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Installer's handbook - 1/3

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USEFUL REFERENCES

For further information on “SEQUENT” and “SEQUENT FASTNESS” systems, it is recommended to refer to the other handbooks and informative documents published by BRC.

• Installation types.

They contain the general wiring diagrams and the installation instructions related to the various types of installation that can be found. The cases listed are mainly distinguished on the basis of the number of cylinders, their location and the vehicle power. It is especially useful when the installer works without specific kits.

• Software handbook.

It is the indispensable guide for those who want to learn managing the system by means of a personal computer, realising configurations, programming ECUs, making diagnosis, modifying working parameters. It describes the operation of the “SEQUENT” and “SEQUENT FASTNESS” software, which runs on Personal Computers, by driving the user in the various steps of each function.

The modular Common Rail for gas

1. INTRODUCTION

Dear installer,

in thanking you for choosing BRC we wish to give you full information on "SEQUENT", the gaseous **LPG** or **CNG** multipoint sequential injection system. It is a highly advanced injection system, result of the experience and continuos BRC'S research in the gaseous injection field, **that can be installed on vehicles with sequential multipoint petrol injection.** Thanks to its high level of integration, SEQUENT can assure higher performances without giving up simplicity of assembly.

Thanks to the high integration of the system, SEQUENT can assure higher performances without compromising the simplicity of the installation. Indeed inside the ECU there are several functions which allow, in most cases, avoiding fastidious and cumbersome devices that, by this time, each installer is used to assemble, as Modular, electronic timing advance processor, crankshaft sensor adapter, Memory, etc.

From the functional and performance point of view SEQUENT has the same basic characteristics of all BRC injection systems as a reduce power loss, no mixer, very small reducer, no backfire risk but also adds some new important ones such as:

- Sequential Injection obtained by using an electronic injector in each cylinder;
- High precision for gas dosage thanks to very precise injectors;
- Auto-diagnosis on ECU inlet/outlet;
- Protection against short-circuits of the ECU inlet/outlet;
- Communication on K line and on CAN bus;

Differences compared to other systems are not only these ones: some conventions you were used to have been radically changed. For this reason please read carefully the installation guides even if you are a very skilful technician in gas injection systems.

To convert a vehicle, the installer will have to use a basic kit and a standard one. Then he will have to buy a two-position built-inn change-over switch, place the components inside the engine compartment as indicated in this guide and personally realise the fixing brackets.

The LPG basic kit includes:

- 1 FLY SF ECU without configuration,
- 1 harness (studied for BRC or Keihin Injectors),
- 1 roll of copper pipe ø 6 or ø 8,
- 1 Water pipe 16x23.
- 1 GENIUS or GENIUS MAX SEQUENT LPG pressure reducer with gas temperature sensor at thermistore,
- 1 "FJ1"cartridge filter for gas or "FJ1 Twin" with double cartridge
- 1 P1 - MAP or P1 - MAP Turbo pressure sensor,
- 1 LPG "ET98 Normal WP or ET98 Super WP" solenoid valve,
- 1 bag containing screws, nuts and various fittings,

The CNG basic kit contains:

- 1 FLY SF ECU without configuration,
- 1 harness (studied for BRC or Keihin Injectors),
- 1 auxiliary harness
- 1 roll of copper or steel pipe,
- 1 Water pipe 8x15
- 1 GENIUS SEQUENT CNG pressure reducer with gas temperature sensor at thermistore,
- 1 "FJ1"cartridge filter for gas,
- 1 P1 - MAP CNG pressure sensor 2,5-4 bar
- 1 "VM A3/E WP classic" CNG electro-assisted valve,
- 1 CNG pressure gauge with resistive pressure sensor
- 1 bag containing screws, nuts and various fittings.

The CNG basic kit (Sequent Fastness version) contains:

- 1 FLY SF ECU without configuration,
- 1 harness (studied for BRC Injectors),
- 1 auxiliary harness
- 1 roll of copper or steel pipe,
- 1 Water pipe 8x15.
- 1 CNG Zenith pressure reducer with water temperature sensor at thermistore,
- 1 High efficiency "FJ1 HE" cartridge filter for gas,
- 1 MAP sensor,
- 1 "VM A3/E WP classic" CNG electro-assisted valve,
- 1 CNG pressure gauge with resistive pressure sensor
- 1 bag containing screws, nuts and various fittings,

The BRC standard kit contains:

- 3 (or 4,5 or 6 depending on the n. of cylinders) BRC gas injectors with nozzles,
- 1 injectors rail for BRC injectors with findings,
- Gas pipe 10x17,
- Gas pipes 5x10.5 to be used on the injectors and pressure points
- A bag containing: manifold pressure nozzle, nylon Y piece, nuts, junctions and "click" clamps for gas pipe 5x10.5 and 10x17, "click" clamps for the pressure points, cap M8x1 for possible RAIL closure.

The Keihin standard kit contains:

- 3 (4, 5 or 6 depending on the n. of cylinders) Keihin gas injectors with nozzles
- 1 injectors rail for Keihin injectors with findings,
- Gas pipe 10x17,
- Gas pipes 5x10.5 to be used on the injectors and pressure points
- A bag containing: manifold pressure nozzle, nylon Y piece, nuts, junctions and "click" clamps for gas pipe 5x10.5 and 10x17, "click" clamps for the pressure points, cap M8x1 for

possible RAIL closure.

The BRC standard kit (Sequent Fastness version) contains:

- 3 (or 4,5 or 6 depending on the n. of cylinders) BRC gas injectors with nozzles and pressure and gas temperature sensor
- 1 injectors rail for BRC injectors with findings,
- Gas pipe 10x17,
- Gas pipes 5x10.5 to be used on the injectors and pressure points
- A bag containing: manifold pressure nozzle, nylon Y piece, nuts, junctions and “click” clamps for gas pipe 5x10.5 and 10x17, “click” clamps for the pressure points, cap M8x1 for possible RAIL closure.

The combinations of Gas Injectors/Reducers allow converting to LPG or CNG the vehicles as in the table hereunder (please refer to “Types of Installation” Guide 2/3).

		INJECTORS	
		Keihin	**BRC**
REDUCERS	**Genius LPG**	LPG	LPG
	Genius MAX LPG	LPG	LPG
	Zenith CNG		CNG
	Genius.M CNG	LPG	

Tab.1

2. WHY CHOOSING SEQUENT

SEQUENT represents the most advanced level of evolution for what concerns the equipment of gas injection, and **it can be defined to all intents and purposes as a "COMMON RAIL" system.**

In fact it first introduces, in the gas propelled field, the winning evolution used for modern Diesel engines: a "rail-line" in pressure (rail) that supplies fuel to all injectors (true injectors) that are assigned to inject it in each cylinder of the engine.

SEQUENT in addition introduces the concept of modularity of the harness. This operation consists in the possibility to install the SEQUENT equipment on the vehicle through the connection of only three electrical wires and to add further electrical connections only and exclusively in case of particularly sophisticated vehicles.

In the SEQUENT system, unlike an injection at continuos flow (stream), the ECU calculates the opening times of the injectors, cylinder per cylinder, and it acts them separately on each gas injector with the highest precision and with the best timing if compared with the opening instant of the intake valve. The sequential injection control allows consequently obtaining the top timeliness and precision of the fuel dosage.

As per all electronic injection systems, a mixer does not aspirate the gaseous fuel, but the correct quantity is determined through the calculations made by the ECU. It allows obtaining the well known advantages of the injection systems, such as:

- No disadvantages in the performances on petrol, caused by the absence of a mixer,
- Maximum performances on gas, typical of the injection systems,
- No additional overall dimensions on the intake pipes,
- Elimination of the backfire risks, due to the injection near the intake valves and increased by **the** fact that **injection is in a timed way with the opening of the intake valve.**

The result is that the original sequential injection operation of the vehicle, the engine had been studied, built and optimised for, is absolutely unchanged, with the following practical results:

- Better driving fluidity,
- Consumption optimisation,
- Reduction of polluting exhaust emissions.

Other advantages of the system, which are typical of the "in series" working type and therefore already known by the BRC installers, are the following:

- There is no need of any specific emulation for the injectors. This is usually made by the same ECU,
- It is normally not necessary to delete the error codes in the petrol ECU, because they do not appear anymore,
- it is not necessary anymore to install the "Memory" devices on those vehicles provided by OBD diagnosis,
- all the petrol ECU functions remain perfectly efficient even while running on gas, assuring the respect of the OBD regulations,
- no particular adjustment is needed, if the configuration is available.

In addition, thanks to the strong integration of the ECU:

- In several cases it is not necessary to install any outside devices of emulation and interruption of the injectors, as Modular LD are integrated in the system harness.
- **Possibility of reading the rpm from the crankshaft sensor** without need of external adapters.
- The **ECU is provided with an internal timing advanced processor,** suitable for most vehicles,
- It is possible to connect **two Lambda Sensors** without need of adapters,
- The ECU contains the main adapters for "UEGO" and "in need of power supply" sensors,
- **Possibility of converting vehicles up to 8 cylinders** in the two-connector ECU version.

3. UNDERSTANDING SEQUENT AND SEQUENT FASTNESS SYSTEMS

3.1 STRUCTURE

The evolution of SEQUENT system allows introducing new and more sophisticated components trying to obtain higher performance.

The system can be used with different configurations and different components (LPG Genius, CNG Genius. M, LPG MAX Genius, the new Zenith Reducer, BRC or Keihin rail, etc.) - Table 1 page 7.

This guide and the Types of Installation 2/3 one has the aim to teach the technician the correct and different use of Sequent and Sequent Fastness systems.

The **SEQUENT** systems, starting from the gas tank to the reducer included, utilise components, which are already well known by the BRC installers. The pressure reducer, in particular, will be the GENIUS SEQUENT. It is the same little-sized reducer of simple installation already installed on the Flying Injection, with the difference that it will be provided with brass water elbows and a new temperature sensor, which is not compatible with the Flying Injection one. The differences if compared to the previous conception equipment start with the rail, connected through the proper pipe to the GENIUS SEQUENT outlet, which connects the gas injectors, supplying them heated and vaporised gas. A pressure sensor, that measures the absolute gas pressure and supplies injectors, is connected to the rail. If it is possible to say that the ECU is the brain of the system, the injectors represent its heart. They are electro-injectors, whose working principle is quite similar to the one of the petrol injectors, but they differ from these last ones for:

- Larger passage sections, suitable for the gaseous fuel,
- Lower electric impedance, to have quick opening times,
- "Peak & hold" electric piloting, to have small piloting currents without disadvantaging performances.

At every injector outlet, the gas is directly introduced, through proper pipes, in the air-intake manifold, downstream the throttle valve.

The changeover switch with level gauge is of the two-position type, with buzzer. It allows carrying out the changeover functions from the petrol-gas and gas-petrol operations, indicating the gas quantity present in the tank and moreover displaying some diagnostic signals in case of malfunction, lack of fuel, not correct programming, etc.

Not least, there is the very powerful, extremely rugged, completely waterproof FLY SF ECU, complying with the EMC regulations, realised with electronic specific components for automotive use, which allow to install it even in the engine compartment. The ECU collects and elaborates full information and checks completely the various system functions; in particular the injectors, managing the instant when the injection happens and its duration with the precision of few microseconds (microsecond = 1/1000000 of second).

The ECU had been studied to bear short-circuits of unlimited duration on each of its inlet/outlet wires, both towards the ground and towards the battery positive. It had been subjected to stringent tests in order to verify its compliance with the regulations in the automotive field.

The SEQUENT system communicates with the outside through a computer, by means of which, with a valid and powerful interface program, it is possible to transfer any information to the ECU, program itself, calibrate the system, verify the correct operation, read and delete the possible error codes memorised and have information about the installation and about the memory contents of the ECU. The interface on the computer is therefore the instrument by means of which the installer interacts with the whole SEQUENT system and by means of which he could "shape" the gas equipment to fit it to the vehicle in the different driving conditions.

The tidy collection of all files related to the different installations made may constitute a very useful proper historic archive, both to keep under control the evolutions of equipment in the time, and to constitute a starting point for new installations.

The guide 3/3 has been entirely dedicated to the interface program on computer.

NEW

The new sequential gaseous injection **FASTNESS** version comes from Sequent experience and is **for CNG only.**

Based on the SEQUENT consolidated structure, it has new innovations coming from BRC experience and recent experimentation with the aim to make the system stronger, easy to install and able to solve even the most difficult problems.

The innovation and changes will be deeply described in the following paragraphs of the present guide:

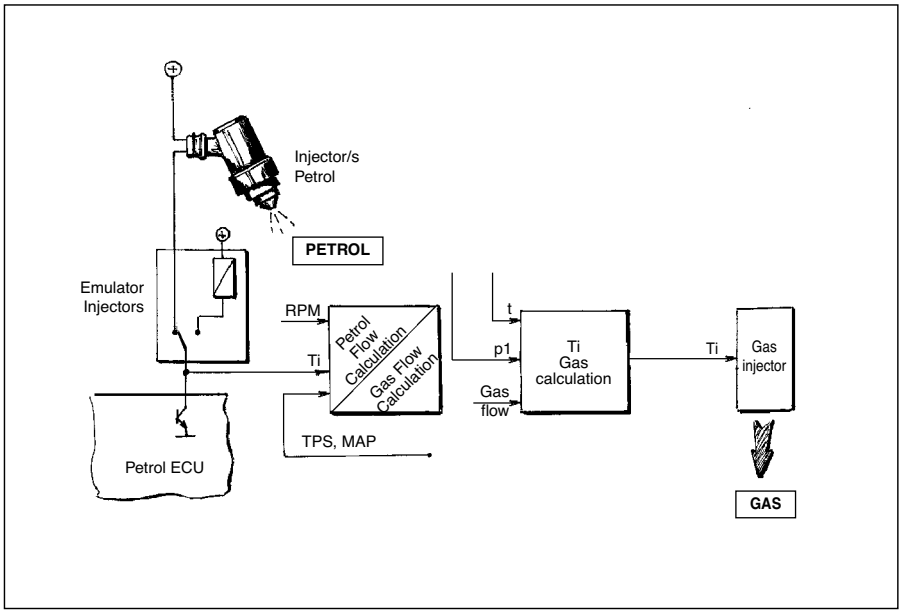
- System components (reducers, sensors, etc.)
- Software and engine control (new strategies).

Both components and software have been studied to obtain the

easiest operation.

3.2 WORKING PRINCIPLE

SEQUENT is a system that is placed “in series” with the petrol system. While running on gas, the petrol ECU still determinates the fuel quantity to supply the engine. SEQUENT is a “passive system” or “slave”, SEQUENT works as an “interpreter” between the petrol system and the gaseous fuel control. The operation of the SEQUENT system is based on the fact that the Fly SF ECU is connected to the petrol ECU terminal/s piloting injectors (picture 1).



Picture 01

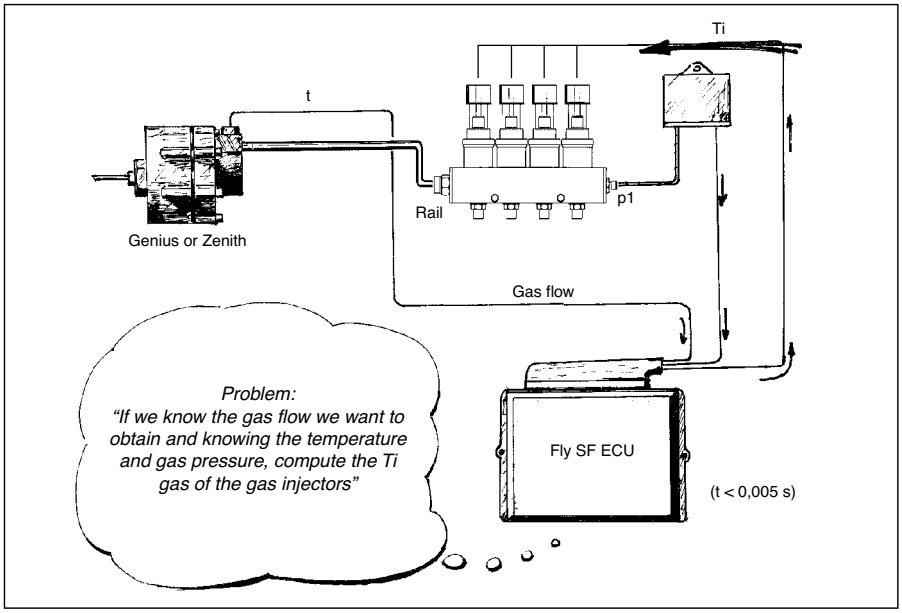


Fig. 02

It recognises this way the petrol injection time (Ti). (While running on gas, the injectors signal will be recognised due to the presence of the injectors integrated emulation inside the ECU).

Due to the Ti and the engine rpm signal, the Fly SF ECU calculates the petrol flow that the original ECU tends to supply to the engine, then converts it into gas flow and realises it piloting opportunely the gas injectors. This choice is of the utmost importance, because the fact of enabling the petrol ECU to be constantly working and piloting the gas dosage, allows carrying out clearly and transparently functions such as stoichiometric control, enrichment in full load and cut-off following the criterions expected by the manufacturer, the restriction of the peak rpm, the coherent control of petrol vapours, the correct communication with the air conditioner equipment, etc. All this without the possibility that some counterfeit error codes could appear. For what concerns the petrol equipment, everything remains unchanged, that is why any error message, while running on petrol or on gas, has to be considered real and believable. Furthermore, if the vehicle shows some problems in the petrol operations, they will be maintained in the gas operation too. It is absolutely necessary when you want to comply with the more and more stringer OBD anti-pollution regulations, even in the gas operation.

The low impedance gas injectors are controlled in the peak & hold mode (see paragraph 4.12), keeping in mind the physical gas parameters (temperature and absolute pressure) read by the Fly SF ECU in real time (picture 2).

It is important to underline how the Ti is a precise and precious parameter, being the result of sophisticated calculating elaboration carried out by the petrol ECU on the basis of a complete and specific system of sensors.

Due to the fact that the temperature and pressure conditions can change depending on the conditions of use of the vehicle, the system has temperature sensors and suitable absolute pressure sensors placed on the gaseous supply of the injectors and on the air-intake manifolds. The Fly SF ECU can thus adjust in real time its calculus and, above all, can correctly operate even in the presence of

strong drift of aforesaid parameters.

The SEQUENT reducers (GENIUS, GENIUS.M GENIUS MAX or ZENITH) tend to keep practically constant a differential of pressure between the gas outlet pressure and the air-intake manifold, exactly how it happens in many petrol systems. This helps optimising the system working, but it is not an indispensable fact, as the control electronics is quicker than the pressure steady state. For example, due to a sudden acceleration, the pressure in the reducer increases in a fraction of second. In this lapse of time, the ECU carries out several cycles of calculus and obviously compensates every delay of mechanical cause.

Another important aspect of the SEQUENT system is the gas injector. As it will be subsequently described, they are low impedance fuel injectors with large passage sections, able to obey, in a very quick way and with great repetitiveness, to the controls by the Fly SF ECU, enabling to supply even big engines.

The Fly SF ECU, in addition to the general program of the system working, has to contain the specific data for every vehicle (it is about a pretty complex whole of configurations and other calibration parameters). The calibration details can come from an archive that BRC will leave at your disposal, or they can be obtained directly from the installer through a proper self-calibration process, driven step to step by the PC program. The personal computer works also as a diagnostic instrument to verify the good working of the system or to spot any possible anomalies. Inside the ECU there is also a powerful self-organising software that, perceiving any possible changes in the vehicle operation, is able to rectify them automatically and without any external help.

Picture 03
Two-position changeover switch with buzzer and support

3.3 CHANGE-OVER FUNCTION

The changeover switch (picture 3) has two positions, which allow the petrol operation and the petrol starting with automatic changeover to gas.

The latter one is to be used for the normal gas operation.

3.3.1 Petrol operation

In this position, the two-colour LED turns red, the petrol injectors are working, while the gas ones are closed, likewise the gas solenoid valves and the spark advances go back to default values. The vehicle regularly runs on petrol, as if the system were not present (normal petrol operation).

3.3.2 Gas operation

In this position, the vehicle starts up on petrol, then, as soon as the temperature conditions of the reducer and the working conditions of the engine (rpm, manifold pressure, etc.) programmed are achieved, it changes over automatically on gas.

