

Diego G3

KME Sp. z o. o. - ul. Św. Teresy od Dzieciątka Jezus 103a, 91-22 Łódź, tel +48 (42) 611 00 26, fax +48 (42) 611 82 52



page - 2 of 25 -

1. Notice

Before beginning of installing the DiegoG3 gas system in a car, it is crucial to read this manual and know all the regulations concerning mounting gas systems in cars.

Staff that installs gas system has to be well qualified and properly trained and equipped.

Not obeying resolutions of this instruction may cause damages of possessions and bodily harms and even life threat.

2. Level of staff qualifications

Only trained by KME company are authorized for installing Diego G3 system. People fulfilling KME requirements get personal certificates. The KME company has a database of authorized for installing gas system. In case of observed glaring mistakes done by certified installer the KME company may revoke the certificate.

3. Description of sequential gas injection system

3.1. Working characteristics.

Diego G3 is LPG/CNG vapored gas injection system. The system consists of high pressure tank, in which the fuel under high pressure is kept. The tank is being filled with tanking valve to which petrol station's tanking pipe is being connected to. The tank is equipped with the system limiting the level of liquid gas to avoid the possibility of pressure enlargement due to temperature rises. The tank is secured from enlargement of fuel pressure thanks to overpressure safety valve that lets the gas go out of the tank if pressure overreaches some level.

The tank is connected to the system dosing gas to the engine by pressure pipe, to which the fuel gets after opening of the gas valve installed by the tank. The fuel floats to the reducer, in which it is being vapored and its pressure is being lowered to the working level of injectors. Vapored gas is floats to the injectors and when injectors are opened – to the inlet manifold of the engine.

Controlling of the gas system is done by the electronic gas controller, which duty is to read signals of petrol injectors and after analysis – using that information to control gas injectors. The operating principle of the system is based on the work of petrol injection – each channel



page - 3 of 25 -

separately. In each moment of work the strategy of fuel injection is being used. The gas injectors are controlled with the signals steering the petrol injectors, which are the results of the reaction of the petrol controller on the current energy need of the engine. This ensured prompt reaction to the changing external conditions.

3.2. Application

The aim of the sequential gas injection system is to supply the engine with alternative fuel - LPG/CNG gas. Thanks to the high-tech construction of the system, the car do not loose usable properties, and gets possibility of being supplied with cheap LPG/CNG gas as fuel.

The gas installation is adjusted to be installed in cars with advanced self-diagnosis systems(OBD II \ EOBD) – with catalytic converter and Lambda sensors – meeting fumes emission standards EURO2-EURO 4.

The system can be adapted to fit all engines with multi-point fuel injection, as well as sequential, semi-sequential or fullgoup and engines with turbo compressors (superchargers).

The use of a very fast micro controller, acting as a signal processor and a "smart" controller of the output unit of the gas injectors, enables precise and instantaneous control of the gas-air mixture at the same moment (time point) at which the petrol ECU would inject fuel for the current cylinder.

The very precise and time-synchronized gas injection means that no difference is felt between running on gas and petrol. There is no significant loss of power or difference in the vehicle's dynamics, and the vehicle offers the same acceleration when running on gas as on petrol.

The vehicle with the Diego system will continue to meet fuel emission standards and will meet OBD II/EOBD requirements without additional emulators.

The vaporized gas is supplied immediately in front of the valves – as in petrol system – which eliminates the possibility of explosions (caused by accumulation of gas in the large volume of the intake manifold).

All engine management and diagnostic functions remain unchanged.

The Diego system has an innovative algorithm, introduced by KME, of calibration of the vehicle during a road test. In all range of loads, the gas control unit collects points reflecting the



page - 4 of 25 -

operation of the engine on petrol and gas, creating maps of the operations of the vehicle. Comparison of those maps makes possible a precise configuration of the vehicle on gas, by establishing a map for gas identical to that for petrol.

Installation is easy due to the small size of the enclosure and the convenient position of the attachment grip. The system is very simple for installers to calibrate, and is unnoticeable to the user thanks to the automatic switching mode. If the gas tank is almost empty the system switches automatically to petrol supply, and this is indicated by a sound signal (buzzer). The gas control unit has a built-in mechanism of self-diagnosis that makes any diagnostics easier.

