Siemens "Simos 6" OBD System Strategy

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1. CATALYST MONITORING

1.01 Diagnostic Overview:

The diagnostic function, which is used for monitoring of the catalyst efficiency, is based on measure of the Oxygen within the catalyst determined by at least two Oxygen sensors. The results can be correlated between Oxygen / Hydrocarbon and Oxygen/ Oxides of Nitrogen.

1.02 General description

The method compares the signal amplitudes obtained from the downstream sensor to modeled signal amplitudes. The modeled signal amplitudes are derived from a borderline catalyst. The data for borderline catalysts are taken from measurement results on real life deteriorated catalysts. In case the measured amplitudes exceed those of the model, the catalyst is considered defective. This information is evaluated within one single air mass flow range.

According to the described operating principle the following main parts can be distinguished:

Computation of the amplitude of the downstream oxygen sensor:
The amplitude of the signal oscillations of oxygen sensor downstream catalyst is calculated. Extracting the oscillating signal component, computing the absolute value and averaging over time accomplish this.

Modeling of a borderline catalyst and of the signal amplitudes of the downstream oxygen sensor:
The model is simulating the oxygen storage capability of a borderline catalyst. The signal of the downstream oxygen sensor is simulated in the catalyst model based on real time engine operating data (e.g. A/F ratio and engine load). The amplitude of the modeled signal oscillations is calculated.

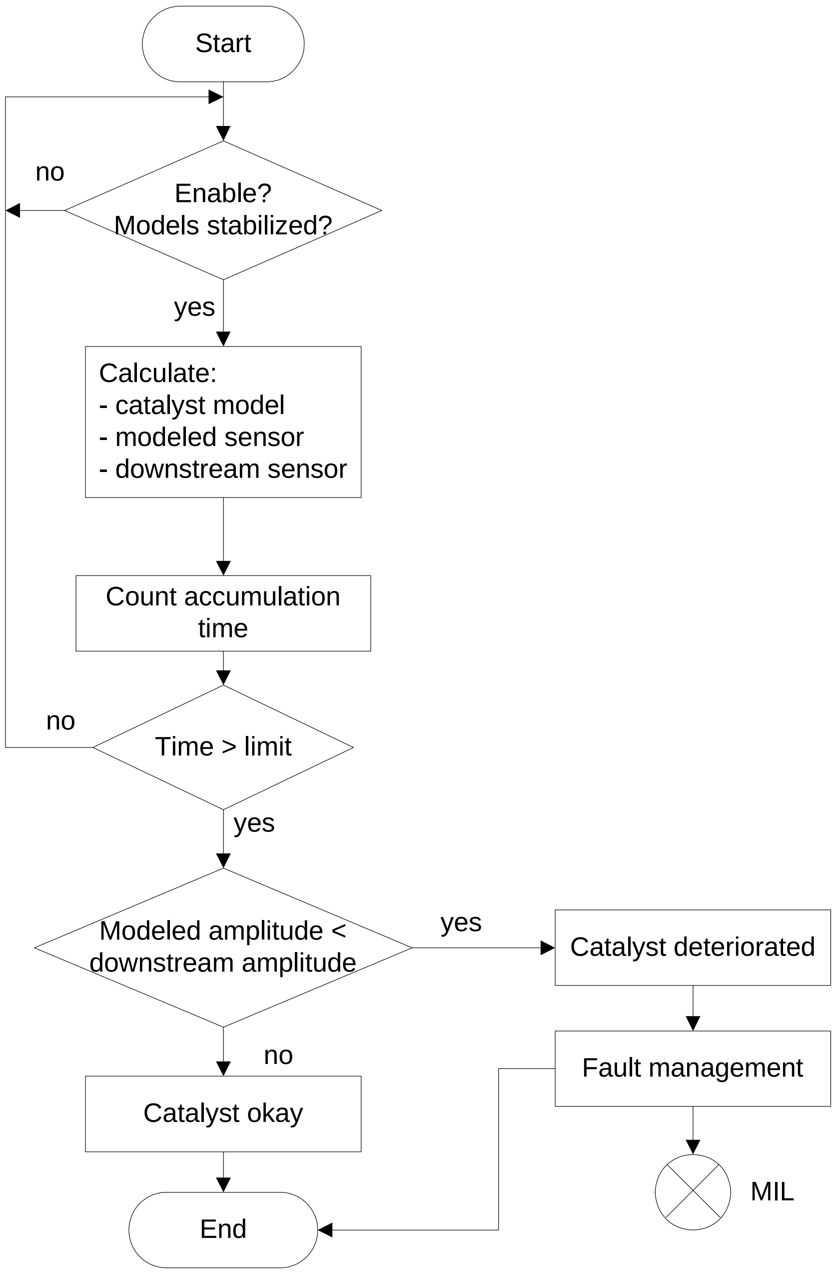
Signal and fault evaluation
The signal amplitudes of the downstream oxygen sensor are compared with the model for a given time. In case of the signal amplitudes of the downstream sensor exceed the modeled amplitudes, the oxygen storage capability of the catalyst falls short of the borderline catalyst model.

Check of monitoring conditions
It is necessary to check the driving conditions for exceptions where no regular Lambda control is possible, e.g. fuel cut-off. During these exceptions, and for a certain time afterwards, the computation of the amplitude values and the post processing is halted. Thus, a distortion of the monitoring information is avoided.

1.03 Monitoring Structure

The catalyst temperature (model) activates the catalyst monitoring function if the catalyst temperature is above a predetermined value.

1.04 Flow Chart Catalyst Monitoring



2. HEATED CATALYST MONITORING

Not applicable

3. MISFIRE MONITORING

3.01 General Description

The method of engine misfire detection is based on evaluating the engine speed fluctuations.

In order to detect misfiring at any cylinder, the torque of each cylinder is evaluated by metering the time between two ignition events, which is a measure for the mean value of the speed of this angular segment. This means, a change of the engine torque results in a change of the engine speed.

Additionally the influence of the load torque will be determined.
When the mean engine speed has been measured, influences caused by different road surfaces have to be eliminated (e.g. pavement, pot holes etc.).

This method consists of the following main parts:

- Correction of normal changes of engine rpm and engine load
- Data acquisition, adaptation of sensor wheel is included
- Calculation of engine roughness
- Comparison with a threshold depending on operating point
- Fault processing, counting procedure of single or multiple misfire events

3.02 Monitoring function description

Data acquisition
The duration of the crankshaft segments is measured continuously for every combustion cycle and stored in a memory.

Sensor wheel adaptation
During fuel cut off within defined engine speed ranges the adaptation of the sensor wheel tolerances is carried out. With progressing adaptation the sensitivity of the misfire detection is increasing. The adaptation values are stored in a non-volatile memory and taken into consideration for the calculation of the engine roughness.

Misfire detection
The following operating steps are performed for each measured segment, corrected by the sensor wheel adaptation.

Calculation of the engine roughness
The engine roughness is derived from the differences of the segment's duration. Different statistical methods are used to distinguish between normal changes of the segment duration and the changes due to misfiring.

Detecting of multiple misfiring
If several cylinders are misfiring (e.g. alternating one combustion/one misfire event), the calculated engine roughness values may be so low, that the threshold is not exceeded during misfiring and therefore, misfiring would not be detected.

Calculation of the engine roughness threshold value
The engine roughness threshold value consists of the base value, which is determined by a load/speed dependent map. During warm-up, a coolant-temperature-dependent correction value is added. In case of multiple misfiring the threshold is reduced by an adjustable factor. Without sufficient sensor wheel adaptation the engine roughness threshold is limited to a speed dependent minimum value. A change of the threshold towards a smaller value is limited by a variation of filter value (low pass filter).

Determination of misfiring

Random misfire
Comparing the engine roughness threshold value with the engine roughness value performs misfire detection. If the engine roughness value is greater than the roughness threshold value a single misfire is detected. With this misfire determination it is possible to identify misfiring cylinders individually.

Random misfire without valid adaptation
To eliminate the influence of the missing flywheel adaptation each engine roughness value is compared with that one on the same flywheel segment on the intermittent revolution. Therefore single misfire events are detected reliable without determination of the flywheel tolerances.

Statistics, Fault processing:
Within an interval of 1,000 crankshaft revolutions, the detected number of misfiring events is totaled for each cylinder. If the sum of cylinder fault counters exceeds a predetermined value, a fault code for emission relevant misfiring is preliminary stored after completion of the first interval after engine has been started or the forth interval during a driving cycle where misfire has been detected.
In the case of misfire detection for one cylinder, the fault is determined by a cylinder selective fault code otherwise the fault code for multiple misfire will be stored additionally.