While the engine works on petrol, the two-colour LED turns red; during the changeover phase from petrol to gas the LED turns orange for an instant (red and green at the same time); last, when the changeover phase is over, the LED turns green and the engine works on gas (gas normal operation).

In case of accidental engine shutdown, the ECU re-changes automatically to petrol, independently of the position of the changeover button, and the two-colour LED turns red (this function is also called “Safety”). Such a function moreover prevents the on-off gas solenoid valves from being energised for a period longer than 5 seconds after the engine stop.

During gas operation, the ECU cuts off and emulates injectors, the gas solenoid valves are open and the gas injectors are controlled depending on the fuel demand and time calculated by the ECU.

3.3.3 Fuel gauge: LPG operation

The changeover has moreover the function of fuel gauge through the four green LEDs. To know how much LPG is contained in the tank it is sufficient to see how many LEDs are turned on. Four LEDs turned on indicate the full filling of the tank (80% of the total tank capacity), three LEDs on indicate the 3/4 of the total filling, two LEDs on mean half tank, one LED on mean1/4 of tank.

The indication of fuel stock is

obtained through the first LED flashing and is purely indicative. The correct signal is obtained when the vehicle is on a level surface and after a few seconds from the starting, even if the indication is immediately present. **It is recommended to use the partial trip odometer to control the fuel distance.** Four green LEDs flashing mean that there could be an excessive quantity of LPG in the tank. In this case it is suggested to run few kilometres until the flashing ends.

3.3.4 Fuel gauge: CNG operation

To know how much CNG is contained in the cylinders it is necessary to connect the level sensor connector to the BRC manometer equipped with a pressure sensor.

Four green LEDs lit indicate the maximum pressure inside the cylinders; the gradual turning off of leds corresponds to lower pressures inside the cylinders. As per the LPG version, also in this case the indication of the fuel stock is obtained through the first LED flashing and is purely indicative.

It is recommended to use the partial trip odometer to control the fuel distance.

Precautions must be taken to ensure that the petrol tank is never allowed to become empty.

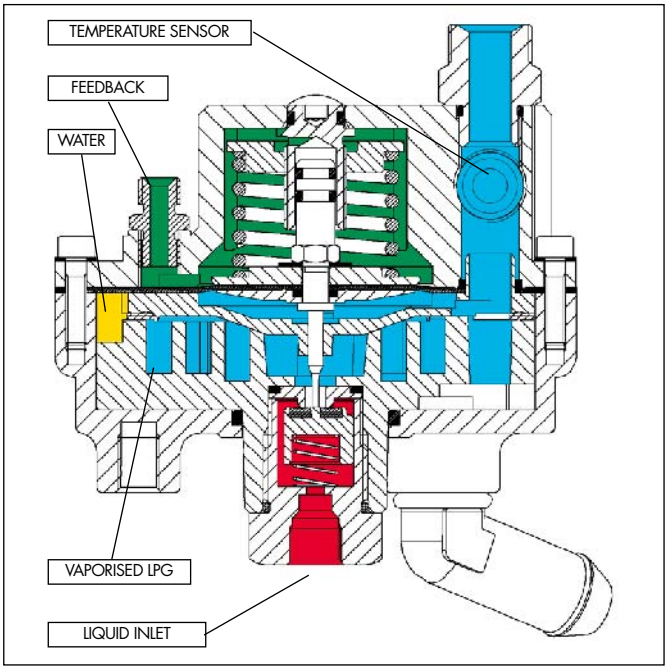
It is necessary to maintain a petrol quantity corresponding to 1/4 or 1/2 of the tank at all times and to renew it periodically both for the LPG and for the CNG versions.

4. DETAILED DESCRIPTION OF THE COMPONENTS

Picture 01
Sequent Genius Reducer

4.1 SEQUENT GENIUS REDUCER (LPG VERSION)

In the LPG version, the SEQUENT GENIUS reducer (picture 1) only consists of one stage, with a variable outlet pressure, which stands approx. 1,2 bar higher than the air-intake manifold pressure. Inside the SEQUENT GENIUS room the LPG evaporation takes place due to the heat exchange with the engine coolant liquid, as in a common reducer. The gas outlet pressure is controlled by a spring-diaphragm-shutter system, equipped with proper vibration-damping systems.



Picture 02
Sequent Genius Reducer - Sectional view -

You should observe that (picture 2), a room opens onto the surface of the diaphragm opposite to the 11\one on which the gas pressure acts. This room is connected to the air-intake manifold through a pipe. The gas outlet pressure is therefore not constant, but follows the intake manifold pressure course. For example, in idling conditions, the manifold pressure if compared with the ambient could be - 0,6 bar and the reducer outlet pressure could be + 0,6 bar.

Picture 03
Temperature sensor

On the other hand, with a complete acceleration, the manifold pressure will be around 0 bar (atmospheric pressure) and the gas pressure around +1 bar. Despite the particular compact dimensions, the reducer guarantees high gas flows, to satisfy powers up to 140 kW (190 CV). As it only consists of one stage, it does not need any draining operations. There is a temperature sensor (picture 3) near the gas outlet hole which gives full requisite information to the Fly SF ECU for a correct flow control. The petrol-gas changeover is also affected by temperature, to avoid the passage of not completely vaporised LPG.

4.2 SEQUENT GENIUS MAX REDUCER (LPG VERSION)

Genius Max reducer has been studied and studied for being installed on motor vehicles with elevated powers motor and for LPG applications. The outer aspect of the reducer is different from the Genius Sequent one, while the working principles are similar.

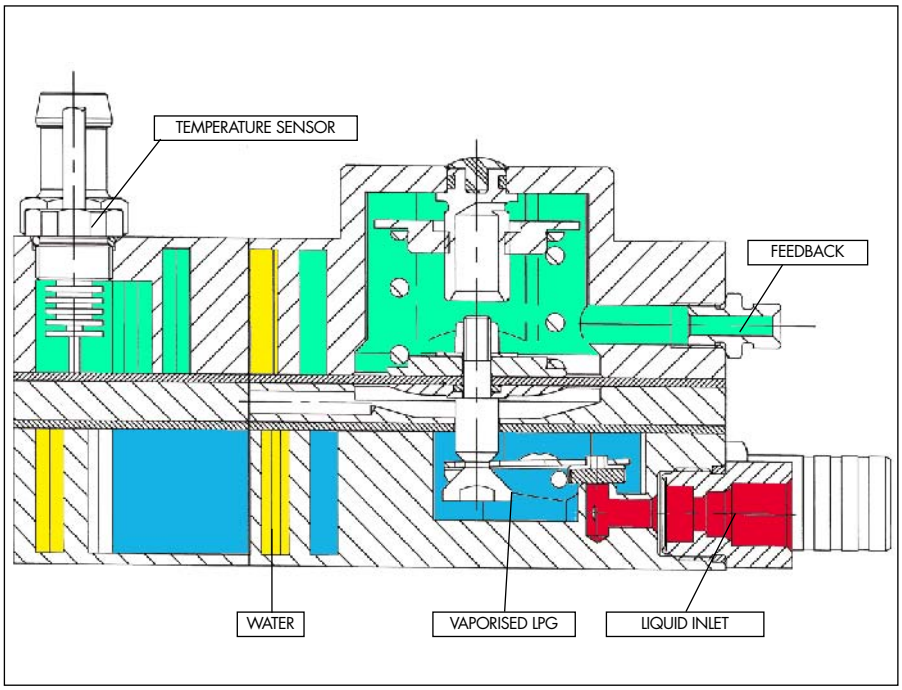
The reducer is constituted from a single stage with a variable outlet pressure that is maintained approximately 1.2 bar more than the pressure of the induction manifold. The status change of the LPG is obtained through a system shutter-lever-spring-diaphragm.

The reducer also contains a circuit where the engine cooling liquid allows the thermal exchange necessary to make the LPG completely gaseous. A temperature sensor is on the reducer, too.

This allows the ECU to acquire the necessary information on Gas conditions for a correct dosing. Check the possible cases described in the Types of installation - 2/3 guide.

Picture 04
Sequent MAX
Genius Reducer

Picture 05
Sequent MAX
Genius Reducer -
Sectional view -



Picture 06
Temperature sensor

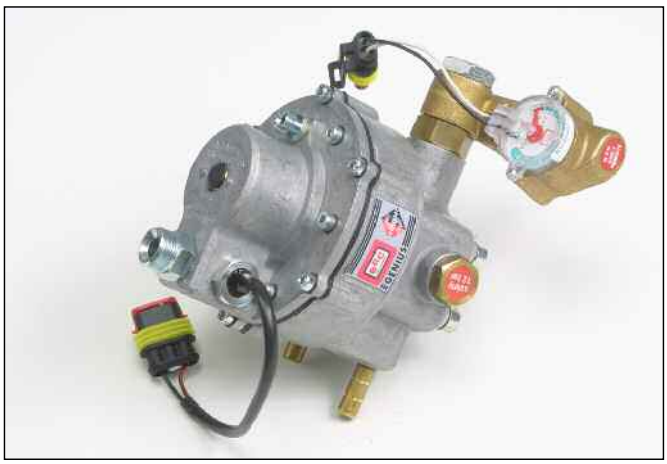
4.3 SEQUENT GENIUS.M REDUCER (CNG VERSION)

In the CNG version the reducer, called SEQUENT GENIUS.M (picture 7), consists of two reduction stages, which have the following operations:

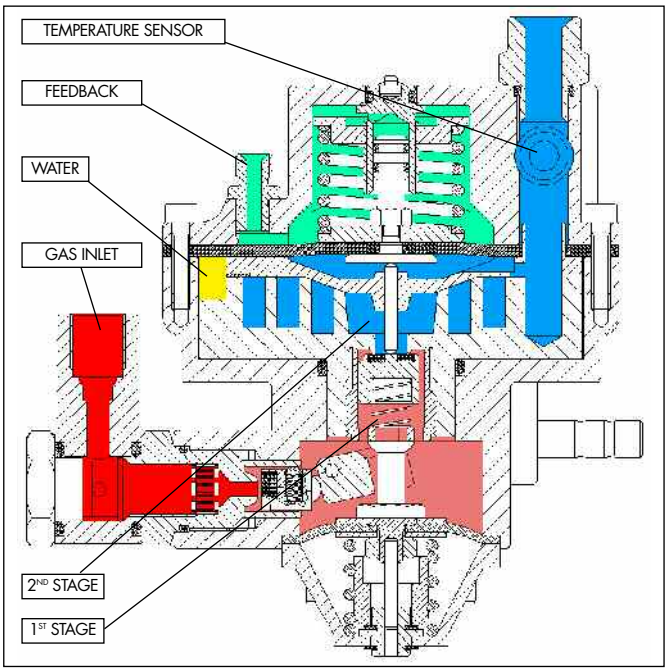
- to face every CNG pressure level coming from the tank (load pressure around 22 MPa corresponding to 220 bar),
- to spread the CNG at the intermediate pressure, of 500 - 600 kPa (5 - 6 bar) in a first stage,
- to bring the heat necessary to avoid an excessive cooling of fuel due to a sudden expansion,
- to spread the CNG further on at the requested pressure, of 200 kPa (2 bar), useful to supply the injection system. Such a value of outlet pressure is conditioned by the pressure signal of the air intake manifold: in practice, the differential pressure is kept constant between the CNG pipe at the outlet of the reducer and the air-intake manifold.

As can be seen from picture 8, the second stage of the SEQUENT GENIUS.M CNG reducer is very similar to the first and only stage of the SEQUENT GENIUS LPG reducer version.

Despite the particular compact dimensions, the reducer guarantees high gas flows, in order to satisfy powers up to 140 kW (190CV).



Picture 07
Sequent M. Genius Reducer



Picture 08
Sequent M. Genius Reducer - Sectional view -

Picture 09
Temperature sensor

4.4 ZENITH REDUCER (CNG VERSION)

This is the new reducer for CNG installation and for **Sequent Fastness** system only and has important innovation and improvement.

The reducer consists of two reduction stages with the following aim:

- to face every CNG pressure level coming from the tank (load pressure around 22 MPa corresponding to 220 bar),
- to spread the CNG at the intermediate pressure, of 500 - 600 kPa (5 - 6 bar) in a first stage,
- to bring the heat necessary to avoid an excessive cooling of fuel due to a sudden expansion,
- to spread the CNG further on at the requested pressure, of 200 kPa (2 bar), useful to supply the injection system. Such a value of outlet pressure is conditioned by the pressure signal of the air intake manifold: in practice, the differential

pressure is kept constant between the CNG pipe at the outlet of the reducer and the air-intake manifold.

In spite of the compact dimensions, the reducer assures high gas flow able to satisfy engine up to 230 kW.

Zenith pressure reducer is supplied with a Delta p (Δp) adjustment equal to about 2000 mbar.

If necessary, this value can be changed between 1600 and 2500 mbar by the technician by acting on the suitable screw.

Among the improvements we point out:

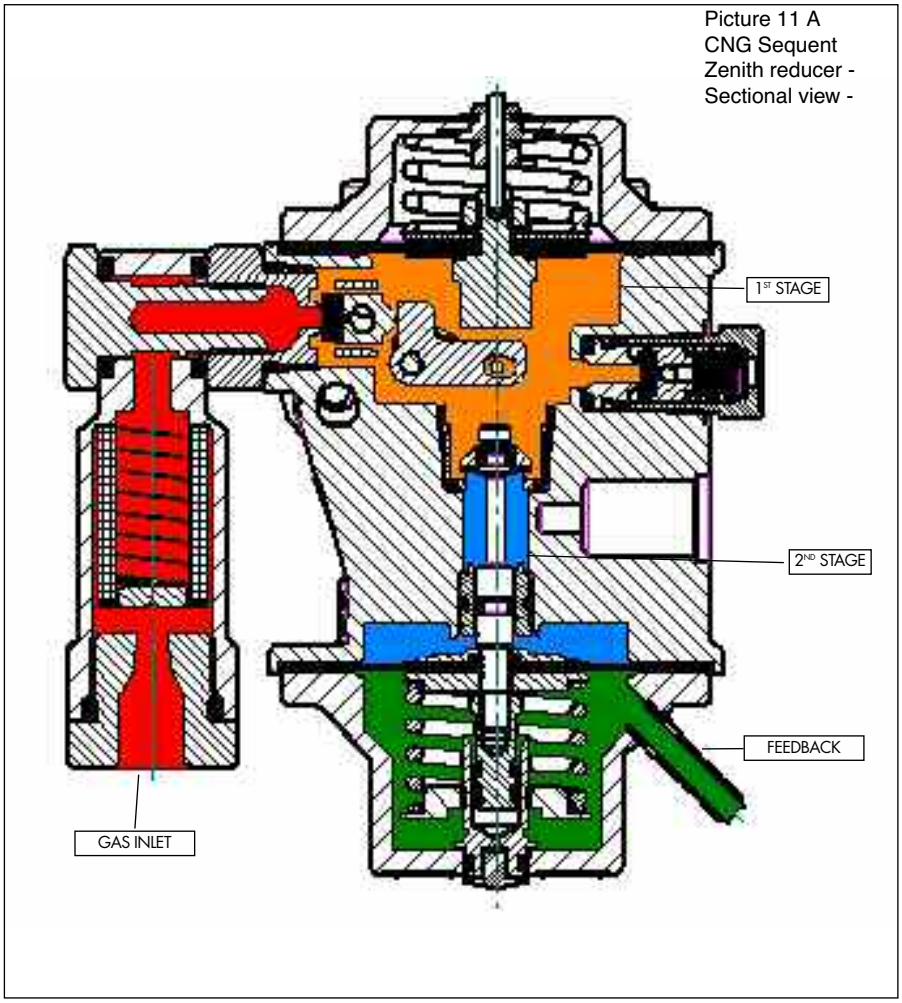
- Swivel-connection with integrated high efficiency filter (*).
- 1st reduction stage with lever.
- Safety valve on the 1st stage.
- 2nd stage reduction with direct and desmodromic connection.
- Water circuit built inside the aluminium body (no washers).
- Temperature water sensor placed on the reducer (no need to adjust it) - picture 12.
- Fixing thanks to two M6 holes.
- Pressure compensation system adjusted according to the flow.
- Connection on the outlet to the 12x19 pipe rubber holder.

Advantages are the following: more precise and stable adjustment, faster response time, possibility to feed more powerful vehicles (with equal injectors and basic Delta P adjustment).

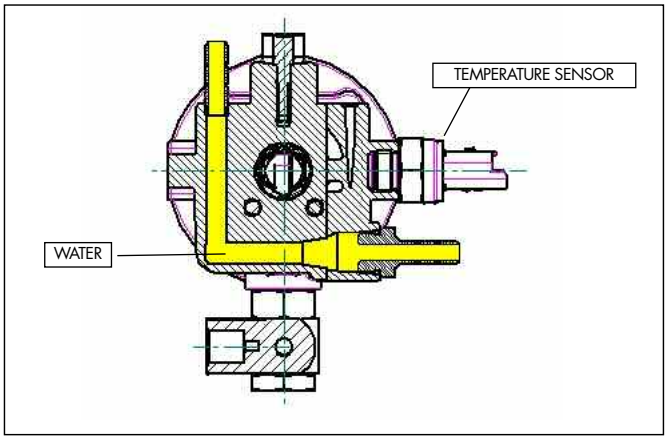
As for its installation and the indications for the power, please refer to Sequent 2/3 “TYPES OF INSTALLATIONS” guide.

(*) The use of the Zenith reducer excludes the use of the filters described in paragraphs 4.7, 4.8 and 4.9.

Picture 10
CNG Sequent
Zenith reducer



Picture 11 A
CNG Sequent
Zenith reducer -
Sectional view -



Picture 11 B
CNG Sequent
Zenith reducer -
Sectional view -

4.5 GAS TEMPERATURE SENSOR

As mentioned in the previous paragraphs, a temperature sensor is installed on LPG and CNG GENIUS and GENIUS MAX reducers. The sensor (picture 3,6 and 9) is resistive, with two wires, based on NTC thermistore.

All the gas changeover strategies of the system as well as the calculus of the gas injection times are based on the temperature measured by the sensor.

The sensor is different from the one used in the Flying Injection equipment. Confusing the two sensors and installing the wrong one, the ECU will not be able to determine the correct gas temperature, to carry out correctly the programmed changeover strategies and to make the corrections in the injection times that depend on gas temperature, during gas operation.

Picture 12
Water temperature sensor on the Zenith reducer

Picture 13
"FJ1" filter with single cartridge and threaded connections

4.6 WATER TEMPERATURE SENSOR (FOR ZENITH REDUCERS)

The temperature sensor shown in picture 12 is used exclusively on the new ZENITH reducer.
This is a resistive sensor, with three wires based on a NTC thermistore.
All strategies for the system changeover to gas are based on the water temperature taking.
This sensor differs from previous one for the mechanical structure: it is more compact and integrates the sensor and connector in its inside.

Picture 14
"FJ1 Twin" filter with double cartridge and rubber holder connections

4.7 "FJ1" FILTER

Exclusively used with LPG Sequent with BRC Injectors and Genius Reducer, the FJ1 filter carries out the important function to trap the LPG or CNG impurities protecting the injectors working.

It is a cartridge filter, (picture 13) that is installed just after the reducer-vaporiser and therefore acts on the gaseous phase. This fact really differs it from the filter present in the ET98 solenoid valve, which works on the liquid. The filtration of the gaseous phase allows trapping all those impurities (oils, waxes, etc...) on which it would not possible to act only filtrating the liquid phase.

Its constructive solution allows screwing the filtering cartridge on a support and therefore a smooth intervention of substitution.

It is suggested to change it every 15000 km.

4.8 "FJ1 TWIN" FILTER

Exclusively used with LPG Sequent System, BRC injectors and Genius MAX reducer, the FJ1 Twin FILTER has a double cartridge with characteristics similar to the

previous one but with inlet and outlet without threaded connection but with rubber holder ones (picture 14 pag. 17).

4.9 “FJ1 HE” FILTER (HIGH EFFICIENCY)

Exclusively used with CNG and LPG Sequent System with Keihin injectors. FJ1 HE is a very small cartridge filter. In spite of this, the filter has in its inside a cartridge that has been studied with innovative filtering elements allowing it to have an higher filtering power compared to the ones used till now (picture 15).

4.10 RAIL

It is the part where the injectors are assembled on; it enables the gas distribution to every injector at the requested pressure.