The gas control unit contains an internal petrol injector emulator and can be used with a variety of gas injectors. The Diego system is available in 4-, 6- and 8- channel version for 3, 4, 5, 6, 8 cylinder engines. It is also possible to install the system in a car with 10, 12 and 16 cylinders with using the MASTER/SLAVE type of work.

The Diego system is ready for American and Japanese vehicles and for HEMI engines.

For American cars like: DOOGE, CHRYSLER, for cars produced in Europe for American market (FORD, VOLVO) or for some others cars like: MITSUBISHI, it is required special version of gas control unit (with marking USA).

Notice!

Diego system does not work with engines, where injectors are controlled by dutycycle (e. g. RENIX type) – where petrol injectors resistance is less than 3 ohms.



page - 5 of 25 -

3.3. Performance in normal working conditions

Supplying of the gas fuel may cause reduction of the maximal power by a few percent. This may be depending on the engine construction and the regulation of the gas system and using additional equipment.

Usage of the gas in liters in most cases does not increase more than 25% of the petrol usage in the same working conditions. This value depends on the characteristics of the gas fuel.

Mounting the gas installation causes rising of the ca's mass by 40 to 60 kg, depending on the mounted tank.

3.4. Extreme extern conditions

The car must not be heated, for example in heating chamber after painting, because it may cause overheating of the fuel tank, opening of the safety valve and leakage of the gas. Prior to that kind of operation, the tank has to be unmounted from the car.



page - 6 of 25 -

4. Description of the elements and their installation

Elements of the system are:

- fuel tank with the multivalve,
- tanking inlet,
- valves,
- elastic and copper gas pipes connecting elements,
- gas electronic control unit (ECU),
- reducer,
- gas injectors,
- vacuum and pressure sensors,
- gas and reducer temperature sensors,
- liquid and vapored phase gas filters,
- control panel
- tank level sensor,
- harnesses, connection wires,
- copper pipes,
- water and gas hoses.

All the elements of the gas system has to meet R67-01 regulation.

Diagram of mechanical part of installation is shown on the figure below.



Cas temperature sensor / Cas temperatury gau Cas temperatury gau Cas time / Filtr gau Estiva wtyskwaczy gazowych Filtr gau

4.1. Gas tanks

Cylindrical and toroidal tanks are used.

4.1.1. Cylindrical tanks.

Cylindrical tanks are mounted to the metal plate of the car's sheathing with the assembly frames with the steel bands.

The place of fixing the tank has to be chosen taking under consideration the possibility of fixing the tank. If the tank is fixed behind the seat, 10 cm space has to be left between the tank and the back of the seat. It has to be checked if there are any elements on the other side of the sheathing that may make fixing of the tank impossible. Drilled holes has to be prevented from corrosion. Assembly frame of the tank has to be fixed with the endurance screws.

4.1.2. Toroidal tanks

Toroidal tanks are fixed typically in the spare wheel recess. One should plan the holes to be cut in the recess. One should check the possibility of proper laying of the gas pipes and fixing the cover of the multivalve. If proper installation of those elements is not possible, one should change the type of the tank or place of fixing. If it is possible, cut holes, prevent steel from corrosion, fix the

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page - 8 of 25 -

tank and fit in the gas-proof cover.



4.2. Installation of the multi valve

Check the operation of the valve and its gasket. Fit the valve to the inlet of the tank and screw in the screws.



4.3. Installation of the copper gas pipes

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page - 9 of 25 -



Pipes are installed to the elements of the car body with the metal or plastic holders.

In case of using the screws one should be sure not to cause damage on the other side of the car body.

Copper pipes in a plastic lag installed outside the car body do not need any other covers.

If the plastic pipes are used instead of copper ones it has to be remembered to prevent them additionally and install them only on short distances (no more than 50cm). Joining the pipes with the other elements of the gas installation is done by joins with copper barrel. Joining pipes in places that cannot be controlled is not permissible.

4.4. Gas inlet

The gas inlet is installed in the bumper's sheathing, in the petrol inlet on on the support.







