GUIDELINE FOR

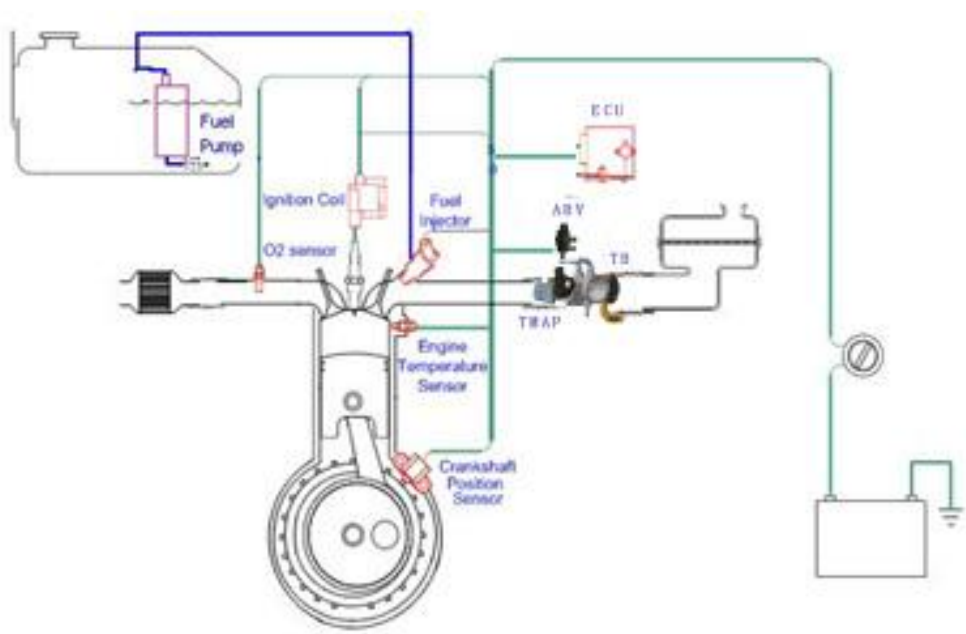
TROUBLE SHOOTING FOR SYNERJECT EMS

CONTENT

1. System Overview

1.1. Components of system and Operating principle

The Engine Management System(EMS) comprises electronic control unit(ECU), throttle body, air bypass valve, fuel pump, fuel injector, ignition coil, crankshaft sensor, O2 sensor, throttle position sensor, T-MAP sensor, cylinder head temperature sensor and so on. Based on the air flow and engine speed, the fuel injector and ignition coil are controlled by ECU to get the optimal combustible mixture of fuel and air and Ignition timing which meet all engine operating conditions. The EMS use sensors to collect parameters such as air flow, temperature of inlet air, cylinder head temperature, atmospheric pressure and the operation state of engine (rpm, load, acceleration and deceleration). All parameters are transferred to the ECU with electronic signal. The ECU output controlling signals after input signal are handled. Through the engine and actuators on the vehicle (ignition coil, fuel injector, air bypass valve and so on), the fuel and fire are exactly controlled and corrected with closed loop. For production conformity, there is ±32％ corrected fuelling in order to match up to the difference of vehicles due to the inconformity of components.



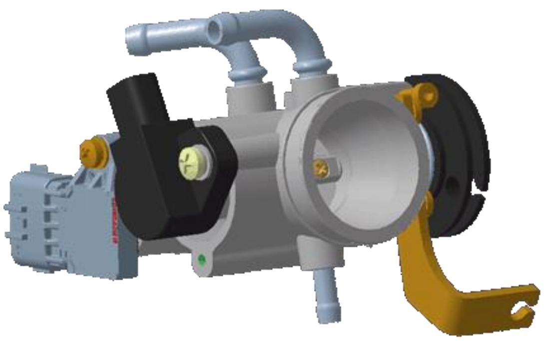
System Schematic

Electronic Control Unit

- ✓ 16 bit CPU operating at 16 MHz
- ✓ 128 KB ROM (Flash)
- ✓ 4 KB RAM
- ✓ 32 pins connectors
- ✓ Input/Output Standard definition

Throttle Body Assembly

- ✓ Based on aluminum throttle body
- ✓ Integrated Throttle Position Sensor and T-MAP Sensor
- ✓ Throttle diameter: Ø32