Available in the following versions:

- for BRC injectors - gas outlet with threaded union (picture 16) or with rubber holder one (picture 17),
- for BRC injectors - gas outlet with rubber holder union and gas temperature and pressure sensor inside the rail body. **This version is exclusively used for Sequent Fastness (picture 18).**
- for Keihin injectors - gas outlet with threaded connection (picture 19) or with rubber holder one (picture 20).

The first and third rail described have a threaded connection for the pipe direct to P1 pressure sensor while the second (for application with Zenith reducer) is without and has a tap to close the hole.

Two threaded holes allow an easy installation of the fixing bracket to the vehicle.

4.11 INJECTORS

4.11.1 BRC INJECTOR

A patent that protects its constructive details covers BRC

Picture 15
“FJ1 HE” filter with rubber-holder connections

Picture 16
Version with BRC injectors and threaded connection

Picture 17
Version with BRC injectors and rubber holder connection

Picture 18
Version with BRC injectors, pressure and gas temperature sensor and rubber-holder connection for Sequent Fastness Applications.

injector.

It is a “bottom feed” injector type (supplied from the bottom). Referring to fig. 21, the gas contained inside the rail goes into the lower side of the injector and is injected in the air intake manifold when the shutter, moved by the electromagnet, frees the passage section.

The tightness is assured by the rubber final part of shutter, which presses on a volcano.

The pressure differential acting on the shutter enables it remaining in the closure position when the coil is not energised, and prevents gas from being discharged in the air intake manifold.

The injector is expressively studied to have a long life in extreme conditions of use:

- The diaphragms insulate the very delicate zone of the magnetic circuit, preventing any gas residual products from modifying its geometry.
- Working temperature: from –40 °C a +120 °C.
- 15 g accelerations.
- Intense electromagnetic forces guarantee opening even when oils or waxes, present in the dirty gas and not trapped by the filter, tend to stick the shutter to its seat.

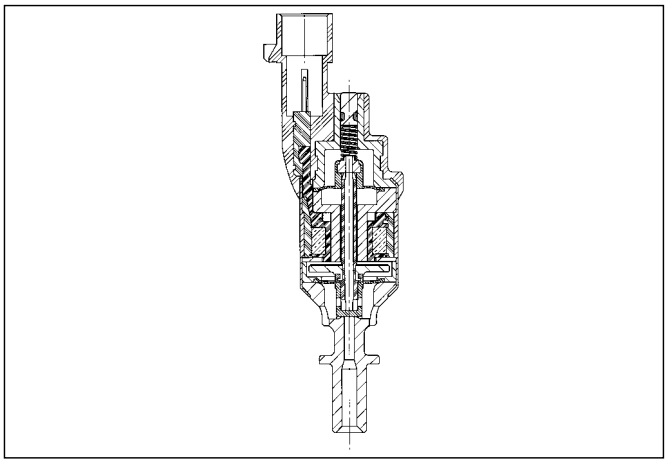
It is a low impedance injector (2,04 ohm / 2,35 mH a 20 °C) and therefore requires a peak & hold piloting.

The shutter opening time is very short; it allows having a good control on the injected gas even in small dosages, like in idling conditions. The gas passage sections allow a correct supply even in the more powerful vehicles nowadays available on the market.

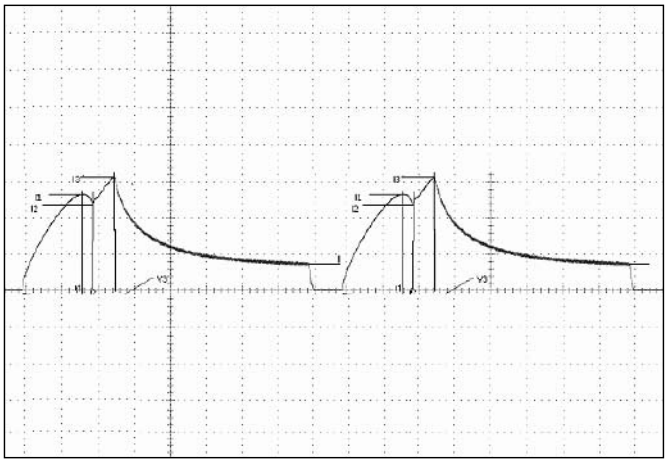
To better meet the needs of a fine idling control and a good supply at high r.p.m. there are two kinds of injectors, with different passage sections. The injectors (pictu-

Picture 19
Version with Keihin injectors and threaded connection

Picture 20
Version with Keihin injectors and rubber holder connection



Picture 21
BRC injector - Sectional view -



Picture 22
Trend of the current inside BRC injector

re 23) are distinguishable by a coloured label, that can be Blue for the BRC injectors Normal type and Orange for the BRC injectors Max type.

The table of picture 24 shows the powers that can be supplied by the BRC injectors depending on the reducer used*.

4.11.2 KEIHIN INJECTOR

It is a “top feed” injector. Referring to picture 25, the gas enters from the top and axially goes through the shutter to reach the lower room. When the shutter opens, attracted towards the top by the electromagnet, the gas is injected in the air-intake manifold.

The pressure differential that acts on the shutter enables it remaining in the closure position when the coil is not energised, and prevents gas from being discharged in the air intake manifold. The vulcanised rubber on the bottom of the shutter guarantees both the seal and the low noise of the injector (< 90 dB).

The injector has been expressively studied to withstand more than 290 million of cycles, equal to 100.000 km, in extreme conditions of use:

- The shutter is covered by teflon so that the injector can work with no problems of wear with LPG and CNG.
- Working temperature: from –35°C to +120°C.
- 15 g accelerations.
- Intense electromagnetic forces guarantee opening even when oils or waxes, present in the dirty gas and not trapped by the filter, tend to stick the shutter to its seat.

It is a low impedance injector (1.25 ohm/ 3,5 mH a 20 °C) and therefore requires a peak & hold piloting.

Picture 23
BRC Injectors type “Normal” and “Max”

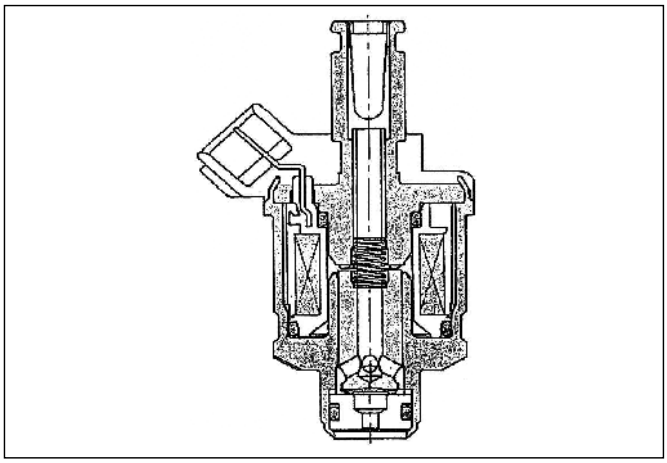
LPG feeding capabilities

		Genius 800	Genius 1200	Genius 1500	Genius MAX
Injectors **Max Type**	Asp.	-	26 kW/cil.	30 kW/cil.	30 kW/cil.
	Superch.	-	32 kW/cil.	36 kW/cil.	36 kW/cil.
Injectors **Normal Type**	Asp.	17 kW/cil.	21 kW/cil.	-	-
	Superch.	22 kW/cil.	26 kW/cil.	-	-

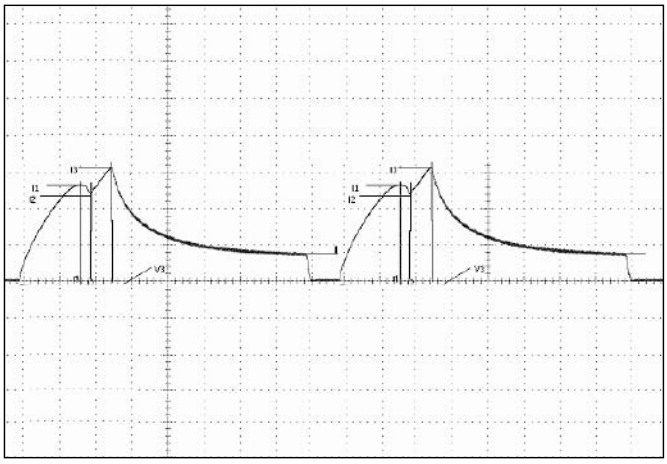
CNG feeding capabilities

		Zenith Δp.1600	Zenith Δp.2000	Zenith Δp. 2500
Injectors **Max Type**	Asp.	19 kW/cil.	22 kW/cil.	25 kW/cil.
	Superch.	22 kW/cil.	25 kW/cil.	29 kW/cil.
Injectors **Normal Type**	Asp.	15 kW/cil.	17 kW/cil.	20 kW/cil.
	Superch.	18 kW/cil.	20 kW/cil.	23 kW/cil.

Picture 24
• The data in the following chart are merely indicative. For the selection of the type of injectors please refer to “Types of Installation” guide.



Picture 25
Keihin injectors - sectional view



Picture 26
Trend of the current inside Keihin injector

Picture 26 shows the typical trend of current in the injector. The shutter is opened by applying all the battery voltage during the peak phase; then the voltage which supplies the injector becomes the one called “hold”, as it is sufficient to keep it open for the necessary time.

The shutter opening time is very short; it allows having a good control on the injected gas even in small dosages, like in the idling conditions. The gas passage sections allow a correct supply even in the more powerful vehicles nowadays available on the market.

To better meet the needs of a fine idling control and a good supply at high r.p.m. there are two kinds of injectors, with different passage sections.

The injectors (picture 27) are distinguishable by a coloured mark, placed on the label, that can be Blue for the Keihin injectors Normal type, Orange for the Keihin injectors Max type and Yellow for Keihin Super Max ones.

Picture 28 depicts the powers that can be supplied by the Keihin injectors depending on the used reducer**.

4.12 GAS TEMPERATURE AND PRESSURE SENSOR

This new concept sensor with a small body and integrated inside the connector also includes the P1 pressure sensor and the gas temperature one. As already described in the previous paragraph, this sensor has to be installed directly on the injectors rail for Sequent Fastness applications.

In this position the pressure and gas temperature measurement is more precise and allows a quick intervention for gas carburation corrections.

4.13 GAS PRESSURE AND MANIFOLD ABSOLUTE PRESSURE (MAP) SENSORS

P1-MAP device (picture 30 and 31) contains two sensors: the P1 sensor that measures the absolute pressure present in the injectors rail and the manifold absolute pressure (MAP) that gives to the Fly SF ECU the information on the absolute pressure present inside the air-intake manifold.

The device is pre-amplified so that the signal is not easily disturbed. The pre-cabled connection makes the installation very simple.

Picture 27
Keihin injectors type “Normal”, “Max” and “Super MAX”

LPG feeding capabilities

		Genius 800	Genius 1200	Genius 1500	Genius Max
Inj. **Sup. Max Type**	Asp.	-	-	35 kW/cil.	35 kW/cil.
	Superch.	-	-	42 kW/cil.	42 kW/cil.
Inj. **Max Type**	Asp.	-	26 kW/cil.	30 kW/cil.	30 kW/cil.
	Superch.	-	32 kW/cil.	36 kW/cil.	36 kW/cil.
Inj. **Normal Type**	Asp.	17 kW/cil.	21 kW/cil.	-	-
	Superch.	22 kW/cil.	26 kW/cil.	-	-

CNG feeding capabilities

		GeniusM 2000	GeniusM 2500
Inj. **Sup. Max Type**	Asp.	-	27 kW/cil.
	Superch.	-	29 kW/cil.
Inj. **Max Type**	Asp.	20 kW/cil.	23 kW/cil.
	Superch.	23 kW/cil.	26 kW/cil.
Inj. **Normal Type**	Asp.	18 kW/cil.	20 kW/cil.
	Superch.	20 kW/cil.	23 kW/cil.

Picture 28

** The data in the following chart are merely indicative. For the selection of the type of injectors please refer to “Types of Installation” guide.

Picture 29
Pressure and gas temperature sensor inside the Sequent Fastness rail body

4.14 MANIFOLD ABSOLUTE PRESSURE (MAP - RAIL SEQUENT FASTNESS)

This new sensor (picture 32) is used for Sequent Fastness only. It is light, very small and easy to be installed to the body.

As all the other sensors described before, its body is compact and integrated with the connector. It has in its inside a pressure sensor suitable for both vacuum and turbo engines allowing a precise set up for all vehicles.

4.15 "FLY SF" ECU (SEQUENT E SEQUENT FASTNESS)

UA detailed description would lie outside the purposes of this handbook. What is important is to know that it is the operating unit controlling the whole system. It is completely made by automotive components, being therefore suitable to bear the temperature inside the engine compartment, even though precautions must be taken to ensure that it is not assembled near red-hot devices such as the exhaust manifold. It is waterproof and is in compliance with the EMC standards. It incorporates components of the latest conception (Motorola 32 bit microprocessor), with a data processing speed higher than most original petrol ECUs. The memory that contains calibration program and data is not volatile, so, once programmed, the Fly SF ECU (picture 33) can be disconnected from the battery with no loss of data. It can be programmed more times without problems, for example it can be transferred from a vehicle to another and re-programmed.

Some data acquisition channels are shared to be connected to different signals according to the various vehicles (e.g. TPS, MAP, etc.).

The task of the ECU consists in collecting and processing full information and, as a consequence, controlling the various functions of the system; in particular the injectors, controlling the injection time and its duration, with a precision of few microseconds (microsecond = 1/1000000 of second).

The ECU is contained in an aluminium rugged waterproof case, able to bear very high temperatures and to protect the inside electronic parts, both from external atmospheric agents and from mechanical stresses it is subjected to, and from electromagnetic radiation irradiated by the electrical components of the engine or other sources (transmitter, repeater, mobile phones, etc.).

The ECU has been studied to withstand prolonged short-circuits, both towards the ground and the battery positive contact, on each of its proper inlet/outlet wires (naturally except for grounds and supplies). This allows not ruining the ECU even when in presence of the more common harness errors (inversion of polarity, wrong connection of one or more wires, etc).

The harness connection takes place through a unique 56-way connector, which contains all the

Picture 30
P1-MAP sensor for aspirated LPG applications

Picture 31
P1-MAP sensor for Turbo LPG and CNG applications

Picture 32
MAP sensor for Sequent Fastness applications

necessary signals for the various functions, as regards the piloting of 4 injectors at most.

In the two-connector version (picture 21), a 56-way and a 24-way, two additional types of Fly SF ECU are available: one for vehicles up to 6 cylinders and the other for vehicles up to 8 cylinders.

The ECU incorporates the following functions that were previously obtained through the installation of external various components:

- **"modular"** function to interrupt and emulate injectors,
- **crankshaft sensor adapter function**, more and more useful on new vehicle models,
- **timing advance processor function**, particularly useful for CNG applications (this function can not be used for Sequent Fly SF and Sequent Fastness ECUs for 8 cylinder vehicles)
- it is possible to connect **2 Lambda oxygen sensors** with no need of adapters,
- **the ECU contains the main adapters for "UEGO" and "in need of power supply" oxygen sensors**, to be assembled externally in other systems.

4.16 CHANGE-OVER SWITCH WITH LEVEL GAUGE

It is the BRC two-position changeover switch, in the standard or built-in versions, equipped with a buzzer and a LEDs indicating the level.

The changeover switch (picture 35 page 24), as mentioned in paragraph 3.3, allows carrying out the following functions: changeover, gas level gauging and diagnosis and can signal irregular situations (lack of gas, breakdowns, automatic petrol re-changeover, etc.), both through the LEDs, and the buzzer.

Picture 33
Fly SF ECU

Picture 34
Fly SF ECU: two connectors' version

4.17 LEVEL SENSOR

The FLY SF ECU controls the indication of gas level by means of a signal on the GREEN LEDs of the changeover switch. To do that, the ECU is able to elaborate the signal coming from the BRC resistive level sensor (PICTURE 36) located on the multivalve of the tank (LPG equipment), or from the BRC resistive pressure sensor (PICTURE 37) of the CNG equipment. The thresholds of the LEDs are freely programmable from PC (refer to the software handbook), to allow an accurate precision in the indication.

4.18 EMULATING FUNCTION OF INJECTORS

The function of interrupting the petrol injectors is completely carried out by the FLY SF ECU.

The emulating function of the injectors is also carried out by the FLY SF ECU, which incorporates a proper resistive load.

By "interruption", we mean the function that, interrupting the electrical connection between the petrol ECU and the injectors, prevents them from introducing petrol into the engine cylinders while running on gas.

During this phase the SEQUENT system should actually supply the engine with the gaseous fuel; a simultaneous introduction of petrol, that will damage the engine and the catalyst, must absolutely be avoided.

Naturally the petrol ECU diagnosis is opportunely designed to recognise the interruptions in the connection with its actuators, in particular with the injectors.

It is therefore necessary to "emulate" the load that was represented by the petrol injectors, in other words, to substitute from the electrical point of view the petrol

injectors that have been disconnected, with “false” injectors, that the petrol ECU will not distinguish from the real ones.

As we told before a resistive type of emulation is already present in the FLY SF ECU anyway some kind of petrol ECUs need not only a resistive load but a resistive-inductive one

For this reason inside SEQUENT harness a suitable Modular LD has been introduced to supply the inductive load required by the petrol ECU during the gas operation when petrol injectors are disconnected through the FLY SF ECU. For further information please refer to § 6.2.17.B.

4.19 HARNESS

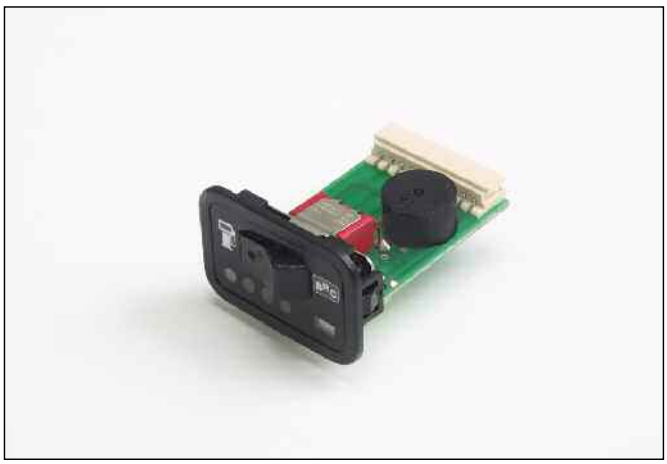
As we indicated before, the harness is one of the main novelties introduced with the SEQUENT system. In this paragraph we will analyse two types with different characteristics according to the type of Sequent configuration.

The first (picture 38) is the usual harness used till now for Sequent application while the second one (picture 39) is the new harness for Sequent Fastness only.

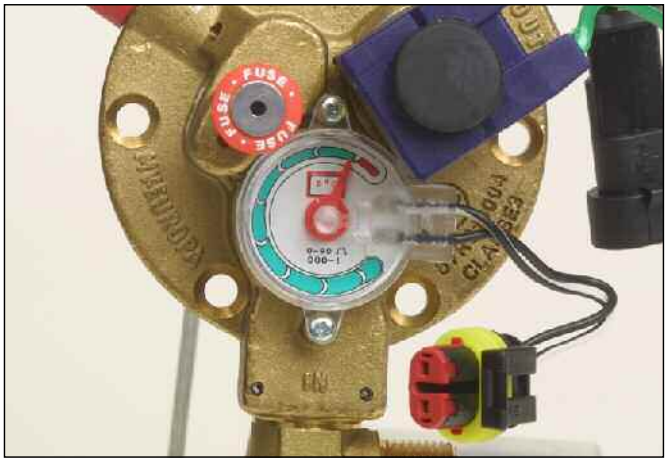
The innovative modular harness allows installing the simpler vehicles with the only connection of three wires (rpm, key contact, TPS: respectively grey, brown and white/violet wires), naturally in addition to the positive and negative battery.

For more sophisticated vehicles, that consequently can require more connections, it is possible to integrate the harness with further connections that allow optimising the vehicle setting up and driving conditions.

Both the main harnesses of the SEQUENT system have a 56-way connector, used by some of the more important European car manufacturers.



Picture 35
Two positions changeover switch with buzzer and without body



Picture 36
Resistive level sensor for BRC Europa Multivalve

Picture 37
Resistive pressure sensor for BRC CNG reducers

Picture 38
Fly SF ECU main harness

If using the **two-connector ECU**, a second part of harness will be necessary, to fit a 24-way connector (picture 40).

Two types 5,6,8-cylinder harness are available: one for vehicles up to 6 cylinders and the other for vehicles up to 8 cylinders.