4.5. Gas system electronic control unit

Used case and electronic elements working within wide range of temperature ensures proper work of the controller and high immunity from interferences. Shapes of the connectors makes it impossible to connect them not properly. The controller should be fixed to the elements of the car body or other elements.



Typical places of fixing the gas ECU are:

- frontal partition,
- wheel housing,
- battery cover
- bracket installed in the engine chamber.

The place of installation should be chosen in such a way that ensure the cover of the controller from water, high temperature, petrol, oils and other chemicals. It should also ensure easy access to the connectors of the controller.

The gas control unit is available in 4-, 6- and 8- channel version:

- 4 cylinders version, for engines with 3,4 cylinders
- 6 cylinders version, for engines with 3,4,5,6 cylinders
- 8 cylinders version, for engines with 3,4,5,6,8 cylinders

The gas control unit designation is printed on the connectors. Each controller has series

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number printed on its connectors that unambiguously identifies it. Examples of the series numbers are shown on the figures below.



4.6. Control panel and gas level sensor

The panel enables to switch from petrol to gas supply. After pushing the button there is a sound from a buzzer. Diodes on a panel show the gas level in the tank (with the co-operation with gas level sensor on multivalve).





During the ride on petrol there is no light on control panel. Gas valves are closed and gas injectors do not work. In this case gas control unit is in stand-by and it does not affect original petrol supply system.

After the button is pushed on the control panel, the status diode is flashing (blinking). It informs that the system is ready to change to gas supply and is waiting for the switching parameters. When switching parameters are fulfilled, the gas control unit switches to gas. The status diode is lighting constantly and control panel starts to show gas level as shown below.



Four lighting green diodes mean that the tank is full. Two lighting green diodes mean the tank is half full. Red diode means the tank reserve. Those indications are approximate.

The readings of gas level are possible when gas level sensor is installed on multivalve. The gas control unit is operating with the following type of sensors:

- 9-level (PW1-KME, PW2-KME, AEB1050, EMER1D, AEB806 (for CNG) or compatible)

- 0-90 ohm (AEB820, BRC or compatible)
- reserve sensor

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page - 13 of 25 -



One should install the control panel inside the passenger compartment (in handy place, near driver). It is not recommended to install the control panel near the lights, to reduce possibility of accidental switching the lights off.



4.7. Reducer

The reducer guarantee gas evaporation from liquid phase to gaseous phase by using heat from cooling system. It measures pressure in intake manifold and it keeps constant gas pressure independently of engine load.



page - 14 of 25 -

The output pressure value can be regulated in wide range (0.6...1.8bar) by regulation screw on the cover of the reducer. The recommended working pressure is 1 bar.



The reducer is available in the following versions:

- SILVER up to 150kW (204HP)
- GOLD up to 260kW (355HP)

Gas control unit monitors the reducer temperature. If the temperature is below the switching threshold (set in the PC software), the engine is supplied by petrol. When the threshold is reached, the gas control unit switches the system to gas supply. This procedure ensures that the gas flows through the reducer only when it can be vaporized completely.

Reducer can be installed in parallel or perpendicular to vehicle axis. Plan the place of installing the reducer to make it easy to connect it to the coolant system and to gas injectors. Because of large weight reducer must be installed solidly to vehicle-car body.

One should install the reducer water hearing system parallel with the cooling system. It is not recommended to install reducer water inlets serial to cooling system. This way of connection may reduce the flow of the engine coolant and may cause overheating of the engine.



page - 15 of 25 -



The reducer cannot be installed with the coil of gas valve downwards. This may result in the valve seizure (stop) due to dirty gas.



Typical places of installing the reducer are:

- wheel housing,
- frontal partition,
- firm elements of the car body.

The recommended hose diameters:

- gas inlet in liquid phase the copper pipe ϕ 6 mm or ϕ 8 mm
- gas outlet in vaporize phase $-\phi 14$ mm or $\phi 12$ mm.
- vacuum inlet from intake manifold ϕ 5 mm

To regulate the pressure Allen key size 4 is needed.

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page - 16 of 25 -

4.8. Gas injectors



The gas control unit can operate with several kind of gas injectors. Gas injectors has to be fixed to the engine in such a way to avoid using long gas pipes

Injectors has to be installed with the metal handles. If it is possible to use stable engine parts, it is permissible to fix the injector directly. It has to be remembered, that injectors has a considerable weight and the engine vibrates during work, so it is not permissible to fix the injector to the petrol pipes or other elements, that are not strong enough to carry that weight.