Air Bypass Valve

- ✓ A solenoid valve with an armature as the only movable part

Fuel Injector

- ✓ DEKA VII short type
- ✓ Extra extend tip
- ✓ Spray and Stream: Split

SYNERJECT

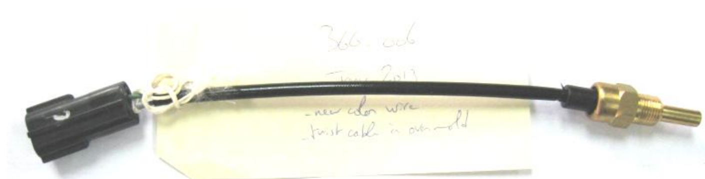
- ***O$_2$ Sensor***

  - ✓ 4 wires heated O_2 sensor
  - ✓ Zirconium type

- ***Ignition Coil***
  - ✓ Inductive coil
  - ✓ Diode in secondary winding

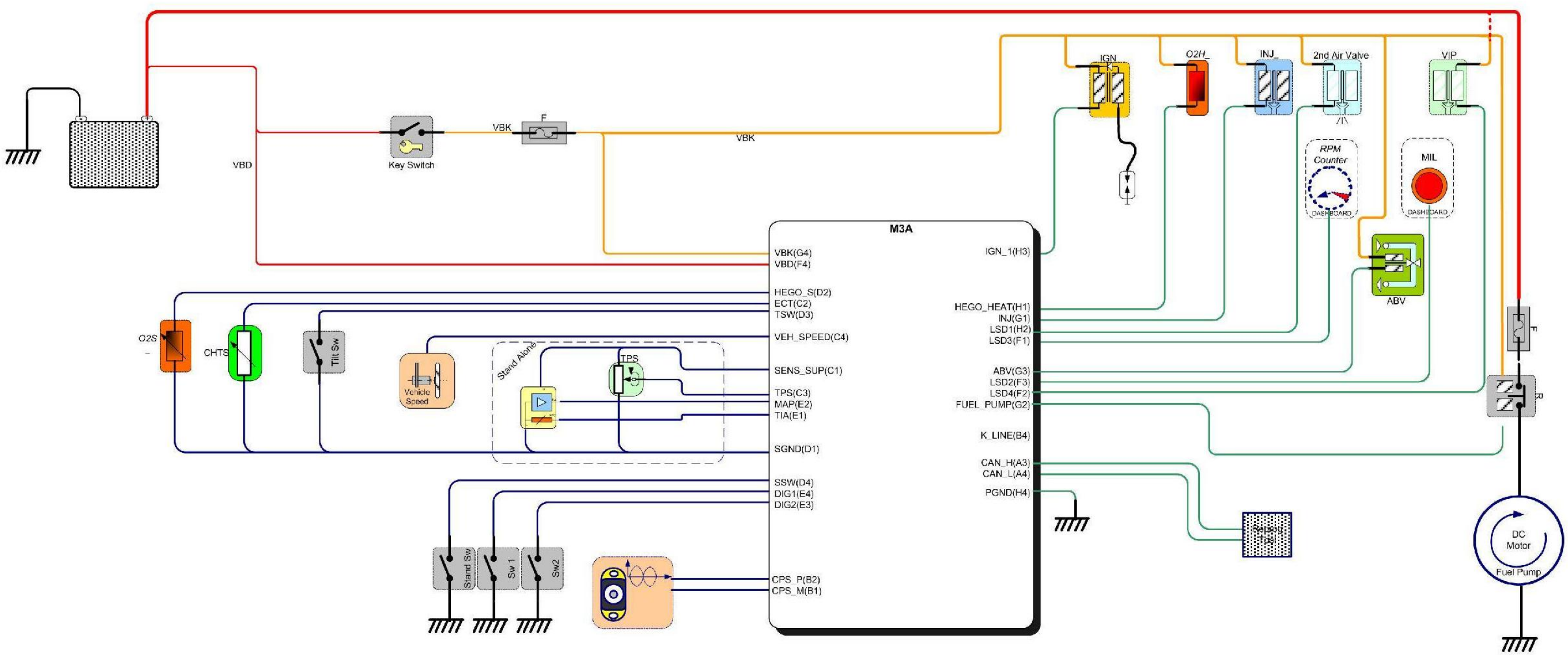
- ***Cylinder Head Temperature Sensor***