Shielded conductors have been used to comply with the EMC standards. The connectors present on the harness are waterproof, except for the one of the changeover switch that is placed in the passenger compartment and is therefore protected from water. As regards the connections of wires and harness connectors you should refer to chap. 6 of the present handbook.

NOTE: as the 56 poles connector used in SEQUENT system is the same used for Flying Injection one, considering the similarity of the external structure of both systems ECUs, it is possible to mistake the two ECUs and using the wrong one for the wrong system.

Such an error is to be accurately avoided, because it can cause the damaging of the original components of the vehicle.

Both the main harness (picture 38) and the 5,6,8- cylinder harness (picture 40) are both available in the Keihin injectors' version and in the BRC injectors one. It is recommended not to invert such harnesses.

On the other hand, the main harness for Sequent Fastness application is available only for BRC injectors so that you have to pair the suitable 5-6-8 cylinder harness with BRC injectors.

Picture 39
Fly SF ECU main harness for Sequent Fastness applications

Picture 40
5-6-8-cylinder FLY SF ECU connection harness

4.20 NORMAL WP "ET98" LPG SOLENOID VALVE

The LPG solenoid valve used in the SEQUENT system is a waterproof type (with watertight connectors) and is an evolution of the well-known LPG BRC ET98 solenoid valve, from which it can be externally distinguished for the white galvanising (picture 41). Inside the LPG solenoid valve, the filtering system has been improved, in particular for the iron-magnetic particles.

Due to the precise working of the injectors, it is compulsory to use this kind of solenoid valve, in the whole assembly of SEQUENT.

4.21 SUPER WP "ET98" LPG SOLENOID VALVE

The Super WP "ET98" solenoid valve is an interception device for LPG necessary and designed to grant higher performances compared to previous ones. An improved coil allows a more efficient opening power with the same current. This permits to have bigger passage sections and a higher LPG flown. Even in this case the solenoidvalve has been conceived to allow the feeding of high power engines keeping a high filtering grade. With waterproof connectors, the solenoidvalve body is brass colour without external covering while the coil is red (picture 42).

4.22 "VM A3/E" CNG ELECTRO-ASSISTED VALVE

The "VM A3/E" CNG electro-assisted valve used in the SEQUENT system is of the waterproof type (with watertight connectors) and is an evolution of the well-known CNG VMA3/E solenoid valve (picture 43)

The valve, that is usually installed inside the engine compartment along the pipes connecting the CNG cylinder/s to the reducer, if combined to the IM series CNG filling adapter, allows refuelling and, at the same time, the free passage

of fuel supply.

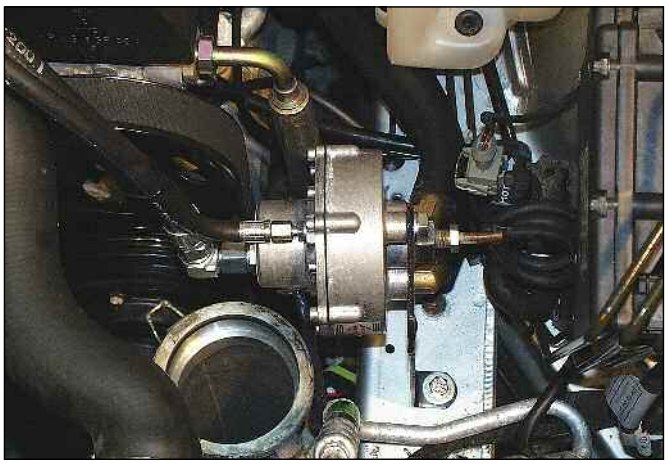
The use of this kind of refuelling solenoid valve, in the SEQUENT system context, has a very important role as the solenoid valve is controlled and operated by the electronic control system. It opens when the starting up begins and closes in case of shutdown, even if the driver does not turn off the ignition key (i.e. as it can happen in case of accident).

Picture 41
LPG “ET98” WP solenoidvalve

Picture 42
“ET98 SUPER” WP LGP solenoidvalve

Picture 43
“VMA3/E” WP CNG electro-assisted valve

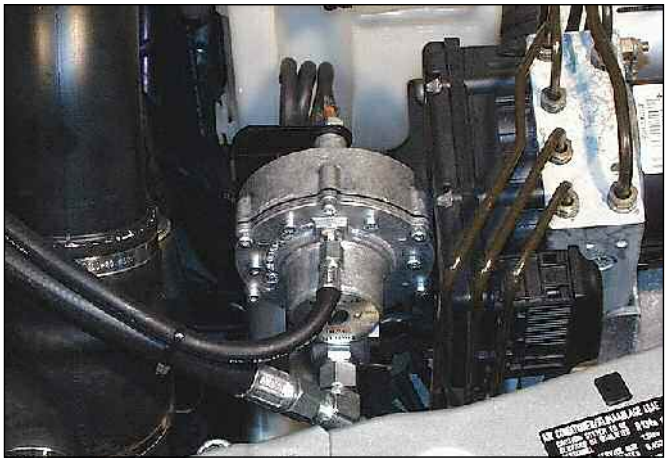
5. MECHANICAL INSTALLATION



Picture 01
Sequent Genius reducer installation with diaphragm parallel to the driving direction

The following installation rules are to be considered as general.

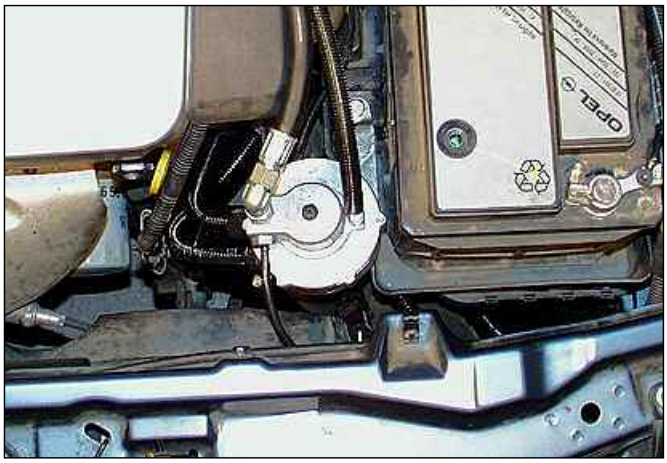
Before installing the various components of the Sequent system it is recommended to check the petrol operation of the vehicle. In particular, it is necessary to carefully check the state of the electronic ignition equipment, the air-filter, the catalyst and the Lambda Oxygen sensor.



Picture 02
Sequent Genius reducer installation with diaphragm perpendicular to the driving direction

5.1 SEQUENT GENIUS REDUCER

The following general installation rules are to be considered effective both for the LPG version and CNG.



Picture 03
Sequent Genius Reducer: further installation position

The reducer must be firmly fastened to the bodywork so that it is not subjected to vibrations during its operation. With the engine under stress, the reducer must not hit any other device. The SEQUENT GENIUS may be installed with any orientation (picture 1,2 and 3); it is not important that the diaphragm is parallel to the running direction.

The pipe that connects the reducer to the filter should not be longer than 200-300 mm. For the connection see paragraphs 5.10.

If you need to tighten or loosen the gas inlet fitting or any other fitting, we recommend to always use two spanners, in order not to move the component screwed on the reducer body.

Picture 04
LPG Sequent Genius MAX: possible installation position

The temperature sensor wire should not be too tight or twisted, it

should nor make sudden folds at the outlet of the sensor.

The copper pipe that goes from the solenoid valve to the SEQUENT GENIUS must not go through too hot areas of the engine compartment.

As no adjustment is programmed on the SEQUENT GENIUS, it is not essential it is assembled in an easily accessible area. However the installer should avoid uneasy places, in order to make any maintenance operations without too many difficulties.

For what concerns the **LPG version** it is important to note that there are rubber-holders connections for 17x23 pipes on the water side; they are quite large pipes because LPG needs to be vaporised and therefore needs a good water flow. The water connection can be made in series or in parallel as regards the passenger compartment heating circuit (picture 6 and 7). In phase of functional inspection of the equipment installed it is important to check that the gas temperature will not reach low values particularly after a long use in power.

The **CNG** Sequent Genius, as it does not have to perform the vaporisation function, is equipped with rubber-holders for 8x15 water pipes. **The connection must be necessarily parallel:** indeed a connection in series made with pipes of such dimensions would strongly decrease the passenger compartment heating.

It is suggested, in this case, to carefully follow the indications of water inlet "IN" and water outlet "OUT" placed on the reducer.

5.2 SEQUENT LPG GENIUS MAX REDUCER

General installation criteria described in the previous paragraph have to be applied for the SEQUENT LPG GENIUS MAX reducer.

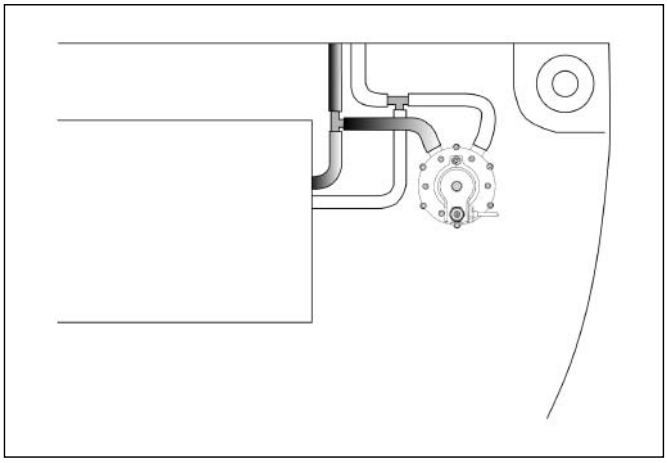
Unlike Sequent Genius reducer, the Genius Max has rubber-holders connections on the outlet so that pipes have to be tightened using the suitable supplied click clamps.

5.3 ZENITH CNG REDUCER

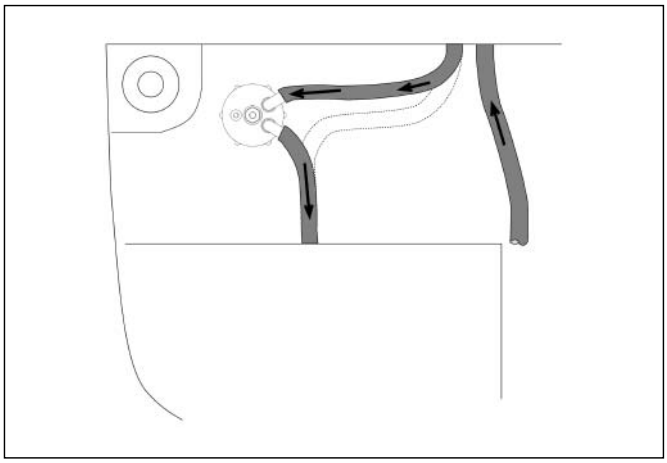
General installation criteria described in § 5.1 have to be applied for the Zenith reducer, too.

As for Genius MAX, the Zenith reducer has rubber-holders connections on the outlet so that pipes have to be tightened using the suitable supplied click clamps.

Picture 05
CNG Sequent Zenith Reducer: example of installation



Picture 06
Reducer heating circuit – parallel type



Picture 07
Reducer heating circuit – series type

5.4 “FJ1” GASEOUS PHASE FILTER

The filter may be fastened to the vehicle’s structure or to the engine with any orientation; but it would be better to position it with the cartridge turned downward (picture 8).

The pipe that connects the filter to the rail should not be longer than 200-300 mm. If you need to tighten or loosen the fittings, we recommend to use always two spanners, in order not to move the component that is screwed on the filter body.

It is recommended to place the filter in an accessible area in order to be able make its programmed replacement.

N.B. During the filter installation it is recommended to follow the direction of the arrow printed on the upper side of the same filter. It represents the exact course of gas flow, or rather from the Sequent Genius reducer to the rail.

Picture 08
“FJ1” gaseous phase filter

Picture 09
“FJ1 TWIN” gaseous phase filter

5.5 “FJ1 TWIN” GASEUOS PHASE FILTER

The above indications are valid for the “FJ1 TWIN” filter too (picture 9). The described filter is available only with rubber-holders connections and can be used only with the Genius MAX.

Picture 10
“FJ1 HE” gaseous phase filter

5.6 “FJ1 HE” GASEUOS PHASE FILTER

The indications in the paragraph 5.4 are valid for the “FJ1 HE” filter, too. The filter is available only with rubber-holders connections.

5.7 RAIL AND INJECTORS GROUP

5.7.1 Installation of BRC injectors on the rail

The rail always has a connection to fix the pipe going to the P1 pressure and it is available is two versions as for the gas inlet that is with threaded connection or with rubber-holder one (see picture 11 page 30).

BRC injectors has to be installed as follow:

- Introduce the O-Ring (1) on the rail seat (2).
- Introduce the O-Ring (3) on the injector threaded part (4).
- Introduce the injector (4) in the rail seat (2).
- Fix the injector to the rail with the washer and nut (5). During the tightening block the injector in the desired position with one hand avoiding its rotation.

Do not use pliers or spanners to block the injector as they can damage the steel body or the plastic covering. Use a maximum torque of 8 ± 0,5 Nm.

- Place the fixing bracket (pictu-

re 6) in the car using the screws and the washers (picture 7).

Please pay attention to the cleaning during assembly to avoid dirtiness damage the injector.

The injector ends with a threaded part to which you have to connect the pipe as indicated in § 5.10.

5.7.2 Installation of KEHIN injectors on the rail

The rail always has a connection to fix the pipe going to the P1 pressure and it is available is two versions as for the gas inlet that is with threaded connection or with rubber-holder one (see picture 12).

Keihin Injectors must be assembled as indicated below (fig. 30A):

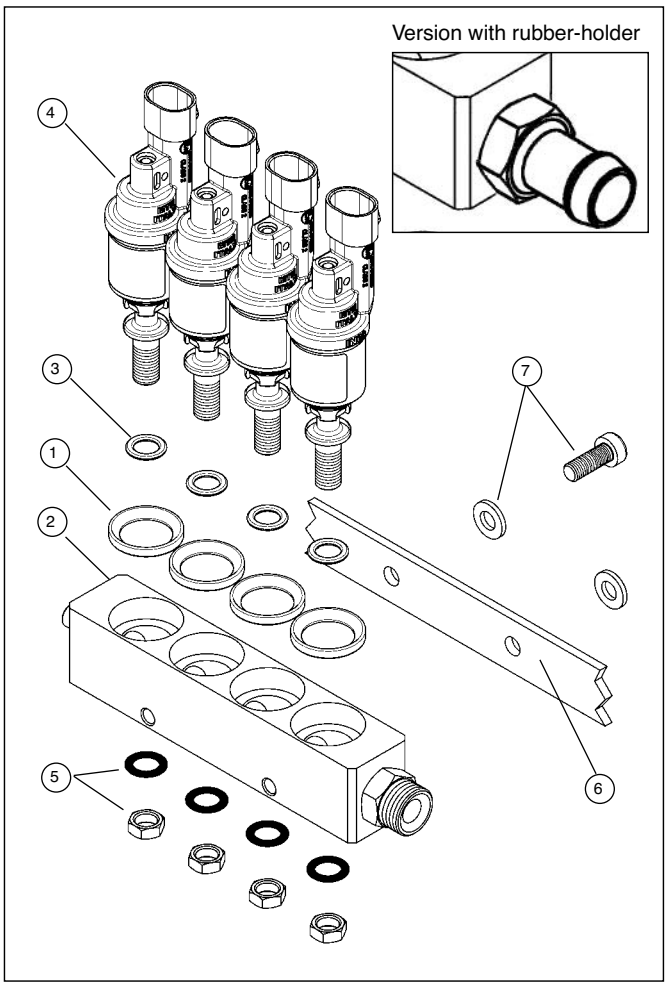
- Mount the rubber ring (1) and the O-Ring (2) in its seat on the injector (3),
- Fit the injector on the rail (4) without cutting or damaging the O-Ring (2). It is suggested to apply a minimum quantity of grease on the O-Ring before the installation. Do not apply too much grease that may overflow and go inside the injector while working.
- Once the injectors are mounted they are fastened to the rail through a suitable bracket (5). Two screws and two washers (6) fix the supporting bracket to the vehicle (7) and the bracket (5).

After installation, the injectors should not have endplay.

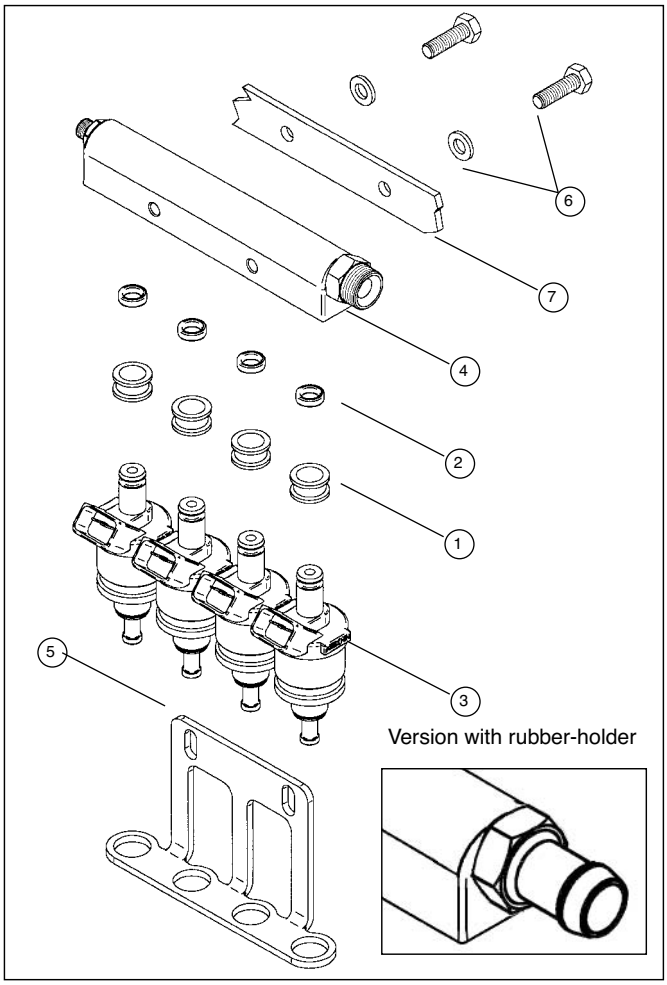
It is recommended to clean carefully during this installation, to prevent any dirties from obstructing the filter placed in the injector inlet, or even worst, damaging the same injector.

The injector ends with a rubber-holder on which the pipe fixed through the supplied click clamp is assembled (see § 5.10).

Picture 11



Picture 12



5.7.3 Installation of BRC injectors on the rail with pressure sensor and gas temperature sensor (in case of Zenith Reducer)

The difference between this rail and the previous ones is the introduction of the new pressure and gas temperature sensor (described in § 4.11) directly placed on the rail body (picture 13).

The rail has not the connection with the P1 pressure sensor (a cap closes the hole) and always has the rubber-holder connection on the gas outlet.

The rail always has a connection to fix the pipe going to the P1 pressure and it is available is two versions as for the gas inlet that is with threaded connection or with rubber-holder one (see picture 11 page 30).

BRC injectors has to be installed as follow:

- Introduce the O-Ring (1) on the rail seat (2).
- Introduce the O-Ring (3) on the injector threaded part (4).
- Introduce the injector (4) in the rail seat (2).
- Fix the injector to the rail with the washer and nut (5). During the tightening block the injector in the desired position with one hand avoiding its rotation.

  Do not use pliers or spanners to block the injector as they can damage the steel body or the plastic covering. Use a maximum torque of 8 ± 0,5 Nm.
- Introduce the washer (6) on the sensor threaded part (7).
- Introduce the sensor (7) in the rail seat (8).
- Place the fixing bracket (picture 9) in the car using the screws and the washers (picture 10).

Please pay attention to the cleaning during assembly to avoid dirtiness damage the injector.

