JIOLAT Group

ISO 9001:2015 Company

DIESEL-TO-NATURAL GAS (DNG) CONVERSION MANUAL

Mercedes Series OM904 & OM906

Detroit Diesel Series MBE 900/4 & 900/6

DISCLAIMER

This manual is intended for use by qualified and experienced technical personnel with formal training in the diesel-to-natural gas engine conversion process and the operation and maintenance of heavy-duty diesel engines. This manual was neither designed nor intended as a technical guide for diesel engines and assumes a high degree of understanding by the reader of diesel engine operation and theory.

ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT THE DIESEL-TO-NATURAL GAS ENGINE CONVERSION PROCESS.

CONTACT INFORMATION

For information about Jiolat's line of engine control systems and other products and services, please visit our website or send us an email. For questions, concerns, or technical support please contact us at:

Jiolat Auto Gas Industries	
Seed Farm Road, Plot of Ram	http://www.jiolat.com
Chander, Delhi-110036 India	jiolat.newdelhi@gmail.com
Tel: +91-27205153	

Jiolat has endeavored to ensure the accuracy of this documnt. Customer feedback is very important to us. Please report any errors or submit any suggestions to Jiolat technical support.

Table of Contents

1 DISASSEMBLY

ATTENTION:

EXCEPT FOR PROCEDURES SPECIFIC TO A DIESEL-TO-NATURAL GAS ENGINE CONVERSION AS OUTLINED IN THIS MANUAL, THE PROCEDURES AND SPECIFICATIONS OUTLINED IN THE WORKSHOP MANUAL ILLUSTRATING AND INSTRUCTING ON HOW TO OVERHAUL THE MERCEDES SERIES OM904 & OM906 DIESEL ENGINES MUST BE FOLLOWED.

NOTE:	Prior to starting the DNG Engine installation process, confirm that all components appear to be in good condition and are in working order.

Jiolat supplies as complete a system as is practical without limiting application flexibility. However, because of variations between engines and vehicles, fabrication of miscellaneous brackets, braces and shields is sometimes necessary. A skilled mechanic familiar with electronic engine controls and natural gas systems will have no trouble with installation of the ECM system. Be prepared and make sure materials and equipment are on hand.

Before beginning disassembly, make sure you have read Jiolat's DNG Information and Safety Guide. In it are procedures to maintain a safe workplace specific to the diesel to natural gas conversion process. Always use the proper tool for the job and keep a fire extinguisher readily accessible during the conversion process.

1.1 General Procedures

Photographing the entire process is highly recommended, especially for the first engine conversion. This will aid in reassembly by helping to identify component locations specific to your engine. Detailed engine photos from all angles before any component is removed is extremely important. Additionally, photos during the disassembly process, as components become uncovered are also essential.

During disassembly, it is important to bag and label all attaching components such as bolts, screws, nuts, etc., for each item as it is removed from the engine. This will make the reassembly process run much smoother and prevent using the wrong components to reassemble the engine.

As each item is removed from your engine, inspect it completely for wear and operation. Replace any broken or extensively worn component before converting to CNG. Read the entire OEM manual prior to beginning disassembly. Some engines have specific guidelines for engine maintenance that should be strictly adhered to during this process.

1.2 Necessary Tools

Jiolat provides all necessary tools specific to installation of new natural gas components. However, to disassemble and prepare the engine, regular machine shop tools are necessary. This includes wrenches, torque wrenches, impact drills, full socket sets in both metric and standard, an engine lift, an engine build

stand capable of rotating the engine, etc. Only qualified technicians should attempt to perform the engine conversion process.

1.3 Removal of Old Components

Remove and discard all components on the engine associated with the diesel injection system (injectors, diesel injector unit pumps, diesel fuel filter, diesel fuel pump, fuel lines, etc.). Remove and discard all components associated with the EGR system (the cooler, connecting pipes, bolts, EGR valve, and EGR position sensor). Discard all associated gaskets and seals.

When removing pistons, rods and bearings make sure to note their position within the engine. It is important to reassemble them in the same location as they were removed. Use diagrams, take notes, or bag and label each component separately to avoid confusion.

1.4 Prepare Engine for Rebuild

A clean engine and vehicle makes installation much easier and faster. Wash the engine and all removed components thoroughly, making sure to maintain their appropriate labels and location identifications. Replace any broken components found during disassembly.

ATTENTION

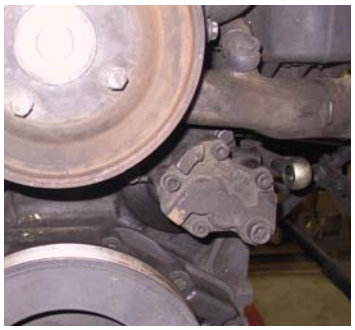
This manual describes the diesel-to-natural gas engine conversion process for the 4-cylinder Mercedes OM904 and the 6-cylinder Mercedes OM906 engines. As these engines are substantially similar, diagrams, pictures and schematics may only depict the 4-cylinder OM904 or the 6-cylinder OM906 engine, not both. Given specifications and instructions cover both engine models, unless otherwise specified.

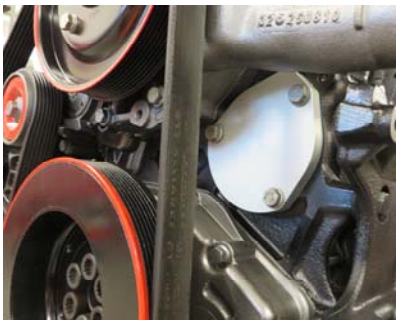
2 REASSEMBLY & INSTALLATION

For an overall view of all newly installed component locations, see Schematic 3.1.

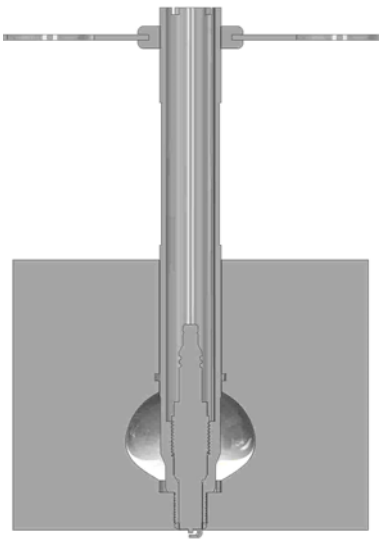
2.1 Blockoff Plates

Where the diesel filter was removed, replace with the Fuel Filter Block Off Plate (Part Number: D.10461) and Gasket (PN: D.10526) as shown. Torque bolts to 25 N-m.





Where the Fuel Pump was removed. replace with the Fuel Pump Block Off Plate (Part Number: D.10451) and Gasket (PN: D.10527) as shown. Torque bolts to 25 N-m.



2.2 Cylinder Head Modifications for Spark Plugs

The cylinder head must be modified to allow for the installation of spark plugs. Generally, the spark plugs are installed at the same location as the diesel injectors, and some important modifications must be made.

Detailed instructions on how to modify the cylinder heads are located in the attached PDF document titled "C.10701 Mercedes Cylinder Head Mod Instructions." In this document you will also see instructions for Spark Plug installation, and valve cover modifications.

2.3 Installing the Cylinder Sleeves

The Mercedes OM904 and OM906 are dry-sleeve engines, which means there are no removable cylinder sleeves that can be replaced. When the cylinders are worn-out there are two options:

1. Slightly bore out the cylinders and use oversized pistons.
2. Bore out the cylinder block and install cylinder liners.

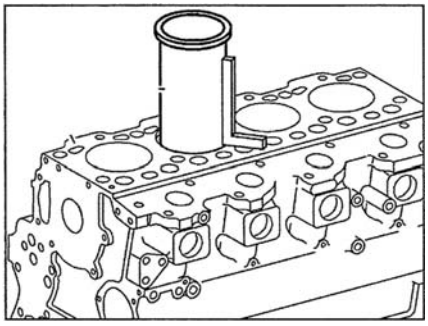
The Jiolat's diesel-to-natural gas engine conversion kit for the Mercedes OM904/OM906 uses the second method.

Dry sleeves must fit extremely well against the block to assure proper heat transfer, and block counter-bores must be clean and square. To avoid piston clearance problems, it is necessary to check the block for roundness, taper, and waviness with a dial bore indicator before and after the sleeve is installed.

NOTE	After installation of a liner whose inner diameter is only pre-bored, the cylinder bore must be fine-bored and finish-honed to its nominal size.