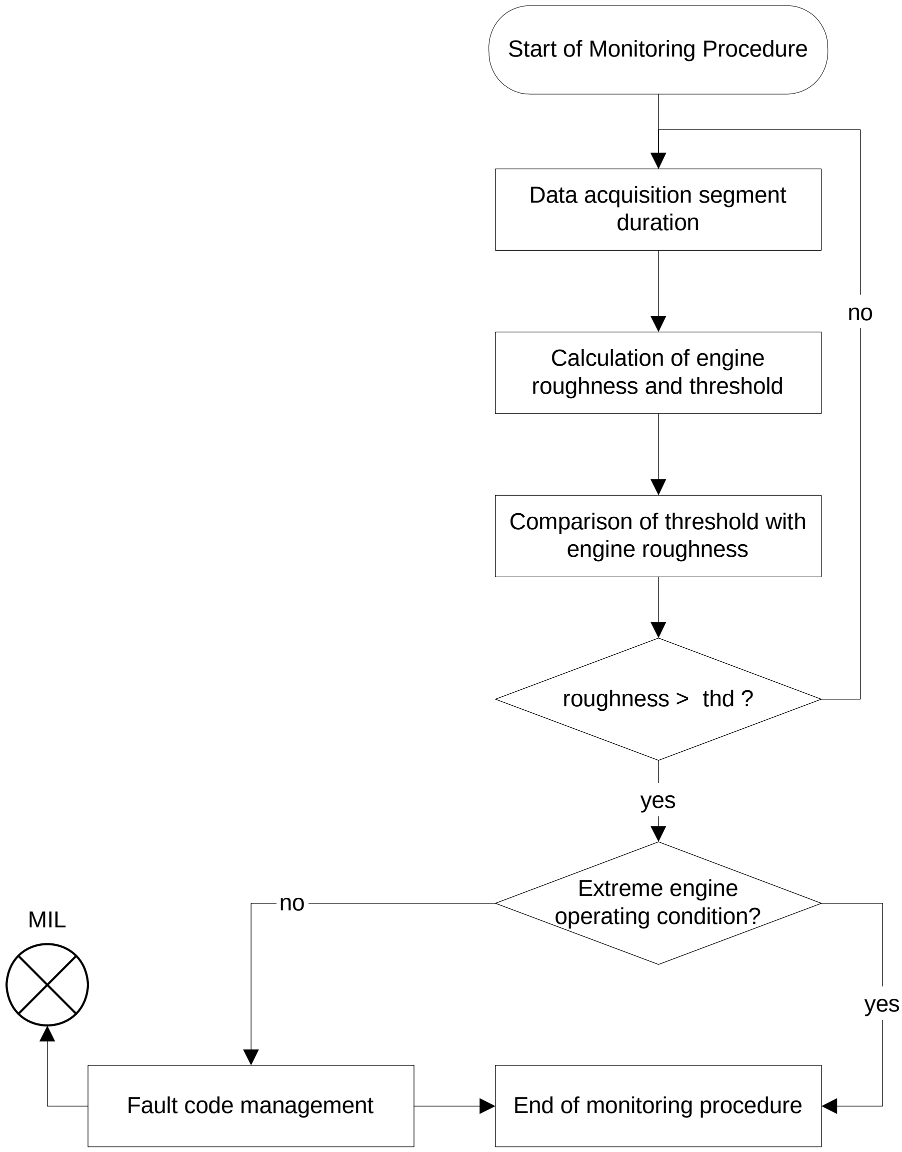
Within an interval of 200 crankshaft revolutions, the detected numbers of misfire events is weighted and totaled for each cylinder.
A load/speed dependent map determines the weighting factor.

If the sum of cylinder fault counters exceeds a predetermined value, the fault code for indicating catalyst damage relevant misfiring is stored and the MIL is illuminated with "on/off"-sequence once per second (blinking).
In case of misfire detection for one cylinder the fault is determined by a cylinder selective fault code otherwise the fault code for multiple misfiring will be stored additionally.
If catalyst damaging misfire does not occur any longer during the first driving cycle, the MIL will return to the previous status of activation (e.g. MIL off) and will remain illuminated continuously during all subsequent driving cycles if catalyst related misfire is detected again. However all misfire events where the catalyst can be damaged is indicated by a blinking MIL. If catalyst damage is not detected under similar conditions in the subsequent driving cycle the temporary fault code will be deleted.

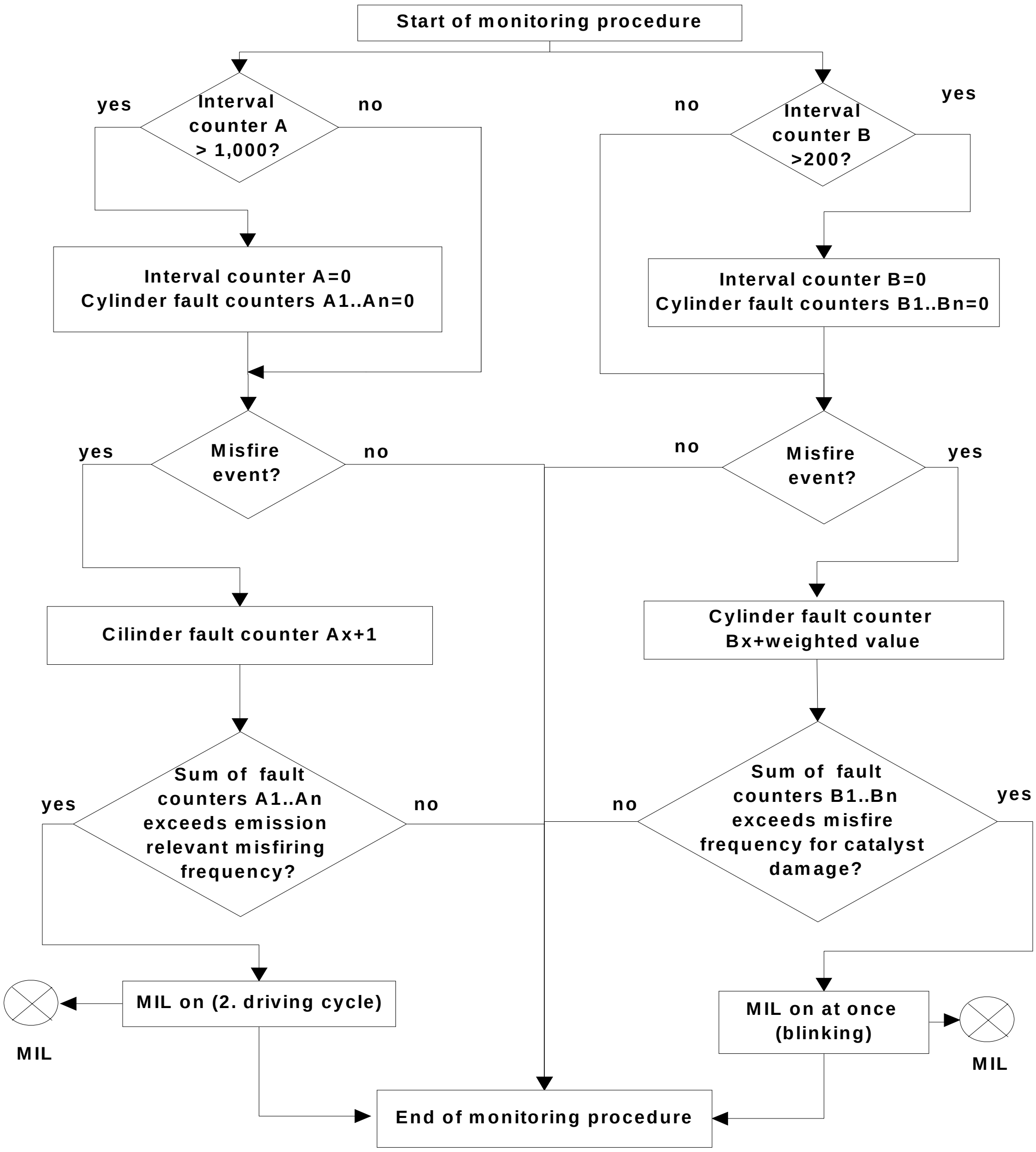
In the case of catalyst related misfire, the Lambda closed loop system is switched to open-loop condition according to the basic air/fuel ratio calculation (Lambda=1).

All misfire counters are reset after each interval.

3.04 Chart and Flow Chart(s)



3.05 Paths for misfire and catalyst damaging misfire rate



4 EVAPORATIVE SYSTEM DIAGNOSIS

4.04 Leakage Check / Reed Sensor

4.04.01 General description

The leakage diagnosis procedure is a pressure check of the EVAP system. In order to perform the check, the EVAP system will be sealed and pressure applied by the leakage diagnosis pump (LDP). The ECM analyzes the pressure variation time.

4.04.02 Monitoring function description

The diagnosis procedure consists of the following steps:

Tank pressure check
The first step of leakage diagnostics is the pressure check of fuel tank system by testing the reed switch. In case of an open reed switch, the fuel tank system has sufficient pressure for the sealed check and no further pressure has to be supplied to the fuel tank system by the LDP.
The diagnosis is waiting until the EVAP purge valve is opened in order to purge the carbon canister. In case the reed switch remains open or the reed switch sticks open, the reed switch is defective.

In the case the reed switch is closed, the LDP is switched on in order to supply pressure to the fuel tank system and the diagnostic is continued with the step 2 to 3 (as described below).