The injector ends with a threaded part to which you have to connect the pipe as indicated in § 5.10

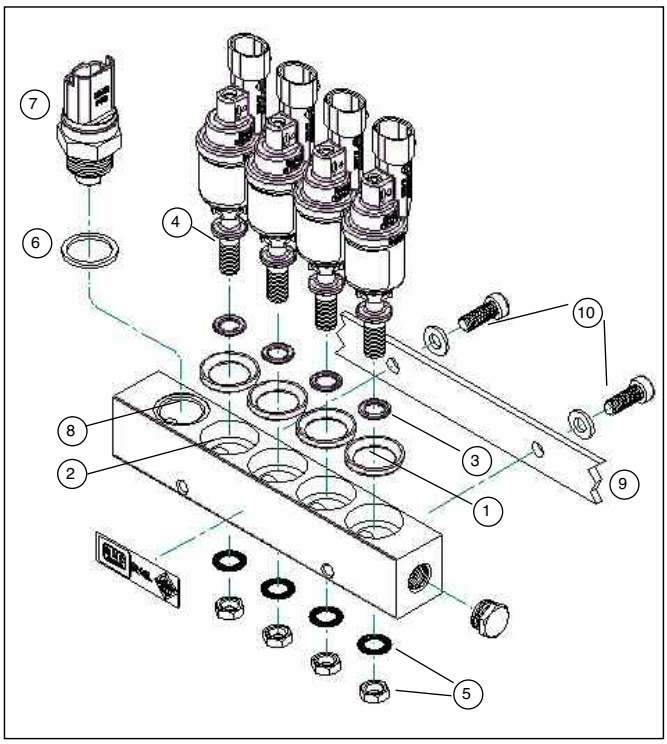


Fig. 13

Picture 14
Example of the rail installation with BRC injectors

5.7.4 Injectors' rail installation in the vehicle

The rail with the injectors can be fixed both to the vehicle and to the engine; the orientation is not important (picture 14 and picture 15 page 32).

The fixing must be stable; it is necessary to place the injectors as close as possible to the engine head so that the air-intake manifold connecting pipes are as short as possible. They should not be longer than 150 mm.

In case of BRC the suitable connection nut has to be assembled on a pipe end as indicated in the § 5.10.

In case of Keihin injectors, pipes must be fixed to the rubber-holder through the click clamp and using the suitable pliers.

Follow the installation criteria for pipes and electric wires indicated in § 5.10 and chapter 6.

As the injectors are not noiseless, it is better not to fix them to the bulkhead that divides the engine from the passenger compartment, because it may become a resonance box that would amplify the noise. In case you are compel-

led to choose this position, it is necessary to equip the fixing bracket with suitable damping systems (silent-block).

5.8 PRESSURE SENSOR (P1-MAP, P1-MAP TURBO)

The **P1-MAP sensor** has to be used in **LPG** applications for **aspirated** engine while the **P1-MAP TURBO sensor** must be always used in **LPG** applications **for boosted engines** and in all **CNG** applications.

The sensor has to be fixed to the vehicle's bodywork (picture 16) avoiding high heat irradiation areas. It is better than pipes are as short as possible and anyway no longer than 400 mm. For the connection see paragraphs 5.10.

Electrical wires should not be too stretched, or twisted and they should not make sudden folds at the sensor outlet.

5.9 MAP SENSOR

This new sensor is dedicated for Sequent Fastness application with Zenith reducer (picture 17).

For assembling instructions follow all the indications in the previous paragraph.

5.10 PIPES

The pipes (picture 18,19 and 20) belonging to the Sequent system are realised by BRC. The pipes ø 10x17 mm supplied in the Sequent kit have a fitting on each ends (picture 18) and pipe ø 5x10,5 mm has the fitting on one end only (picture 19).

The applications for the P1 sensor and for BRC injectors you have to use the ø 5x10,5 mm pipe that must be cut at the desired length to allow installing a rubber-holder with a fitting-nut. In such cases installation will be as follows (picture 20):

• Mount the fitting with rubber-holder (1) on the suitable nut (2).

• Fit the click clamp (3) on the pipe (4).

• Fit the pipe on the previously assembled rubber-holder.

• Tighten the pipe on the rubber-holder with the click clamp and the suitable pliers.

In case of Keihin injectors, use the ø 5x10,5 mm pipe to be fixed on the free end with the click clamps without using the rubber-holder and the connection nut.

Do not leave any rubber residuals while cutting the pipe or fitting the rubber-holder; these chips could obstruct the pipes or other components of the equipment, prejudicing its working.

Before mounting the pipe it is recommended to blow it with compressed air, in order to expel any impurities or residuals. Verify that the clamp guarantees tightness.

Picture 15
Example of the rail installation with Keihin injectors

Picture 16
Example of the P1-Map sensor installation

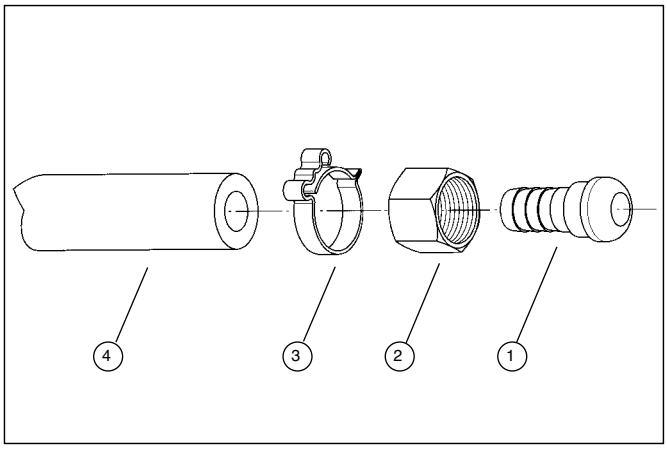
Picture 17
Example of the Sequent Fastness MAP sensor installation

We recommend not to use pipes that are different from the ones supplied and to always mount them using high-quality wrenches in order to avoid damaging the hexagons. Each time it is needed to remove a fitting, use two wrenches, in order to hold firmly the component which is not be unscrewed. The fittings are tight and they seal on conical-spherical surfaces. Do not apply excessive torque wrenches to avoid damaging the fittings.

Do not use any dope. The usual criteria related to the correct installation of pipes should be always respected, without any relative motions on running to avoid rubbings and wears, contacts against sharp edges or driving belts, etc. Once mounted, the pipes should not be too stretched, they should not make any folds or be positioned in such a way to have the tendency to make folds in the future.

Picture 18
gas pipe ø10x17 to be used in all kits where the rail gas outlet is with threaded connection

Picture 19
Gas pipe
ø5x10,5 mm



Picture 20
Pipe-holder assembly

5.11 NOZZLES

The installation of the nozzles is one of the most important operations of the whole installation.

We recommend to clearly spot all the points that will be drilled, before beginning to drill.

Use the specific tools included in the tool-case for the installation of the Flying Injection components code 90AV99004028.

The drill should be quite near the cylinder head, but preserving the same distance on all manifold branches and the same nozzle orientation. Each nozzle has to be perpendicular to the intake-pipe axis, or at least, shape an angle such to convey the flow towards the engine and not towards the throttle-body (picture 21 and 22).

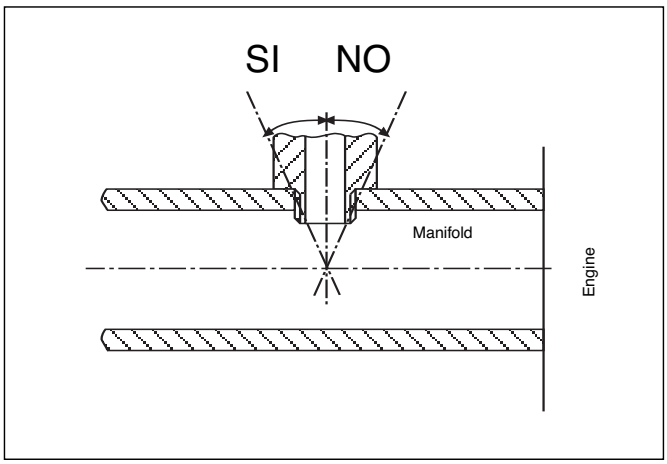
On the plastic manifolds, spot the areas whose walls are as less thin as possible.

After having marked properly the drilling points with a felt-tipped pen, before starting to drill, verify with the drilling-machine equipped with a helicoidal bit, that there are not overall dimensions such to avoid the correct drilling of all branches following the direction wanted. Make a chasing and drill (picture 23).

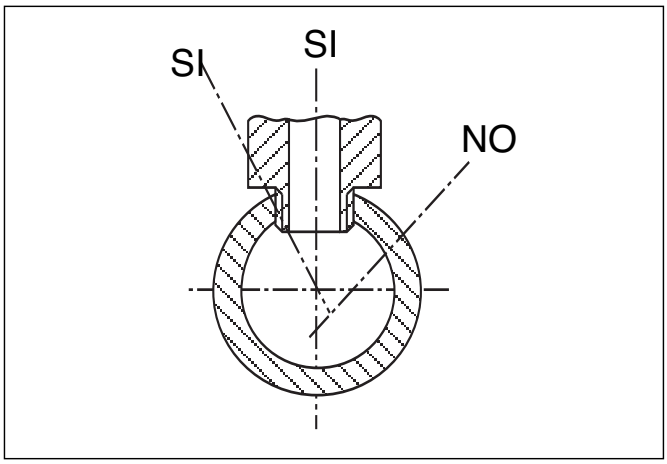
Use a correctly sharpened 5 mm helicoidal bit, and then thread with an M6 screw tap (picture 24).

While drilling and threading, take all necessary measures to prevent the chips from going into the manifold.

In particular, we recommend to frequently remove the chips while drilling and to grease the bit during the breaking last phase of the wall, in order to stick the chips to the bit. The last part of wall should broken slowly so that the chips are very thin: this way the chips stick better to the bit and, if any of them falls inside, it would cause no damages. Even during the M6 threading, it is necessary to grease, extract and

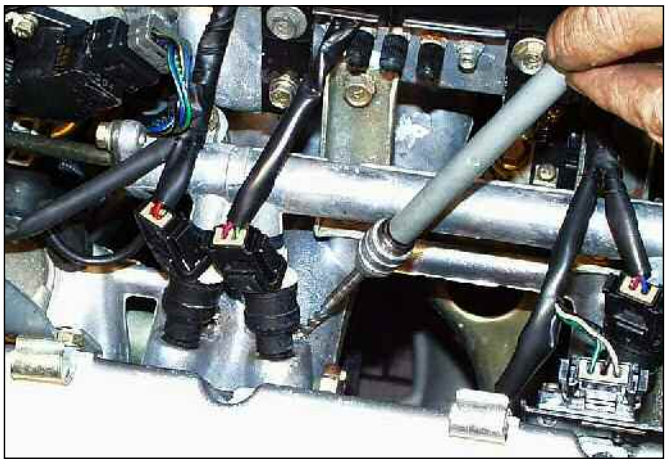


Picture 21
Inclination of the drilling on manifolds



Picture 22
Orientation of the holes on the manifolds

Picture 23
Drilling of manifold



Picture 24
Threading of manifold

often clean the screw tap.

By using the two 10-mm wrenches (fig. 39), screw every single nozzle to the fitting of the 10x17 pipe.

By using two 10 mm wrenches (picture 25) screw each nozzle to the used ø 5x10,5 mm pipe connection. Using some Loctite 83-21 (picture 26) screw the nozzle and the pipe on the manifold hole. Fit the nozzles correctly in order to avoid tightening them excessively and stripping them.

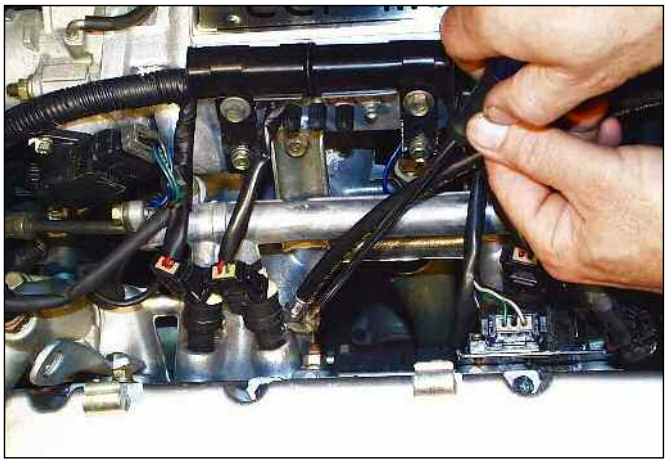
During the clamping phase it is recommended to always use a proper wrench, as the one contained in the tool-case code 90AV99004028.

Do not change either the inside diameter of the nozzles or their outside shape.

N.B. In presence of small diameter air-intake manifolds, it can be necessary to mount some special nozzles, shorter than the standard ones.

Picture 25
Nozzle clamping on pipe-fitting
Solo per injectors BRC

Picture 26
Threads-blocker product
Only for BR injectors



Picture 27
Nozzle clamping with pipe on manifold

5.12 ECU (ELECTRONIC CONTROL UNIT)

It can be fixed both inside the passenger and in the engine compartment (picture 28 and 29 page 36). Use the fixing holes on the aluminium body avoiding to subject the structure to excessive stresses (e.g.: do not fix the ECU on a convex surface, thinking you can tighten the bolts thoroughly and level

Picture 28
ECU installation inside passenger compartment

everything). If available, use always the suitable fixing bracket.

Avoid too hot areas or subjected to high thermal radiation. Even though the ECU is waterproof, avoid installing it in areas subjected to continuos dripping water in case of rain, so that the water does not penetrate and stagnate in the harness or sheaths.

No adjustment is programmed on the ECU; it is therefore not important it is easily accessible. It is more important, instead, that the cable going from the ECU with the computer connection is placed in a very accessible area and protected by the cap from possible water infiltration.

5.13 CHANGE-OVER SWITCH

Choose an easily accessible and visible place for the driver and fix the device with the screws supplied. Substituting the label with the spare one, the changeover switch can also be installed in vertical position. Eliminating the external body, the changeover switch can be directly built in the vehicle's dashboard using the special tool to drill, code 90AV99000043.

Specific built-in changeover switches are also available for every single vehicle; they are to be positioned in place of the original switch-cover plates. Please refer to the price list in force to know the available models.

Make anyway sure it is always a specific changeover switch in the two-position version with buzzer.

5.14 HARNESS

The harness of the Sequent system guarantees the correct transmission of every inlet and outlet signal of the ECU. From a "mechanical" point of view, it is recommended to place the harness very carefully and to avoid forcing on the connections (never pull the wires to let the connector go through a hole or to disconnect it!!!). Avoid making too remarked folds, too strong clamping, sliding against moving parts, etc. Avoid certain pieces of wires from being too stretched when the engine is under stress. Fix opportunely the pieces of wire near the connectors, to prevent their dangling from wearing them out in the future. Avoid any contact with sharp edges (burr the hole rims and mount some wire-leads). Avoid placing the wires of the Sequent system too close to the spark plug cables or to other parts subjected to high voltage.

Picture 29
ECU installation in the engine compartment

Each connector is polarised, for this reason it is fitted without stress only in the right direction.

Important: all not pre-cabled connections should be carried out through electric brazing (soft soldering) and opportunely insulated. The soldering should not be "cold" and should not risk coming off in the future. Any unused wire of the harness should be shortened and separately insulated. Never use welders that are connected to the battery of the same vehicle, or welders of the quick type.

5.15 INSTALLATION TYPES

For various mechanical and electrical installation types, please refer to the specific handbook 2/3.

6. ELECTRICAL CONNECTIONS

The following general installation rules are to be considered indispensable for a good understanding of the system.

The FLY SF ECU must be connected with the electric equipment of the SEQUENT system (supplies, grounds, signals, sensors, actuators, etc.) through a 56-pole connector that contains all the necessary signals for the various operations, as regards the piloting up to 4 injectors.

The two-connector (56-way connector and 24-way connector) version, the ECU can control vehicles up to 8 cylinders. Most of the harness wires end on pre-cabled connectors, therefore it becomes very easy to connect the components of the system to the ECU. Furthermore, the conductors are divided into more sheaths, in order to simplify the installation and the identification of the various wires.

All the connections of the wires that do not end on a connector should be executed by well-done and duly insulated soft soldering. Avoid any connections by simply twisting the wires or using other scarcely reliable systems. For the mechanical assembly and the location of the harness, make reference to the paragraph 5.14 of the present handbook.

6.1 CAUTIONS AND DIFFERENCES COMPARED WITH PREVIOUS SYSTEMS

The SEQUENT system differs from other BRC systems in some essential points. It is fundamental to take note of the cautions contained in this paragraph to avoid installation mistakes that can cause the breaking of the gas equipment components or even damages to the vehicle's original equipment. All the Sequent ECU harness terminals are waterproof in compliance with the latest European regulations.

Considering the introduction of the new Sequent Fastness (Zenith reducer, Rail with pressure and gas temperature sensor and Map one) it is necessary to clearly recognised the new main harness for Sequent Fastness (picture 15 page 46) from the old one for Sequent (picture 2 page 38). For this reason, the following paragraph will describe all the electrical changes of the new Fastness Main Harness.

6.2 SEQUENT MAIN HARNESS (REFER TO GENERAL WIRING PLAN IN PICTURE 2)

6.2.1 CONNECTION OF THE SOLENOID VALVES

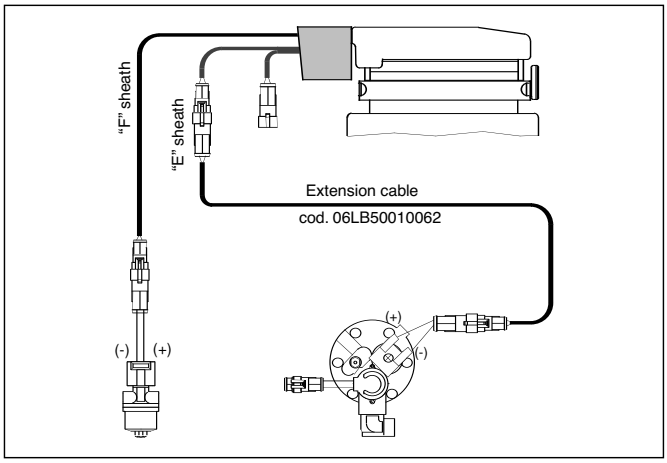
An important difference compared to other BRC systems, that can cause mistakes if it is not taken into account, is the connection of the solenoid valves. In the previous systems, a terminal of the solenoid valve was perpetually connected to the ground (usually to the vehicle's body, near the solenoid valve itself), while the other terminal was coming from the gas equipment ECU. In the SEQUENT the philosophy is different and is similar to the one used to pilot the injectors and other actuators on the original petrol equipment. No solenoid valve terminal is connected perpetually to the ground, but a wire comes from the +12V battery (through fuse and relay), while the FLY SF ECU controls the other.

Do not connect directly the solenoid valve terminals to the ground: that may cause a short-circuit and will burn the fuses on the harness and/or prejudice the correct operation of the equipment.

Another difference is that there are piloting wires, separated for the front and back solenoid valve. This separation allows the FLY SF ECU understanding whether and, in case, which of the two solenoid valves is burnt or in short-circuit. It is therefore necessary to avoid connecting the two solenoid valves in parallel: this may prejudice the ECU diagnosis function (picture 1).