  - ✓ NTC thermistor
  - ✓ -40°C / +150°C



1.2. Wiring Diagram

GENERIC M3A STAND ALONE WIRING DIAGRAM



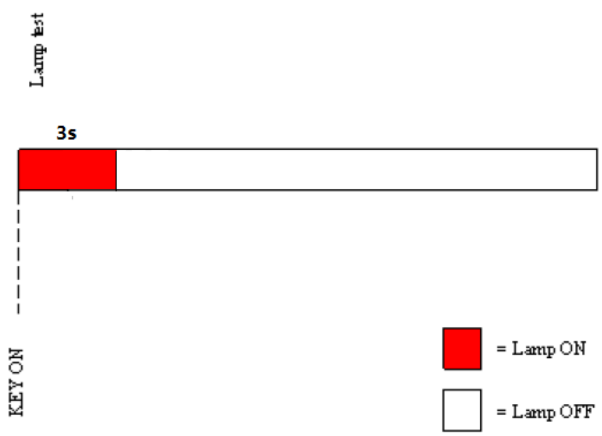
2. Trouble Shooting With EMS Malfunction Lamp & Flash Code

2.1. EMS Malfunction Lamp Diagnostics

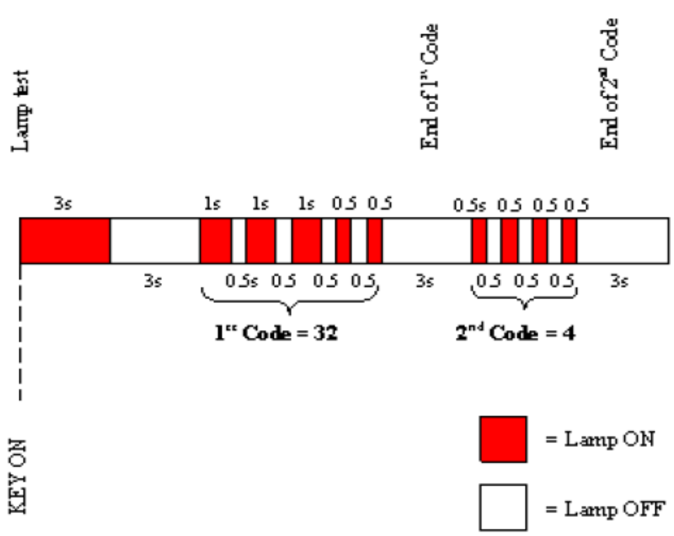
The function of EMS diagnosis means the issue of engine will be detected by the diagnostic software. During the system diagnosis, it will automatically find the problem and display the information of fault by EMS malfunction lamp to help finding the solution.

The EMS malfunction lamp which shows states of the EMS, the engine and the information of fault is on the dashboard. It indicates fault with different flashing model below.

A、If there is no flash code stored in ECU, after key on the lamp then illuminates in the example shown below.



B、If there are flash codes stored in ECU, after key on the lamp then illuminates in the example shown below.



This sequence will be repeated 4 times before the lamp switches off.

2.2. Flash Code and Diagnosis Name

Flash Code	Description	Diagnosis Name	Trouble Shooting Level
1	Engine over temperature diagnosis	TCO_OVER_TEMP	2
2	Crank wrong tooth number diagnosis	TOOTH_NR	1
3	Throttle position adaptation diagnosis	V_TPS_AD_BOL_1	1
4	Throttle position sensor 1 diagnosis	TPS_1	1
5	Throttle plausibility diagnosis	TPS_1_INTM	1
6	Battery voltage diagnosis	VBK	1
7	Intake air temperature sensor diagnosis	TIA	1
9	Idle Speed controller adaptation diagnosis	ISC_ISA_AD_MV	2
10	Injector valve diagnosis	IV	1
11	Ignition coil diagnosis	IGA	1
12	Electrical fuel pump diagnosis	EFP	1
13	Engine overspeed diagnosis	N_64_MAX	2
16	Engine temperature diagnosis	TCO	1
18	MIL diagnosis	MIL	1
19	O2 sensor signal circuit diagnosis	VLS_UP_1	1
20	O2 Sensor Heater diagnosis	LSH_UP_1	1
21	MAP sensor diagnosis	MAP	1
23	Lambda control diagnosis	TI_LAM_COR	2
26	Second air valve diagnosis	SAV	2

3. Troubles shooting

3.1. *General trouble shooting procedure*

In all cases (for all the external components) the following procedure applies:

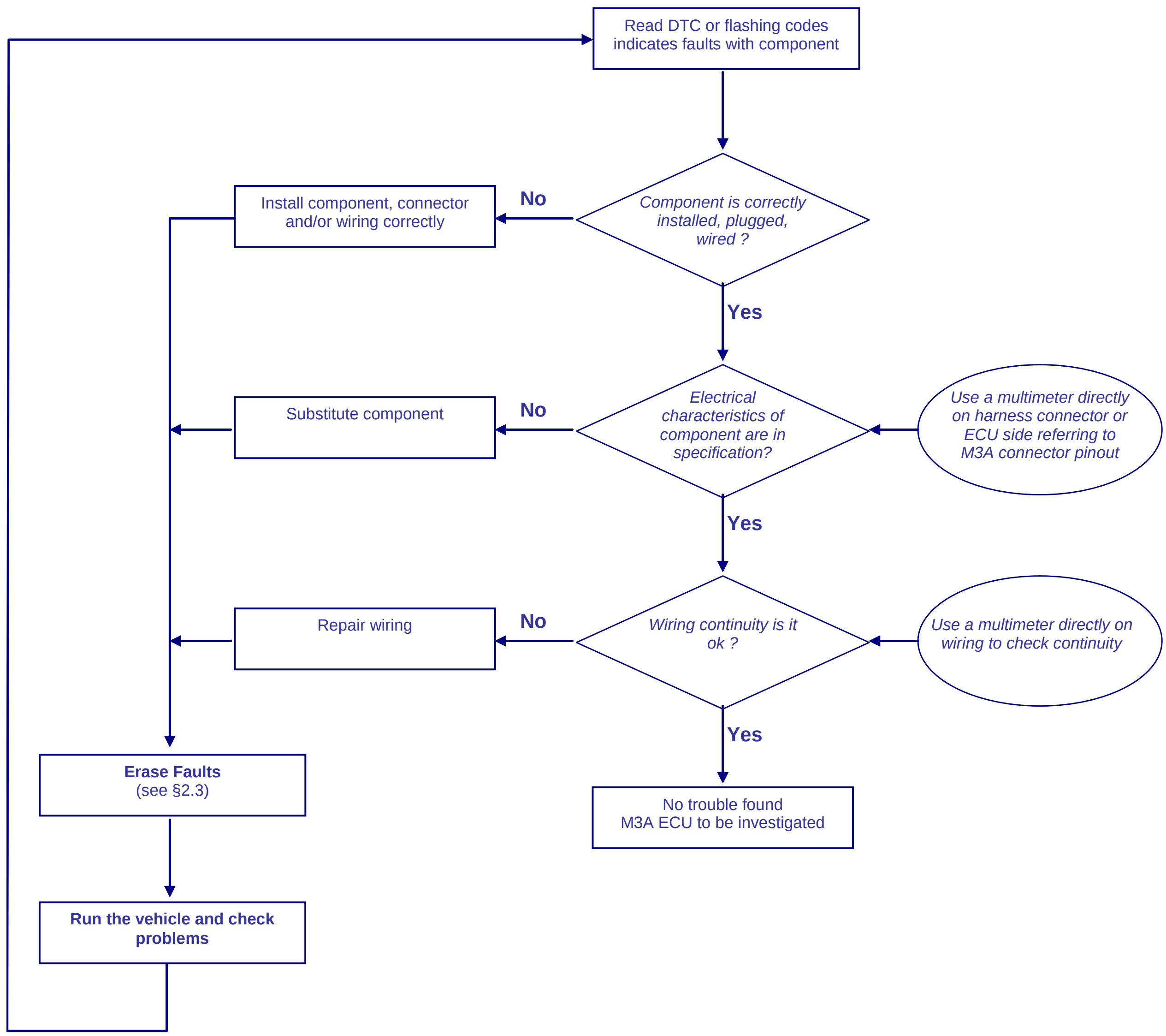
- Disconnect component from the harness.
- Using voltmeter to check continuity at component connector pins. If no fault is detected (no short or open circuit and electrical values according to component spec) check continuity on harness connector and component side. All three cases (short circuit to power, short circuit to ground, open loop) have to be tested ; to do so, turn key on and connect multimeter to harness connector to test component "in default" output.
- Next step is to check continuity on harness connector, ECU side. Unplug harness connector and verify harness continuity on component "in default" lines.
- Should component and harness tests reveal no fault check discontinuity on relevant pins on ECU connector.