Procedure:

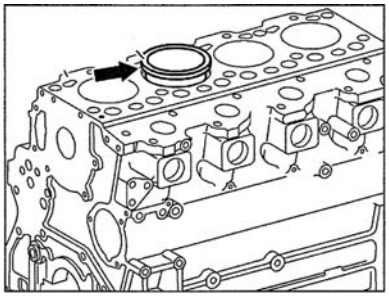
1. Carefully clean the cylinder block and check for dimensional accuracy and distortion. It is of importance that the bore is circular and cylindrical, since it determines the internal geometrical shape of the pressed-in thin-walled liner. Bores, which are out-of-round or damaged, can be refinished (fine-bored or honed) for the installation of oversize liners.



2. Bore the engine block.

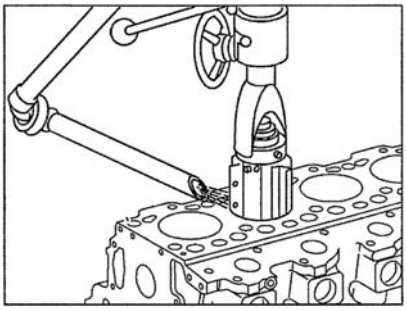
3. Install the sleeves.

4. Press in the cylinder sleeve.



5. The sleeve is "pressed" into the cylinder and the interference fit is .0025" (.0635mm). Use liquid nitrogen to install them.

Oil and grease should not be used to insert the liners since they tend to cake and hinder the dissipation of heat. Special lubricants such as molybdenum disulphide should be used instead.



6. Hone the sleeves per spec to fit pistons (involves cutting flange portion of sleeve - deck block very slightly with sleeve installed).

After insertion, the cylinder diameter is to be measured crosswise at several points (but at least at the top and bottom). Out-of-roundness and shrinkages caused by inaccurate bores must be equalized out by means of re-honing.

Instruction for cylinder liner installation:

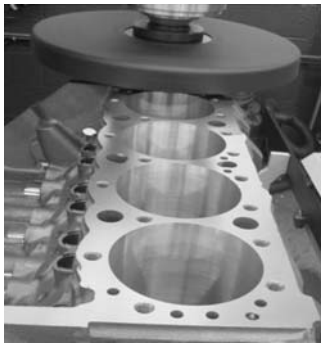
a. Bore engine block to a depth of about 4.1735" (106.0069mm).

b. For the fist pass, cut 0.020” all the way through the cylinder.

c. For the second pass cut bore for the sleeve to get 0.0025” press fit.

d. The depth of the bore should be about 8.4345" (214.2363mm).

e. Press in sleeve (after cooling with liquid nitrogen) and cut off the rest of the sleeve protruding out of the block.



f. Slightly deck the block.

The top of the liner must be flush with the sealing surface of the cylinder block. If necessary, grind over cylinder block and liner (deck block).

g. Final honing of cylinder:

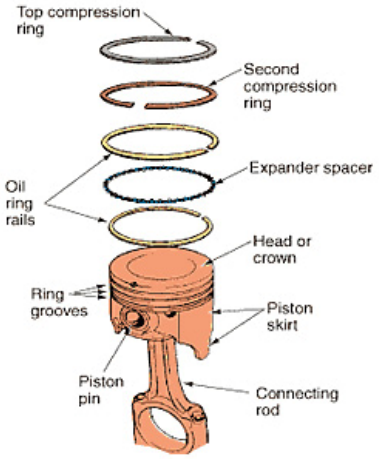
Cylinder Sleeve ID: 102.015 - 102.020mm

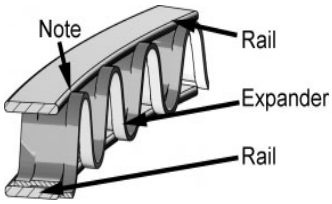
2.4 Pistons and Piston Rings

⚠ WARNING	Do not use diesel pistons when converting a diesel engine to a natural gas engine. Severe and possibl y irre parable engine damage will result, as well as high oil consumption.

⚠ WARNING	Correct orientation and sequence of ring installation, as well as ring gap orientation are very important. Incorrect installation will cause excessive blow-by and oil consumption and will result in engine smoking during operation or engine failure.

For minimal leak-down and reduced oil consu mption, reduced-cro ss section piston rings are supplied, as well as 3-piece oil rings. Accuracy of piston asse mbly is **very** im portant, as is ring clearance and gap.





Ring gaps are often a confusing an d misunderstood part of a re-ring job. There are mini mum an d m aximum ring gap spec ifications, which m ust be observed for the best perfor mance of a new ring set.

Minimum gap tolerances must be observed in order to prevent the ring ends from butting together as the ring expands when the engine approaches operating temperature.

Maximum ring gap is an important part of ring performance in that too much gap results in lost compression, power loss and ultimately poor oil control. The following chart indicates the specifications for compression ring gap as outlined by the SAE (Society of Automotive Engineers) as standards for the automotive piston ring manufacturers.

SAE Recommended Automotive Compression Ring Gap Clearance	
Ring Diameter	End Clearance Inspection Limit
3.5425 - 4.3299	.012 - .022
4.3300 - 5.1174	.014 - .026
5.1175 - 5.9049	.016 - .030
5.9050 - 6.8899	.020 - .035

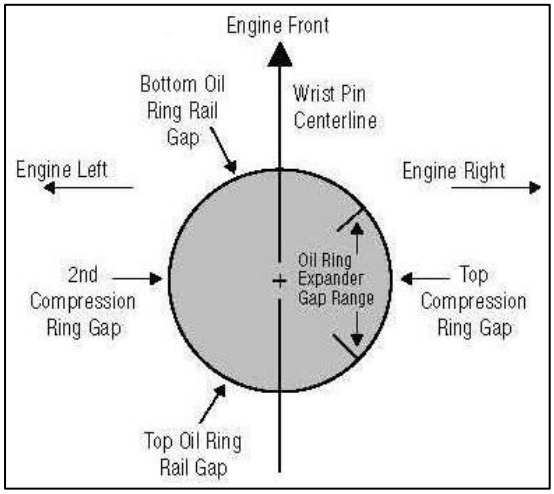
NOTE	When installing piston rings, always use a ring spreader. Do not attempt to spread rings for installation by hand.

Installation Procedure:

1. Remove old pistons and liners according to OEM specifications.
2. Inspect connecting rods. If damaged, recondition or replace before installing new Jiolat piston heads.
3. Install new Jiolat sleeves into cylinders.
4. Clean cylinder walls of dirt and debris using hot water and mild soap. Dry the liner.
5. Immediately after cleaning, lightly coat the skirt and cylinder walls with oil for initial installation. Do not use detergent oil, synthetic oil, or an additive until the rings have seated.
6. Inspect all piston ring gaps to ensure they are according to spec.
7. Replace the pistons with the Jiolat Natural Gas Piston Kit and Piston Ring Set.
   a. Install the 3 piece oil ring set on to the bottom most oil ring groove first. Begin with the expander ring. IMPORTANT: When installing, ensure the end faces of the scalloped expander ring are facing upwards as shown.

Top of Engine

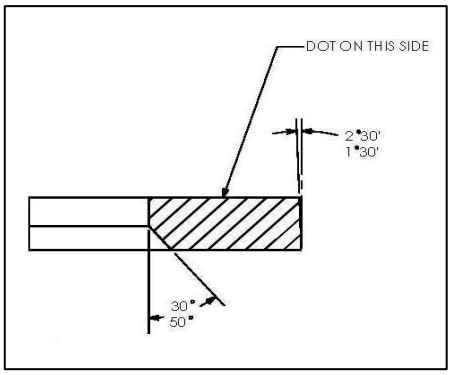
   b. Install the top and bottom oil control rings (or rails) into the oil ring groove, following the Ring Orientation Diagram for ring gap spacing.



   c. Install the middle compression ring into the middle ring groove of the piston. IMPORTANT: Orientation of this ring is critical. The beveled edge on the ID of the ring should face downward. A small dot or depression located on the

face of the ring should be facing upward.

d. Install the top compression ring on the top most ring groove of the piston.



8. Lube the new piston assembly very lightly with engine oil.
9. Install pistons, making sure to note directionality as indicated on piston heads.
10. Be sure to lubricate pins with Lubriplate, or an assembly oil to prevent galling on initial fire-up.

2.5 Valves

New valves, valve seals, valve seats, and valve guides are provided. Dimensional specifications and installation procedures are the same as for the OE diesel parts, except for the valve seat angles. The intake valve seat angle is set at 20° and the exhaust seat angle is set at 30°. This will greatly increase durability and extend the valve adjustment frequency. For adequate lubrication and to prevent excessive oil consumption, high quality valve guide seals are also supplied.

