Diagnosis manual

SGI, type 1

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1. GENERAL INTRODUCTION

This instruction manual is a supplement to the “SGI Dealer Information” documentation that has already been issued. Its primary object is to offer people a helping hand when they have to perform fault diagnosis to the SGI system.

This manual can be used in workshops as a practical supplement to the “SGI Dealer Information” when tracing, solving or excluding SGI system faults.

The AG Technical Department takes for granted that, whenever a request for modem contact is made, all the suggestions and recommendations of this troubleshooting manual have been performed and followed.

If you still have specific questions after reading this description you can contact the Technical Department of AG Autogas Systems.

Of course we are open to suggestions and constructive criticism.

2. TROUBLESHOOTING THE SGI SYSTEM

2.1. Introduction:

Troubleshooting the SGI system has been considerably simplified in relation to the DGI system. This is mainly due to the fact that the SGI system is based on the development of a revolutionary vapour-injector principle. The opening and closing characteristics of the injector type used for this system are almost identical to those of a petrol injector. This makes it possible to follow the actuation of the petrol injector by means of the engine-management computer by converting the petrol-injector opening period. This is also called the copy strategy or conversion strategy.

The main advantage is that the LPG computer needs to read out fewer signals (fewer connections), which makes the installation simpler and reduces the risk of making mistakes. In addition to this the application development of the SGI system for new engines has been simplified (less complicated software).

A number of points, however, remain essential when troubleshooting the SGI system:

- When tracing a fault it is extremely important to know exactly under what circumstances the fault occurs. Listening to and questioning the user is probably not only the first step, but also the most important one:

  A number of very essential questions, for example, are:

  - Has the fault occurred right from the moment the vehicle came into use?
  - Does it also occur when the engine runs on petrol (possibly to a lesser degree)?
  - When exactly does the fault occur?
  - How long does it last?
  - Have any important activities been carried out on the vehicle recently?
    - Accident
    - Repairs
    - Maintenance
  - Under what circumstances does the fault occur?
    - At what engine temperature
    - At what engine load
    - At what RPM

Be aware that most problems, such as jerking and hesitating, are (still) more prominent when the engine runs on LPG than when it runs on petrol. In spite of the clean petrol-engine generation, many engines are still subject to “hiccups” and “jerks”, a phenomenon that cannot be helped. These minor faults may be experienced as major faults when running on LPG. (It is virtually impossible in a copy strategy to improve on the original).

In addition to the points listed before, the ignition voltage of the sparking plugs obviously is still higher with the engine running on LPG than when it is running on petrol. Normally speaking, the driver will therefore observe a fault occurring in the ignition system more clearly with the engine running on LPG.

The performance of the SGI installation also largely depends on how all the electrical connections have been made. It is very important to prevent any negative effects of dirt and moisture and (in the long run) damage to hoses and/or wires.

In this manual the following points are taken for granted:

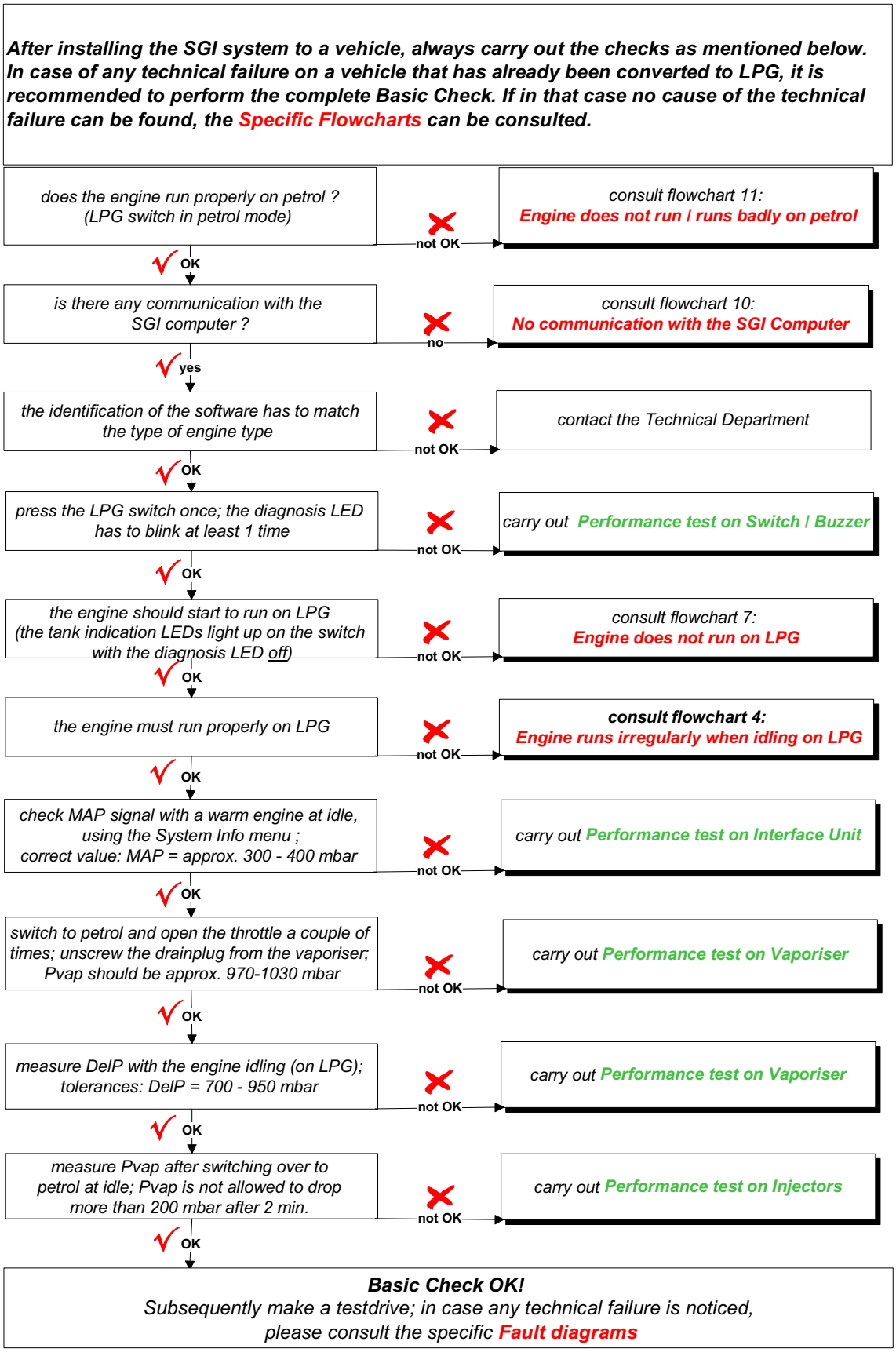
- The troubleshooter:
  a) has a thorough knowledge of the SGI system
  b) has a Psion or laptop (in good working order) at his disposal
  c) has the SGI Breakout Box at his disposal
  d) preferably has the engine-management read-out equipment of that specific car.

As is shown in the Table of Contents, the **Fault Finding** chapter is constructed as follows:

Paragraph:	***Purpose:***
Basic SGI system Check	The first check after installation or when starting troubleshooting
Performance tests	Testing specific SGI components
Fault diagrams	Flow charts with a complaint as starting point
SGI Cabling diagram	Checking all kinds of SGI connections
Specific measurements	Specific measurements to SGI sensors

2.2. Flow charts:

2.2.1. Basic Check SGI system



2.2.2. Performance tests:

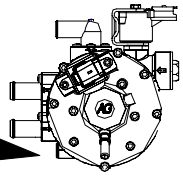
Performance test on vaporiser

check the vaporiser for leakage:
- cooling liquid > visually (level OK?)
- LPG > using a leakage tester
(Also check the vacuumconnection !)
- vacuum > visually

leakage → Tighten the 4mm Allen screws on the front cover; if necessary, replace vaporiser

OK

turn the engine off; tap sludge from vaporiser by unscrewing the drainplug



much sludge → check both filters of the vaporiser; if necessary clean or replace filters, (filterkit: AG 600.017)

normal

check Pvap in the System Info menu, with the engine running on petrol (drainplug off); Pvap = 970 - 1030 mbar ?

no → perform Measurement B in **Specific Measurements**

OK → replace LPG pressure sensor (AG 600.025)

not OK → check all connections with the SGI computer consulting **SGI Cabling diagram**

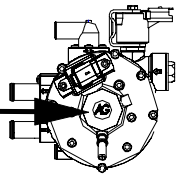
OK → replace SGI computer

yes

screw the drainplug back in the vaporiser and run the engine on LPG; check DelP in the System Info menu; DelP = 700 - 900 mbar ?

no

adjust DelP at 850 mbar by turning the adjustment screw inside the front cover of the vaporiser



yes

perform a testdrive; check whether the vaporiser does not create too much noise (during acceleration)

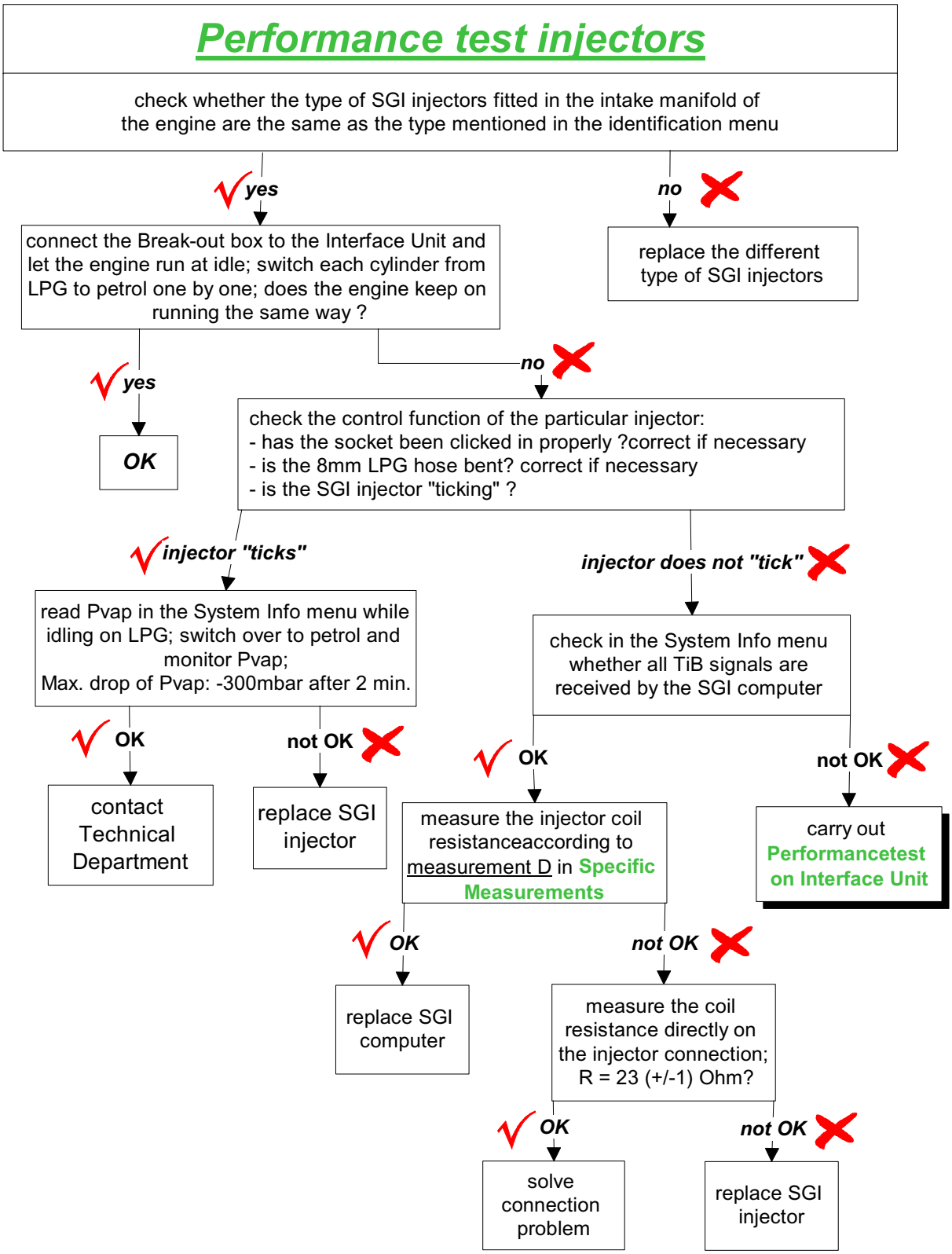
too noisy → replace the adjustment screw by a modified type(AG 600.016)

OK

OK !

NOTE: With new SGI vaporisers it is usual that DelP is approx. 50 mbar higher than normally; after a certain period DelP will drop to its normal level

Performance test injectors



NOTE: Motormanagement systems with E-OBD will shut down each cylinder at which it detects a misfire (e.g because of a bent 8mm LPG hose) and will also store a fault code in its memory (check engine indication lights up). Shutting down a cylinder will be done by not controlling its petrol injector anymore (no TiB signal is received by the SGI computer).

Performance test on Interface Unit

N.B.: NEVER measure directly inside the 32-pole socket of the Interface Unit!!!
Always use the Breakout Box!

check whether the correc type of Interface Unit has been fitted;
- AG 600.130: 4 disconnections, standard simulation
- AG 600.135: 4 disconnections, special simulation
- AG 600.140: 8 disconnections

OK → connect the Breakout Box to the Interface Unit with the fuel switches to the LPG position; does the engine run on petrol ? (LPG switch in petrol mode)

not OK → replace the Interface Unit for the correct type

no → check the feed and earth to the Interface Unit according to the **SGI Cabling diagram**

yes → set the fuel switches of the Breakout Box to the petrol position, and switch the LPG switch to the LPG mode; switch each fuel switch one by one (starting by no.1) to LPG; does the engine run properly on LPG?

not OK → check all disconnections of the petrol injectors according to the fitting instructions; correct if necessary

OK → check, using the System Info menu whether all TiB signals are measured

OK → check the vacuum connection according to the fitting instructions (also on the Interface Unit!)

