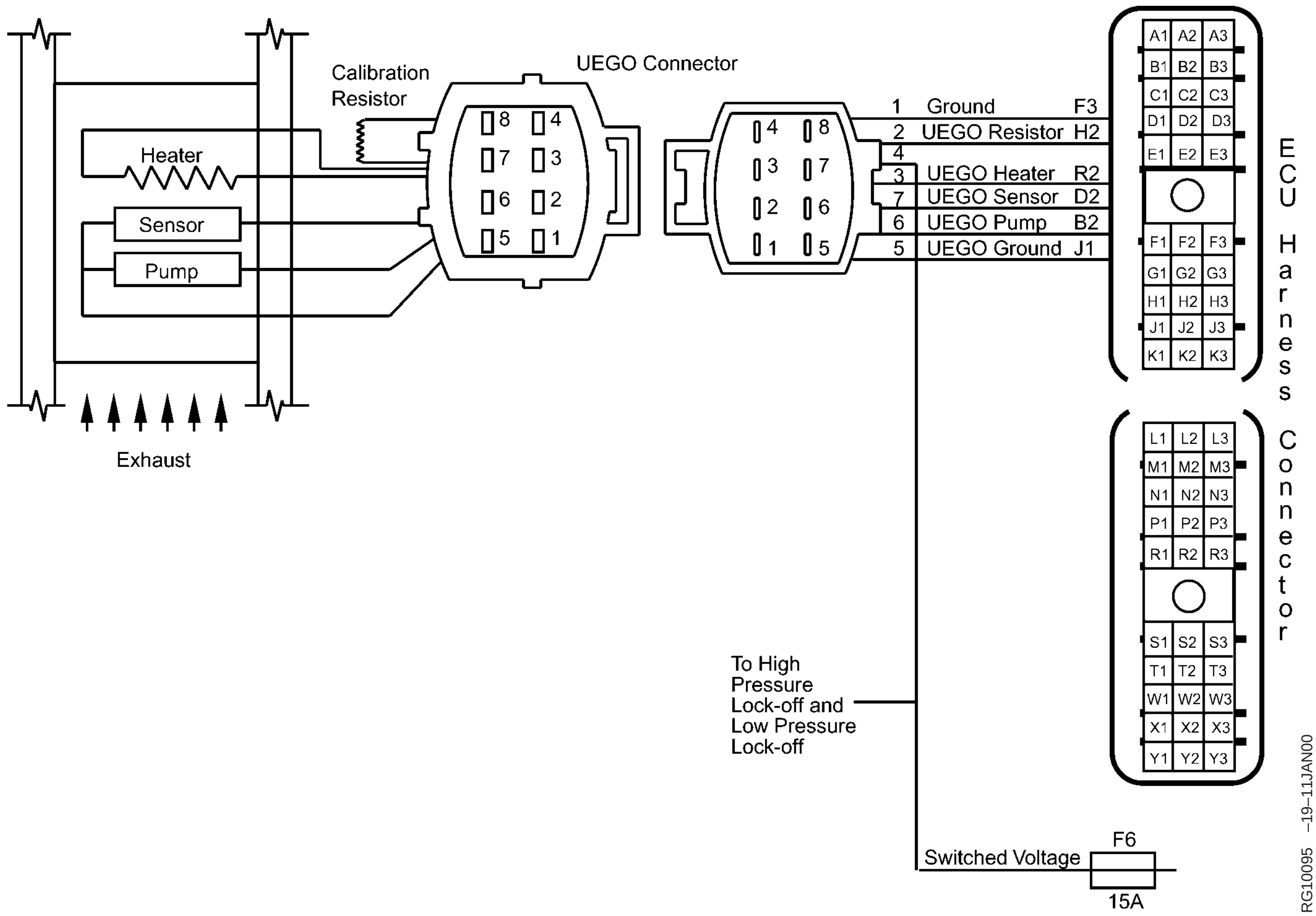
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



RG10186 –19–16AUG00

DPSG,RG40854,144 –19–10JUN99–1/1

DTC 69 UEGO Calibration Resistor Low



Continued on next page RG,RG34710,3180 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F4 is used in the location of fuse F6 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F3	1	21D Black	Black/Yellow	Ground
H2	2	24 Gray	Gray/Black	UEGO Resistor
	4	59 Pink	White/Lt. Blue	Switched Voltage
R2	3	23 White	White/Lt. Blue	UEGO Heater
D2	7	25 Dk. Green	Dk. Green/Orange	UEGO Sense
B2	6	26 Lt. Blue	Lt. Blue/White	UEGO Pump
J1	5	27 Black	Black/Orange	UEGO Ground

UEGO - Universal Exhaust Gas Oxygen sensor

The UEGO sensor is used to measure the oxygen content in the exhaust gas. The amount of oxygen in the exhaust is directly related to air/fuel ratio. The UEGO calibration resistor is used to allow for interchange ability of UEGO sensors.

The ECU uses the UEGO sensor:

When the system is operating in closed loop, the ECU uses information from the UEGO to correct fuel delivery with the Closed Loop multiplier and the Adaptive learn multiplier.

DTC 69 will set if:

The UEGO calibration resistor voltage drops below 0.1 volts

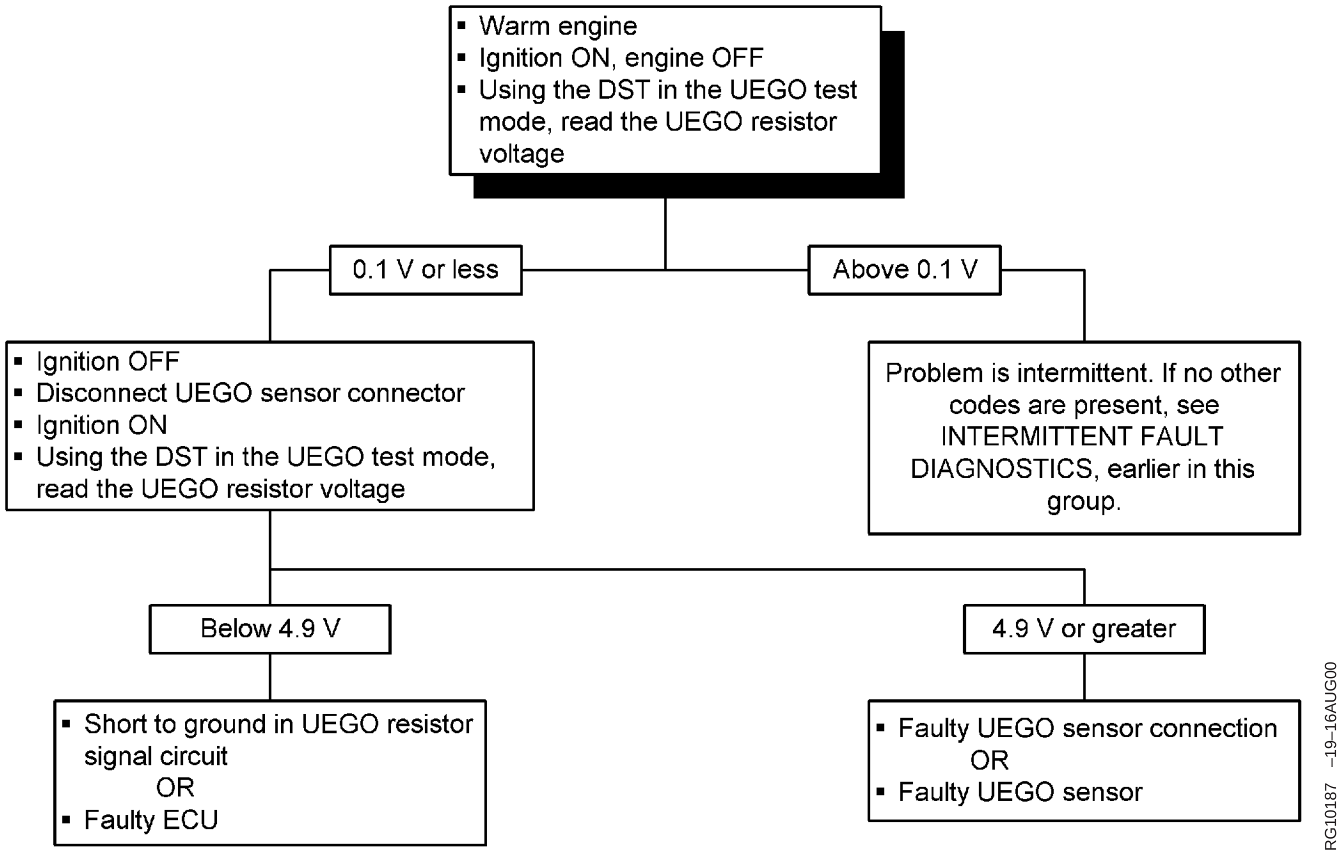
If DTC 69 sets, the following will occur:

- Closed loop disabled for remainder of key-on cycle
- Adaptive learn disabled for remainder of key-on cycle
- Boost limited to 10 psig maximum
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3180 –19–15JUL96–2/2

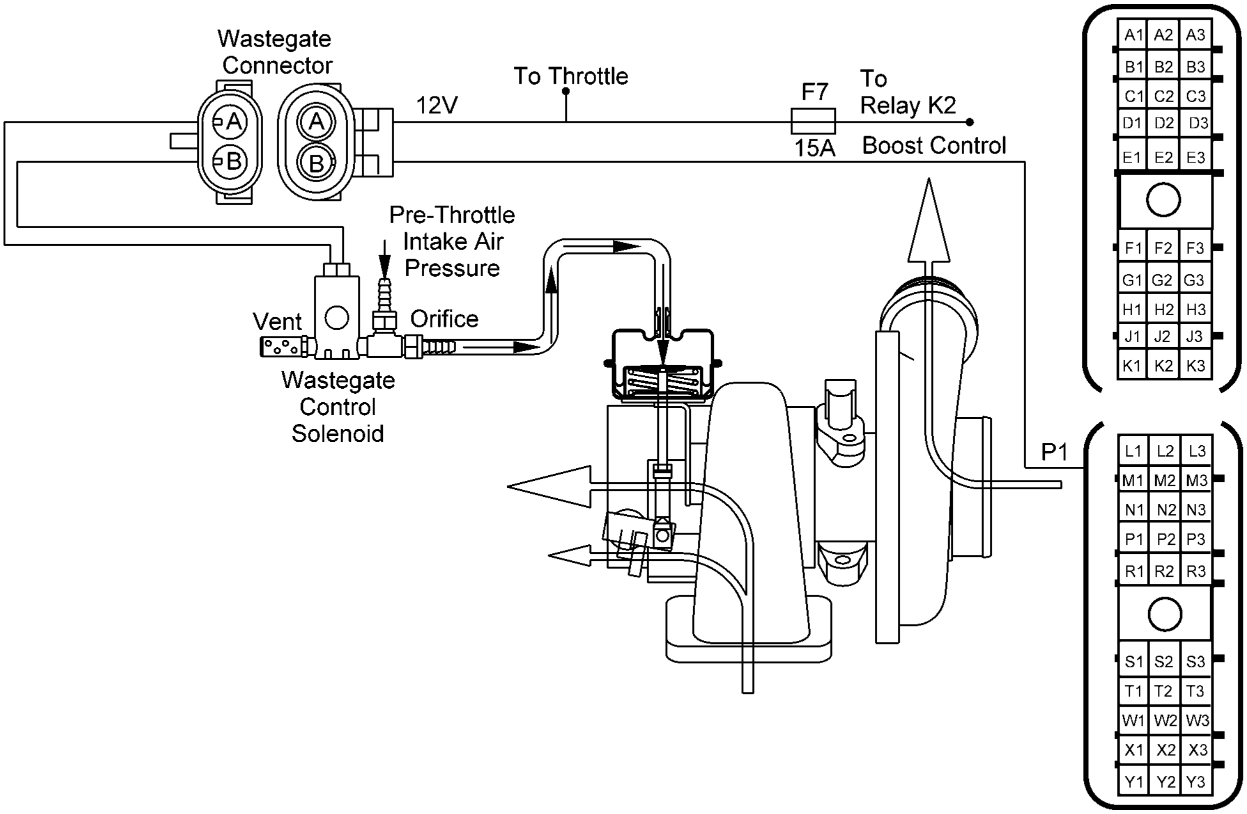
DTC 69 UEGO Calibration Resistor Low - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the UEGO connector looking for dirty, damaged, or poorly positioned terminals.



DPSG,RG40854,145 –19–10JUN99–1/1

DTC 71 Boost Higher Than Expected



RG10077 –19–24MAY99

NOTE: In early wiring harnesses, fuse F5 is used in the location of fuse F7 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
P1	B	37 Tan	Tan/Orange	Boost Control
	A	57 Pink	Pink/Yellow	VBAT

Boost control circuit

The ECU controls the amount of boost that the turbocharger is allowed to generate by sending a pulse width modulated (PWM) signal to the wastegate solenoid. The wastegate control solenoid routes pre-throttle intake air pressure to either the wastegate diaphragm or to a vent. When the solenoid is energized, pressure is routed to the vent, spring force holds the wastegate closed and the turbo generates maximum boost. When the solenoid is not energized, pressure is routed to the wastegate diaphragm, overcoming spring force, opening the wastegate, causing the turbo to generate minimum boost. The ECU uses the MAP sensor to determine the amount of boost (intake air pressure) that is being introduced into the engine.

DTC 71 will set if:

MAP sensor reads 3 psi above current command (command based on engine speed and foot pedal position) continuously for 10 seconds anytime engine is running.

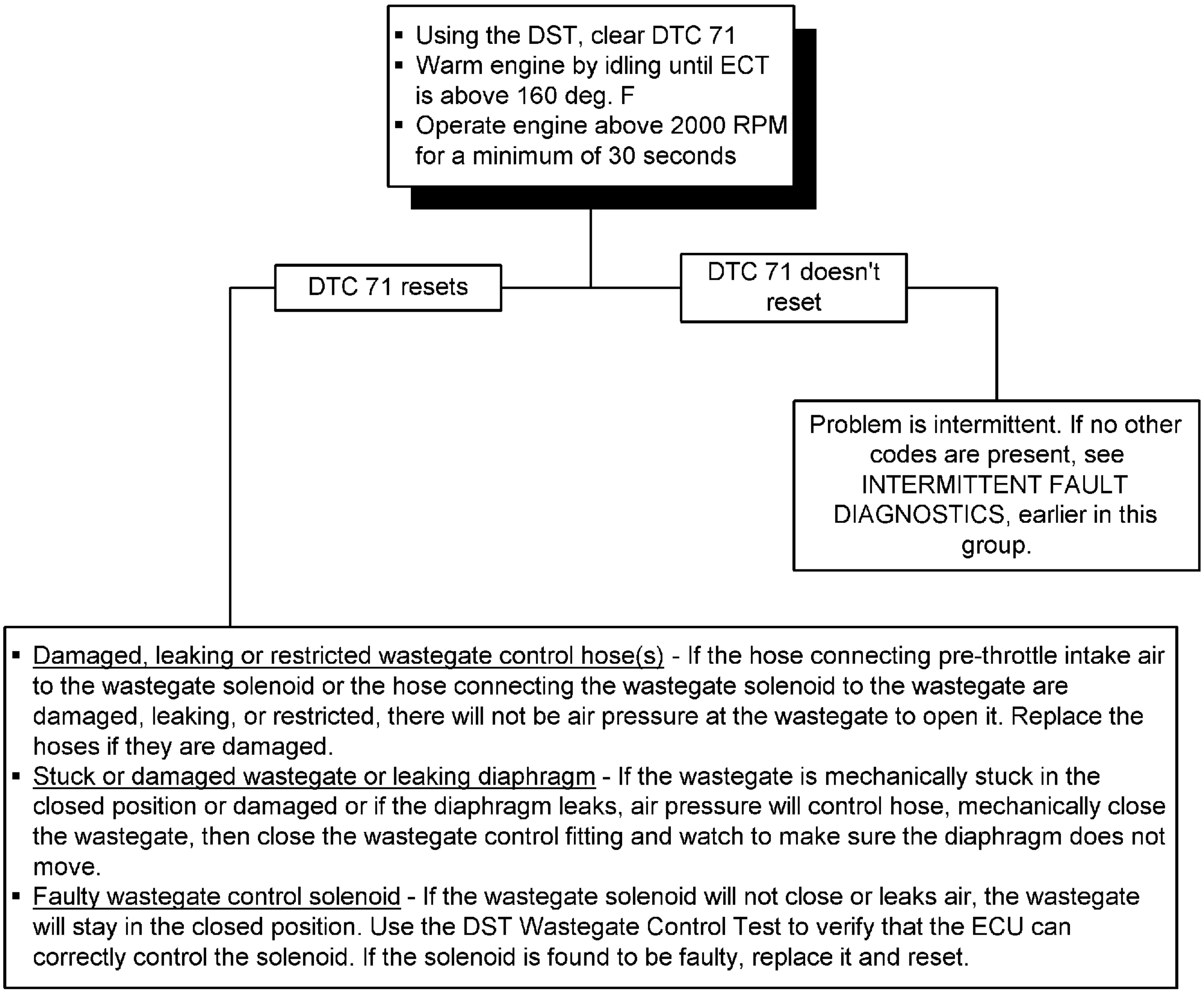
If DTC 71 sets, the following will occur:

- Boost limited to 10 psig maximum (using throttle to restrict boost)
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3182 –19–15JUL96–1/1

DTC 71 Boost Higher Than Expected - Continued

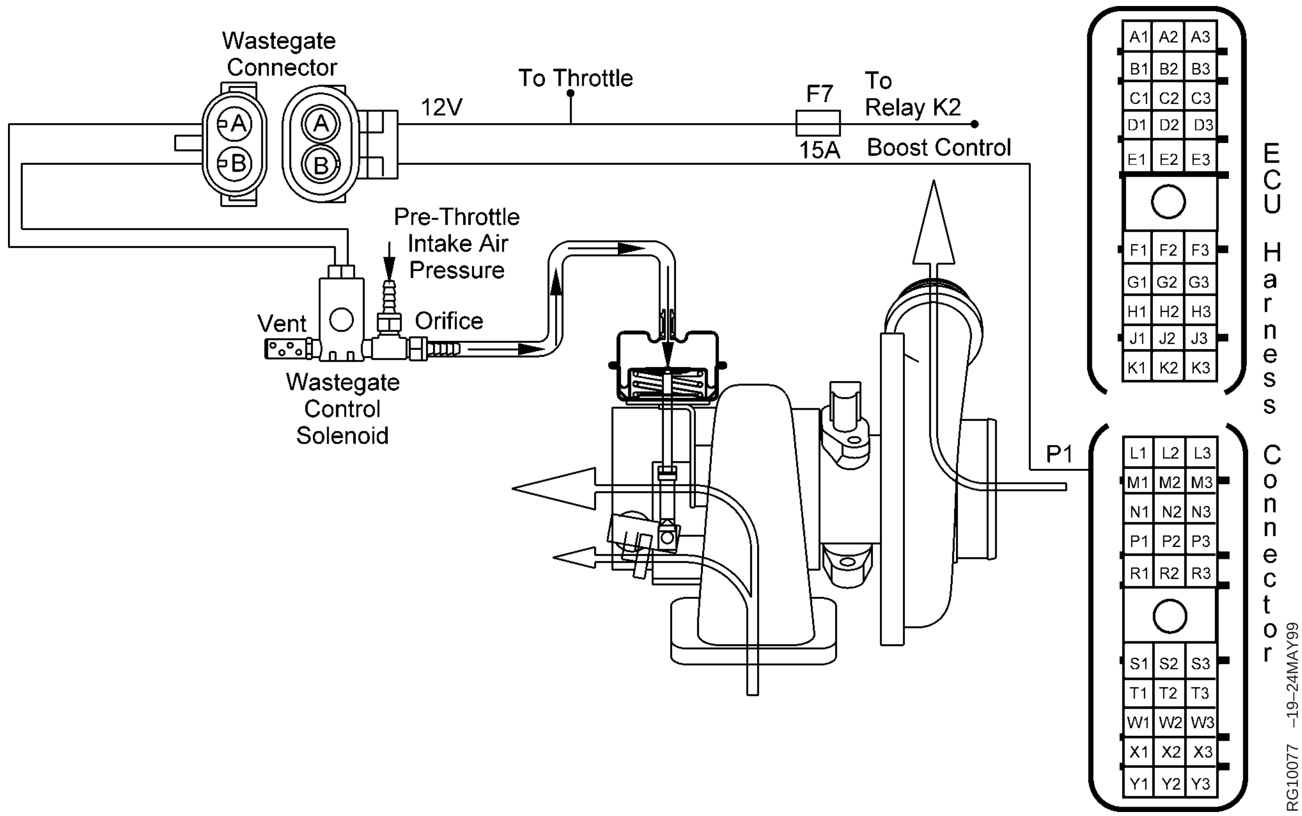
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Wastegate connector looking for dirty, damaged, or poorly positioned terminals.



RG10188 –19–16AUG00

DPSG,RG40854,146 –19–10JUN99–1/1

DTC 72 Boost Lower Than Expected



NOTE: In early wiring harnesses, fuse F5 is used in the location of fuse F7 shown in the electrical schematic.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
P1	B	37 Tan	Tan/Orange	Boost Control
	A	57 Pink	Pink/Yellow	VBAT

Boost control circuit

The ECU controls the amount of boost that the turbocharger is allowed to generate by sending a pulse width modulated (PWM) signal to the wastegate solenoid. The wastegate control solenoid routes pre-throttle intake air pressure to either the wastegate diaphragm or to a vent. When the solenoid is energized, pressure is routed to the vent, spring force holds the wastegate closed and the turbo generates maximum boost. When the solenoid is not energized, pressure is routed to the wastegate diaphragm, overcoming spring force, opening the wastegate, causing the turbo to generate minimum boost. The ECU uses the MAP sensor to determine the amount of boost (intake air pressure) that is being introduced into the engine.

DTC 72 will set if:

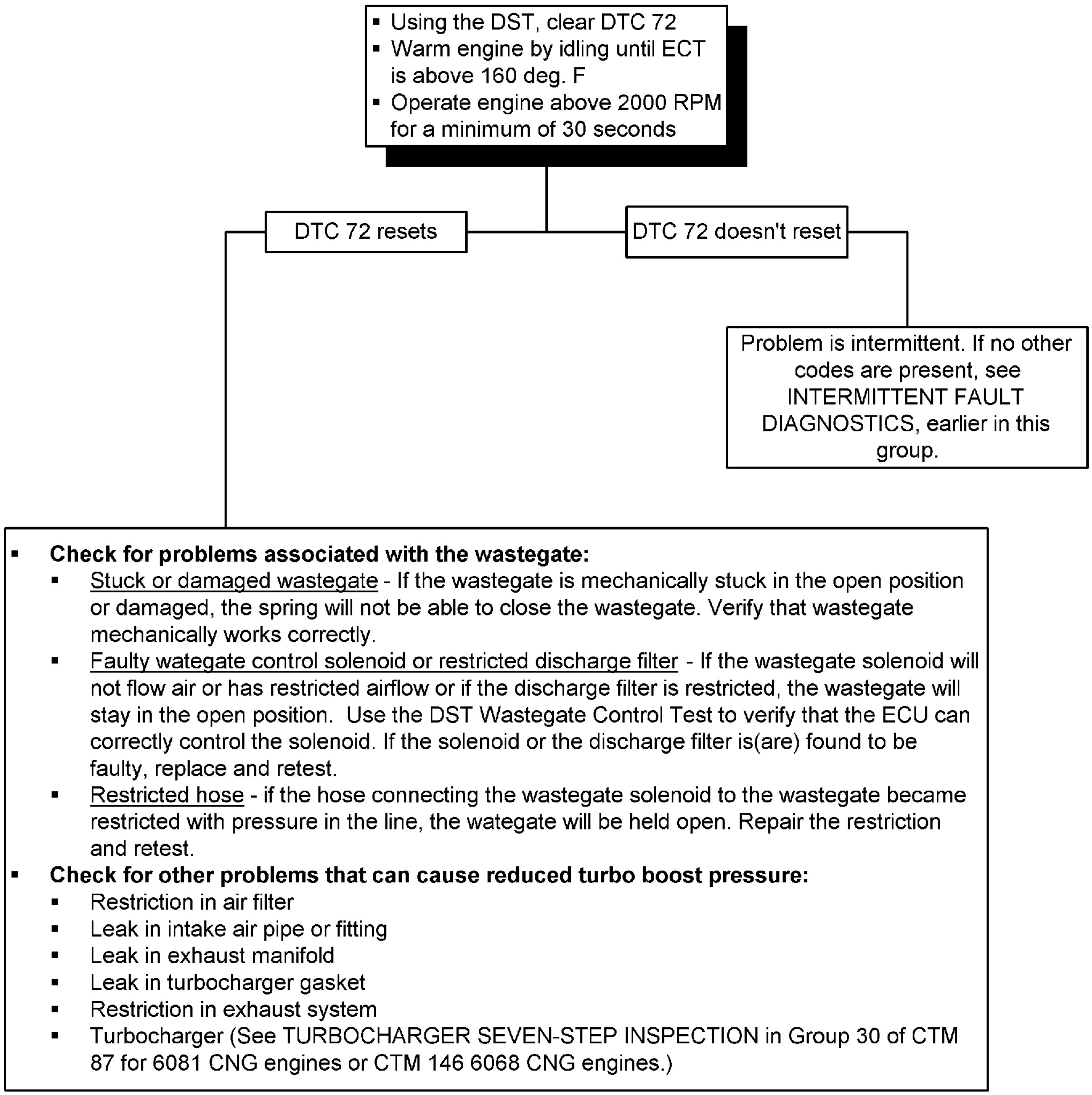
- The commanded boost is above 26 psia (near full FPP depression and engine speed above 1250 RPM)
- **AND** the MAP sensor reads 5 psia below current command (command based on engine speed and foot pedal position) continuously for 10 seconds anytime engine is running

If DTC 72 sets, the following will occur:

CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

DTC 72 Boost Lower Than Expected - Continued

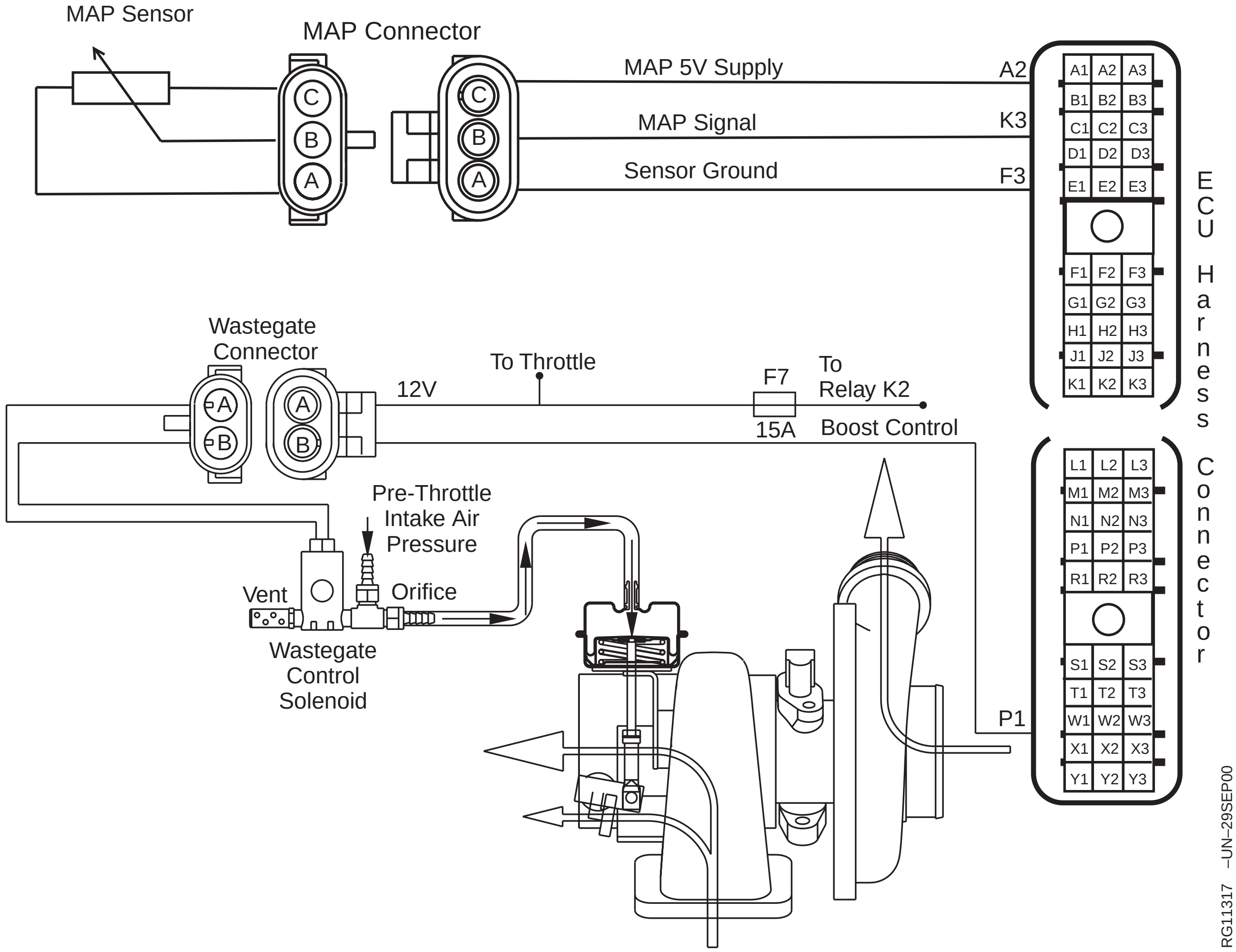
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Wastegate connector looking for dirty, damaged, or poorly positioned terminals.



RG10189 –19–17NOV00

DPSG,RG40854,147 –19–10JUN99–1/1

DTC 73 Overboost



NOTE: *In early wiring harnesses, fuse F5 is used in the location of fuse F7 shown in the electrical schematic.*

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
P1	B	37 Tan	Tan/Orange	Boost Control
	A	57 Pink	Pink/Yellow	VBAT

Boost control circuit

The ECU controls the amount of boost that the turbocharger is allowed to generate by sending a pulse width modulated (PWM) signal to the wastegate solenoid. The wastegate control solenoid routes pre-throttle intake air pressure to either the wastegate diaphragm or to a vent. When the solenoid is energized, pressure is routed to the vent, spring force holds the wastegate closed and the turbo generates maximum boost. When the solenoid is not energized, pressure is routed to the wastegate diaphragm, overcoming spring force, opening the wastegate, causing the turbo to generate minimum boost. The ECU uses the MAP sensor to determine the amount of boost (intake air pressure) that is being introduced into the engine.

DTC 73 will set if:

The MAP sensor reads 4 psia above current limit (based on engine speed and foot pedal position) continuously for 1.5 seconds anytime engine is running or cranking.