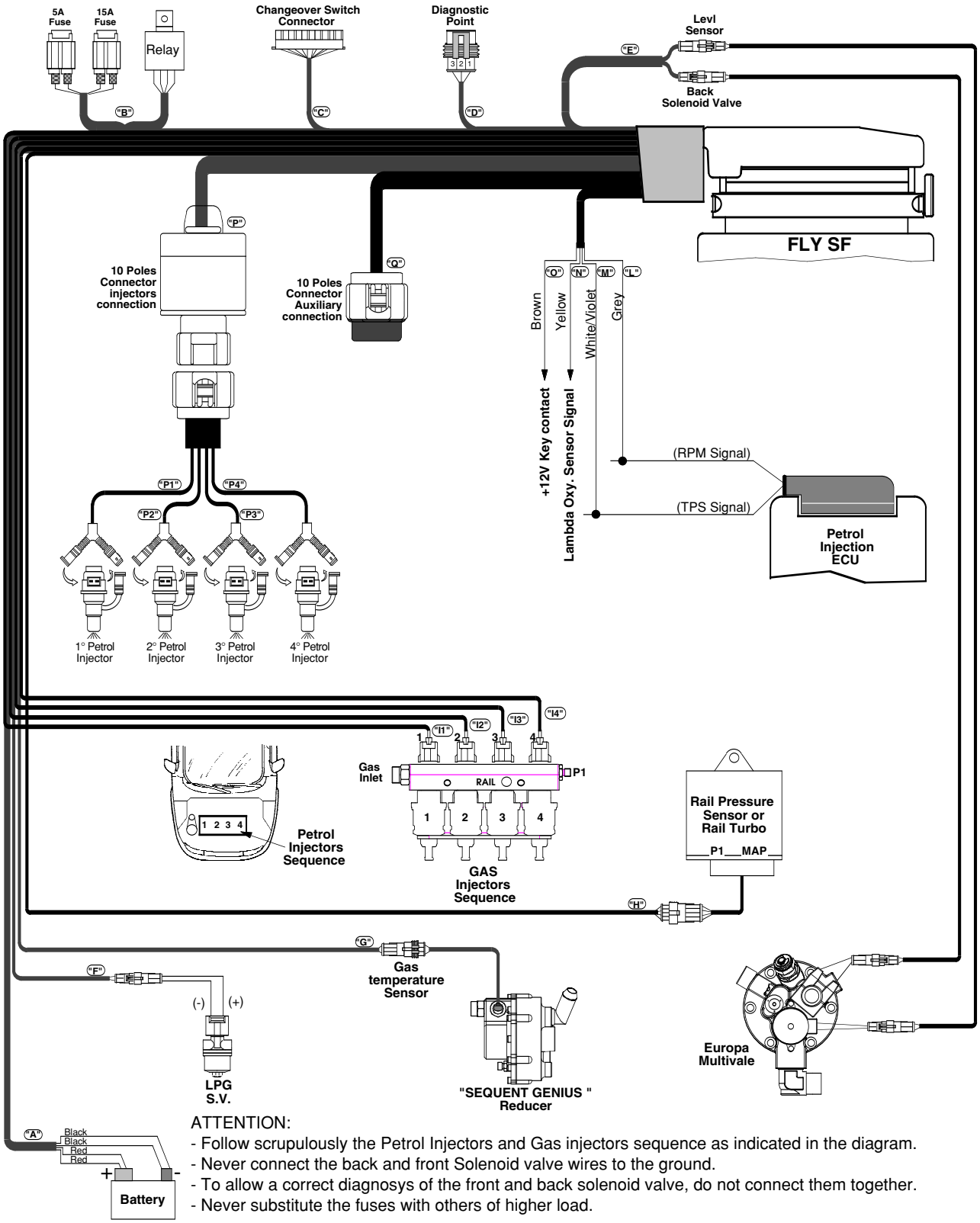
6.2.2 56-POLES HARNESS

As the 56-pole connector used by the SEQUENT system **is the same already used for the Flying Injection**, even considering the similarity of the external structure of systems, it is possible to confuse the



Picture 01
Connection of front and back solenoidvalves

Picture 02 - General wiring diagram



ATTENTION:
- Follow scrupulously the Petrol Injectors and Gas injectors sequence as indicated in the diagram.
- Never connect the back and front Solenoid valve wires to the ground.
- To allow a correct diagnosys of the front and back solenoid valve, do not connect them together.
- Never substitute the fuses with others of higher load.

ECU of a system with the other one, fitting it in the wrong equipment.

Such an error must be avoided, as it can damage the ECUs and/or the original equipment of the vehicle.

If, after the installation of the equipment and the ECU, the vehicle does not start up, it is a good tip not to insist, before having checked that the ECU is of the correct type.

6.2.3 Sequent Genius and gas temperature sensor

The temperature sensor contained in the Genius Sequent, Genius M and Genius Max is different from the one used for the Flying Injection.

Confusing the two sensors and mounting the wrong one, the ECU will not be able to determine the correct gas temperature, to act correctly the programmed changeover strategies and to make the corrections in the injection times that depend on the gas temperature, while running on gas.

6.2.4 Supplies and ground from battery

Sheath “A” in figure 2 contains two red and two black wires to be connected to the car battery: the red wires to the positive and the black ones to the negative. It is important to connect the wires as they are, allowing that they reach separately the terminals of the battery, without joining the wires of same colour in an only wire or joining them along the harness.

The grounds must be always connected to the battery negative and not to the vehicle’s structure, engine ground or other grounds present on the vehicle.

6.2.5 Fuses and Relay

At the outlet of the sheath “B” (see picture 2) there are the two 15A and 5A fuses of the SEQUENT equipment. The harness is supplied with the two fuses with correct amperage, fitted in the right place. It is recommended not to substitute the fuses with others of different amperage and not to invert their position. The 5A fuse will be fitted in the fuse-holder with the smaller section wires, while the 15A fuse will be fitted in the fuse-holder with the larger section wires.

At the outlet of the sheath “B” there is also a relay that the SEQUENT utilises to interrupt the battery positive coming from the actuators.

After finishing the connections, it is recommended to properly fix and protect both the fuses and the relay.

6.2.6 Change-over switch

The 10-pole multipolar cable “C” inside the harness, ending on the 10-way connector, is used for the connection of the ECU to the changeover switch placed in the passenger compartment (picture 2). In order to make easier its passage across the wall openings, it is suggested to bend the connector by 90° to make it parallel to the wires.

The SEQUENT equipment uses the BRC two-position changeover switch with buzzer (see BRC Price List for sale codes).

6.2.7 Diagnostic point

The PC connection to the FLY SF ECU is based on a diagnostic point, directly coming from the harness. It is the 3-way connector diagnostic point (female-holder on the harness), equipped with a protection cap. The diagnostic point is usually placed near the 56-pole connector of the ECU. The connecting cable “D” differs from the one used for the connection of the PC on the Flying Injection system, for the type of connector. For the PC connection it is necessary to use the suitable cable code DE512114.

6.2.8 Level sensor

The resistive type level sensor has to be connected directly to the harness through the 2-pole connector, pre-cabled (Sheath “E” on drawing of picture 2). There is no error possibility, because the connector of the level sensor is the only one of this type. The connection between the ECU and the sensor can be made through the special extension cable (06LB50010062) ended on the special connector of the resistive sensor for the Europa Multivalve. The sheath “E” also contains the 2-pole connector for the back solenoid valve connection (see par. 6.2.8).

6.2.9 Solenoidvalves

The solenoidvalves has to be connected to the harness through the pre-cabled connectors connected to the wires contained in the sheaths “E” and “F”. The front solenoid valve will be connected to the connector of the sheath “F”, while the rear one (“Europa” multivalve) will be connected to the connector of sheath “E” through a suitable extension cable code 06LB50010062 (picture 1 page 37 and 3 page 40).

The sheath “E” also contains the connector for the resistive level sensor described in par. 6.2.8.

6.2.10 Gas temperature sensor

The temperature sensor, placed on the pressure reducer, is of the two-wire resistive type, based on NTC thermistore. It is a sensor, which is different from the one used in the Flying Injection equipment. By confusing the two sensors and mounting the wrong one, the ECU will not be able to determine the correct gas temperature, to act cor-

rectly the programmed changeover strategies and to make the corrections in the injection times that depend on the gas temperature, while running on gas. The connection with the harness comes through the special 3-way connector (male-holder on the harness) on which the 2 wires contained in the sheath “G” of the harness end.

6.2.11 Rail P1 pressure sensor and Manifold absolute pressure sensor (MAP)

The P1-MAP pressure sensor is connected to the harness through a suitable pre-cabled connector, which is connected to the wires, contained in the sheath “H”.

The P1-MAP pressure sensor is a device containing two sensors in the same box: one to measure the gas pressure inside the injector supplying rail and the other one to measure the air-intake manifold pressure.

6.2.12 Gas injectors

The gas injectors are connected to the harness through the wires with pre-cabled connectors contained in the sheaths “I1”, “I2”, “I3”, “I4” (see picture 2).

The connectors of the gas injectors are numbered from 1 to 4 (or from 1 to 8 with the two-connector ECU); the same for the sheaths of the wires that will be connected to the petrol injectors.

It is very important to maintain the correspondence between gas and petrol injectors.

In practice, the gas injector connected to the connector n° I1 should correspond to the cylinder containing the petrol injector to which we will connect the injector connection Sequent plug (or the Orange and Violet wires of the universal injector connection Sequent harness) marked with the n° P1,

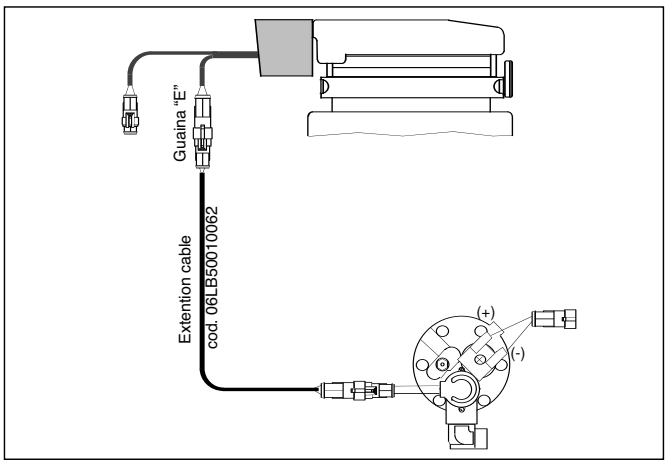


Fig. 03

and so on. In case there is no correspondence, you will note a worsening in the equipment performances, such as, for example: worse driving conditions, higher unsteadiness of the lambda control, less “clean” petrol/gas changeover, etc.

The number that distinguishes the gas injectors’ connectors is stamped on the harness wires coming to the same connector.

6.2.13 RPM signal

The SEQUENT system is able to acquire the engine speed signal (often indicated as “rpm signal”) by connecting directly to the rpm indicator.

It is sufficient to connect the Grey wire contained in the sheath “L” to the original equipment rpm indicator signal wire going from the petrol ECU to the revolution counter in the dashboard. This wire is not to be cut but only stripped, welded with the wire of the SEQUENT harness and insulated (picture 2 page 38).

6.2.14 TPS signal

In the sheath “M” there is the White/Violet wire to be connected to the TPS wire (throttle valve position sensor) of the original equipment; this wire should not be cut, but only stripped, soldered with the wire of the SEQUENT harness and insulated. The TPS wire, if not correctly connected, can enable the SEQUENT system to work nevertheless in a sort of steady condition but it can deteriorate the driving conditions, in particular in sudden accelerations and tip-outs.

6.2.15 Oxygen sensor signal

In the sheath “N” there is the Yellow wire to be connected, **if necessary,** to the wire of the Lambda Oxygen sensor, placed before the catalyst. This wire is not to be cut but only stripped, welded with the wire of the SEQUENT harness and insulated.

The connection of the Yellow wire allows a quicker self-learning by the FLY SF ECU and is therefore very useful in the event of the self-learning phase requiring a further configuration refinement (refer to the software hand-book).

6.2.16 Positive Key contact

The Brown wire of the SEQUENT equipment, contained in the sheath indicated with the letter “O” in picture 2, has to be connected to the key contact positive signal of the original equipment. This wire has not to be cut but only stripped, welded with the wire of the SEQUENT harness and insulated.

6.2.17 10-Pole-connector

FOR PETROL INJECTORS HARNESS CONNECTION

The interruption of the petrol injector is possible by using the "P" sheath ending with a 10-pole-connector. You only have to connect one of the specific harnesses for the petrol injectors' stopping according to the type in the vehicle (Bosch or Sumitomo).

List of the codes for **Bosch** connector harnesses:

- code 06LB50010102 Right (DX) Sequent connection harness for 4 petrol injectors
- code 06LB50010103 Left (SX) Sequent connection harness for 4 petrol injectors,
- code 06LB50010105 Right (DX) Sequent connection harness for 2 petrol injectors,
- code 06LB50010106 Left (SX) Sequent connection harness for 4 petrol injectors,
- code 06LB50010101 Universal Sequent connection harness for 4 petrol injectors,
- code 06LB50010104 Universal Sequent connection harness for 2 petrol injectors,

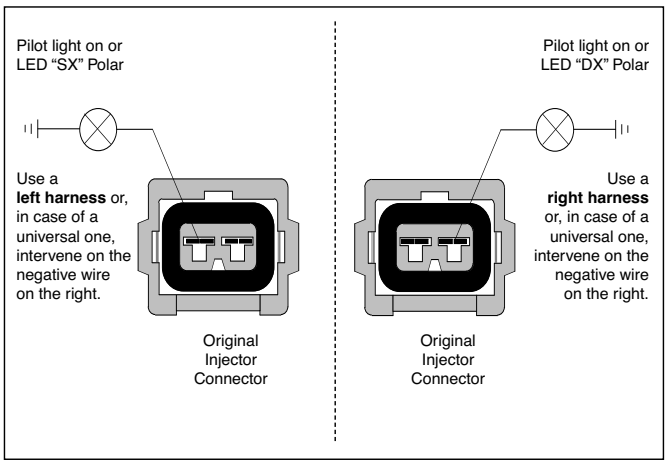
to be chosen according to the petrol injectors' polarity.

List of the codes for **Sumitomo** connector harnesses:

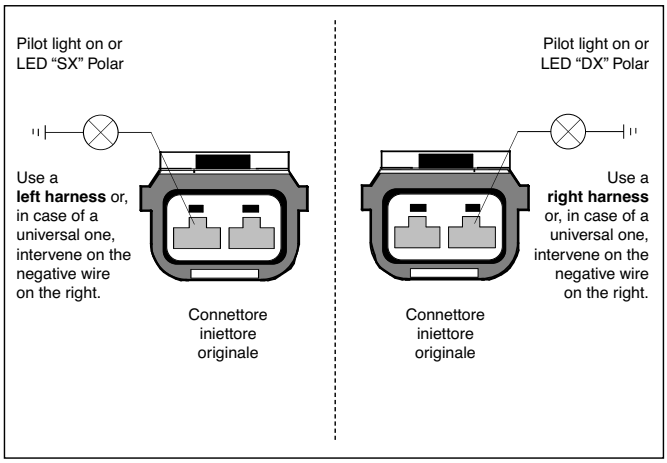
- code 06LB50010113 Right (DX) Sequent connection harness for 4 petrol injectors,
- code 06LB50010114 Left (SX) Sequent connection harness for 4 petrol injectors,
- code 06LB50010115 Right (DX) Sequent connection harness for 2 petrol injectors,
- code 06LB50010116 Left (SX) Sequent connection harness for 2 petrol injectors,

to be chosen according to the petrol injectors' polarity.

The connection is very easy and the philosophy is the same BRC used from the beginning.



Picture 04a
Bosch connector



Picture 04b
Connector type Sumitomo

To select the right harness you only have to follow the instructions inside the single packages.

It is important to keep the same injection sequence we have during the petrol operation while operating with gas. It is necessary to stop the petrol injectors' signals with the same order you will follow to connect the gas injectors.

You could pair a consecutive number to each cylinder (i.e. from 1 to 4 in case of a 4-cylinder engine and note that this order only help to carry out the SEQUENT installation so that it could be different from the one the car manufacturer assigned). Generally in case of a transversal engine you will indicate as number 1 the cylinder placed on the cam belt side (see picture 2)

The petrol injector sprinkling in the first cylinder will be stopped with the group 1 of the Sequent petrol Injectors' Connection Harness (or with the Orange and Violet wires identified with the number 1 of the Universal Petrol Injectors' Connection Harness) and so on.

The numbers identifying both gas and petrol injectors are printed directly on the harness connection wires.

6.2.17.A Polarity of the injectors

For the selection of the correct injectors' interruption **harness** (**Right** or **Left**) or to precisely know what is the negative wire (in case you prefer to use the **Universal harness**) it is important to know the injector's polarity that is where the positive wire is placed in order to intervene on the Negative one.

Referring to the picture number 4 it is necessary to:

- Disconnect the connectors of all

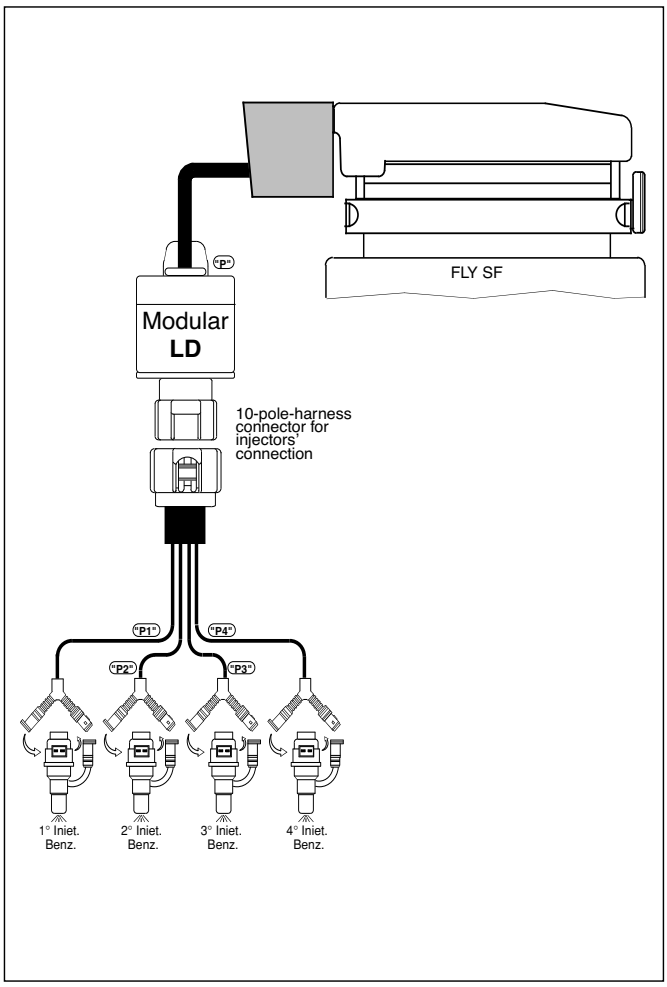
the injectors and, if necessary, all other connectors if installed upstream (before doing this, please contact BRC technical Assistance Service)

• Switch the dashboard on

• Find out which pin of each female connectors just disconnected has a +12 V voltage (use the POLAR device code 06LB00001093 or a pilot-light. [Check all of them!!]

• If watching the connector as indicated in the picture 4 (pay attention to the reference teeth) the +12V wire is on the right you have to use a RIGHT Harness. If you are installing a Universal harness you will have to stop the negative wire (on the left).

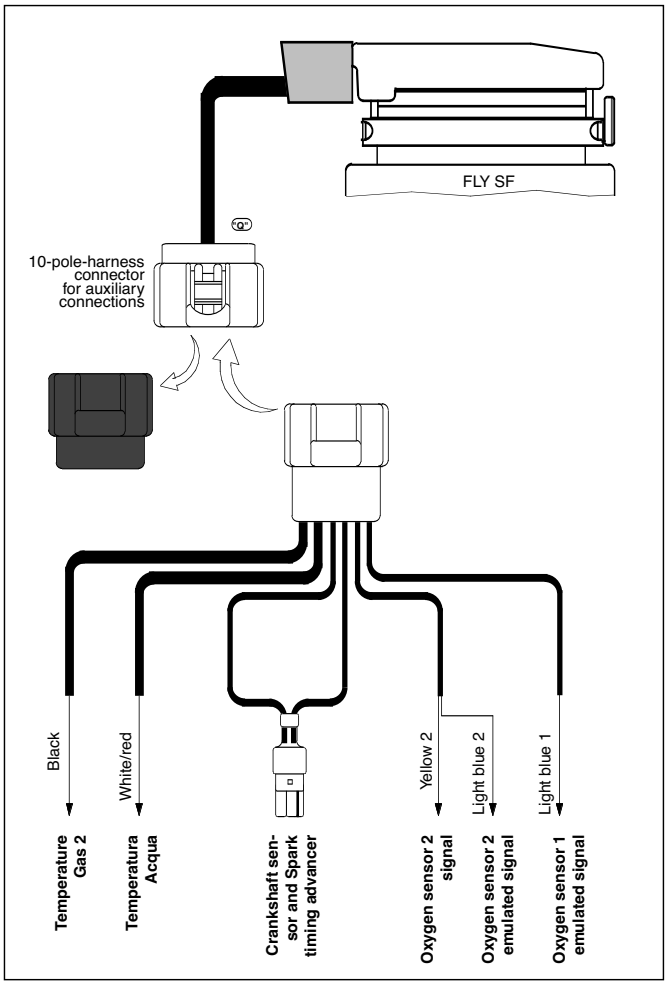
• If the feeding is on the left use the LEFT Harness. If you are installing a Universal harness you will have to stop the negative wire (on the right).



Picture 05

6.2.17.B Modular LD

As can be seen from paragraph 4.18, even when you should use an additional resistive-inductive load, it is not necessary to add any outside modules but simply to connect the male of the Sequent harness with the female connector of the DX/SX or universal injectors harness (picture 5). This connection enables to supply a resistive-inductive load to the original petrol ECU.