OK → check the connections of the internal MAP sensor with Measurement MAP in **Specific Measurements**

OK → perform Measurement Mode signal in **Specific Measurements**

OK → **OK !**

OK → close off the hose to the petrol injectors; does the engine start to run properly on LPG ?

yes → determine whether one or more petrol injectors are still being controlled open ("ticking")

yes → one (or more) petrol injector(s) is (are) leaking

no → replace Interface Unit

no → carry out **Performance test on Injectors**

not OK → check the connection between the SGI computer and the Interface Unit, using the **SGI Cabling diagram**; correct, if necessary

OK → use the Break-out box to make the following connections:

Pinnr.	Pinnr.
2F	3F
2E	3E
2D	3D
2C	3C

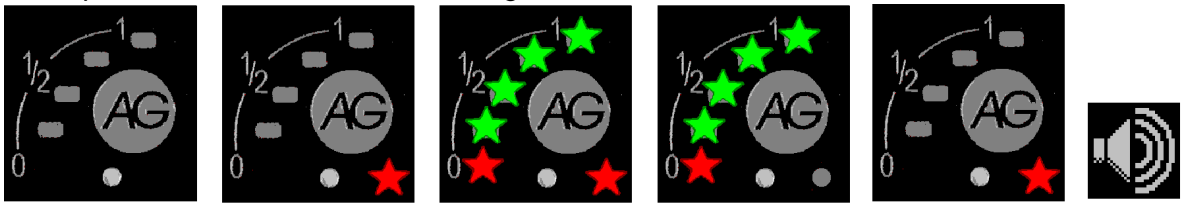
do the TiB signals become visible now?

yes → replace Interface Unit

no → replace SGI computer

Performance test Switch / Buzzer

The operation of the SGI switch is diagrammed below:



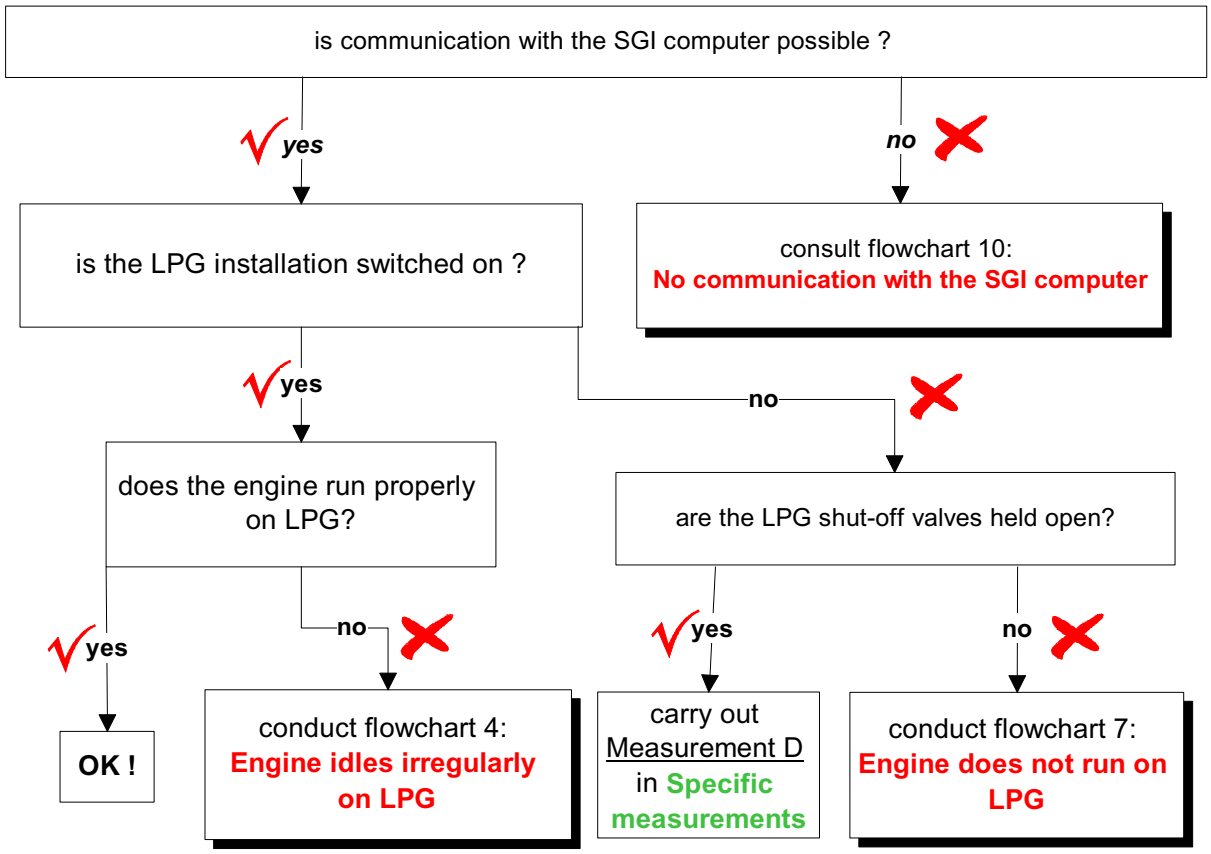
If the LPG-switch indications do not function properlythe following checks can be conducted.

Disconnect the 35-pole socket of the SGI computer and start the engine; make a connection between poles 35 and 34; check whether the LEDs on the switch light up

- yes → make a connection between poles 35 and 17; can the buzzer be heard ?
  - no → check the connections with the switch or the buzzer according to the SGI Cabling diagram; correct, if necessary
    - OK → replace switch or buzzer
  - yes → make a connection between poles 35 en 6; is the diagnostic LED on?
    - neen → check the connections with the switch or the buzzer according to the SGI Cabling diagram; correct, if necessary
    - yes → switch ignition off and reconnect the 35-pole socket; run the engine on LPG and check whether the tank indication corresponds with the actual LPG tank contents
      - OK → **OK !**
      - not OK → check the connections (also earth connection) with the tank sensor, according to the SGI Cabling diagram; correct, if necessary
        - OK → check whether the position of the tank float corresponds with the actual contents of the tank, using a visual tanksensor
          - OK → replace tanksensor or switch
          - not OK → replace tankmeter
- no → carry out Feed and Earth check in Specific measurements
  - OK → check the connections with the switch or the buzzer according to the SGI Cabling diagram; correct, if necessary

Performance test SGI computer

**It is obvious that a universal, foolproof performance test for checking the SGI computer performance cannot be developed. It is therefore important to contact our Technical Department whenever you are in doubt about the operation of the SGI computer.
A number of cases in which the SGI computer will have to be replaced are listed below.**



***N.B.1*: If the shut-off valves are continuously opened and closed when the ignition is switched on, this is probably caused by the fact that no software has been programmed in the SGI computer. In that case a new SGI computer will have to be ordered from our Technical Department.**

***N.B.2*: If the diagnostic LED lights up continuously and no communication is possible with the SGI computer when the ignition is switched on (or when the engine is running) this is probably caused by a hardware fault in the SGI computer. The computer will have to be replaced.**

N.B.3: Always check whether the SGI computer is sufficiently protected against dirt and moisture (be aware of possible corrosion inside the ECU connector). If not, this may be the reason why the SGI computer does not function properly.

2.2.3. Fault diagrams:

The following **Fault diagrams** show the flow charts that are based on the complaint (the symptoms) as the driver observes it (them).
It is essential to ask the customer to specify the complaint as accurately as possible. In this way the correct fault diagram can be used right away.
Always conduct the Basic Check before consulting these diagrams!

The following faults serve as starting points for the **Fault diagrams**:

1. Does not change over / changes over too late on LPG
2. Engine runs badly after changeover to LPG
3. Engine stalls on LPG
4. Engine idles irregularly on LPG
5. Switches back to petrol too soon
6. Hesitating on LPG
7. Does not run on LPG
8. Engine fires badly
9. Engine-fault light lights up
10. No communication with the SGI computer
11. Engine does not run / runs badly on petrol

We welcome any additions to these **Fault diagrams.** Please contact our Technical Department. You can find the telephone numbers in the annexe.

1. Does not change over / changes over too late on LPG

Conduct the *Basic Check* as completely as possible

OK

start the engine; does the diagnostic LED flash at least once?
(press switch, if necessary)

yes

warm up the engine; open the throttle a couple of times; does LPG switch on now?

yes

switches LPG on correctly; give explanation to the driver

no

conduct **Performance test switch/buzzer**

no

check the engine-temperature signal in the System Info menu; engine hot: ECT (MT) > 60 deg.C.?

no

check connections with the temperature sensor according to the installation manual or the **SGI cabling diagram** (in case of an external sensor, see **Connections external ECT sensor**)

yes

check the MAP signal in the System Info menu; when engine is idling: MAP (Load) < 400 mbar ?

no

check the vacuum connections of the Interface Unit and the SGI vaporiser; correct if necessary

OK

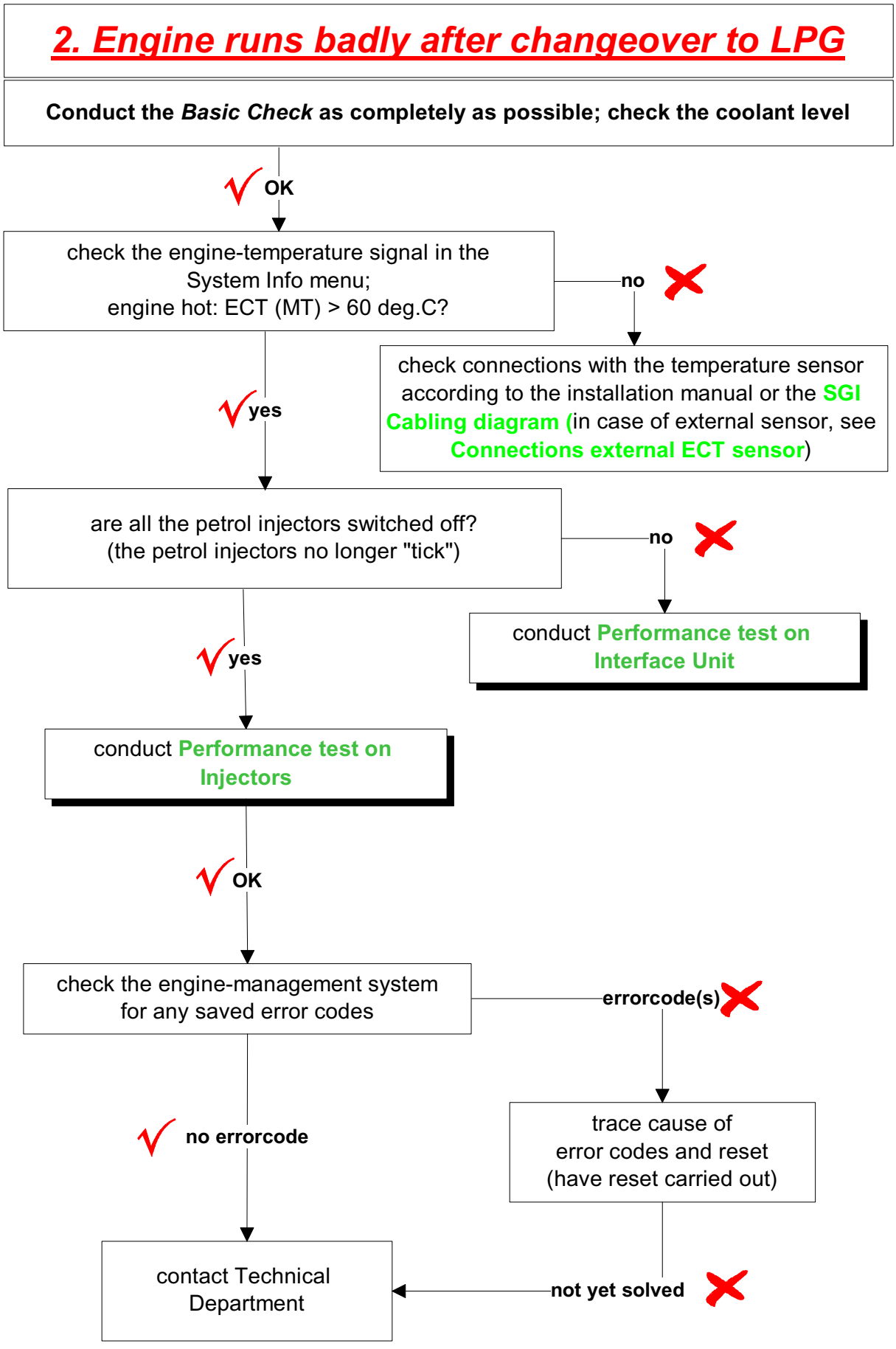
conduct **Performance test Interface Unit**

yes

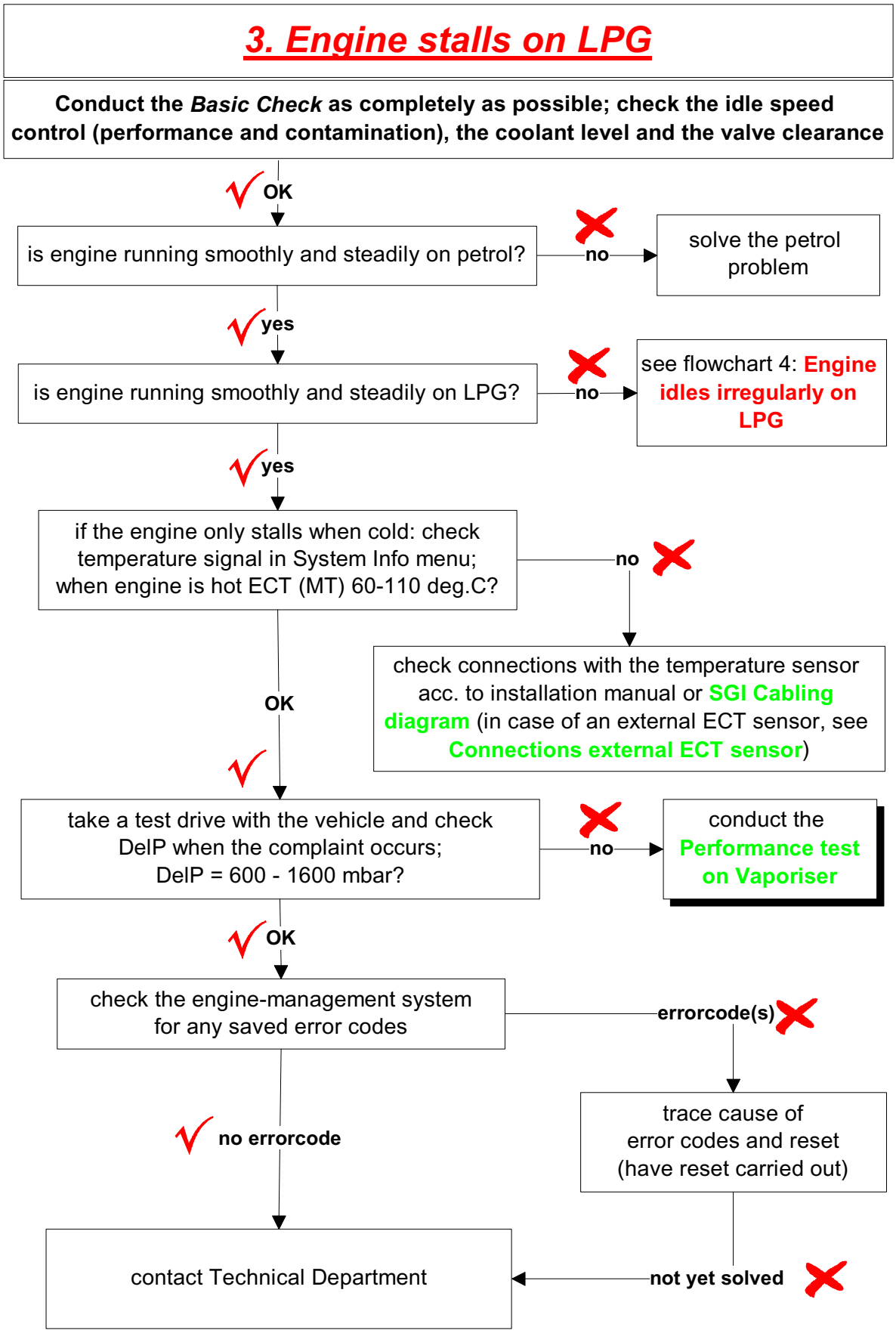
contact Technical Department

NOTE: In certain cases (especially at low engine load) it can take a while before the system switches on LPG, because of the flushing-strategy, which is specific for each engine type