Remark : a continuity between pins could be normal. The wiring harness diagram has to be used as reference to define what is normal and what is problematic.

In case a diagnosis tool can be used focus directly on raised diagnostic for multimeter use. Diagnosis tool could present an actuator test which allows to check directly the command of component (injector for exemple).

In the following paragraphs for each diagnostic, the flash code number is mentioned in subtitle and the possible faults linked to this diagnosis are listed below with beside symptom reference (for diagnosis tool use if applicable).

When dismounting any component the operator must first verify if it was installed according to its specification, both for physical (mounting) and electrical (pinout) installation.



3.2. *Engine over temperature diagnosis*

Diagnosis
The engine overtemperature diagnosis is raised if the engine temperature (TCO, either water temperature or cylinder head temperature) is too high.

Possible faults

- Engine Temperature sensor failure
- Coolant fluid leakage
- Engine malfunction

Trouble shooting
Check that the following errors are not present :

- n°9 (Coolant Temperature Sensor diag - chapter **Error! Reference source not found.**)
- n°10 (Coolant temperature intermittent diagnosis chapter **Error! Reference source not found.**)

If all these failures are cleared and the engine overtemperature is present do the following actions.

- Try to know running conditions when default appeared
- Check engine temperature is realistic : when engine is cold, engine temperature read by through the diagnosis tool is ambiant temperature, +/- 5 °C. If not, check wiring, especially wiring resistance is 0 ohm, replace temperature sensor otherwise
- Verify cooling system is not damaged (no leakage on pipes or connects) and that no cracks are visible on engine cylinder head or crankcase
- Control coolant volume and quality inside cooling circuit
- Check engine blowing system if any
- Check lubricant level and quality
- Replace the Engine Temperature sensor

3.3. *Crank wrong tooth number diagnosis*

Possible faults
Incorrect number of teeth seen by the CRK driver.
The crankshaft signal acquisition may tolerate up to two missing/additional teeth without loosing synchronization, depending on the used target wheel and on configuration data.

Trouble shooting
The general trouble shooting procedure does not apply.

Please refer to electrical characteristics of vehicle manufacturer's crank sensor choice.

- Disconnect sensor from harness.
- Verify sensor electrical specifications with multimeter and check harness continuity on this line.
- Check ECU input, especially sensor voltage under cranking (> 1 V) and polarity : crk + signal has to raise after the long tooth.
- Check crankshaft sensor mounting (air gap must be within specification tolerances, there should not be burrs neither on the target wheel nor on the sensor) and control target wheel rotating it manually.
- Check engine startability : errors 19 and 20 can occur if lots of engine start/stop phases happen during a driving cycle.
- Check crank voltage on oscilloscope : no disturbance due to wrong connection quality.
- Reprogram software and clear the fault
- Replace the M3A module and clear the fault

Run the engine at idle speed up to max rpm, during several minutes, and restart the engine several times to test if the fault is not detected again.

3.4. *Throttle position adaptation diagnosis*

Possible faults
TPS position sensor adaptation is out of range

Note : this fault maybe raised in case of Throttle Position Sensor 1 diagnosis (**Flash Code 4**).

Trouble shooting
The general trouble shooting procedure does not apply if the sensor is integrated in the M3A module.

If TPS is stand alone, it is possible to check electrical characteristics. Internal resistance of TPS must be equal to 2kΩ on total range ; in function of throttle position and measured pin, resistance could be included in 0-2kΩ. Those characteristics are given for a standard Synerject's TPS ; they must be adapted to customer specifications.

- Check throttle closed position, on its mechanical stop position, can be achieve easily, without any risk to be stucked before (no excessive friction of the throttle shaft or grip cable)
- Check stop position screw is at its original position,i.e. paint point is not cracked.
- Clear the fault and reset the adaption value
- Conduct a new test with this configuration (at least 5 key_on / key_off with powerlatch, i. e. typically 10 s between key_off and key_on ; this minimum duration can be different depending on application)
- Reprogram software and clear the fault
- Replace the M3A module and clear the fault

Repeat key ON/OFF five times (standard calibration) with a break of 5s (at least in standard calibration) on key ON to test if the fault is not detected again.

