Tier Ⅱ Dual Fuel System (Gasoline)

G424E/G430E Tier Ⅱ Dual Fuel Engine Lift Trucks

G20E-3, G25E-3, G30E-3, G32E-3 with G424E Tier Ⅱ Dual Fuel Engine

G20P-3, G25P-3, G30P-3, G32P-3, G33P-3 with G430E Tier Ⅱ Dual Fuel Engine

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Read and understand all safety precautions and warnings before operating or performing lubrication, maintenance and repair on this product.

Basic safety precautions are listed in the “Safety” section of the Service or Technical Manual. Additional safety precautions are listed in the “Safety” section of the owner/operation/maintenance publication.
Specific safety warnings for all these publications are provided in the description of operations where hazards exist. WARNING labels have also been put on the product to provide instructions and to identify specific hazards. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons. Warnings in this publication and on the product labels are identified by the following symbol.

⚠ WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.
Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

DOOSAN cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by DOOSAN is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. DOOSAN dealers have the most current information available.

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine or other type of prime mover should be equipped with an over speed (over temperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system. Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

IMPORTANT DEFINITIONS

WARNING—indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.

CAUTION—indicates a potentially hazardous situation, which, if not avoided, could result in damage to equipment.

NOTE—provides other helpful information that does not fall under the warning or caution categories.

*** This manual shows just Dual fuel Engine and engine control system for TIER-Ⅱ Gasoline Engine, so regarding other ares, please refer to the separate manual of SB4136E for G424E TIER-Ⅱ LP Engine and SB4137E for G430E TIER-Ⅱ LP Engine, and SB2215E for G424 Engine(Basic) and SB4005E for G430 Engine(Basic).**

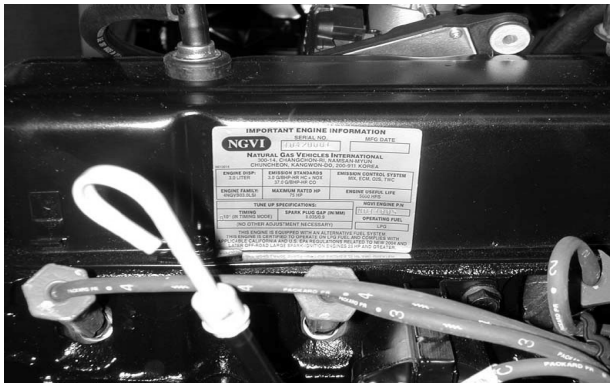
Index

CHAPTER 1 ENGINE SPECIFICATION

Indication of Engine Serial Number

G424E Dual Fuel Engine

G430E Dual Fuel Engine



Specifications (G424E Dual Fuel Engine)

GENERAL DESCRIPTION	
ENGINE TYPE:	Water-cooled, Inline 4-Cycle, 4-Cylinders
COMBUSTION SYSTEM:	Naturally Aspirated 1-Venturi Intake Manifold Semi-spherical Combustion chamber
EXHAUST SYSTEM:	Cast Iron, Dry
VALVE CONFIGURATION:	OHC, 2 Valves per Cylinder
DISPLACEMENT:	2,350 cc (143 CID)
BORE:	86.5 mm (3.41 in.)
STROKE:	100 mm (3.94 in.)
COMPRESSION RATIO:	8.6:1
COMPRESSION PRESSURE:	1,128 kPa (163.5 psi)
VALVE TIMING:	Intake Valve: 12° BTDC(Open)/ 40° ABDC(Close) Exhaust Valve: 54° BBDC(Open)/ 6° ATDC(Close)
FIRING ORDER:	1-3-4-2
SPARK PLUGS:	BPR5ES: 0.7-0.8 mm (0.028-0.031 in.) Air Gap
WEIGHT:	146 Kg (322 lbs.), Dry
ROTATION:	Counter-Clockwise (CCW) when viewed from Flywheel End
FUELTYPE:	LPG/Gasoline
GOVERNED SPEED:	2600 +/- 25 RPM
IDLE RPM:	700 +/- 25 RPM for LPG 750 +/- 25 RPM for Gasoline
IGNITIOIN TIMING:	Electronic controlled by ECM
LP FUEL SYSTEM	
MIXER:	Piston Type Air Valve Assembly inside, Downdraft
REGULATOR:	Two-Stage Negative Pressure Regulator
FUEL FILTRATION:	40 Microns Maximum
GASOLINE FUEL SYSTEM	
FUEL FILTER-PRIMARY	60 Microns
FUEL PUMP	Electric Fuel Pump (12V)
FUEL FILTER-SECONDARY	10 Microns
GASOLINE REGULATOR ASM	Gasoline Pressure Regulator (270kPa)
FUEL INJECTOR ASS'Y	Electric Fuel Injector (12V)
COOLING SYSTEM	
WATER PUMP ROTATION:	V-Belt Drive - Clockwise (CW) when viewed from engine front
THERMOSTAT:	Opening Temperature: 82°C (180°F) Fully Open Temperature: 95°C (203°F)
COOLING WATER CAPACITY:	3.1 L (block only)
LUBRICATION SYSTEM	
OIL PRESSURE:	50 kPa (7 psi) @ Low Idle 450 kPa (65 psi) @ Hi Idle
OIL TEMPERATURE:	Upper Limit: 125°C (257°F)
	Recommended: 99 - 110°C (210 - 230°F)
	Lower Limit: 80°C (176°F)
CRANKCASE CAPACITY:	3.7 L
OIL FILTER:	0.3 L
ENGINE OIL SPECIFICATION:	API - SJ, SAE 10W30 or SAE 5W30
ENGINE ELECTRICAL	
IGNITION TYPE:	Electronic Advanced by ECM
IGNITION COIL:	12 V operation volt, Ignition driver circuitry inside
DISTRIBUTOR:	Mitsubishi Distributor
STARTER MOTOR:	12 Volt, 1.2 kW, Reduction drive
ALTERNATOR:	12 Volt, 61 Amp
ENGINE OIL PR. S/W:	24.5 kPa (3.6 psi)
ENGINE CONTROL MODULE(ECM):	12 V operation volt, 24 pins of I/O
VR SENSOR:	Magnetic pick up sensor(assembled on Timing belt cover)
TMAP:	Intake Air Temp. & Manifold Absolute Press. Sensor
PEDAL ANGLE SENSOR:	Two-Output Signals (Installed on Accelerator Pedal)
OXYGEN SENSOR:	Heated Exhaust Gas Oxygen Sensor (HEGO) 12 V operation volt
ECT-ECM:	Engine Coolant Temperature Sensor for ECM
ECT-GAUGE	Engine Coolant Temp. Sensor for GAUGE on Instrument Panel
TPS:	Throttle Position Sensor (built in Throttle Body)

THROTTLE BODY:	Electronic Throttle Body
FUEL TRIM VALVE (FTV):	12 V operation volt
LP FUEL LOCK-OFF:	12 V operation volt, ON/OFF Control by ECM
EXHAUST SYSTEM	
CATALYTIC MUFFLER:	Three-way Catalyst included

Specifications (G430E Dual Fuel Engine)

GENERAL DESCRIPTION	
ENGINE TYPE:	Water-cooled, Inline 4-Cycle, 4-Cylinders
COMBUSTION SYSTEM:	Naturally Aspirated 1-Venturi Intake Manifold
EXHAUST SYSTEM:	Cast Iron, Dry
VALVE CONFIGURATION:	Pushrod Actuated Overhead Valves - 2 Per Cylinder
DISPLACEMENT:	2.967 cc (181 CID)
BORE:	101.60 mm (4.00 in.)
STROKE:	91.44 mm (3.60 in.)
COMPRESSION RATIO:	9.25:1
COMPRESSION PRESSURE:	690 kPa (100 psi) Minimum
FIRING ORDER:	1-3-4-2
SPARK PLUGS:	AC R46TS - 0.9 mm (0.035 in.) Air Gap
WEIGHT:	165 Kg (363 lbs.), Dry
ROTATION:	Counter-Clockwise (CCW) when viewed from Flywheel End
FUELTYPE:	LPG/Gasoline
GOVERNED SPEED:	2500 +/- 25 RPM
IDLE RPM:	700 +/- 25 RPM for LPG, 750 +/- 25 RPM for Gasoline
IGNITIOIN TIMING:	Electronic controlled by ECM
LP FUEL SYSTEM	
MIXER:	Piston Type Air Valve Assembly inside, Downdraft
REGULATOR:	Two-Stage Negative Pressure Regulator
FUEL FILTRATION:	40 Microns Maximum
GASOLINE FUEL SYSTEM	
FUEL FILTER - PRIMARY	60 Micron
ELECTRIC FUEL PUMP	Electric Fuel Pump (12V)
FUEL FILTER - SECONDARY	10 Micron
GASOLINE REGULATOR ASM	Gasoline Pressure Regulator (270kPa)
FUEL INJECTOR ASS'Y	Electric Fuel Injector (12V)
COOLING SYSTEM	
WATER PUMP ROTATION:	V-Belt Drive - Clockwise (CW) when viewed from engine front
THERMOSTAT:	Opening Temperature: 82°C (180°F)
	Fully Open Temperature: 96°C (205°F)
COOLING WATER CAPACITY:	3.8 L (block only)
LUBRICATION SYSTEM	
OIL PRESSURE (MIN. HOT):	28 kPa (4 psi) @ 700 RPM
	124 kPa (18 psi) @ 2000 RPM
OIL TEMPERATURE:	Upper Limit: 130°C (266°F)
	Recommended: 99 - 110°C (210 - 230°F)
	Lower Limit: 80°C (176°F)
CRANKCASE CAPACITY:	3.8 L (4.0 qts.)
OIL FILTER:	0.95 L (1 qt.)
ENGINE OIL SPECIFICATION:	API - SJ, SAE 10W30
ENGINE ELECTRICAL	
IGNITION TYPE:	Electronic Advanced by ECM
IGNITION COIL:	12 V operation volt
DISTRIBUTOR:	Delco EST Distributor with ignition module
STARTER MOTOR:	12 Volt, 2.0 kW
ALTERNATOR:	12 Volt, 61 Amp
ENGINE OIL PR. S/W:	21.4 kPa (3.1 psi)
ENGINE CONTROL MODULE(ECM):	12 V operation volt, 24 pins of I/O
VR SENSOR:	Magnetic pick up sensor(assembled on Flywheel Housing)
TMAP:	Intake Air Temp. & Manifold Absolute Press. Sensor
PEDAL ANGLE SENSOR:	Installed on Accelerator Pedal
OXYGEN SENSOR:	Heated Exhaust Gas Oxygen Sensor (HEGO)
	12 V operation volt
ECT-ECM:	Engine Coolant Temperature Sensor for ECM

ECT-GAUGE	Engine Coolant Temp. Sensor for GAUGE on Instrument Panel
TPS:	Throttle Position Sensor (built in Throttle Body)
THROTTLE BODY:	Electronic Throttle Body
FUEL TRIM VALVE (FTV):	12 V operation volt
LP FUEL LOCK-OFF:	12 V operation volt, ON/OFF Control by ECM
EXHAUST SYSTEM	
CATALYTIC MUFFLER:	Three-way Catalyst included

CHAPTER 2 DUAL FUEL SYSTEM OPERATIONAL OVERVIEW

MI-04 General Description

Woodward's MI-04 control system is designed to provide a complete, fully integrated solution that will meet or exceed TIER-2 Large Spark Ignited Engines emission standards established by the California Air Research Board (CARB) and the Environmental Protection Agency (EPA) for 2004. The MI-04 is a closed loop system utilizing a catalytic muffler to reduce the emission level in the exhaust gas. In order to obtain maximum effect from the catalyst, an accurate control of the air fuel ratio is required. A small engine control module (SECM) uses a heated exhaust gas oxygen sensor (HEGO) in the exhaust system to monitor exhaust gas content.