Picture 06

6.2.18 10-POLE CONNECTOR FOR AUXILIARY HARNESS CONNECTION

In case of “particular” vehicles, SEQUENT offers the possibility, through the sheath “Q” ending with a 10-pole connector, to take other signals that are not usually necessary in most vehicles converted.

In this connector it is sufficient, after having removed the protecting cap, to fit the specific auxiliary connection Sequent Harness code

06LB50010100, from which 5 wires and 1 connector are shunted to realise the auxiliary connections (picture 6).

The further possible connections, due to the 5 wires and the connector of the auxiliary connection Sequent harness are the following:

Connector:
Crankshaft sensor signal
and
Timing Advance Processor

Black wire:
Gas Temperature 2

White/Red wire:
Water Temperature

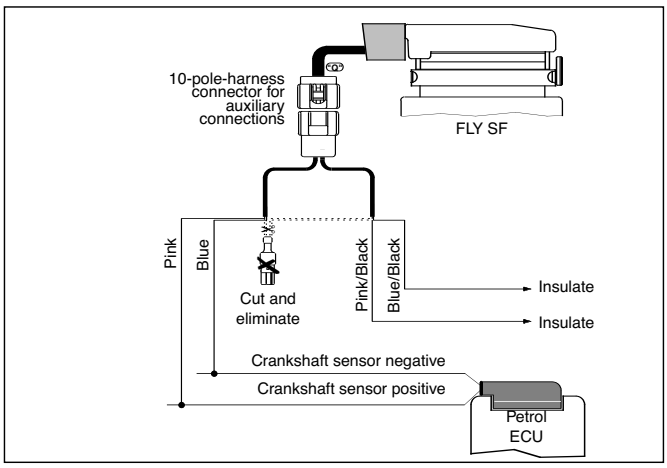
Light blue wire (Gr. 1):
Emulated Lambda Signal
Lambda Sensor 1

Yellow wire (Gr. 2):
Lambda Signal Sensor 2

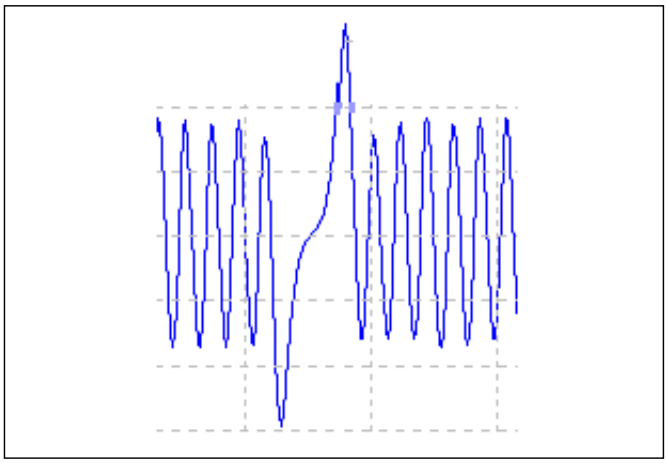
Light blue wire (Gr. 2):
Emulated Lambda Signal
Lambda Sensor 2

Warning: for the possible connection of the Auxiliary Harness wires, please refer to the instructions inside the package, to the specific wiring diagrams of every single vehicle or ask the BRC after-sales service.

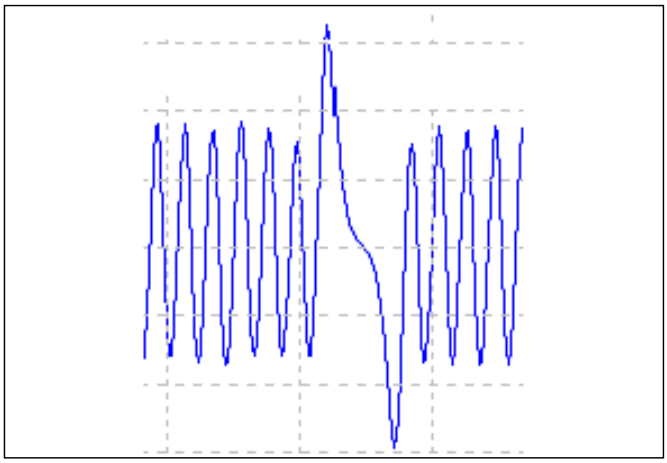
It is recommended to insulate the unused wire terminals and connector.



Picture 07



Picture 08
Negative



Picture 09
Positive

6.2.18.A Crankshaft Sensor Signal

The SEQUENT system is able to acquire the rpm speed signal by connecting the Grey wire directly on the rpm indicator signal.

If this signal is not available or does not have such operations to be interpreted by the FLY SF ECU, it is possible to take the **Crankshaft sensor** signal through the Connector present on the Auxiliary Connection Harness.

First it is necessary to remove this connector to obtain the following 4 wires:

Blue
Pink
Blue/Black
Pink/Black

These last two wires (along with the remaining 5 wires of the Auxiliary Harness) should be insulated singularly.

It is sufficient to connect the Sequent Auxiliary Harness Blue and Pink wires respectively to the negative and positive of the crankshaft sensor (picture 7), without interrupting them. The negative and positive of the crankshaft sensor are recognisable by the signal present on the wires that, if it is displayed by a cathode-ray oscilloscope, in correspondence with the

reference “hole”, has the trend illustrated in pictures 8 and 9.

If you do not have the cathode-ray oscilloscope, you can connect the wires to the signal without worrying about the polarity, and then verify that, in all the working conditions of the engine, the r.p.m. are correctly read; if not, or in case you have an irregular gas operation of the vehicle, you have to try to invert the polarity.

If you use this connection, cut and insulate the “L” grey wire (§ 6.2,13).

6.2.18.B Signal for the Ignition Timing Advance Variation

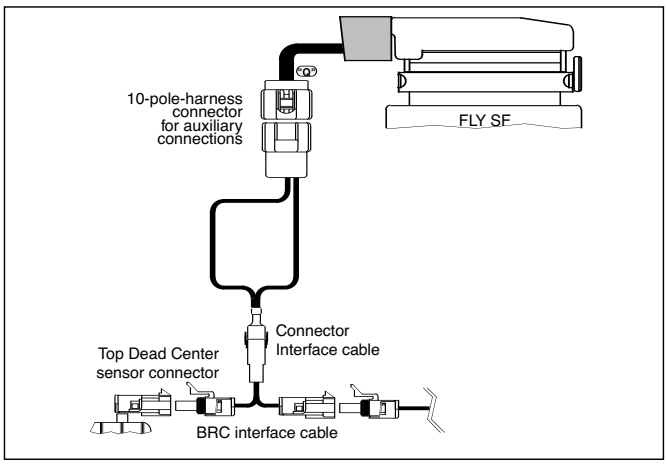
If you want to use the “timing advance” function, the FLY SF ECU is equipped with, and the connector of the vehicle Top Dead Center sensor **is plug-compatible** with one of the specific interface cables supplied by BRC, the diagram to be followed is represented in picture 10.

In this case it is **NOT** necessary to remove the connector of the Auxiliary Connection Harness, but it is possible to connect it to one of the Timing Advance Processor Harnesses normally used for the Aries electronic Advance Processor (for the correct choice refer to the specific wiring diagrams of the single vehicles or to the BRC Price List: Timing Advance Processors - Different Devices -).

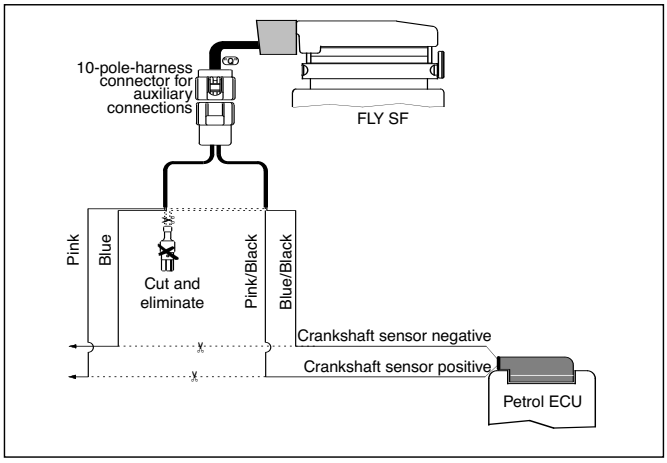
If you want to use the “timing advance” function, the FLY SF ECU is equipped with and the connector vehicle of the Top Dead Center sensor is **NOT plug-compatible** with one of the specific interface cables supplied by BRC, the diagram to be followed is represented in picture 11.

In this case **it is necessary to remove** the connector of the Auxiliary Connection Harness, obtaining thus the following 4 wires:

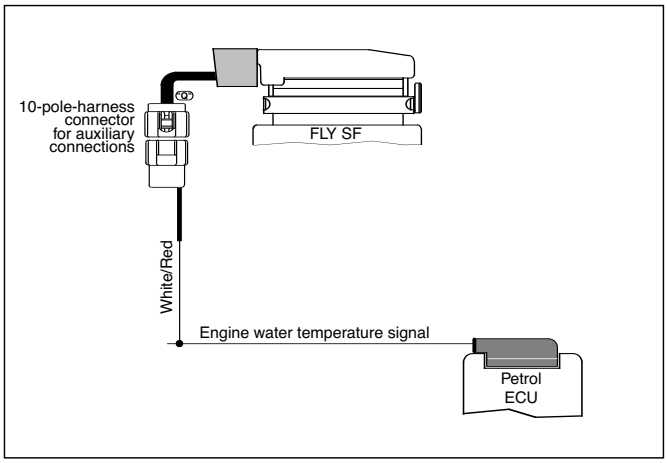
Picture 10



Picture 11



Picture 12



Blue
Pink
Blue/Black
Pink/Black

The wires going from the crankshaft sensor to the petrol ECU should be interrupted. The Pink and Blue ones have to be connected to the side that goes towards the crankshaft sensor, while the Blue/Black and Pink/Black wires will have to be connected to the side going to the petrol ECU. As regards to the polarity of the Pink and Blue wires, see the previous paragraph.

For what concerns the connection of the Blue/Black and Pink/Black wires, the Blue/Black wire should be connected to the Petrol ECU side of the wire to which the Blue wire has been connected on the crankshaft sensor; the same for the Pink and

Pink/Black wires.

Pay Attention to the fact the Spark timing function is not available for 8 cylinder vehicles ECUS.

In case you use this type of connection, cut and insulate the "L" grey wire indicated in the electrical plans on the "Types of Installation 2/3" Guide.

6.2.18.C Engine Water Temperature Signal

This signal is sometimes useful to compensate the cold enrichment programmed by the carmaker that can be counterproductive in the gas operation. This kind of connection is normally for CNG applications.

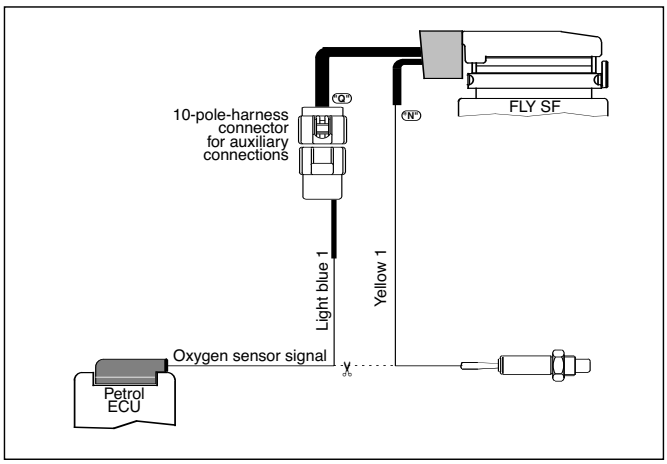
For its correct use it is recommended to refer to the BRC indications. The signal is taken on the wire of the engine water sensor of the original equipment of the vehicle. This wire should not be cut, but only stripped and soldered with the White/Red wire of the SEQUENT Harness for Auxiliary connections (picture 12).

6.2.18.D Lambda Oxygen Sensor Signal

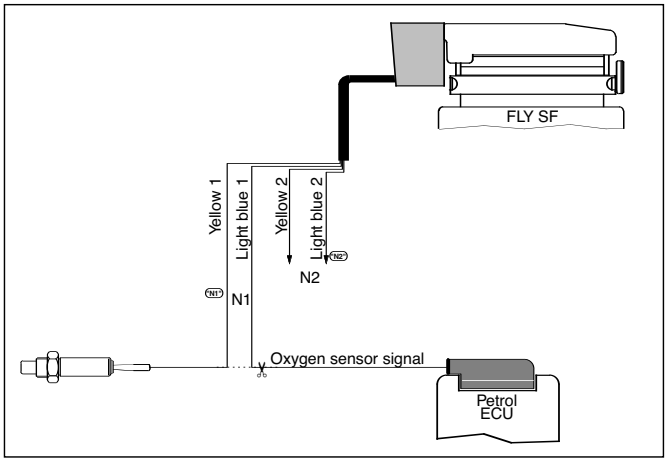
In the SEQUENT system the Lambda oxygen sensor signal is not normally taken and emulated.

The possible connection of the Yellow wire going out from the main harness allows a quicker vehicle self-learning. In case of emulation of the Lambda oxygen sensor signal, it is necessary to cut the wire going from the ECU to the Lambda oxygen sensor, connect the Light blue "1" wire of the Auxiliary Harness from the ECU side to the Yellow "1" wire of the Lambda oxygen sensor side (picture 13).

These connections should be realised only on particular vehicles, on the BRC after-sales service's advice.



Picture 13



Picture 14

In case of two-bank vehicles, Sequent offers the possibility to act on the second Lambda oxygen sensor, through the Yellow "2" and Light blue "2" wires present on the Auxiliary Harness.

These last connections too should be only realised on particular vehicles, on the BRC after-sales service's advice.

6.3 SEQUENT FASTNESS MAIN HARNESS (REFER TO GENERAL WIRING PLAN IN PICTURE 15)

In the following paragraphs only the differences compared to the previously described Sequent Harness (see § 6.2) will be described to avoid useless repetitions.

As you may note in the two general wiring plans in picture 2 page 38 and picture 15 page 46 there are some important differences.

In the Sequent Fastness one (picture 15) the 10-pole connector for the auxiliary connection has been eliminated while a 5-pole ones for the crankshaft sensor and for the spark timing managing and/or rpm reading has been added.

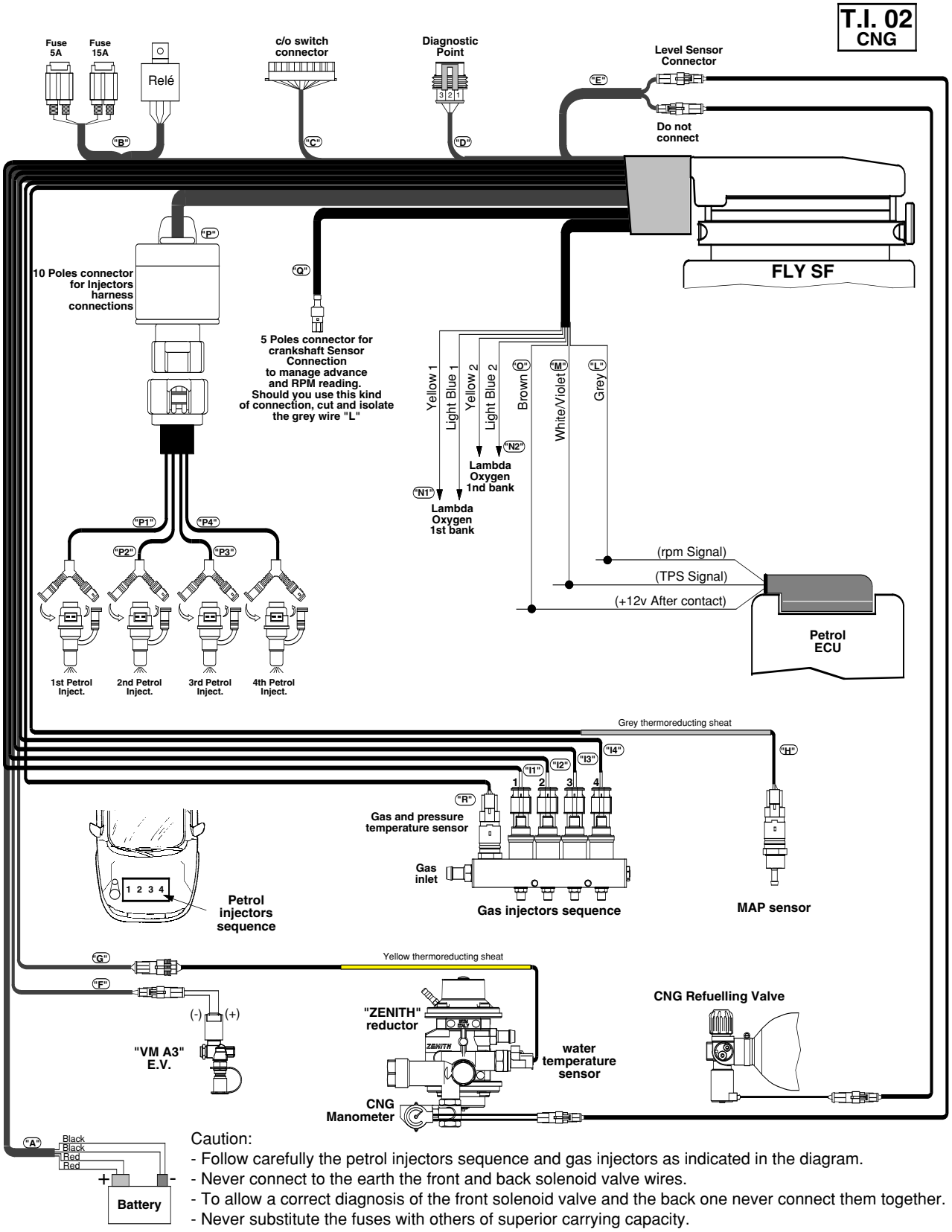
The black wire (gas temperature 2) and the White/Red one (water temperature) have been eliminated and the last one is incorporated on the Zenith reducer.

6.3.1 ZENITH SEQUENT FASTNESS AND WATER TEMPERATURE SENSOR

The connection to the harness is made with the suitable 4-pole connector (male holder on the harness) where the 3 wires contained in the harness "G" sheath end.

In the final part about 10 cm of yellow thermo-narrowing is introduced to avoid confusion

Picture 15 - Sequent Fastness General wiring diagram with Zenith Reducer



Caution:

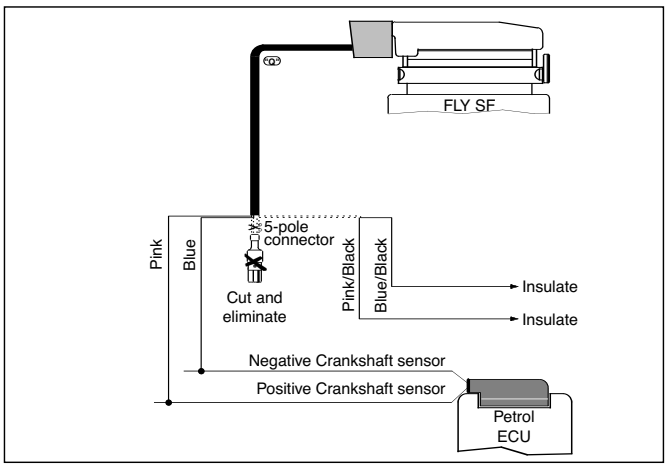
- Follow carefully the petrol injectors sequence and gas injectors as indicated in the diagram.
- Never connect to the earth the front and back solenoid valve wires.
- To allow a correct diagnosis of the front solenoid valve and the back one never connect them together.
- Never substitute the fuses with others of superior carrying capacity.

with other connectors.