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page - 17 of 25 -



In case of the 6 cylinders engines and 4-sections gas injectors rail only the first 3 sections of each injectors rail are used.(as on figure)

4.8.1. Selection of the nozzles

The preliminary nozzles' size is selected according to the following table:

From	То	Sequential	Semi-sequential	Fullgroup		
HP/cyl.	HP/cyl.	[mm]	[mm]	[mm]		
8,75	10	1,7	1,6	1,4		
10,25	11,75	1,8	1,7	1,5		
12	13,5	1,9	1,8	1,6		
13,75	15,25	2,0	1,9	1,7		
16,5	17	2,1	2,0	1,8		
17,25	18,75	2,2	2,1	1,9		
19	20,5	2,3	2,2	2,0		

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	gas injection system Diego G3
KME	page - 18 of 25 -

20,75	22,25	2,4	2,3	2,1
22,5	23,75	2,5	2,4	2,2
24	25,5	2,6	2,5	2,3
25,75	27,25	2,7	2,6	2,4
27,5	29	2,8	2,7	2,5
29,25	30,75	2,9	2,8	2,6
31	32,5	3,0	2,9	2,7
32,75	34,25	3,1	3,0	2,8
34,5	36	3,2	3,1	2,9
36,25	37,75	3,3	3,2	3,0

Given values are approximate for the pressure of 1bar. In some cases may need to be corrected. The diagnostic PC program has a mechanism of suggesting nozzles sizes.

4.9. Pressure sensor

Pressure sensor measures the gas pressure in the injector's slat and vacuum inside the intake manifold. According to that measurements, the corrections are being calculated.



PS-CC1



PS-CC2

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page - 19 of 25 -



Pressure sensor has to be installed in a distance from the hot parts of the engine, and connected according to the diagram.

Thanks to the use of the plugs, the installation is easier and mistakes are excluded.

4.10. Temperature sensor

To proper work of the system, the temperature sensor of gas and reducer is needed. Depending on the position where it is installed there are several types of temperature sensor.







For reducer

For MATRIX injectors

Other

4.11. Gas filters

To ensure good performance of the gas system it is always necessary to use both liquid phase filter and vaporized phase filter.

Liquid phase filter is installed in the reducer. Vaporized gas filter is installed in the gas pipe between reducer and injectors. Install the vaporized filter with the bands.



page - 20 of 25 -



NOTICE: Filters have a strictly define gas flow direction.

4.12. Gas inlets in the intake manifold



The holes for gas inlets to the intake manifold should be drilled as close as it is possible to cylinder head. It is important to keep the same hoses length to each cylinder. The holes should cross axis of each intake pipe. Gas inlets should be directed to the cylinder.

Intake manifold should be removed prior to drilling not to allow any filings to get inside the intake. Not obeying this rule may cause engine damage.

Holes for gas inlets should be made by drill with diameter 5mm, after that holes should be tapped to M6. Gas inlets should be protected against accidental unscrewing. Inner inlet diameter should

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page - 21 of 25 -

be at least 3.5 mm.

4.13. Harnesses

The gas control unit can operate with engines which have max 8 cylinders/channels. In the kit there are 5 main types of connection wires. Common color coding has been applied to certain function blocks in order to avoid the incorrect connections.

Before starting the installation of the harnesses one should disconnect minus clamp of the battery.

After installing the gas installation, one should check if all the soldered parts are properly isolated and all the elements are solidly fixed and not in range of moving parts of the vehicle.

4.13.2. Installation of the harnesses

Recommendations:

- All the connections with the electrical installation of the vehicle has to be solid. (soldered) and well isolated. Wires should be leaded not to be exposed to mechanical damages done by moving parts.
- In need of connecting to shielded signals, it is not permissible to cut the shields.
- "+12V key" signal should not disappear during the engine start and should disappear immediately after turning the engine off.

4.13.3. Verification of the connecting sequence of the cylinders.

After installation of the gas system it is necessary to check the order of injectors' connection. For each cylinder the circuit must be closed. For each channel of gas control unit signal from each petrol injector (corresponding cylinder) must be linked to corresponding channel of gas control unit which control gas injector.