MI-04 Dual Fuel System of G424E Engine

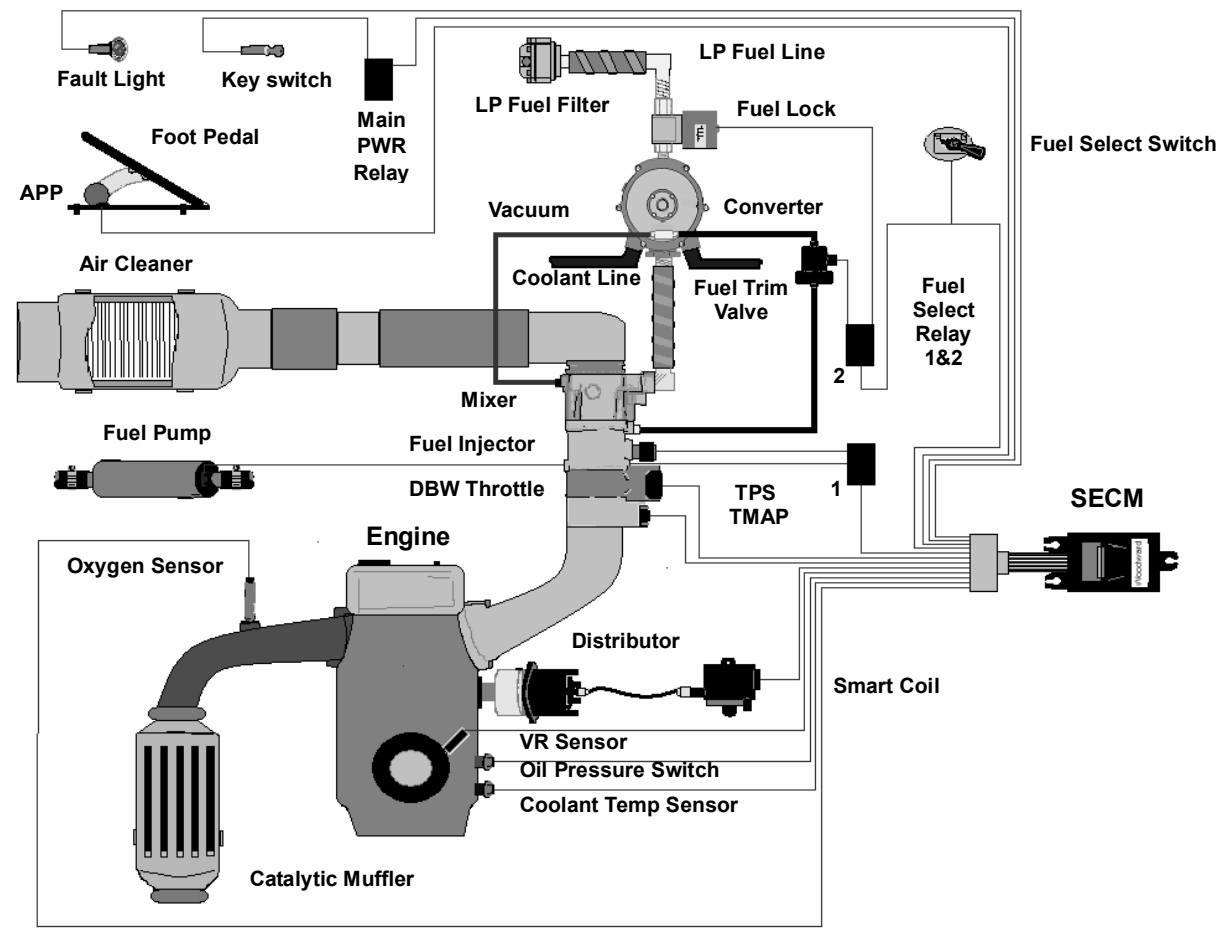


Figure 10

The SECM makes any necessary corrections to the air fuel ratio by controlling the inlet fuel pressure to the air/fuel mixer by modulating the fuel trim valve (FTV) connected to the regulator. Reducing the fuel pressure leans the air/fuel mixture and increasing the fuel pressure enriches the air/fuel mixture. To calculate any necessary corrections to the air fuel ratio, the SECM uses a number of different sensors to gain information about the engines performance. Engine speed is monitored by the SECM through a variable reluctance (VR) sensor. Intake manifold air temperature and absolute pressure is monitored with a (TMAP) sensor. The MI-04 is a drive by wire (DBW) system connecting the accelerator pedal to the electronic throttle through the electrical harness; mechanical cables are not used. A throttle position sensor (TPS) monitors throttle position in relation to the accelerator pedal position sensor (APP) feedback. Even engine coolant temperature and adequate oil pressure is monitored by the SECM. The SECM controller has full adaptive learning capabilities, allowing it to adapt control function as operating conditions change. Factors such as ambient temperature, fuel variations, ignition component wear, clogged air filter, and other operating variables are compensated.

MI-04 Dual Fuel System of G430E Engine

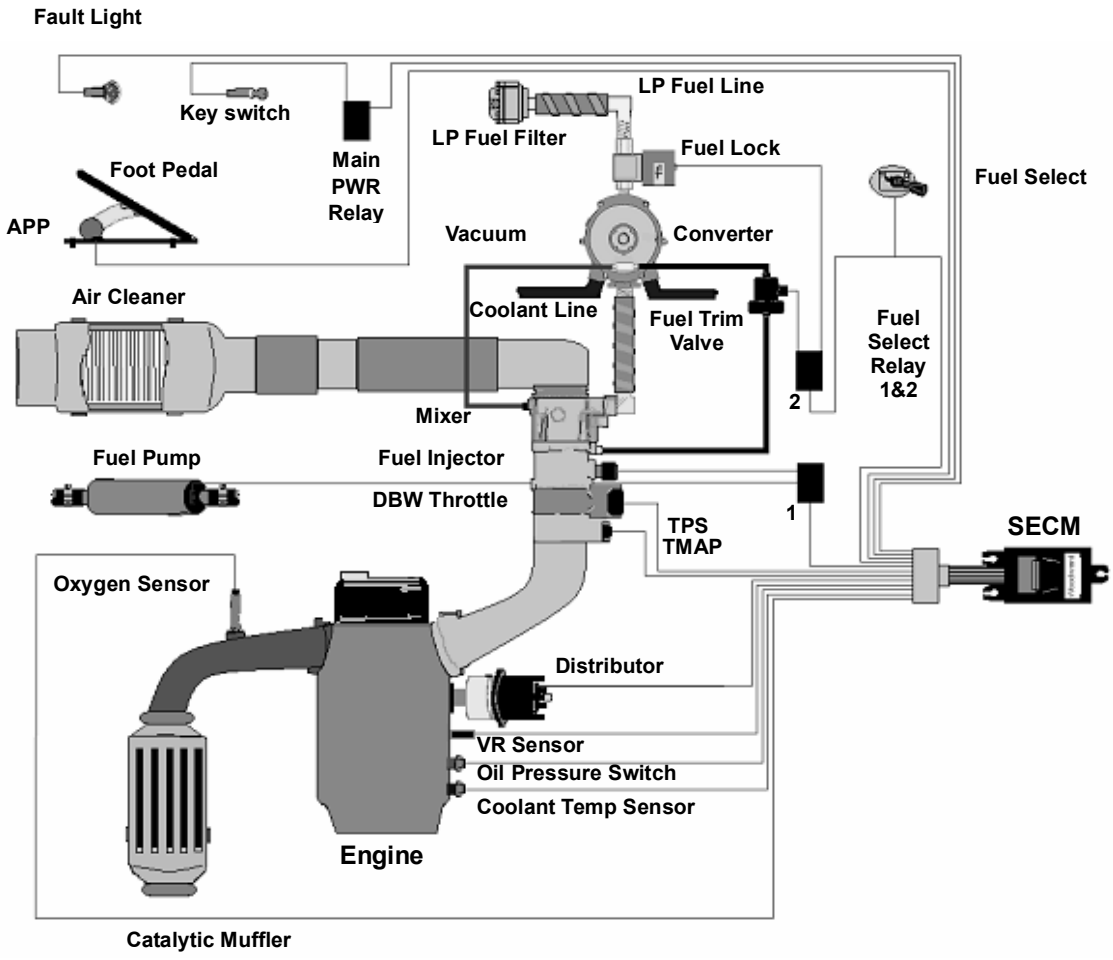
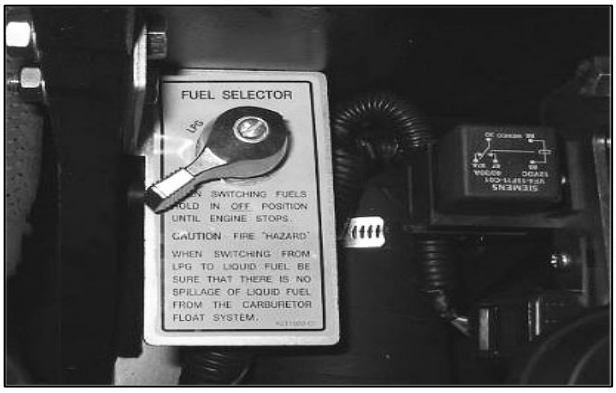


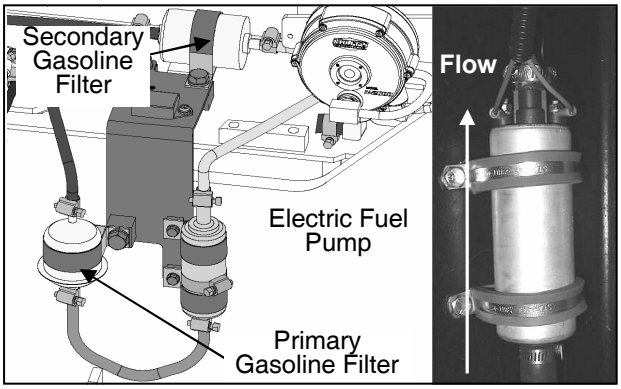
Figure 10

MI-04 Dual Fuel Gasoline Delivery System

A manual fuel select switch enables the forklift operator to choose between LPG or Gasoline operation. When the select switch is in the Gasoline position an electric fuel pump supplies the fuel and generates the injection pressure. The fuel is pumped through a Primary 60 micron filter to the pump (Figure 23). The pump then discharges the fuel at an increased pressure through a Secondary 10 micron filter to a pressure regulator. The pressure regulator incorporates a spring-loaded diaphragm with no bias signal connected, maintaining a constant operating fuel pressure at the metering orifice (270 Kpa) regardless of the amount of fuel being injected. The electric fuel pump incorporates a G-Rotor pumping element driven by an electric motor with permanent magnets, an internal check valve to prevent back flow and is mounted external from the fuel tank.



Fuel Select Switch



Electric Fuel Pump

*Mounting locations shown are specific to G20/25/30E-3 model.

The pump discharge is located on the electrical terminal side of the pump. Both fuel filters and fuel pump have a specific inlet orientation to fuel flow, which should be noted upon installation.

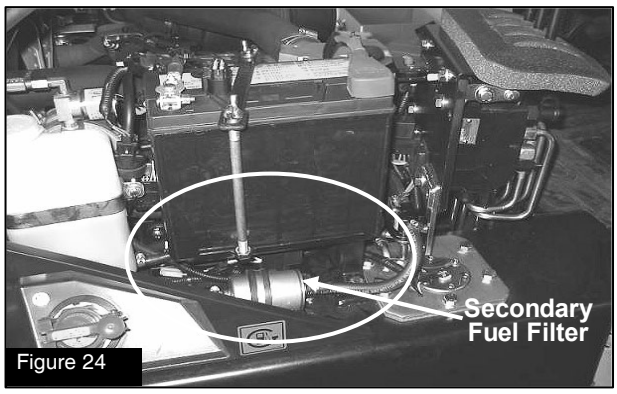


Figure 24

The fuel pressure regulator returns fuel to the tank through the return line when the fuel pressure is too great. (Figure 25)

(Figure 26) shows the fuel pressure regulator mounted near the battery tray.

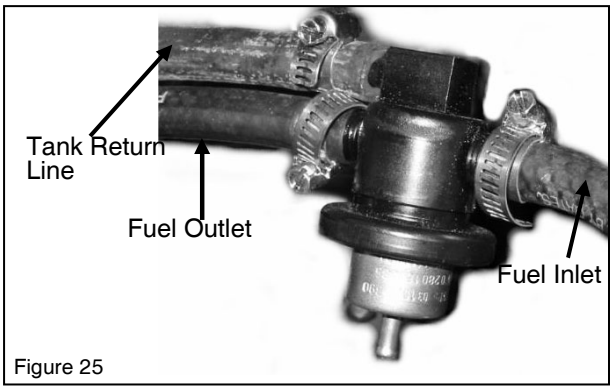


Figure 25

A single fuel injector is controlled by the SECM and when energized meters fuel before the throttle into the mixer to throttle adapter. For proper fuel atomization and delivery to the throttle, a separate venturi booster section has been installed inside the mixer to throttle adapter.

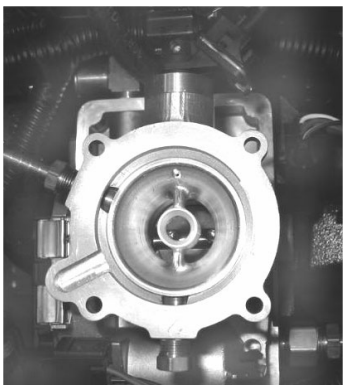

Figure 26

WARNING
The gasoline fuel injection system of the MI-04 system operates at a fuel pressure of 270 Kpa (~39psi). Pressurized fuel is present in the fuel lines when the engine is not running. Safety glasses should be worn at all times when removing fuel lines or eye injury may occur! Avoid directing high-pressure fuel spray onto hot engine components!.

MI-04 Gasoline Fuel Injection

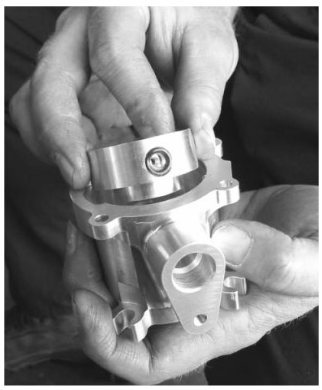
A single Seimens high flow fuel injector is used to inject fuel into the LPG mixer to throttle adapter. Intake air to the engine continues to flow through the LPG mixer however propane is not supplied to the mixer while in gasoline operation. A booster venturi (Figure 27) inside the adapter receives the fuel from the injector and distributes it into the air stream before the throttle valve. The VR signal from the 30-5 timing wheel located on the crankshaft pulley is used by the SECM as an engine position reference for correct operation of the injector. The SECM uses the measured air-fuel ratio from the oxygen sensor to control the amount of fuel delivered by the injector.

Figure 27



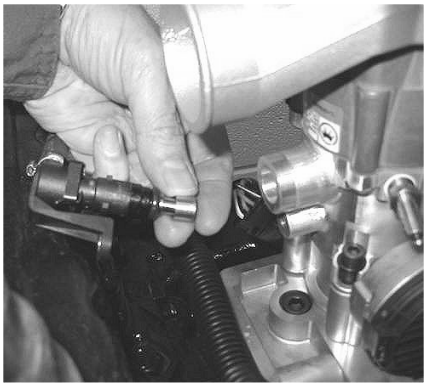
A view of a separate injector venturi used in a two-piece throttle adapter is shown in (Figure 28) for a clearer description. The MI-04 dual fuel throttle adapter uses a single piece adapter where the venturi cannot be removed.

Figure 28



In (Figure 29) the fuel injector is shown out of the throttle body adapter. A spacer is used on the tip of the injector to properly seat the injector with the venturi o-ring.