Correctly adjusted valves are very important for the engine to work satisfactorily. If the valves are not adjusted to specification, the air/fuel mixture intake in the cylinders will be insufficient to generate good engine power and assure easy starting of the engine.

Valve Clearance	Intake/Exhaust	0.45mm/0.65mm

Note that the valve bridges will need to be modified to accommodate the spark plug tubes. This procedure is described in document C.10701 Mercedes OM904/OM906 Cylinder Head Mod Instructions.

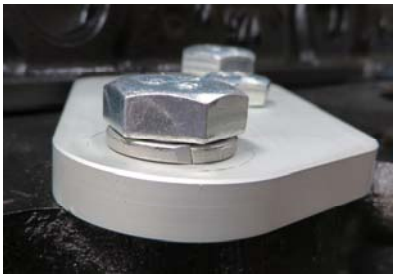
2.6 Ignition Coils

1. Insert the metal springs (SP-9201N6) into the silicone spark plug boots (20 206 904).
2. Push silicone spark plug boots together with spring on to coil-on-plug ignition coil.
3. Insert the ignition coil/silicone spark plug boot unit into the Jiolat spark plug adapter tubes.
4. Place an Jiolat COP spacer (D.10709) between the coil and the standoff of the Jiolat Valve Cover Plate.
5. Slide an M6 lock washer on to the M6x1x40 screw, and tighten on the assembly to secure the coil into place.

2.7 High-pressure Diesel Injector Pumps

Where the diesel injector unit pumps used to be installed, install the Jiolat Blockoff Kit (PN: 40 904 710). Lubricate the O-rings before installation, and slide a lock washer on to the M10 bolts. Torque to 50 N-m.





2.8 Oxygen and Exhaust Temperature Sensors

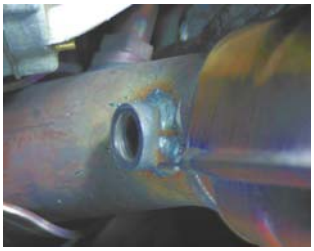
UEGO (aka 5-Wire Oxygen Sensor) and Exhaust Temperature Sensor

NOTE	Excessive oil consumption will rapidly contaminate and physically clog the internal structure of the UEGO sensor negatively affecting engine and emissions performance. Jiolat recommends oil consumption of less than 0.7L/1000km (~2 US pints/1000 miles).

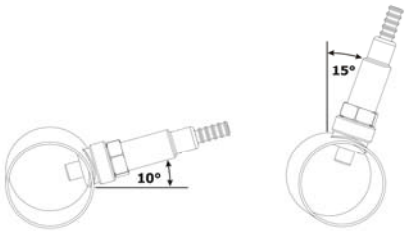
The UEGO and Exhaust Temperature Sensors are located close to the turbo on the exhaust pipe. When clamping the exhaust flanges together ensure there are no leaks upstream of the sensor. An exhaust leak upstream of the Oxygen sensor will cause incorrect sensor readings.

Procedure

1- Find a suitable location to install the sensor bung on the exhaust system. It is recommended that the weld boss be installed approximately 12" - 18" after the turbo and before the catalytic converter for the UEGO, and 15" – 30" for the Exhaust Temperature Sensor. Never install the sensor in the exhaust manifold between the cylinder head and the turbo.

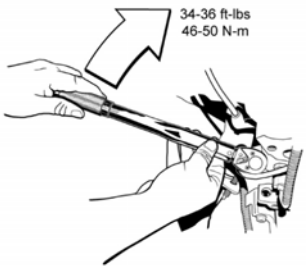


2- Determine the orientation of the weld boss. Ideally the sensor should be oriented at 10° - 15° off the vertical (12 o'clock) position. However, depending on engine configuration the sensor can be installed where necessary between the 9 o'clock and 3 o'clock positions, taking care not to install them directly vertical or horizontal.



3- Verify that you have adequate clearance for the sensor and wiring harness before installing the weld boss.

4- Once the weld boss is complete, apply anti-seize to the threads of the oxygen sensor, making sure to not contaminate the tip.



5- Insert the oxygen sensor and torque to 34-36 ft-lbs (46-50 N-m).

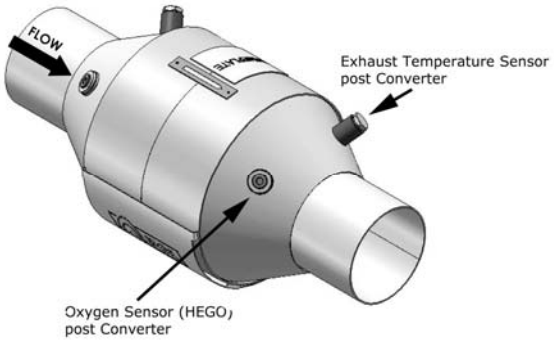
HEGO (aka 4-Wire Oxygen Sensor) and Secondary Exhaust Temperature Sensor

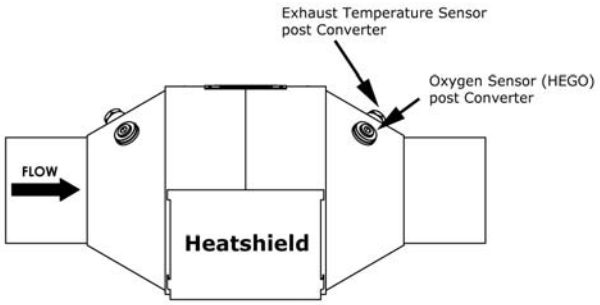
The HEGO and Secondary Exhaust Temperature Sensor are located on the Catalytic Converter. Both sensors also need to be clocked such that they are 10-15 º off the vertical and horizontal positions. The sensors should be installed a ½ turn past finger tight.

2.9 Catalytic Converter

The Catalytic Converter should be installed approximately 3-4 ft after the turbocharger and no more than 6' from the exhaust. **Installing the converter further away from the turbocharger will significantly effect emissions and is not allowed.**

The picture below shows an ideal location to install the catalytic converter. It is located vertically behind the passenger side of the cab on the exhaust pipe before the muffler. When installing the converter, make sure the sensors are clocked in positions that are approximately 10 – 15º off the vertical or horizontal positions.





⚠ WARNING	Immediately shut off the engine if a misfire develops. An engine misfire condition will severely damage the catalytic converter.

2.10 Air/Fuel Module

The gas injection manifold is a critical component of the fuel delivery system. Ensure cleanliness of this part for proper fuel mixing.

⚠ CAUTION	The injector manifold is an engineered, pressurized component with multiple internal passages. Modifications to it such as drilling or tapping are not authorized. Mount the manifold using only the mounting holes and hardware provided.

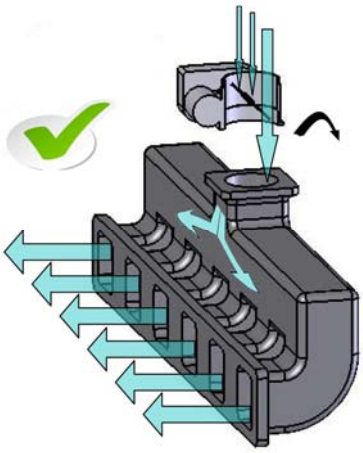
⚠ CAUTION	Use only approved gas supply hoses, which are specifically engineered for chemical and physical resistance to the harsh environment they operate in. For the safety of the installation, do not substitute inferior gas supply hoses.

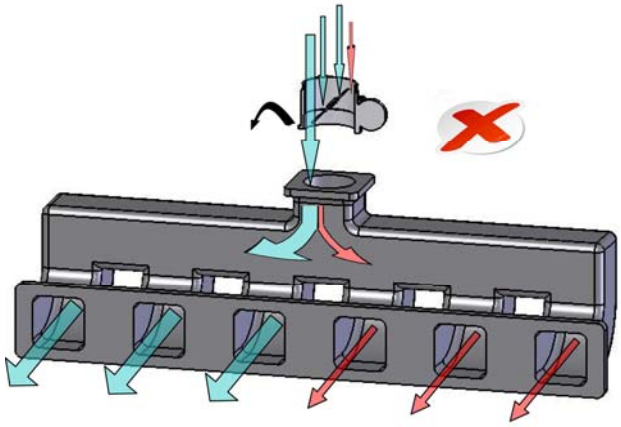
NOTE	When cutting hoses, m ake sure to blow out debris before attaching it to the fuel s ystem. Cutting material in the hose can severely damage injectors and the engine.