2. Engine runs badly after changeover to LPG

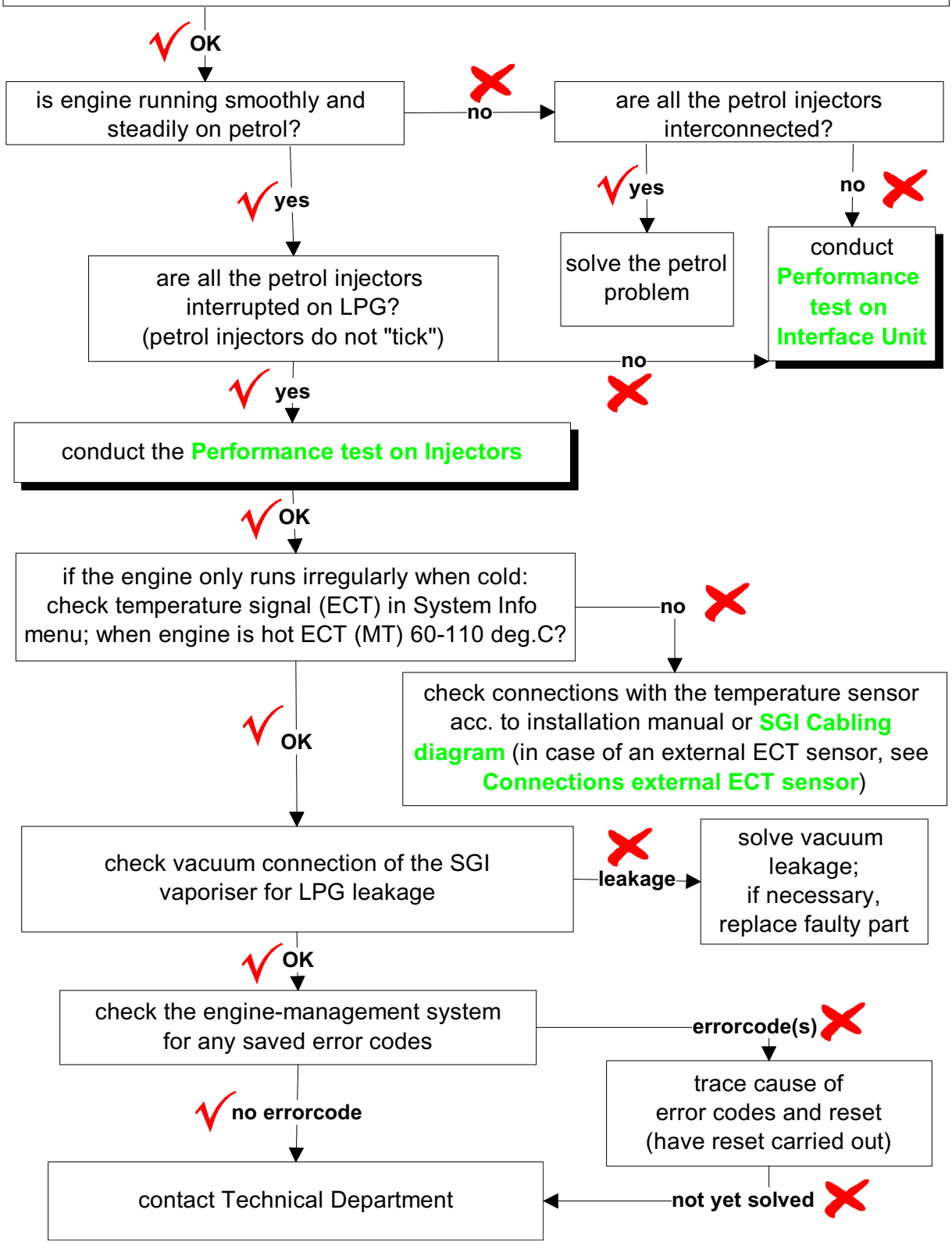


3. Engine stalls on LPG

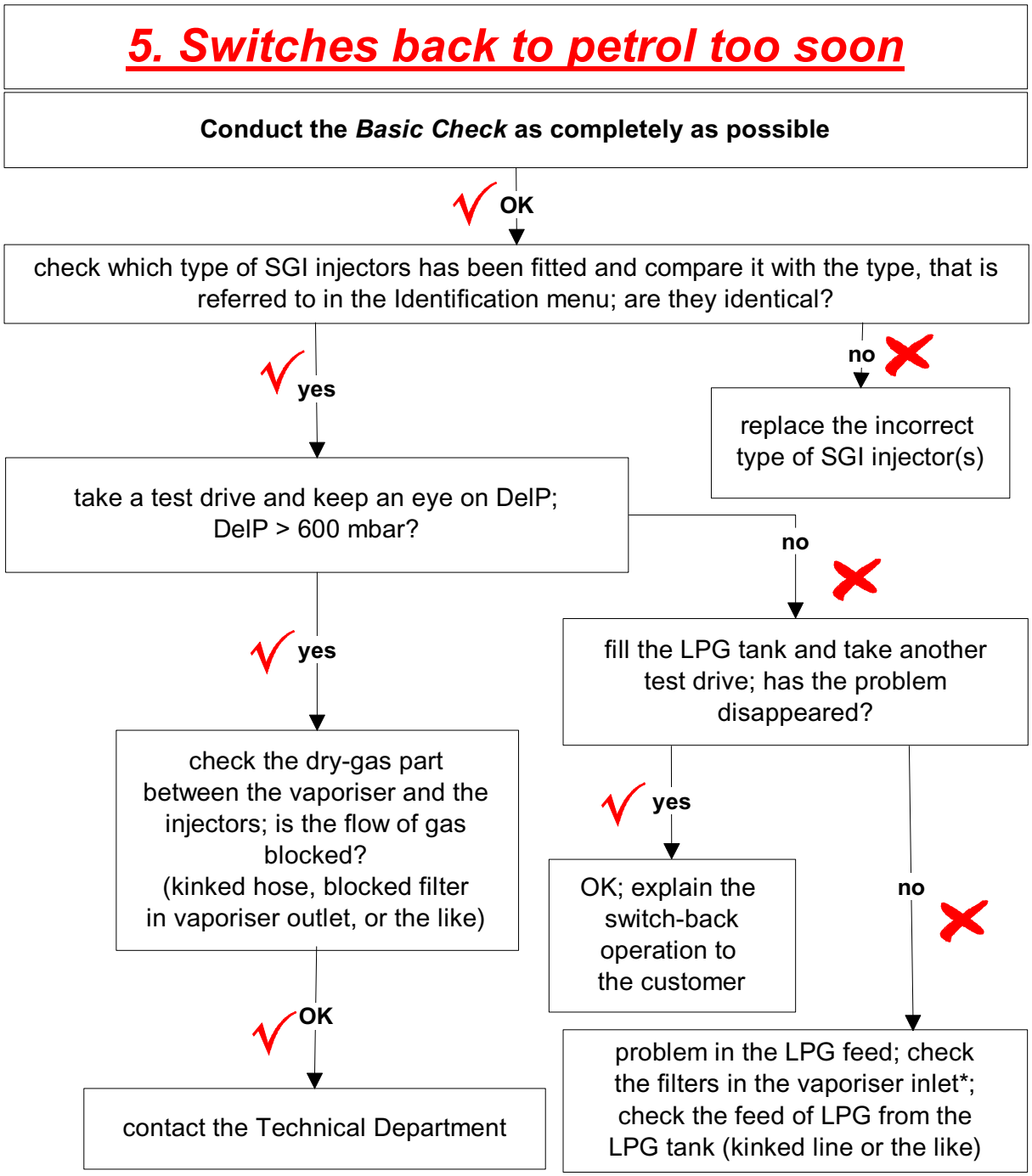


4. Engine runs irregularly when idling on LPG

Conduct the *Basic Check* as completely as possible; check the idle speed control (performance and contamination), the intake manifold for vacuum leakage, the ignition system, the valve clearance and the coolant level



5. Switches back to petrol too soon



*** : For larger engines it can be useful to replace the paper filter element by a metal type (AG 600.015) to increase the flow capacity of the inlet filter**

NOTE 1: the LPG system may briefly be cut out, due to flash-over of the ignition. Possibly the ignition problem is only noticeable when the engine is running on LPG, due to the higher ignition voltage that is required for LPG!
NOTE 2: engines which have more power output than 200hp, it is necessary to mount an 8mm LPG line from the tank.
NOTE 3: it can happen with turbo charged engines, that the pressure inside the LPG tank becomes too low, which could also cause the engine to switch back to petrol too soon

6. Hesitation on LPG

Conduct the *Basic Check* as completely as possible; check the operation of the ignition, the valve clearance (distribution timing) and the coolant level!!!

√ OK

ask the driver under what circumstances the engine hesitates; at **high** or **low** load

high load

check whether the correct type of SGI injectors has been fitted; replace, if necessary

√ OK

check the engine-temperature signal in the System Info menu; engine hot: ECT (MT) 60-110 deg.C?

not OK ✗

check connections with the temperature sensor acc. to installation manual or **SGI Cabling diagram** (in case of an external sensor, see **Connections external ECT sensor**)

√ OK

take a test drive and keep an eye on DelP; 600 < DelP < 1200?

no ✗

fill the LPG tank and take another test drive; has the problem disappeared now?

√ yes

check the dry-gas part between the vaporiser and the injectors; is the flow of gas blocked? (kinked hose, blocked filter in vaporiser outlet, or the like)

√ OK

contact our Technical Department

low load

conduct **Performance test on Injectors**

√ yes

OK

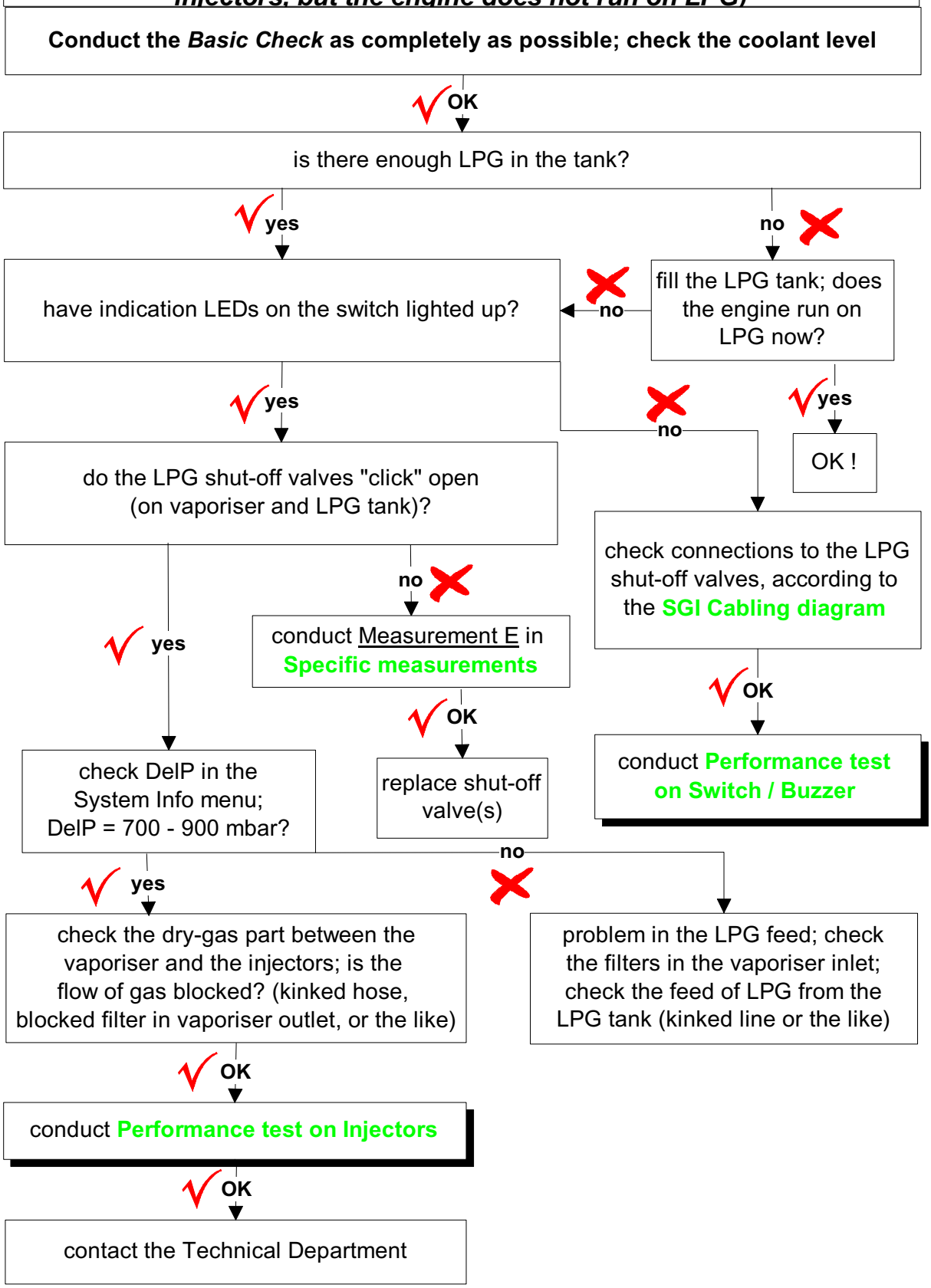
no ✗

problem in the LPG feed; check the filters in the vaporiser inlet*; check the feed of LPG from the LPG tank (kinked line or the like)

**** : For larger engines it can be useful to replace the paper filter element by a metal type (AG 600.015) to increase the flow capacity of the inlet filter***

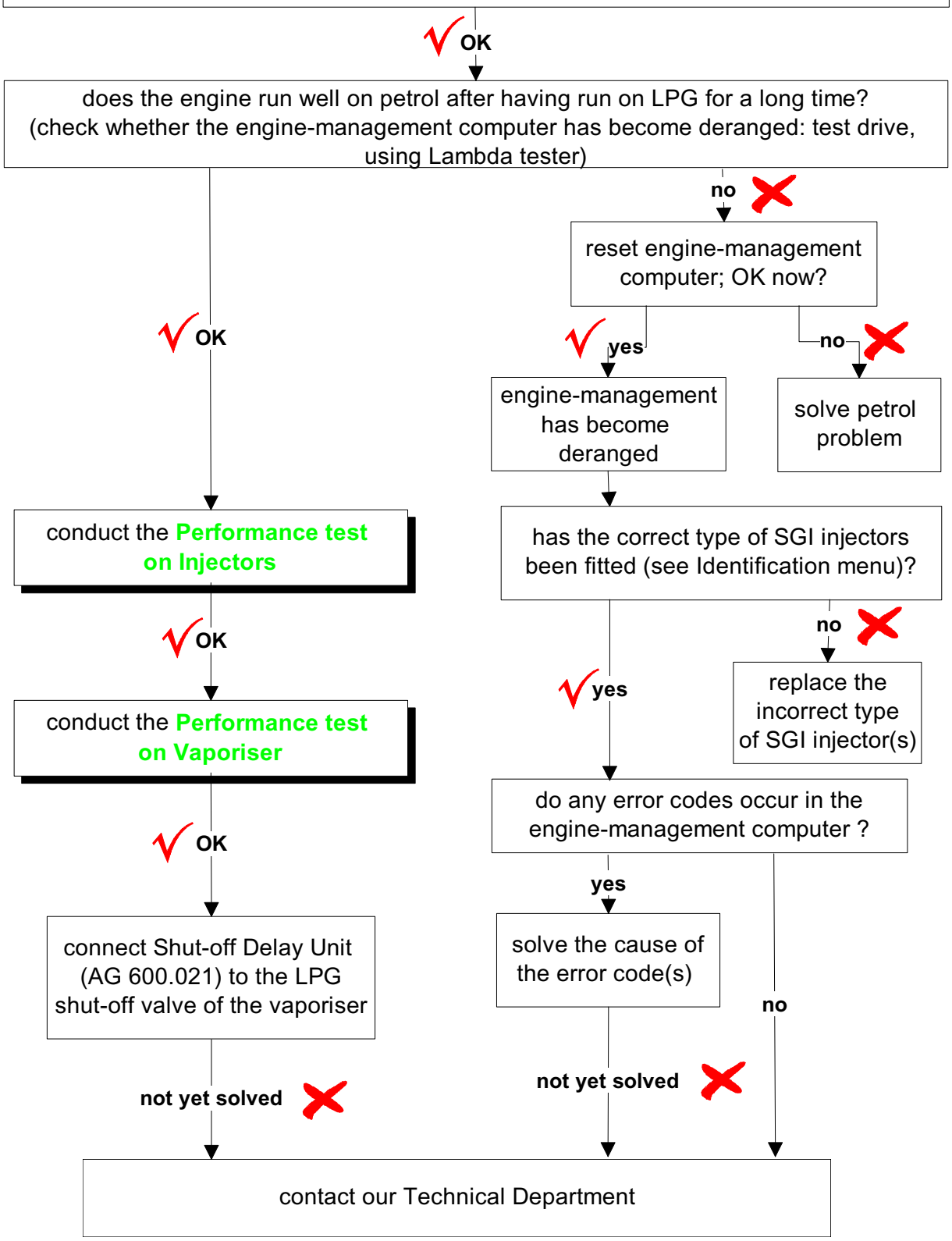
7. Engine does not run on LPG

(when this complaint occurs the SGI computer does switch off the petrol injectors, but the engine does not run on LPG)