Figure 29

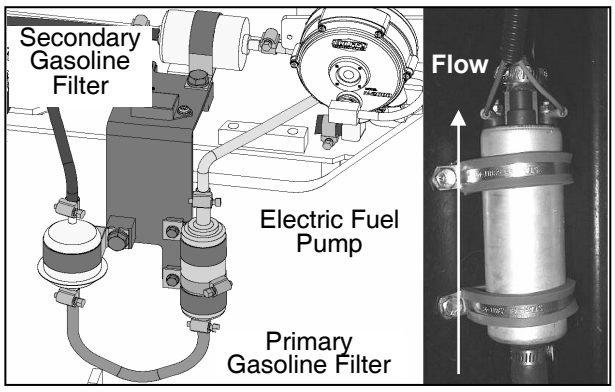


CHAPTER 3 MAINTENANCE SCHEDULE

RECOMMENDED MAINTENANCE SCHEDULE

Suggested maintenance requirements for an engine equipped with an MI-04 fuel system are contained in this section. The owner should, however, develop his own maintenance schedule using the requirements listed in this section and any other requirements listed by the engine manufacturer..

Replace Gasoline Primary and Secondary Fuel Filter Elements



Park the lift truck in an authorized refueling area with the forks lowered, parking brake applied and the transmission in Neutral.

1. Place the fuel select switch in the Gasoline position. Remove the fuel select relay #2 for the electric fuel pump. Start and run the engine until the fuel in the system runs out of fuel and the engine stops.

2. Turn off the ignition switch.

3. Replace the fuel filter taking care to install the new filter with flow in the proper direction. When replacing the Primary fuel filter use a hose clamp between the tank and the filter to prevent fuel from spilling during replacement.

4. Prefilling the primary gasoline filter with fuel will greatly reduce the cranking time necessary to prime the pump anytime the primary gasoline filter or pump is drained for service.

5. Re-install the fuse for the pump and crank the engine several times before attempting a start to prime the fuel pump.

Inspect the Fuel Pump Insulated Mounting Clamps

- Turn the ignition key to the ON position (without cranking the engine), you should hear the electric fuel pump running.
- After 5 seconds the pump should stop running.
- If the pump continues to run check the rubber insulation on the electric fuel pump mounting clamps.
- If the housing of the pump makes contact with the engine chassis a ground path can be created causing the pump to run anytime the ignition key is in the ON position and the fuel select switch is in GAS position, causing pre-mature pump failure.
- If the clamp insulation is damaged replace the clamp with a new insulated clamp.

Maintenance Schedule

CHECK POINT	Interval Hours						
	Daily	Every 250hrs or a month	Every 500 Hours or 3 months	Every 1000 Hours or 6 months	Every 1500 Hours or 9 months	Every 2500 Hours or 15 months	Every 4000 Hours or 2 years
Fuel Lock-Off/Fuel Filter Section (LPG & Gasoline)							
Replace Primary Gasoline fuel filter					**X**		
Replace Secondary Gasoline fuel filter						**X**	
Inspect fuel pump insulated retaining clamps					**X**		

CHAPTER 4 BASIC TROUBLESHOOTING

Basic Troubleshooting (Gasoline)

The MI-04 systems are equipped with built-in fault diagnostics. Detected system faults can be displayed by the Malfunction Indicator Lamp (MIL) and are covered in the Advanced Diagnostics section. Items such as fuel level, plugged fuel lines, clogged fuel filters and malfunctioning pressure regulators may not set a fault code by the Small Engine Control Module (SECM). Below are basic checks that should be made before referring to the Advanced Diagnostics section, if engine or drivability problems are encountered.

Consider all parts of the ignition and mechanical systems as well as the fuel system.

Problem	Probable Cause	Corrective Action
Engine Cranking but Will Not Start (Gas)	Fuel tank empty	Fill fuel container ● The tank should be at least ¼ full to properly prime the fuel pump. ● Fuel select switch is not on GAS
	Clogged fuel filter	Repair/replace as required ● *See Primary and Secondary Fuel Filter replacement*
	Improper fuel supply line connection between the tank and the fuel pump	Check connection ● Verify correct hose connections ● Clamps must be tight ● Look for kinked, pinched and/or collapsed hose
	Electric Fuel Pump malfunction (GAS)	Check electrical connection ● Check Relay and fuse Turn key ON and verify pump is operating
	Fuel Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
	Fuel Injector malfunction	Test Injector operation ● *See Tests and Adjustments*
	Incorrect air/fuel or ignition/spark control	*See Advanced Diagnostics*
	No VR Sensor Signal	**Verify the VR signal is present** ● *See Advanced Diagnostics*

Problem	Probable Cause	Corrective Action
Difficult to Start (Gas)	Fuel tank almost empty	Fuel Pump Cavitations ● The tank should be at least ¼ full to properly prime the fuel pump ● Fuel select switch is not on GAS
	Clogged fuel filter	Repair/replace as required ● *See Primary and Secondary Fuel Filter replacement*
	Electric Fuel Pump malfunction (GAS)	Check electrical connection ● Check Relay and fuse Turn key ON and verify pump is operating ● *See Tests and Adjustments*
	Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
	Fuel Injector malfunction	Test Injector operation ● *See Tests and Adjustments*
	Air filter clogged	Check air filter ● Clean/replace as required
	Incorrect air/fuel or ignition control	*See Advanced Diagnostics*
	Engine Mechanical	*See Engine Manufacturers Service Manual*
Will Not Run Continuously (Gas)	Isolate the gasoline system by running the lift truck on LPG	Verify LPG cylinder is full and valve is open. If the problem does not exist in LPG mode proceed with the corrective action steps below. If the problem also exists in LPG mode then the root cause is most likely to be something other than the fuel system ● *See Advanced Diagnostics*
	Fuel tank almost empty	Fuel Pump Cavitations ● The tank should be at least ¼ full to properly prime the fuel pump
	Clogged fuel filter	Repair/replace as required ● *See Primary and Secondary Fuel Filter replacement*

Problem	Probable Cause	Corrective Action
Will Not Run Continuously (Gas)	Electric Fuel Pump malfunction (GAS)	Check electrical connection ● Check Relay and fuse Turn key ON and verify pump is operating ● *See Tests and Adjustments*
	Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
	Fuel Injector malfunction	Test Injector operation ● *See Tests and Adjustments*
	Incorrect idle speed or ignition problem	*See Advanced Diagnostics*
	Engine Mechanical	*See Engine Manufacturers Service Manual*
Will Not Accelerate/Hesitation During Acceleration or Engine Stalls (Gas)	Isolate the gasoline system by running the lift truck on LPG	Verify LPG cylinder is full and valve is open. If the problem does not exist in LPG mode proceed with the corrective action steps below. If the problem also exists in LPG mode then the root cause is most likely to be something other than the fuel system ● *See Advanced Diagnostics*
	Fuel tank almost empty	Fuel Pump Cavitations ● The tank should be at least ¼ full to properly prime the fuel pump
	Clogged fuel filter	Repair/replace as required ● *See Primary and Secondary Fuel Filter replacement*
	Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
	Fuel Injector malfunction	Test Injector operation ● *See Tests and Adjustments*

Problem	Probable Cause	Corrective Action
Will Not Accelerate/Hesitation During Acceleration or Engine Stalls (Gas)	Throttle butterfly valve not opening or sticking	*See Advanced Diagnostics*
	Foot Pedal signal incorrect or intermittent	
	Incorrect air/fuel or ignition control	
	Engine Mechanical	*See Engine Manufacturers Service Manual*
Rough Idle (Gas)	Isolate the gasoline system by running the lift truck on LPG	Verify LPG cylinder is full and valve is open. If the problem does not exist in LPG mode proceed with the corrective action steps below. If the problem also exists in LPG mode then the root cause is most likely to be something other than the fuel system ● *See Advanced Diagnostics & Tests and Adjustments*
	Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
	Clogged fuel filter	Repair/replace as required ● *See Primary and Secondary Fuel Filter replacement*
	Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
	Fuel Injector malfunction	Test Injector operation ● *See Tests and Adjustments*
	Vacuum leak	Check for vacuum leaks ● Between mixer and throttle body ● Between throttle body and intake manifold ● Between intake manifold and cylinder head

Problem	Probable Cause	Corrective Action
Rough Idle (Gas)	Incorrect Idle speed control	*See Advanced Diagnostics & Tests and Adjustments*
	Incorrect timing or spark control	
	Engine Mechanical	*See Engine Manufacturers Service Manual*
High Idle Speed (Gas)	Incorrect Idle speed control	*See Advanced Diagnostics & Tests and Adjustments*
	Throttle sticking	
	Foot pedal sticking or incorrect pedal signal	Check pedal return spring travel for binding *See Advanced Diagnostics*
Poor High Speed Performance (Gas)	Isolate the gasoline system by running the lift truck on LPG	Verify LPG cylinder is full and valve is open. If the problem does not exist in LPG mode proceed with the corrective action steps below. If the problem also exists in LPG mode then the root cause is most likely to be something other than the fuel system ● *See Advanced Diagnostics & Tests and Adjustments*
	Clogged fuel filter	Repair/replace as required ● *See Fuel Filter replacement*
	Plugged fuel line	Remove obstruction from the fuel line ● Close liquid fuel valve ● Using caution, disconnect the fuel line (some propane may escape) ● Clear obstruction with compressed air ● Re-connect fuel line ● Slowly open liquid fuel valve & Leak test
	Air filter clogged	Check air filter ● Clean/replace as required
	Faulty vapor connection between the pressure regulator/converter and the mixer	Check connection ● Verify no holes in hose ● Clamps must be tight ● Look for kinked, pinched and/or collapsed hose
	Pressure regulator malfunction	Test pressure regulator operation ● *See Tests and Adjustments*
Poor High Speed Performance (Gas)	Air/Fuel Mixer malfunction	Check mixer ● *See Air/Fuel mixer section*
	Restricted exhaust system	Check exhaust system ● Measure exhaust back pressure
	Incorrect ignition control	*See Advanced Diagnostics & Tests and Adjustments*
	Incorrect air/fuel control	
	Incorrect throttle position	

CHAPTER 5 MI-04 ADVANCED DIAGNOSTICS

Fault List Definitions

Several sensors in the MI-04 system have input low/high faults and a sensor range fault. These are the coolant temperature sensor, the throttle position sensor and the pedal position sensors. Signals to these sensors are converted into digital counts by the SECM. A low/high sensor fault is normal set when the converted digital counts reach the minimum of 0 or the maximum of 1024 (1024=5.0 VDC with ~204 counts per volt). A sensor range fault is set if the parameter measured by the sensor is outside the normal operating range.

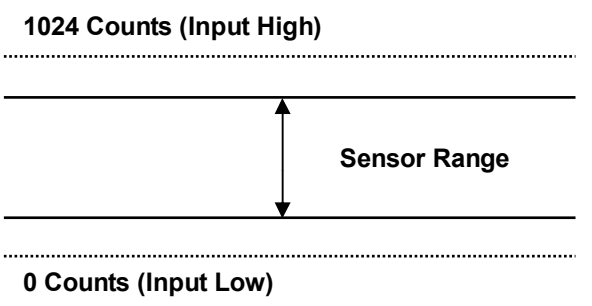


Figure F1

Injector Fault: (Fuel Injector Fault) is normally set when the injector driver signal is open due to the connector becoming disconnected.

Low Oil Pressure: (Low Oil Pressure) the oil pressure switch has closed or become failed, normally indicating a low oil condition in the engine.

Table a. MI-04 Diagnostic Fault Codes (Flash Codes)

DFC	Probable Fault	Action	Corrective Action, First Check
51	**Injector Fault**	Stored Fault Code (MIL, Disable Adaptive learns)	Check Injector (INJ) for an open wire or injector connector being disconnected ***INJ PIN A (SIGNAL) TO PIN B (PWR)*** Check INJ for an open coil by disconnecting the INJ connector and measuring the coil resistance (~12Ω +/- 2Ω) ***INJ PIN A (SIGNAL) TO PIN B (PWR)***
52	**Low Oil Pressure** Low Engine Oil Pressure	Delayed Engine Shutdown	Check engine oil level Check electrical connection to the oil pressure switch ***SECM PIN 23 to Oil Pressure Switch***
31	**Running Reset**	Stored Fault Code Reset Counter to be incremented	Check to ensure that proper grounding of the harnessing has been achieved. Check to ensure that there are no intermittent connections in the electrical harness or associated connections. Check for interruptions in Vbatt supply to the SECM. Check to ensure that the ignition system (distributor, coil, cap, rotor, plugs, and high tension leads) is operating normally.