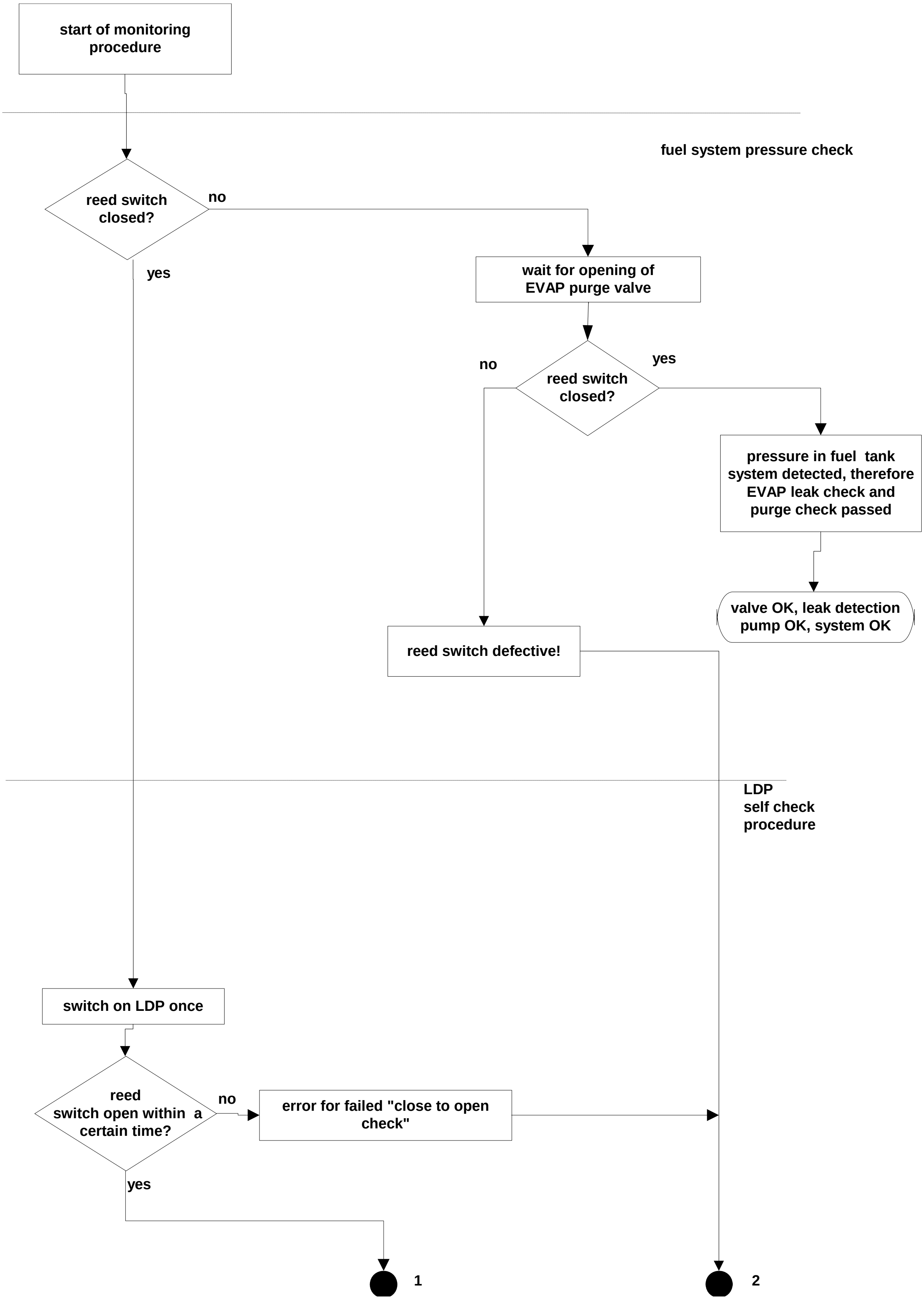
LDP Self-check procedure

Closed check
LDP control is disabled and the reed switch has to be closed otherwise the reed switch is defective.
Close to open check
LDP control is switched on once and the diaphragm has to move to the upper position. The time is measured between closed and open position of diaphragm detected by the reed switch. When the final upper position of diaphragm is reached in a certain time, then the check will be passed.

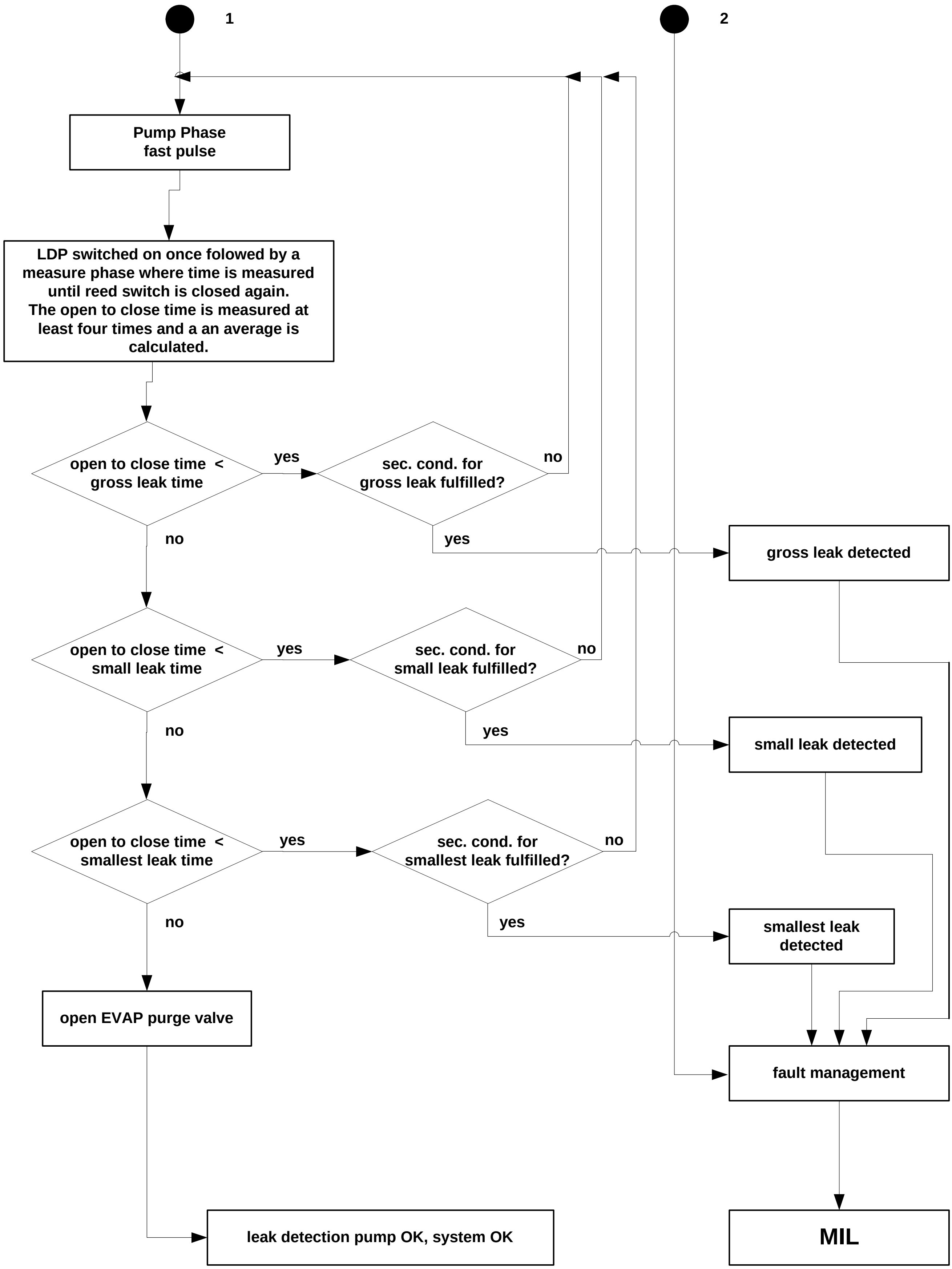
Leak check of EVAP system
Fast pulse
After the self-check procedure, the LDP control supplies pressure to the fuel tank system with a pressure dependent number of compression strokes in a certain time. In order to supply pressure to the fuel tank system, the LDP can perform compression strokes in several attempts.

EVAP system sealed check, measure stroke and measure phase
The decrease of fuel tank pressure is measured via time of diaphragm movement followed by a compression stroke. Within a certain time, the LDP control is determined within at least four measurement strokes. The averaged time is a measure for the tightness of fuel tank system.

4.04.03 Chart(s) and flow chart(s)



Siemens "Simos 6" OBD System Strategy



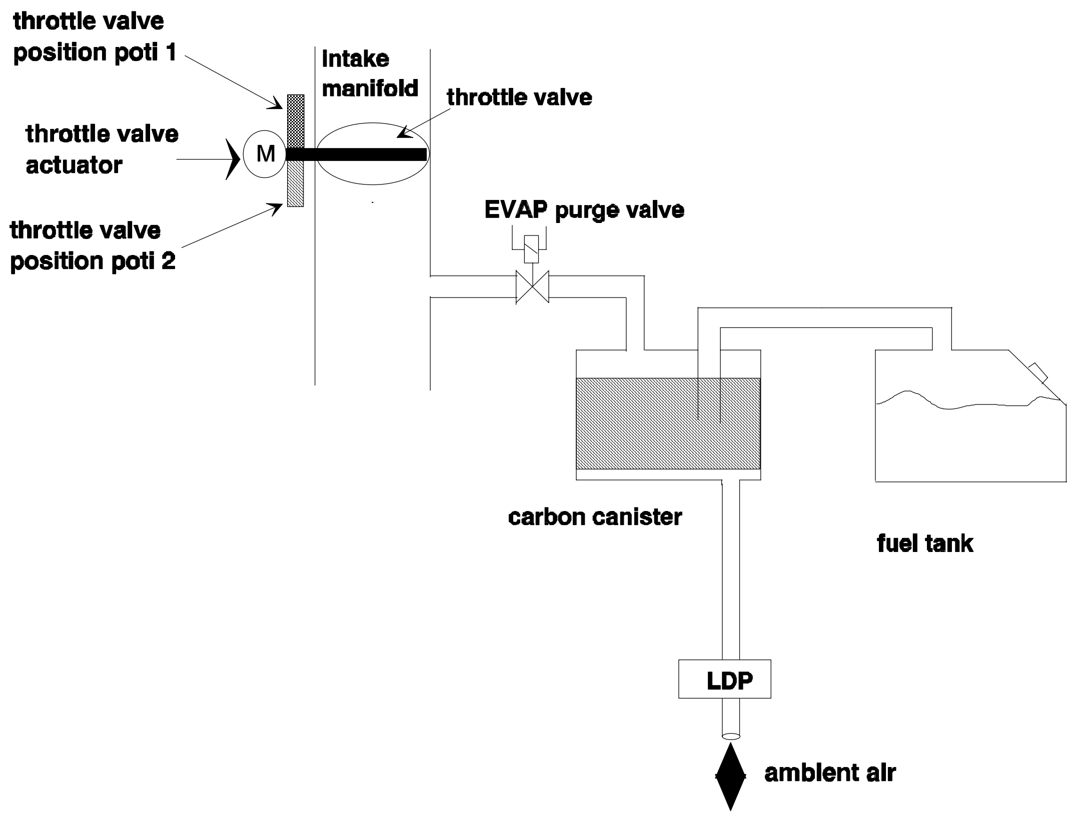
4.05 Purge Check

4.05.01 General description

The purge flow through the EVAP Purge Valve is checked when the vehicle is at rest during an idle condition and the Lambda controller is active. The EVAP Purge Valve is opened while monitoring the Lambda controller and the airflow through the throttle unit.