Continued on next page

RG,RG34710,3186 –19–15JUL96–1/2

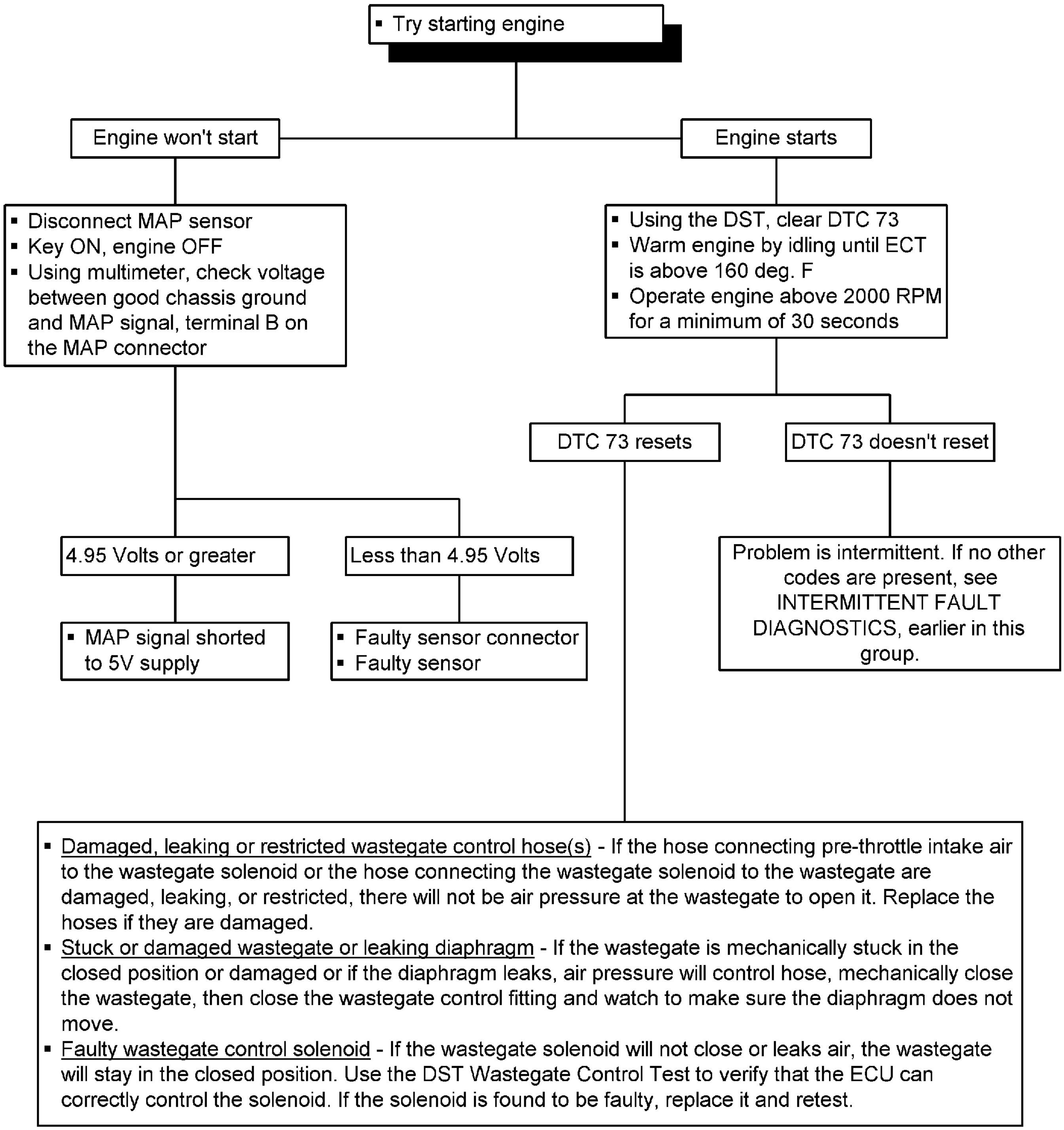
If DTC 73 sets, the following will occur:

- Boost limited to 10 psig maximum (using throttle to restrict boost)
- Adaptive learn disabled for remainder of key-on cycle
- CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3186 –19–15JUL96–2/2

DTC 73 Overboost - Continued

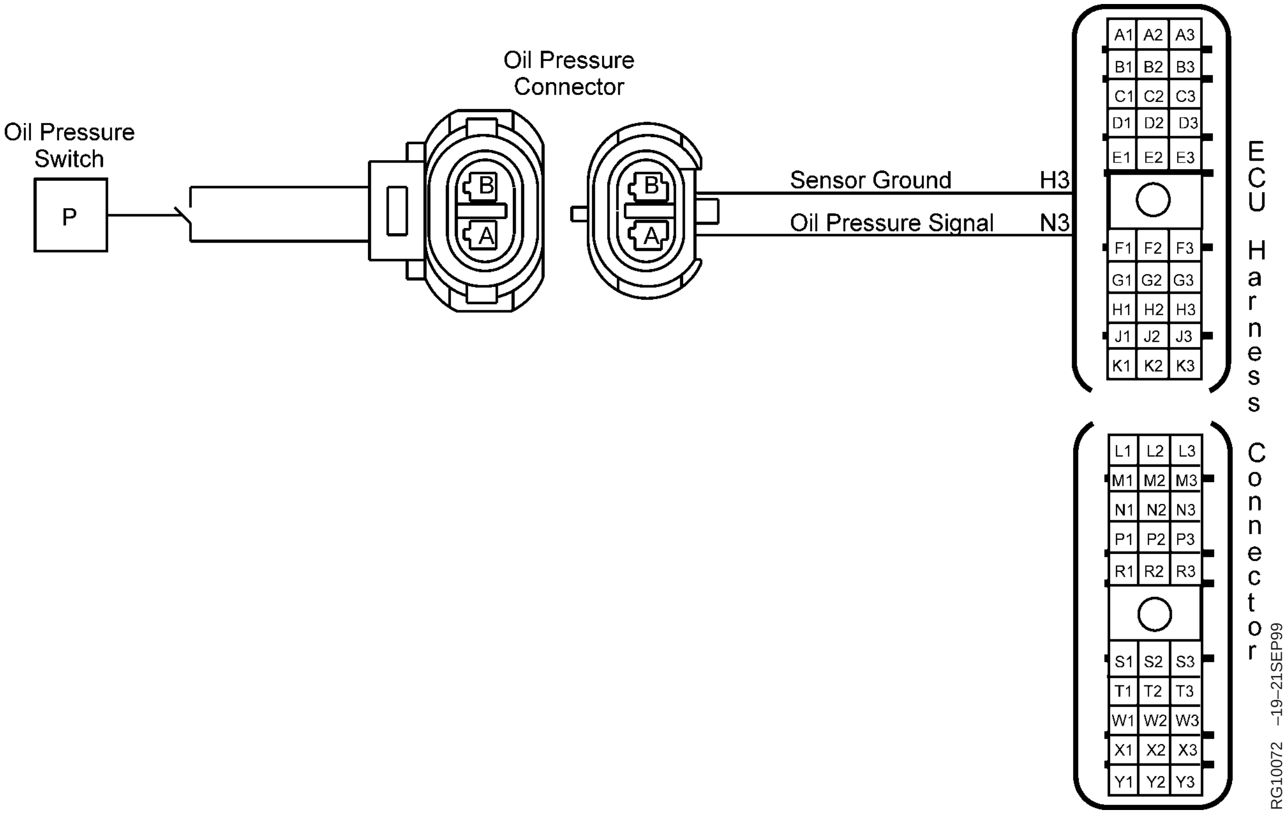
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Wastegate, and the MAP sensor connectors looking for dirty, damaged, or poorly positioned terminals.



RG10190 –19–31AUG00

DPSG,RG40854,148 –19–10JUN99–1/1

DTC 74 Oil Pressure Low



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
N3	A	42 Lt. Green	Lt. Green/Black	Oil Pressure Signal
H3	B	20B Black	Black/Tan	Sensor Ground

Oil Pressure switch

The oil pressure switch is used to alert the ECU in the event of a low engine oil pressure condition. Oil pressure causes the contacts in the switch to close, when oil pressure drops below 9 psi the switch opens giving it a resistance greater than 2 Kilo-ohms. If this fault occurs, engine power output will be limited by the ECU to help reduce load on the engine. The engine can be severely damaged if it is allowed to operate with low oil pressure.

DTC 74 will set if:

Engine oil pressure drops below 9 psi

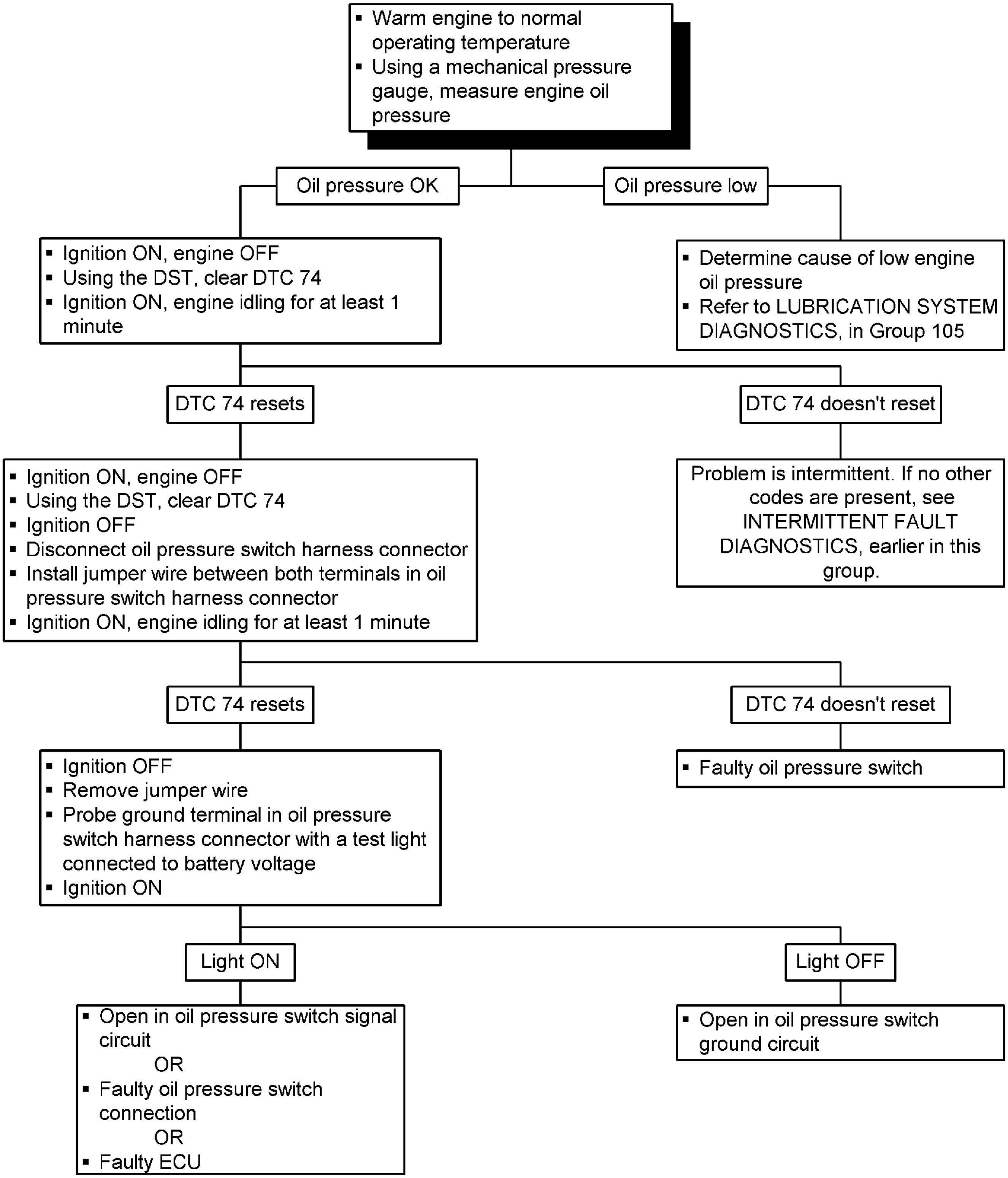
If DTC 74 sets, the following will occur:

- Engine power output limited by ECU by opening turbo wastegate and closing throttle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

RG,RG34710,3188 –19–15JUL96–1/1

DTC 74 Oil Pressure Low - Continued

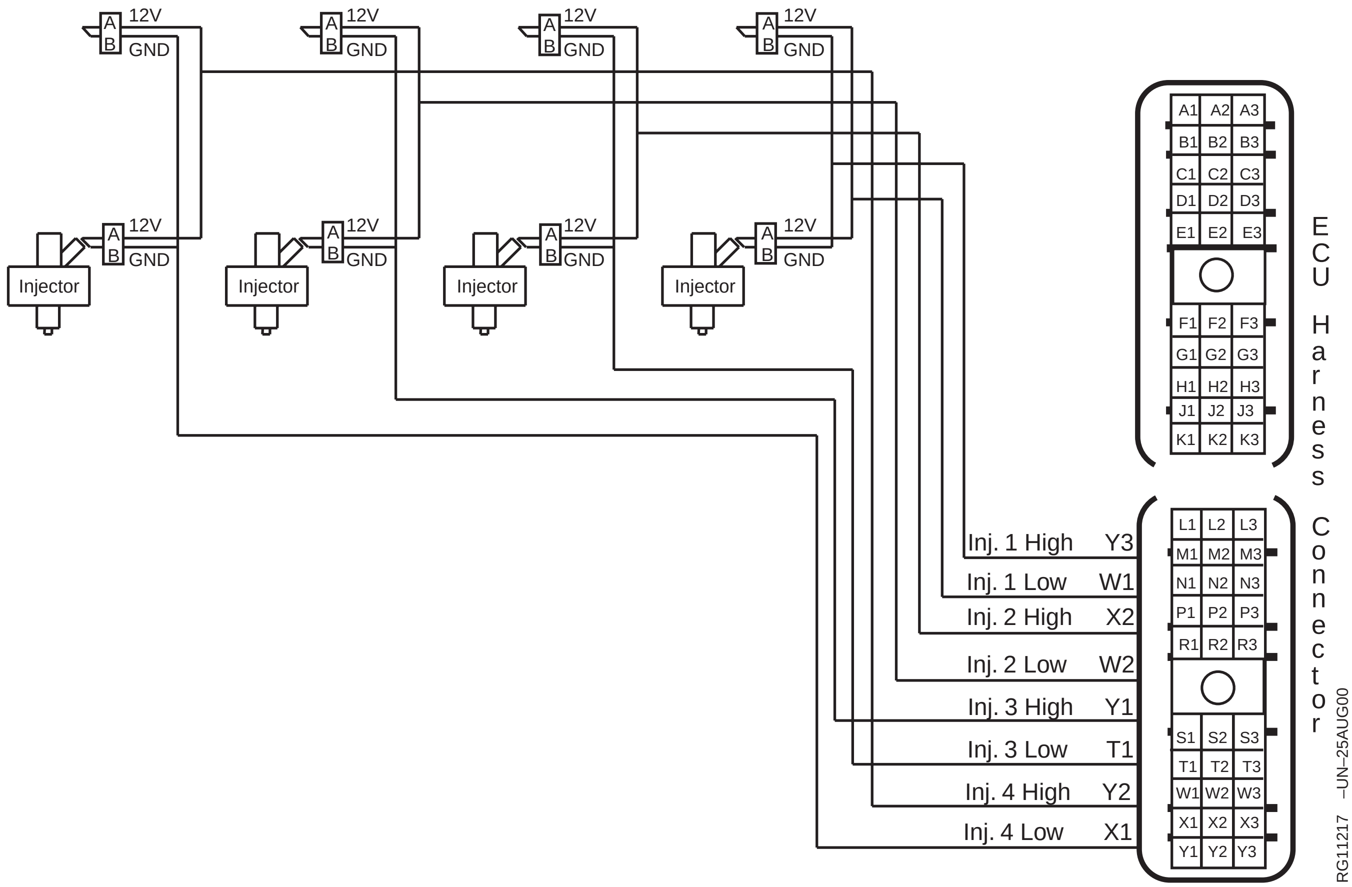
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Oil Pressure switch connector looking for dirty, damaged, or poorly positioned terminals.



RG10191 –19–16AUG00

DPSG,RG40854,149 –19–10JUN99–1/1

DTC 75 Injector Duty Cycle High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
Y3	A	1 Orange	Orange/Lt. Blue	Inj. 1 High
W1	B	2 Brown	Brown/Lt. Blue	Inj. 1 Low
X2	A	3 Orange	Orange/Lt. Green	Inj. 2 High
W2	B	4 Brown	Brown/Lt. Green	Inj. 2 Low
Y1	A	5 Orange	Orange/White	Inj. 3 High
T1	B	6 Brown	Brown/White	Inj. 3 Low
Y2	A	7 Orange	Orange/Yellow	Inj. 4 High
X1	B	8 Brown	Brown/Yellow	Inj. 4 Low

Fuel Injector control circuit

Eight electrically pulsed injectors are located on the fuel metering block. The ECU controls the “on” time (pulse width) of each pair of injectors to deliver the correct amount of fuel to the engine.

DTC 75 will set if:

In order to obtain the desired air/fuel ratio, the ECU is required to keep the injectors turned on longer than what is expected for 1.5 seconds anytime the engine is running

If DTC 75 sets, the following will occur:

- Adaptive learn disabled during active fault
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

Possible Failures

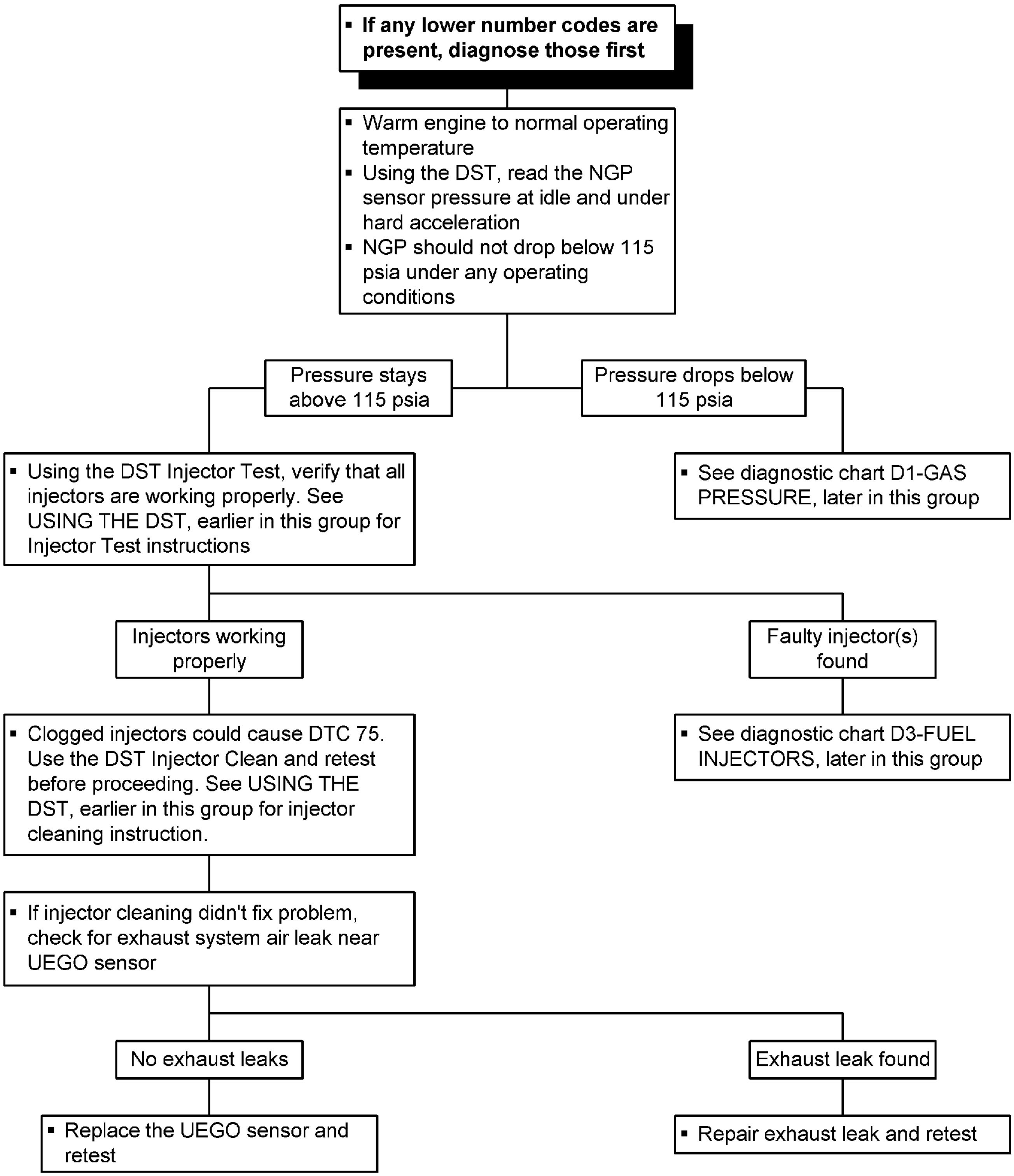
Continued on next page

- **Faulty fuel injector(s)** - The injector duty cycle will be high if an injector or an injector driver fails. Use the DST Injector Test to determine if injector(s) is faulty.
- **Clogged injectors** - Injectors that are partially clogged could cause the injector duty cycle to be high. Use the DST Injector Clean, then retest.
- **Exhaust leak** - If there is an exhaust leak near the UEGO sensor; under certain conditions, fresh air could be drawn across the UEGO sensor causing a false lean condition which could cause the injector duty cycle to be high. Determine if there is an exhaust leak, if there is repair it and retest.
- **Faulty UEGO sensor** - A faulty UEGO sensor could send the ECU a faulty lean condition, causing the injector duty cycle to be high. If no other problems are found, replace the UEGO sensor and retest.

RG,RG34710,3189 –19–15JUL96–2/2

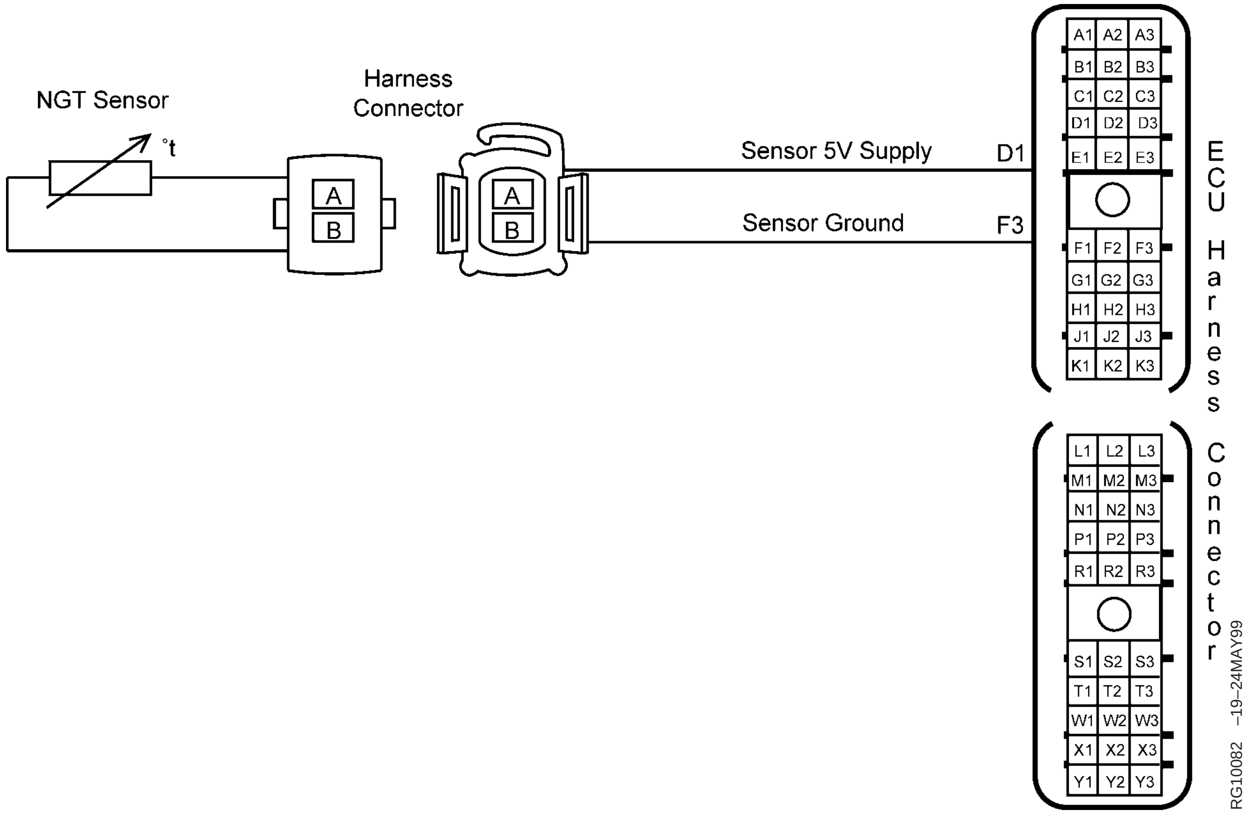
DTC 75 Injector Duty Cycle High - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and all of the Injector connectors looking for dirty, damaged, or poorly positioned terminals.



RG10192 –19–16AUG00

DTC 77 NGT Lower Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
D1	A	14 White	White/Lt. Green	NGT 5V Supply
F3	B	21A Black	Black/Yellow	Sensor Ground

NGT - Natural Gas Temperature sensor

The NGT sensor is a thermistor (temperature sensitive variable resistor) located in the fuel metering valve. It is used to measure the temperature of the fuel prior to injection. The NGT sensor adjusts the 5 V supply voltage sent by the ECU. Higher temperatures result in lower voltages to the ECU, lower temperatures result in higher voltages.

The ECU uses the NGT sensor measurement:

In conjunction with the NGP sensor to determine Fuel density at the injectors.

DTC 77 - will set if:

- NGT lower than -43°F (41.7°C) with the ECT above 0°F (-17.8°C).

If DTC 15 sets, the following will occur:

- Adaptive Learn disabled
- CEL on for remainder of key on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault will set
- Boost pressure is limited to 15 psia (0 psig) maximum for remainder of key on cycle

DPSG,RG41221,62 –19–10JUL00–1/1

DTC 77 NGT Lower Than Expected - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Temperature sensor connector looking for dirty, damaged, or poorly positioned terminals.

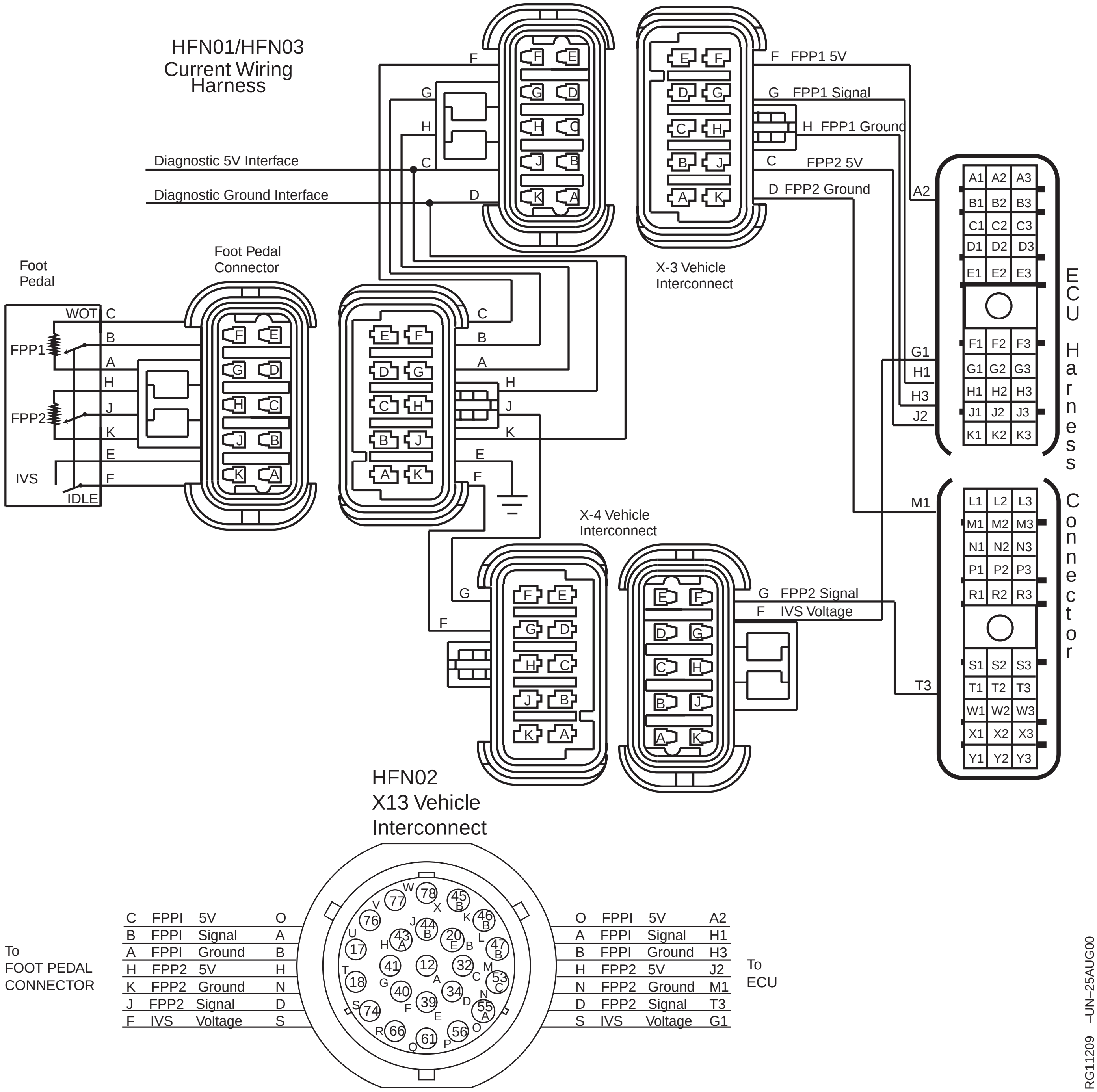
Diagnostic Aids

- Gas Temperature Thermostat - If the thermostat that controls the gas temperature out of the heat exchangers failed close, DTC 77 will result.
- Coolant Lines - If the coolant lines to the heat exchanger have become clogged or restricted, DTC 77 may result.
- Heat Exchanger - If the heat exchanger is full of sediment or contaminant in the coolant passages, DTC 77 may result.
- Ground Problems - ECU grounds must be a good battery ground. Faulty grounds may cause many unrelated problems as well.
- NGT Sensor - If no other problems are found, replace the NGT sensor and retest.

RG11139 –19–16AUG00

DPSG,RG41221,63 –19–10JUL00–1/1

DTC 78 IVS Status OFF Unexpected



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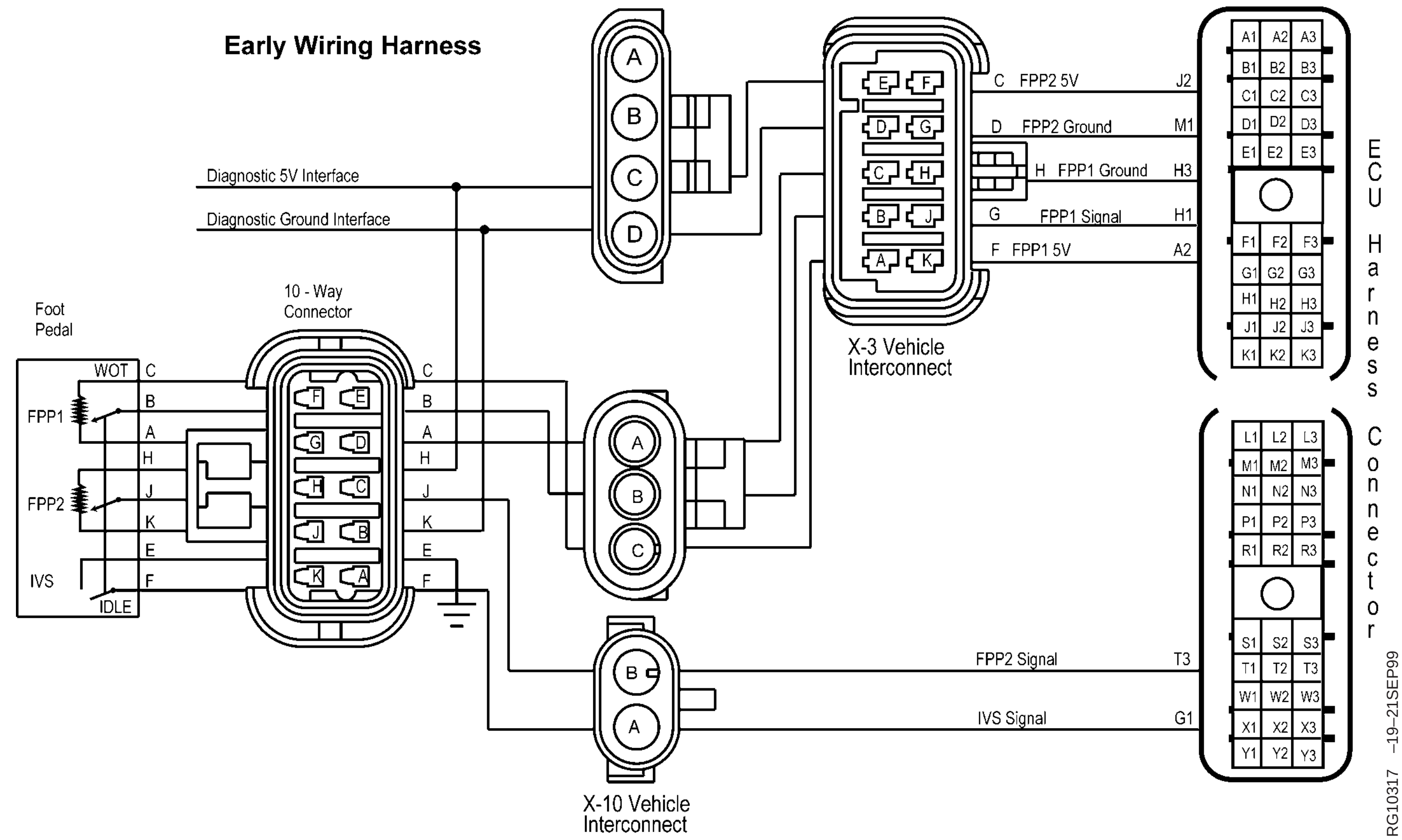
RG,RG34710,3190 –19–15JUL96–1/3



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

IVS – Idle Validation Switch

The foot pedal assembly contains an Idle Validation Switch (IVS) and two independent Foot Pedal Position (FPP) sensors. When the foot pedal is in the idle position, the IVS is open; giving the ECU an IVS status of “ON”. When the foot pedal is depressed more than idle, the switch contacts close, grounding the IVS and giving the ECU an IVS status of “OFF”. The IVS status is compared to the two FPP sensor signals to determine each signal’s validity. If the ECU determines that the IVS status is invalid, it will set a fault code and use the FPP1 and FPP2 signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the IVS status input:

As a redundant input to the FPP1 input and the FPP2 input; to allow the ECU to determine when the foot pedal is on and off the idle position

DTC 78 will set if:

Continued on next page

- The FPP1 sensor signal voltage is less than 0.60 volts **OR** the FPP2 sensor signal voltage is less than 0.62 volts
- **AND** the IVS status is “OFF” (off-idle position)