CHAPTER 6 ELECTRICAL CONNECTIONS

G424E Dual Fuel Electrical Connection

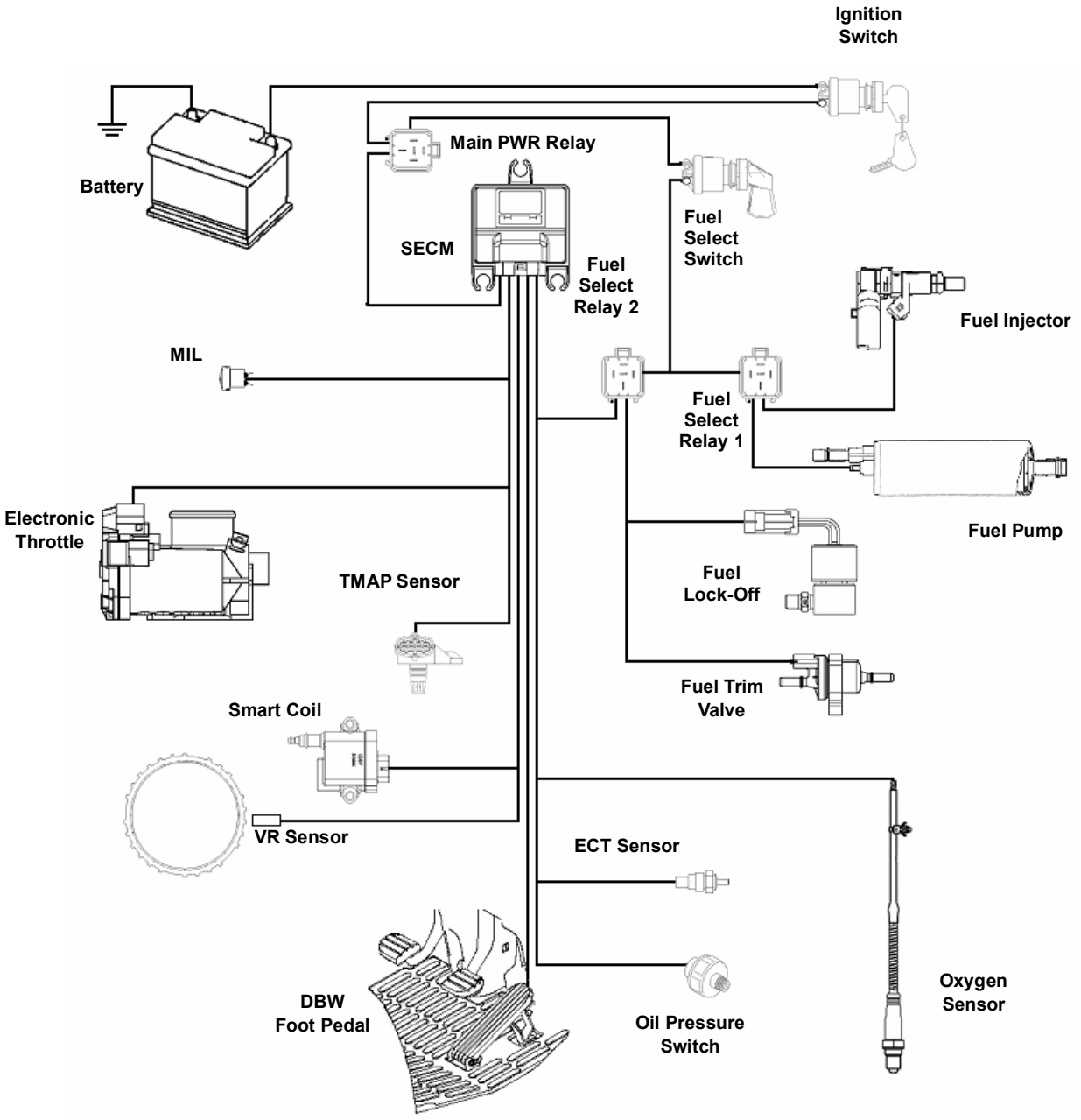


Figure E1

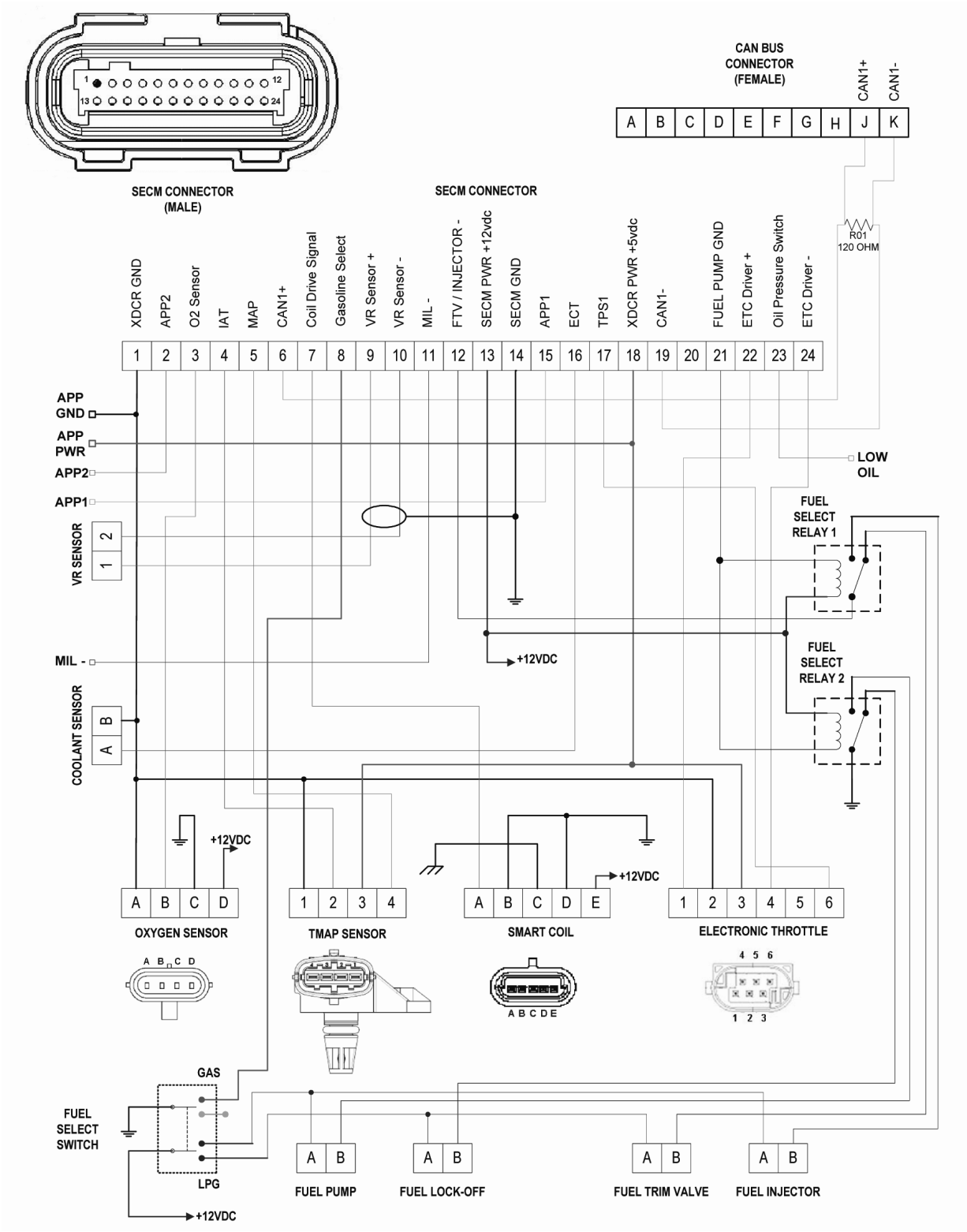

CAN BUS CONNECTOR (FEMALE)
CAN1+
CAN1-
A B C D E F G H J K
SECM CONNECTOR (MALE)
SECM CONNECTOR
R01 120 OHM
XDCR GND
APP2
O2 Sensor
IAT
MAP
CAN1+
Coil Drive Signal
Gasoline Select
VR Sensor +
VR Sensor -
MIL -
FTV / INJECTOR -
SECM PWR +12vdc
SECM GND
APP1
ECT
TPS1
XDCR PWR +5vdc
CAN1-
FUEL PUMP GND
ETC Driver +
Oil Pressure Switch
ETC Driver -
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
APP GND
APP PWR
APP2
APP1
VR SENSOR
MIL -
COOLANT SENSOR
LOW OIL
FUEL SELECT RELAY 1
FUEL SELECT RELAY 2
+12VDC
+12VDC
+12VDC
A B C D
OXYGEN SENSOR
1 2 3 4
TMAP SENSOR
A B C D E
SMART COIL
1 2 3 4 5 6
ELECTRONIC THROTTLE
GAS
FUEL SELECT SWITCH
LPG
+12VDC
A B
FUEL PUMP
A B
FUEL LOCK-OFF
A B
FUEL TRIM VALVE
A B
FUEL INJECTOR