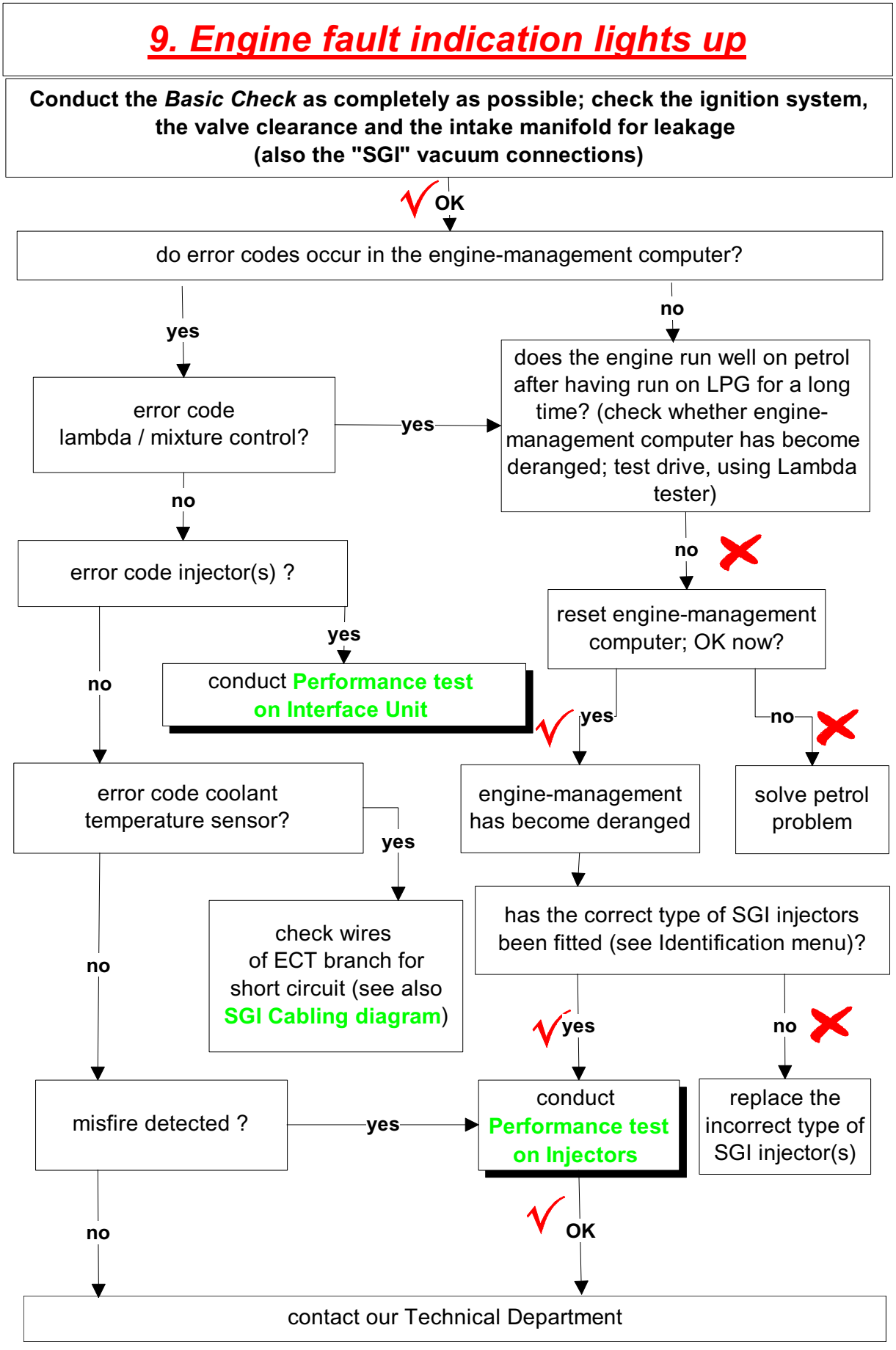


8. Engine does not fire well

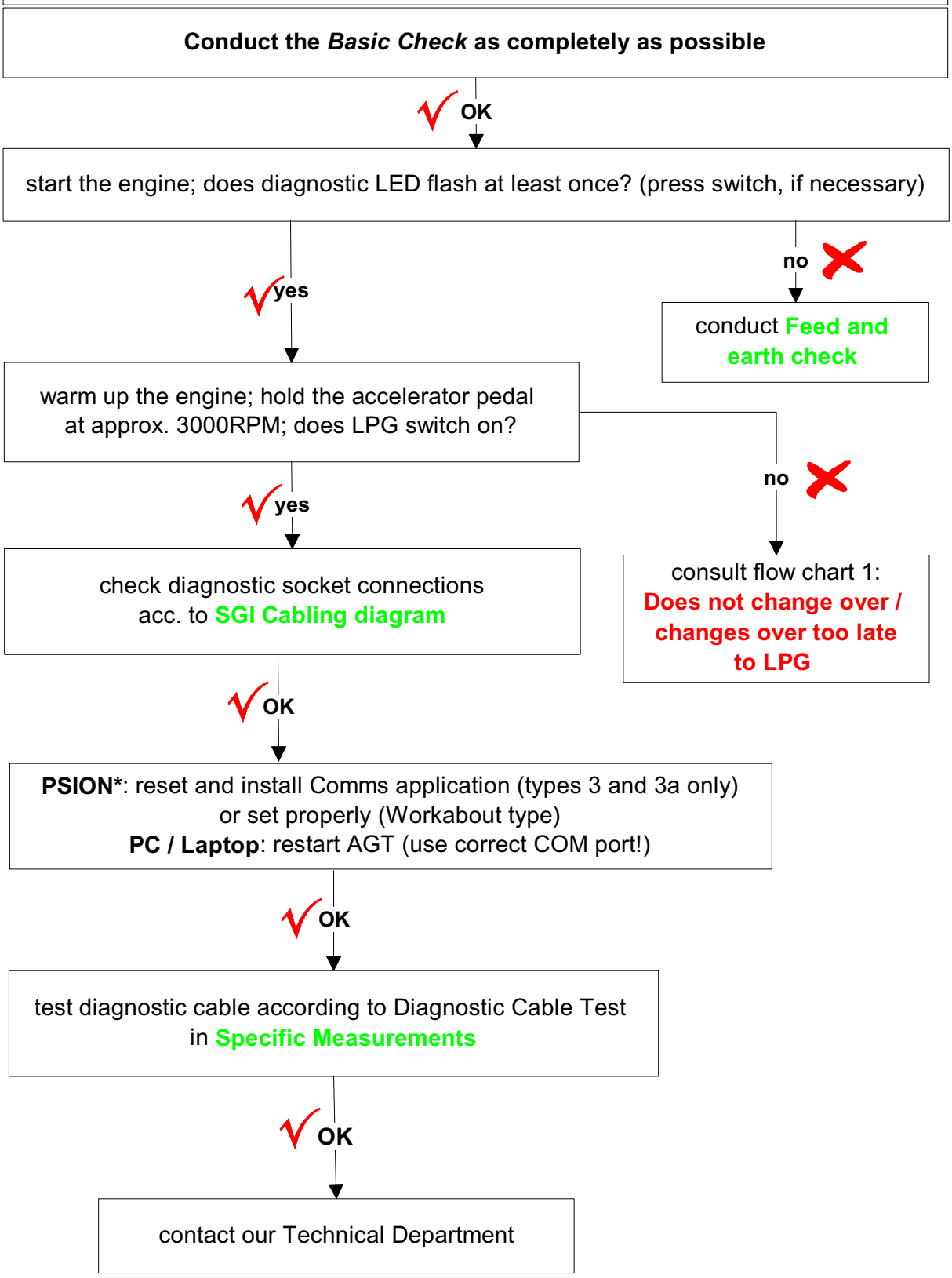
Conduct the *Basic Check* as completely as possible; check the idle speed control (performance and contamination), the intake manifold for leakage (close to air-mass meter), the ignition system and the valve clearance