If the injectors are connected incorrectly, the system can not work properly or problems may occur with the calibration of the system.

cyl.	4-cyl.	6-cyl.	8-cyl.	Emulator wire	Emulator wire	Gas injector wire
no.				(petrol ECU side)	(petrol injector side)	
1	Х	X	Х	Gray-black	Gray	Gray-white
2	Х	X	Х	Yellow-black	Yellow	Yellow-white
3	Х	X	Х	Violet-black	Violet	Violet-white
4	Х	Х	Х	Blue-black	Blue	Blue-white

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5	Х	Х	Green-Black	Green	Green-white
6	Х	Х	Red-Black	Red	Red-White
7		Х	Brown-Black	Brown	Brown-White
8		Х	Pink-Black	Pink	Pink-White

5. Verification of the installation

To verify the correctness of installation the system, one should:

- verify the selection of the elements with list in this manual.
- verify the conformity of the installation with this manual.
- fill the tank with gas fuel and check the leak-tightness of all elements.
- verify the connecting sequence of the cylinders.
- check the correctness of the system work with PC software.

6. Starting the gas injection system

Before starting the system, one should input to the gas ECU proper regulation parameters. It is done with the special PC software.

In case of incorrect work of a car on gas supply there is a possibility of making a corrections in order to adjust the system to the individual characteristics of the car, resulting from e. g. the level of wear of its elements.

The change of any element of the car (reducer, nozzles, filters, injectors etc.) or parameters (gas pressure, pipe's length) requires repetition of the process of calibrating the system.

8. Most common errors and recommendations

8.1. Installation

 In FORD cars electromagnetic interferences due to inefficient ignition system are common. In this case connecting the case of the ECU to the minus of the battery may help. Changing the damaged elements of the ignition system will help in most cases.

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- While during changing from petrol supply to gas supply the engine stops, the emulator wires has to be checked. Mistakes in connection by petrol injectors may be a cause (switched wires color and black-color).
- Laying wires in the vicinity of the injection system, coils etc is not recommended.
- All signals should be get from as near to the petrol ECU as it is possible.
- Bent pipes from the injectors to the inlet manifold may be a cause of loss of power and a jerky engine work.

Most certainly the ignition coils, spark plugs, high voltage pressure should be checked. Their incorrect state may cause disturbances during gas supply.

Improper work of the system, that appeared after some time of proper work (e. g. month, 6 months) in most cases are caused by wear of the ignition system elements.

8.2. Collecting map of engine working points

The regulation of the controller according to the gathered map is a basis of the proper work of the gas injection system.

Not regulating the controller during the road test may cause:

- In a new cars with diagnostics and OBD turning on the CHECK ENGINE,
- Bigger fuel consumption above 20% more than on petrol,
- Jerky switching supply from petrol to gas and from gas to petrol,
- Cylinder misfires, turning channels off,
- Loss of power, jerking above some level of rounds per minute

The change of any element of the car (reducer, nozzles, filters, injectors etc.) or parameters (gas pressure, pipe's length) requires repetition of the process of calibrating the system.

8.3. Jerking of the engine – injection time disappearance.

In cars, that has petrol injection times of 20ms and above (for high RPM) the injectors may stay full open, which may cause jerking and injection time disappearance. With parameters available in the PC software (configuration wizard \rightarrow switching) by using option "Switch to petrol with automatic return to gas when injectors full open" this problem may be solved.



page - 25 of 25 -

9. Technical service and maintenance

Tochnical convico	After km:							
		10000	20000	30000	40000	50000	60000	
Checking the gas-tightness	Х	Х	Х	Х	Х	Х	Х	
Calibration		Х	Х	Х	Х	Х	Х	
Reducer working pressure regulation	Х	Х	Х	Х	Х	Х	Х	
Changing of the vaporized phase filter		Х	Х	Х	Х	Х	Х	
Changing of the liquid phase filter			Х		Х		Х	
Checking of the gas injectors		Х	Х	Х	Х	Х	Х	
Checking of the reducer		Х	Х	Х	Х	Х	Х	



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