Figure E2

G430E Dual Fuel Electrical Connection

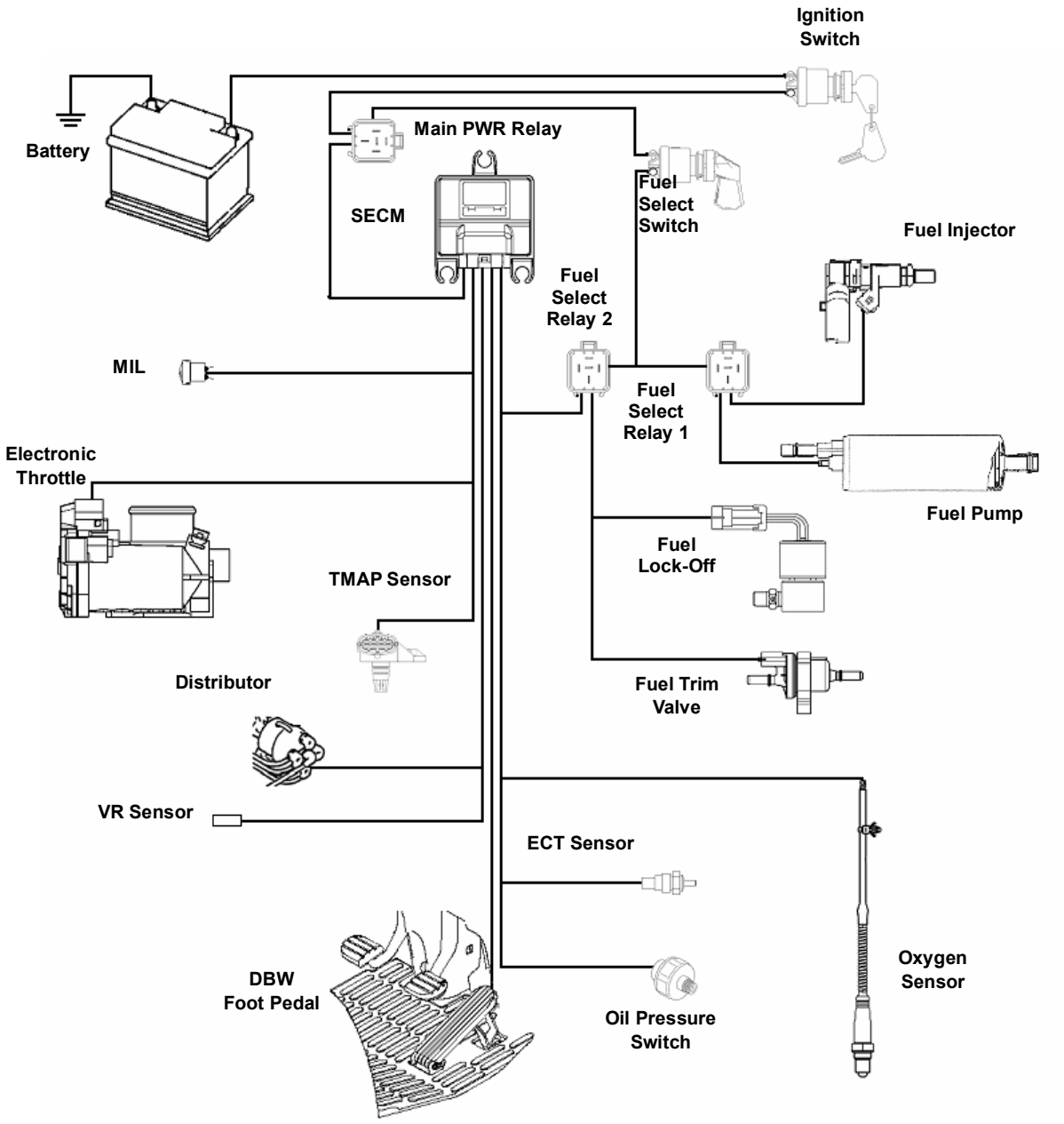


Figure E1

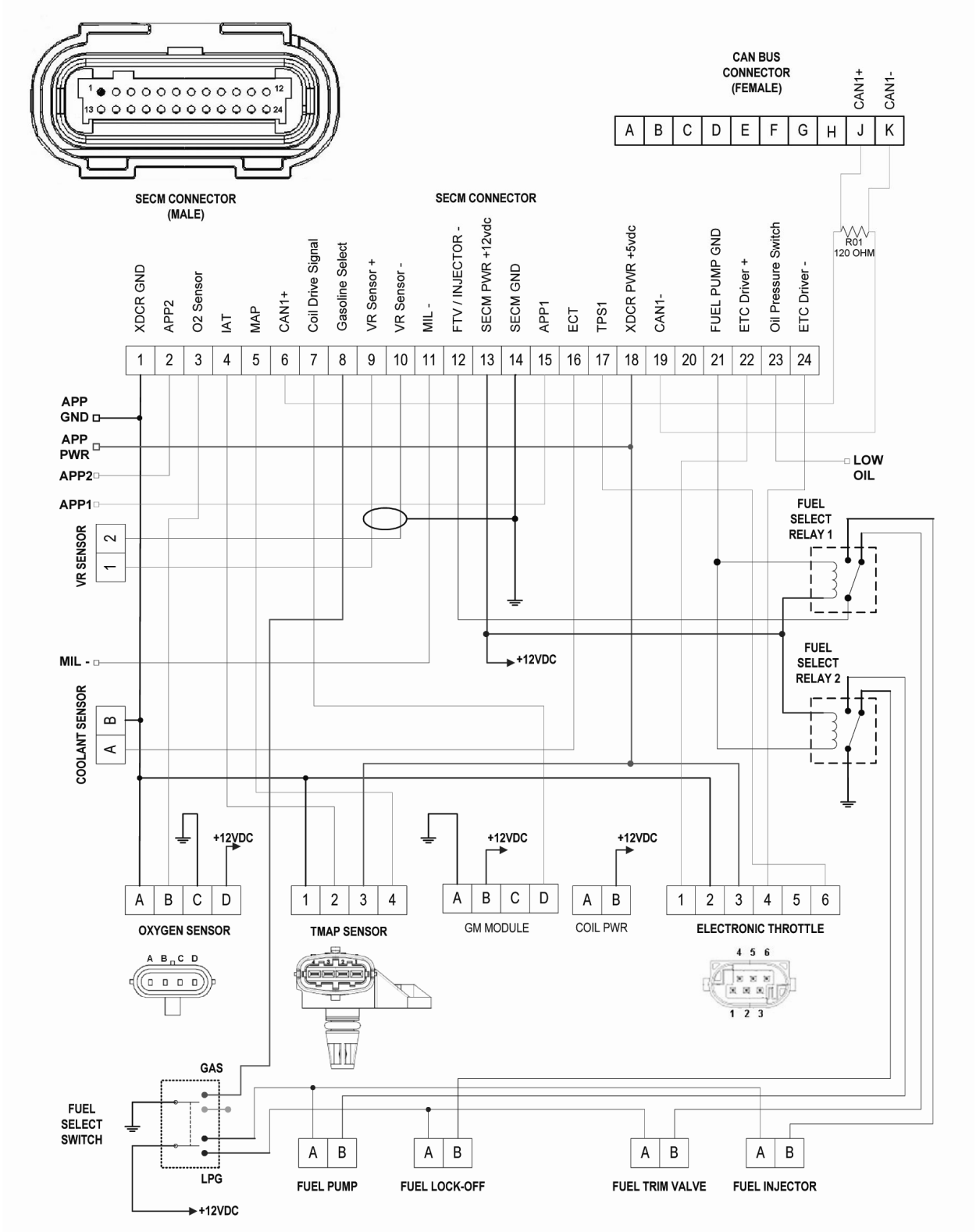

CAN BUS CONNECTOR (FEMALE)
CAN1+
CAN1-
A B C D E F G H J K
SECM CONNECTOR (MALE)
SECM CONNECTOR
R01 120 OHM
XDCR GND
APP2
O2 Sensor
IAT
MAP
CAN1+
Coil Drive Signal
Gasoline Select
VR Sensor +
VR Sensor -
MIL -
FTV / INJECTOR -
SECM PWR +12vdc
SECM GND
APP1
ECT
TPS1
XDCR PWR +5vdc
CAN1-
FUEL PUMP GND
ETC Driver +
Oil Pressure Switch
ETC Driver -
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
APP GND
APP PWR
APP2
APP1
VR SENSOR
LOW OIL
FUEL SELECT RELAY 1
FUEL SELECT RELAY 2
MIL -
COOLANT SENSOR
+12VDC
OXYGEN SENSOR
TMAP SENSOR
GM MODULE
COIL PWR
ELECTRONIC THROTTLE
GAS
FUEL SELECT SWITCH
LPG
FUEL PUMP
FUEL LOCK-OFF
FUEL TRIM VALVE
FUEL INJECTOR

Figure E2

Resistance Checks

NOTE
All resistive checks are made with the sensor or device disconnected from the harness.

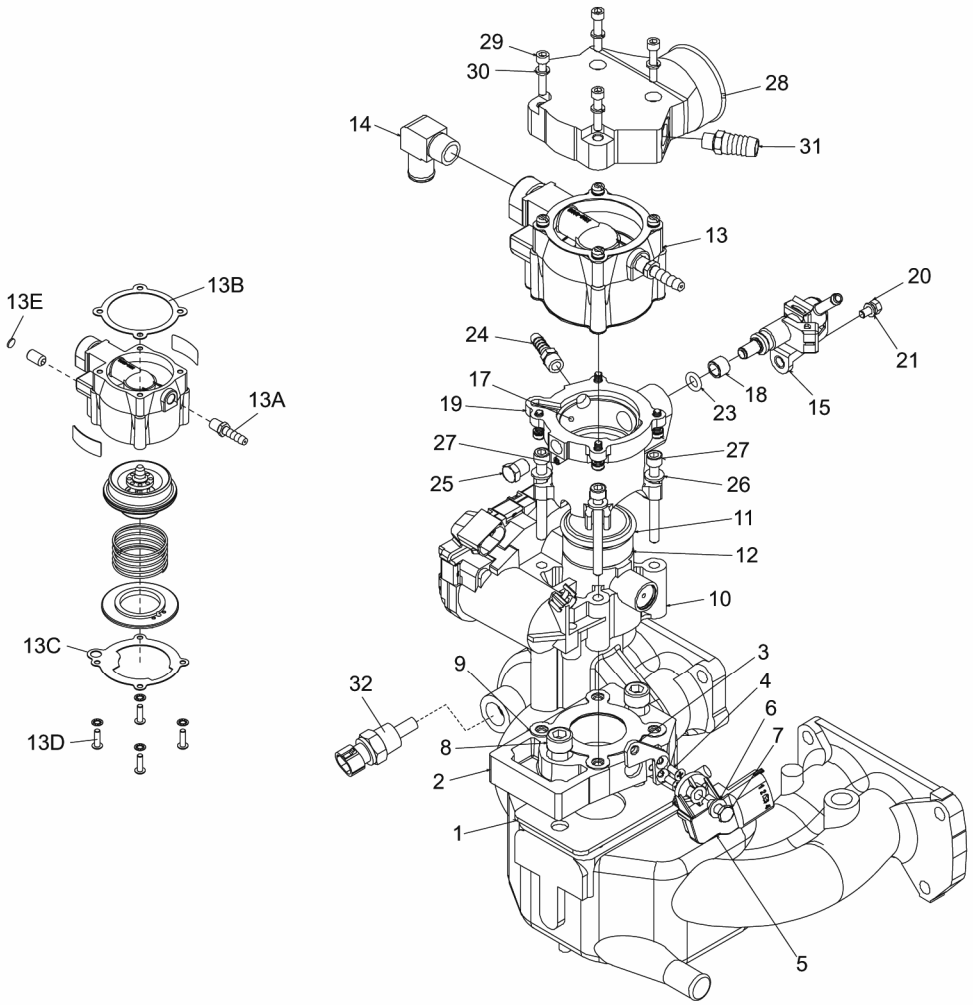
CONNECTOR	POINT TO POINT	EXPECTED RANGE
INJ (FUEL INJECTOR)	INJ PIN A (SIGNAL) TO PIN B (PWR)	(~12Ω +/-2Ω)

CONNECTOR	POINT TO POINT	EXPECTED RANGE
FUEL PUMP (GAS)	PUMP HOUSING TO CHASSIS	(0Ω)*Pump housing should be isolated from chassis ground

CONNECTOR	POINT TO POINT	EXPECTED RANGE
VR SENSOR	VR PIN 1 (+) TO PIN 2 (-)	~320Ω

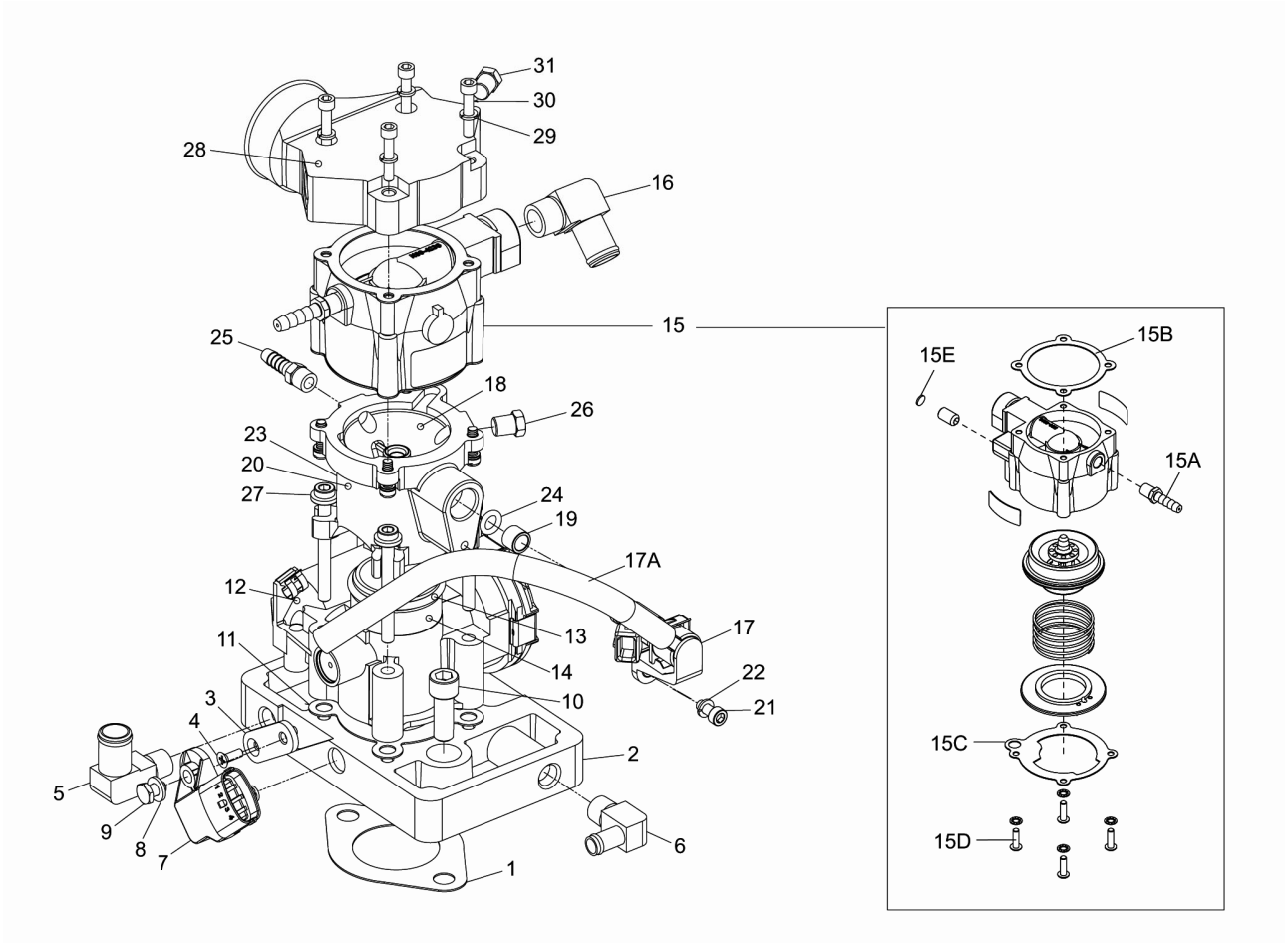
CHAPTER 7 N-CA55-500TR AIR/FUEL MIXER

Installing the Mixer/Throttle Assembly - G424E Dual Fuel:



1	GASKET-INTAKE MANIFOLD
2	ADAPTER-INTAKE MANIFOLD
3	BRACKET-TMAP
4	BOLT-TMAP BRACKET
5	TMAP SENSOR
6	WASHER-TMAP MTG
7	BOLT-TMAP MTG
8	BOLT-ADAPTER
9	GASKET-ITB
10	THROTTLE BODY(ITB 32MM)
11	O-RING
12	O-RING SPACER
13	LP MIXER(CA55)
13A	FITTING-ORIFICE
13B	GASKET-MIXER,AIR HORN
13C	GASKET-MIXER,ADAPTER
13D	SCREW
13E	CAP-IDLE SCREW
14	FITTING-FUEL
15	INJECTOR ASSEMBLY FUEL HOSE
17	VENTURI
18	VENTURI SPACER
19	APOLLO ADAPTER
20	BOLT-INJECTOR MTG
21	WASHER-SPRING
22	SET SCREW
23	O-RING
24	FITTING
25	BOLT-END PLUG
26	WASHER
27	BOLT
28	AIR HORN ADAPTER
29	WASHER
30	BOLT
31	FITTING-VENTILATION
32	COOLANT TEMP SENSOR-ECM

Installing the Mixer/Throttle Assembly - G430E Dual Fuel



1	GASKET-INTAKE MANIFOLD
2	ADAPTER-INTAKEMANIFOLD
3	BRACKET-TMAP
4	BOLT-TMAP BRACKET
5	FITTING-OUTLET
6	FITTING-INLET
7	TMAP
8	WASHER-TMAP MTG
9	BOLT-TMAP MTG
10	BOLT-ADAPTER
11	GASKET-ITB
12	THROTTLE BODY
13	O-RING
14	O-RING SPACER
15	MIXER
15A	FITTING-ORIFICE
15B	GASKET-MIXER,AIR HORN
15C	GASKET-MIXER,ADAPTER
15D	SCREW
15E	CAP-IDLE SCREW
16	FITTING-TO CONVERTER INLET
17	INJECTOR ASSEMBLY
17A	FUEL HOSE
18	VENTURI
19	VENTURI SPACER
20	APOLLO ADAPTER FOR DUAL FUEL
21	BOLT-INJECTOR MTG
22	WASHER
23	SET SCREW
24	O-RING
25	FITTING-TO TRIM V/V
26	BOLT-END PLUG
27	BOLT-ITB.CONN
28	AIR-HORN ADAPTER
29	WASHER-AIR HORN
30	BOLT-AIR HORN
31	PLUG
32	HOSE-COOLANT(FORMED)
33	CLAMP-HOSE(WATER PUMP)
34	CLAMP-HOSE(FITTING)

CHAPTER 8 TEST AND ADJUSTMENTS

WARNING

- **LP gas is highly flammable. To prevent personal injury, keep fire and flammable materials away from the lift truck when work is done on the fuel system.**
- **Gas vapor may reduce oxygen available for breathing, cause headache, nausea, dizziness and unconsciousness and lead to injury or death. Always operate the forklift in a well ventilated area**
- **Liquid propane may cause freezing of tissue or frostbite. Avoid direct contact with skin or tissue; always wear appropriate safety protection including gloves and safety glasses when working with liquid propane.**

CAUTION

The regulator/converter and mixer are part of a certified system complying with EPA and CARB 2004 requirements. Only trained certified technicians should perform disassemble, service or replacement of the regulator/converter or mixer.