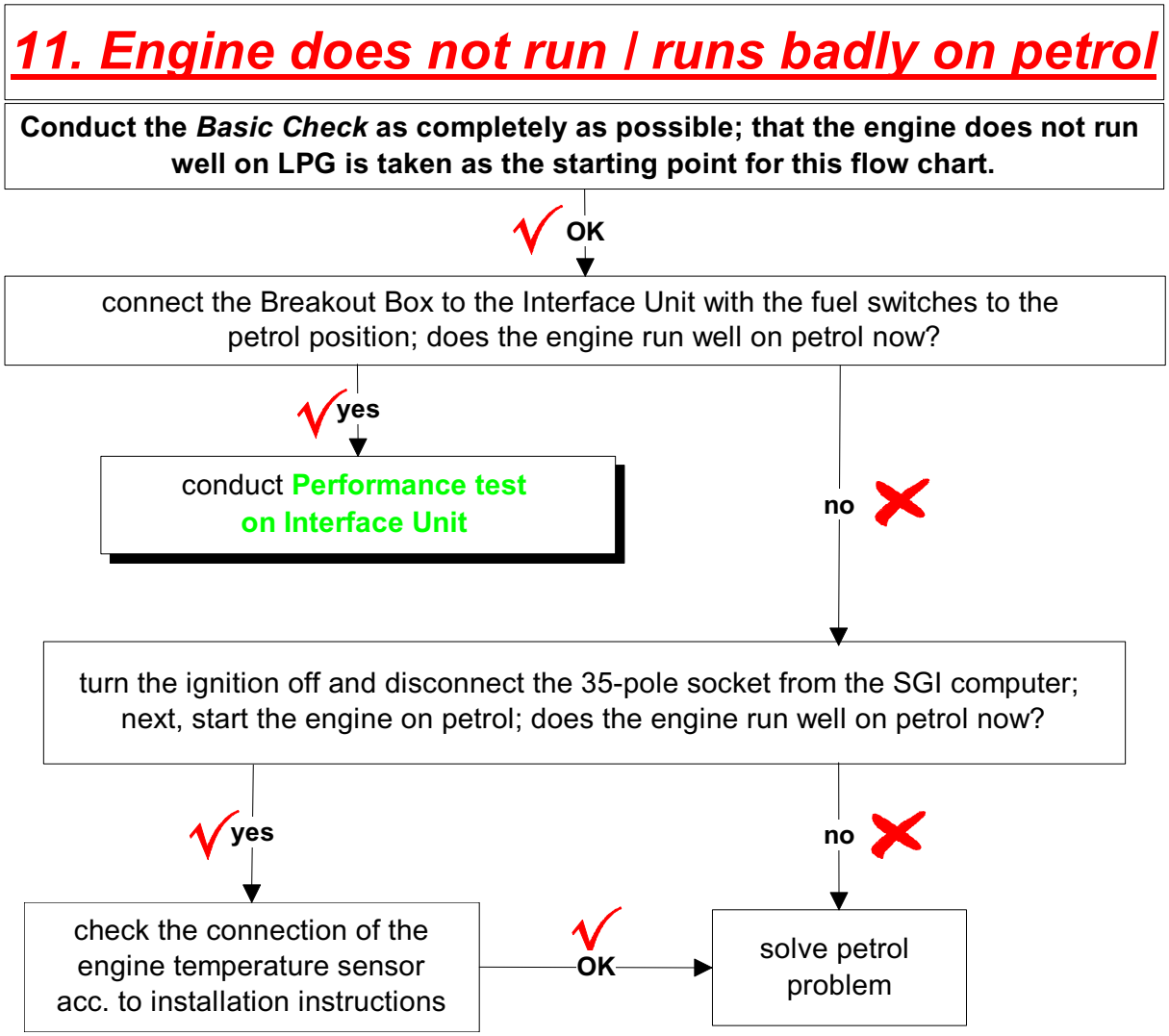
9. Engine fault indication lights up



10. No communication with the SGI computer



*: see also the supplied manuals

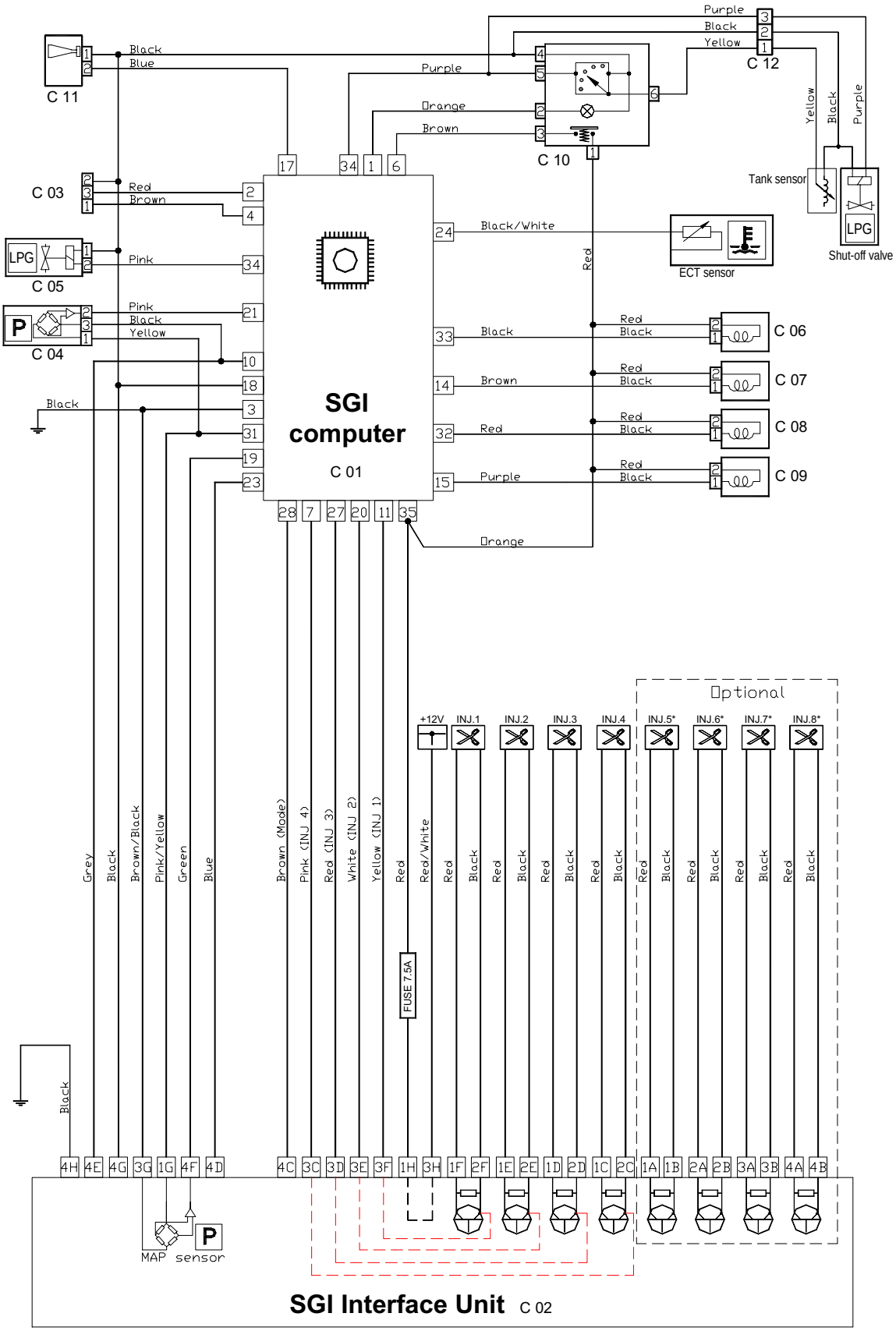


2.2.4. SGI Cabling diagram:

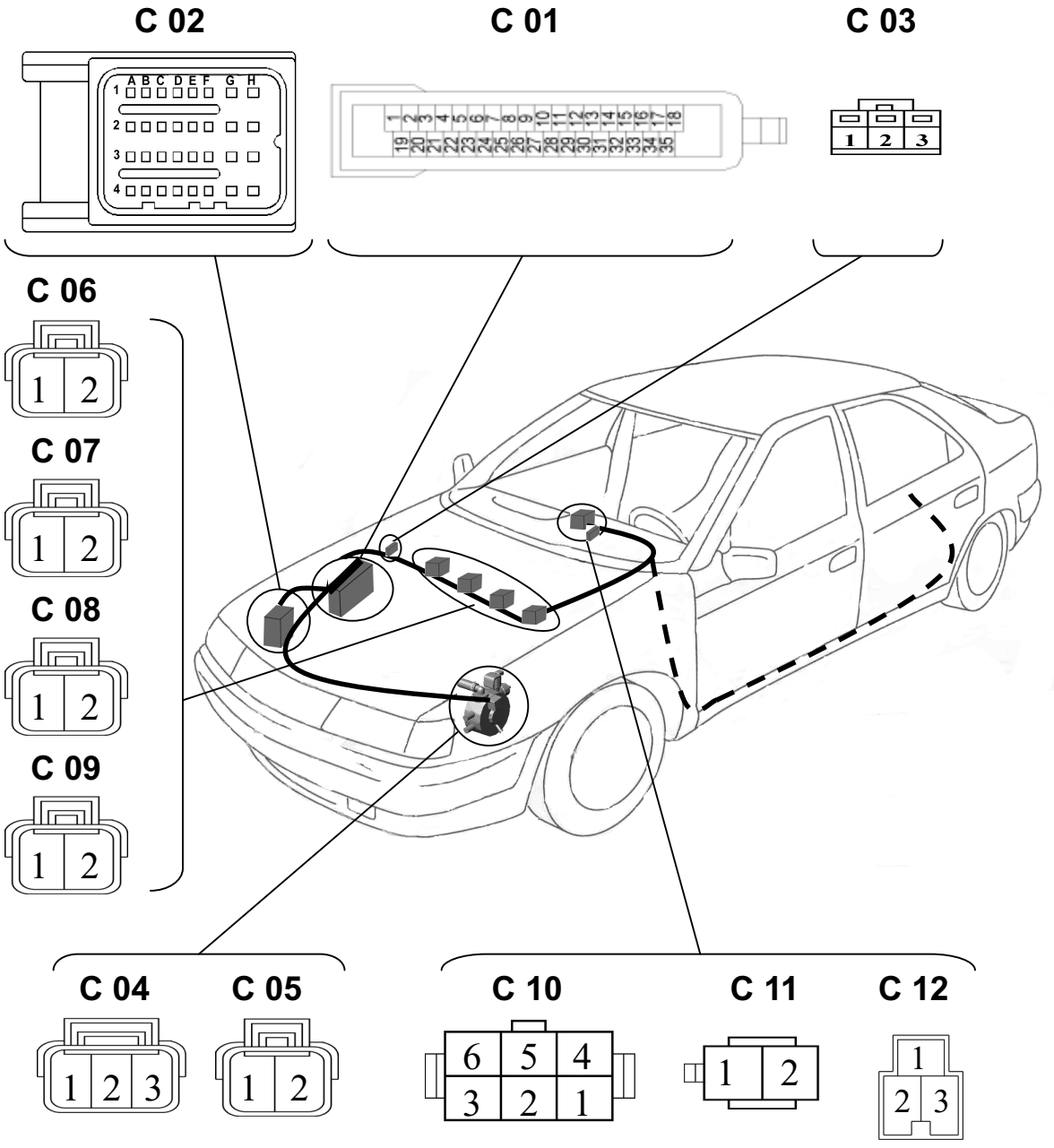
Neither the cabling diagrams in the installation instructions nor those in the "SGI Dealer Information" are sufficiently detailed to enable circuit testing of the complete SGI system cable tree.
In this manual, however, all the connections in the SGI cable tree will be shown. The cabling diagram has been divided into a diagram and an overview, showing all the connected components.
Subsequently the SGI switch connections will also be diagrammed separately (**SGI switch Connections**), as well as the connections of the external coolant temperature sensor (**Connections external ECT sensor**).

In the flow charts of this manual there are a number of references to a specific Measurement. These measurements are dealt with in the paragraph of **Specific Measurements** at the end of this chapter. All the interconnections and signals of the various sensors can be checked on the basis of these measurements.

I. Schematic overview:



II. Components with connections:



C 01: SGI COMPUTER

1	ORANGE	13	—	25	BLACK
2	RED	14	BROWN	26	—
3	BLACK/BROWN	15	PURPLE	27	RED
4	BROWN	16	—	28	BROWN
5	—	17	BLUE	29	—
6	BROWN	18	BLACK	30	—
7	PINK	19	GREEN	31	YELLOW/PINK
8	—	20	WHITE	32	RED
9	—	21	PURPLE	33	BLACK
10	GREY	22	—	34	PURPLE
11	YELLOW	23	BLUE	35	RED+ORANGE
12	RED	24	BLACK/WHITE		

C 02: SGI INTERFACE UNIT (*: optional)

1A	RED*	2D	BLACK	3G	BLACK/BROWN
1B	BLACK*	2E	BLACK	3H	RED/WHITE
1C	RED	2F	BLACK	4A	RED*
1D	RED	2G	—	4B	BLACK*
1E	RED	2H	—	4C	BROWN
1F	RED	3A	RED*	4D	BLUE
1G	YELLOW/PINK	3B	BLACK*	4E	GREY
1H	RED	3C	PINK	4F	GREEN
2A	RED*	3D	RED	4G	BLACK
2B	BLACK*	3E	WHITE	4H	BLACK
2C	BLACK	3F	YELLOW		

C 03: DIAGNOSIS

1	BROWN
2	BLACK
3	RED

C 04: PVAP SENSOR

1	YELLOW
2	PURPLE
3	BLACK

C 05: LPG SHUT-OFF

1	BLACK
2	PURPLE

C 06: SGI INJECTOR 1

1	BLACK
2	RED

C 07: SGI INJECTOR 2

1	BLACK
2	RED

C 08: SGI INJECTOR 3

1	BLACK
2	RED

C 09: SGI INJECTOR 4

1	BLACK
2	RED

C 10: LPG SWITCH

1	RED
2	ORANGE
3	BROWN
4	BLACK
5	PURPLE
6	YELLOW

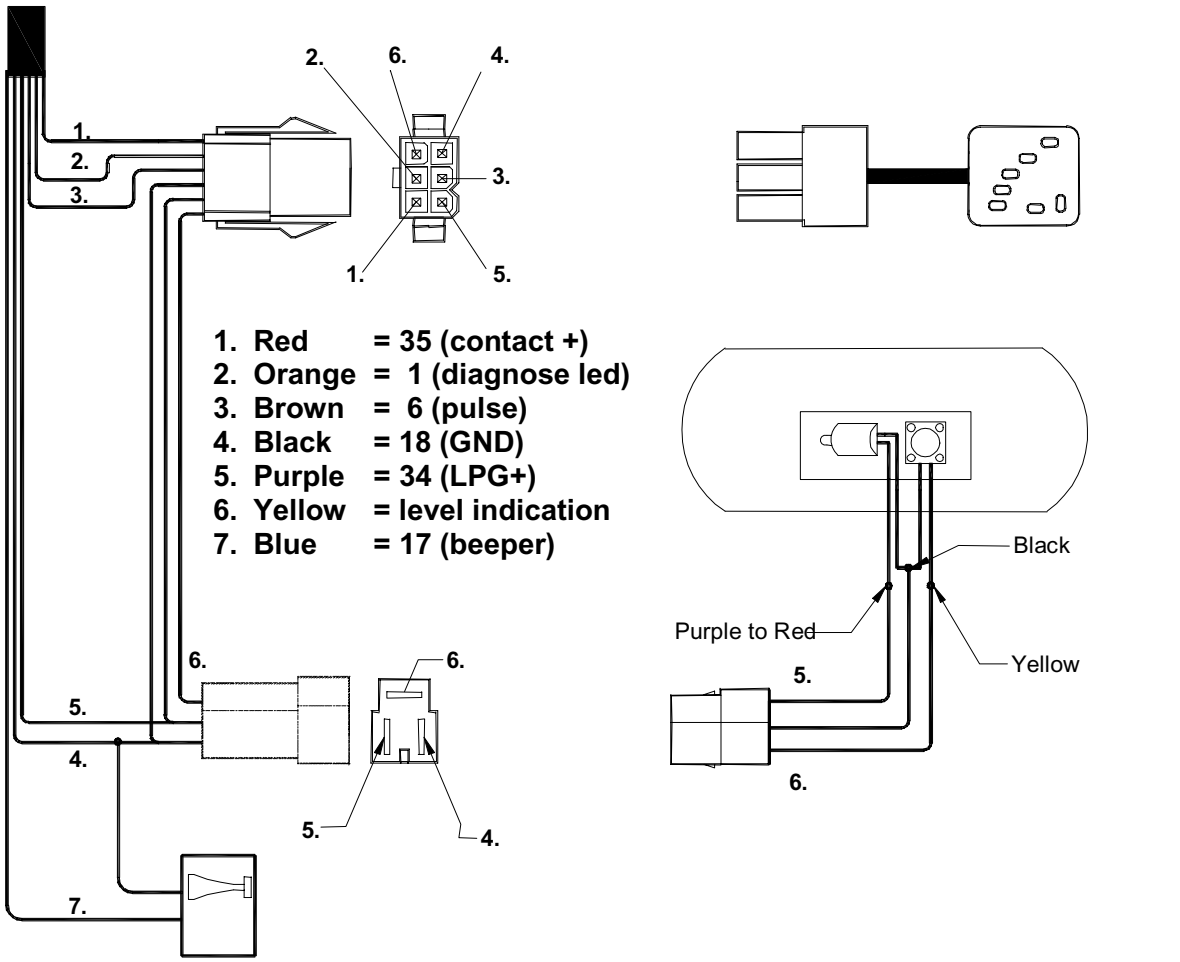
C 11: BUZZER

1	BLACK
2	BLUE

C 12: LPG SWITCH (to tank)

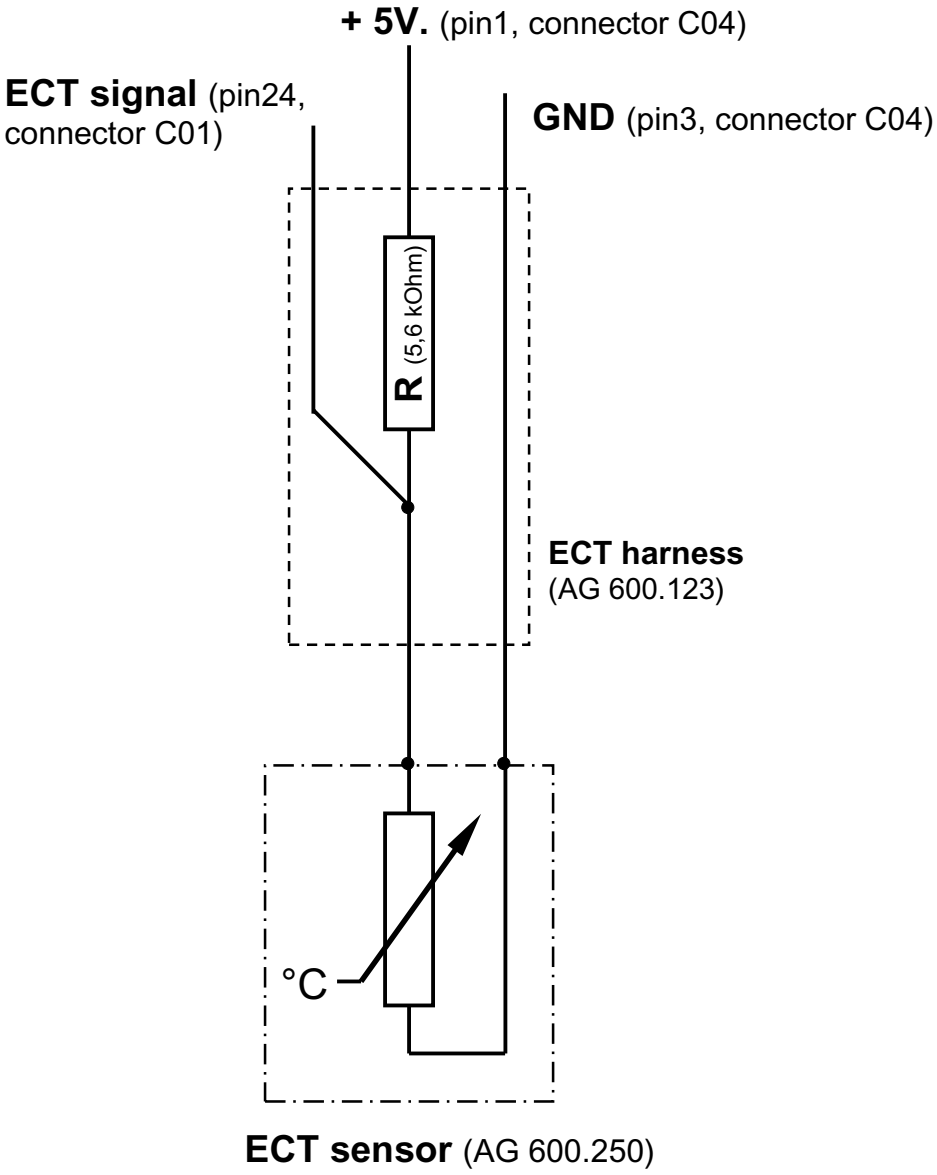
1	YELLOW
2	BLACK
3	PURPLE

III. Connections to SGI switch:



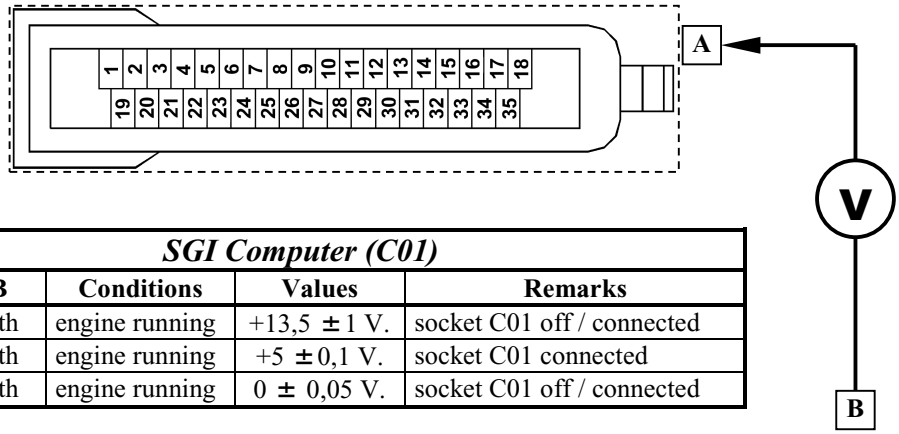
IV. Connections external ECT (Engine Coolant Temperature) sensor:

In some cases it is not possible to use the signal from the original Engine Coolant Temperature (ECT) sensor. In those cases an external ECT sensor is supplied in the SGI kit.
The connections for this external ECT sensor are shown in the diagram below.