For rich or lean mixture through the EVAP Purge Valve:
Flow through the EVAP Purge Valve is assumed as soon as the Lambda controller compensates for a rich or lean shift.

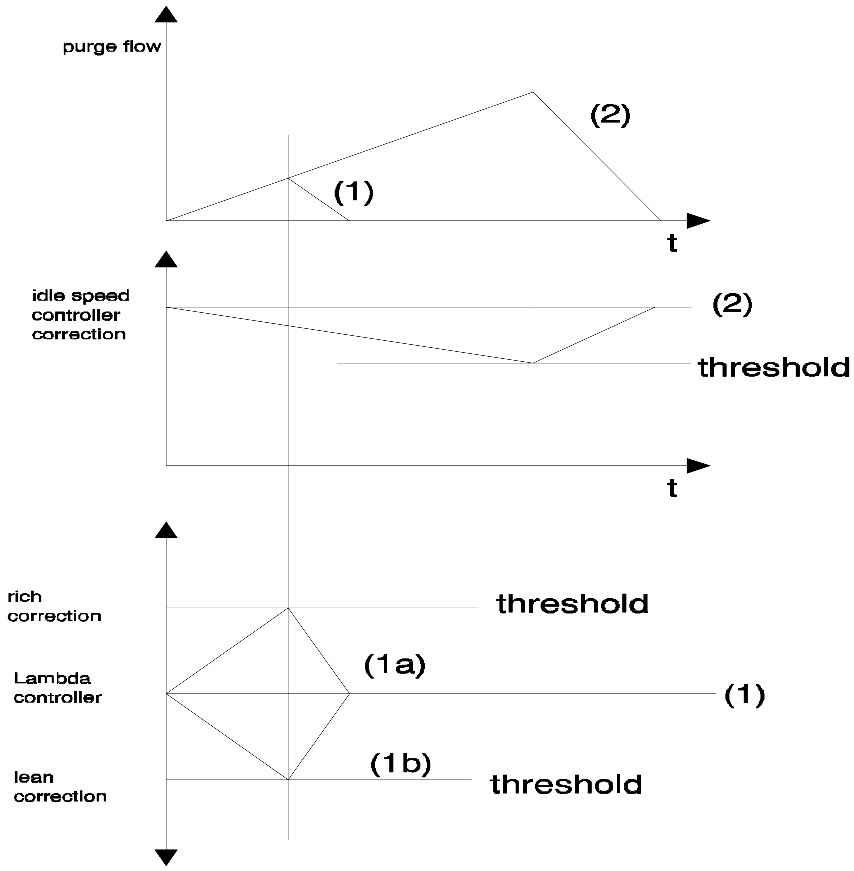
After this procedure the EVAP Purge Valve is reset and the diagnosis is completed.



4.05.02 Monitoring function description

For stoichiometric mixture flow through the EVAP Purge Valve:
In this case, the Lambda controller does not need to compensate for a deviation. However, when the EVAP Purge Valve is completely opened, the cylinder charge increases significantly. Therefore, flow through the throttle unit must be decreased in order to maintain the desired idle speed. Flow through the EVAP Purge Valve is assumed when the flow through the throttle unit is reduced by idle control. If both mixture compensation and reduction of the airflow through the throttle unit does not occur for two diagnosis cycles, then a defective EVAP Purge Valve is assumed and the MIL is illuminated.

4.05.03 Chart(s) and flow chart(s)



Open purge valve and monitor effects of purge flow:

(1) Lambda purge flow <>1: Abortion if fresh air (1a) or HC (1b) detected

(2) Lambda purge flow = 1: Throttle unit actuator will reduce the flow rate through the throttle due to additional flow through purge valve

MIL will be illuminated if none of said effects occurs.

5 SECONDARY/ AIR SYSTEM MONITORING

Not applicable

6 FUEL SYSTEM MONITORING

6.04 General Description

Mixture Pilot Control
The airflow sucked in by the engine and the engine speed is measured. These signals are used to calculate an injection signal. This mixture pilot control follows fast load and speed changes.

Lambda-controller
The ECM compares the Oxygen sensor signal upstream the catalyst with a reference value and calculates a correction factor for the pilot control.

6.05 Monitoring function description

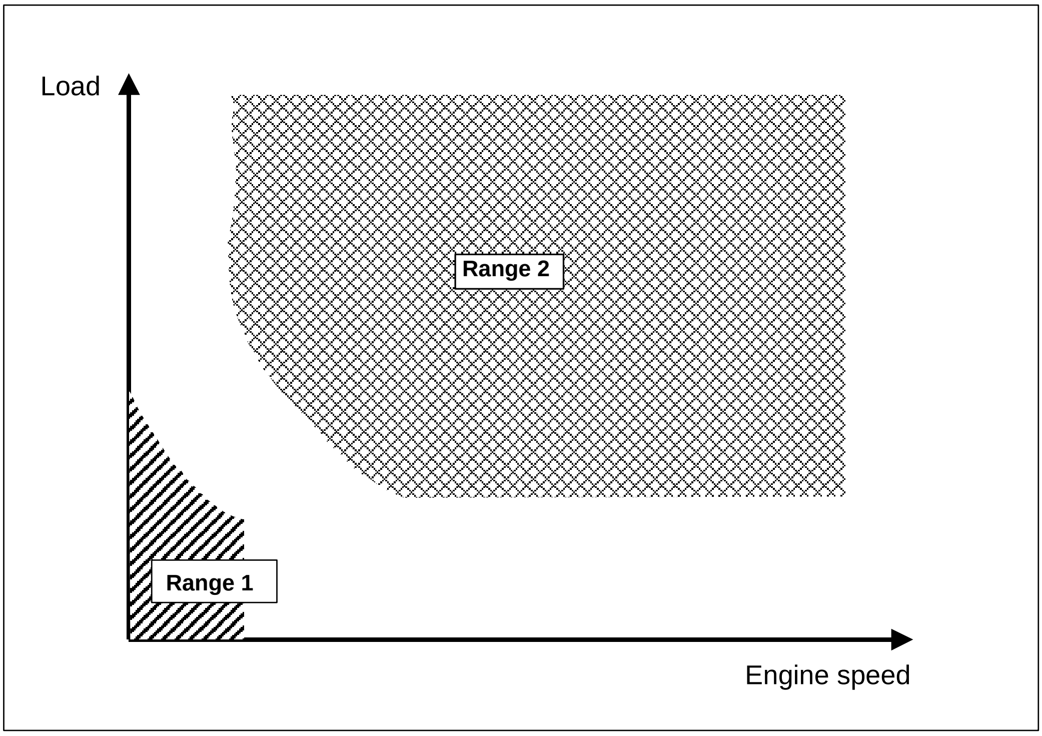
6.05.01 Adaptive pilot control

Drifts and faults in sensors and actuators of the fuel delivery system as well as unmeasured air leakage influence the pilot control. The controller corrects amplitudes increases. If there are different correction values needed in different load speed ranges, a certain time passes until the correction is complete. The correction values will be determined in two different ranges.

6.05.02 Fuel trim

The basic air/fuel ratio control using the signal from the front O2 sensors(s) is corrected by an adaptation calculation. This adaptation results in a factor, which is applicable for the whole working range. A further trim control based on the signal(s) from the rear O2 sensor(s) is correcting the adaptation factor. Therefore this trim control is working in the same way in the whole range. If the trim control reaches the allowed limit the fault code for fuel delivery trim control is set. The control loop downstream catalyst will detect any deviation from the characteristic curve of oxygen sensor upstream catalyst due to poison.

6.06 Chart(s) and flowchart(s)



Lambda deviations in **range 1** are compensated by an additive correction value multiplied by an engine speed term. This creates an additive correction per time unit.