Testing the Gasoline Fuel Delivery System

Gasoline System Test Hardware

1. Universal 278000 Noid “test” light
2. Pinch-off pliers, hose clamp or Vise-Grip type pliers
3. Small fuel “catch” container.

Operating fuel pressure of the gasoline system is 270 Kpa (~39 psi). At least ¼ of the fuel tank should be filled with fuel to provide a proper fuel prime from the tank “pick-up” tube to the fuel pump, anything less may cause the pump to cavitate allowing air into the fuel system. A primary 100-micron fuel filter is used inline before the electric fuel pump and a 10-micron secondary fuel filter is used between the fuel pump and the fuel pressure regulator. The regulator does not use a bias control signal on the diaphragm and always supplies a constant pressure. When fuel pressure is too high the regulator routes excessive fuel through the return line back to the fuel tank. Regulated fuel pressure is supplied from the regulator outlet exits to the fuel injector. The fuel lines from the fuel pump to the injector are under pressure even when the engine is not running and care should be taken when disconnecting these fuel lines, as pressurized fuel will be discharged.

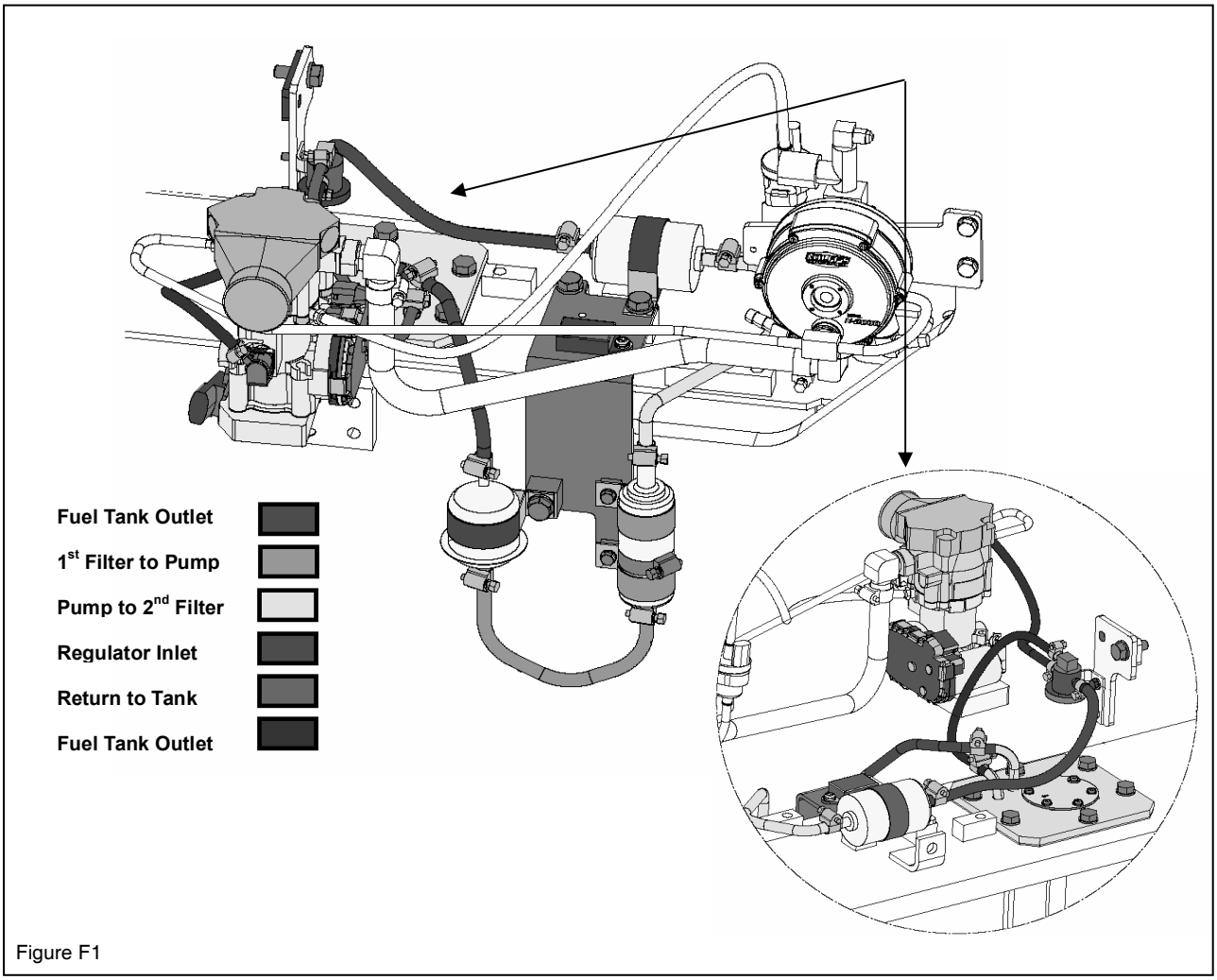


Figure F1

NOTE
Pump, filter and regulator mounting locations as shown are specific to G20/25/30E-3 lift trucks

The return line from the regulator to the fuel tank is not under pressure and can safely be removed without pressurized fuel spray.

Verify that the Fuel Selector Switch is in the Gasoline position before performing the following tests. A fuel pressure tap is not provided in the MI04 gasoline system.
In order to check the operating fuel pressure of the system a pressure gauge and T fitting must be installed before the pressure regulator to measure fuel pump supplied pressure or after the pressure regulator to measure regulated pressure.

WARNING
The gasoline fuel injection system of the MI-04 system operates at a fuel pressure of 270 Kpa (~39psi). Pressurized fuel is present in the fuel lines when the engine is not running. Safety glasses should be worn at all times when removing fuel lines or eye injury may occur! Avoid directing high-pressure fuel spray onto hot engine components!

As a "quick check" of fuel system performance, the tank return line from the regulator can be removed from the tank fitting and placed into a small empty fuel container or "fuel catch". If the fuel pump is supplying sufficient fuel pressure and the regulator is functioning properly, the regulator will bypass fuel through the return line while the engine is running. If no fuel is bypassed through the return line while the engine is running, insufficient fuel pressure may be the cause either from a faulty fuel pump or clogged fuel filter.

If the fuel pump and regulator are supplying sufficient fuel pressure to the fuel injector, the fuel injector may be faulty and can be checked with a universal Noid test light. (FIGURE F2)

Figure F2

Universal 278000 Noid Test Light

To check for SECM signal pulses to the fuel injector simply disconnect the electrical harness from the fuel injector and connect the Noid test light to the end of the harness in place of the injector. Crank the engine with the ignition key and you will see the Noid light flash every time the SECM sends a signal to the fuel injector to open and spray fuel. If SECM pulses are not present at the injector and a DFC code 51 (Injector Fault) has not been set, the Fuel Select Relay #1 may be at fault.

When the Fuel Select Switch is placed in the Gas position a low or ground signal is supplied through the switch to PIN 8 of the SECM. This ground signal informs the SECM that the lift truck should operate in Gasoline mode. When the SECM PIN 8 input is "low", the SECM PIN 21 output becomes "low" supplying the ground signal to the coil of both the #1 and #2 Fuel Select Relays. Voltage (+12 VDC) is supplied to one side of the coil for both the #1 and #2 Fuel Select Relays when the key switch is in the ON position. When the #1 Fuel Select Relay coil is energized the relay will switch SECM PIN 12 output from the FTV to the fuel injector. The SECM PIN 12 output signal supplies the fuel injector with the correct drive pulses.

NOTE
Refer to Electrical Connections for the system wiring schematic of the Fuel Select Relays.

If the Noid light shows valid signals from the SECM to the injector, a final visual check of the fuel injector can be made.

To check the actual fuel discharge from the fuel injector, remove the fuel injector mounting-bolt from the mixer to throttle adapter and remove the fuel injector. Place the fuel injector in an appropriate fuel container so that any fuel spray from the injector will remain in the container during the test. You can simply crank the engine and visually watch the fuel injector open or if available you may use the injector test in the Service Tool software.

Figure G3

NOTE
Take care not to lose the injector spacer when removing the fuel injector. (FIGURE G3).

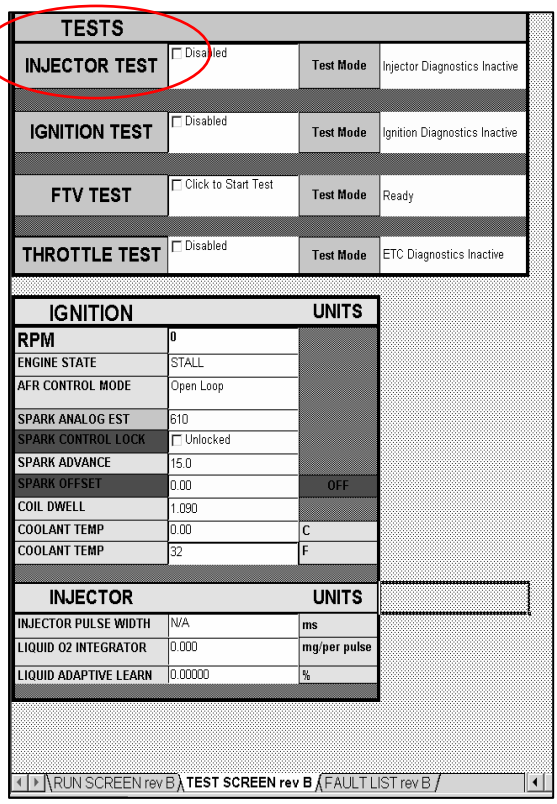


Figure G4

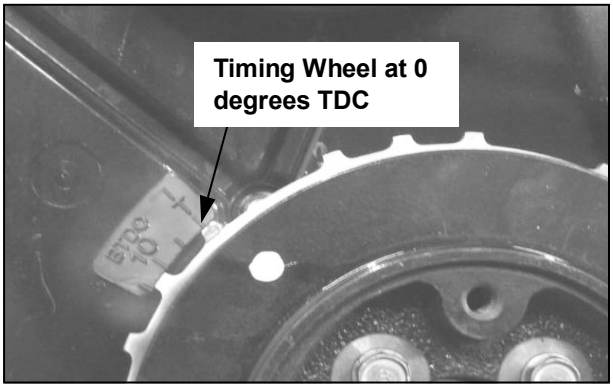
To use the injector test in the Service Tool software simply select the checkbox to the right of the INJECTOR TEST. (FIGURE G4) The box will change to read Enabled and the test mode will go active. This will pulse the injector for 7 seconds when the engine is not running.

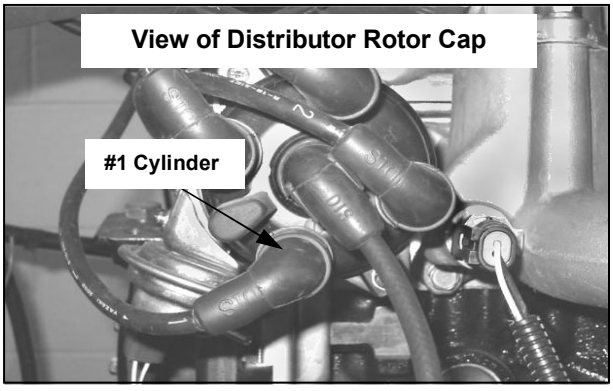
CAUTION
Running the injector test with the injector installed in the throttle adapter will discharge raw gasoline into the intake manifold and could result in excessive engine wear through misfire or loss of lubrication.

Timing Adjustment - G424E LP and Dual Fuel Engine

Ignition Timing Adjustment

With the MI-04 system both mechanical and vacuum advance are no longer inside the distributor. All ignition timing advance is controlled by the SECM. The only timing adjustment that can be made by a technician is the mechanical alignment of the distributor. The SECM uses a 40-degree timing window from –5 degrees BTDC to 35 degrees BTDC. Because of this an accurate adjustment cannot be made with a standard timing light since the SECM will maintain the correct timing even if the distributor is moved (as long as the distributor setting remains within the 40-degree window). Therefore the ignition timing setting of the distributor becomes very important and is described in the following steps.





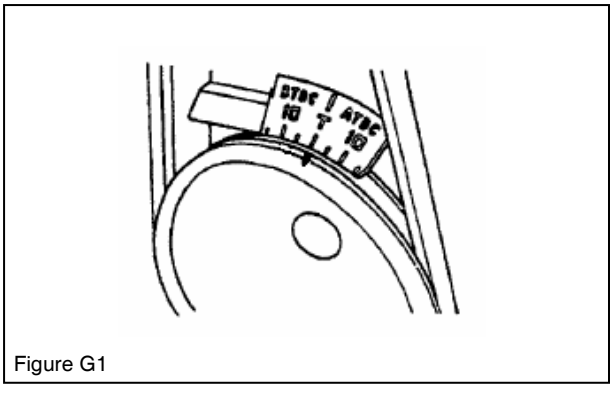
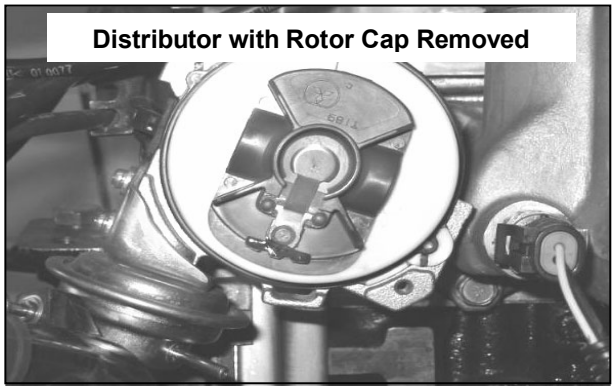


Figure G1

1. Using the timing indicator on the crankshaft pulley, set the engine on 0 degrees Top Dead Center (TDC) of number 1 cylinder (Figure G1).