If DTC 78 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

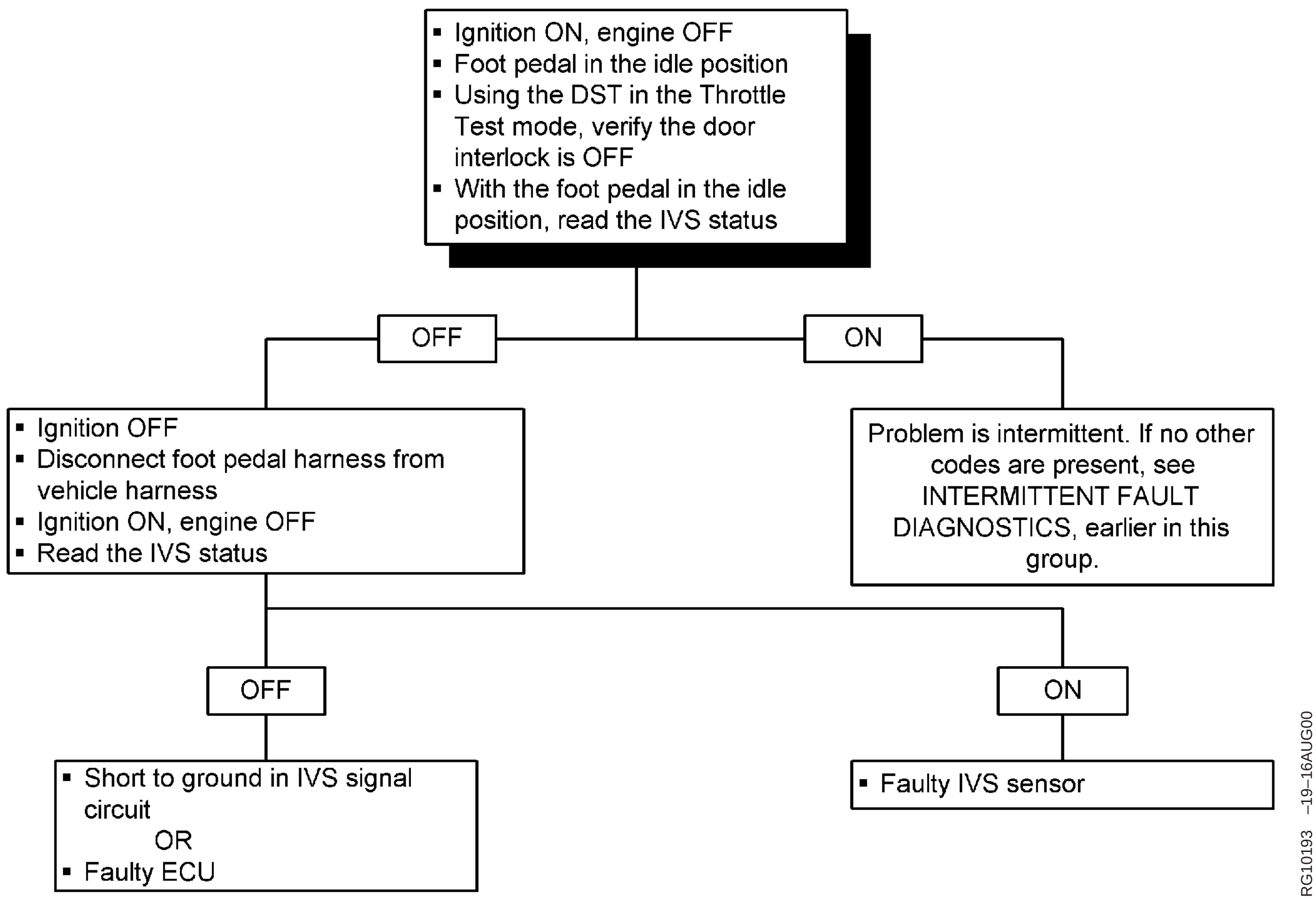
- No change in driveability
- Reduced engine power and degraded driveability

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3190 –19–15JUL96–3/3

DTC 78 IVS Status OFF Unexpected - Continued

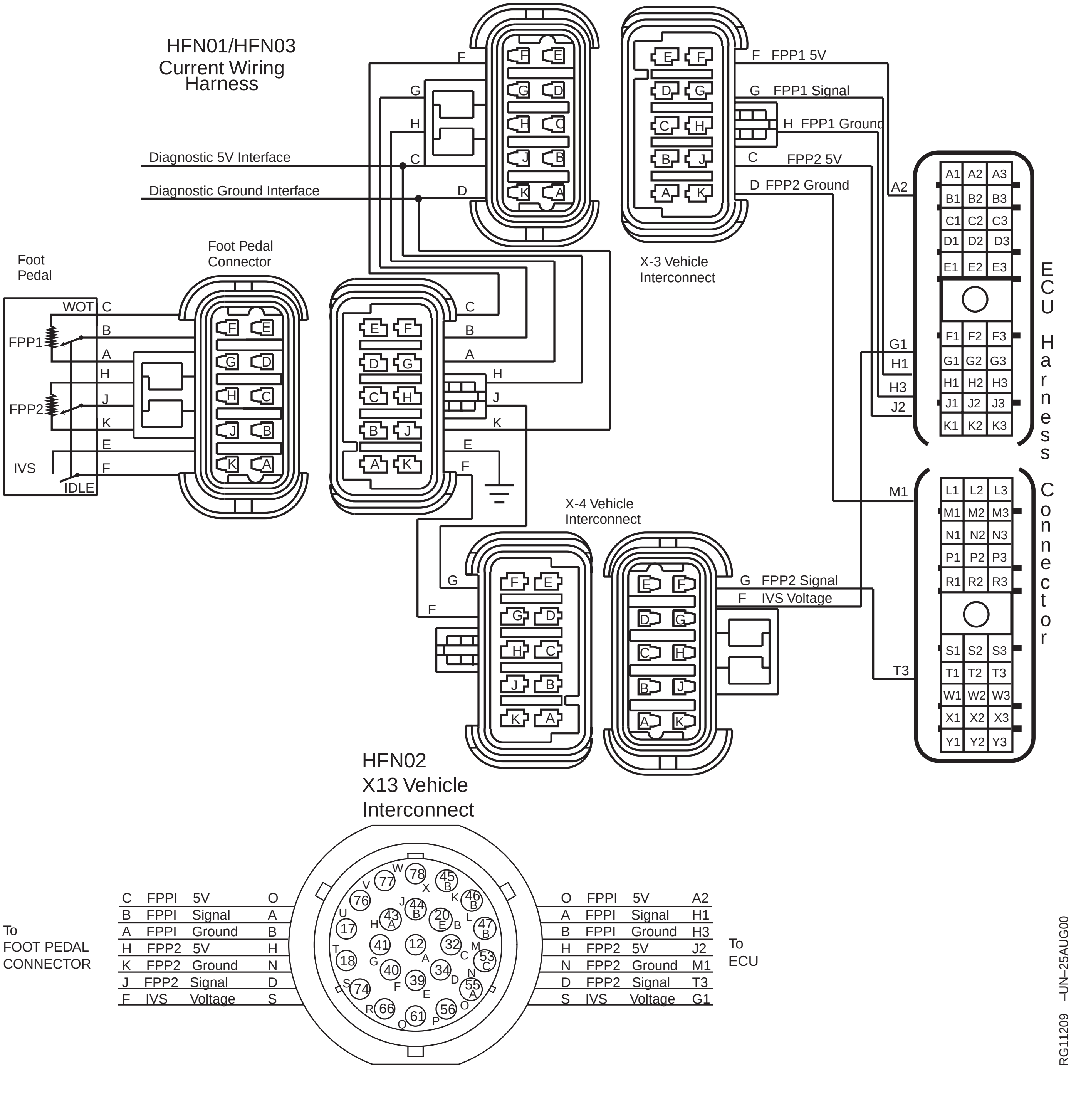
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10193 –19–16AUG00

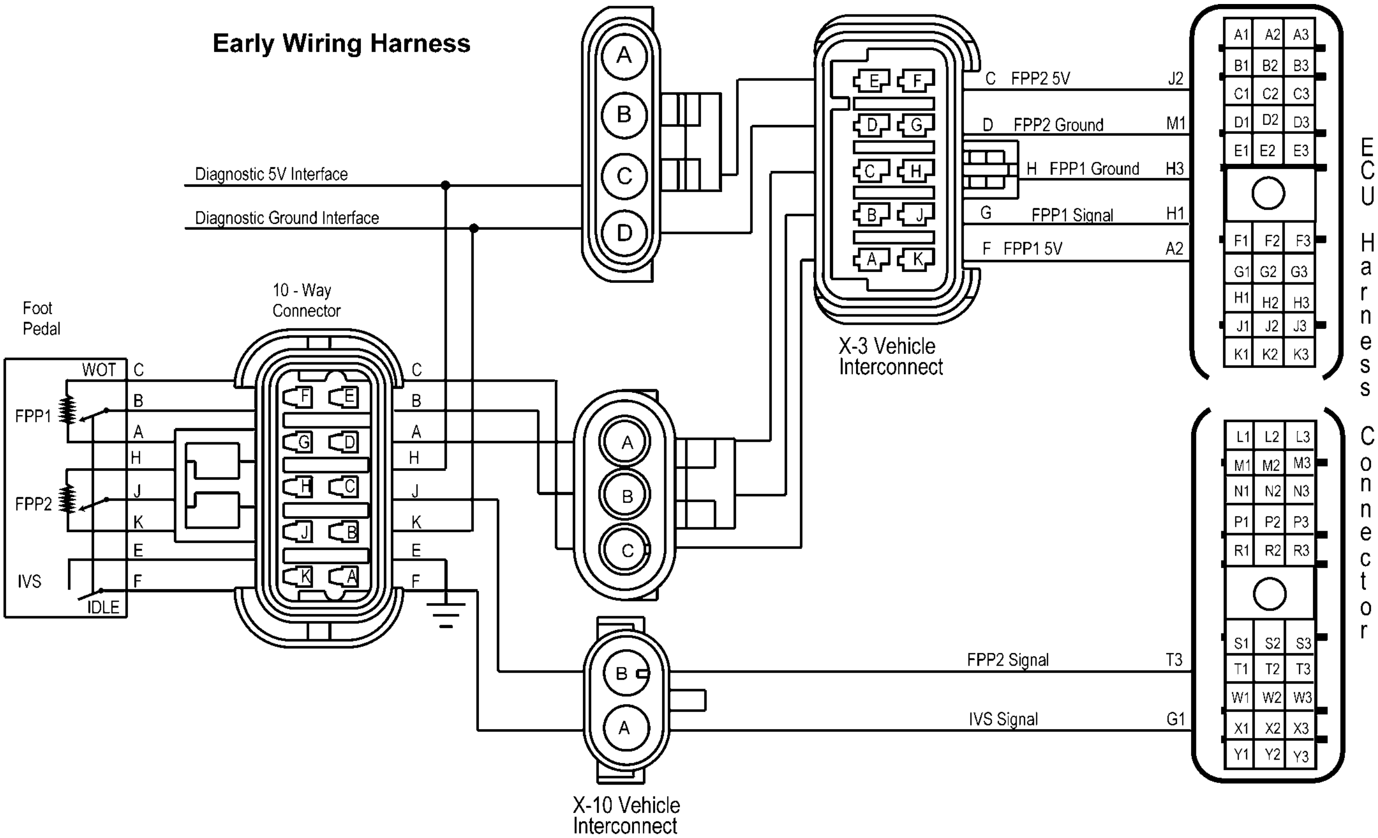
DPSG,RG40854,151 –19–10JUN99–1/1

DTC 79 IVS Status ON Unexpected



Continued on next page

RG,RG34710,3191 –19–15JUL96–1/3



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

IVS – Idle Validation Switch

The foot pedal assembly contains an Idle Validation Switch (IVS) and two independent Foot Pedal Position (FPP) sensors. When the foot pedal is in the idle position, the IVS is open; giving the ECU an IVS status of “ON”. When the foot pedal is depressed more than idle, the switch contacts close, grounding the IVS and giving the ECU an IVS status of “OFF”. The IVS status is compared to the two FPP sensor signals to determine each signal’s validity. If the ECU determines that the IVS status is invalid, it will set a fault code and use the FPP1 and FPP2 signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the IVS status input:

As a redundant input to the FPP1 input and the FPP2 input; to allow the ECU to determine when the foot pedal is on and off the idle position

DTC 79 will set if:

Continued on next page RG,RG34710,3191 –19–15JUL96–2/3

- The FPP1 sensor signal voltage is greater than 1.15 volts **OR** the FPP2 sensor signal voltage is greater than 1.1 volts
- **AND** the IVS status is “ON” (idle position)

If DTC 79 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

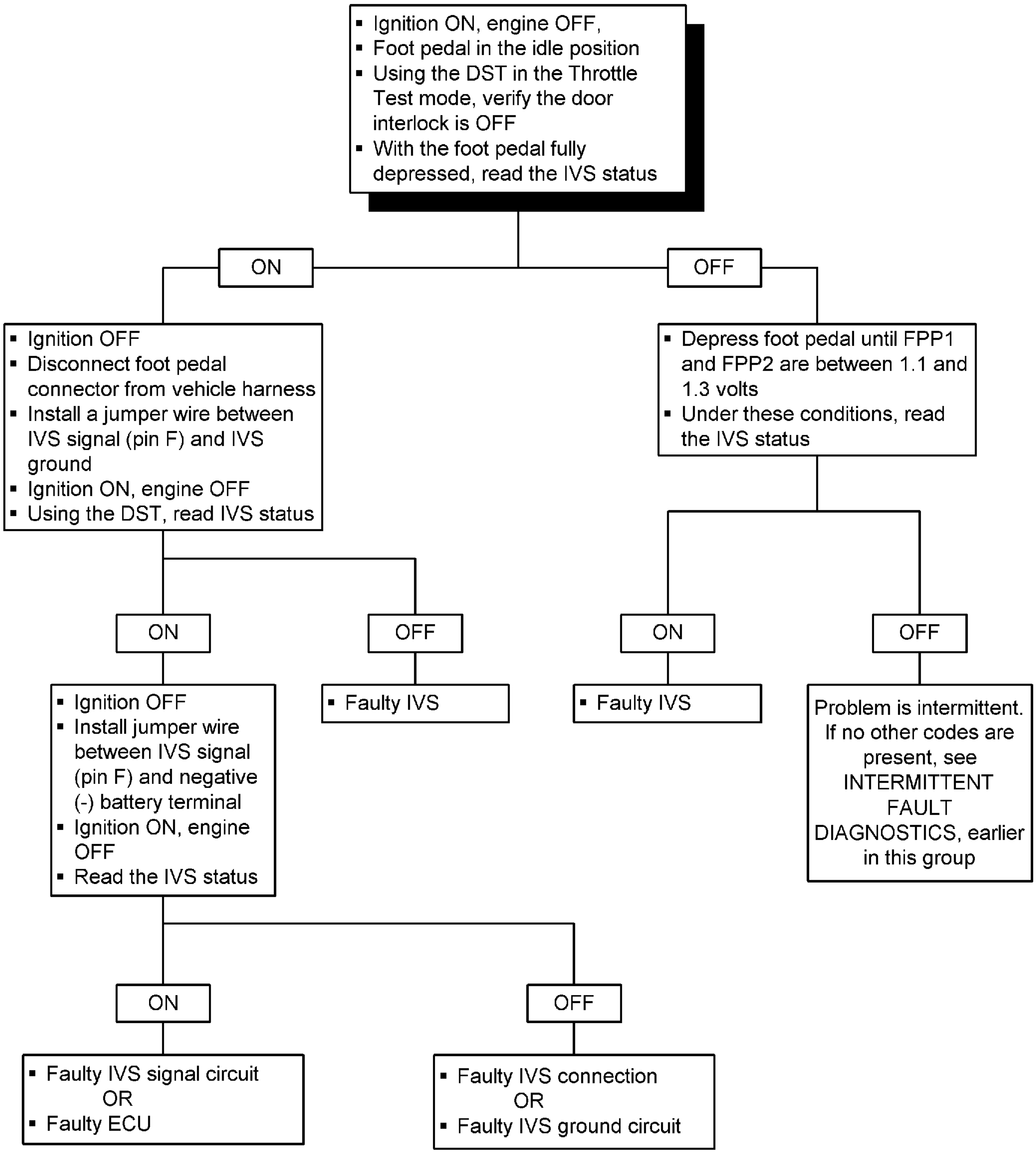
- No change in driveability
- Reduced engine power and degraded driveability

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3191 –19–15JUL96–3/3

DTC 79 IVS Status ON Unexpected - Continued

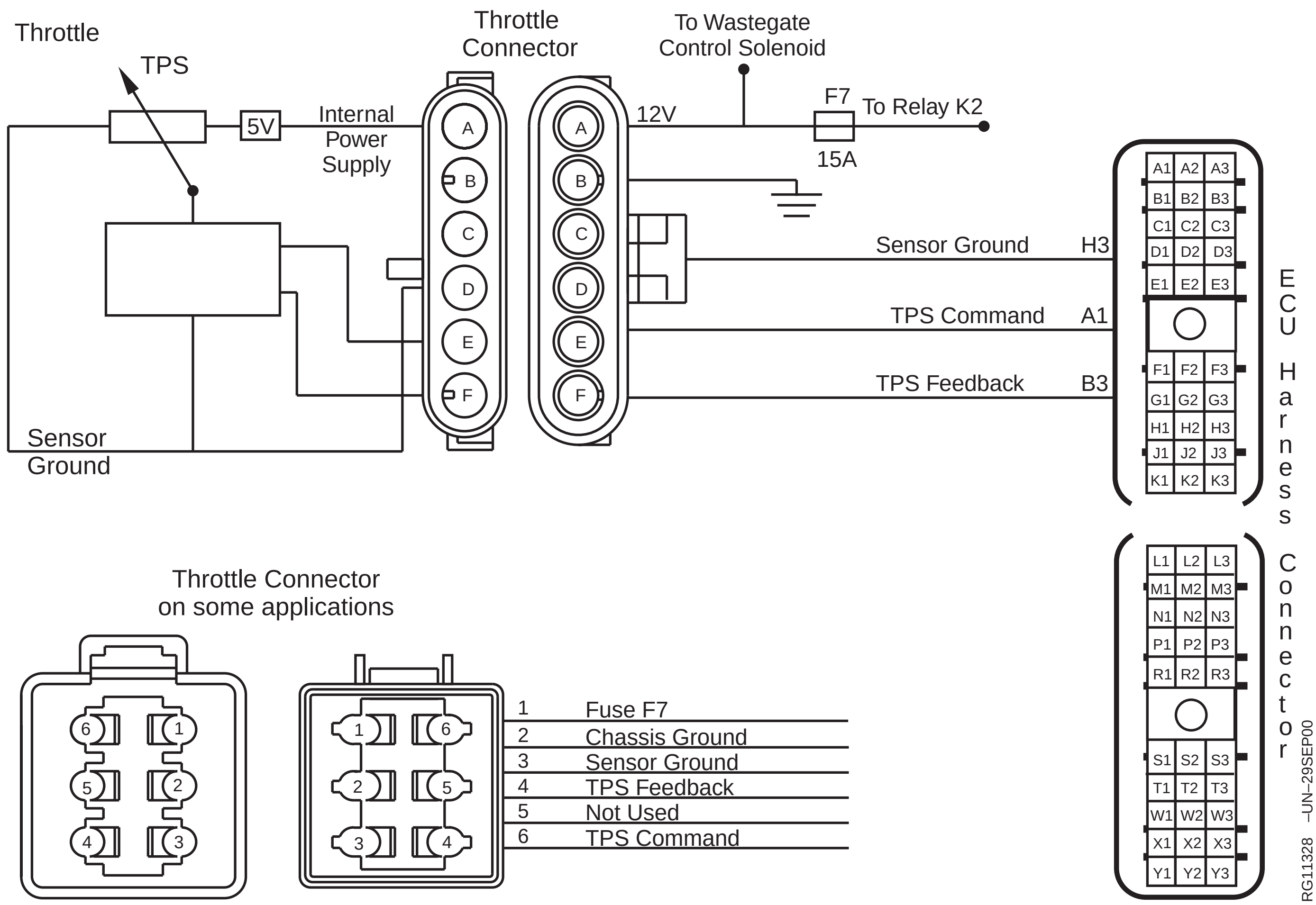
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10194 –19–16AUG00

DPSG,RG40854,152 –19–10JUN99–1/1

DTC 81 TPS Lower Than Expected



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A1	E (6)	35 Lt. Green	Lt. Green/Brown	TPS Command
B3	F (4)	19 Purple	White/Purple	TPS Feedback
H3	D (3)	20C Black	Black/Tan	Sensor Ground
	A (1)	65 Pink	Pink/Yellow	VBAT
	B (2)	58A White	White	Ground

IMPORTANT: If the throttle is determined to be faulty through diagnostics, see THROTTLE OPERATION in Group 100 earlier in this manual.

TPS - Throttle Position Sensor

The TPS is a variable resistor (potentiometer) used to measure throttle opening. The TPS is located in the throttle. The TPS Feedback voltage varies with throttle position. Less throttle opening results in lower feedback voltage; greater throttle opening results in higher feedback voltage

The ECU uses the TPS Feedback to:

Determine if the throttle is opening as commanded

DTC 81 will set if:

The TPS Feedback voltage drops below 2.5 volts (50%) when the commanded position should be greater than 63%

If DTC 81 sets, the following will occur:

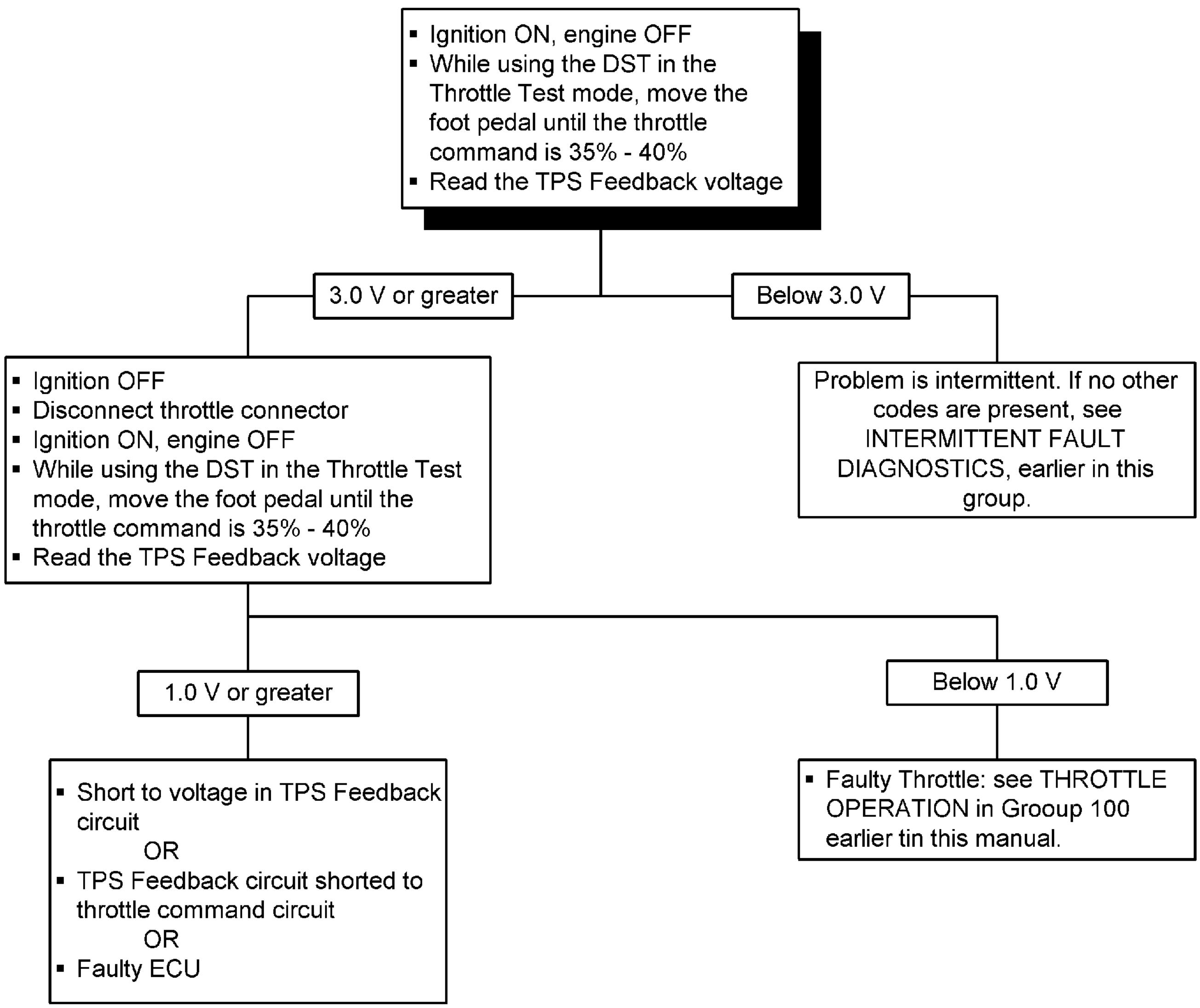
Continued on next page

- Adaptive learn disabled for remainder of key-on cycle
- CEL turned ON and stays ON 15 seconds after a fault becomes inactive.
- ECU will use a default “limp home” value of 1400 rpm with fuel cut.

RG,RG34710,3192 –19–15JUL96–2/2

DTC 81 TPS Lower Than Expected - Continued

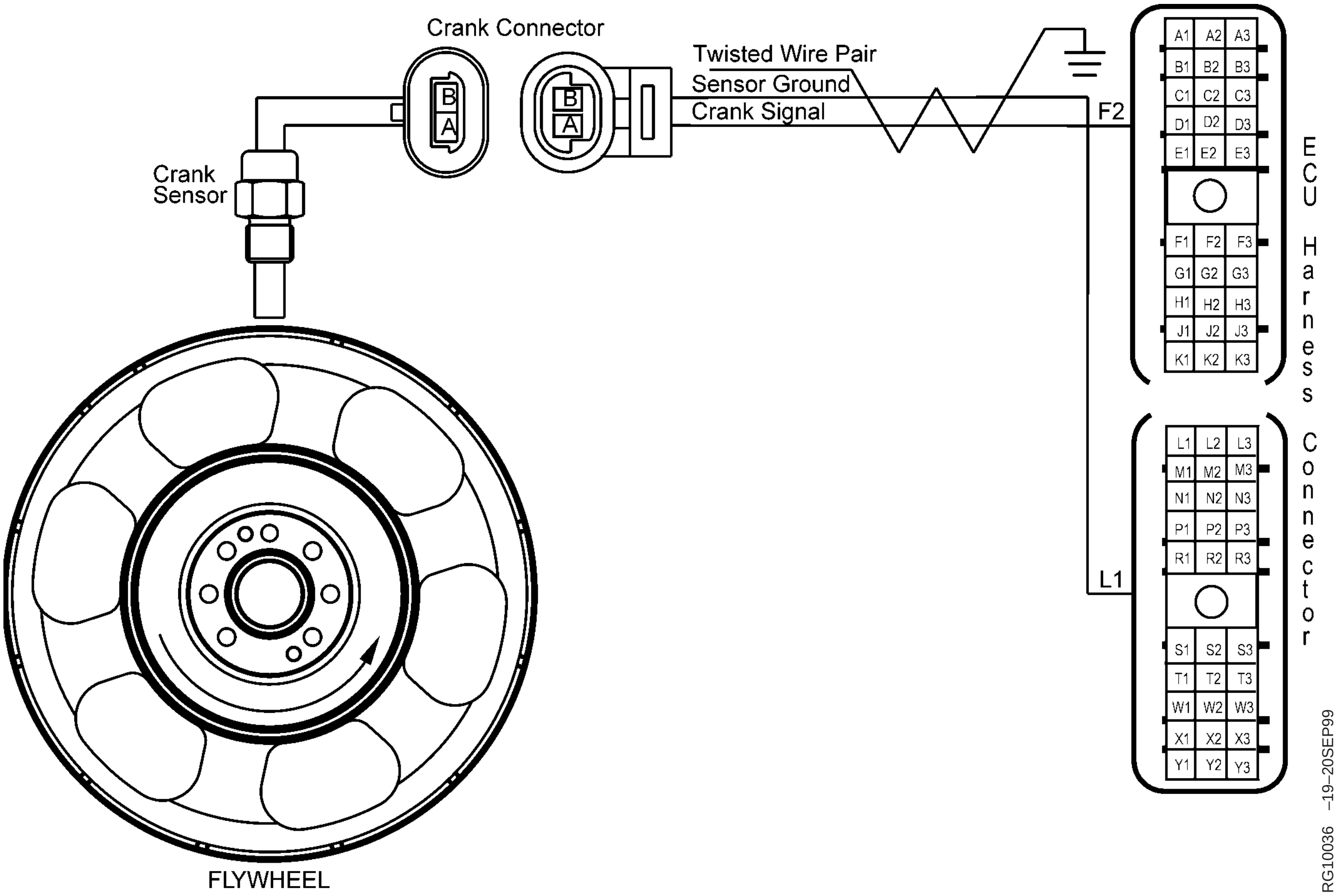
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Throttle Position sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11325 –19–17OCT00

DPSG,RG40854,153 –19–10JUN99–1/1

DTC 82 Crankshaft Position Sensor Error (6068 CNG Only)



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F2	A	31 White	N.A.	Crank Signal
L1	B	33A Black	N.A.	Sensor Ground

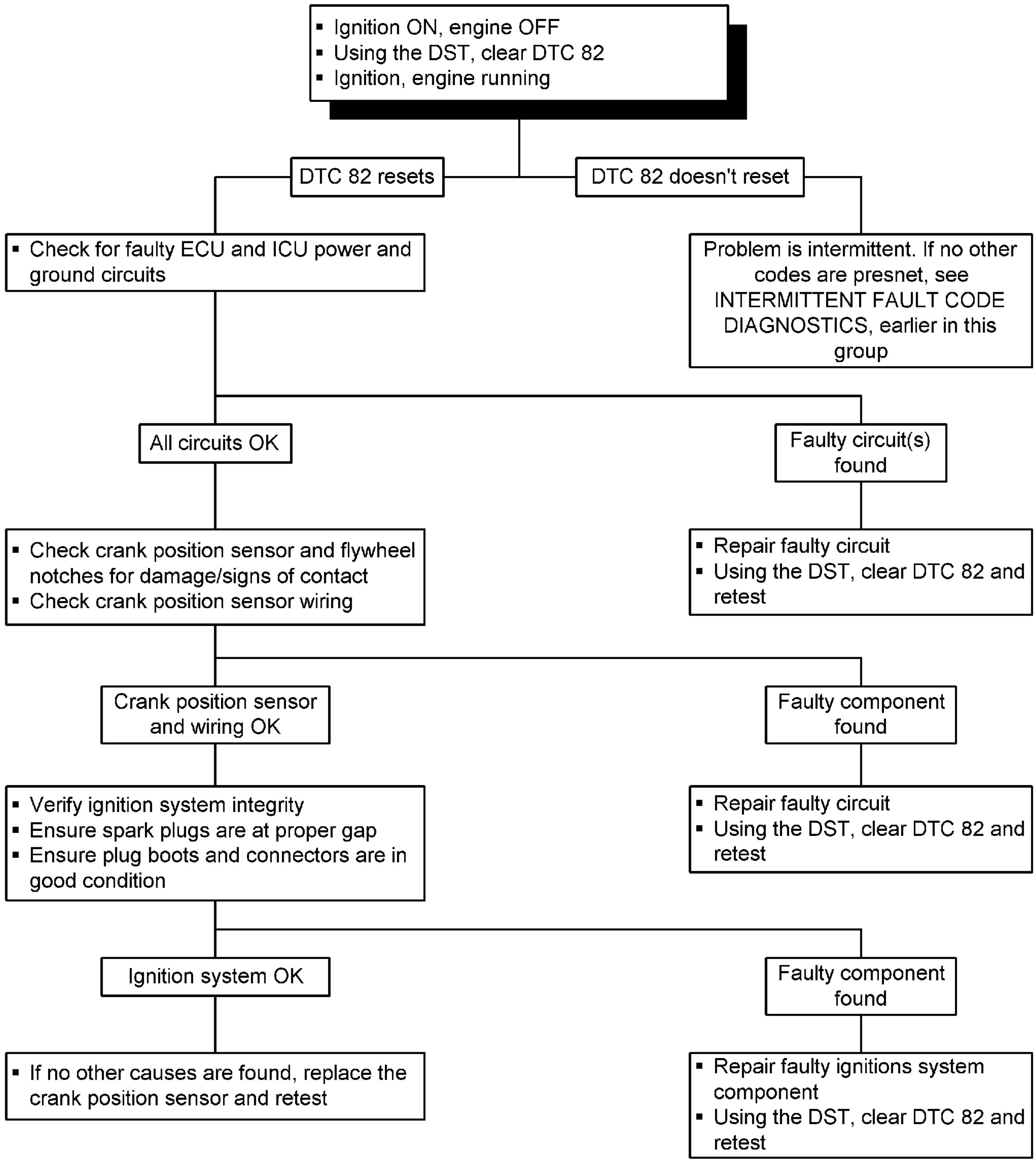
Crankshaft position sensor

- The crankshaft position sensor is an inductive-type position sensor that detects 12 notches into the engine flywheel. Eleven of the notches are evenly spaced with the twelfth notch advanced 15 degrees. This advance results in a wider gap between notches 12 and 1. For every other rotation of the crankshaft, the camshaft position sensor detects the pin while the crankshaft sensor is between notches This advance results in a longer gap between notches 12 and 1 of the flywheel. The ECU uses the crankshaft sensor to calculate RPM and to determine when each cylinder is at TDC for ignition control.
- **DTC 82 will set if:**
  The ECU detects unexpected high frequency pulses from the crankshaft position sensor anytime the engine is running.
- **If DTC 82 sets, the following will occur:**
  CEL turned ON and stays ON 15 seconds after a fault becomes inactive.