3.5. *Throttle position sensor 1 diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground or Open loop (sym_1)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure does not apply if the sensor is integrated in the M3A module.

If TPS is stand alone, it is possible to check electrical characteristics. Internal resistance of TPS must be equal to 2kΩ on total range ; in function of throttle position and measured pin, resistance could be included in 0-2kΩ. Those characteristics are given for a standard Synerject's TPS ; they must be adapted to sensor specification.

- Apply general procedure if possible
- Reprogram software and clear the fault
- Replace the M3A module and clear the fault

Put key ON to test if the fault is not detected again.

3.6. *Throttle plausibility diagnosis*

Possible faults
Difference between the two last TPS acquisitions is out of range

Trouble shooting
The general trouble shooting procedure does not apply as the sensor is integrated in the M3A module.

- TPS track wear
- The vibration level module is exposed to being excessive and wipers are vibrating off the track causing intermittent fault. (Note: This would be extreme case.)
- Internal connection problem which is intermittent

3.7. *Battery voltage diagnosis*

Possible faults

VBK too high (sym_0)
VBK too low (sym_1), this fault must not be raised with a generic calibration

Trouble shooting
The general trouble shooting procedure does not apply

Battery voltage without load must be superior to 8V.

- Check battery voltage on ECU connector
- Unplug battery and measure its voltage directly in order to discard wiring problem
- Check if the charging circuit is operating
- Replace battery if faulty
- Reprogram software and clear the fault
- Replace the M3A module and clear the fault

Put key ON to test if the fault is not detected again.

3.8. *Intake air temperature sensor diagnosis*

Possible faults
Shot circuit to battery or open loop (sym_0)
Short circuit to ground (sym_1)

Note : this fault maybe raised in case of battery voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure does not apply if the sensor is integrated in the M3A module.

If TIA sensor is stand alone, it is possible to check electrical characteristics. Internal resistance of TIA sensor must be included between 80Ω and 100kΩ. Those characteristics are given for a standard Synerject's TIA sensor ; they must be adapted to sensor specification.

- Apply general procedure if possible
- Reprogram software and clear the fault
- Replace the M3A module and clear the fault

Put key ON to test if the fault is not detected again.

3.9. *Injector valve diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground (sym_1)
Open loop (sym_2)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

Internal resistance of standard Synerject's injector must be approximately equal to 12-14Ω.

Run the engine at idle speed during several minutes to test if the fault is not detected again.

3.10. *Ignition coil diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground or Open loop (sym_1)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

Primary resistance of standard Synerject's ignition coil must be approximately equal to 0.63Ω at ambient temperature.

Run the engine at all speeds to test if the fault is not detected again.

3.11. *Electrical fuel pump diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground (sym_1)
Open loop (sym_2)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

Internal resistance of standard Synerject's fuel pump must be included in 10-30Ω.

Put key ON during 10s without run the engine to test if the fault is not detected again.

3.12. *Engine overspeed diagnosis*

Diagnosis
An *engine overspeed* is detected in the case the system is measuring an engine speed over a threshold (typically 500 rpm above the engine cut off speed).

Possible faults
- Incorrect ratio of CVT or gear box
- Gear box has been switched down at incorrect vehicle speed

Trouble shooting
Control the CVT or the gear box.

Check there is no damage on engine due to high rpm.

3.13. *Engine temperature diagnosis*

Possible faults
Shot circuit to battery or open loop (sym_0)

Short circuit to ground (sym_1)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

The resistance of coolant temperature sensor is homologous with test temperature as the below table.

Temperature (^{o}C)	Resistance (Ω)	Tolerance (Ω)
60	2636	+/- 263.6
100	697	+/- 69.7
120	397	+/- 39.7

Run the engine during several minutes to reach very hot temperature to test if the fault is not detected again.

3.14. *MIL diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground (sym_1)
Open loop (sym_2)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

Use a standard 9V battery to light ON the MIL.

With a generic calibration, MIL must be lighted ON at key ON.

3.15. *O2 sensor signal circuit diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground (sym_1)
Open loop (sym_2)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

Use the vehicle during several minutes to reach usual engine temperature and do fuel-cut at deceleration to test if the fault is not detected again.

3.16. *O2 Sensor Heater diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground (sym_1)
Open loop (sym_2)

Note : this fault maybe raised in case of Battery Voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure applies.