The installation of the Throttle Body and Injector Manifold/Mixing Ring on the Air/Fuel Module is directional. Orientation of the module and associated components are important and dependent on the engine configuration.

For more information, see attached PDF document titled "C.10705 Assembly Manual, Air/Fuel Module, Mercedes 904."

To prevent a bias of air flow from the air/fuel module, the throttle plate rotating axis must be parallel to the cylinders as shown.



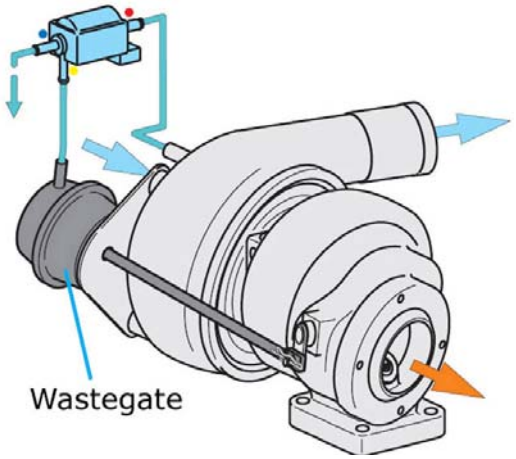


Procedure

1. Once the air/fuel module has been assembled, configure the orientation on to the engine.
2. Lubricate the O-ring for the air/fuel module adapter and install.
3. Clamp the assembly to the engine using the OE clamp for the intake manifold adapter.

4. Attach all wiring harness connections per the wiring diagram in Schematic 6.4.

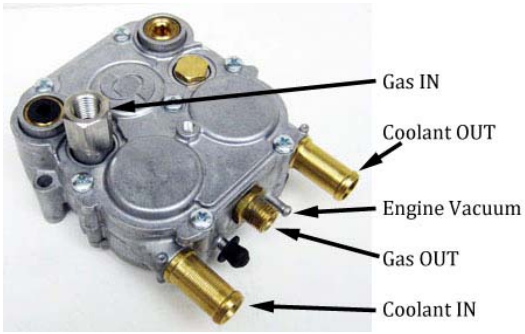
2.11 Wastegate Solenoid



The Waste gate Solenoid is connected to the Waste gate Actuator and the intake sy stem using flexible rubb er tubing. The Wastegate Actuator is installed on the internal-wastegated turbocharger. A more detailed diagram is shown in Schematic 3.3. Install the turbo Boost Pressur e Sensor, Wastegate Solenoid and Wastegate actuator upstream of the Throttle. Install the M anifold Pressure Sensor, Pressure Regulator, and Blow off valve (if used) downstream of the Intake Manifold.

To attach the turbo to the external wastegate actuator, you will need to modify the OE bracket. Weld the bracket to the Wastegate Actuator Spacer (D.10472) as shown. The slots in the Spacer should be perpendicular to the sides of the bracket.

2.12 CNG Regulator Mounting

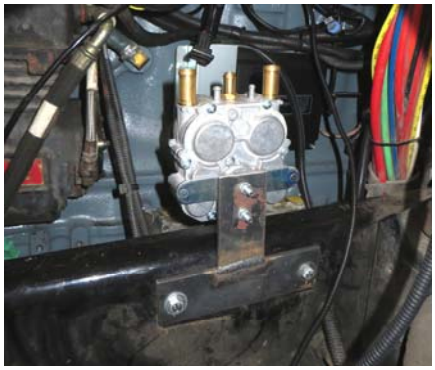


In so me applications, the regulator mounting locati on is critical and failure to locate it as specified will alter the calibration, causing degraded performance and/or emissions. The installation m ust be made in accor dance with the code of the au thority having jurisdiction, or in the absence of a local code, in accordance with the c urrent edition of the *American Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems NFPA 52*.

Determine the proper location using the following criteria:

- Install the unit in the engine compartment, but NOT on the engine block.
- Ensure unit maintains ready access for installation and maintenance.
- Do not place within 5” (12cm) of exhaust pipes or exhaust manifold.
- Do not place within 2” (5cm) of moving parts, e.g. V-belts, pulleys, etc.
- Do not place in splash path.
- Do not place on frontal sheet metal.
- Do not place on radiator tank.
- Do not install unit so that it interferes with OEM mechanical operation or where mechanical operation endangers unit, e.g. engine rock or hood closing, etc.

- Do not install in areas that interfere with routine service operations, e.g. checking or adding oil or transmission fluid, etc.
- Installer-made brackets are acceptable if they meet the above criteria.

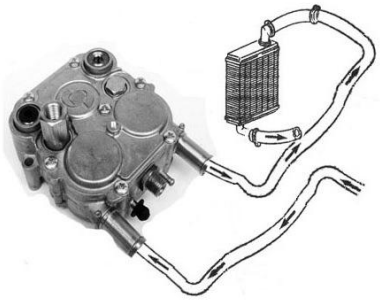


In addition, the regulator must be near to your intended gas injection block location and should be situated such that the connecting hoses and low-pressure CNG filter will fit between the regulator and the injection block.

You may need to fabricate a bracket to mount the regulator. Paint it to protect it from corrosion, and use plated fasteners. Ensure that the regulator body is not stressed when the regulator is mounted to the bracket, and make sure the installation is rigid with no parts rubbing against each other.

CNG Regulator – Gas and Coolant Connections

The regulator requires heat to keep it from freezing as the CNG expands from high pressure to a usable lower pressure in the engine control system. This heat is supplied by hot engine coolant. Vehicles have varying coolant hose routings and functions. The regulator coolant ports are connected in parallel with an existing engine coolant circuit as shown.



You must select coolant hoses using the following guidelines:

- There must be coolant flowing in the lines at all times when the engine is running. Some coolant lines only conduct coolant after or before the engine thermostat opens.
- The coolant lines chosen must have enough pressure drop across them to flow coolant through the regulator even at idle.
- The regulator will divert some coolant flow away from the original function of the hoses. Ensure that this is acceptable and that installation of the regulator does not compromise a critical vehicle function such as transmission oil cooling.
- Do not select a coolant return point that diverts the coolant directly to the radiator, bypassing the engine thermostat. This will provide cooling at all times which will not allow the engine to reach its normal operating temperature.

CAUTION	Do not plumb the regulator in series with a coolant line. The relatively high restriction of the regulator and the high coolant pump output on some engines at high speed will cause a large pressure drop across the regulator. This will impede the original function of the coolant circuit and the fast-flowing coolant may induce erosion and cavitations of the regulator heat transfer passages.

TIP: Vehicle interior heating hoses are often a good choice for regulator heating. They are large diameter and high flow, and the diverted coolant is not significant.

When you have chosen the coolant tap locations according to the above critria, install the coolant plumbing as shown above.

1. Secure all coolant hoses to fittings and tees with the supplied clamps. Do not over tighten clamps.
2. Refill coolant system or unclamp hoses. Check and eliminate any coolant leaks.

TIP: Be careful running the engine to check for leaks. If the coolant has been drained air pockets may prevent the coolant pump from properly circulating the coolant resulting in possible overheating and engine damage. Check coolant level after engine has cooled down to ensure that the coolant level is correct.

CNG Supply Tubing

The high pressure tubing connection to the regulator uses tube compression fittings. Depending on the application, your system will use 6 mm, 8mm, 10mm, 1/4", or 3/8" tubing diameter fittings. Ensure that the fitting diameter matches the tubing diameter. 6mm and 1/4" are especially close in size but mixing will not allow a secure installation. Note the following:

- Ream and clean the tube end carefully. Blow out the tubing with compressed air before connecting to eliminate all debris.
- Ensure that stresses are relieved in the tubing area and that the tubing will not be flexed, stressed or abraded in any operating condition.

2.13 Wiring Harness

When installing the wire harness, follow your application-specific wiring diagram for correct connection and installation. See Schematics 6.4 and 6.5 for reference. Ensure you have the correct wiring diagram for your application before you begin installation.

Before installing the wire harness disconnect the ground terminal on the battery.

- Do not route near hot spots such as exhaust components.
- Do not route near belts, pulleys, fans, or any other moving parts.
- Do not route wiring with high-tension ignition coil leads.

CAUTION	Do NOT route any wiring harness leads within 8" of an ignition lead. Doing so can cause voltage spikes in the harness which could damage any electronic components. Such failures are not covered by warranty.

- Do not route wire next to sharp edges such as those on sheet metal brackets and body panels.
- Do not route wire in any area where it may be splashed or dripped on with chemicals. Some chemicals, particularly Power Steering Fluid can damage the insulation on the wires.
- Fasten wires down with tie straps and cable clamps. Do not allow wires to hang loose especially from terminating devices. Tie the harness down at regular distance intervals and provide it with some form of strain relief in close proximity to the end connector.