DPSG,RG40854,74 –19–30APR99–1/1

DTC 82 Crankshaft Position Sensor Error (6068 CNG Only) - Continued

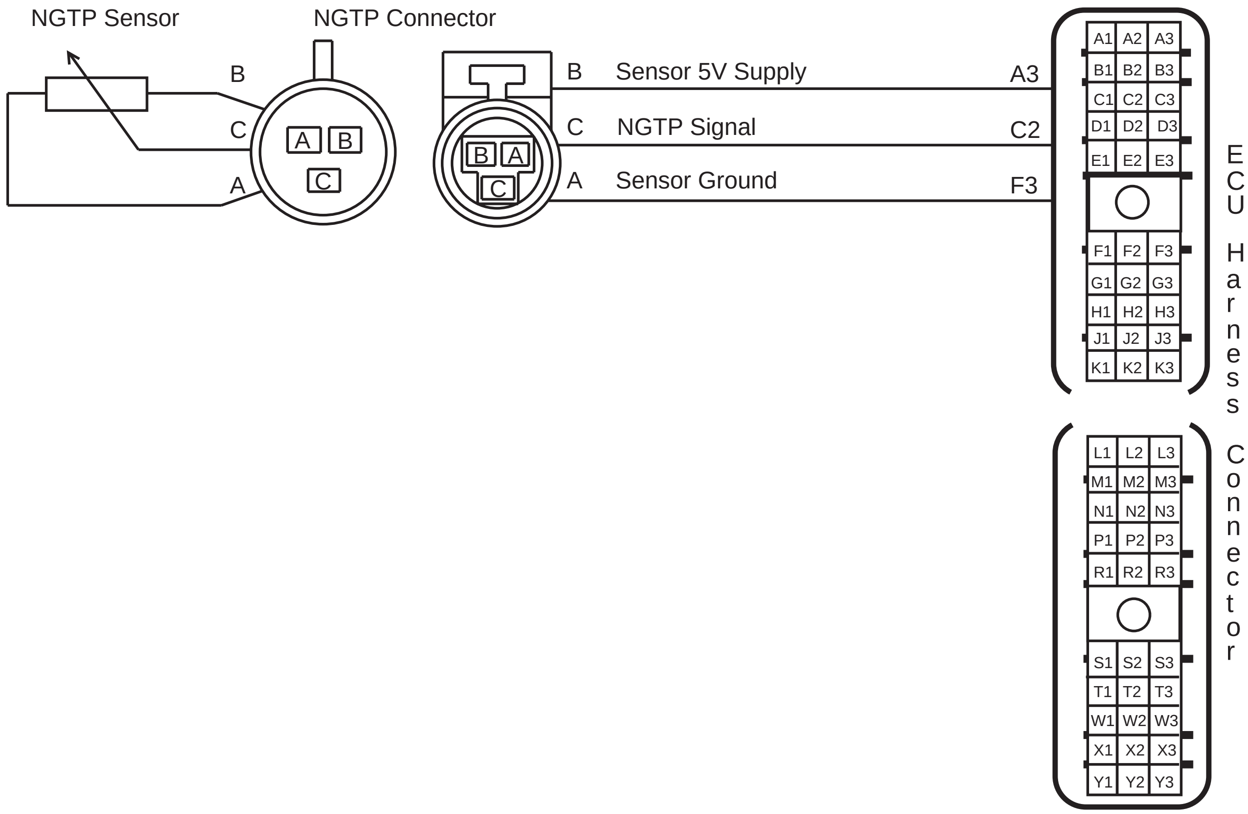
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Crankshaft Position sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10196 –19–16AUG00

DPSG,RG40854,154 –19–10JUN99–1/1

DTC 83 NGTP Higher Than Expected



RG11216 –UN–25AUG00

NOTE: This code is not used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54C Yellow	Purple/Red	Sensor 5V Supply
C2	C	17 Dk. Blue	Dk. Blue/White	NGTP Signal
F3	A	21G Black	Black/Lt. Green	Sensor Ground

NGTP - Natural Gas Tank Pressure sensor

The NGTP sensor is a pressure transducer mounted on the pressure regulator. The NGTP sensor measures gas pressure prior to regulation. The NGTP signal voltage varies as fuel pressure in the storage tanks varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGTP sensor:

In conjunction with the NGTT sensor to determine the amount of fuel in the storage tanks. The ECU then transfers this information to the fuel gauge on the dash

DTC 83 will set if:

- The engine is running
- **AND** the MAP sensor reading is 8 psia or less
- **AND** engine speed is less than 1200 RPM
- **AND** the NGP sensor reading is 105 psia or less
- **AND** the NGTP sensor reading is greater than 300 psia

If DTC 83 sets, the following will occur:

- Adaptive learn disabled during active fault
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault may set

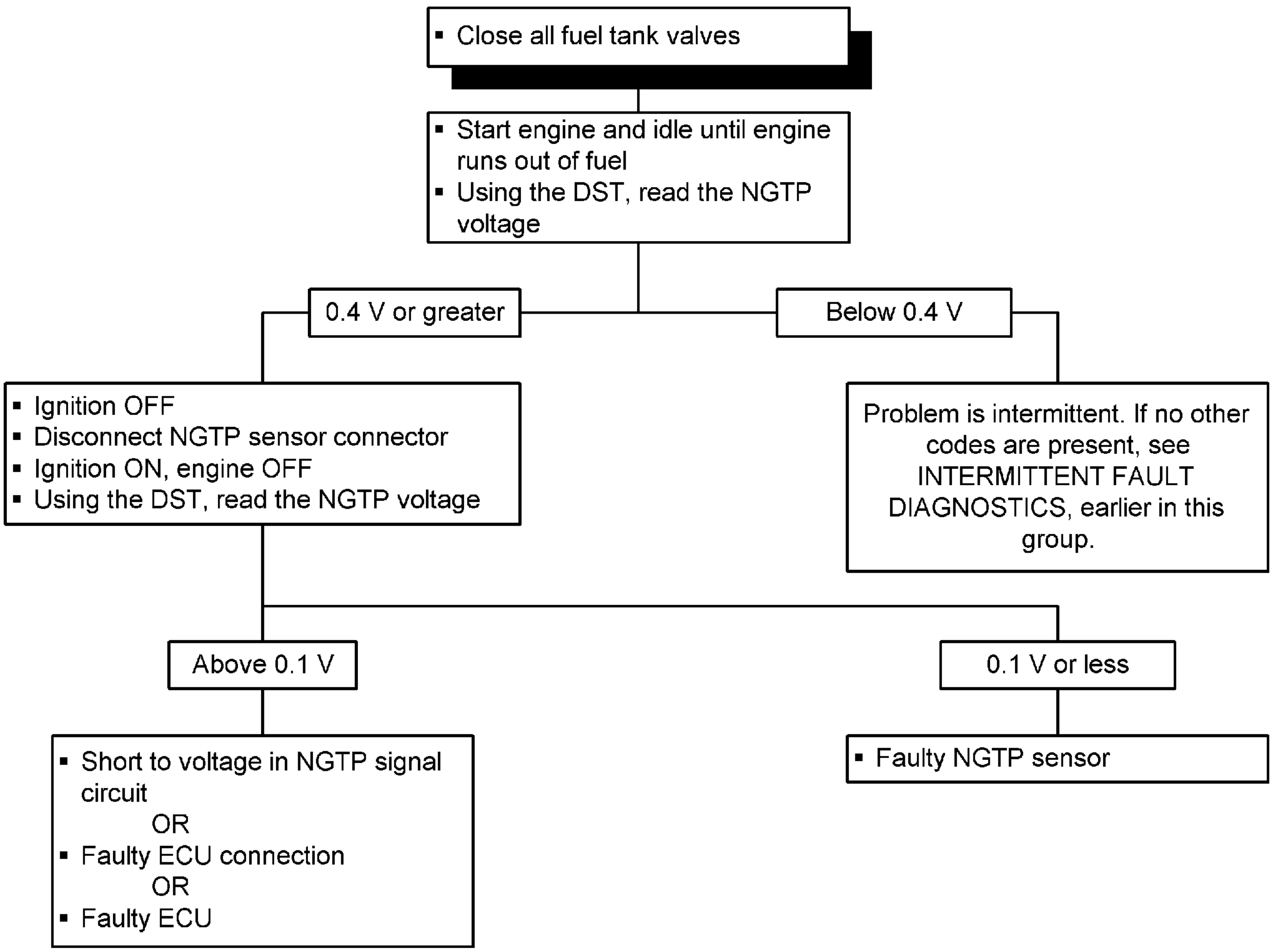
Continued on next page

- CEL off

RG,RG34710,3193 –19–15JUL96–2/2

DTC 83 NGTP Higher Than Expected - Continued

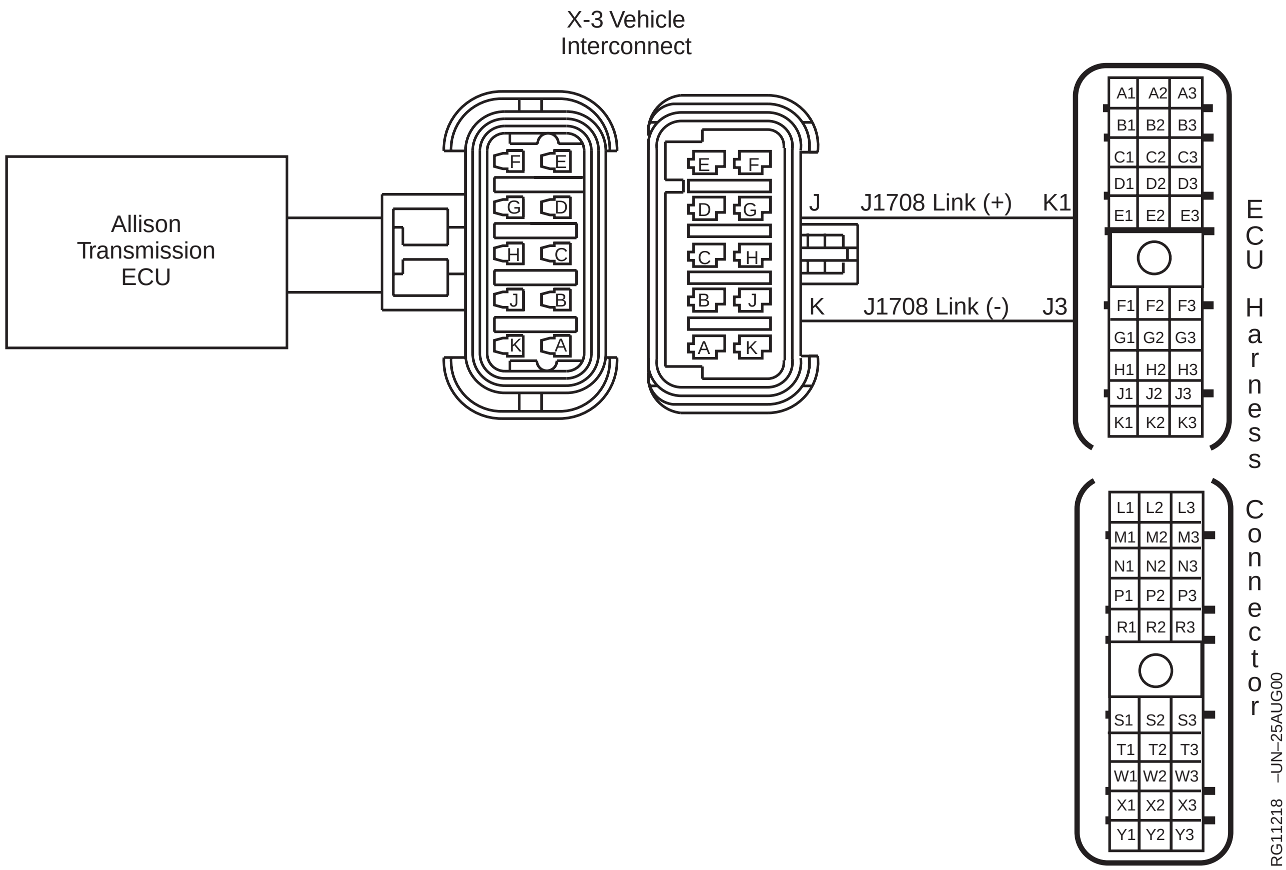
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Tank Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG10197 –19–16AUG00

DPSG,RG40854,155 –19–10JUN99–1/1

DTC 84 Vehicle Network Transmit Fault



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
J3	K (X-3 V.I.)	47 Purple	Purple	J1708 Link (-)
K1	J (X-3 V.I.)	46 Dk. Blue	Dk. Blue/Pink	J1708 (+)

Vehicle transmit circuit

The Allison transmission ECU and the engine ECU communicate on an SAE J1708 vehicle network. The engine ECU outputs the foot pedal position (FPP) to the transmission ECU and receives the calibration identification number from the transmission ECU. If the communication link is lost, torque will be limited because the engine ECU will not be able to determine what type of transmission is being used.

The ECU uses the vehicle network transmit circuit:

To communicate FPP to the transmission ECU

DTC 84 will set if:

The engine ECU is unable to transmit data after three attempts anytime the engine is running

If DTC 84 sets, the following will occur:

Limited torque allowed

DTC 84 Vehicle Network Transmit Fault - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.

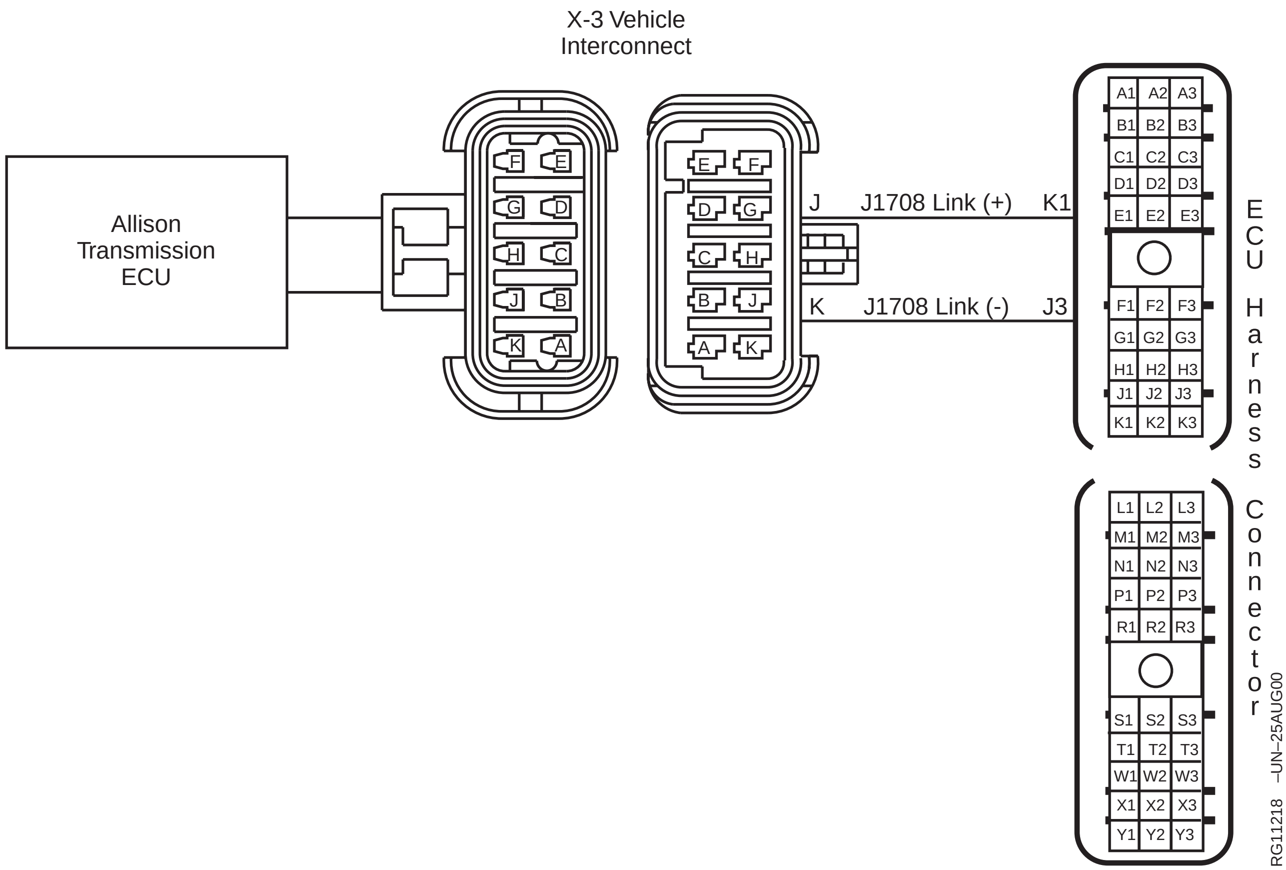
- **IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.**

- Verify network circuits integrity with a continuity check and connector visual inspection.
- If circuits are OK, refer to Allison transmission ECU diagnostics.

RG10198 –19–16AUG00

DPSG,RG40854,156 –19–10JUN99–1/1

DTC 85 Vehicle Network Receive Fault



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
J3	K (X-3 V.I.)	47 Purple	Purple	J1708 Link (-)
K1	J (X-3 V.I.)	46 Dk. Blue	Dk. Blue/Pink	J1708 (+)

Vehicle receive circuit

The Allison transmission ECU and the engine ECU communicate on an SAE J1708 vehicle network. The engine ECU outputs the foot pedal position (FPP) to the transmission ECU and receives the calibration identification number from the transmission ECU. If the communication link is lost, torque will be limited because the engine ECU will not be able to determine what type of transmission is being used.

The ECU uses the vehicle network receive circuit:

To receive transmission identification information

DTC 85 will set if:

The engine ECU is unable to receive data in the last three update intervals

If DTC 85 sets, the following will occur:

Limited torque allowed

RG,RG34710,3196 –19–15JUL96–1/1

DTC 85 Vehicle Network Receive Fault - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.

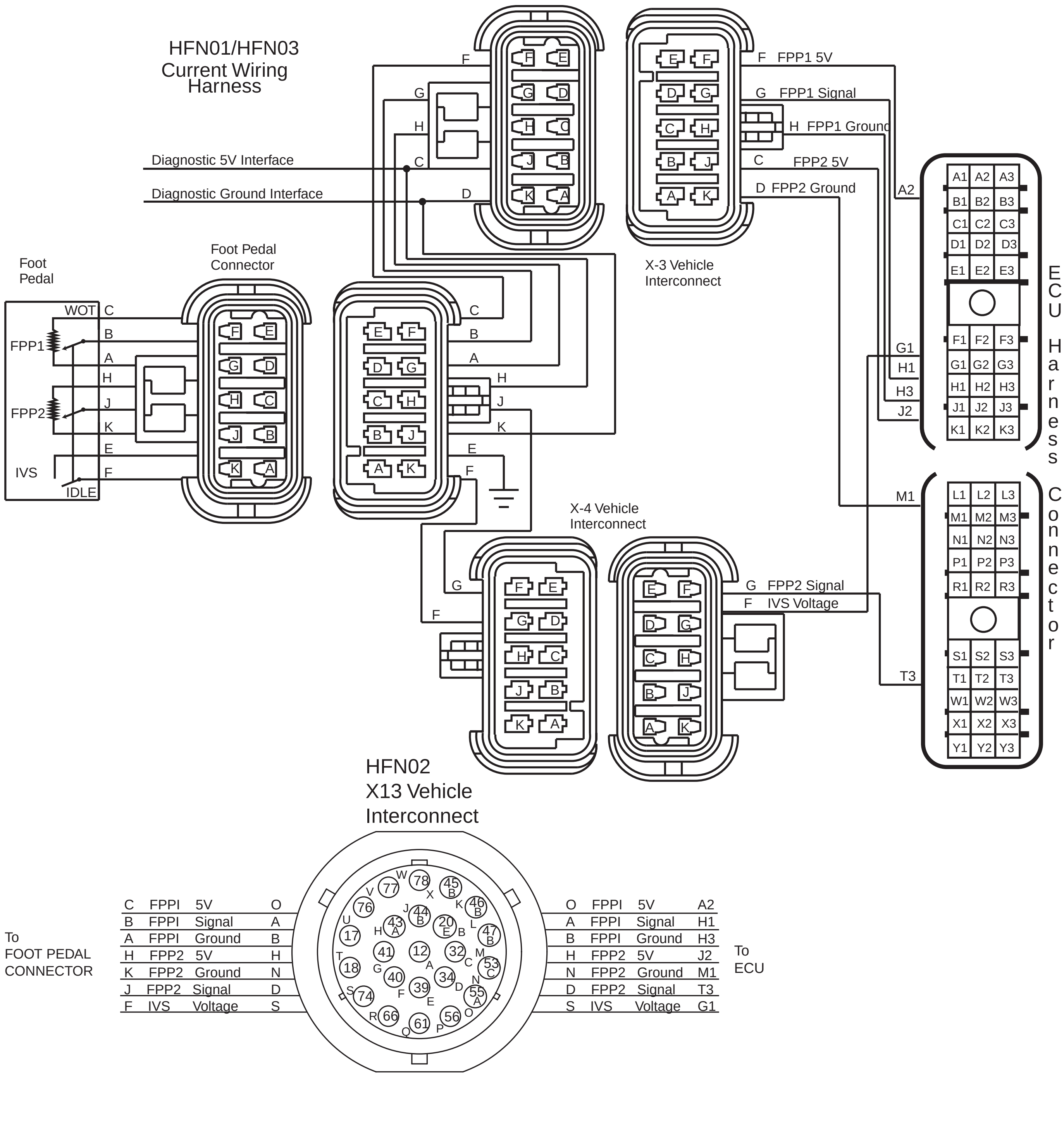
- **IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.**

- Verify network circuits integrity with a continuity check and connector visual inspection.
- If circuits are OK, refer to Allison transmission ECU diagnostics.

RG10199 –19–16AUG00

DPSG,RG40854,157 –19–10JUN99–1/1

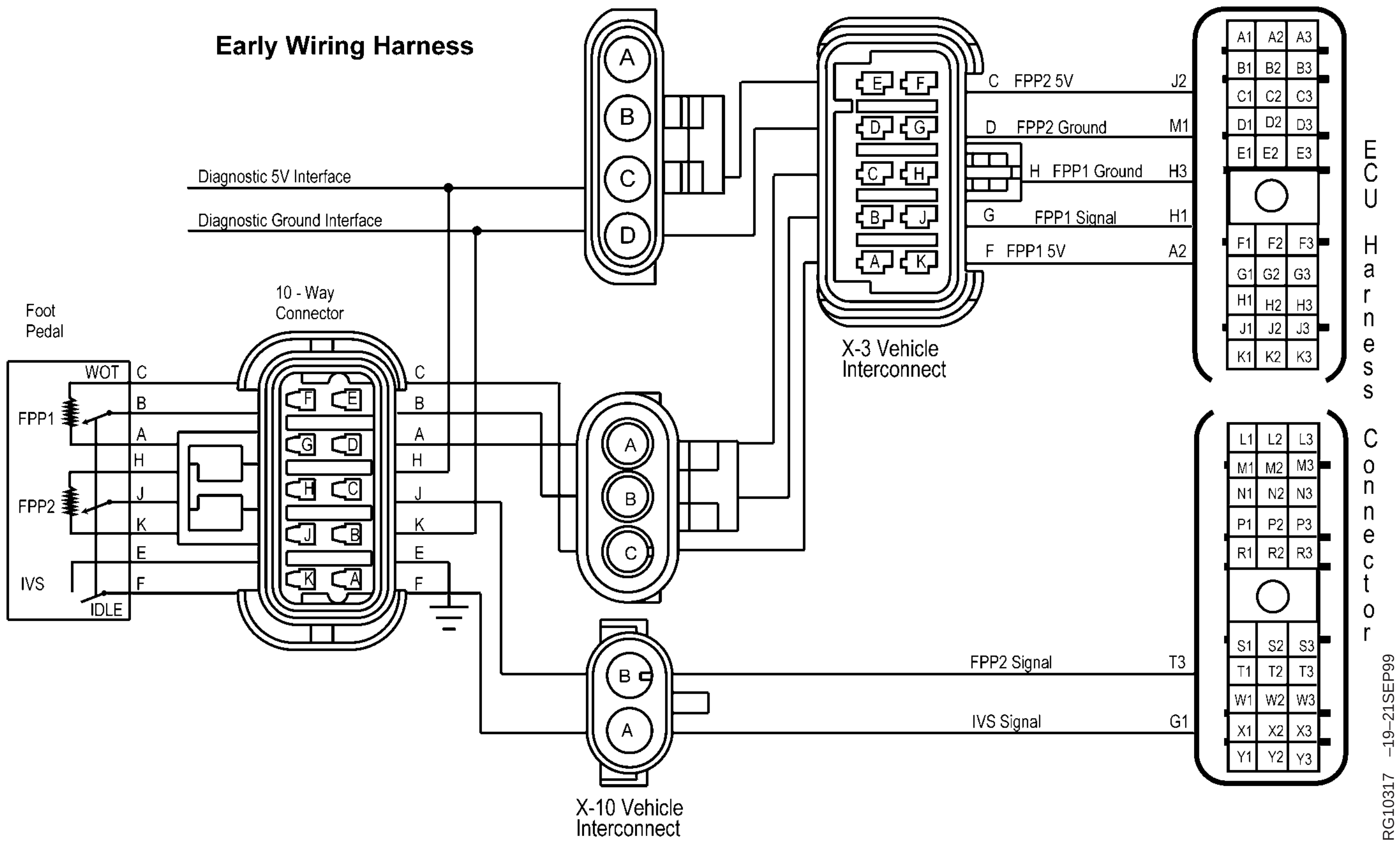
DTC 86 FPP1 Signal Different Than Expected



RG11209 –UN–25AUG00

Continued on next page

RG,RG34710,3198 –19–15JUL96–1/3



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

FPP1- Foot Pedal Position 1 sensor

The foot pedal assembly contains two independent FPP sensors and an Idle Validation Switch (IVS). The FPP sensors are variable resistors (potentiometers) used to measure the position of the foot pedal. The FPP signal voltages vary as the foot pedal is depressed and released. Less depression of the pedal results in lower signal voltages; greater depression results in higher signal voltages. The two FPP signals are compared to each other and to the IVS status to determine each signal's validity. If the ECU determines that the FPP1 signal is invalid, it will set a fault code and use the FPP2 and IVS signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the FPP1 sensor signal:

As a redundant input to FPP2; to give the ECU a command of the operator's desired engine load

DTC 86 will set if:

Continued on next page

- The FPP1 signal voltage is different than the FPP2 signal voltage by more than 20%
- **OR** the FPP1 voltage does match the IVS status

If DTC 86 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

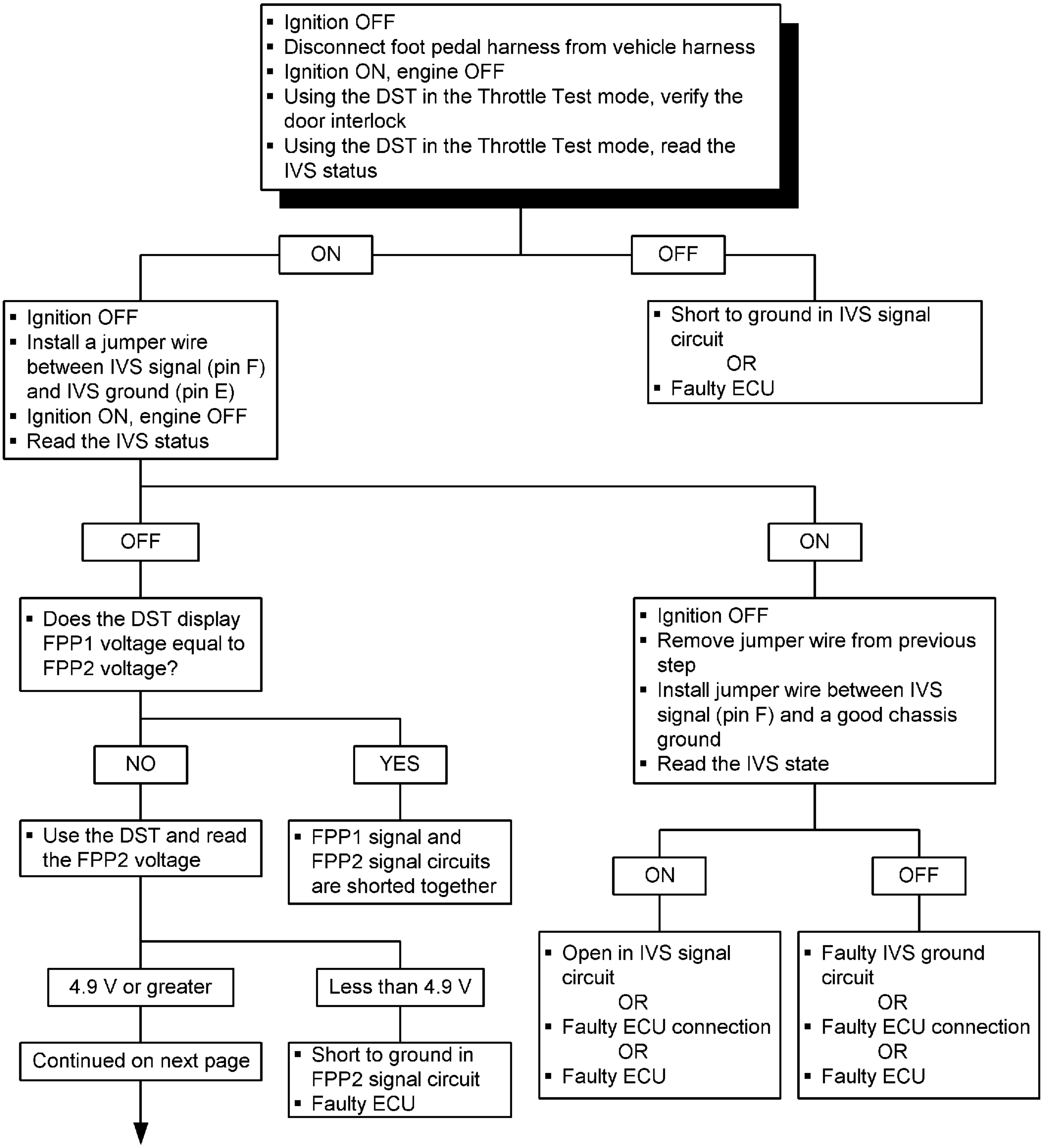
- No change in driveability
- Reduced engine power and degraded driveability
- Step power changes between idle and approximately 50% engine power as the pedal is depressed

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3198 –19–15JUL96–3/3

DTC 86 FPP1 Signal Different Than Expected - Continued

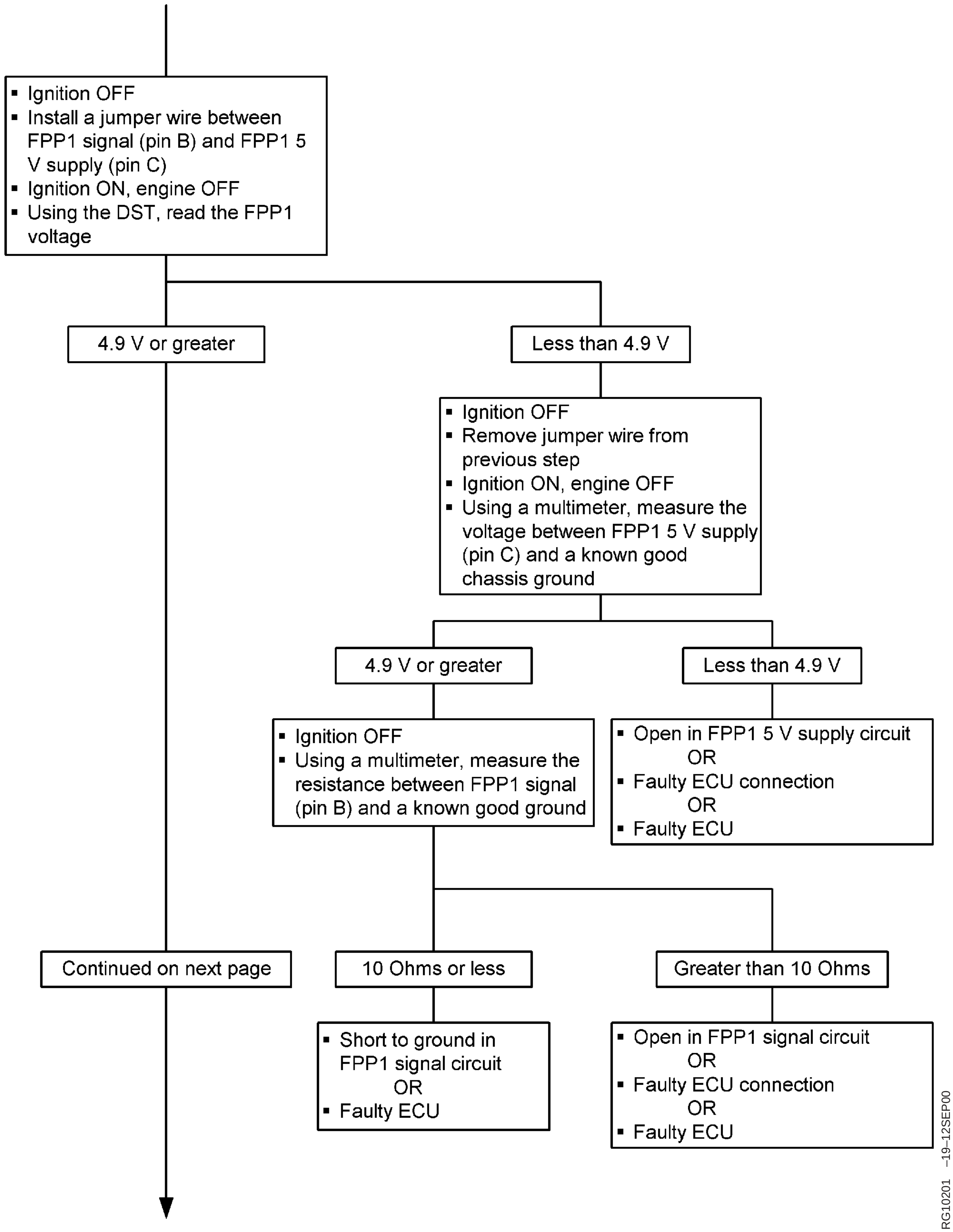
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10200 –19–06OCT00