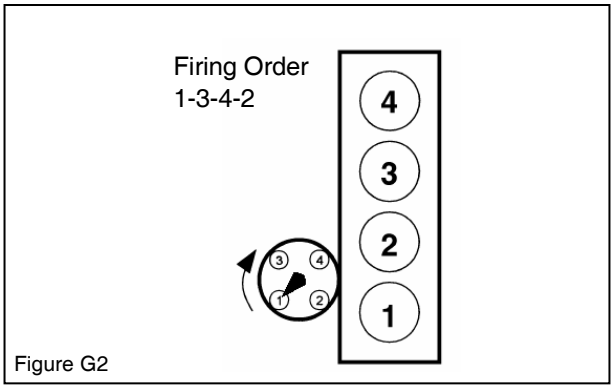
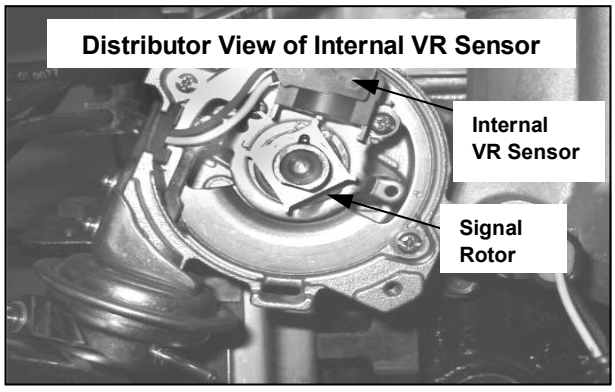
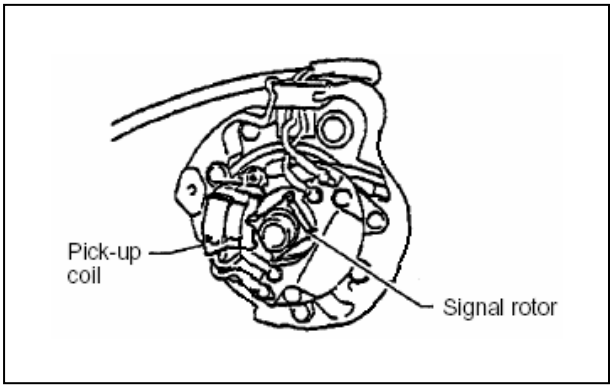


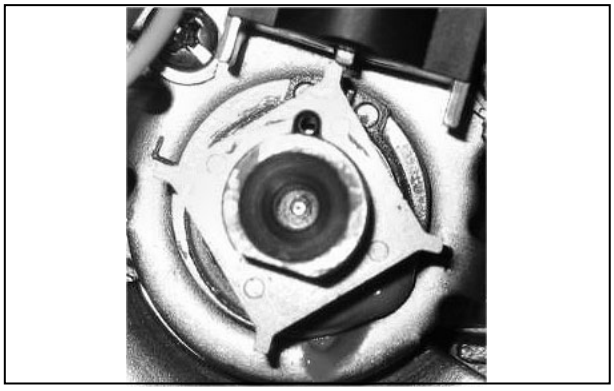
Figure G2

2. Remove the distributor rotor cap and verify that the distributor rotor is lined up with number 1 cylinder on the distributor cap (Figure G2).



3. Remove the distributor rotor and dust cover so that the internal VR sensor and signal rotor gear are visible (Figure G3). The internal VR sensor inside the distributor is not used by the SECM for a speed reference with the G420E/G424E engine and it's wiring harness does not connect to the system. The distributors internal VR sensor is only used as an alignment reference point for setting the correct distributor position.





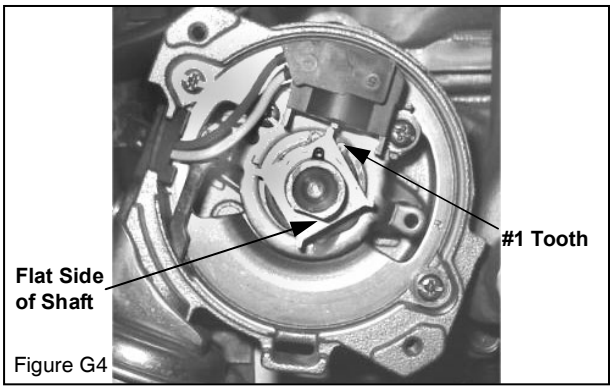
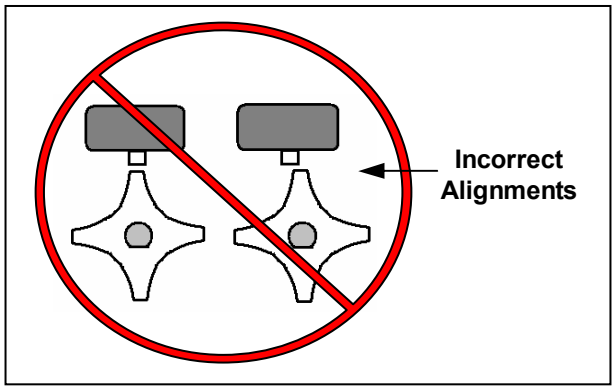


Figure G4



4. Loosen the distributor hold down nut and rotate the distributor so that the signal rotor gear tooth of the #1 cylinder (tooth opposite the flat side of the distributor shaft) lines up with the sensor pickup. (Figure G4).

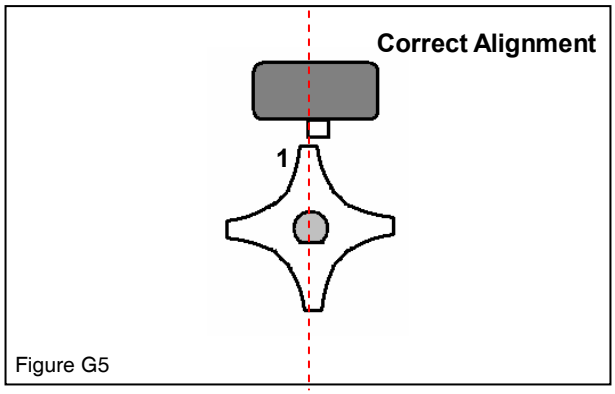


Figure G5

5. To correctly set the distributor, align the center of the #1 cylinder tooth with the leading edge of the VR sensor pickup (Figure G5). Keep in mind that the distributor rotates in a clockwise direction.

6. Once the proper alignment is obtained, lock the distributor in place by tightening the hold down nut to the specified torque value and re-install the rotor, dust cover and rotor cap.

WARNING
Improper alignment of the distributor may cause system ignition problems resulting in ignition misfires or backfires.

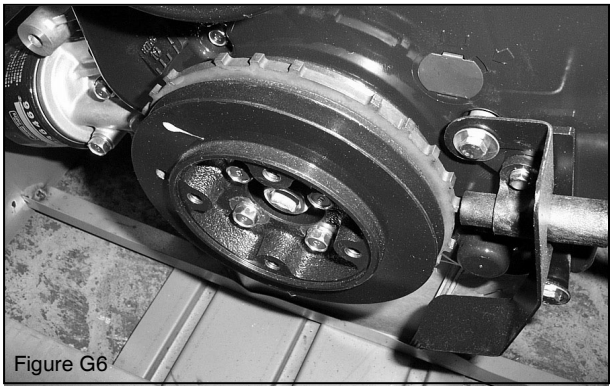


Figure G6

7. After you have completed setting the distributor alignment you will need to adjust the VR sensor used by the SECM for speed reference. This sensor is mounted near the crankshaft pulley wheel (Figure G6).

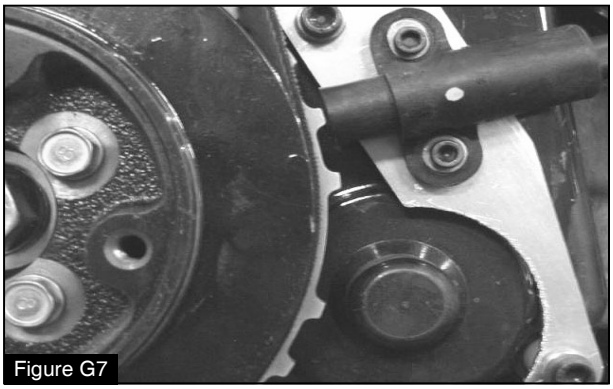


Figure G7

8. Rotate the crankshaft pulley so that one of the gear teeth on the timing wheel aligns in the center of the VR sensor (Figure G7).

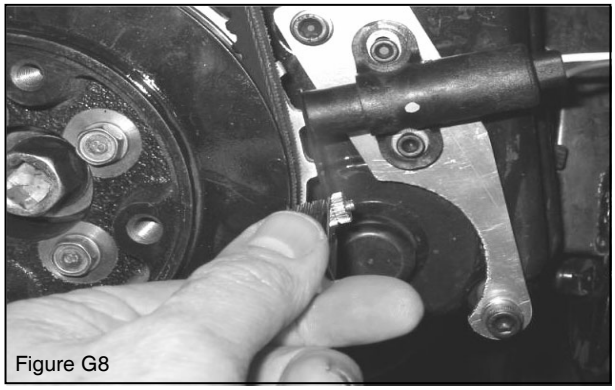


Figure G8

9. Using a feeler gauge (Figure G8), loosen the sensor retaining bolts and adjust the gap between the sensor and the gear tooth from 1.25mm to 1.5mm. Re-tighten the sensor retaining bolts when complete.

10. Rotate the crankshaft pulley 180 degrees and align a timing gear tooth in the center of the VR sensor pickup as you did in step 8. Verify that the sensor gap is still within 1.25mm to 1.5mm. This step is to check timing gear run out and insures proper speed signal amplitude.

11. If the VR sensor gap is not within the specification repeat steps 9 & 10 and continue adjusting the sensor gap until you are within tolerance. This completes setting ignition timing and sets the center of the SECM ignition control range at 15 degrees BTDC.

Timing Adjustment - G430E Dual Fuel Engine

With the MI-04 system both mechanical and vacuum advance are no longer inside the distributor. All ignition timing advance is controlled by the SECM. The only timing adjustment that can be made by a technician is the mechanical alignment of the distributor. The SECM uses a 40-degree timing window from –5 degrees BTDC to 35 degrees BTDC. Because of this an accurate adjustment cannot be made with a standard timing light since the SECM will maintain the correct timing even if the distributor is moved (as long as the distributor setting remains within the 40-degree window). Therefore the ignition timing setting of the distributor becomes very important and is described in the following steps.

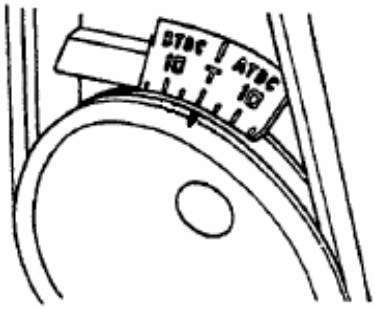


Figure G1

1. Using the timing indicator on the crankshaft pulley, set the engine on 0 degrees Top Dead Center (TDC) of number 1 cylinder (Figure G1).

2. Remove the distributor rotor cap and verify that the distributor rotor is lined up with number 1 cylinder on the distributor cap (Figure G2).

3. The internal distributor alignment arrows are now visible (Figure G3). The internal crank signal from the GM ignition module is not used by the SECM for a speed reference with the 3.0L engine. The distributors internal alignment arrows are only used as an alignment reference point for setting the correct distributor position within the timing window.

4. Loosen the distributor hold down bolt and rotate the distributor so that the module-housing arrow aligns with the rotor arrow as shown in Figure G3.

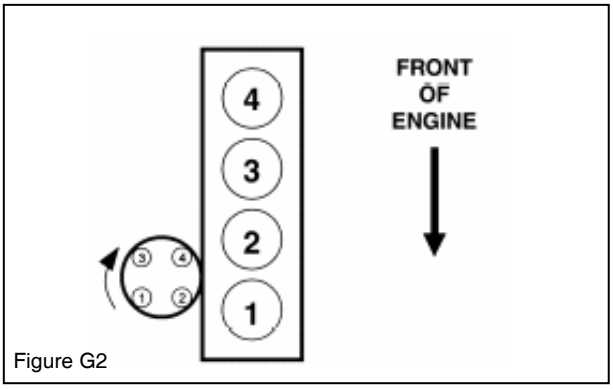


Figure G2

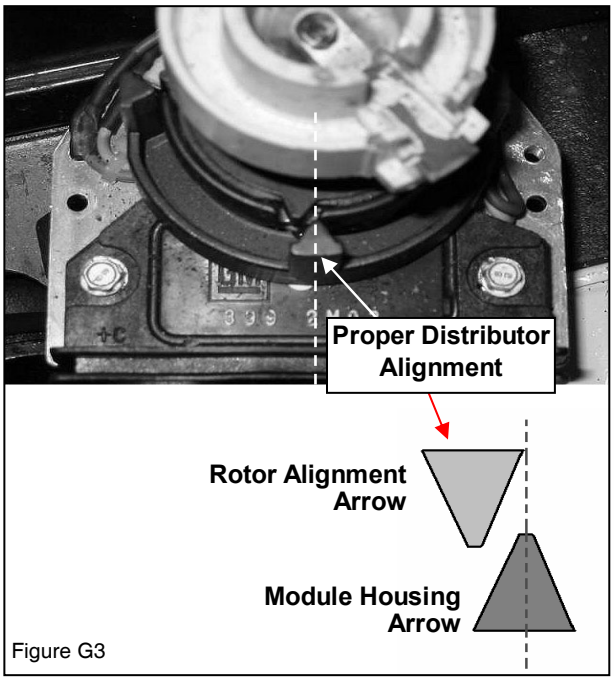


Figure G3

5. Once the alignment arrows are adjusted as shown in Figure G3, the outside corner of the distributor housing should not align with the distributor reference mark on the engine block and should resemble the alignment as shown in (Figure G4).