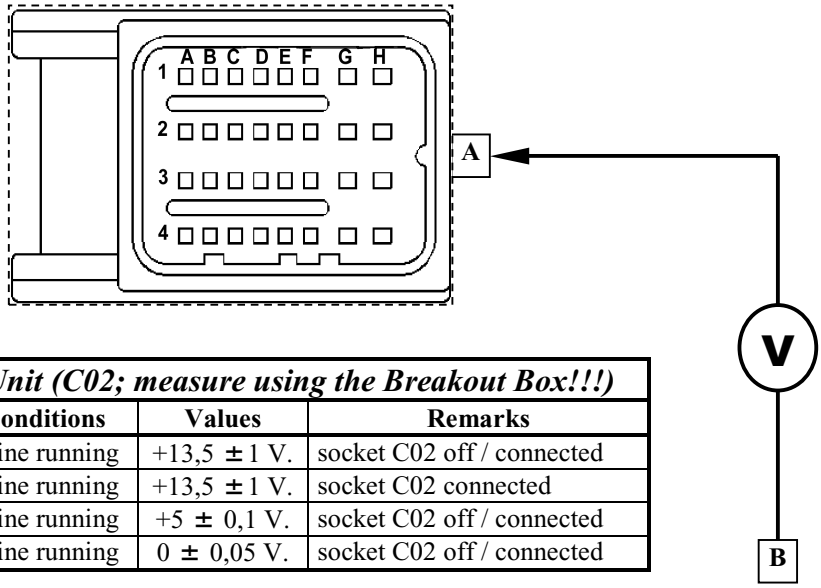


Specific Measurements:

A. Feed and earth check

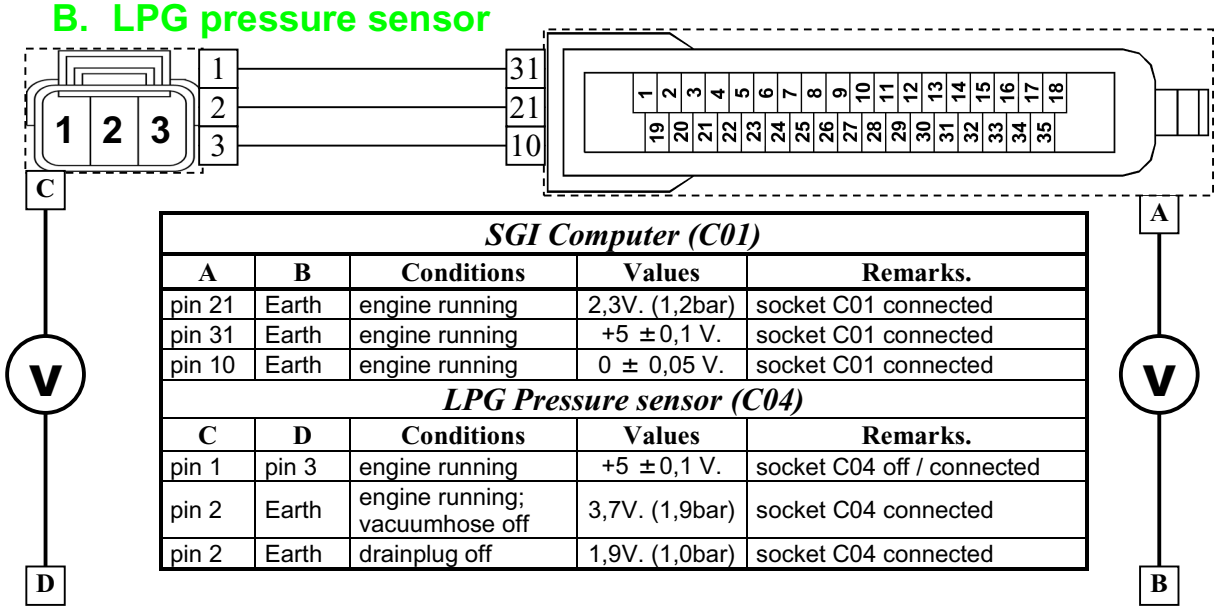


SGI Computer (C01)				
A	**B**	**Conditions**	**Values**	**Remarks**
pin 35	Earth	engine running	+13,5 ± 1 V.	socket C01 off / connected
pin 31	Earth	engine running	+5 ± 0,1 V.	socket C01 connected
pin 3	Earth	engine running	0 ± 0,05 V.	socket C01 off / connected

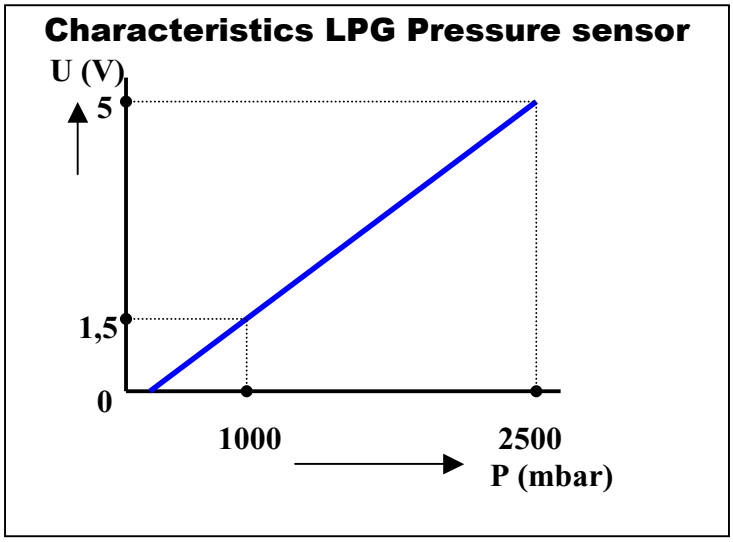


SGI Interface Unit (C02; measure using the Breakout Box!!!)				
A	**B**	**Conditions**	**Values**	**Remarks**
pin 3H	Earth	engine running	+13,5 ± 1 V.	socket C02 off / connected
pin 1H	Earth	engine running	+13,5 ± 1 V.	socket C02 connected
pin 1G	Earth	engine running	+5 ± 0,1 V.	socket C02 off / connected
pin 4H	Earth	engine running	0 ± 0,05 V.	socket C02 off / connected

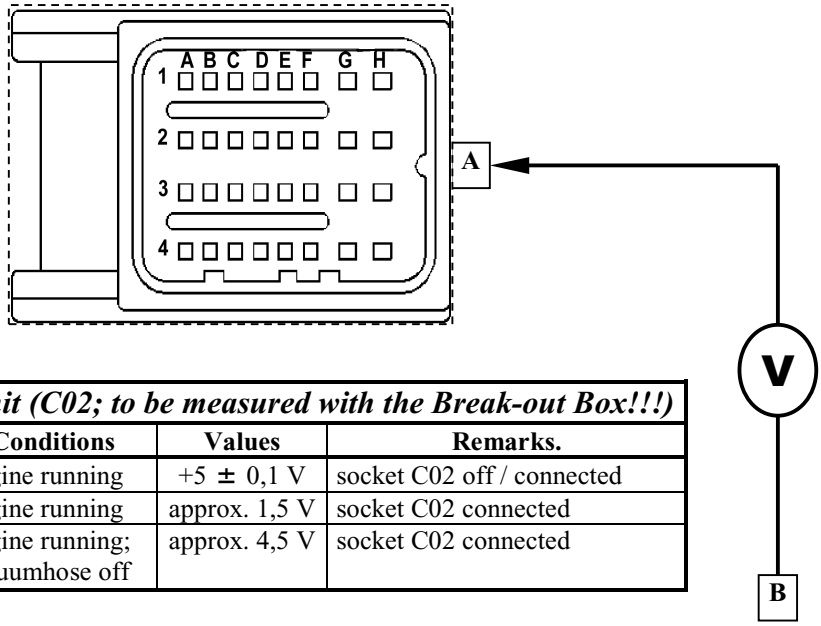
B. LPG pressure sensor



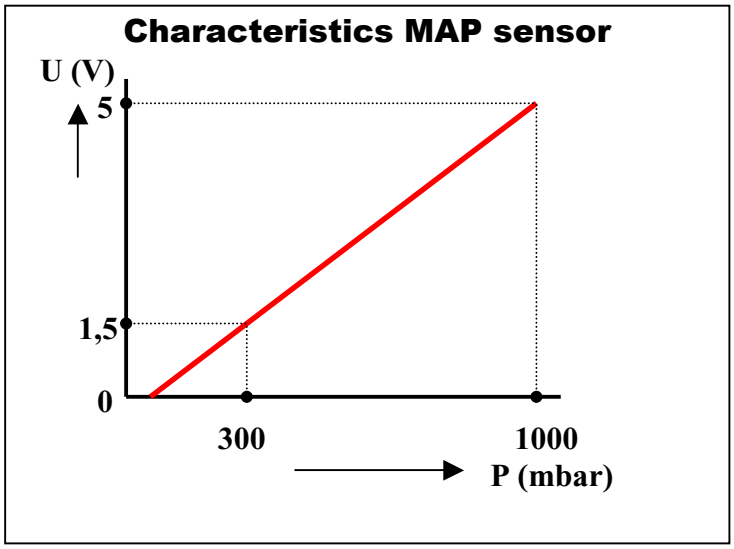
SGI Computer (C01)				
A	**B**	**Conditions**	**Values**	**Remarks.**
pin 21	Earth	engine running	2,3V. (1,2bar)	socket C01 connected
pin 31	Earth	engine running	+5 ± 0,1 V.	socket C01 connected
pin 10	Earth	engine running	0 ± 0,05 V.	socket C01 connected
LPG Pressure sensor (C04)				
C	**D**	**Conditions**	**Values**	**Remarks.**
pin 1	pin 3	engine running	+5 ± 0,1 V.	socket C04 off / connected
pin 2	Earth	engine running; vacuumhose off	3,7V. (1,9bar)	socket C04 connected
pin 2	Earth	drainplug off	1,9V. (1,0bar)	socket C04 connected



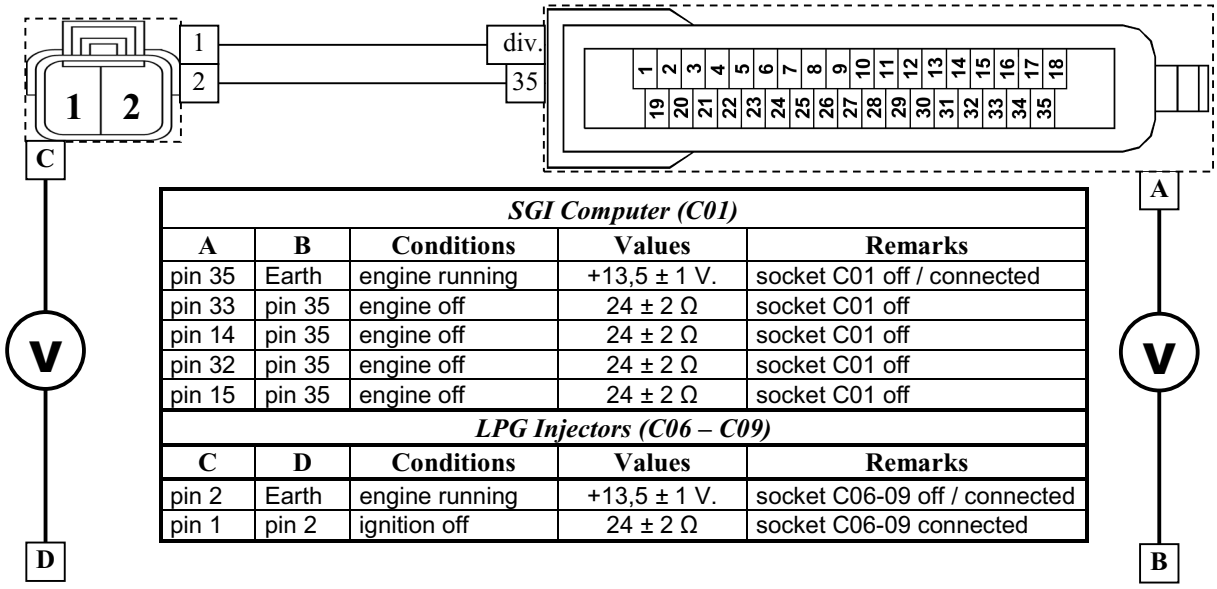
C. MAP sensor (integral in Interface Unit)



SGI Interface Unit (C02; to be measured with the Break-out Box!!!)				
A	**B**	**Conditions**	**Values**	**Remarks.**
pin 1G	pin 3G	Engine running	+5 ± 0,1 V	socket C02 off / connected
pin 4F	Earth	Engine running	approx. 1,5 V	socket C02 connected
pin 4F	Earth	Engine running; vacuumhose off	approx. 4,5 V	socket C02 connected



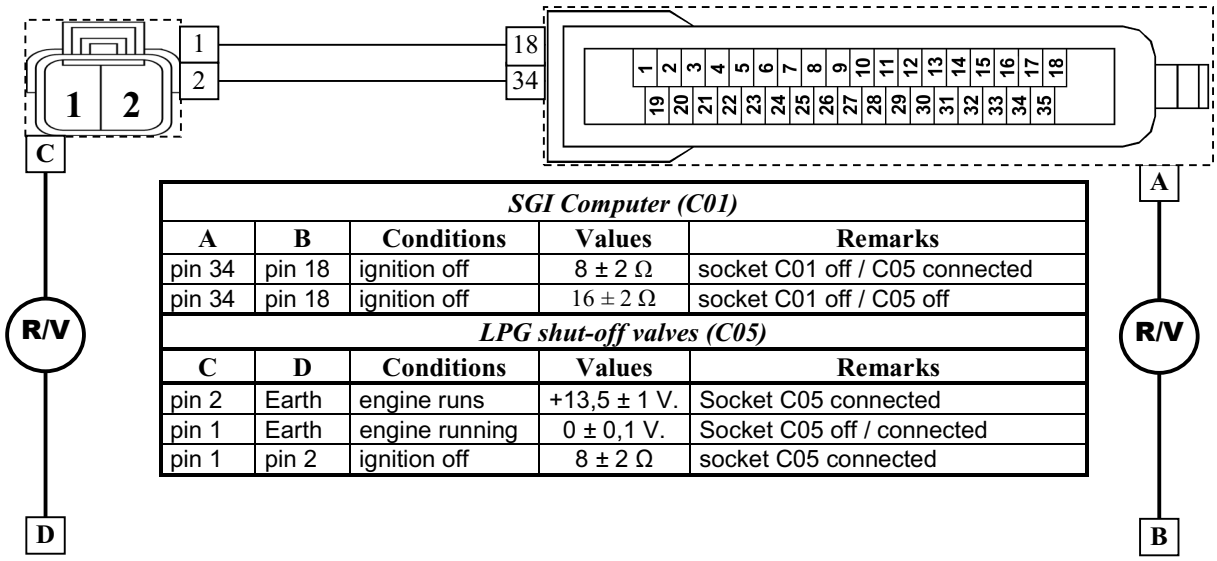
D. SGI injectors



SGI Computer (C01)				
A	**B**	**Conditions**	**Values**	**Remarks**
pin 35	Earth	engine running	+13,5 ± 1 V.	socket C01 off / connected
pin 33	pin 35	engine off	24 ± 2 Ω	socket C01 off
pin 14	pin 35	engine off	24 ± 2 Ω	socket C01 off
pin 32	pin 35	engine off	24 ± 2 Ω	socket C01 off
pin 15	pin 35	engine off	24 ± 2 Ω	socket C01 off
LPG Injectors (C06 – C09)				
C	**D**	**Conditions**	**Values**	**Remarks**
pin 2	Earth	engine running	+13,5 ± 1 V.	socket C06-09 off / connected
pin 1	pin 2	ignition off	24 ± 2 Ω	socket C06-09 connected

Note: if the SGI-computer control wire actuates two SGI injectors (in 5, 6 or 8-cylinder engines), the measured resistance value from socket C01 is halved!