CAUTION	Electrical connectors, particularly the ECM main connector, will withstand a limited number of insertions before the terminals become unreliable. After 50-100 insertions the connections may cause erratic, difficult to diagnose conditions. Replace connector terminals if connectors have been repeatedly inserted and removed, or if they are contaminated with dirt, oil or other substances.

Some connectors, connector cavities or loose wires may not be used for your particular application. Any unused connectors or connector cavities must be properly capped using the mating connector with cavity plugs in all unused cavities. Loose wires must be cut to a short length and capped by heating a small length of heat shrink on the end of the wire and pinching it with pliers before it cools. The wire should then be tucked into the Wire Harness loom and secured using tie straps.

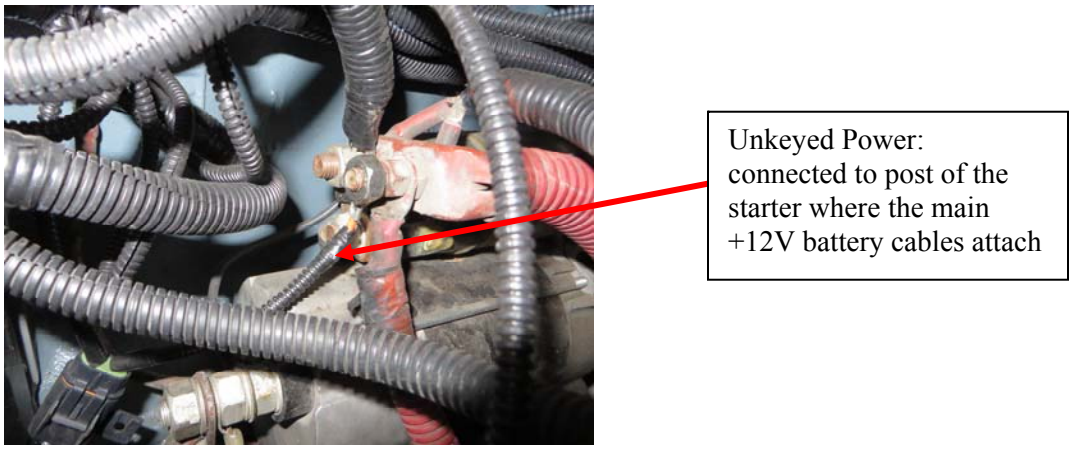
Correct unused lead termination

Installation

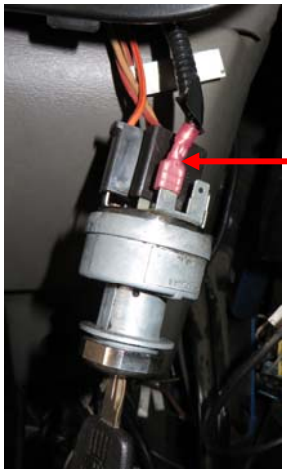
Before starting, make sure all CNG storage cylinders are closed and high pressure CNG lines are all drained. When connecting the wiring harness to its end devices, follow your application-specific wiring diagram to ensure the wire colors match the specified components. See attached document "Wiring Harness Schematics" for reference if needed.

The best place to start for your power connections is the fuse box. Almost all the powered components on the vehicle get power from this location. Here are some instructions for selecting power sources:

- For Unkeyed Power, find an uninterrupted vehicle voltage source. This will connect to the Orange ECU wire. Toggle the key through all positions, including the "OFF" and "Start" positions, while measuring the voltage of your selected source. There should be no interruption in the power supply. Do not connect this wire directly to the battery as this is a common point for extreme corrosion, which may cause the wire to break. The ECM system will draw up to 1 Amp from this wire, so ensure the system you splice into can handle the extra current. The Unkeyed Power allows the ECM to retain vehicle statistics, diagnostic trouble codes and other important information when the vehicle is turned off. Use the fuse holder and the 1 amp fuse supplied to protect the circuit.



- For Keyed Power, find a power source which supplies vehicle voltage while the key is in the "ON" and "Start" positions. This will connect to the Red/Green line of the ECU. Suggested possibilities for this are OEM power supply to the OEM ECM, and power to the OEM ignition coil. If an ignition power lead is selected, be sure there is no resistor between the power source and your splice. Some ignition systems use ballast resistors on the power connection to reduce peak current to the ignition coils. Splicing after this point may cause improper operation of the ECM and the ignition system. The ECM system will draw up to 10 amps from this line. Be sure the system you splice into can handle the extra current. Use the fuse holder and the 10 or 15 amp fuse supplied.



Keyed Power: Attach to the terminal that shows continuity when the key is in both the Run and Crank position

After finding power sources, select a ground source. Grounding should be done on a reliable engine block ground. Find a mounting stud on the engine block. It must match the size of your ground terminal. The most common size for ground terminals is 10 mm. It should be away from exhaust manifolds and drip or splash paths. Use only serrated heavy-duty grounding lugs. Non-serrated, inferior quality grounding lugs are a major cause of unreliable operation and electronic component damage. Damage to ECM components caused by using unapproved grounding lugs will not be covered by warranty.

Next, disconnect the ground terminal on the battery. Now, lay the harness out with connectors generally in the positions you want them. This will give you a rough idea of which connections you have to lengthen or shorten. Start tying the harness down to local components along the route of the wire harness. Good items to tie the harness to are the OEM wiring harness (provided it is properly secured), local brackets and frame members. Be sure to route the wiring for the Oxygen Sensor well away from the exhaust component it is installed into. The sensor itself has high temperature wiring but the connector and connecting harness and wire cannot withstand the temperatures associated with hot exhaust components. As the harness gets tied down, you will be able to determine exact lengths by which harness leads need to be extended or shortened.

CAUTION	Before re-connecting the ground terminal to the battery, check the condition of all battery, starter and alternator electrical connections and cables. If there is any sign of corrosion or a poor connection, then the terminal must be replaced or repaired. A poor connection caused by corrosion or poor connections can cause power spikes which will lead to damaged electrical components. Damage of this kind to any component in the ECM system is not covered by warranty.

NOTE	DNG Engine / Vehicle Systems integration is a complicated procedure. Transmission shift points and clutch engagement operations, as well as accurate readout of dashboard gauges and OBD system warning and MILs may require OE support or access to OE workshop manuals. Access to workshop manuals and special tools is the responsibility of the DNG Engine installer not Jiolat. In some instances a transmission re-flash may be necessary as shift points may need to be matched with the natural gas engine performance characteristics.

2.14 ECM

Once the wiring has been checked, connect the ECM using the following procedure:

1. Disconnect the battery ground terminal and close the manual valve on the fuel tank.
2. Connect the wiring harness header connector to the ECM.
3. Re-connect the battery ground terminal.

CAUTION	Do not connect the ECM directly to a vehicle with a vehicle voltage above 12v (remember, 12v automotive electrical systems have a nominal vehicle voltage of 13.8v). If you are installing a ECM system on a vehicle with a vehicle voltage above 12v, you will require a Voltage Adjusting Module and a specialized wiring harness.

In order for the ECM to display the tank pressure, a tank pressure sensor must be installed on the engine. This is not part of Omnitek's standard conversion but can be purchased separately from a high-pressure fuel system supplier.

CAUTION	The ECM system is designed to control resistive type fuel gauges only. Interfacing with multiplexed or digitally-controlled gauges may require a special application module or use of the optional Jiolat gauge. Do not attempt to connect the ECM system's fuel gauge wiring to any type of gauge except resistively-triggered.

In most cases the fuel gauge signal wire in the ECM system wiring harness must be extended to reach the dashboard fuel gauge.

CAUTION	Connecting the ECM system fuel gauge signal wire to a positive voltage source, such as the "+" wire on the gauge, will cause immediate and irreparable damage to the ECM! If in doubt, double check your connections or call Jiolat.

Malfunction Indicator Lamp

The ECM system uses a Malfunction Indicator Lamp to indicate a malfunction and a separate Engine Protection Lamp to indicate when the control system has entered engine protection mode. The lamps may be either an unused original dashboard lamp or optional lamps available from Omnitek. If an original equipment dashboard lamp is used, ensure that the circuitry used is "switched ground", i.e. there is always vehicle voltage on one terminal of the lamp, but the lamp illuminates only when a ground on the other terminal of the lamp is established.

Ensure that the rated lamp voltage matches the vehicle voltage. In most cases, the MIL wire in the ECM system wiring harness must be extended to reach the dashboard.