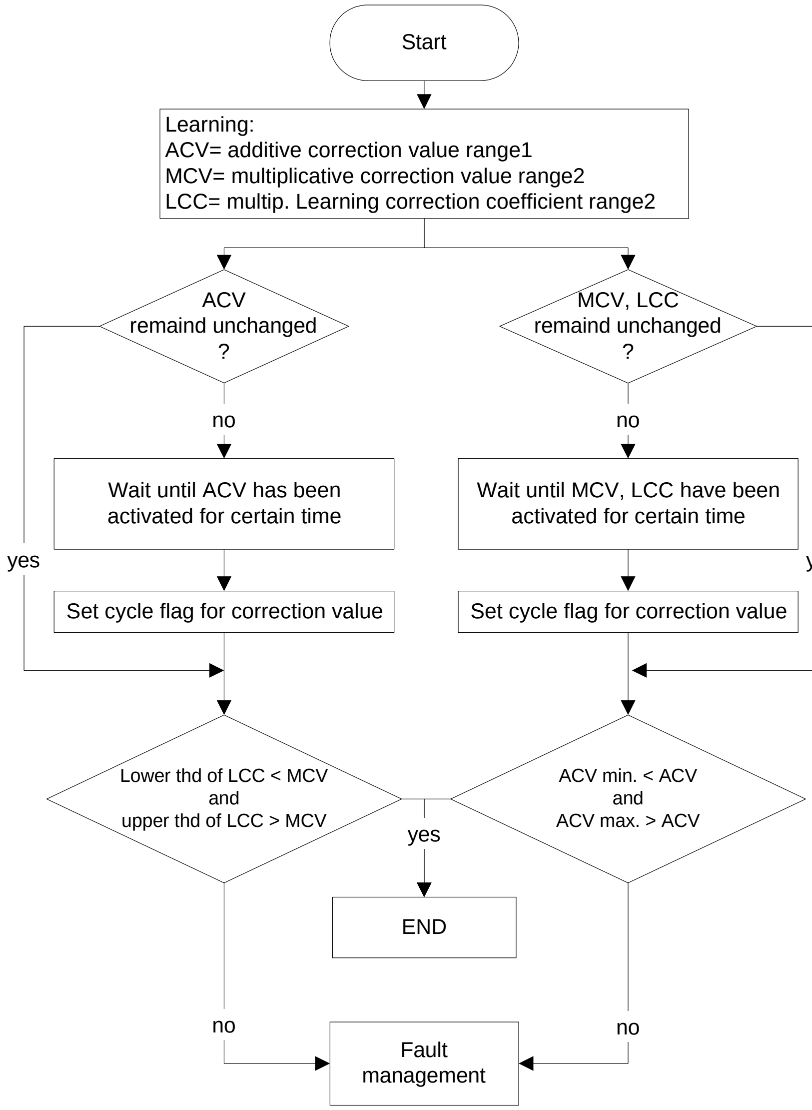
Lambda deviations in **range 2** are compensated by multiplication of a factor.

A combination of all two ranges will be correctly separated and compensated.

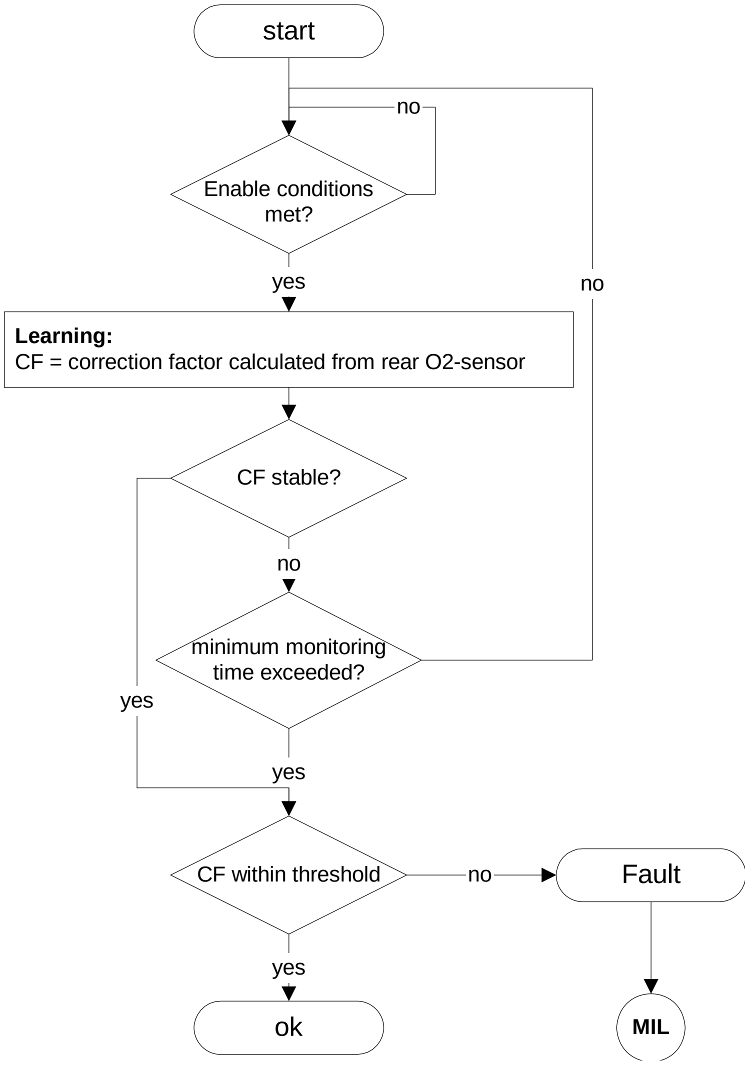
Each value is adapted in its corresponding range only. But each adaptive value corrects the pilot control within the whole load/speed range by using a linear interpolation formula. The stored adaptive values are included in the calculation of the pilot control just before the closed loop control is active.

Diagnosis of the fuel delivery system
Faults in the fuel delivery system can occur which cannot be compensated for by the adaptive pilot control.
In this case, the adaptive values exceed a predetermined range.
If the adaptive values exceed their plausible ranges, then the MIL is illuminated and the fault is stored.

Flow Chart Adaptive Pilot Control Monitor:



Flow Chart Trim Control Monitor:



7 OXYGEN SENSOR AND HEATER MONITORING

The Lambda control consists of a linear oxygen sensor upstream catalyst and a 2-point oxygen sensor downstream catalyst

7.04 O2S front open circuit diagnosis manager

To detect open lines at the O2S front, an **open circuit diagnosis manager** (internal ECU software) handles the logical information from the following diagnostics.

- Functional check heater
- Signal activity check
- Intrusive check temperature measurement

Combinations and outcome of these diagnoses lead to the different failure location for open circuit.

7.04.01 Open circuit (UN)

If the functional check heater failed and the intrusive check temperature measurement failed, an open circuit in the line for Nernst voltage exists.

7.04.02 Open circuit (VM)

An open circuit in line Virtual Mass can be detected if the functional check heater failed and the signal activity checks failed.

7.04.03 Open circuit (IP)

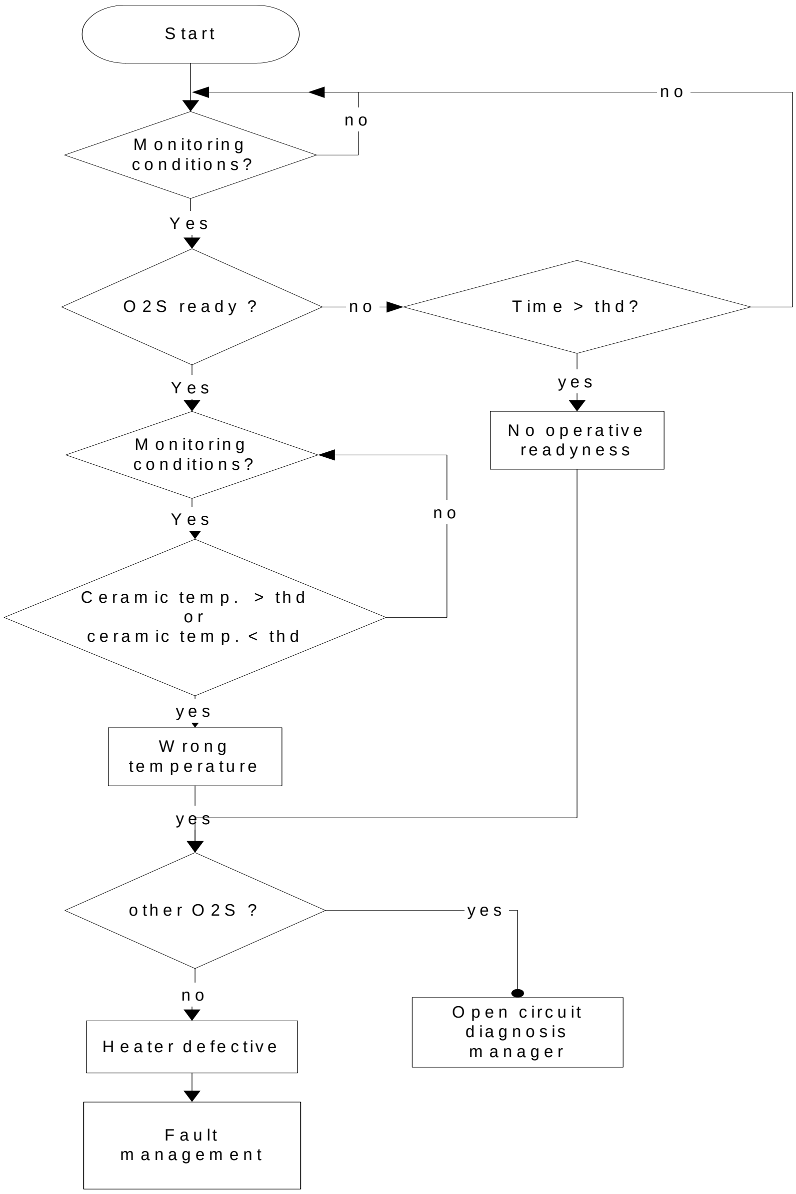
If the sensor signal activity check failed and no failure for the heater is detected, an open circuit in line Pumping current exists.