6. Once the proper alignment is obtained, lock the distributor in place by tightening the hold down nut to the specified torque value and re-install the distributor rotor cap.

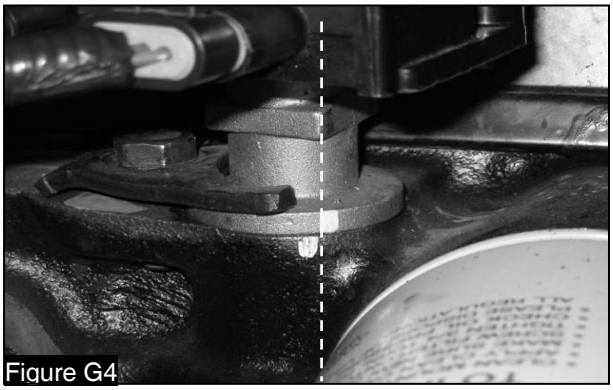


Figure G4

WARNING
Improper alignment of the distributor may cause system ignition problems resulting in ignition misfires or backfires.

7. After you have completed setting the distributor alignment you will need to adjust the VR sensor used by the SECM for speed reference. This sensor is mounted in the bell housing of the flywheel at the bottom of the engine. Circular timing reference marks have been precisely machined into the surface of the flywheel (Figure G6). The MI-04 VR sensor will use these machined marks for speed reference

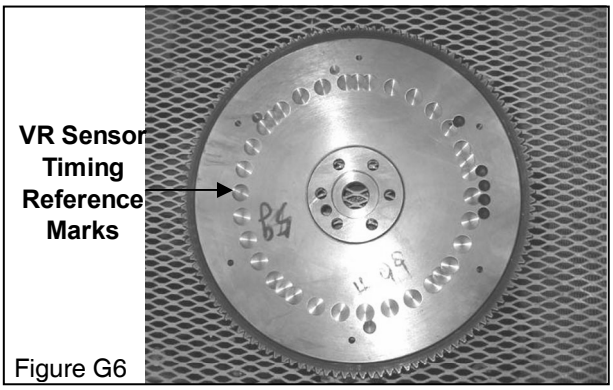


Figure G6

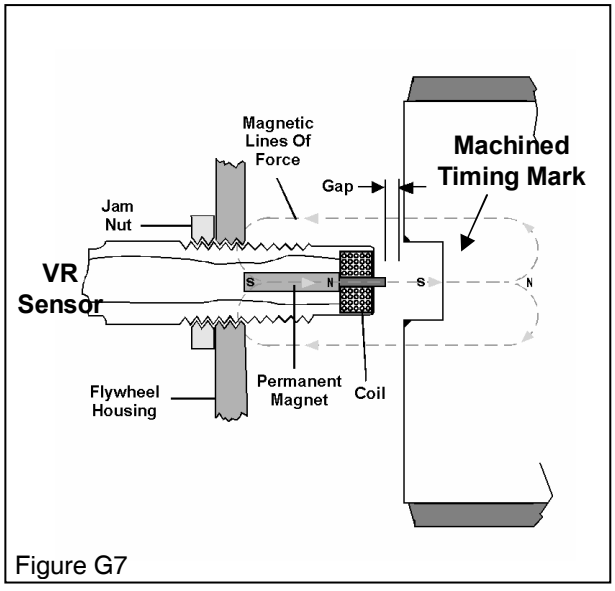


Figure G7

8. Figure G7 shows a functional diaghram of the VR sensor and the principle of operation. The sensor will detect each timing mark in the flywheel and output a signal. The larger the gap between the sensor and the flywheel the smaller the amplitude of the speed signal. If the gap is too small the VR sensor will make contact with the flywheel and become damaged during operation. Therefore it is necessary to adjust the VR sensor for proper operation.

9. With the engine timing still at 0 degrees TDC, the VR sensor will align between the machined timing marks on the flywheel (Figure G8). Loosen the VR sensor locknut and adjust the sensor inward toward the flywheel until the sensor makes contact with the flywheel.

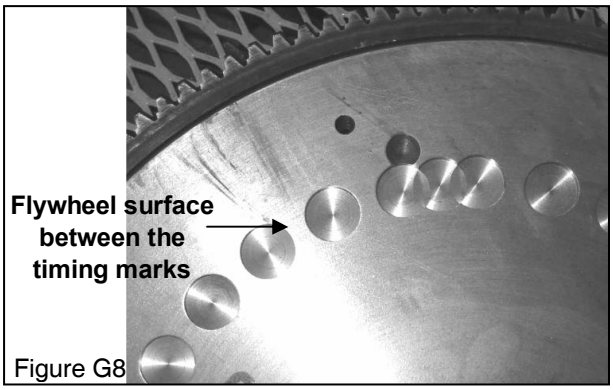
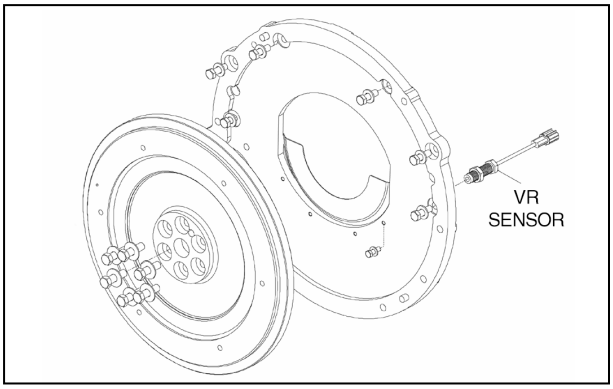


Figure G8

10. Once the VR sensor makes contact with the flywheel back the sensor outwards 1 turn and tighten down the sensor locknut. This should adjust the sensor signal strength within the proper range. This completes setting ignition timing and sets the center of the SECM ignition control range.



WARNING
Improper assemble of VR sensor may cause VR sensor failure.
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Idle Mixture Adjustment

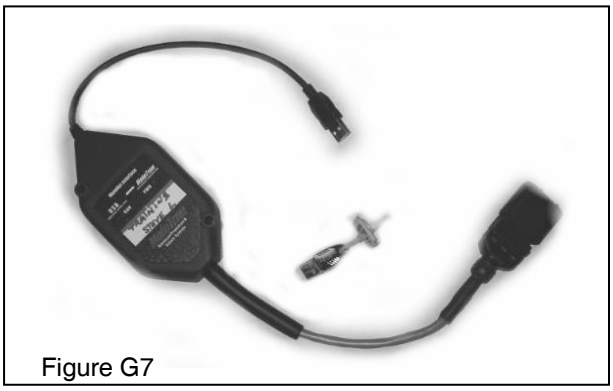


Figure G7

The method for making the idle mixture adjustment to a running engine is to use the Service Tool software by connecting a laptop computer to the SECM. If you do not have the Service Tool a multimeter capable of measuring Duty Cycle, such as a Fluke 87 III, can be used. Connect the meter positive lead to between battery positive and the meter negative to the FTV signal wire. Set the range for 4 or 40 and the MIN/MAX setting to + (usually the default setting of the meter). The multimeter will then read the Duty Cycle percentage the same as the Service Tool. In order to use the Service Tool a USB (Universal Serial Bus) to CAN (Controller Area Network) communication adapter by Kavaser will be required along with a Crypt Token (Figure G7). The Crypt Token acts as a security key allowing the laptop to retrieve the necessary data from the SECM.

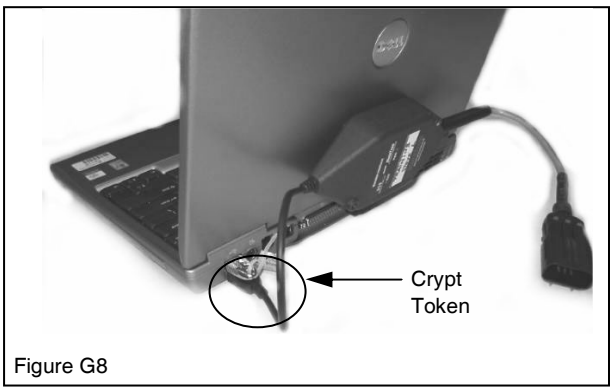


Figure G8

1. Install the Crypt Token in an available USB port in the computer (Figure G8).

2. With the ignition key in the OFF position, connect the Kavaser communication cable from a second USB port on the computer to the CAN communications cable on the engine. (*If your laptop computer does not have a second USB port an appropriate USB Hub will need to be used).

3. Connect a timing light to the engine.

4. Turn the ignition key to the ON position (Do Not Start the Engine).

5. Launch the MotoView program on your computer and open the Service Tool display.

6. Start the engine; you should now see the idle RPM on your Service Tool display Run Screen (Figure G9).

NOTE
Service Tool software (MotoTuneViewer) and the security Crypt Token is obtainable by certified technicians through authorized dealers.

AFR		
RPM	0	
AFR	0.0000	
AFR SETPOINT	0.00000	
FTV DUTY CYCLE	45.00	%
O2 SENSOR VOLTS	0	VDC
MAP	10.78	KPA
INTAKE MANIFOLD TEMP	0.00	C
INTAKE MANIFOLD TEMP	32	F
COOLANT TEMP	0.00	C
COOLANT TEMP	32	F

Figure 28

7. Adjust the idle mixture screw on the mixer until a reading of 25-40% is reached for the FTV Duty Cycle in Closed Loop Idle (Figure G12).

8. To make this adjustment you will need to adjust the idle mixture screw all the way inward. If the FTV Duty Cycle measures between 25-40% no further adjustment is necessary. If the measured FTV Duty Cycle is above 40%, adjust the screw outward until the duty cycle drops below 40%.

9. Use the accelerator pedal to increase RPM above idle momentarily (Rev the engine) then release the pedal to return to idle RPM. The duty cycle setting should remain within the adjustment range (25-40%). Place your thumb over the adjustment port for a more accurate reading by preventing air from leaking past the mixture adjustment screw, which may cause the duty cycle to decrease.

10. To obtain an accurate FTV Duty Cycle reading when the tamper proof cap is not installed, place your thumb over the idle screw port so that no air will leak past the screw threads.

11. If the FTV Duty Cycle reading is above 40% adjust the idle adjustment screw outward and re-check the duty cycle reading. Continue to do this until the FTV Duty Cycle reading is within the optimum range (25-40%). DO NOT adjust the screw so far outward that the tamper proof cap cannot be installed. A duty cycle measurement at Closed Loop Idle of 40-50% is acceptable if the optimum range of 25-40% cannot be reached through adjustment. If the FTV Duty Cycle cannot be adjusted below 50%, the mixer is faulty and should be replaced.

12. Turn the ignition key to the OFF position to shut down the engine.

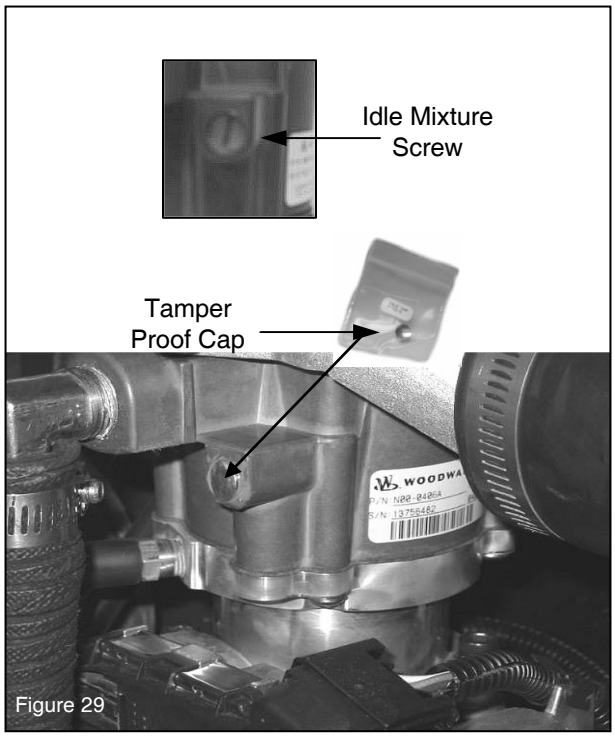
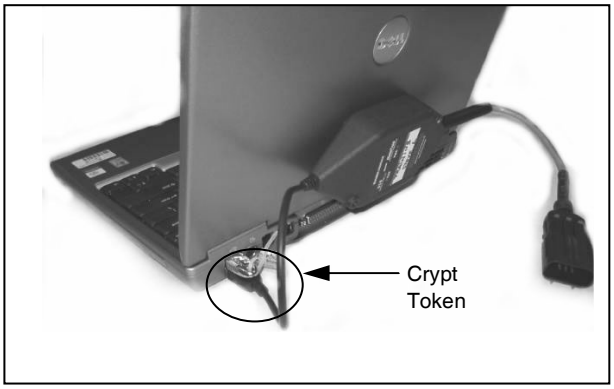


Figure 29

13. Install the tamper proof cap on the idle mixture screw adjustment port so that no further adjustments can be made (Figure 29).

NOTE
If the FTV Duty Cycle reading is cannot be adjusted between 25-40%, check for possible vacuum leaks, manifold leaks or a faulty mixer.

CHAPTER 9 SERVICE TOOL KIT

A343079 USB (Universal Serial Bus) to CAN (Controller Area Network) Converter Assembly	
A343080 Service Tool Software (includes CD and Crypt Token (License Dongle))	
A334071 Extension Cable(L=200cm) **A334082** Extension Cable(L=20cm)