TIP: Poor grounding is the most common cause of electrical malfunction on a vehicle. Ensure the ground connection is made on a reliable engine block mounting lug. Use the serrated type ground lug and ensure the ground terminal is properly strain relieved.

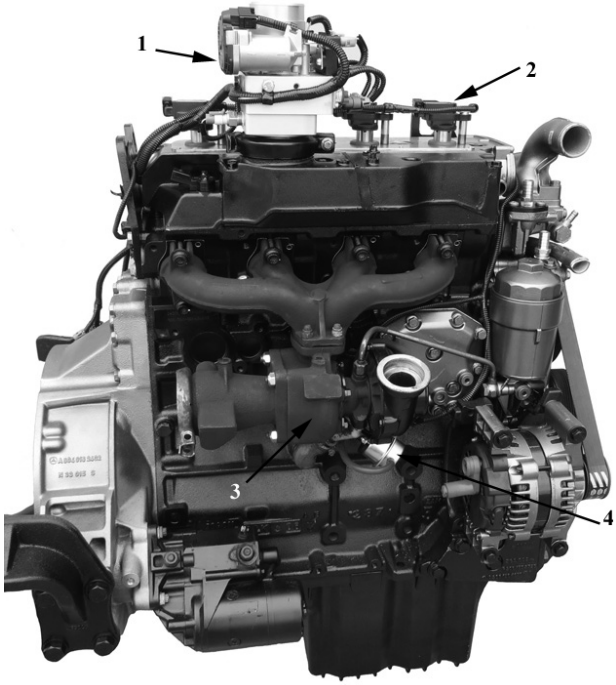
3 SCHEMATICS

3.1 DNG Component Locations

#1. 1 x Air/Fuel Module -
Throttle Body and Injector Manifold/Mixing Ring, incl:
1 x Electronic Throttle
3 x Natural Gas (NG) Injectors
1 x NG Pressure/Temperature Sensor
1 x MAP Sensor
1 x Boost Sensor
1 x Intake Air Temperature Sensor
1 x Intake Manifold Adapter
1 x Injector Manifold
2 x MAP / Boost Sensor Braket

#2. 4 x Ignition Coil

#3. 4 x Injector Blockoff



#1. 1 x Air/Fuel Module

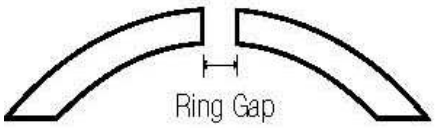
#2 4 x Ignition Coil

#3 1 x Turbocharger

#4. 1 x Wastegate Actuator

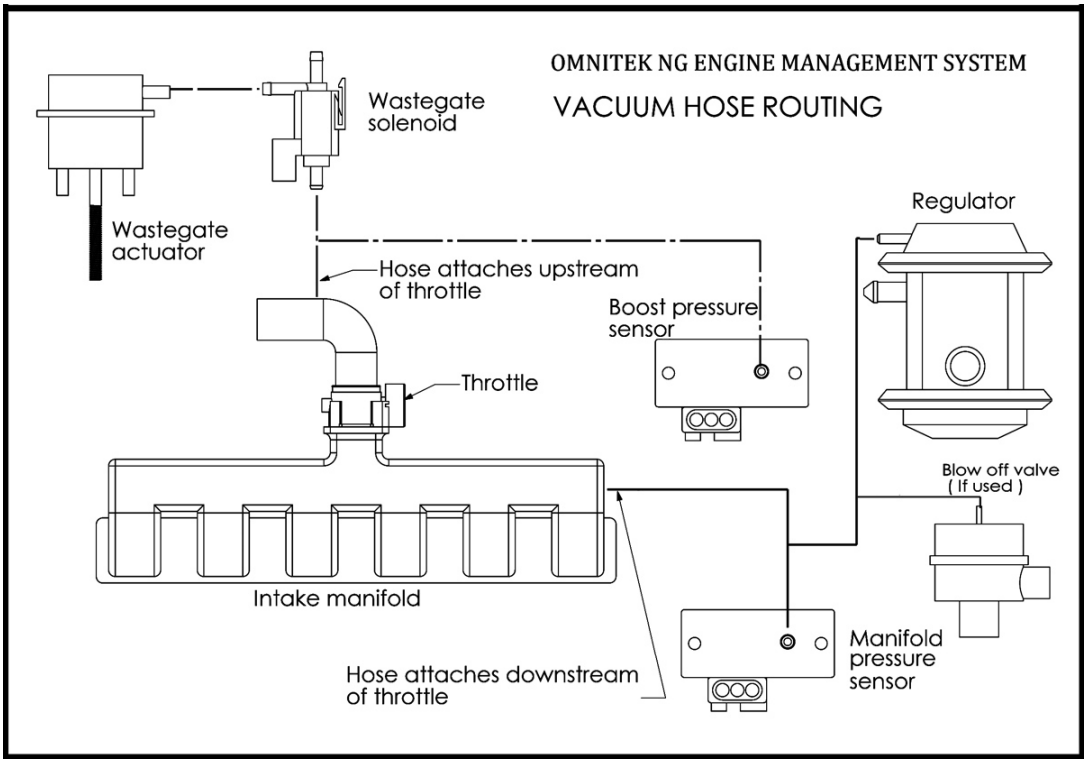
3.2 Ring Gap Clearances

End gaps for rails on 3 piece oil rings	
Cylinder Diameter	Ring Gap Tolerance
Bores under 4”	0.010 – 0.050
Bores 4” and above	0.015 – 0.055

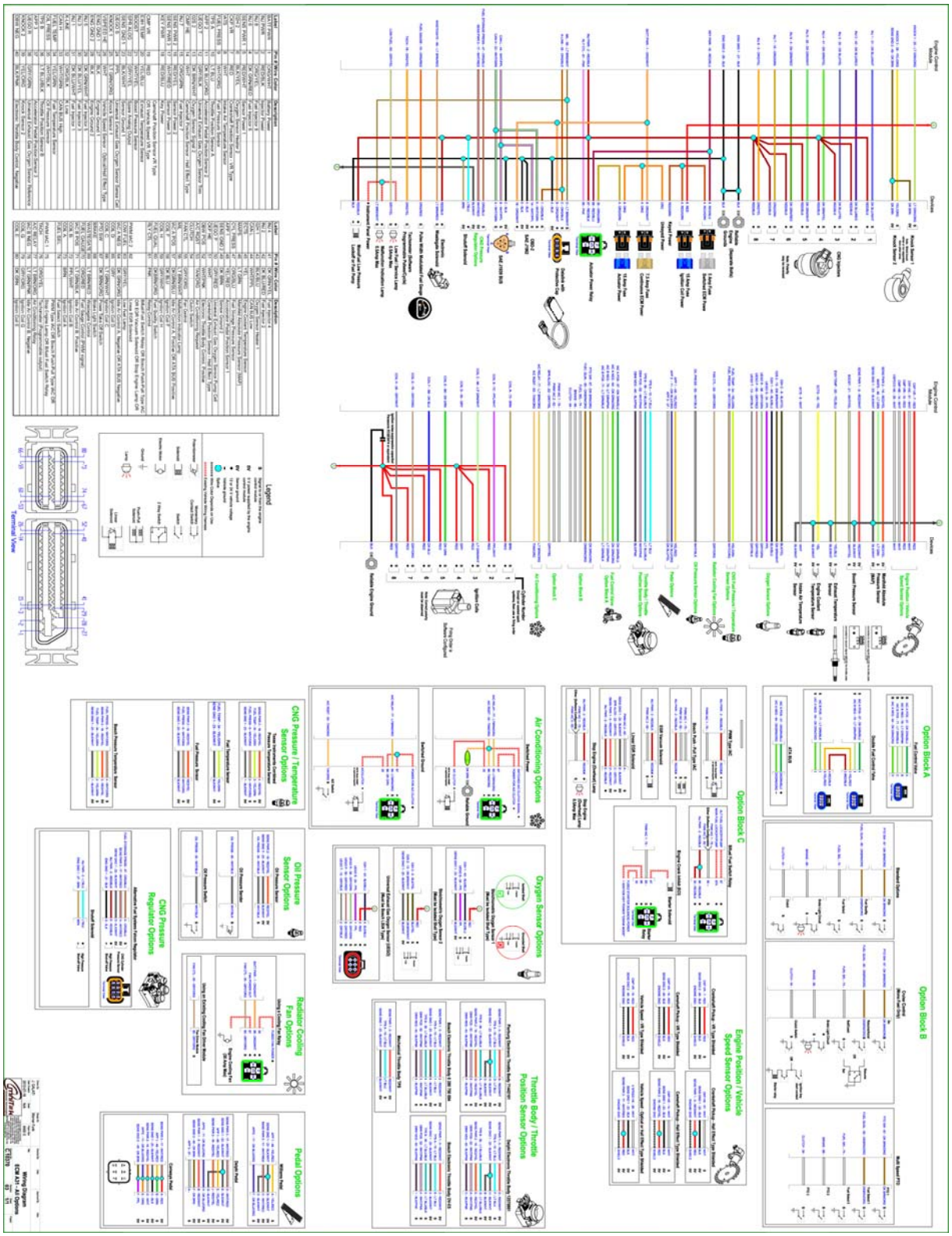


End gaps for compression rings	
Ring Diameter	Ring Gap Tolerance
3 – 4”	0.012 – 0.022
4 – 6”	0.016 – 0.026
6 – 7”	0.020 – 0.032