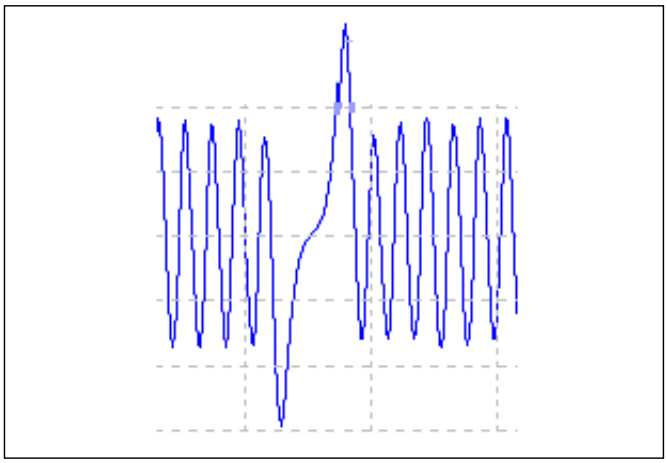
6.3.2 Pressure and Gas temperature sensor

The pressure and gas temperature sensor as described in paragraph 4.12 is placed directly on the rail (dedicated for BRC injectors). The connection to the harness is made through the suitable 4-pole connectors (male holder on the harness) where the 4 wires contained in the harness "R" sheath of the harness end.

Also in this case as before, in the final part of the harness, about 10 cm of grey thermo-narrowing are introduced.



Picture 16



Picture 17
Negative

6.3.3 Absolute pressure sensor MAP

The new conceived MAP pressure sensor is connected to the harness through suitable precabled connector, joint to the wires contained in the "H" sheath.

6.3.4 Oxygen sensor signal (Row 1 and Row 2)

The SEQUENT system does not usually include the picking up and emulation of the Lambda Oxygen sensor signal.

The possible connection of the Yellow wire coming out from the "N1" sheath (picture 15) allows a faster self-learning of the vehicle. In case of emulation, it is necessary to cut the wire going to the Oxygen sensor, connect the Light Blue wire on the ECU side and the Yellow wire on the Oxygen sensor side (picture 14 page 45).

These connections have to be carried out only on particular vehicles and on advice of the BRC Technical Assistance Service.

In case of two-bank vehicles, Sequent offers the possibility to act on the second Lambda oxygen sensor, through the Yellow and Light blue wires present in the "N2" sheath.

These last connections too should be only realised on particular vehicles, on the BRC after-sales service's advice.

We underline that the row 1 and 2 number is printed on the N1 and N2 harnesses wires.

6.3.5 5-pole-connector for crankshaft to manage advancing and/or rpm reading

In case of particular vehicles, Sequent offers the possibility through the sheath "Q" ending with a 5-pole connectors to carry out the connection for crankshaft sensor for the timing advancer management and/or rpm reading.

Pay attention: for the possible connections of the 5-pole harness wires please refer to the indications contained in the following paragraphs. We recommend you to insulate the wires' ends and the connector if not used.

6.3.5 A Crankshaft Sensor signal

The SEQUENT system is able to acquire the rpm speed by connecting to the Grey wire directly on the rpm indicator signal.

If this signal is not available or does not have such operations to be interpreted by the FLY SF ECU, it is possible to take the **Crankshaft sensor signal** through the Connector present on "Q" sheath connector.

First it is necessary to remove this connector to obtain like that the following 4 wires:

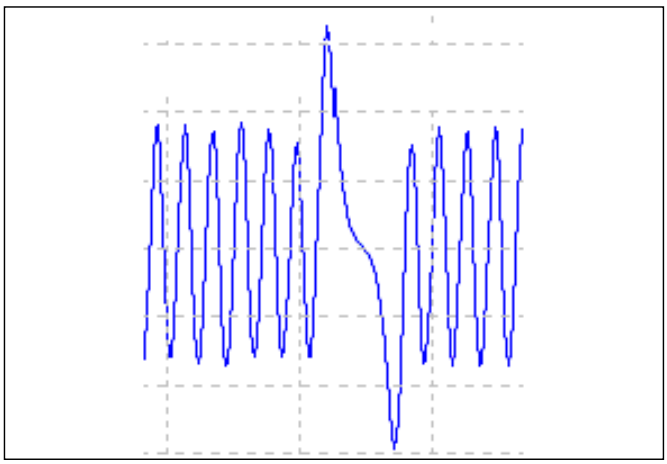
Blue
Pink
Blue/Black
Pink/Black

These last two wires should be insulated singularly.

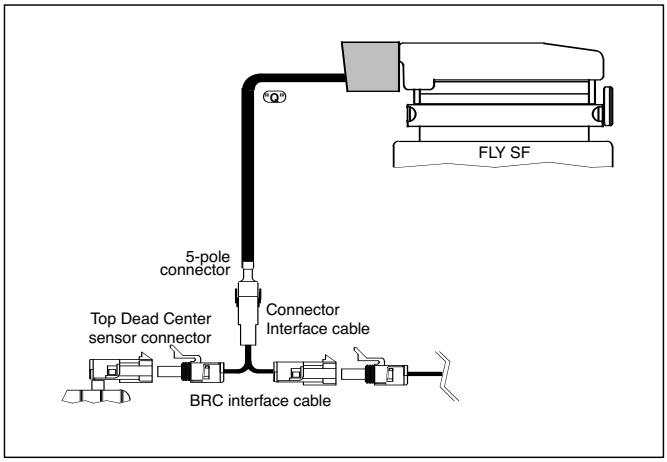
You only have to connect the Blue and Pink wires of the 5-pole harness respectively to the negative and positive of the crankshaft sensor (picture 16), without interrupting them. The negative and positive of the crankshaft sensor are recognisable by the signal present on the wires that, if it is displayed by a cathode-ray oscilloscope, in correspondence with the reference “hole”, has the trend illustrated in pictures 17 and 18 page 48.

If you do not have the cathode-ray oscilloscope, you can connect the wires to the signal without worrying about the polarity, and then verify that, in all the working conditions of the engine, the r.p.m. are read correctly; if not, or in case you have an irregular gas operation of the vehicle, you have to try to invert the polarity.

In case you use this type of connection, cut and insulate the “L” grey wire.



Picture 18
Positive



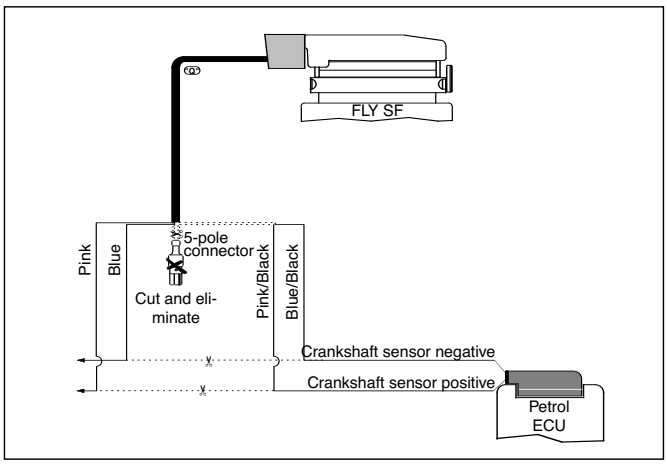
Picture 19

6.3.5 B Signals for the ignition timing Advance Variation

If you want to use the “timing advance” function, the FLY SF ECU is equipped with, and the connector of the vehicle Top Dead Center sensor **is plug-compatible** with one of the specific interface cables supplied by BRC, the diagram to be followed is represented in picture 19.

In this case **it is NOT** necessary to remove the 5-pole connector, but it is possible to connect it to one of the Timing Advance Processor Harnesses normally used for the Aries electronic Advance Processor (for the correct choice refer to the specific wiring diagrams of the single vehicles or to the BRC Price List: Timing Advance Processors).

If you want to use the “timing advance” function, the FLY SF ECU is equipped with and the connector vehicle of the Top Dead Center sensor is NOT plug-compatible with one of the specific interface cables supplied by BRC, the diagram to be followed is represented in picture 20.



Picture 20

In this case it is necessary to remove the 5-pole harness connector, obtaining thus the following 4 wires:

Blue
Pink
Blue/Black
Pink/Black

The wires going from the crankshaft sensor to the petrol ECU should be interrupted. The Pink and Blue ones have to be connected to the side that goes towards the crankshaft sensor, while the Blue/Black and Pink/Black wires will have to be connected to the side going to the petrol ECU. As regards to the polarity of the Pink and Blue wires, see the previous paragraph.

For what concerns the connection of the Blue/Black and Pink/Black wires, the Blue/Black wire should be connected to the Petrol ECU side of the wire to which the Blue wire has been connected on the crankshaft sensor; the same for the Pink and Pink/Black wires

Pay Attention to the fact the Spark timing function is not available for 8 cylinder vehicles ECUS.

In case you use this type of connection, cut and insulate the "L" grey wire indicated in the electrical plans on the "Types of Installation 2/3" Guide.

For all other connections not described in this paragraph, please refer to the previous one 6.2.

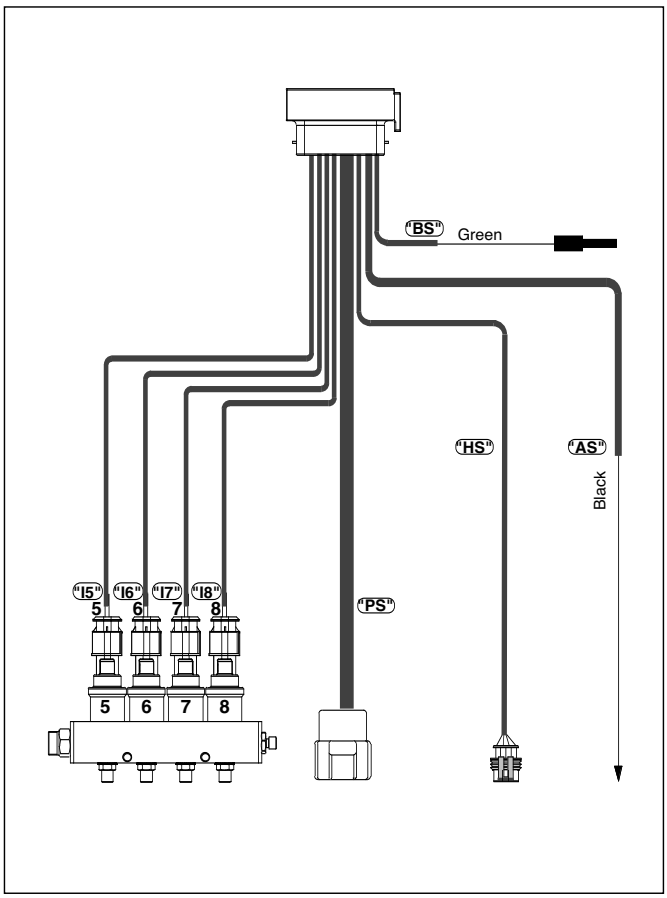
6.4 DESCRIPTION OF THE 5-6-8 CYLINDER HARNESS (FOR ALL SEQUENT CONFIGURATIONS)

As mentioned in paragraph 4.19, in addition to the main harness, ending with a 56-way connector, used for the conversion of 4-cylinder vehicles, another harness is available to be used on **two-connector FLY SF ECUs**, ending with a 24-way connector (picture 20).

This harness therefore allows realising, with only one two-connector FLY SF ECU, the conversion of 5-6-8 cylinder vehicles, without needing two standard FLY SF ECUs.

Obviously two different types of 5-6-8 cylinder harnesses are available: one is for vehicles up to 6 cylinders, and the other for vehicles up to 8 cylinders.

The main difference between the two harnesses is the quantity of "I" connectors for the gas injectors connection.



Picture 20
5-6-8-cylinder harness

The 5-6-cylinder version of harness is equipped with only two "I" connectors (specific for 5 and 6-cylinder vehicles).

The 8-cylinder version of harness is equipped with four "I" connectors (specific for 8-cylinder vehicles).

6.4.1 GROUND FROM BATTERY

The sheath "AS" in picture 16 contains a Black wire that will be connected to the vehicle's battery with one of the Black wires of the main harness.

Please refer to the cautions reported in paragraph 6.2.4.

6.4.2 SUPPLY

The sheath "BS" in picture 16 contains a Green wire that will have to be connected to the free central terminal of the relay belonging to the sheath "B" of the vehicle's battery main harness (picture 2 page 38 and 15 page 46).

6.4.3. RAIL "P1" PRESSURE SENSOR AND MANIFOLD ABSOLUTE PRESSURE SENSOR (MAP)

The possible second P1-MAP pressure sensor can be connected to the 5-6-8-cylinder harness through the proper pre-cabled connector of the wires contained in the sheath "HS" (picture 16).

Attention: in the Sequent Fastness applications this connector is not used but cut and insulated.

6.4.4 GAS INJECTORS

The Gas Injectors (from the 5th to the 8th) are connected to the harness by means of the wires with pre-cabled connectors contained in the sheaths "I5", "I6", "I7", "I8" (see picture 20).

If it is a 5-6-cylinder harness the sheaths indicated with "I" will obviously be only two.

The connectors of the gas injectors are progressively numbered and in the same way as the sheaths of the wires that will be connected with the petrol injectors.

It is very important to maintain the correspondence between the gas injectors and the petrol ones.

Practically, the gas injector to which the n° 15 connector will be connected, should correspond to the cylinder containing the petrol injector, where we will connect the plug P5 of the Injectors Connection Sequent Harness (or the Orange and Violet wires of the Universal Injectors Connection Sequent Harness) and so on. In case the correspondence is not respected, it is possible to note a worsening in the equipment performances such as, for example: worse driving conditions, greater instability of the Lambda control, less “clean” petrol/gas changeover, etc.

The number that distinguishes the connectors of the gas injectors is stamped on the harness wires going to the same connector.

6.4.5 10-POLE CONNECTOR FOR PETROL INJECTORS HARNESS CONNECTION

The interruption of the petrol injectors (from the 5th to the 8th) is possible by using to the sheath “PS” ending with a 10-pole connector.

It is sufficient to connect it to one of the specific injectors interruption harnesses described in paragraph 6.2.17.

While running on gas, it is important to keep the same injection sequence you have during petrol operation. It is therefore necessary to interrupt the signals of the petrol injectors with the same order of the gas injectors’ connection.

The numbers that distinguish both the gas injectors’ connectors and the petrol ones are printed directly on the corresponding wires of harness connection.

7. GLOSSARY OF TERMS AND ACRONYSM USED IN THE HANDBOOK

Terms or Acronyms	Meaning
Absolute Pressure	It is the pressure measured with reference (zero value) to the perfect vacuum.
Battery Pos. (+12V Battery)	It is the pole with greater electric potential of the vehicle's battery. Normally it is with a tension included between 8 and 16 V as to the ground.
Bottom Feed	Literally supplied by the bottom. Compare with "Top Feed". It is a particular kind of injector, in which the fuel path only covers the lower side of the injector.
CAN Bus	It is a communication system between the ECUs and the devices assembled on the vehicle.
Catalyst	It is the device assembled on the exhaust pipe that has the duty to reduce the polluting emissions.
Changeover Switch	In this handbook it is the device assembled in the passenger compartments that enables the driver to choose the kind of feeding (gas or petrol). See also paragraph 4.9.
Configuration	See "Mapping"
Connector	It is the device that has the duty to connect parts of harnesses with other parts of the harnesses or with electrical devices.
Crankshaft position (sensor)	It is a sensor that is assembled near a gearwheel, integral with the driving shaft that produces an electrical signal which represents the driving shaft position.
Cut-Off	It is a particular working condition of the engine in which the injectors do not supply fuel to the cylinders, which therefore sucks up pure air. Typically we are in cut-off during a tip-out of the accelerator, with possible deceleration of the vehicle (engine brake), starting from not too slow running conditions.
Diagnosis	It is the identification process of a problem cause or nature, breakdown, or particular condition or situation to be detected or signalised as malfunction.
Differential Pressure	It is the difference of pressure between two areas, as for example between the air-intake manifold and the atmospheric pressure.
Duty Cycle	In a rectangular waveform it is the ratio between the duration of high level and the period of the same waveform. In formula, if Ton is the high level duration and Toff is the low level duration, then Tp = Ton + Toff is the period and DC = Ton / Tp = Ton / (Ton+Toff) is the Duty Cycle.
ECU (Electronic Control Unit)	In this context it is the Electronic Control Unit of the engine or of the gas carburetion.
Electro-injector	see Injector.
EOBD	See "OBD". European On Board Diagnostics. OBD system implementation at European level, regularised by institutions like ISO.
Flow	It is a physical quantity that defines the quantity of a fluid material that passes through a particular section in the time unit. The mass flow defines, for example,

	how many grams of a material pass in a second in a certain section.
Ground	It is the electrical potential of reference (voltage equal to zero Volt). By “ground” we mean the whole of cables and electrical conductors connected to this potential. The ground potential is present on the negative pole of the vehicle’s battery, that by extension it is called “ground” of the battery.
Harness	In this handbook it is the whole of wires coming from the connector which the ECU is connected to reach all the other points of the electric equipment of the system
Injector	It is the device that has the duty to supply fine precision-metered quantities of pressured fuel, by injecting them in the air-intake manifold.
Injectors Rail	It is the part where the injectors are assembled; it enables gas distribution in every injector at the wanted pressure.
K Line	Communication line of the engine ECU towards the external diagnostic instrument.
Key contact	It is the voltage or the electric node downstream the switch powered by the vehicle’s ignition key. It is normally at low potential; it reaches the potential of the positive battery when the switch turns off.
LED	Light Emission Diode. They are electronic semiconductor devices able to give light off, if crossed by electric current.
LPG	Liquefied petrol gas. It is a fuel obtained from the distillation of petrol. It mainly consists of butane and propane in very variable proportions. It is in gaseous phase at ambient pressure and temperature, while it is mostly liquid inside the tank.Linea K Linea di comunicazione della centralina controllo motore verso lo strumento esterno di diagnosi.
Magnetic Circuit	It is where the magnetic flux concentrates, usually made in iron or other ferromagnetic material. It is a part of an electromagnetic device (solenoid valve, injector, electric engine, etc.).
MAP (Manifold Absolute Pressure)	It is the absolute pressure of the air-intake manifold of the engine (see absolute pressure). By extension it even indicates the sensor that measures it.
Mapping/Map	It is the whole of data that defines the fuel quantity to be dosed depending on the working conditions of the engine.
Multivalve	It is the device, placed on the tank, that performs several functions, superintending refuelling, measuring the fuel level, safety protections, etc.
OBD (On Board Diagnostics)	See also “Diagnostics”. It is the monitoring system of all or some inputs and control signals of the ECU. If one or more signals are out of the programmed limits, a malfunction of the system or of the related systems detected, signalised and stored.
OR (O Ring)	It is a gasket consisting of a rubber ring.
Oxygen Sensor	It is a sensor that detects the concentration of oxygen in the exhaust gases. It enables the ECU to determine if the air/fuel mixture is too rich or too lean of fuel, allowing the working of the system in closed loop.
PC	Personal Computer
Peak & Hold (piloting)	See also “Piloting”. It is the particular driving of the injectors that supplies a greater starting current to the coil in the opening phase, in order to reduce the opening times of the injector (peak); the current is later reduced to a lower value, sufficient to keep the injector open (hold).
Piloting	In this handbook, it indicates the action and the way the electric actuators are controlled by the ECU or other electric device, through electrical power signals.

Rail	See Injectors Rail
Relative Pressure	It is the pressure measured with reference (zero value) to the atmospheric pressure.
Relay	It is an electromechanical device that is able to open and close one or more electrical contacts following the proper electrical piloting.
RPM	is the English acronym that means “revolutions per minute”. Usually it is used to indicate the revolution speed of the driving shaft.
Self-diagnosis	See Diagnostic
Sensor	It is the device that detects the value of a physical quantity like: temperature, pressure, speed, and converts them into an electrical signal that can be used by the ECU or by any electrical circuit.
Sequential Injection	Injection control system in modern electronic injection vehicles. In every cylinder the injection phase starts and ends in independent times from the other cylinders and controlled by the engine ECU so that they are mapped with the cylinder phase and position.
Solenoid valve	It is the electromechanical device that has the duty to interrupt the flow of a fluid. In the present handbook, the solenoid valve interrupts the gas flow when it is not powered on, while it lets the gas flow when it is.
Throttle Valve	It is the valve that regulates the air load aspirated by the engine. Normally the accelerator pedal controls it but it is more often controlled directly by the petrol ECU.
Top Feed	Literally Supplied from the top. Compare with “Bottom Feed”. It is a particular kind of injector in which the fuel path crosses axially the whole length of the same injector, arriving from the top and being injected in the lower side of the device.
TPS (Throttle Position Sensor)	It is a throttle valve position sensor. It supplies an electrical signal that indicates the opening of the throttle valve (see throttle valve).
Trivalent Catalyst	It is the catalyst that reduces the HC, CO and NOx values.