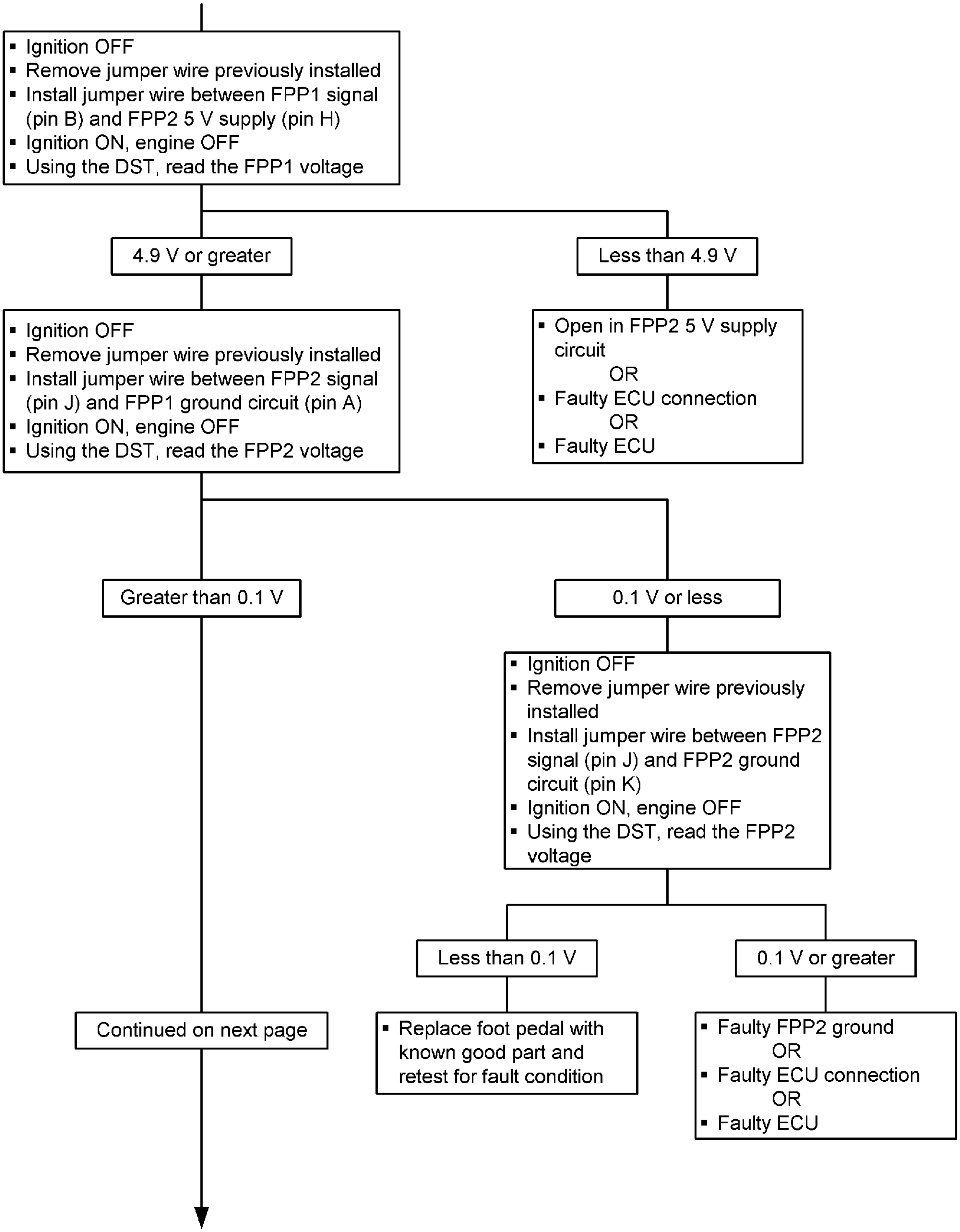
DPSG,RG40854,158 –19–10JUN99–1/1

DTC 86 FPP1 Signal Different Than Expected - Continued



DPSG,RG40854,159 –19–10JUN99–1/1

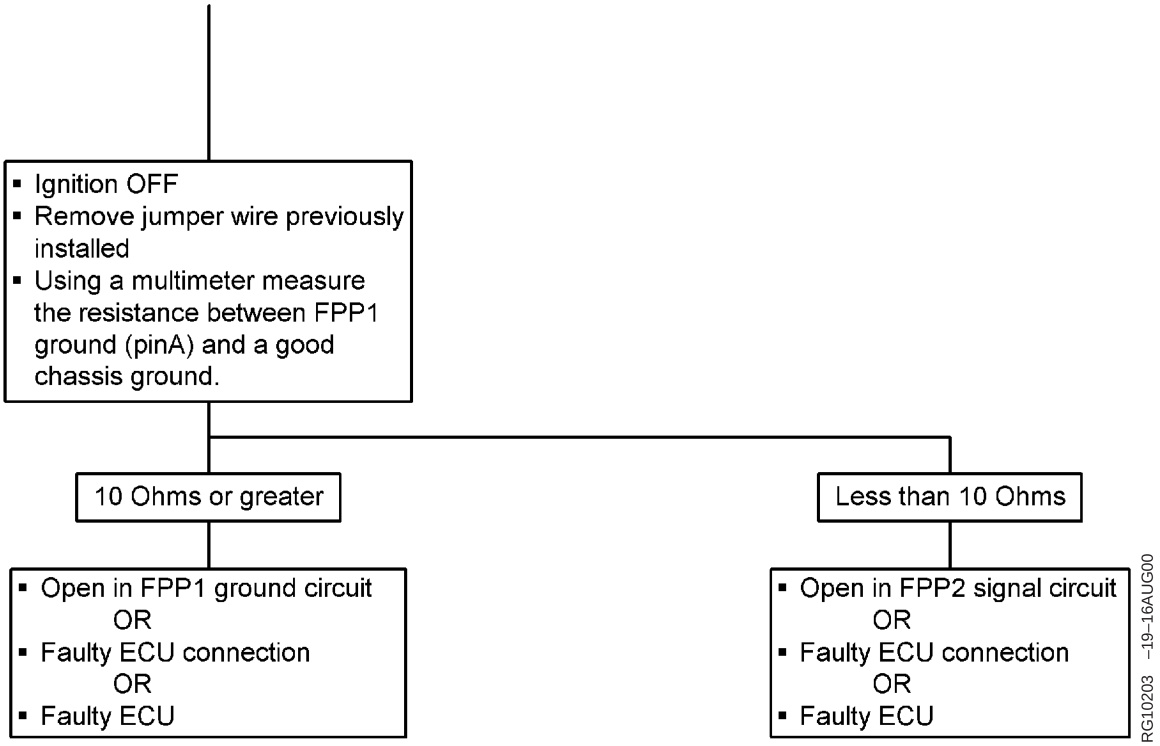
DTC 86 FPP1 Signal Different Than Expected - Continued



RG10202 –19–16AUG00

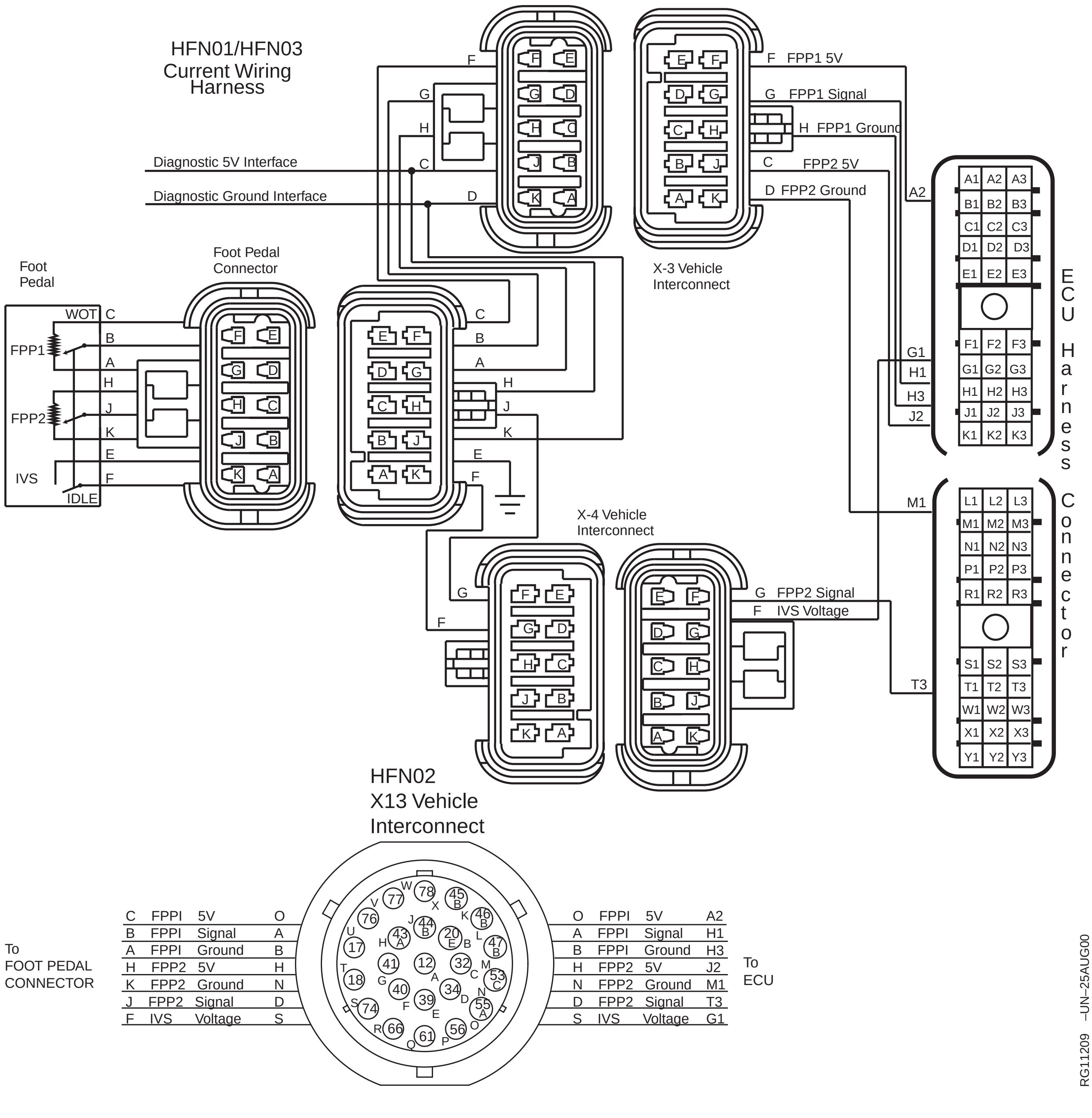
DPSG,RG40854,160 –19–10JUN99–1/1

DTC 86 FPP1 Signal Different Than Expected - Continued



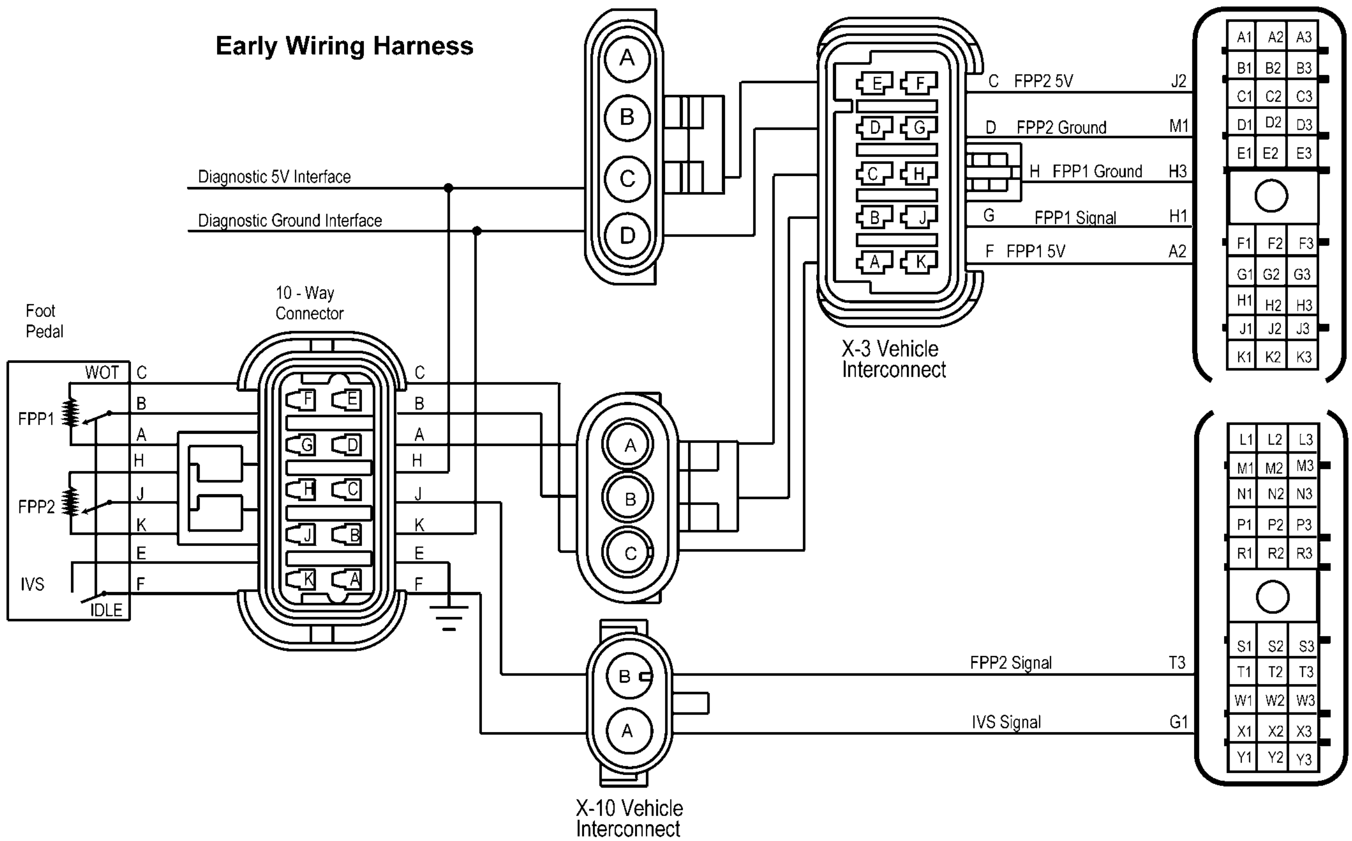
DPSG,RG40854,161 –19–10JUN99–1/1

DTC 87 FPP2 Signal Different Than Expected



Continued on next page

RG,RG34710,3199 –19–15JUL96–1/3



RG10317 –19–21SEP99

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A2	F (X-3 V.I.) (O)	35 Lt. Green	Lt. Green/Red (Red)	FPP1 5V Supply
H1	G (X-3 V.I.) (A)	12 Dk. Blue	Dark Blue (Black)	FPP1 Signal
H3	H (X-3 V.I.) (B)	20D Black	Black/White (White)	FPP1 Ground
J2	C (X-3 V.I.) (H)	43 Gray	Gray/White	FPP2 5V Supply
M1	D (X-3 V.I.) (N)	53 Gray	White	FPP2 Ground
T3	G (X-4 V.I.) (D)	34 Purple	NA	FPP2 Signal
	B (X-10 V.I.)	NA	34 Purple	FPP2 Signal
G1	F (X-4 V.I.) (S)	74 Dk. Green	NA	IVS Signal
	A (X-10 V.I.)	NA	74 Dk Green	IVS Signal

FPP2- Foot Pedal Position 2 sensor

The foot pedal assembly contains two independent FPP sensors and an Idle Validation Switch (IVS). The FPP sensors are variable resistors (potentiometers) used to measure the position of the foot pedal. The FPP signal voltages vary as the foot pedal is depressed and released. Less depression of the pedal results in lower signal voltages; greater depression results in higher signal voltages. The two FPP signals are compared to each other and to the IVS status to determine each signal's validity. If the ECU determines that the FPP2 signal is invalid, it will set a fault code and use the FPP1 and IVS signals to control the engine. If the ECU cannot validate any of the three signals, the ECU will allow an engine speed of only 800 RPM.

The ECU uses the FPP2 sensor signal:

As a redundant input to FPP1; to give the ECU a command of the operator's desired engine load

DTC 87 will set if:

Continued on next page

- The FPP2 signal voltage is different than the FPP1 signal voltage by more than 20%
- **OR** the FPP2 voltage does match the IVS status

If DTC 87 sets, the following will occur:

Adaptive learn disabled for remainder of key-on cycle

Depending on whether or not there are other fault codes, one of the following will occur:

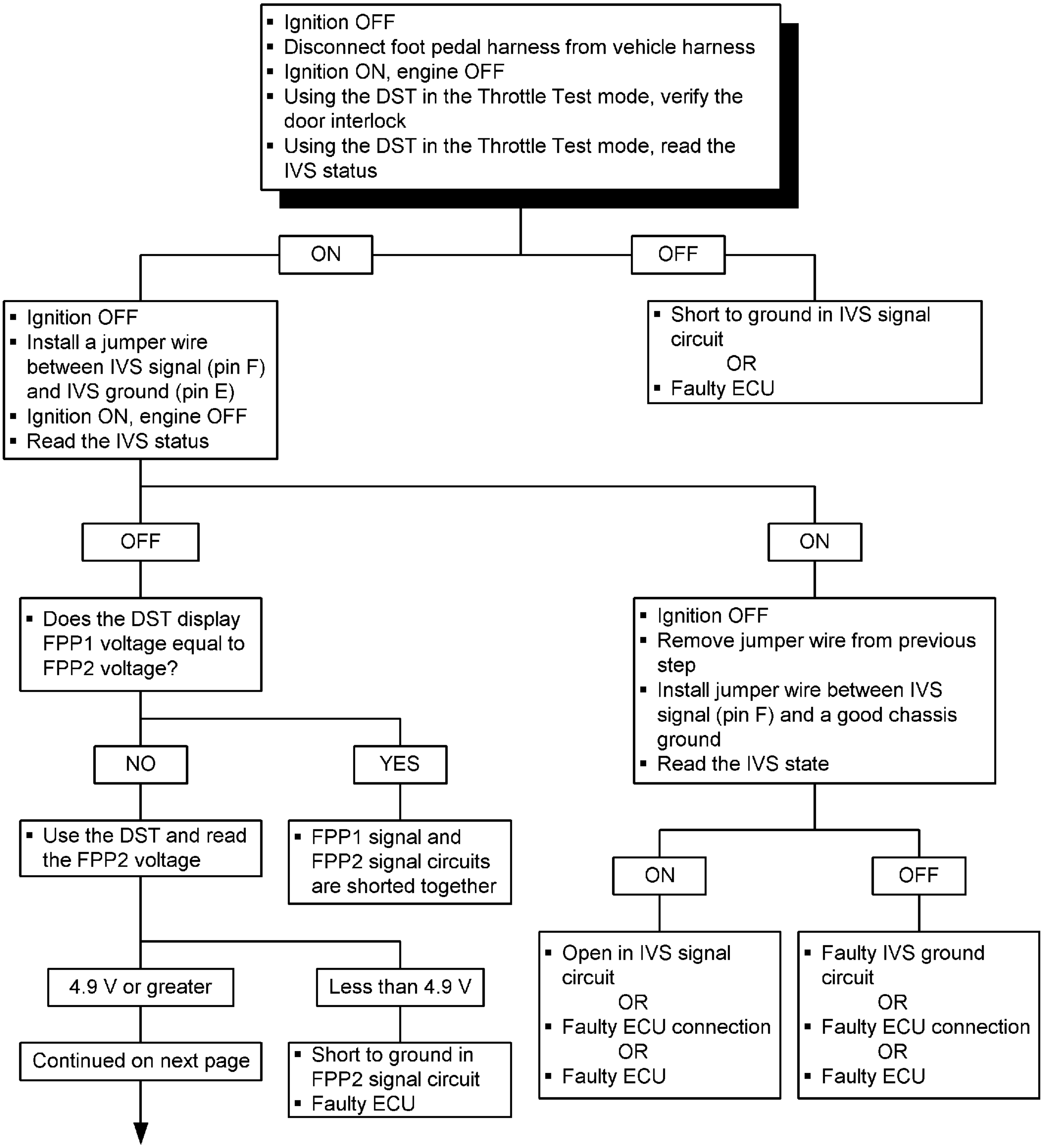
- No change in driveability
- Reduced engine power and degraded driveability
- Step power changes between idle and approximately 50% engine power as the pedal is depressed

CEL turned on and stays on for remainder of key-on cycle

RG,RG34710,3199 –19–15JUL96–3/3

DTC 87 FPP2 Signal Different Than Expected - Continued

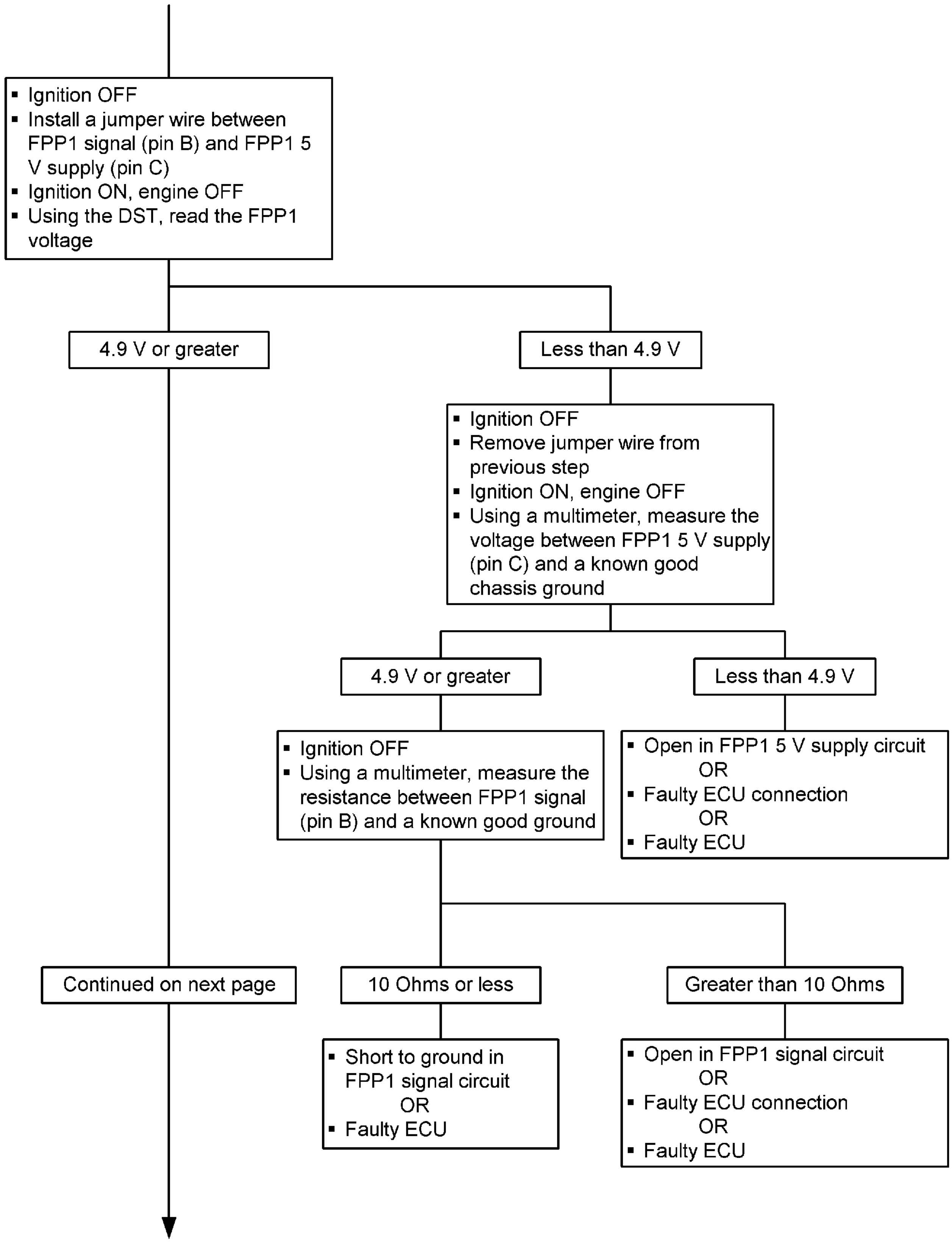
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Foot Pedal connector, and all of the Vehicle Interconnect connector looking for dirty, damaged, or poorly positioned terminals.



RG10200 –19–06OCT00

DPSG,RG40854,162 –19–10JUN99–1/1

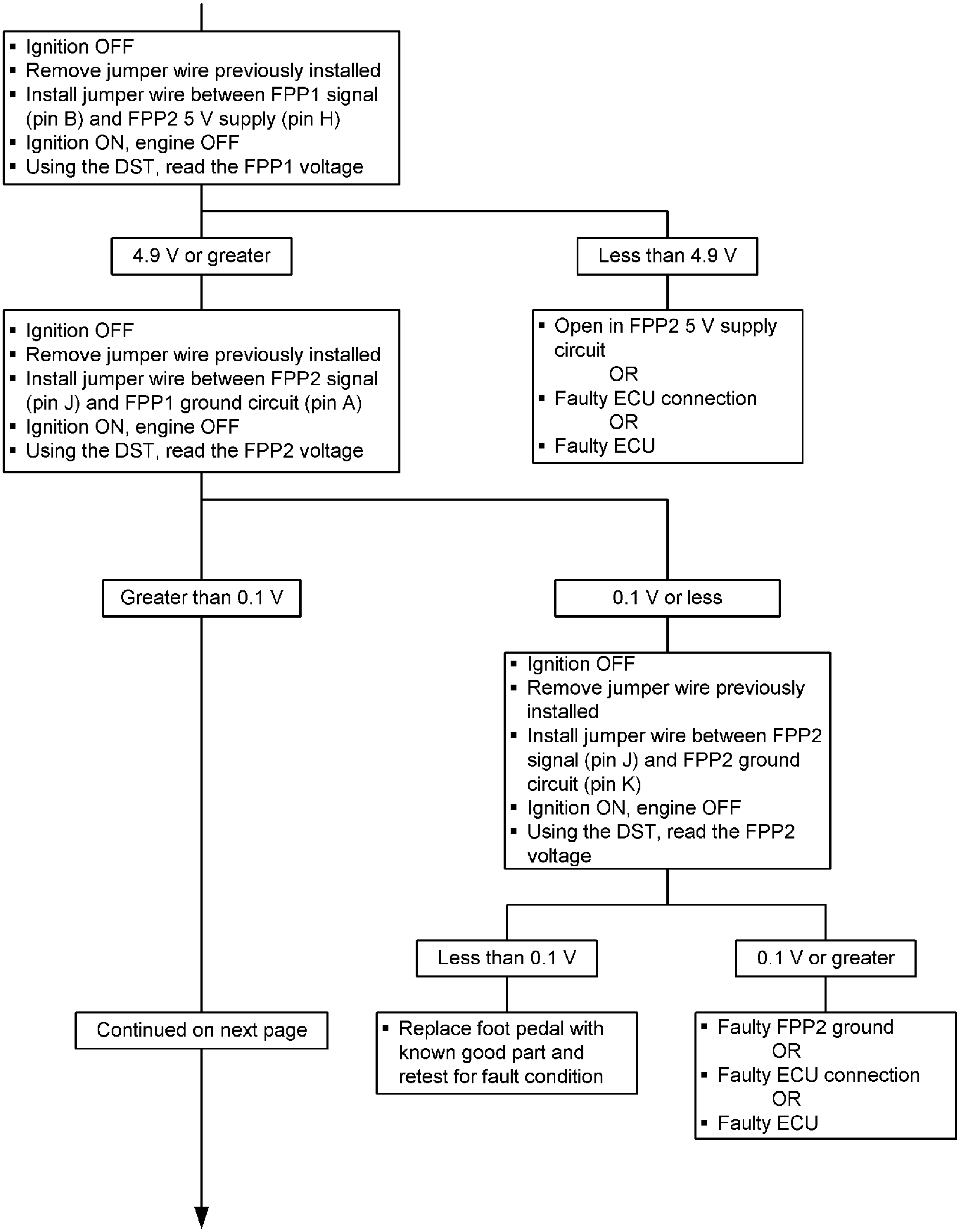
DTC 87 FPP2 Signal Different Than Expected - Continued



RG10201 –19–12SEP00

DPSG,RG40854,163 –19–10JUN99–1/1

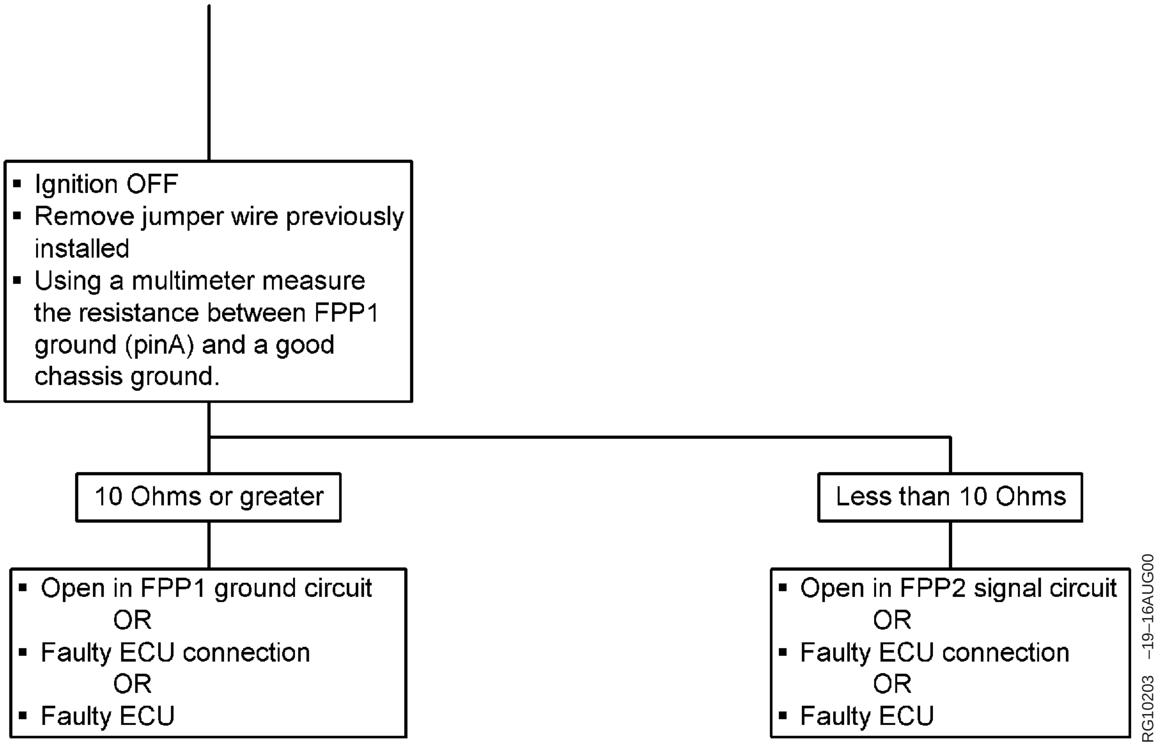
DTC 87 FPP2 Signal Different Than Expected - Continued



RG10202 –19–16AUG00

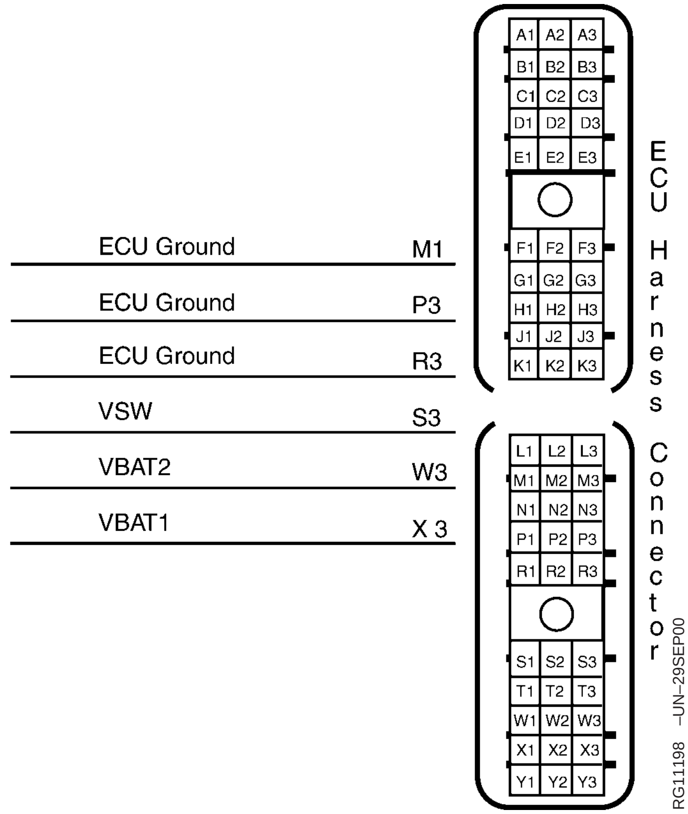
DPSG,RG40854,164 –19–10JUN99–1/1

DTC 87 FPP2 Signal Different Than Expected - Continued



DPSG,RG40854,165 –19–10JUN99–1/1

DTC 94 ECU Internal Voltage Error



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
M1	Chassis Ground	53 Gray	White	Ground
P3	Chassis Ground	52 Lt Blue	White	Ground
R3	Chassis Ground	51 White	White	Ground
S3	K1/K2	48 Pink	Pink/Tan	Switched Voltage
W3	F3	50 Red	Red/Tan	Battery Voltage
X3	F4	49 Red	Red/Tan	Battery Voltage

Internal Voltage Regulator

The internal 4 volt supply powers some circuits and the microprocessor. The accuracy of the 5 volt supplies are very important to the accuracy control by the ECU. The ECU determines if there is a problem with the output of the regulator monitor of 5 volts.