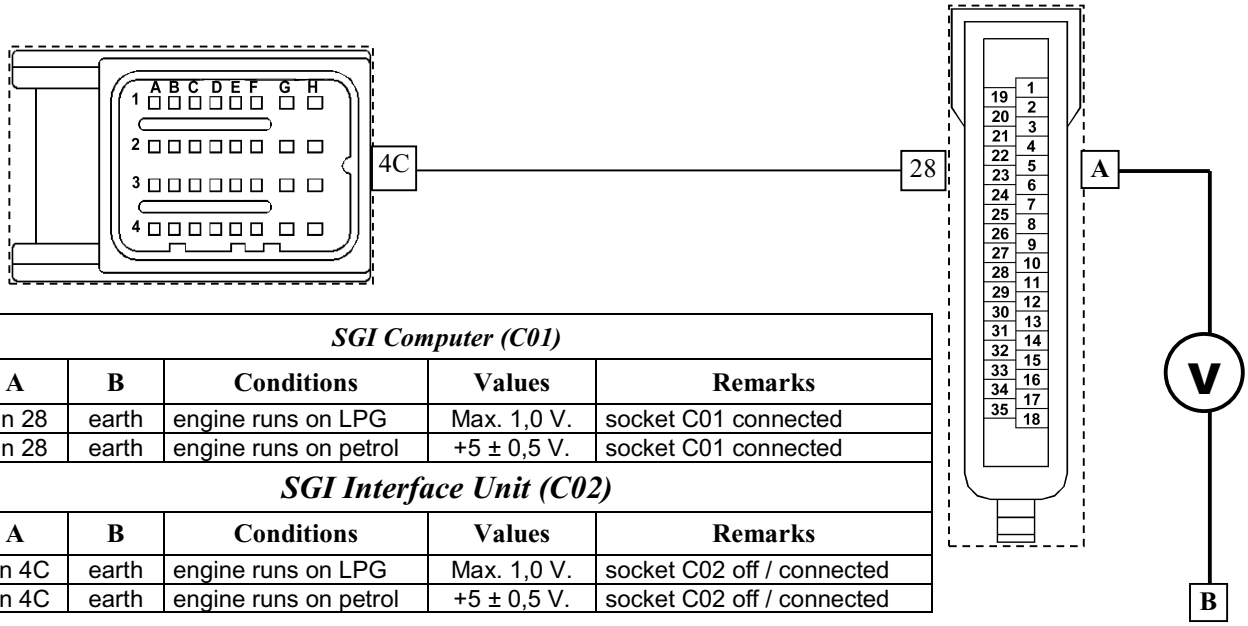
E. LPG shut-off valves



SGI Computer (C01)				
A	**B**	**Conditions**	**Values**	**Remarks**
pin 34	pin 18	ignition off	8 ± 2 Ω	socket C01 off / C05 connected
pin 34	pin 18	ignition off	16 ± 2 Ω	socket C01 off / C05 off
LPG shut-off valves (C05)				
C	**D**	**Conditions**	**Values**	**Remarks**
pin 2	Earth	engine runs	+13,5 ± 1 V.	Socket C05 connected
pin 1	Earth	engine running	0 ± 0,1 V.	Socket C05 off / connected
pin 1	pin 2	ignition off	8 ± 2 Ω	socket C05 connected

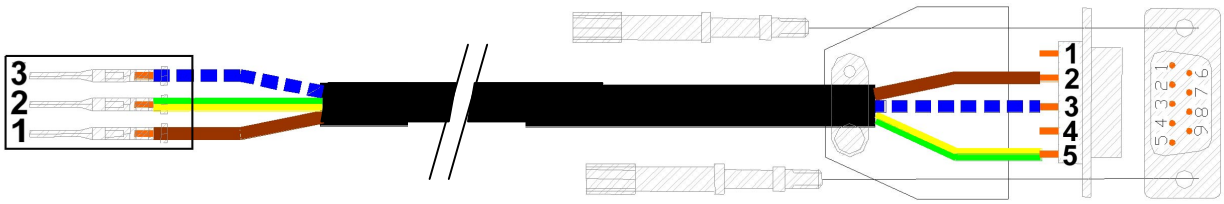
F. Mode signal

Control of the Interface Unit by the SGI computer takes place by means of the so-called Mode signal.
When the petrol injectors are interconnected, a voltage of approx. 5 Volts is measured on this control wire. When the engine runs on LPG, this wire is connected to earth in the SGI computer, which causes the Interface Unit to interrupt and simulate the petrol injectors.



SGI Computer (C01)				
A	**B**	**Conditions**	**Values**	**Remarks**
pin 28	earth	engine runs on LPG	Max. 1,0 V.	socket C01 connected
pin 28	earth	engine runs on petrol	+5 ± 0,5 V.	socket C01 connected
SGI Interface Unit (C02)				
A	**B**	**Conditions**	**Values**	**Remarks**
pin 4C	earth	engine runs on LPG	Max. 1,0 V.	socket C02 off / connected
pin 4C	earth	engine runs on petrol	+5 ± 0,5 V.	socket C02 off / connected

G. Diagnostic cable AG 258110



Connections diagnostic cable AG 258110	
3-pole diagnostic socket	**9-pole communication socket**
pin 1	pin 2
pin 2	pin 5
pin 3	pin 3

3. COMMUNICATION WITH THE SGI COMPUTER

Communication with the SGI computer is necessary to be able to interpret signals, to read out error codes, to read out identification and version data and to make a fault diagnosis. Communication can be established by means of a so-called Psion (Workabout) or with a PC (Laptop). The complete procedure is described in the supplied manuals. The start-up procedures when using a Psion 3(a), Psion Workabout and PC are described below.
Make sure you have your communication device at hand for communication with the SGI computer.

Psion 3(a)
Switch on the Psion and press [SYSTEM] (to the bottom left of the screen); Use the horizontal cursor control keys to find out whether the communication software has been installed once [CommsC];
if it is shown twice, remove one of them; if not available, install the software.

PSION Workabout
Switch on the Workabout and press [MENU]
Go to [SYSTEM SCREEN] using the cursor control keys 1x down
Press [ENTER]
Find the application [CommsC], using the horizontal cursor control keys.
Press [ENTER]; you can communicate now.

PC (Laptop)
For communication in MS-DOS the program “AGT” (AG Terminal), which is supplied in the AG test kit, has to be started.

Comment 1: Communication is only possible with a 12 V power supply connected to the SGI computer. It is branched off from the petrol injectors, so communication is possible both on LPG and on petrol.

Comment 2: For the same reason it is possible that, when the ignition is switched on, power is supplied very briefly to the petrol injectors (hence the Interface Unit), making communication possible only when the engine is running.

Comment 3: If the SGI installation fuse (of the Interface Unit) is faulty or absent, no communication is possible. Both the power supply and the earth connections must be sound, see also §2.2.4: **SGI Cabling diagram**.

Comment 4: In case no communication is possible with the SGI computer, fault diagram (10) “**No communication with the SGI computer**” can be consulted.

4. THE SGI BREAKOUT BOX

4.1. Introduction:

In case of a fault it must be possible to test all the connections in the cable tree. It shouldn't be much of a problem to test connections to the 35-pole computer socket. (It is recommended, though, to use a Breakout Box.)

De 32-pole connector

At the Interface Unit, use is made of a very compact 32-pole Molex socket. As such a socket is also used in modern engine-management computers it can be considered a high-quality plug-and-socket connection.

As the breaker points are not easily accessible, it is difficult to test the connections to the Interface Unit.

In spite of this, NEVER use measuring pins or paperclips to test the connections, because these objects may well damage the breaker points.

Measuring with pins or paperclips should always be prevented. Instead, AG Autogas Systems have developed the SGI Breakout Box, with which all the connections to the SGI Interface Unit can be tested safely.

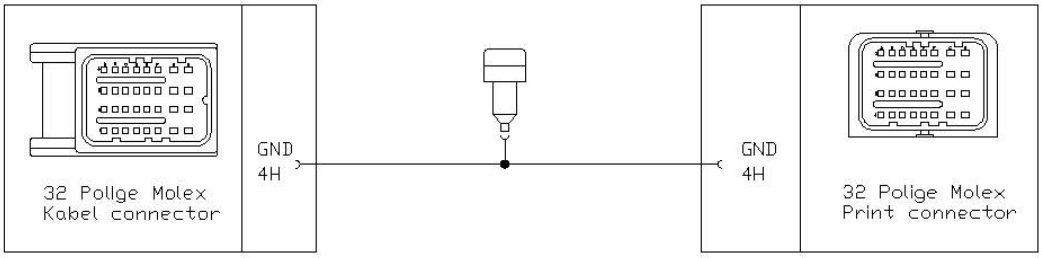
The AG SGI Break-out Box

NOTE:

NEVER use a measuring pin or a paperclip when testing the 32-pole Molex plug-and-socket connection; this may cause immediate contact problems!!
(See also the relevant Service Report)

4.2. Operation:

The signals are branched off, using 4mm connectors. This makes it easy to connect a scope or a multimeter. In the Figure below the branch lines for pole number 4H (= Earth) are diagrammed. The next paragraph shows the complete electrical circuit diagram with all the branch lines of the Breakout Box.

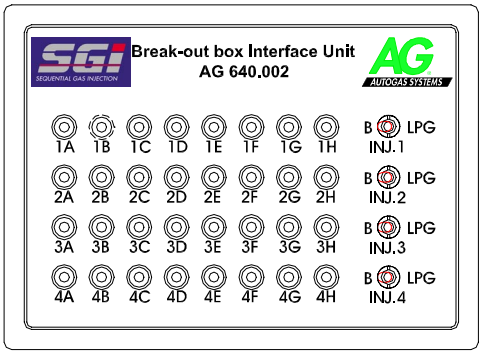


Schematic diagram of the AG SGI Breakout Box

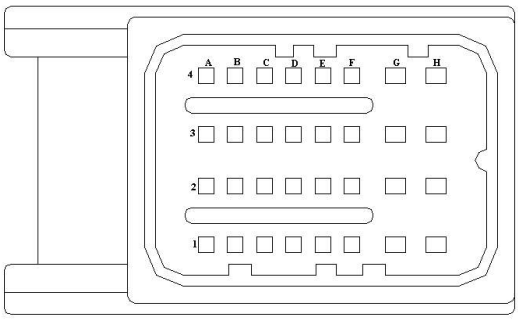
4.2.1. Measuring points

A. SGI Breakout Box

First of all a fast and simple check of the connections of the SGI injectors can be carried out with the AG SGI Breakout box. All the (electrical) signals can be measured using a scope or a laptop computer.
A second feature of the Breakout Box is that it can run each cylinder (to a maximum of 4) separately on petrol or on LPG by means of the fuel switches.
In the following paragraphs both functions are described in detail.
The AG SGI Breakout Box is a panel with 32 measuring points. Each point is connected to a connection in the Interface Unit cable tree. By placing the AG Breakout Box between the Interface Unit and the SGI cable tree it is possible to test all the signals efficiently and faultlessly.



Pinnumbers on the AG SGI Breakout Box



Pinning of the 32-pole "Molex"-socket

Pinno.	Wire colour:	Function:	Connection:
1A	Red *	Disconnection injector 5, input	Injector side
1B	Black *	Disconnection injector 5, output	Computer side
1C	Red	Disconnection injector 4, input	Injector side
1D	Red	Disconnection injector 3, input	Injector side
1E	Red	Disconnection injector 2, input	Injector side
1F	Red	Disconnection injector 1, input	Injector side
1G	Yellow/purple	Feed + 5 Volt	Pinno. 31 (SGI computer)
1H	Black>Red	Feed + 12 Volt (to SGI computer)	Pinno. 35 (SGI computer)
2A	Red *	Disconnection injector 6, input	Injector side
2B	Black *	Disconnection injector 6, output	Computer side
2C	Black	Disconnection injector 4, output	Computer side
2D	Black	Disconnection injector 3, output	Computer side
2E	Black	Disconnection injector 2, output	Computer side
2F	Black	Disconnection injector 1, output	Computer side
2G	*	+5 V output	-
2H	*	+15 V output	-
3A	Red *	Disconnection injector 7, input	Injector side
3B	Black *	Disconnection injector 7, output	Computer side
3C	Pink	Output petrol injector Signal 4	Pinno. 7 (SGI computer)
3D	Red	Output petrol injector Signal 3	Pinno. 27 (SGI computer)
3E	White	Output petrol injector Signal 2	Pinno. 20 (SGI computer)
3F	Yellow	Output petrol injector Signal 1	Pinno. 11 (SGI computer)
3G	Black / Brown	Earth	Pinno. 3 (SGI computer)
3H	Red / White	+12 V input	Feed petrol injectors
4A	Red *	Disconnection injector 8, input	Injector side
4B	Black *	Disconnection injector 8, output	Computer side
4C	Brown	Mode signal (earth controlled)	Pinno. 28 (SGI computer)
4D	Blauw	Measurement ambient temperature	Pinno. 23 (SGI computer)
4E	Grey	Earth (sensors)	Pinno. 10 (SGI computer)
4F	Green	Map signal	Pinno. 19 (SGI computer)
4G	Black	Earth	Pinno. 18 (SGI computer)
4H	Black	Earth	Apart aan Earth

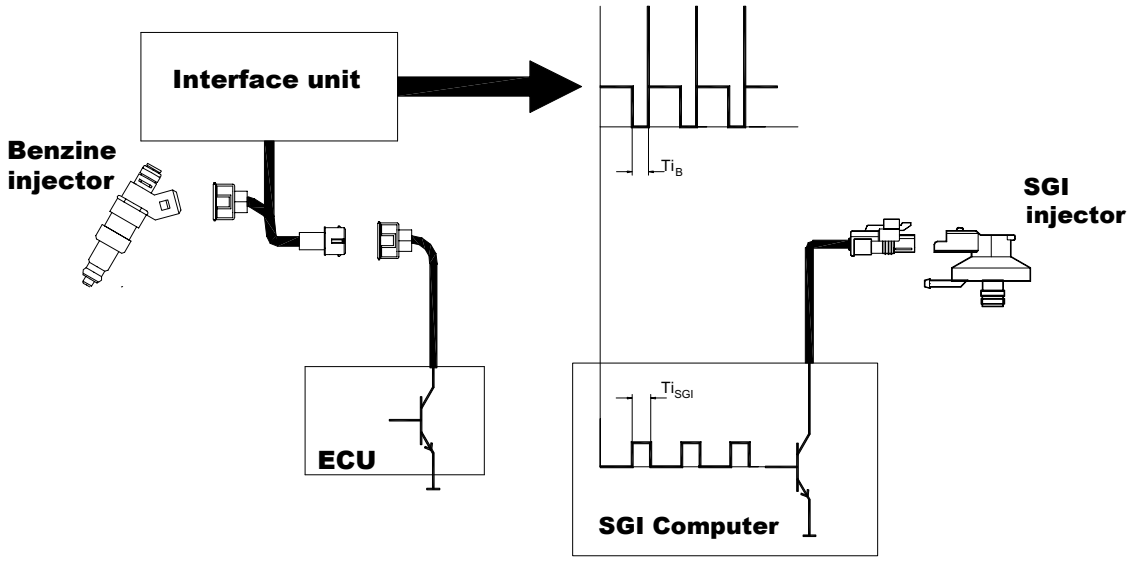
Table: Pinning of the 32-pole interface socket **: optional connection*

4.2.2. Interface Unit: Explanation

In 99% of all the current engine-management systems the injectors are opened when the injector coil is connected to Earth, whilst the other side receives a 12-Volts power supply.
When the SGI system is installed, the wires that are connected to Earth are interrupted through the Interface Unit (see Figure 10). The Interface Unit has an *inj-in* and an *inj-out* signal for each injector.

When running on LPG the opening period of the petrol injector is measured by simulating it in the Interface Unit. This opening period is passed on to the SGI computer as the (*TiB*) input signal.
The computer then converts this opening period into the correct opening periods for each SGI injector separately.

The Figure below shows the petrol-injector opening period (Ti_B) together with the relevant scope representation.

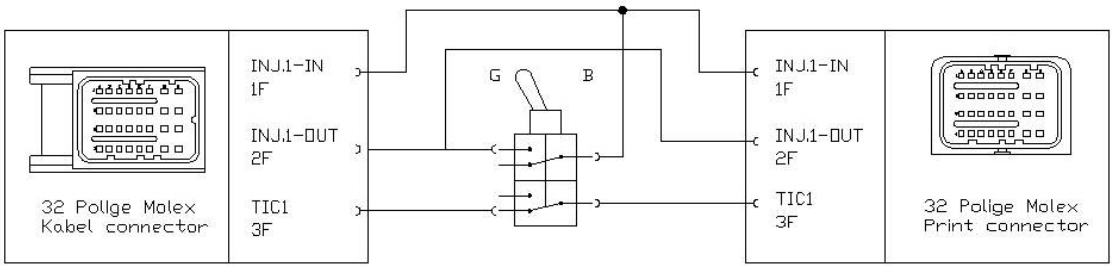


Signal processing by the Interface Unit

Even though the Interface Unit could cut off as many as 8 cylinders (AG 600.140), it only provides the TiB signal for up to 4 cylinders. When two SGI computers are used for one engine, the TiB signals for cylinders 5 - 8 can be routed to the second SGI computer by passing round the Interface Unit. In that case it is not possible to use fuel switches on the Breakout Box for cylinders 5 – 8, as the Interface Unit is bypassed.

4.2.3. The fuel switches

Now that the exact operation of the Interface Unit is clear, the operation of the fuel switches will be explained on the basis of the Figure below. Staring point is a properly running engine on LPG.



Elektrical schematics of the fuel switches.

When the fuel switches are in the normal position (LPG) all the signals are connected normally.

Changeover of the fuel switch to petrol results in:

1 Interruption of the input signal (TiB). The SGI computer will not receive any signal, so no LPG is injected.
2 Interruption of the petrol injectors is undone by connecting *inj-in* and *inj-out*. The interruption in the Interface Unit itself will not be undone, because the connection bypasses the Interface Unit.