7.04.04 Open circuit (IA)

The signal activity check during fuel cut-off detects a malfunction, if the oxygen sensor signal is above a defined range. The open circuit diagnosis manager identifies an open line for adjustment voltage.

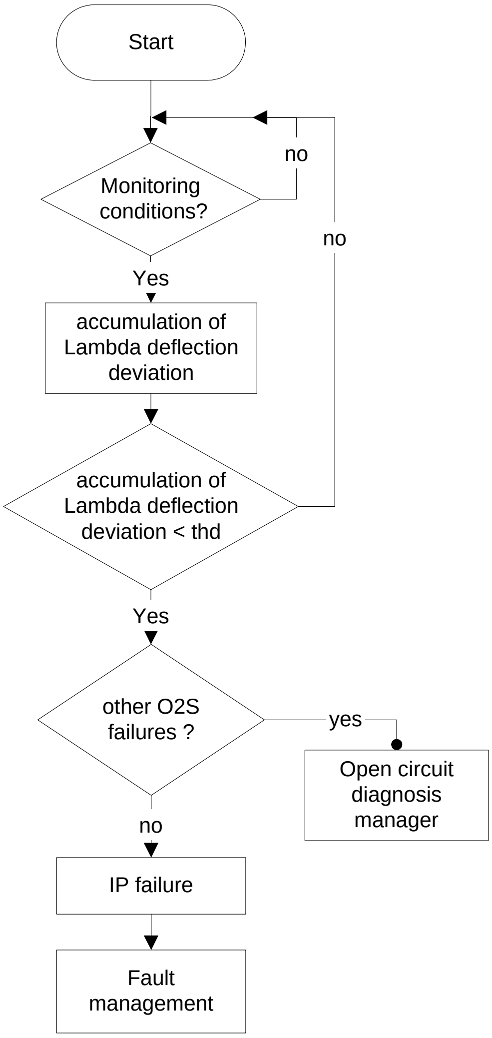
7.05 O2S front Functional check heater

The purpose of this function is to detect oxygen sensor heater failures.
After engine start the diagnosis monitors the time required to reach O2S readiness. Is the time threshold exceeded and no other O2S failure exists, the heater is defective and the failure management is triggered.
After O2S readiness, the ceramic temperature is continuously monitored for an upper and lower threshold. If the ceramic temperature exceeds one of the thresholds and no other O2S failure exists, the heater is defective and the failure management is triggered. If other O2S failures exist, the diagnosis result is handed over to the open circuit diagnosis manager.



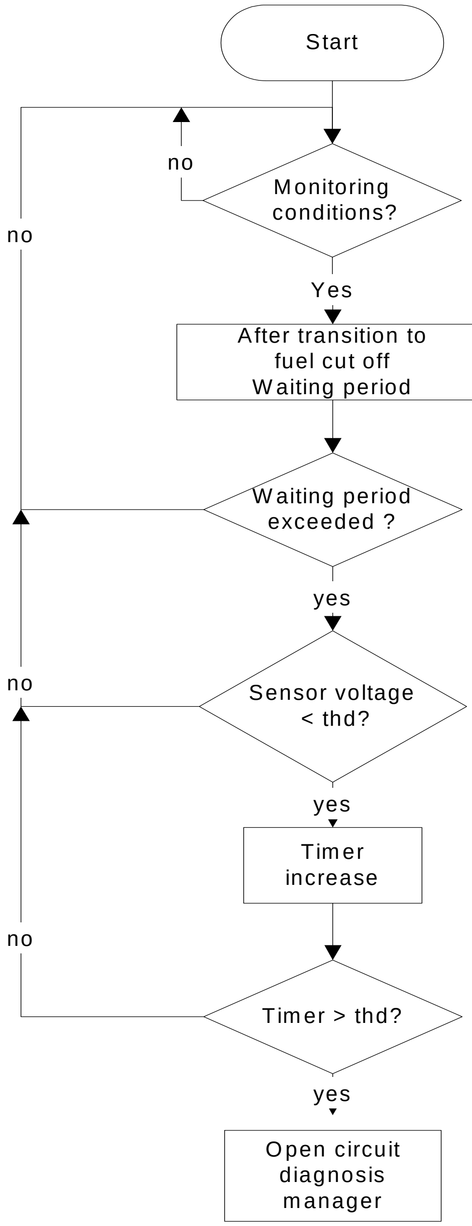
7.06 O2S front Signal activity check

The purpose of this function is to detect an insufficient deflection of the O2S signal. For a time period the lambda deflection is accumulated and has to exceed a threshold. If the threshold is not exceeded, the diagnosis result is handed over to the open circuit diagnosis manager.



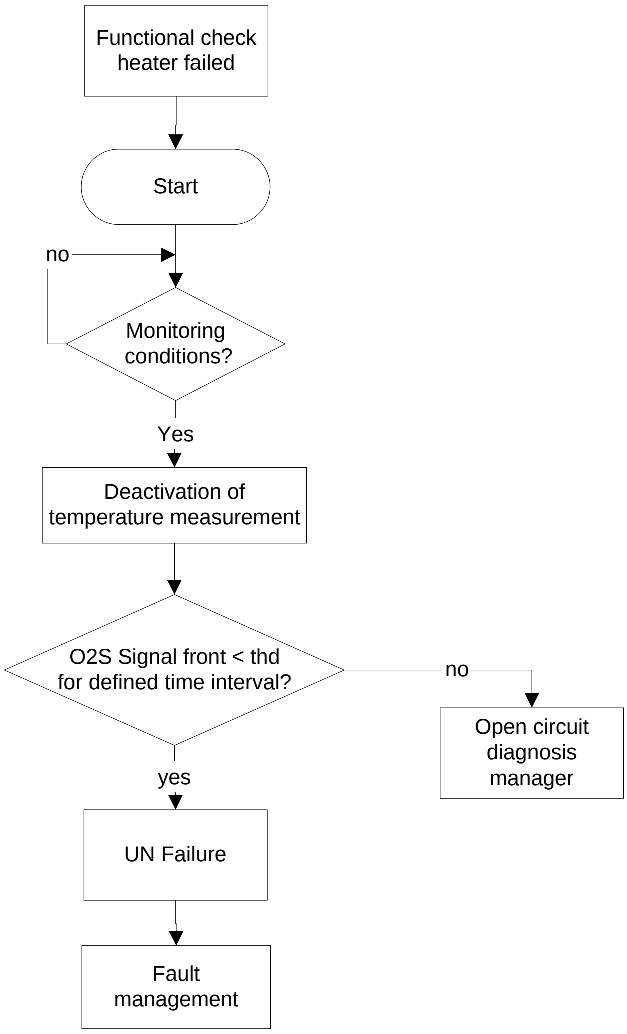
7.07 O2S front Signal activity check (fuel cut off)

The oxygen sensor signal monitoring during fuel cut-off detects if the oxygen sensor signal is below a defined range. The diagnosis result is handed over to the open circuit diagnosis manager.



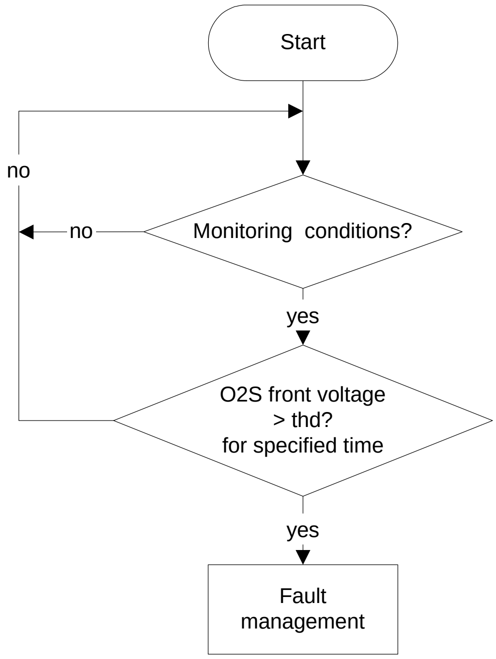
7.08 O2S front Intrusive check temperature measurement

If the functional check for the heater has detected a failure, the oscillator of the O2S controller used to measure the sensor internal resistance is disabled in order to allow more detailed error detection. Does the O2S signal falls below a threshold for a certain time during the defined diagnosis period it is an indicator for a broken VN-line. In any case the result of this test is handed over to the open circuit diagnosis manager either to enter the failure in the error management or to proceed with further diagnostics.