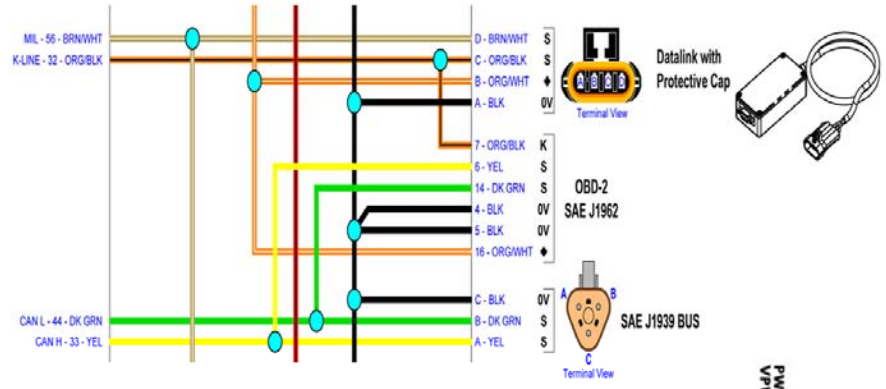
3.3 Vacuum Hose Routing

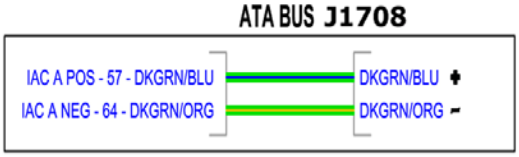


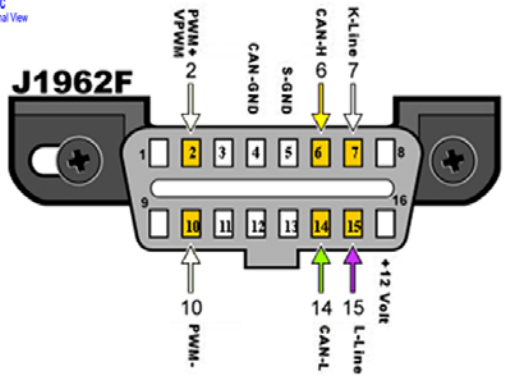
3.4 Wiring Schematic



3.5 J1939 Connectors Diagram

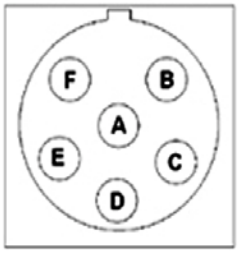




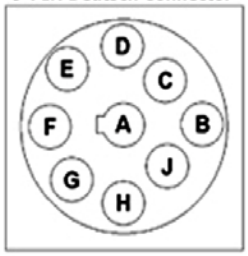


SAE J1708 / J1939

6-PIN Deutsch Connector



9-PIN Deutsch Connector



Vehicle Diagnostic Connector Pin Description

6-Pin Connector		9-Pin Connector	
A	J1708 (+)	A	Power (+)
B	J1708 (-)	B	Power (-)
C	Power (+)	C	CAN J1939 H YEL
D	NA	D	CAN J1939 L GRN
E	Power (-)	E	CAN J1939 Shield
D	NA	F	J1708 (+)
		G	J1708 (-)
		H	CAN J1939 HI (+) Chassis New Flyer Only, See Note 6
		J	CAN J1939 LO (-) Chassis New Flyer Only, See Note 6

3.6 Removing and Installing Spark Plugs

Spark Plugs

Remove

⚠ WARNING ⚠

To reduce the possibility of personal injury, do not touch any ignition wires or components while the engine is operating, unless using suitably insulated tools.

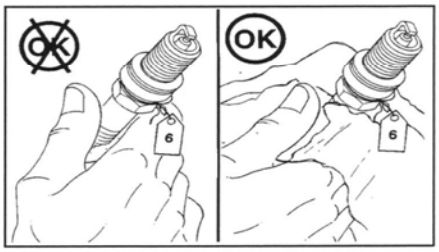
With the engine shut off, disconnect the wire assembly from the coil post end (A) first. Then remove the spark plug end (B).

NOTE: Blow out dirt before removing the plugs.

NOTE: Do **not** use a spark plug socket with rubber inserts.

Loosen the spark plugs using a 5/8-inch magnetic spark plug socket with extension and ratchet.
Turn the plugs **counterclockwise** to loosen.
Do **not** completely remove the spark plug from the threads.

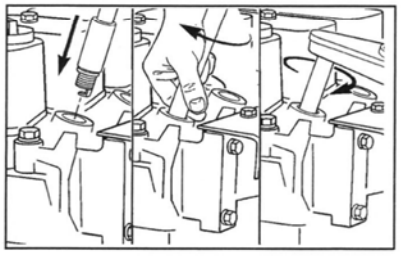
Lift the spark plug out of the adapter with the 3/8-inch-inside-diameter hose, or magnetic spark plug socket, being careful **not** to drop the plug. Mark or tag the spark plugs with the cylinder number from which they are removed.



Clean

△ CAUTION △

Spark plug life is largely dependent on cleanliness of the plug's porcelain. Dirt, oil, and fingerprints reduce the seal strength between the spark plug boot and the porcelain. Do not touch the porcelain area on the spark plug. Use rubbing alcohol and a lint-free cloth to clean the porcelain area on the spark plug before installing.



Install

△ CAUTION △

Mechanical overtightening can damage the spark plug and cylinder head.

Spark plug life is largely dependent on cleanliness of the plug's porcelain. Dirt, oil, and fingerprints reduce the seal strength between the spark plug boot and the porcelain. Do not touch the porcelain area on the spark plug. Use rubbing alcohol and a lint-free cloth to clean the porcelain area on the spark plug before installing.

NOTE: If using the same socket that was used for removal, clean using rubbing alcohol before installing plugs.

Install new spark plugs in the cylinder head. Use an extension and magnetic spark plug socket or a clean 3/8-inch-inside-diameter rubber hose and thread in by hand to make sure that the threads are smooth and the plug is **not** cross-threaded.
Turn the plug **clockwise** to tighten. Use a torque wrench to complete the installation.

Torque Value: 32 N•m [23 ft-lb]

Replace the spark plug wires one at a time to prevent crossing the wires across cylinders.

Clean the boot/coil wire with rubbing alcohol inside and out.

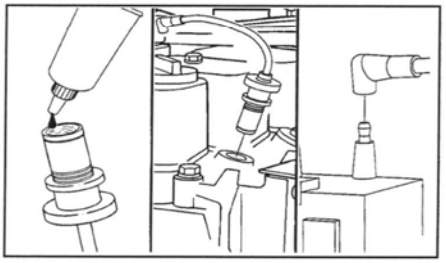
△ CAUTION △

Avoid contact with the boot to prevent contamination of the grease.

NOTE: Do **not** overapply the grease.

Apply a pea-sized amount of dielectric grease (Dow Corning Number 4, Dow Corning Number 11, or GE/Novagard silicon dielectric compound Number G624) to the inside of the boot and spread it around the inner diameter to ease assembly on the plug. Apply a thin coating of grease to the outside of the boot to aid in installation on and removal from the engine.

Carefully place the spark plug boot onto the top of the spark plug terminal. Firmly press each plug boot down until a snap is felt. This snap is the terminal clip being completely pushed over the plug terminal.



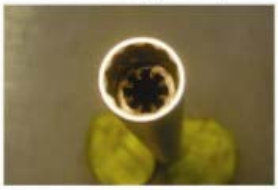
3.7 Spark Plug Failure Modes

High Transversal Forces

Damage caused by socket

During installation and removal, if the socket is not fully seated on the plug or is applied at an angle, the side force can cause cracks in the ceramic between the housing and insulator.