To put it briefly, this means that the fuel switches can undo the interruptions made by the Interface Unit.

It is simple to check whether the actuation of the SGI injectors is connected correctly by means of the fuel switches. This is also a useful check to test the petrol-injector interruptions that were made when the SGI system was installed.

On the following pages the operating instructions of the SGI Breakout Box (§4.2.4) are described.

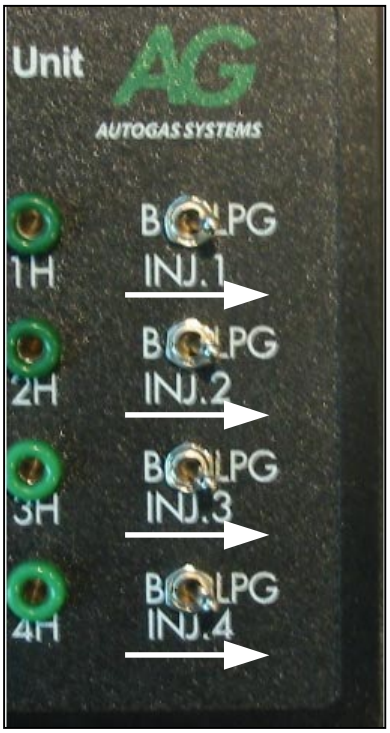
4.2.4. Operating instructions

In this paragraph the general preparations for making a diagnosis are described. On the basis of the relevant flow charts a description is given of the measurements that should be carried out, and under what circumstances.

General preparations:

1. Switch the ignition to the “off” position;
2. Connect the Breakout Box between the Interface Unit and the 32-pole socket (see the illustration below);

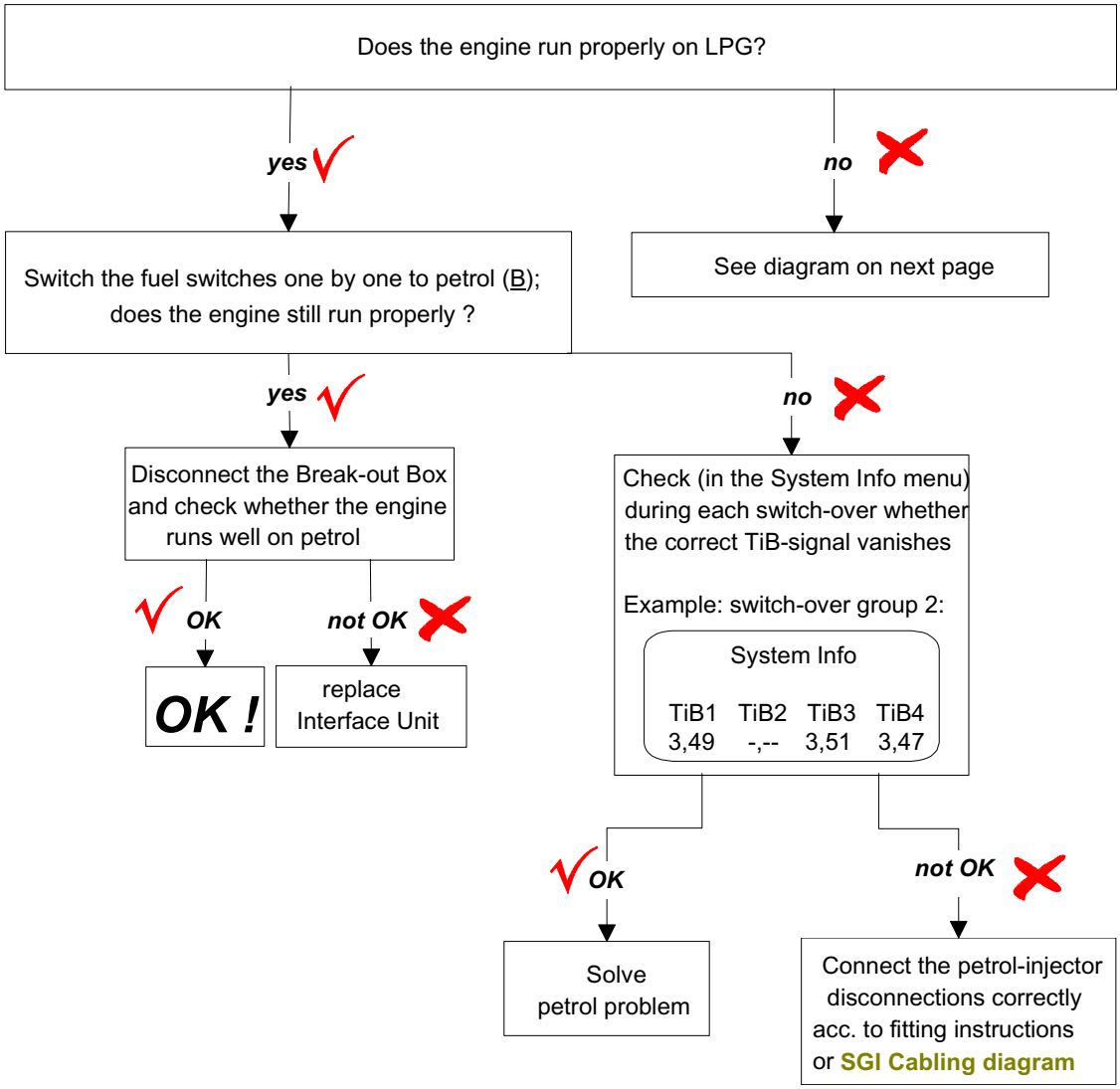
3. Set all the fuel switches to **G** (see the illustration below);



4. Connect the Psion (or laptop) to the diagnostic plug of the SGI computer;
5. Start the engine with the switch in the **LPG position** (diagnostic LED flashes);
6. Warm up the engine until the tank-indication LEDs on the LPG switch light up and the **diagnostic LED** is **off** (see the Figure below).

The flow charts below can now be followed in order to determine whether the SGI installation functions properly by means of the Breakout Box.

Engine runs properly on LPG:



The above diagram can be checked to find out whether the engine runs well on LPG (this is recommended after each installation).

If, however, the engine does not run properly on LPG, the diagram on the next page can be consulted.
Several causes may be suggested and it is possible to trace the exact cause by means of the diagram.

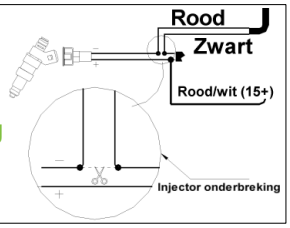
Engine does not run properly on LPG:

Does the engine run properly on LPG ?

yes ✓ → see previous diagram

no ✗ → check whether all TiB-signals are received (in the System Info menu)

"TiB: -,-- " → check the connections of the concerning injector-breaks acc. to the fitting-instructions and/or SGI Cabling diagram (see drawing as well); correct if necessary



✓ correct → Measure whether all signals reach the SGI computer by using an oscilloscope acc. to table below:

TiB	Pinnr SGI ECU
1	11
2	20
3	27
4	7

✓ OK → replace Interface Unit

✗ not OK → replace SGI computer

OK ✓ → Switch the fuel switches to petrol (B) one by one

no noticeable difference* → Switch the specific fuelswitch back to LPG (G)

✓ all OK → solve the petrol problem

engine starts to run properly* → Check (in the System Info menu) during switch-over whether the correct TiB-signaal vanishes
Example: during switch-over group 2:

System Info			
TiB1	TiB2	TiB3	TiB4
3,49	-,--	3,51	3,47

✓ OK → Check whether the injector is controlled properly (connect the injectorplug onto another SGI injector and check whether this injector is functioning

✓ OK → replace specific SGI injector

✗ not OK → Carry out measurement D (SGI injectors); if OK, replace SGI computer

✗ not OK → SGI-injector controlgroups not synchrone with the disconnection groups of the petrol injectors; connect according to SGI Cabling diagram)

***: be aware of possible switching off the petrol injector control function by the motormanagement computer (because of misfire detection)!**

NOTE:
Whether a petrol injector or an SGI injector functions properly can often be felt or heard by holding a screwdriver against the injector (other side of screwdriver near the ear), or by listening to the characteristic clicking sound of the injectors when the engine is idling. The same applies to switching on of the SGI injectors.

> If one of the injectors does not produce the characteristic sound all the connections for the cylinder concerned should be checked.

The **SGI Cabling diagram** section includes a diagram with the complete overview of the SGI cable tree. This diagram, which is universal for all the 4-cylinder engines, can be used for testing the cable tree. (The interruption groups for cylinders 5 – 8 are indicated as an option.)

When contact with the SGI computer is no longer possible, the Breakout Box can be used to make a final diagnosis.

5. MAINTENANCE OF VEHICLES FITTED WITH AN SGI SYSTEEM

This chapter is dedicated to the maintenance of vehicles that have been fitted with an SGI system. Very little or no service at all is carried out on cars with a G-3 LPG system.
Non-adjustable and *self-learning* does not mean that the system services itself!

For a number of cars this implies that special attention needs to be paid to several points during servicing.
The following two paragraphs deal with specific issues: **Valve clearance**, **Ignition system** and **4-Gas analysis**.
The third paragraph is a general guideline for maintenance work on cars that are fitted with an (SGI) LPG installation.

5.1. Valve clearance:

Lead used to be added to petrol to increase the octane number and, with its damping and lubricating characteristics, it also reduced damage to valves and valve seats.

In 3-way exhaust catalytic converters, which have been mandatory since 1990, it is no longer possible to use leaded fuel. This is due to the fact that the catalytic converter will be damaged by the presence of lead in the emission gasses.
Since then additives have been used in petrol to take over the lubricating characteristics of the absent lead.

As there are no such additives in LPG, the valves will wear faster when running on LPG than when running on petrol.

In most engines this will not immediately present any problems for the endurance life of the cylinder head, provided that the valve clearance is regularly checked and, if necessary, adjusted. When the valve clearance decreases the wear pattern will, however, increase considerably. This is why engines fitted with hydraulic valve lifters usually do not suffer from valve wear as much as engines with adjustable valves.
In a limited number of engines running on LPG the combination of the materials used and the thermal management in the cylinder head cause an unacceptable wear pattern. In order to prevent such a wear pattern it is advisable to replace the cylinder head in these engines, before or during installation of the LPG system, by one that has hard valves and valve seats.

Often this has already been done at the request of the importer of the vehicle.
Also refer to the workshop manual and/or service reports of the (car make) importer.

5.2. Ignition system:

LPG is a fuel that is almost similar to petrol, as far as composition and characteristics are concerned. It is, however, more difficult to combust an LPG / air mixture. As an LPG / air mixture has a higher electric resistance than a petrol / air mixture it requires an ignition voltage which is also approximately 20% higher.

As the so-called secondary resistance in the ignition system is higher when running on LPG, there is also a greater risk of failure to ignite properly (misfiring).
Problems caused by moisture, dirt or by the ageing process in the ignition system (e.g. sparking plugs or cables) will occur at an earlier stage when running on LPG.

The load on the sparking plugs is heavier when running on LPG, so they will need to be replaced sooner. This is because the thermal load and the voltage are higher in the ignition system (platinum sparking plugs also have a shorter life span on LPG than on petrol).

Sometimes a different specific brand and / or type of sparking plugs or a different electrode distance is used to ensure proper performance of the LPG system. This will be explicitly mentioned in the installation manual. It is important to inform the user as well (and it should be included in the maintenance manual).

Checkpoints

- Check whether the correct (original) sparking plugs have been fitted;
- Electrode distance of the sparking plugs;
- Earth of the coils;
- Primary resistance of the coils;
- Contact resistance of the spark-plug wires, which may be caused by e.g. dirt, oil or grease. This can be inspected visually. Cables need to be especially checked for desiccation as well.

See also the workshop manual and / or service reports of the (car make) importer.

5.3. 4-Gas analysis:

Conducting a 4-gas analysis can be very helpful to find a possible problem with an engine. To be able to understand how the exhaust gases are influenced in certain circumstances, It is important to know what these originate from.
The basic chemical transformation is shown below:

$$HC + (O_2 + CO_2 + N_2) = CO_2 + H_2O + N_2$$

(fuel) + (air) = (carbon dioxide) + (water) + (nitrogen)

This is of course a theoretically ideal perception of how the combustion develops inside an engine.

Unfortunately, the combustion does not take place as ideally as in the basic chemical transformation as shown above, because of which an amount of unwanted exhaust gases are emitted, like carbon monoxide (CO), hydrocarbons (HC) and nitrous oxygen (NOx). These gases are measured (except NOx) with a 4-gas analysis, together with carbon dioxide (CO2) and oxygen (O2).

How the exhaust gases are developed is explained in the text below, separated for a lean and for a rich mixture.

- **Lean mixture:**

In this case there is a shortage of fuel (= too much oxygen), which results in the following transformation:

(too little) HC + O2 = CO2 + O2 + H2O

An amount of O2 (oxygen) remains in the exhaust gases. When the amount of fuel supplied to the engine is much too small, also an amount of HC (unburnt hydrocarbons) will be measured.
The exhaust gases from the engine are kept shortly by the catalyst to react with the gases which are formed in the engine with a rich mixture.

- **Rich mixture:**

In case too much fuel is supplied to the engine (shortage of oxygen), the following transformation will occur:

(too much) HC + O2 = CO2 + CO + HC + H2O

In this situation not all fuel is burnt, because of which CO (carbon monoxide) and HC (hydrocarbons) are formed.

The catalyst stores the oxygen (O2) of the exhaust gases developed during a lean combustion and adds these to the gases which result from a rich combustion. This will result in the following transformation is :

O2 + CO + HC = CO2 + H2O
(lean) + (rich)

The result is that no directly harmful gases are emitted.
This is the reason why the effectiveness of the catalyst is optimal with a changing mixture (= lambda signal) from lean to rich and back.

The final result of the combustion can therefore be judged according to the Lambda signal by using a lambdatester.

In case the combustion develops as it should, the following values can be measured when using a 4-gas analyser:

Exhaustgas	Value (petrol)	Value (LPG)
CO	0 %	0 %
HC	< 30 ppm	< 30 ppm
O2	0 %	0 %
CO2	15,5%	13,5 %
Lambda	0,97-1,03	0,97-1,03

In case of a technical failure, because of which the combustion will not be ideal, the exhaust gases will be influenced negatively, of course. A few of these failures are mentioned below, together with the expected effect on the composition of the exhaust gases:

FAILURE	CO	HC	O2	CO2
Ignition problem	+	+	+	-
Rich mixture	+	+	-	-
Lean mixture	-	-	+	-
Very lean mixture	--	++	++	--
Incorrect ignition timing	+	+	+	-
Faulty Lambda sensor	+	+	0	-
Stretched distributionbelt	++	++	++	--
Leakage in exhaust system	0	0	+	-
Valve clearance too small	0	+	0	0

++	: much higher
+	: higher
0	: unchanged
-	: lower
--	: much lower

It can be useful to note certain certain specific experiences in a similar way in addition to the table as shown above.

For example: if an SGI injector leaks, this will result in a poor starting behaviour of the engine. During running on LPG the combustion can still be correct according to the 4-gas analysis. However, when swithing over to petrol, the mixture will become very rich for a certain period (gas is leaking into the intake manifold through the leaking injector), because of which the amount of CO and HC will temporarily become much higher.

5.4. General service schedule:

In this paragraph a general guideline is given for the supplementary work when carrying out periodic maintenance to a vehicle.
Of course this chart should be interpreted on the basis of the particular type of vehicle in question (original service schedule) and its use.
It may be useful to enclose such a schedule in the maintenance booklet of the car, so that faults can be prevented.

	Service schedule for vehicles with an SGI system:		
	Minor servicing	**Major servicing**	**After approx. 40.000 mls.**
Proceed as described	• Drain vaporiser • Check or adjust valve clearance • Check mixture control	As minor service, but also carry out: • Check (if necessary replace) spark plugs, ignition cables, rotor and distribution cap • Clean and, if possible, adjust throttle body and idle speed regulator • Visually check coolant and LPG hoses (connections included) • Perform gas-leakage test • Check and, if necessary replace filters of LPG shut-off valve and vaporiser	As major service, but also carry out now: • Replace filters of LPG shut-off valve and vaporiser