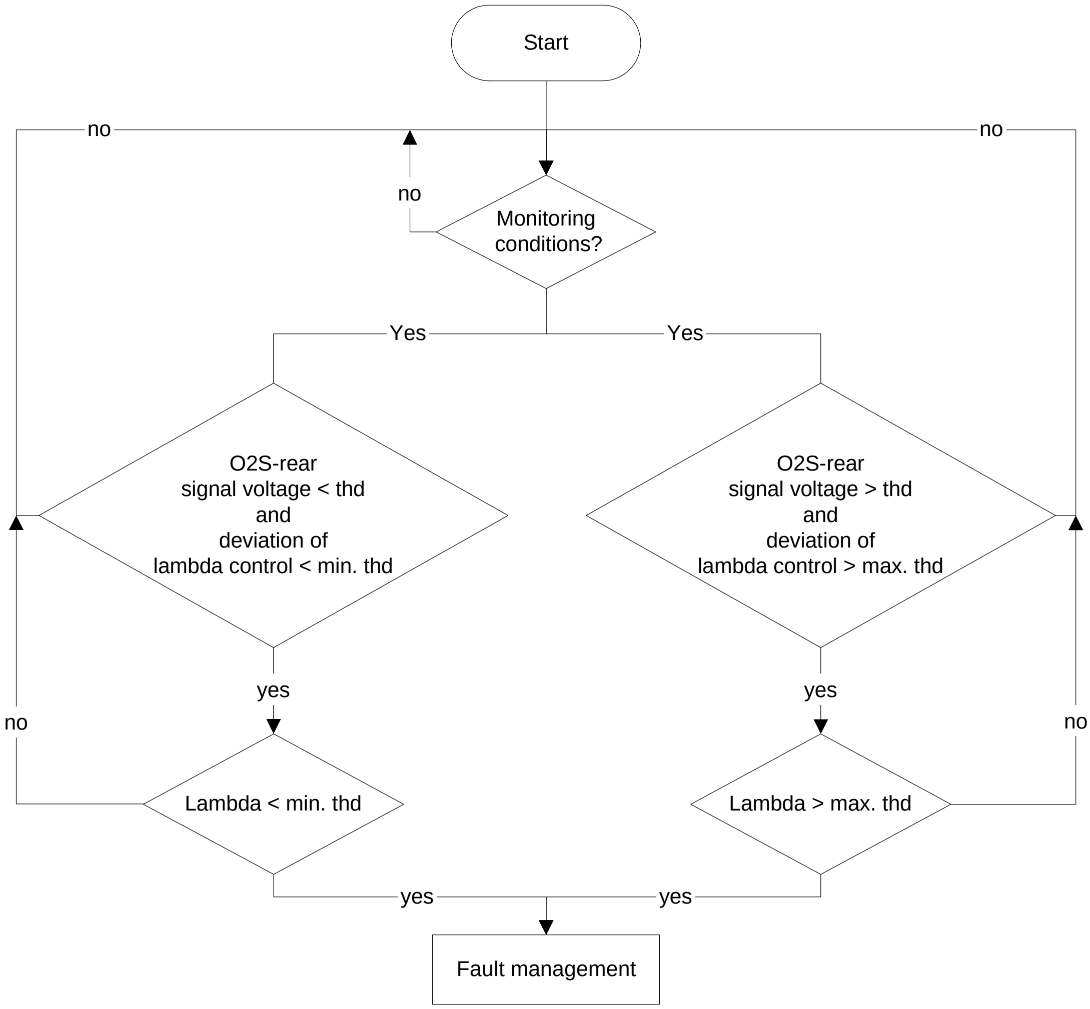
7.09 O2S front Signal range check

The purpose of this diagnosis is to determine that the O2S front signal is in the proper working range. Exceeds the signal voltage under non-idle conditions the threshold, a malfunction is detected.



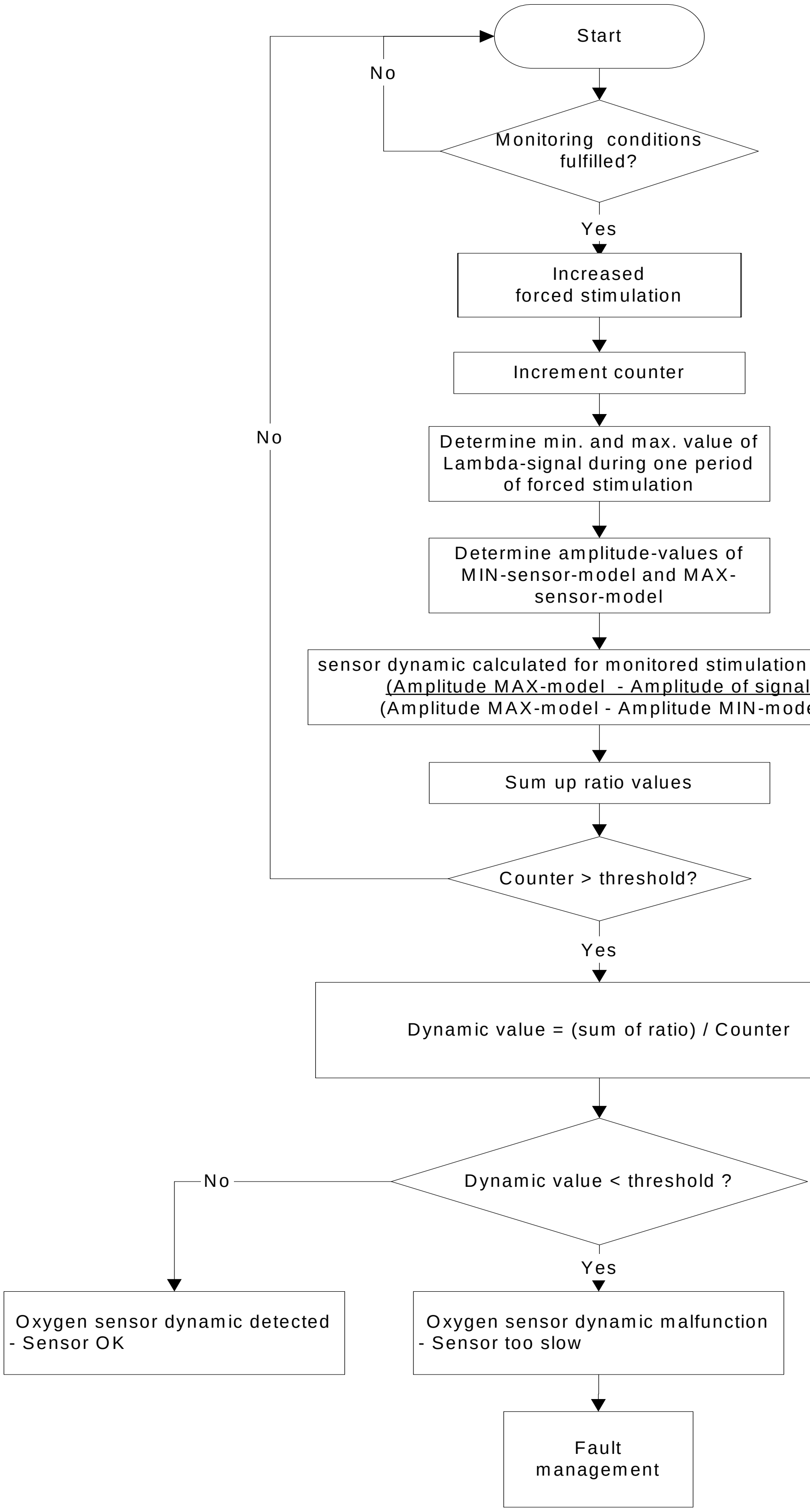
7.10 O2S front rationality check high/low

The purpose of this diagnosis is to determine character shift down or up of the O2S front. If the O2S rear indicates rich conditions and lambda controller deviates to rich side but O2S front signal remains on the lean side then a character shift down malfunction of the O2S front is detected.
A character shift up malfunction of the O2S front is detected, if the O2S rear indicates lean conditions and lambda controller deviates to lean side but O2S front signal remains on the rich side.



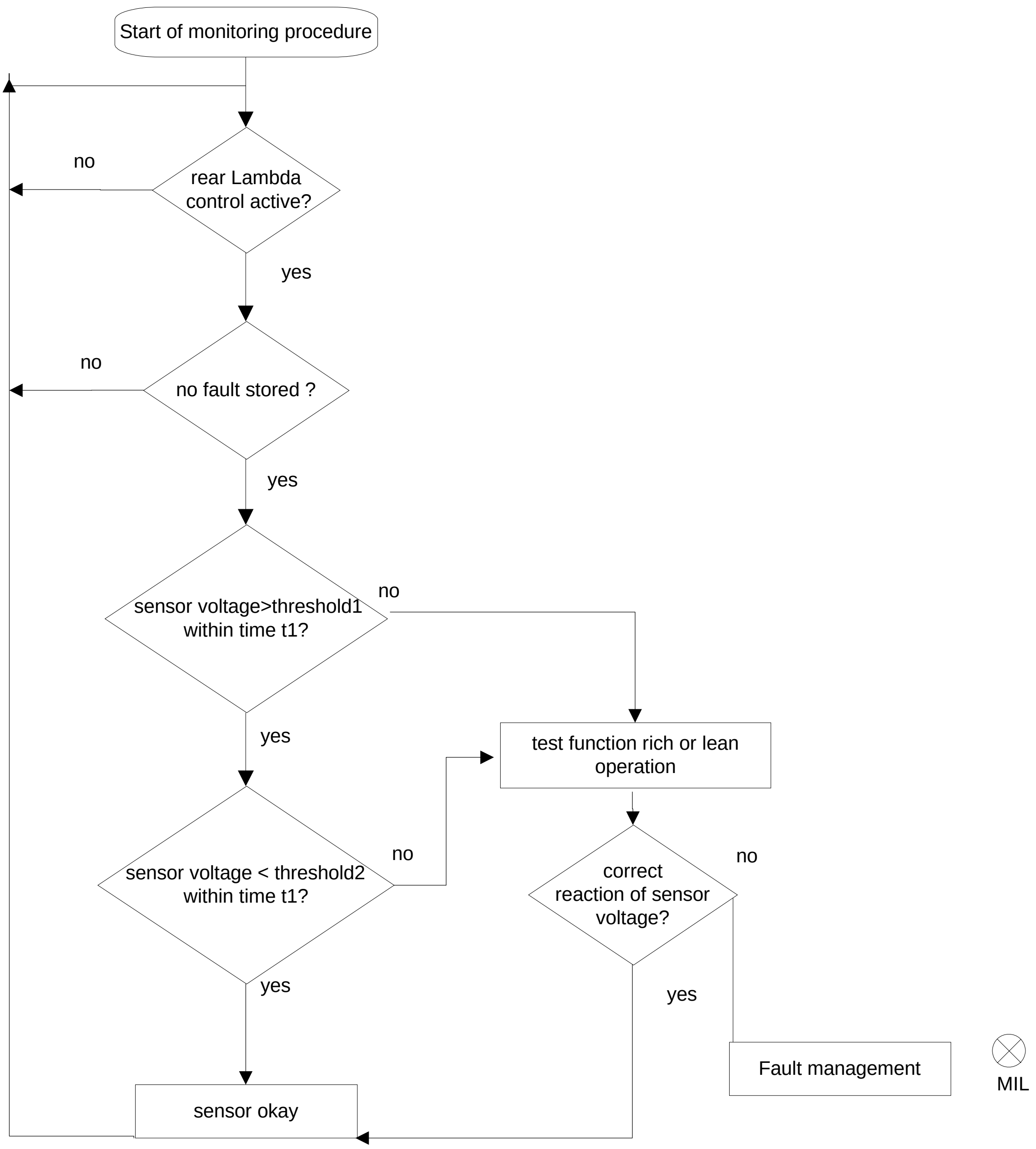
7.11 O2S front Response check

The purpose of this diagnosis is to determine if the dynamic behavior of the O2S front signal is in range for proper function.