Internal resistance of standard Synerject's O_2 sensor heater (please refer to O_2 sensor pinout to localize heater) must be approximately equal to 13Ω when sensor is at ambiant temperature.

Use the vehicle during several minutes to reach usual engine temperature and do fuel-cut at deceleration to test if the fault is not detected again.

3.17. *MAP sensor diagnosis*

Possible faults
Short circuit to battery (sym_0)
Short circuit to ground or open loop (sym_1)

Note : this fault maybe raised in case of battery voltage diagnosis (**Flash Code 6**)

Trouble shooting
The general trouble shooting procedure does not apply if the sensor is integrated in the M3A module.

- Reprogram software and clear the fault
- Replace the M3A module and clear the fault

Put key ON to test if the fault is not detected again.

3.18. *Lambda control diagnosis*

Diagnosis
The lambda control diagnosis is raised if :
- the injection time correction is too high (sym_0 - engine is running too lean)
- the injection time correction is too low (sym_1 - engine is running too rich)

Possible faults
If the engine is running too rich :
- Airflow estimation is biased (M3A components – MAP, TIA – failure, intake air leakage, TB failure or carboning, exhaust leakage)
- Fuel flow is too high (pressure regulator failure, injector malfunction or carboning, canister purge malfunction, M3A failure)
- Richness estimation is biased (O2 sensor malfunction, exhaust leakage, ...)

If the engine is running too lean :
- Airflow estimation is biased (M3A components – MAP, TIA – failure, intake air leakage, TB failure or carboning, exhaust leakage)
- Fuel flow is too less (fuel leakage, fuel pump failure, pressure regulator failure, injector malfunction, clogging or carboning, M3A failure)
- Richness estimation is biased (O2 sensor malfunction, exhaust leakage, ...)

Trouble shooting
As this fault may be linked to fuel components failure the presence of the following failure codes should be checked prior to further investigation :

- **Flash Code 12** (fuel pump diag)
- **Flash Code 10** (injector diag)
- **Flash Code 19** (O2 sensor diag)

If all these failures are cleared and the lambda control diagnosis is present the following investigations should be done. Depending on the symptom (too lean or too rich) if this information is available some tests can be skipped. The proposed sequence is logical from the less intrusive and expensive tests to the more intrusive and expensive ones.

- *Check intake air leakage*
  - Control if there is an air leakage somewhere in the intake circuit
  - If yes fix the problem, clear the DTC and run the vehicle to check that there is no more lambda control diagnosis
- *Check exhaust leakage*
  - Control if there is an exhaust leakage somewhere in the circuit
  - If yes fix the problem, clear the DTC and run the vehicle to check that there is no more lambda control diagnosis
- *Check fuel leakage*
  - Control if there is a fuel leakage somewhere in the circuit
  - If yes fix the problem, clear the DTC and run the vehicle to check that there is no more lambda control diagnosis
- *Control fuel flow*
  - Disconnect the fuel circuit, insert a pressure regulator to maintain the pressure in the circuit at 2.4 bar, and either supply directly the pump with the battery or use the actuator test (with the diagnosis tool) to activate the fuel pump. Let the fuel flow into a bowl during a given time. Measure if the flow quantity is corresponding to the expected one. If it is lower then replace the fuel pump
  - Do the same test with a new fuel pump. If the fuel quantity is still low replace the fuel pressure regulator
  - Clear the DTC and run the vehicle to check that there is no more lambda control diagnosis
- *Control injector clogging*
  - Disconnect injector from harness. Dismount the inlet hose and verify that the fuel inlet is not obstructed. Inspect visually injector tip to control any damage
  - Test injector directly supplied by battery to verify that injector opens and closes (end of stroke opening and closing can be heard) : connect ground to one pin, touch +VBAT and release. Needle should open and close again. An alternative solution is to use the actuator test provided by the diagnosis tool
- *Control O2 sensor*
  - Run the engine at idle, wait the lambda control is active through diagnosis tool (ti_lam_cor different to 0...), check sensor voltage, VLS_UP_1, is fluctuating (> 700 mV and < 200 mV). If voltage range is lower, check wiring between sensor and ECU and change O2 sensor if no fault on wiring harness is detected.
  - Disconnect O2 sensor from harness, dismount from exhaust and inspect sensor visually. In case something looks wrong replace the O2 sensor
  - Clear the DTC and run the vehicle to check that there is no more lambda control diagnosis