The ECU uses the Internal Voltage to:

Calculate the external 5 volt supplies to all of the sensors.

DTC 94 - will set if:

- Vref exceeds 4.5 Volts
- Vref is below 3.686 Volts

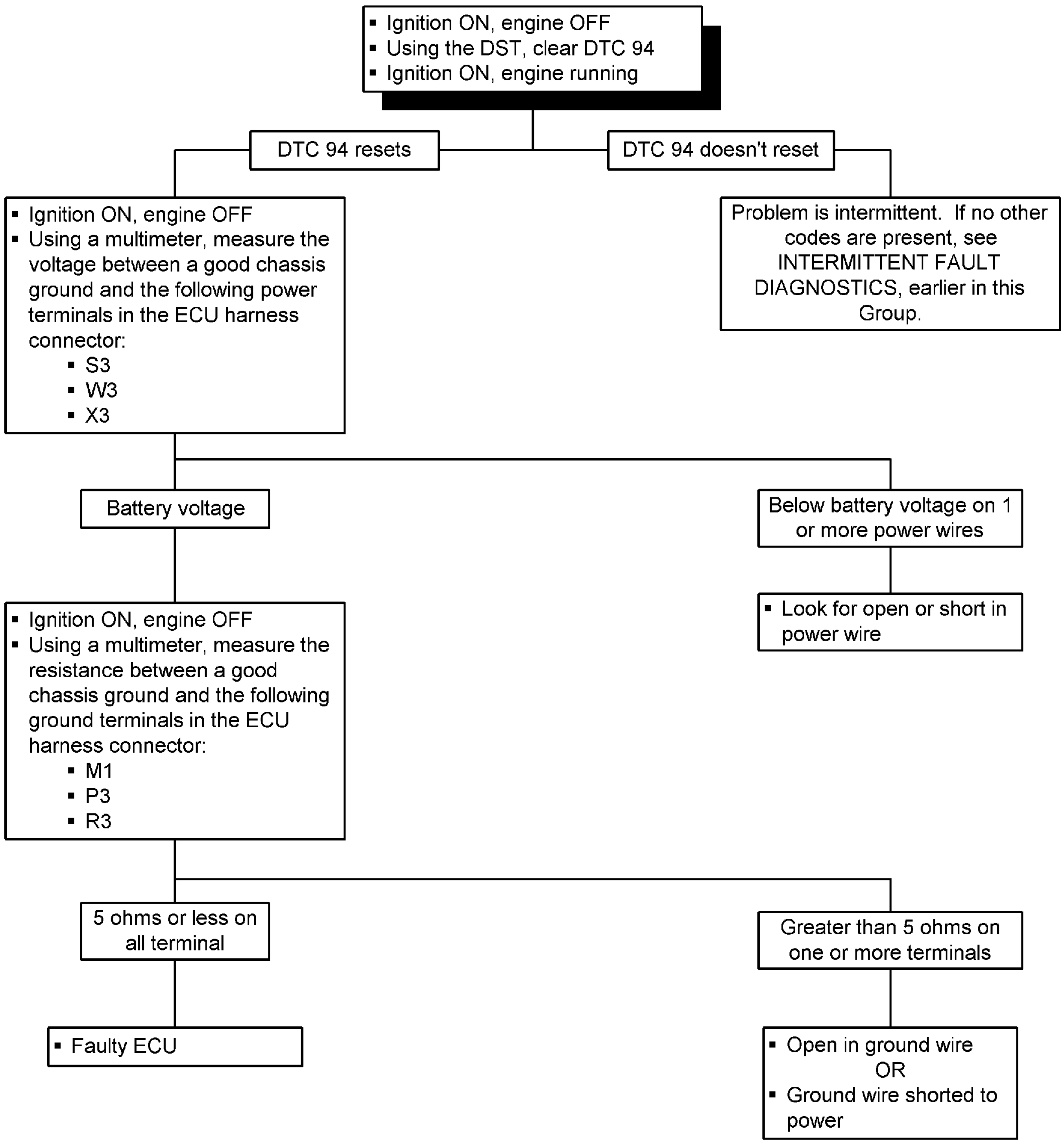
If DTC 94 sets, the following will occur:

- Adaptive Learn disabled
- CEL on for remainder of key on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault will set
- Boost pressure is limited to 10 psig maximum for remainder of key on cycle

DPSG,RG41221,64 –19–10JUL00–1/1

DTC 94 ECU Internal Voltage Error - Continued

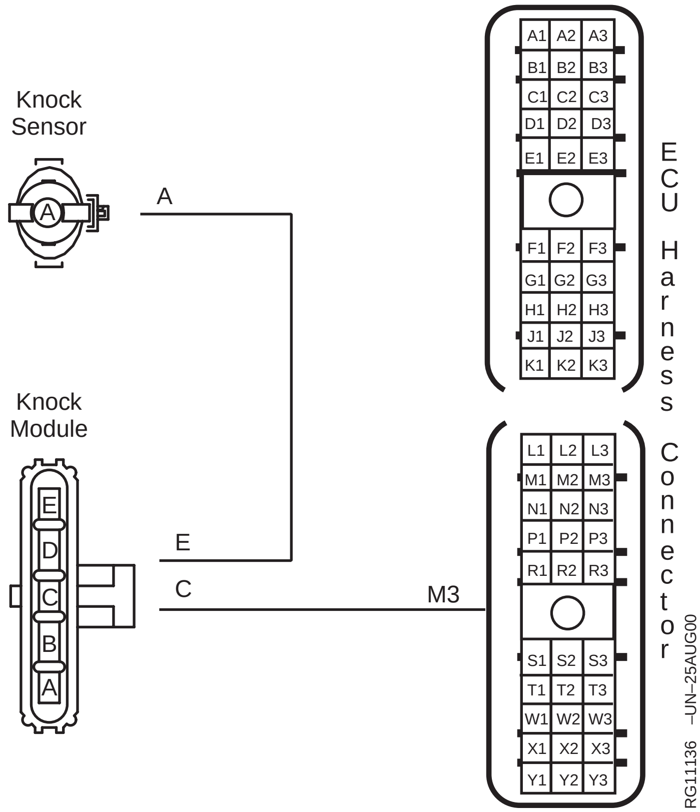
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors looking for dirty, damaged, or poorly positioned terminals.



RG11140 –19–22NOV00

DPSG,RG41221,65 –19–10JUL00–1/1

DTC 95 Knock Sensor Error



NOTE: This code is ONLY used on the HFN02 6081 engines.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
M3	C	9 Dk Green	NA	Knock signal

Knock Sensor

The knock sensor is used to determine normal engine combustion. Normally this sensor has no effect on normal engine operation. The sensor will reduce the risk of engine damage due to low fuel quality or if the MAT exceeds design limits.

The ECU uses the Knock sensor:

To detect knock in engine due to poor fuel or MAT over limiting.

DTC 95 will set if:

The signal from the knock module to the ECU is less than 2.5 volts after the ECU has retarded timing (8° ignition retard and 8 psi derate). If the sensor continues to detect knock the engine power will be reduced.

If DTC 95 sets, the following will occur:

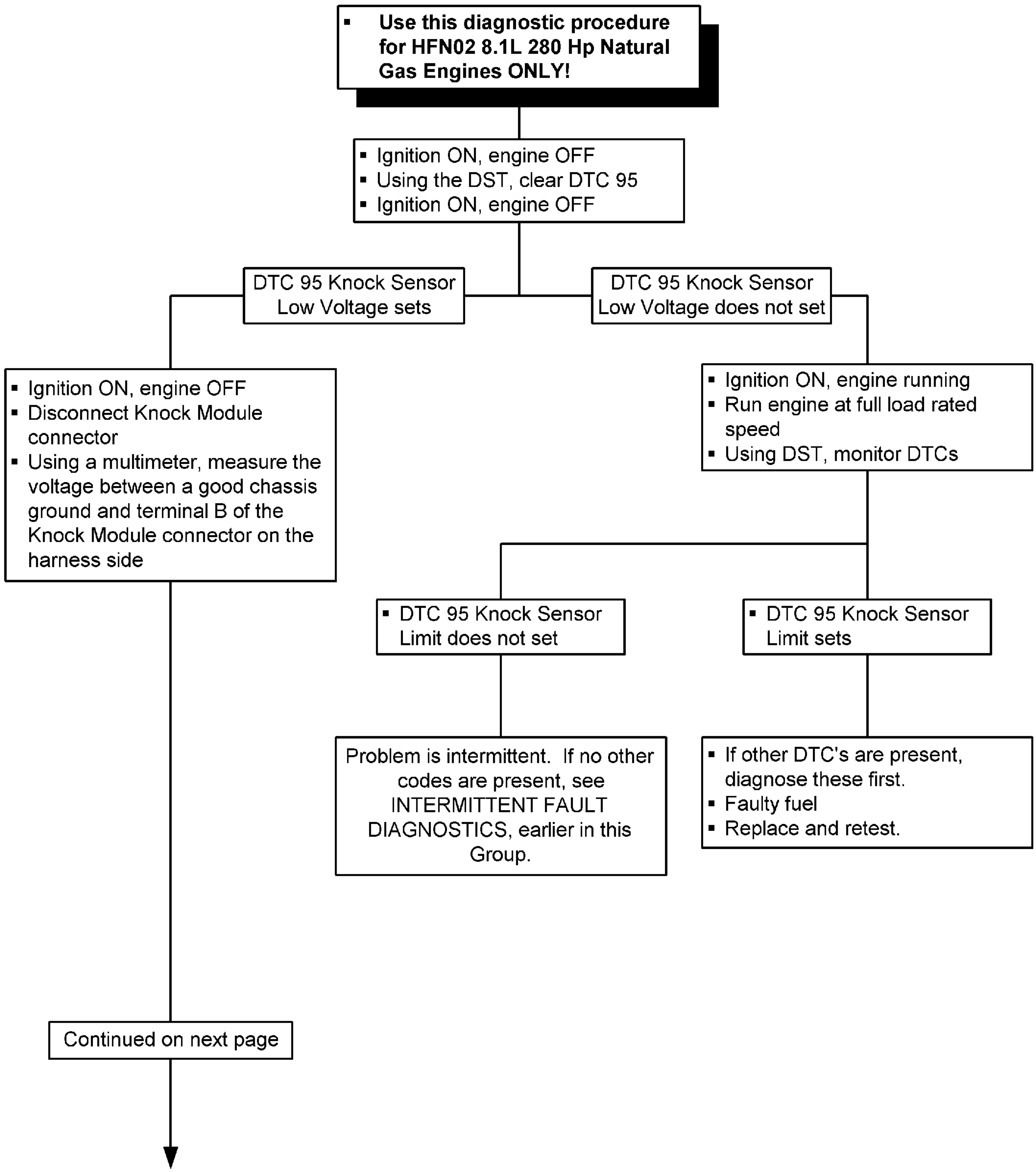
- Adaptive Learn disabled
- CEL on for remainder of key on cycle
- Closed loop multiplier allowed to stay at its limit if needed
- Closed loop limit fault will set
- Boost pressure is limited to 10 psig maximum for remainder of key on cycle

IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

DPSG,RG41221,66 –19–10JUL00–1/1

DTC 95 Knock Sensor Error - Continued

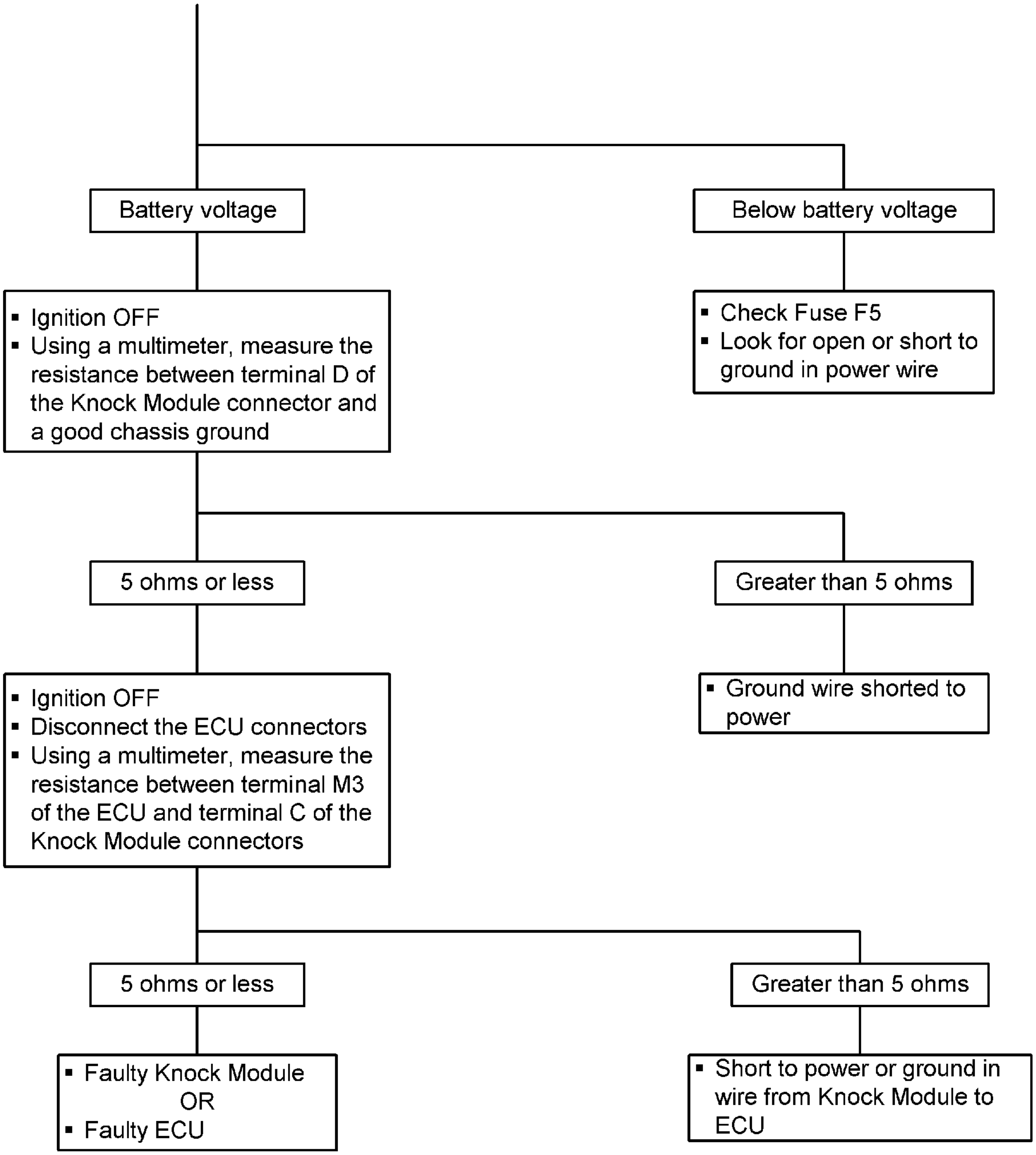
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, Knock Module connector, and the Knock sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11141 –19–22NOV00

DPSG,RG41221,67 –19–10JUL00–1/1

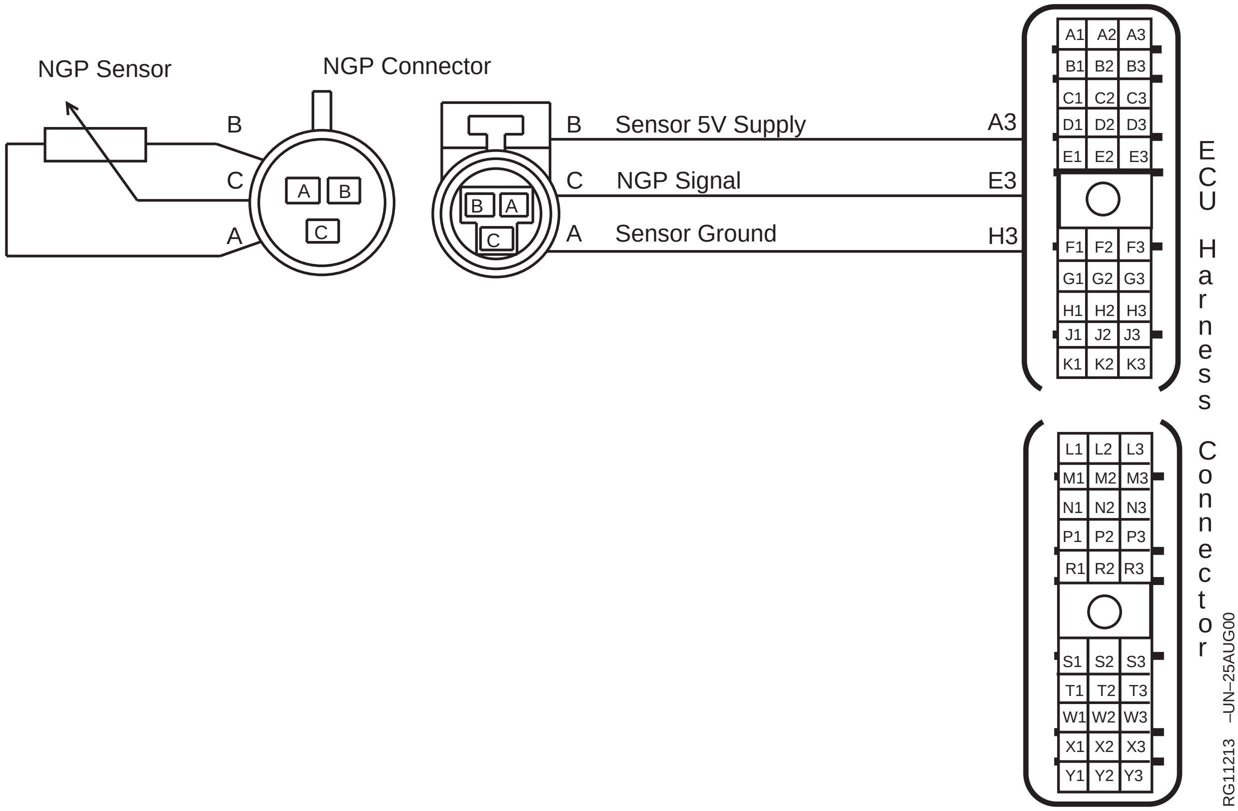
DTC 95 Knock Sensor Error - Continued



RG11199 –19–22NOV00

DPSG,RG41221,71 –19–21JUL00–1/1

DTC 96 NGP Voltage Excessively High



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
A3	B	54B Yellow	Yellow/Red	Sensor 5V Supply
E3	C	15 Yellow	Yellow	NGP Signal
H3	A	20D Black	Black/Yellow	Sensor Ground

NGP - Natural Gas Pressure sensor

The NGP sensor is a pressure transducer mounted in the fuel metering valve. It is used to measure the regulated gas pressure prior to injection. The NGP signal voltage varies as fuel pressure in the metering valve varies. Higher pressure results in a higher signal voltage to the ECU; lower pressure results in a lower voltage.

The ECU uses the NGP sensor signal:

In conjunction with the NGT sensor value to calculate fuel density at the injectors

DTC 96 will set if:

The NGP voltage is greater than 4.5 volts and below 4.92 volts for more than 40 msec.

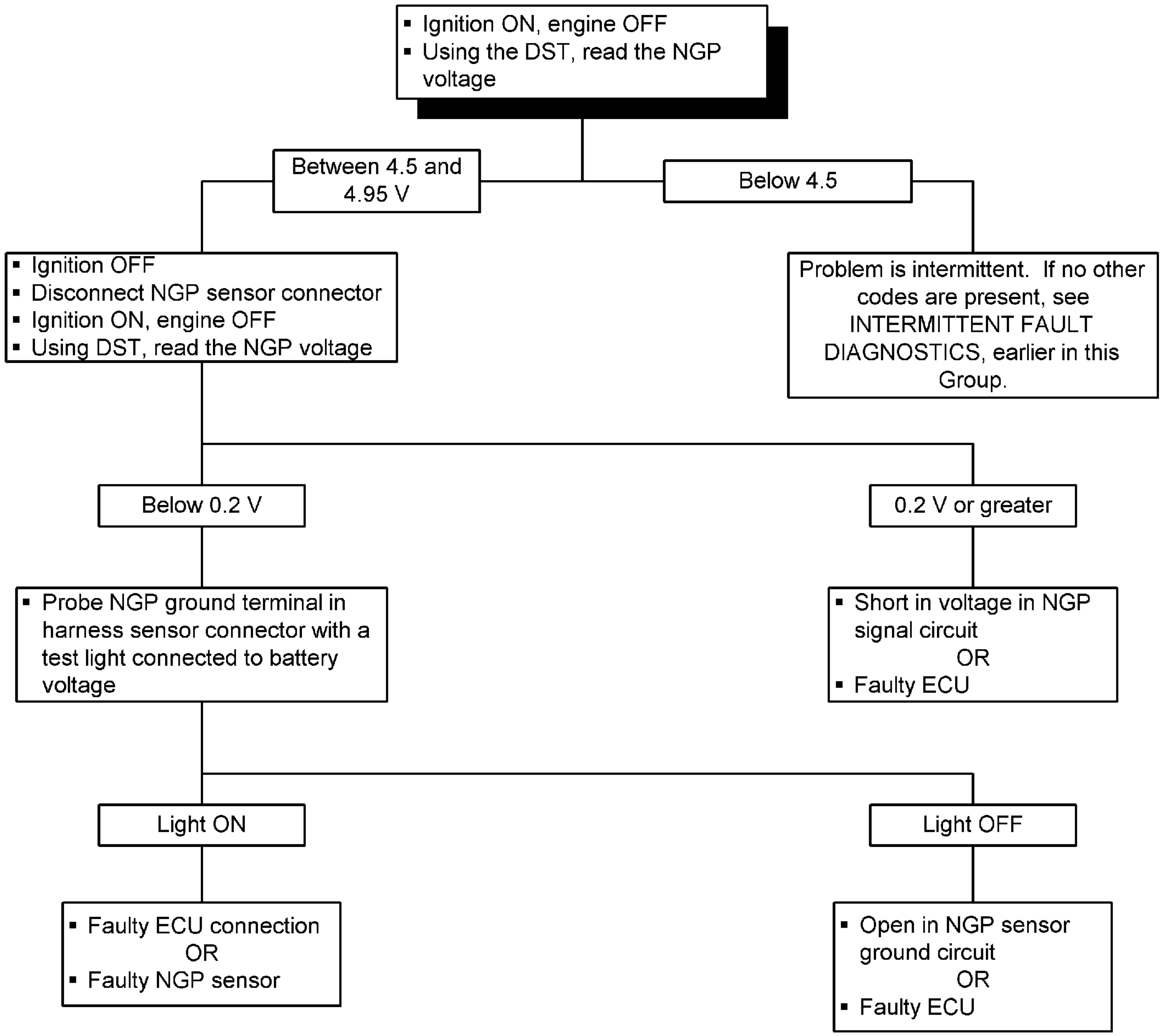
If DTC 96 sets, the following will occur:

- CEL on for remainder of key on cycle.
- Power relay and low pressure shut-off valve are closed until key cycles. If pressure remains high after key cycle, power relay and shut-off valve will close again.

DPSG,RG41221,68 –19–10JUL00–1/1

DTC 96 NGP Voltage Excessively High - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and the Natural Gas Pressure sensor connector looking for dirty, damaged, or poorly positioned terminals.



RG11142 –19–16AUG00

DPSG,RG41221,69 –19–10JUL00–1/1

D1 - Gas Pressure

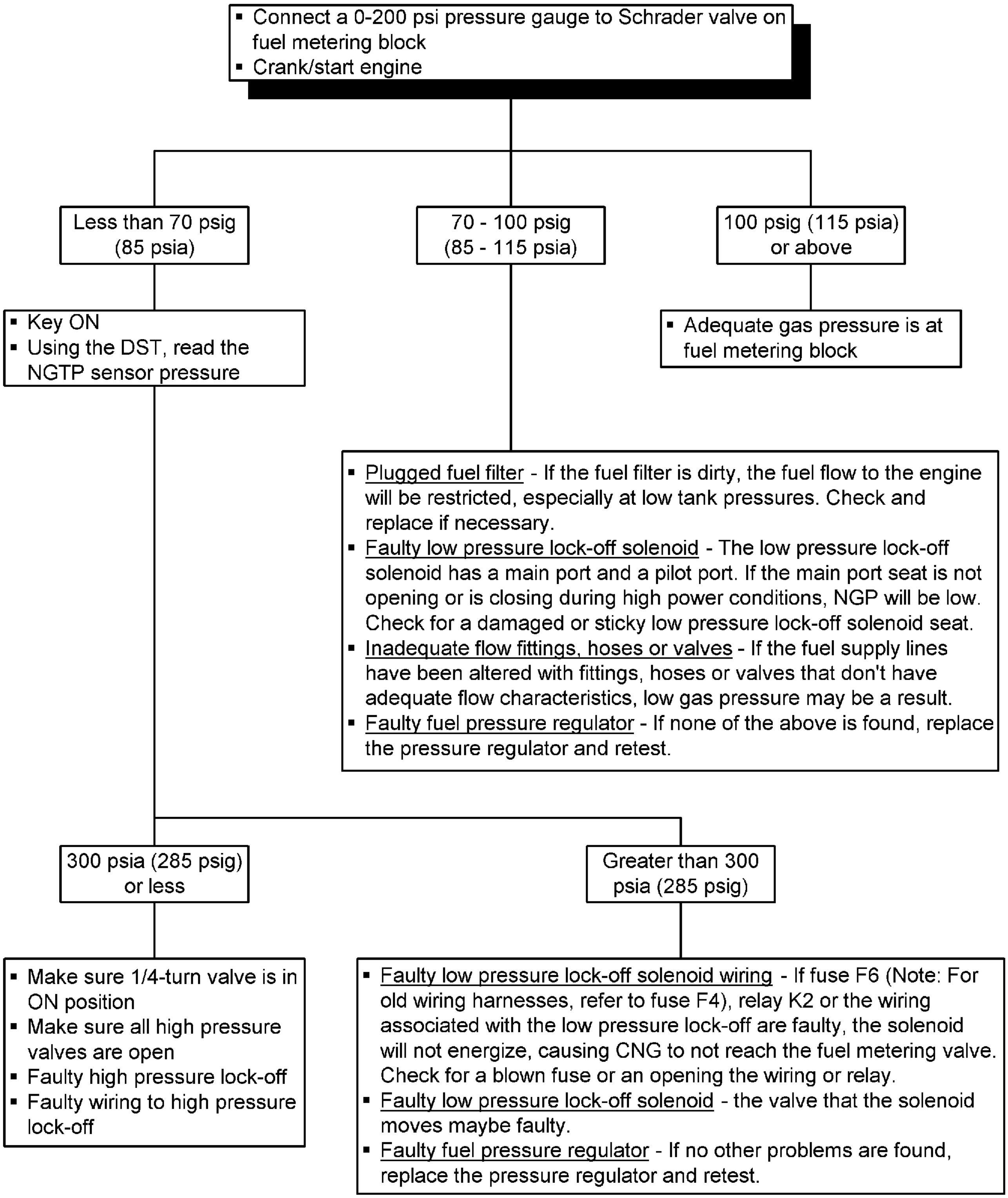
NOTE: This diagnostic chart should only be used when referred by another diagnostic chart.

This chart will help determine if adequate fuel pressure is at the fuel metering block.

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

RG,RG34710,3200 –19–15JUL96–1/1

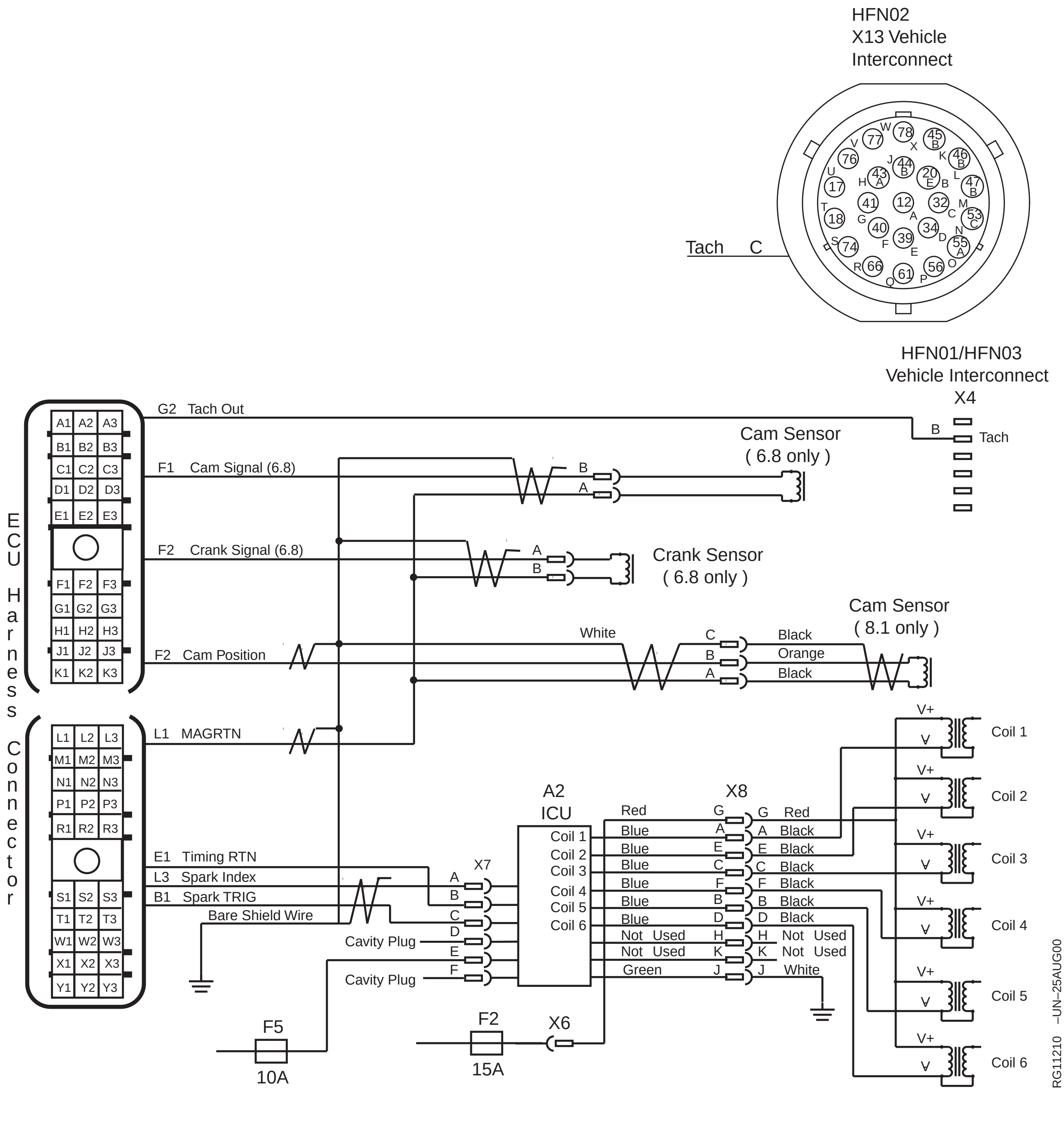
D1 - Gas Pressure - Continued



RG10204 –19–16AUG00

DPSG,RG40854,166 –19–10JUN99–1/1

D2 - Ignition System



Continued on next page

RG,RG34710,3201 –19–15JUL96–1/2

NOTE: In early wiring harnesses, fuse F6 is used in the location of fuse F5 shown in the electrical schematic below.

NOTE: This diagnostic chart should only be used when referred by another diagnostic chart.

ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
F2 (6068 CNG ONLY)	A	31 White	N.A.	Crank Signal
F2 (6081 CNG ONLY)	B	31 Lt. Blue	Lt. Blue/Green	Cam Signal
F1 (6068 CNG ONLY	B	73 White	NA	Cam Signal
L1	A	33 Black	Black/Gray	Sensor Ground
G2	B (X-4 V.I.) (C)	32 Lt. Blue	Lt. Blue/Red	Tach. Out
E1	B	30 Gray	Gray/Brown	Timing RTN
L3	A	28 Black	Purple/White	Spark Index
B1	C	29 White	White/Purple	Spark Trig
	E	62 Pink	Pink	VBAT

This chart will help determine if there is an ignition system problem and the source of the problem.