Socket with supports (not recommeded)



Use a torque wrench with a wide bore. Wrenches with supports, as seen to the right, are more likely to damage the ceramic.

Deposits

Normal operating conditions

Plugs are covered with normal oil ash. Engine is operating as desired.

High Electrode Wear

Engine is operating as desired, but plugs have reached the end of their life. Replace plugs.

Excessive Engine Oil

Plugs are coated with oil indicating high oil consumption. This could lead to a spark plug failure such as cracked insulator or oil fouling resulting in difficulty starting.

Iron Deposits

The red coating is iron. The conductive iron leads to misfires as the spark travels from the center electrode to the housing instead of jumping between the electrodes (note white lines on the ceramic). The engine is not operating as desired. Valves may not be seating correctly.

Mishandling or Impact

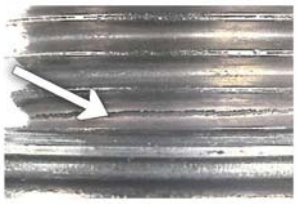
Plug was damaged during installation or impacted during use. Use caution when installing new plugs. Do not drop plugs into cylinder head during installation.

Excessive heat

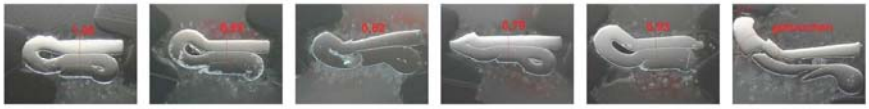
A melted ground electrode indicates pre-ignition. Ensure proper heat range of the plug is used and check ignition timing.

Over torquing:

Cracks in the threads



Seal ring deformation



25Nm 55Nm 58Nm 60Nm 65Nm 85Nm

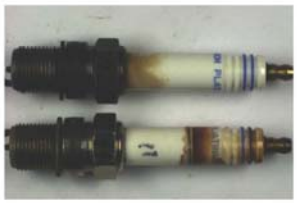
Based on the shape of the seal ring, it is possible to determine the installation torque of a spark plug.

M14 plugs should be torqued to 28 Nm (21 Lb-ft)

Over torquing is the most common cause of problems with industrial spark plugs. Over torquing can cause the seal between the ceramic and housing to break and cause cracks in the housing allowing combustion gases to escape. If the ceramic is not loose, the discoloration on the ceramic is called corona discharge and is normal when high voltages are present.

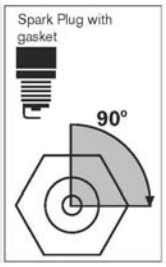
If using anti seize lubricant, 1000°C **"metal free"** lubricant must be used. Hot metal lubricants can cause spark plugs to seize in the cylinder head.

Corona Discharge



Omnitek recommends when installing spark plugs to use a torque wrench and the correct torque in ft.-lbs. As a general guideline, if a torque wrench is not available, hand tighten the plug until it is seated in the cylinder head. Spark plugs with gaskets should be tightened an additional 90°.

***Note: Avoid overtightening or undertightening as spark plug or engine damage may result. Always follow the manufacturer recommended torque specifications.**



3.8 Oxygen Sensor Failure Modes

For the end user and repair shops performing a vehicle tune-up, remove the oxygen sensor and check for these symptoms:

Lead Poisoning

Ethylene Glycol (Antifreeze) Contamination

Rich Fuel Mixture

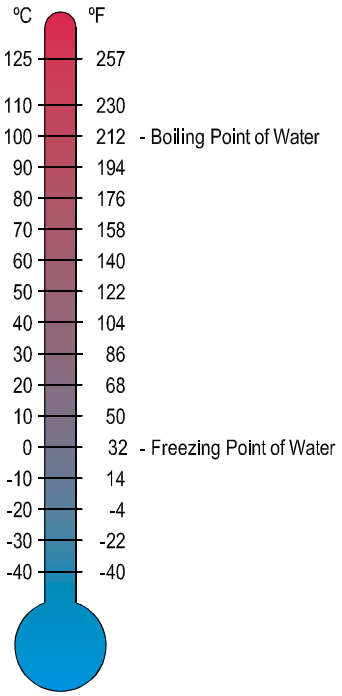
Silicone Poisoning

REPLACE FOR BETTER PERFORMANCE AND A CLEANER ENVIRONMENT

4 REFERENCES

Unit Conversions

To Convert From	Into	Multiply by
Celsius (ºC)	Fahrenheit (ºF)	(ºC x 1.8) + 32
meter (m)	foot	3.28
meter (m)	inch	39.37
Pascal (Pa)	Bar	1×10^{-5}
Pascal (Pa)	pounds / sq. inch (PSI)	1.45×10^{-4}
Pascal (Pa)	atmosphere	9.87×10^{-6}
Pascal (Pa)	kiloPascal (kPa)	0.001
kiloPascal (kPa)	Bar	0.01
kiloPascal (kPa)	pounds / sq. inch (PSI)	0.145
kiloPascal (kPa)	atmosphere	9.87×10^{-3}
kiloPascal (kPa)	Pascal (Pa)	1000



Metric Prefixes

Giga (G)	Mega (M)	kilo (k)	deca (de)	**Base Unit**	deci (d)	centi (c)	milli (m)	micro (µ)
1 000 000 000	1 000 000	1000	10	**1**	0.1	0.01	0.001	0.000001
10^9	10^6	10^3	10^2	**10^1**	10^{-1}	10^{-2}	10^{-3}	10^{-6}

Example: 3.2 m (meter) = 3200 mm (millimeter) = 0.0032 km (kilometer).

Torque Specification

SAE O-Ring Boss (ORB) Steel Fittings

Dash Size	Minimum	Maximum
-4	20 Nm	22 Nm
-5	24 Nm	27 Nm
-6	33 Nm	35 Nm
-8	68 Nm	78 Nm
-10	98 Nm	110 Nm

37º and 45º Flared Steel Fittings

Dash Size	Minimum	Maximum
-4	13 Nm	15 Nm
-5	18 Nm	20 Nm
-6	23 Nm	26 Nm
-8	47 Nm	52 Nm
-10	69 Nm	72 Nm

Automotive Acronyms

Acronym	Meaning
ECM	Engine control module
HO2S	Heated Oxygen sensor
ECTS	Engine coolant temperature sensor
IATS	Intake air temperature sensor
IAC	Idle air controller
MIL	Malfunction indicator lamp
LPSO	Low-pressure shut-off *(valve)*
FPS	Fuel storage pressure sensor
FTS	Fuel temperature sensor
DTC	Diagnostic trouble code
CMP	Camshaft speed sensor
CKP	Crankshaft speed sensor
MAP	Manifold absolute pressure
NPT	National piper taper *(thread)*
ORB	O-ring boss (SAE J475)
DIC	Distributorless ignition controller
TPS	Throttle position sensor
MAF	Mass airflow *(sensor)*

JIOLAT AUTO GAS INDUSTRIES
Head Office : HR-18A, Gali No. 10, Industrial Area (Near Police Station), Anand Parbat, Delhi-110005
Works : Seed Farm Road, Plot of Ram, Chander, V.P.O., Alipur, New Delhi-110036
Mob. : +91-9811286222, 9350834469, Ph. No. + 91-11-28764977, 28764979
Website : jiolatautogas.com, E-mail : jiolat.newdelhi@gmail.com

5 ENGINE CHECK LIST

To be performed after engine conversion

Date: _____ **Engine Conversion Number: _____**

Visual Inspection: **Oil Leaks : Yes No**

Engine run-in/tested at factory: Yes No **How long: _____ minutes / miles**

Ignition timing set to exact specification: Yes No **Idle: _____ Degrees BTDC**

Cylinder head bolts re-torque after run-in/test: Yes No **Torque: _____ Nm**

Valve adjust after run-in/test: Yes No Engine Hot Cold

Intake: _____ mm Exhaust: _____ mm

Compression Test within specifications: Yes No (cylinders within 5 - 7 % of each other)

Cyl. #1 _____ Cyl. #2 _____ Cyl. #3 _____ Cyl. #4 _____ Cyl. #5 _____ Cyl. #6 _____

Cyl. #7 _____ Cyl. #8 _____ Cyl. #9 _____ Cyl. #10 _____ Cyl. #11 _____ Cyl. #12 _____

Vacuum Signal at Idle: _____ psi **Charging System Voltage: _____ Volts**

ENGINE PASSED: Yes No

Remarks: _____

_____

Inspected by: Name _____