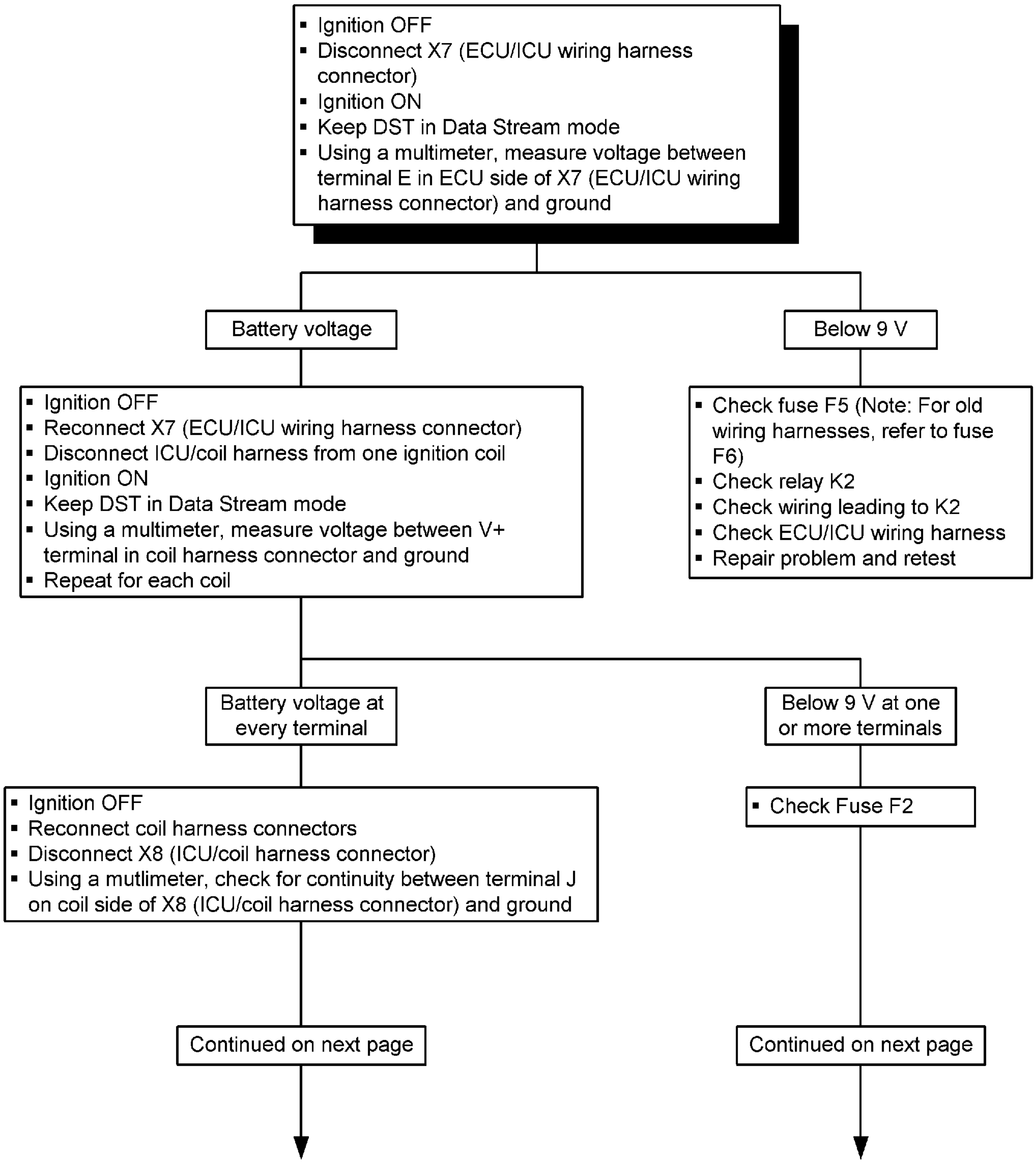
IMPORTANT: DO NOT connect or disconnect the ECU to/from the wiring harness without first removing the negative (-) battery cable from the battery.

NOTE: When the ignition is in the “ON” position without having been in the “START” position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won’t be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

RG,RG34710,3201 –19–15JUL96–2/2

D2 - Ignition System - Continued

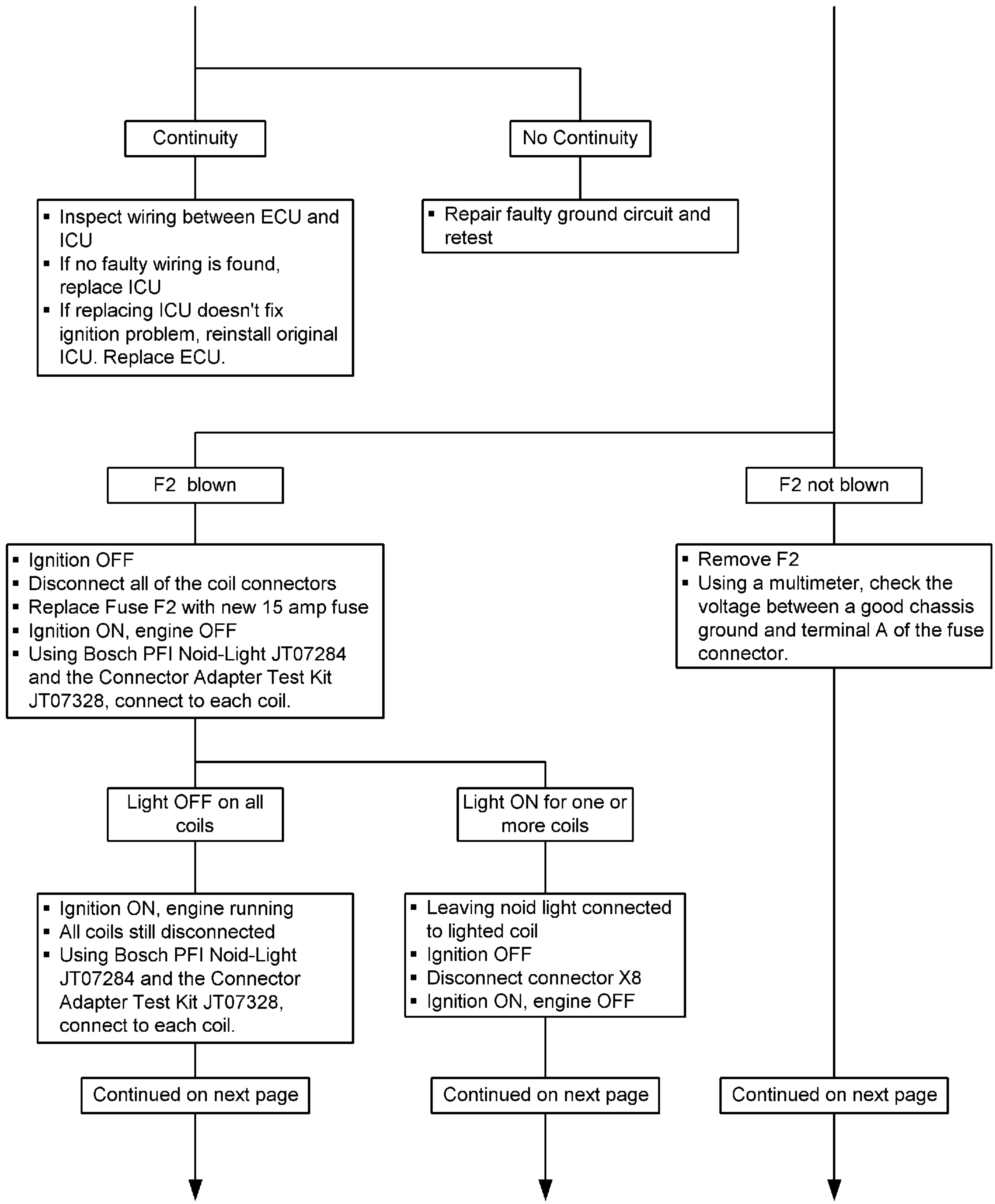
Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors, ICU connector, and all of the related sensor connectors looking for dirty, damaged, or poorly positioned terminals.



RG10205 –19–20NOV00

DPSG,RG40854,167 –19–10JUN99–1/1

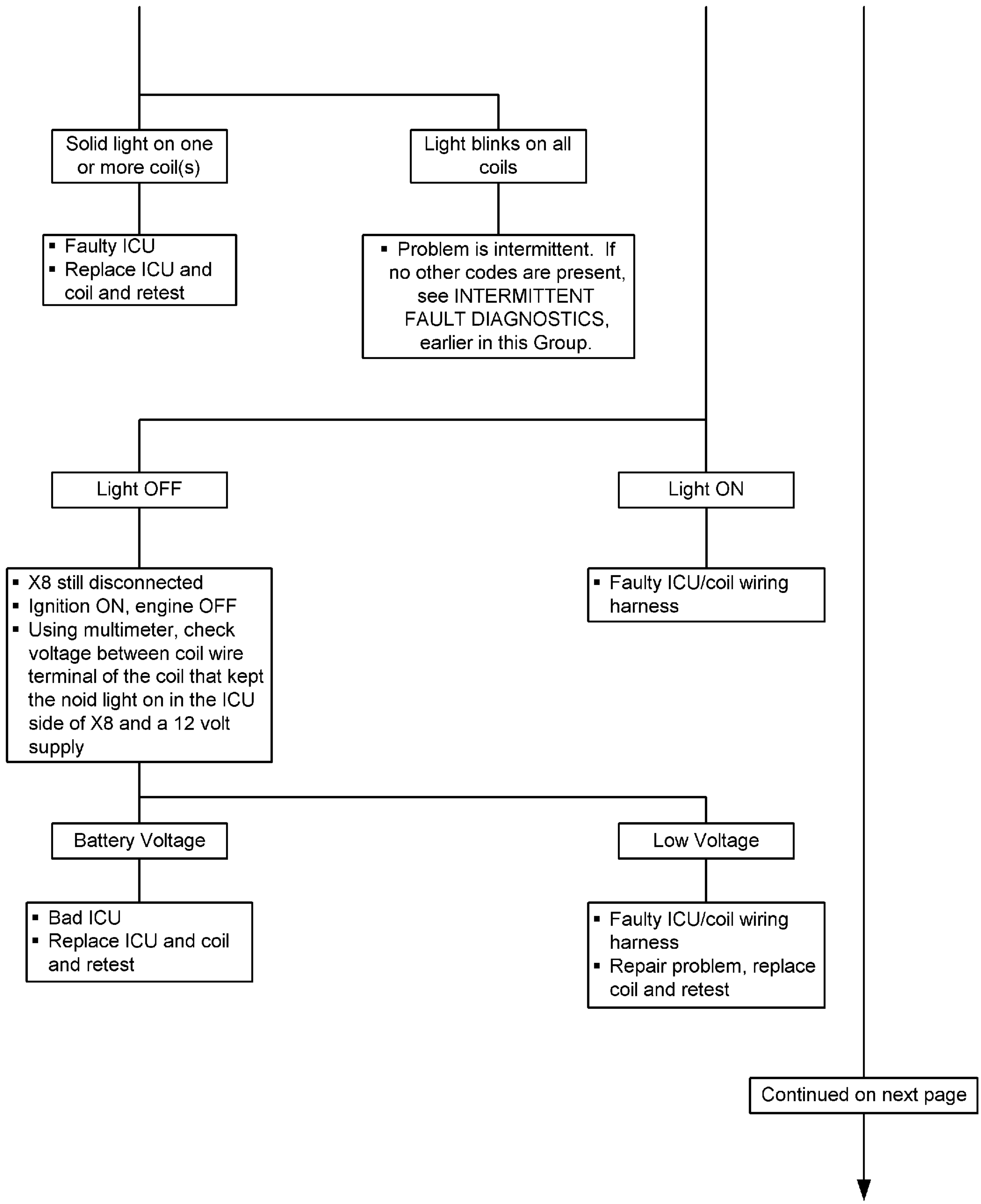
D2 - Ignition System - Continued



RG11297 –19–20NOV00

DPSG,RG41221,3 –19–14AUG00–1/1

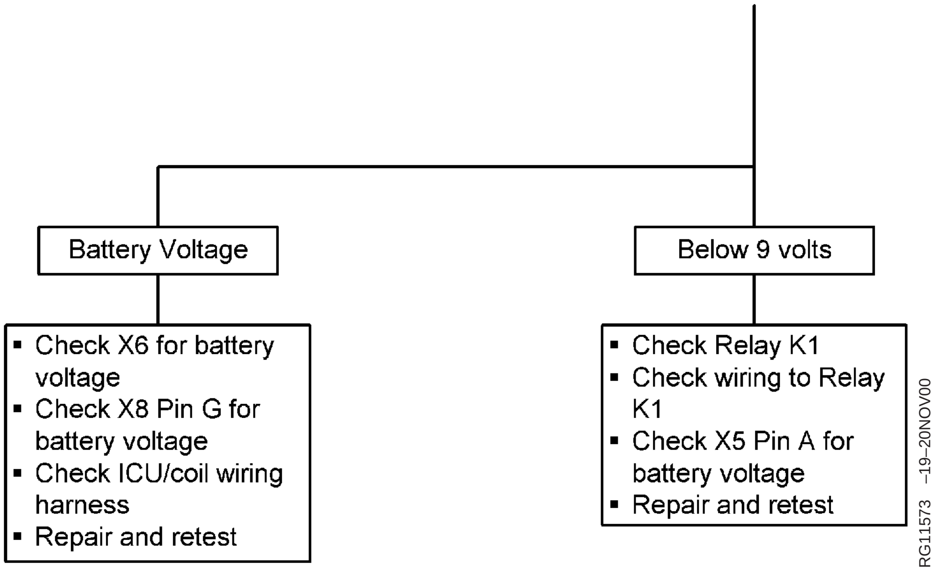
D2 - Ignition System - Continued



RG11575 –19–20NOV00

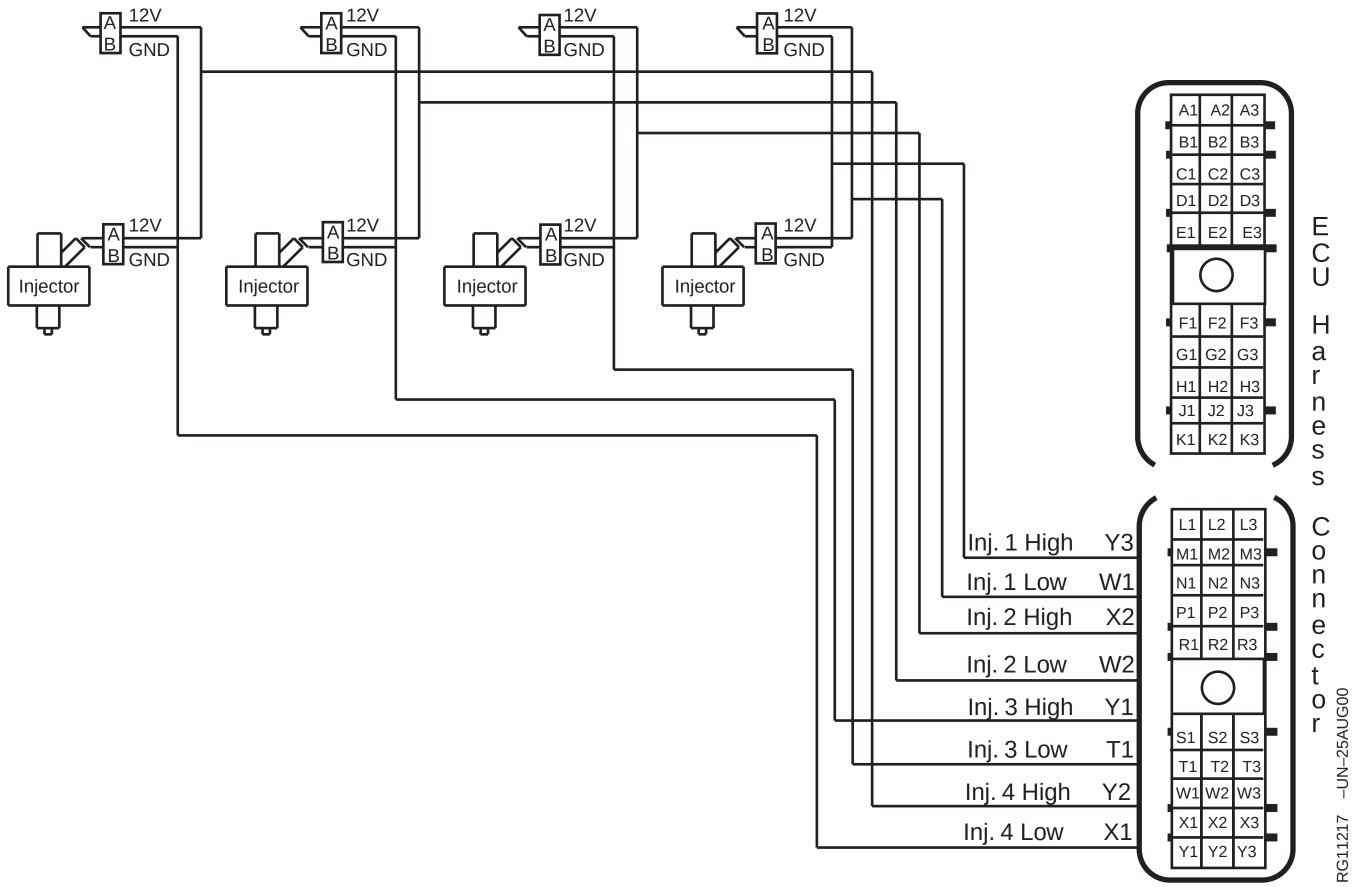
RG41221,000006B –19–20NOV00–1/1

D2 - Ignition System - Continued



RG41221,000006C –19–20NOV00–1/1

D3 - Fuel Injectors Diagnostic Chart



ECU Pin #	Harness Connector Pin #	Current 6.8/8.1 Harness	Early 8.1 Harness	Function
Y3	A	1 Orange	Orange/Lt. Blue	Inj. 1 High
W1	B	2 Brown	Brown/Lt. Blue	Inj. 1 Low
X2	A	3 Orange	Orange/Lt. Green	Inj. 2 High
W2	B	4 Brown	Brown/Lt. Green	Inj. 2 Low
Y1	A	5 Orange	Orange/White	Inj. 3 High
T1	B	6 Brown	Brown/White	Inj. 3 Low
Y2	A	7 Orange	Orange/Yellow	Inj. 4 High
X1	B	8 Brown	Brown/Yellow	Inj. 4 Low

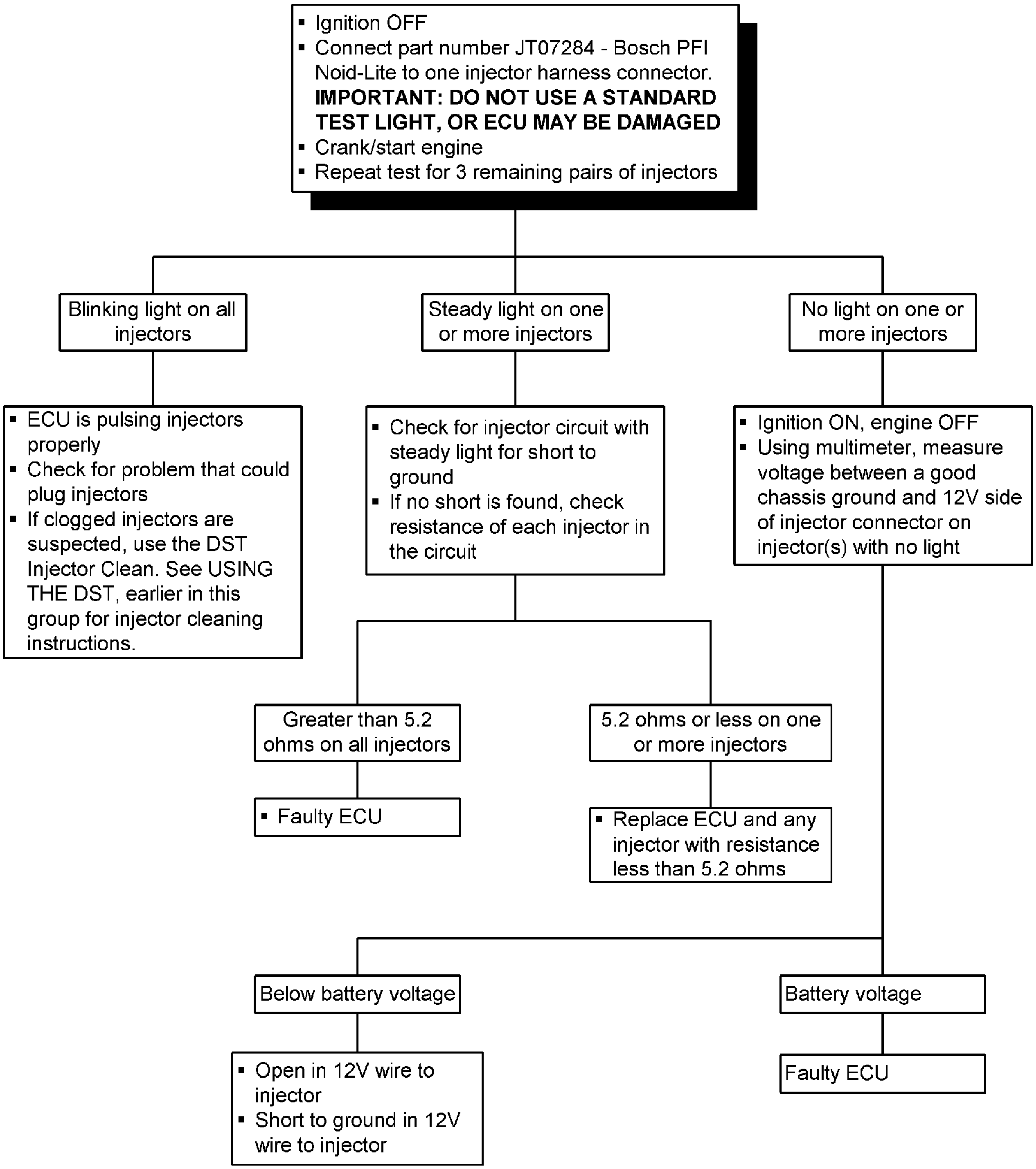
NOTE: This diagnostic chart should only be used when referred by another diagnostic chart.

NOTE: When the ignition is in the "ON" position without having been in the "START" position for the past 4-5 seconds, the ECU will turn off the engine control system relays. Therefore, if taking voltage readings under these conditions there won't be voltage at the control system output devices. By connecting the Diagnostic Scan Tool (DST) and executing the Data Stream option, the ECU will keep the relays energized. See USING THE DIAGNOSTIC SCAN TOOL (DST) in Group 115 for instructions on using the DST.

This chart will help determine if the ECU is commanding the fuel injectors correctly and if the fuel injectors are operating correctly.

D3 - Fuel Injectors Diagnostic Chart - Continued

Note: Before using this diagnostic procedure, perform a preliminary inspection of the ECU connectors and all the Injector connectors looking for dirty, damaged, or poorly positioned terminals.



RG10142 –19–16AUG00

DPSG,RG40854,169 –19–10JUN99–1/1

Specifications

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

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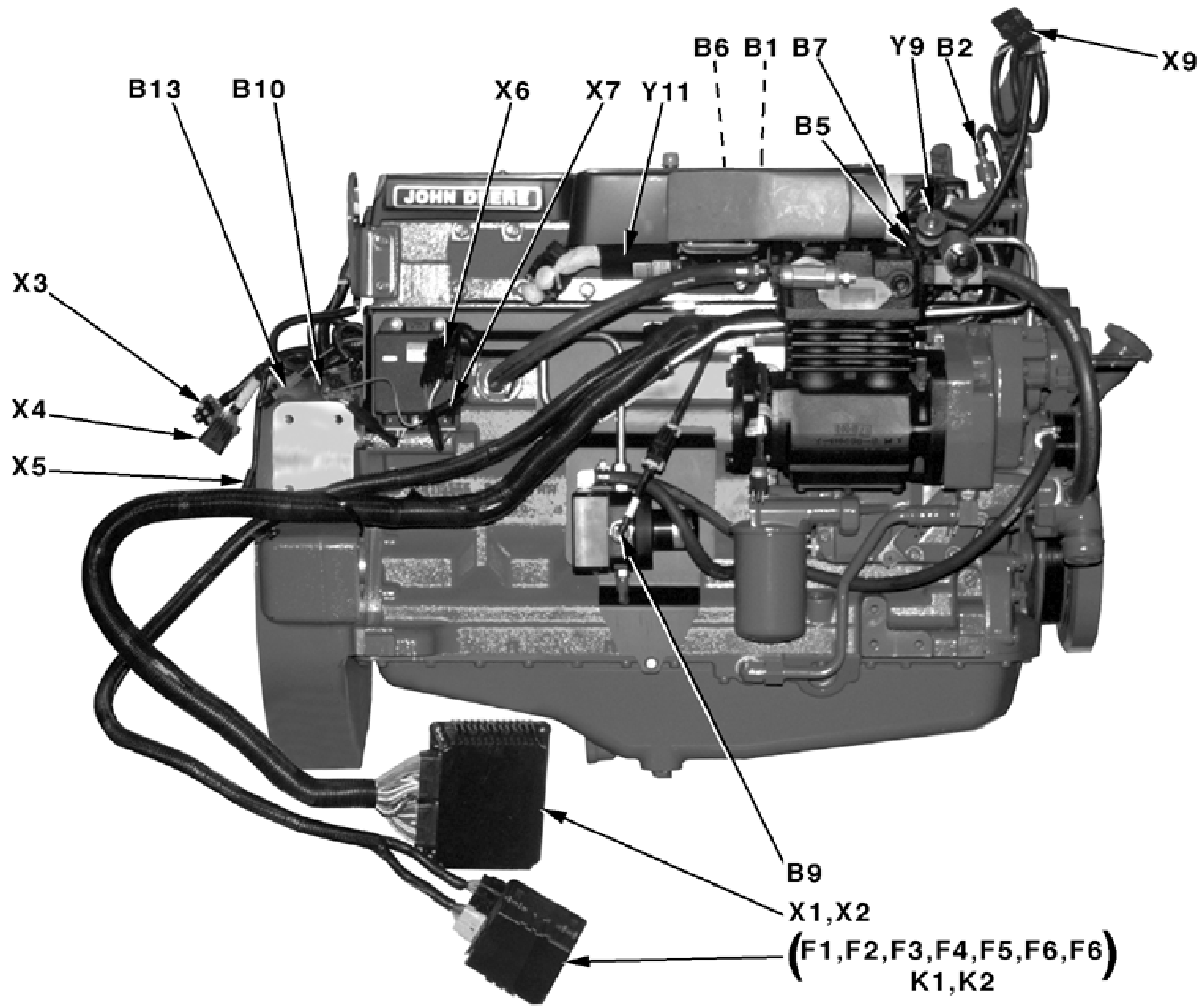
OM60113,80A –19–25APR97–1/1

Engine Diagnostics and Testing Procedures Specifications

ITEM	SPECIFICATION
Compression Pressure	
6081 CNG (10.5:1 C/R)	1069–1276 kPa (10.7–12.8 bar) (155–185 psi)
6068 CNG (11.0:1 C/R)	1242–1518 kPa (12.4–15.2 bar) (180–220 psi)
Oil Pressure at Minimum No Load at 850 rpm (Idle):	
6081 CNG	138 kPa (1.4 bar) (20 psi)
6068 CNG	100 kPa (1.0 bar) (14.0 psi)
Oil Pressure at Maximum Full Load At 2200 Rpm (Rated Speed):	
6081 CNG	400 kPa (4.0 bar) (58 psi)
6068 CNG	275 kPa (2.75 bar) (40 psi)
Thermostat:	
Initial Opening (Range)	89°C (192°F)
Full Open (Nominal)	100°C (212°F)

RG,RG34710,3211 –19–15JUL96–1/1

Electronic Engine Control System Component Location Diagram (6068 CNG Engine Left)

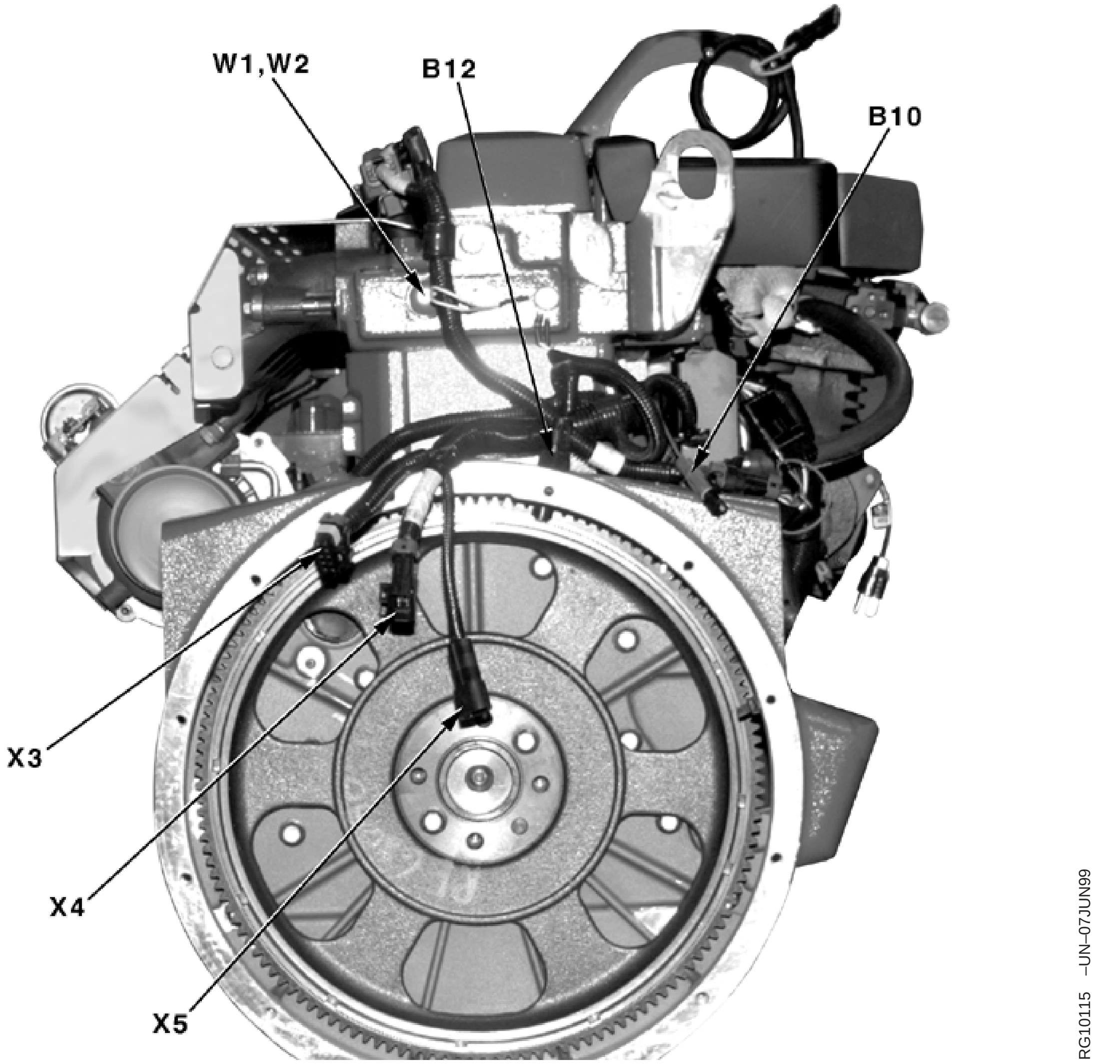


RG10114 –UN–07JUN99

B1—Manifold Absolute Pressure (MAP) Sensor
B2—Preturbine Pressure (PTP) Sensor
B3—Exhaust Back Pressure (EBP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B9—Natural Gas Tank Pressure (NGTP) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
B12—Crank Position Sensor
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
K1—Relay
K2—Relay
W1—Ground (2 wires)
W2—Ground (3 wires)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X6—Ignition Coil Power
X7—Ignition Control Unit (ICU) Connector
X8—Diagnostic Connector
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

DPSG,RG40854,82 –19–09JUN99–1/1

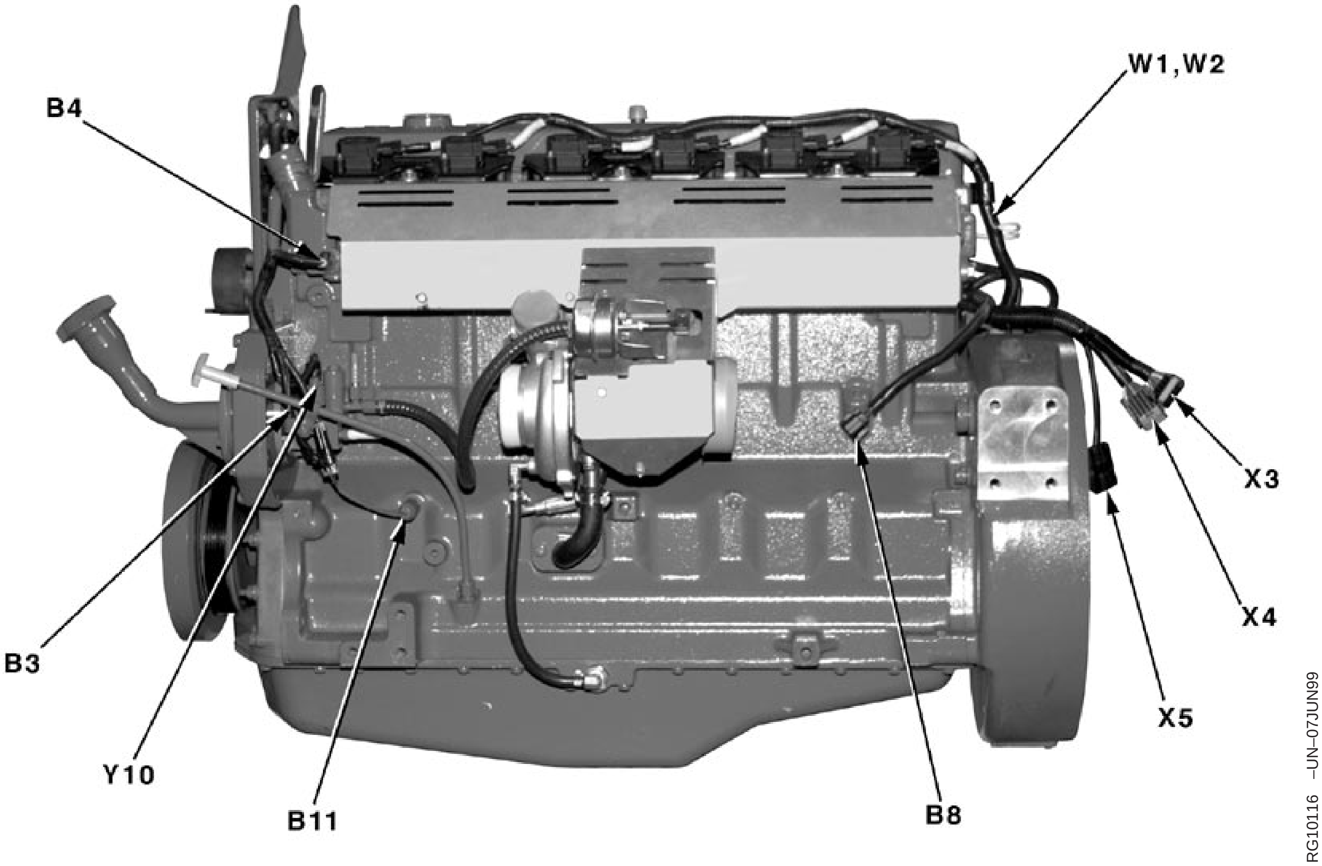
Electronic Engine Control System Component Location Diagram (6068 CNG Engine Rear)



B1—Manifold Absolute Pressure (MAP) Sensor
B2—Preturbine Pressure (PTP) Sensor
B3—Exhaust Back Pressure (EBP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B9—Natural Gas Tank Pressure (NGTP) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
B12—Crank Position Sensor
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
K1—Relay
K2—Relay
W1—Ground (2 wires)
W2—Ground (3 wires)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X6—Ignition Coil Power
X7—Ignition Control Unit (ICU) Connector
X8—Diagnostic Connector
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

DPSG,RG40854,269 –19–28JUL99–1/1

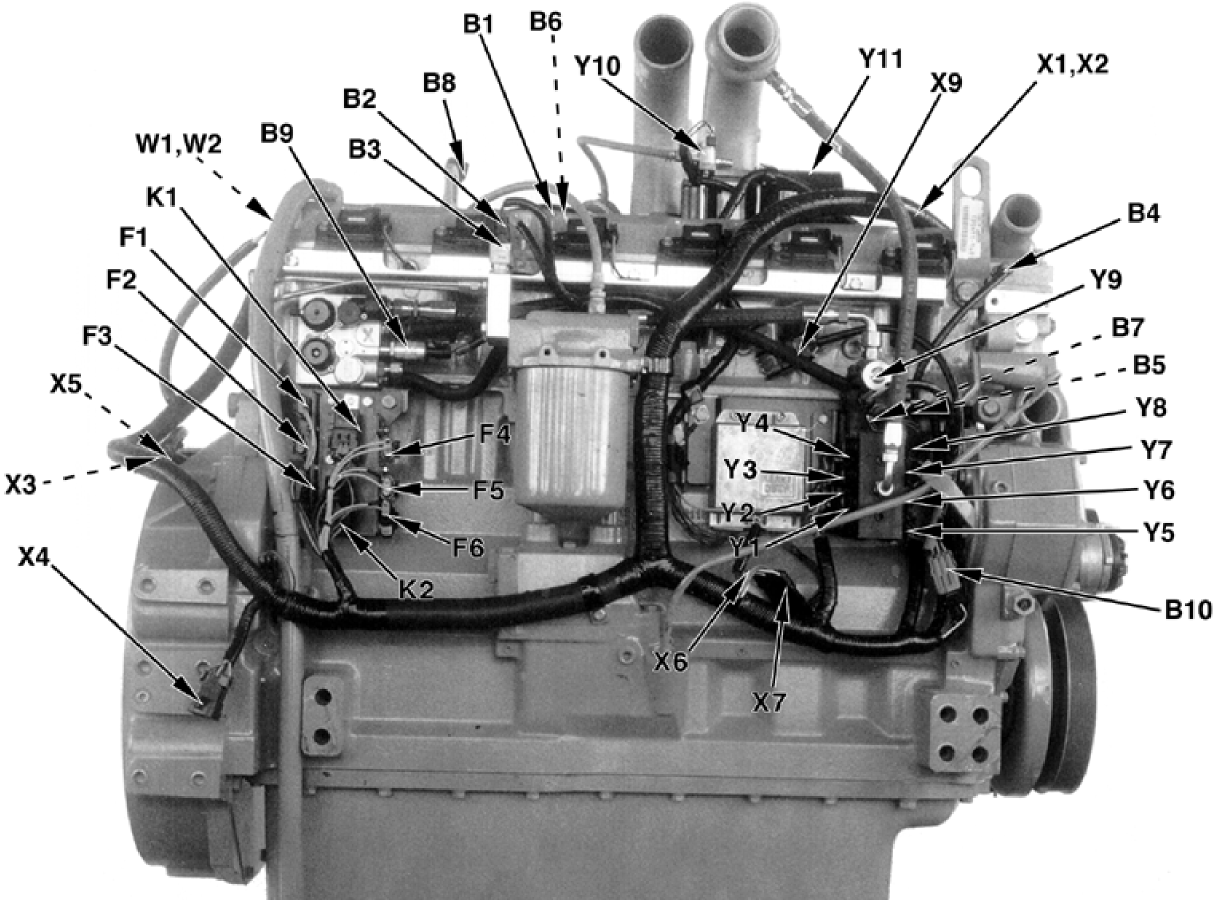
Electronic Engine Control System Component Location Diagram (6068 CNG Engine Right)



B1—Manifold Absolute Pressure (MAP) Sensor
B2—Preturbine Pressure (PTP) Sensor
B3—Exhaust Back Pressure (EBP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B9—Natural Gas Tank Pressure (NGTP) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
B12—Crank Position Sensor
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
K1—Relay
K2—Relay
W1—Ground (2 wires)
W2—Ground (3 wires)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X6—Ignition Coil Power
X7—Ignition Control Unit (ICU) Connector
X8—Diagnostic Connector
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

DPSG,RG40854,270 –19–28JUL99–1/1

Electronic Engine Control System Component Location Diagram (6081 CNG Engine with Early Wiring Harness - HFN01)

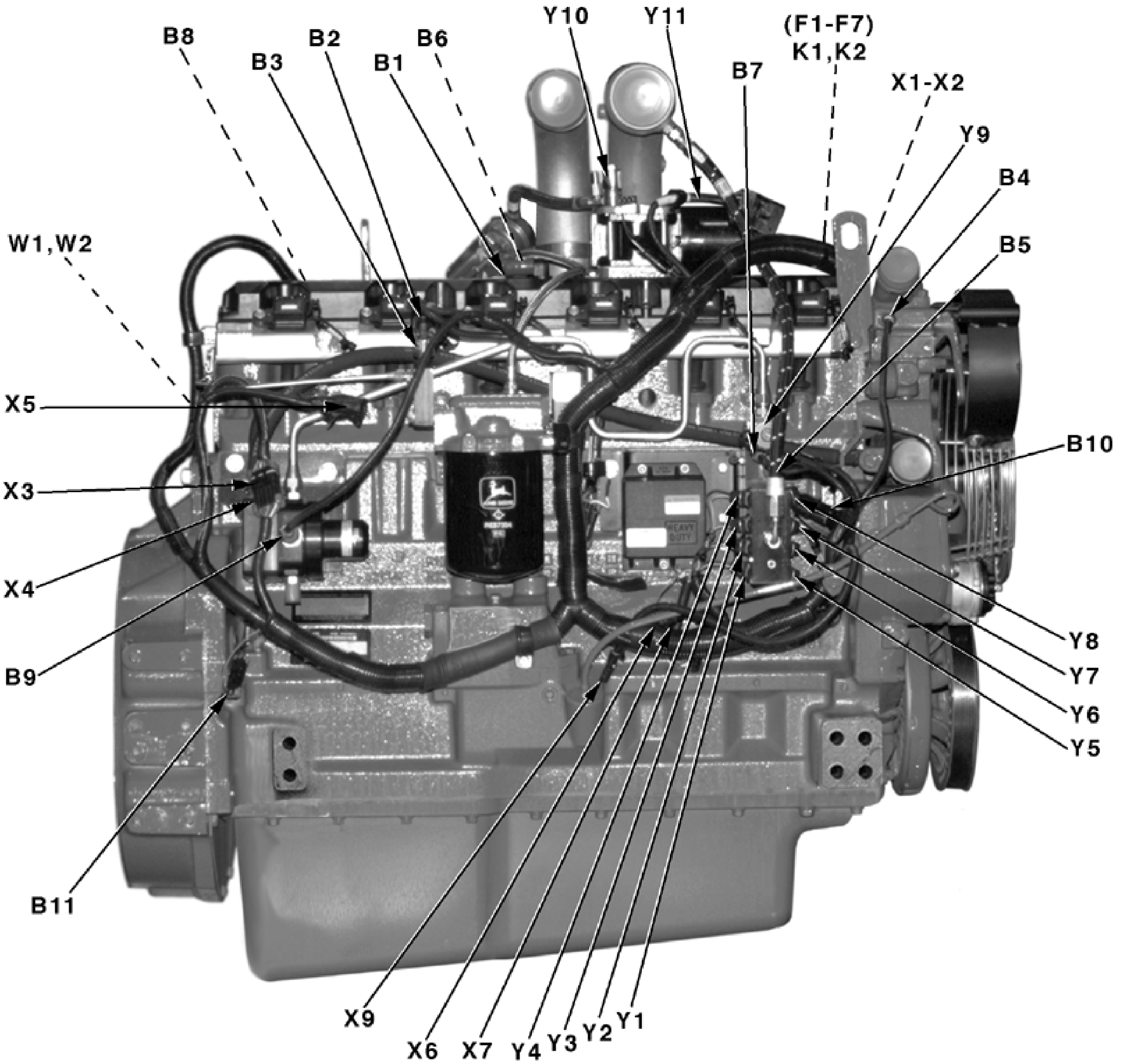


B1—Manifold Absolute Pressure (MAP) Sensor
B2—Preturbine Pressure (PTP) Sensor
B3—Exhaust Back Pressure (EBP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B9—Natural Gas Tank Pressure (NGTP) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (35A)
F4—Fuse (15A)
F5—Fuse (15A)
F6—Fuse (10A)
K1—Relay
K2—Relay
W1—Ground (2 wires)
W2—Ground (3 wires)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X6—Ignition Coil Power
X7—Ignition Control Unit (ICU) Connector
X9—Diagnostic Connector
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

NOTE: For the Early Wiring Harness shown in previous illustration, the fuses and relays are mounted ON the engine.

RG,RG34710,3212 –19–15JUL96–1/1

Electronic Engine Control System Component Location Diagram (6081 CNG Engine with Current Wiring Harness - HFN01/HFN03)



RG10113 –UN–12JUL99

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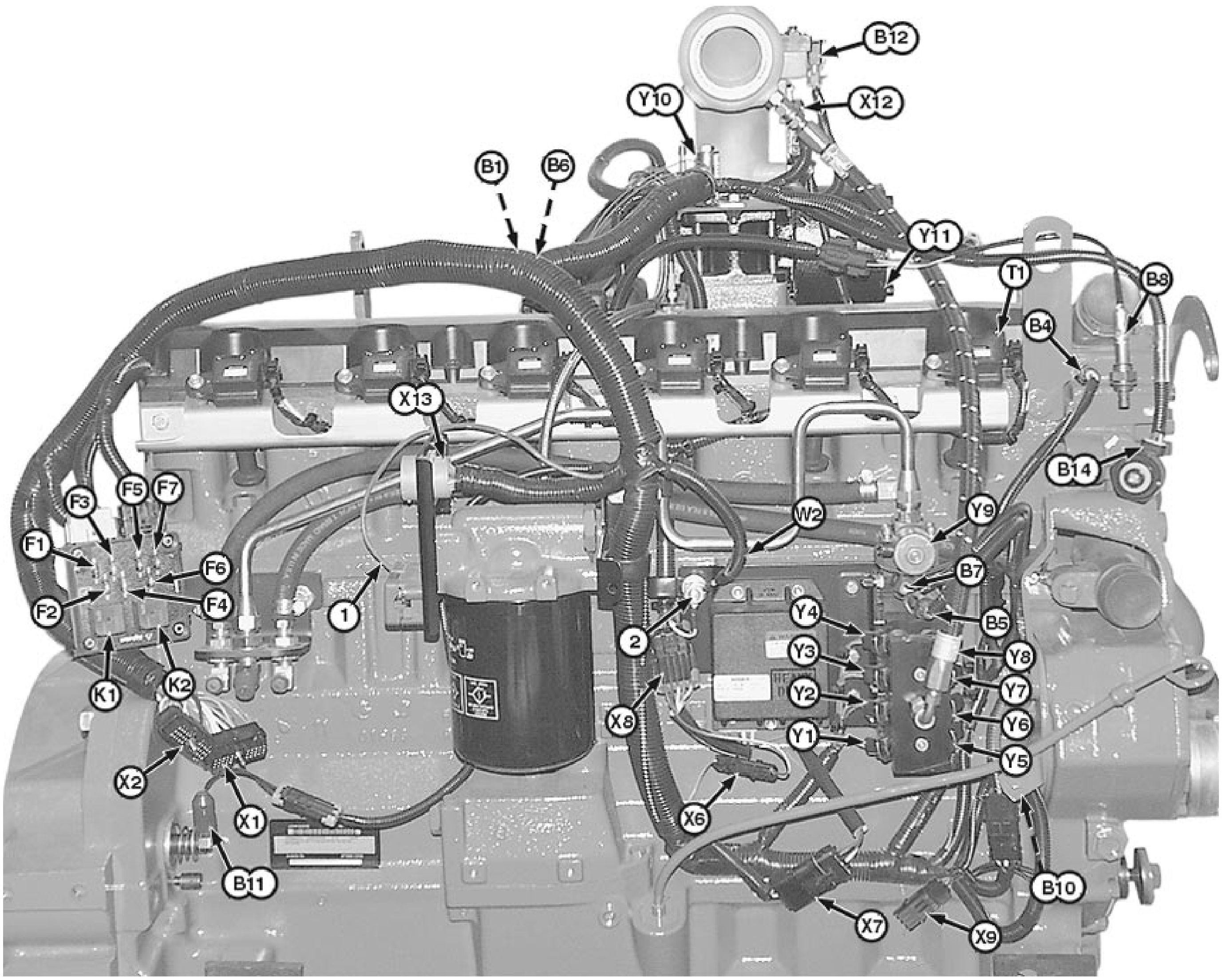
DPSG,RG40854,271 –19–28JUL99–1/2

B1—Manifold Absolute Pressure (MAP) Sensor
B2—Preturbine Pressure (PTP) Sensor
B3—Exhaust Back Pressure (EBP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B9—Natural Gas Tank Pressure (NGTP) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
K1—Relay
K2—Relay
W1—Ground (2 wires)
W2—Ground (3 wires)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X3—Vehicle Interconnect #3
X4—Vehicle Interconnect #4
X5—Vehicle Interconnect #5
X6—Ignition Coil Power
X7—Ignition Control Unit (ICU) Connector
X9—Diagnostic Connector
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

NOTE: With the Current Wiring Harness shown on previous illustration, the fuses and relays are mounted in a fuse/relay box AWAY from the engine.

DPSG,RG40854,271 –19–28JUL99–2/2

Electronic Engine Control System Component Location Diagram (6081 CNG Engine Wiring Harness - HFN02)



RG11154B –UN–21SEP00

1—Battery Power
2—Engine System Ground Terminal
B1—Manifold Absolute Pressure (MAP) Sensor
B4—Engine Coolant Temperature (ECT) Sensor
B5—Natural Gas Pressure (NGP) Sensor
B6—Manifold Air Temperature (MAT) Sensor
B7—Natural Gas Temperature (NGT) Sensor
B8—Universal Exhaust Gas Oxygen (UEGO) Sensor
B10—Cam Position Sensor
B11—Oil Pressure Switch
B12—Upstream Throttle Pressure (UTP) Sensor
B13—Knock Sensor
B14—Environment Sensor
F1—Fuse (5A)
F2—Fuse (15A)
F3—Fuse (20A)
F4—Fuse (20A)
F5—Fuse (10A)
F6—Fuse (15A)
F7—Fuse (15A)
K1—Relay
K2—Relay
T1—Fuel Injector
W2—Ground (1 wire)
X1—Electronic Control Module (ECM) Connector
X2—Electronic Control Module (ECM) Connector
X6—Ignition Coil Power
X7—Ignition Control Unit (ICU) Connector
X8—Spark Plug Harness Connector
X9—Diagnostic Connector
X12—Knock Module Connector
X13—Vehicle Interconnect #3
Y1—Fuel Injector
Y2—Fuel Injector
Y3—Fuel Injector
Y4—Fuel Injector
Y5—Fuel Injector
Y6—Fuel Injector
Y7—Fuel Injector
Y8—Fuel Injector
Y9—Low Pressure Lockoff Solenoid
Y10—Turbocharger Wastegate Control Solenoid
Y11—Electronic Throttle

Continued on next page

DPSG,RG40854,271 –19–28JUL99–1/2

NOTE: With the Current Wiring Harness shown on previous illustration, the fuses and relays are mounted in a fuse/relay box AWAY from the engine.

DPSG,RG40854,271 –19–28JUL99–2/2

ECU Terminal Identification

TERMINAL	FUNCTION	Circuit Number and Wire Color for Current 8.1/6.8/HFN02 (Wire Color for Early 8.1) Wiring Harnesses
A1	Throttle Command	35 Lt Green (Lt Green/Brown)
A2	5 Volt Supply to MAP, FPP1, PTP, UTP (HFN02 ONLY)	55 Lt Green (Lt Green/Red)
A3	5 Volt Supply to NGTP, NGP, EBP, Environment sensor (HFN02 ONLY)	54 Yellow (Yellow/Red)
B1	Spark Trigger	29 White (White/Purple)
B2	UEGO Pump Cell	26 Lt Blue (Lt Blue/White)
B3	TPS Signal (feedback)	19 Purple (Purple/Lt Blue)
C1	NGTT Signal (Option for HFN02)	18 Yellow (Yellow/Dk Blue)
C2	NGTP Signa (Option for HFN02l	17 Dk Blue (Dk Blue/White)
C3 Non HFN02 ONLY	PTP Signal	10 Lt Blue (Lt Blue/Dk Blue)
C3 HFN02 ONLY	UTP Signal	10 Lt Blue (Lt Blue/Dk Blue)
D1	NGT Signal	14 White (White/Lt Green)
D2	UEGO Sense Cell	25 Dk Green (Dk Green/Orange)
D3	ECT Signal	16 Yellow (Yellow/Gray)
E1	EST Return	30 Gray (Gray/Brown)
E2	MAT Signal	13 Tan (Tan)
E3	NGP Signal	15 Yellow (Yellow)
F1 6068 ONLY	Cam Position Signal	73 White
F1 6081 ONLY	Not Used	76 Green
F2 6068 ONLY	Crank Position Signal	31 White
F2 6081 ONLY	Cam Position Signal	31 Lt. Blue (Lt Blue/Lt Green)
F3	Sensor Ground for NGTP, NGTT, PTP, MAP, EBP, ECT, NGT, UEGO, UTP (HFN02 ONLY), Environment (HFN02 ONLY)	21 Black (Black/Yellow)
G1	IVS Signal	74 Green (Green)
G2	Engine Speed Output	32 Lt. Blue (Lt Blue/Red)
G3	Ground	22 White (White)
H1	FPP 1 Signal	12 Dk Blue (Dk Blue)
H2	UEGO Resistor	24 Gray (Gray/Black)

RG,RG34710,3215 –19–15JUL96–1/1

ECU Terminal Identification—Continued

TERMINAL	FUNCTION	Circuit Number and Wire Color for Current 8.1/6.8/HFN02 (Wire Color for Early 8.1) Wiring Harnesses
H3	Sensor Ground for Oil Pressure Switch, MAT, TPS, NGP, FPP1	20 Black (Black/Tan)
J1	UEGO Ground	27 Black (Black/Orange)
J2	5 Volt Supply to Diagnostic Connector / FPP2 Sensor	43 Gray (Gray/Red)
J3	SAE J1708 Vehicle Communication Link (-)	47 Purple (Purple)
K1	SAE J1708 Vehicle Communication Link (+)	46 Dk Blue (Dk Blue/Pink)
K2	Diagnostic Transmit	44 Dk Green (Dk Green)
K3	MAP Signal	11 Lt Green (Lt Green)
L1	Cam Position Sensor Return/Crank Position Sensor Return	33 Black (Black/Gray) / 33 Black (N.A.)
L2	Diagnostic Receive	45 Orange (Orange)
L3	Spark Index	28 Purple (Purple/White)
M1	Ground for Diagnostic Connector and FPP2 Sensor	53 Gray (White)
M2	Fast Idle Signal	41 Gray (Gray/Dk Blue)
M3 Non HFN02 ONLY	EBP Signal	9 Dk Green (Dk Green/White)
M3 HFN02 ONLY	Knock Module output	9 Dk Green (Dk Green/White)
N1	Not Used	77 Dk Green
N2	Fuel Gauge	56 Tan (Tan/Brown)
N3	Oil Pressure Switch Signal	42 Lt Green (Lt Green/Black)
P1	Wastegate Control Solenoid	37 Tan (Tan/Orange)
P2	Not Used	78 Dk Green
P3 6068 ONLY	Ground	52 Lt Blue
P3 6081 ONLY	Ground	52 White (White)
R1	“Check Engine” Light	39 Lt Blue (Lt Blue/Black)
R2	UEGO Heater	23 White (White/Lt Blue)
R3	Ground	51 White (White)
S1	Low Pressure Lock-Off Solenoid	36 White (White/Black)
S2	Throttle Inhibit	40 Red (Red/Dk Green)
S3	Switched Vehicle Power	48 Pink (Pink/Tan)
T1	Injector Driver 3 Ground	6 Brown (Brown/White)
T2	Gas Disable	38 Tan (Tan/Black)
T3	FPP2 Signal	34 Purple (Purple)
W1	Injector Driver 1 Ground	2 Brown (Brown/Lt Blue)

DPSG,RG34710,96 –19–23JUL99–1/1

ECU Terminal Identification—Continued

TERMINAL	FUNCTION	Circuit Number and Wire Color for Current 8.1/6.8/HFN02 (Wire Color for Early 8.1) Wiring Harnesses
W2	Injector Driver 2 Ground	4 Brown (Brown/Lt Green)
W3	Battery Power	50 Red (Red/Tan)
X1	Injector Driver 4 Ground	8 Brown (Brown/Yellow)
X2	Injector Driver 2 12 Volt Supply	3 Orange (Orange/Lt Green)
X3	Battery Power	49 Red (Red/Tan)
Y1	Injector Driver 3 12 Volt Supply	5 Orange (Orange/White)
Y2	Injector Driver 4 12 Volt Supply	7 Orange (Orange/Yellow)
Y3	Injector Driver 1 12 Volt Supply	1 Orange (Orange/Lt Blue)

RG41221,0000008 –19–05SEP00–1/1

Group 105
Engine Diagnostics and Testing Procedures Tools

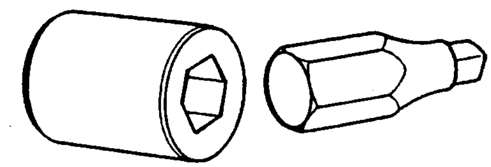
NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

SERVICEGARD is a trademark of Deere & Company.

OM60113,80A –19–25APR97–1/8

Oil Galley Plug Tool. JDG782

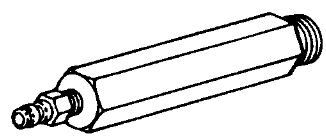
Used to remove and install oil galley plug.



RG6612 –UN–29JAN93

OM60113,80A –19–25APR97–2/8

RG6759 –UN–30APR93



Compression Test Adapter 6081 . . . . JDG814

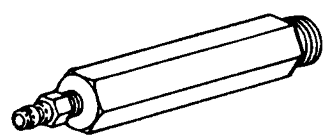
Used with JT01682[1] (D114547BA)[2] Gauge and Hose Assembly to test compression pressure.

[1] *Part of JT01674 (D14546BA) Compression Test Kit*

[2]*Use with JT01681 Special Adapter for quick coupler connection.*

OM60113,80A –19–25APR97–3/8

RG6759 –UN–30APR93



Compression Test Adapter 6068 . . . . JDG1346

Used with JT01682[1] (D114547BA)[2] Gauge and Hose Assembly to test compression pressure.

[1] *Part of JT01674 (D14546BA) Compression Test Kit*

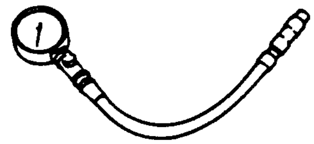
[2]*Use with JT01681 Special Adapter for quick coupler connection.*

Continued on next page

OM60113,80A –19–25APR97–4/8

RG6760 –UN–30APR93

Compression Test Kit. JT01674 (D14546BA)



Use with JDG814 Compression Test Adapter to test compression pressure.

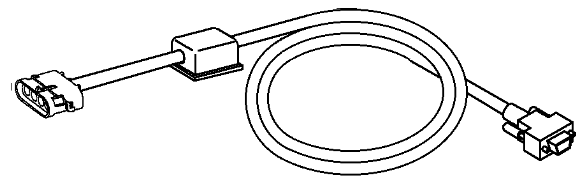
OM60113,80A –19–25APR97–5/8

Gauge and Hose Assembly. JT01682 (D14547BA)

Use with JDG814 Compression Test Adapter to test compression pressure.

OM60113,80A –19–25APR97–6/8

ECU Communication Kit JT07267



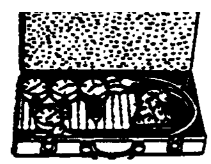
RG11576 –UN–22NOV00

Used in a computer to read information from the Electronic Control Unit.

OM60113,80A –19–25APR97–7/8

RG5162 –UN–23AUG88

Universal Pressure Test Kit JT05470 (D15027NU)



Used for testing engine oil pressure.

OM60113,80A –19–25APR97–8/8

Group 110
Starting and Charging System Diagnostics Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

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RG,RG34710,3206 –19–15JUL96–1/2

Digital Multimeter JT05791

Test electrical components for voltage, resistance, or current flow. It is especially good for measuring low voltage or high resistance circuits.

RW11274 –UN–12DEC88

RG,RG34710,3206 –19–15JUL96–2/2

Group 115
Electronic Engine Controls Diagnostics Tools

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

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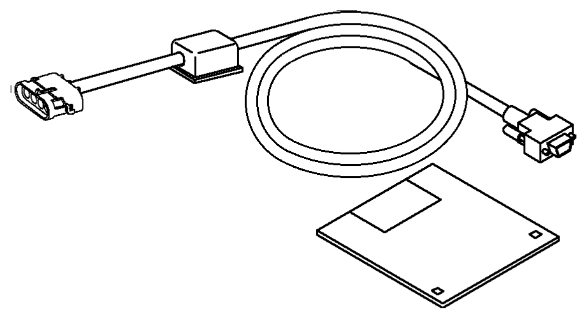
RG,RG34710,3208 –19–15JUL96–1/10

ECU Communication Kit JT07267

Used in a computer to read information from the Electronic Control Unit.



RG8139 –UN–20AUG98

RG,RG34710,3208 –19–15JUL96–2/10

Digital Multimeter JT05791

Test electrical components for voltage, resistance, or current flow. It is especially good for measuring low voltage or high resistance circuits.

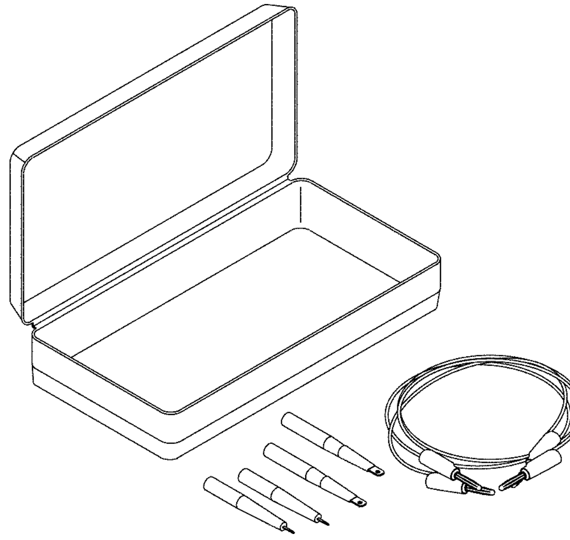
RW11274 –UN–12DEC88

Continued on next page

RG,RG34710,3208 –19–15JUL96–3/10

Connector Adapter Test Kit JT07328

Used with JT05791 Digital Multimeter to make voltage and resistance measurements in control system wiring harness connectors. Can also be used to test terminals for proper fit.

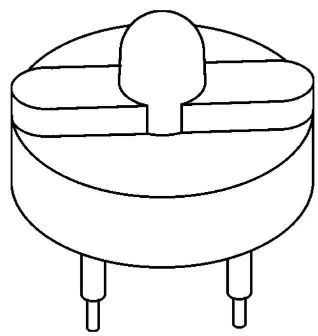


RG8803 –UN–26NOV97

RG,RG34710,3208 –19–15JUL96–4/10

Bosch PFI Noid-Light JT07284

Used to test fuel injector drive operation.

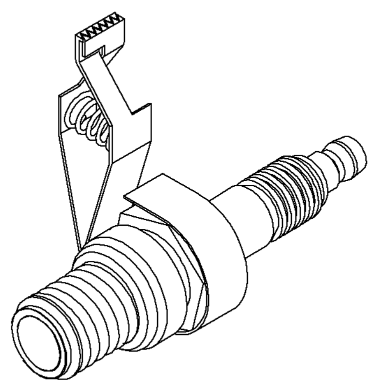


RG8136 –UN–20AUG98

RG,RG34710,3208 –19–15JUL96–5/10

Electronic Ignition Spark Tester JT07285

Used to check for ignition system spark.

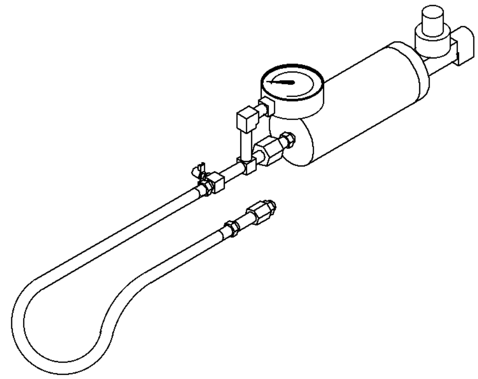


RG8137 –UN–20AUG98

Continued on next page RG,RG34710,3208 –19–15JUL96–6/10

Fuel Injector Cleaner JT07282

Used with JT07281 Injector Cleaner Accessory Kit and JT07283 Pro Inject-R Kleen fluid to clean fuel injectors.



RG8138 –UN–20AUG98

RG,RG34710,3208 –19–15JUL96–7/10

Injector Cleaner Accessory Kit JT07281

Used with JT07283 Pro Inject-R Kleen to clean fuel injectors.

RG,RG34710,3208 –19–15JUL96–8/10

Pro Inject-R Kleen JT07283

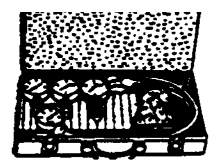
Used with JT07282 Fuel Injector Cleaner and JT07281 Injector Cleaner Accessory Kit to clean fuel injectors.

RG,RG34710,3208 –19–15JUL96–9/10

RG5162 –UN–23AUG88

Universal Pressure Test Kit JT05470 (D15027NU)

Used with JT01735[1] Gas Cock to test natural gas fuel pressure.



[1] *Part of JT07281 Injector Cleaner Accessory Kit*

RG,RG34710,3208 –19–15JUL96–10/10

Other Material

Number	Name	Use
	O-Ring Lubricant	Lubricate natural gas fuel line fitting O-rings.

RG,RG34710,3209 –19–15JUL96–1/1

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