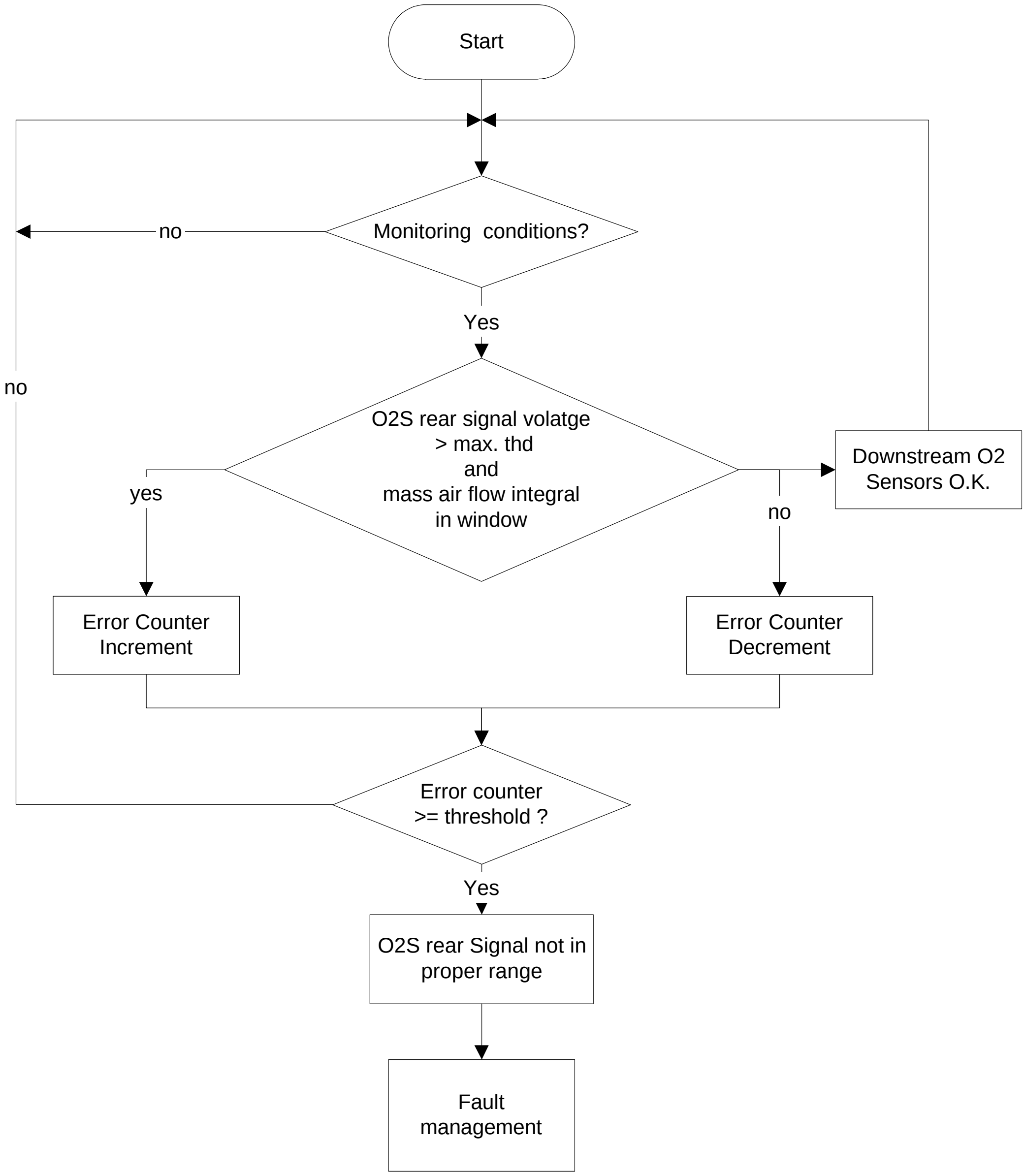
7.12 O2S rear oscillation check

Does the O2S rear signal voltage not oscillating at reference for a defined period of time the lambda set value is significantly shifted to rich/lean under open loop conditions? The reaction of the O2S rear signal voltage will be evaluated against thresholds for malfunction.



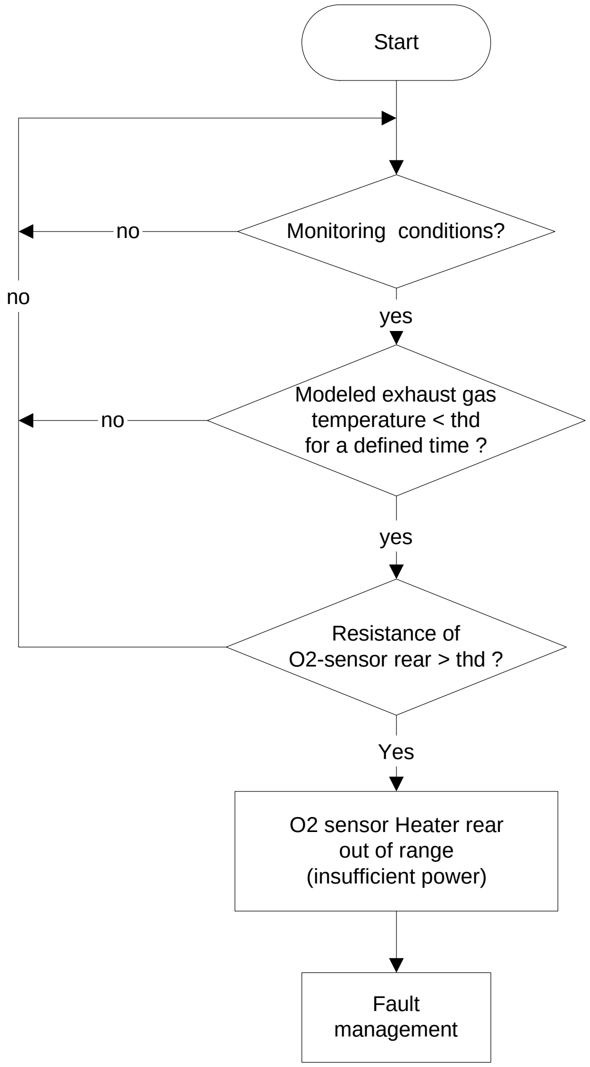
7.13 O2S rear Signal range check

The purpose of this diagnosis is to monitor the required range for proper operation. If the signal voltage, under fuel cut off conditions, does not fall below the threshold for a specified mass airflow integral, a malfunction is detected.



7.14 O2S heater out of range

The purpose of this diagnostic is to determine insufficient power of the heater for the downstream O2-sensor. It is monitored whether the resistance of the rear O2-sensor is below a threshold. If not the heater has insufficient power.



8. EGR MONITORING

Not applicable

9. PCV MONITORING

The PCV system assures that no gas from the crankcase system escapes into the atmosphere.

All connectors which are not necessary to open during typical maintenance repair actions are implemented as hard to open.

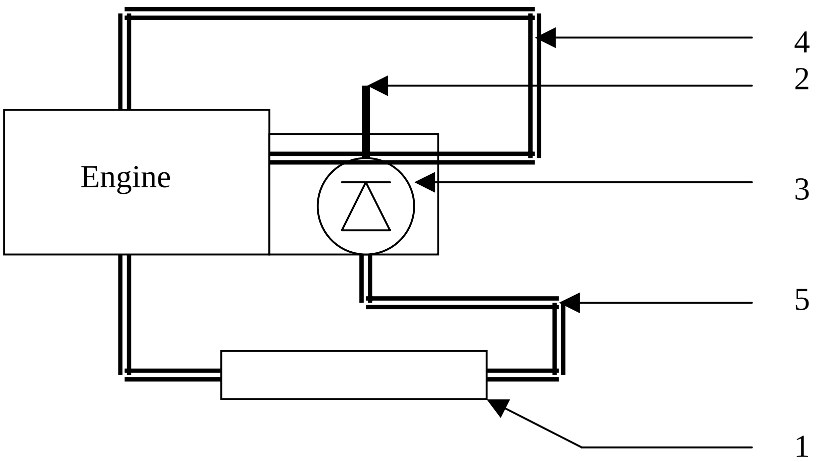
All easy to open connectors are monitored by the OBD system.

10. ENGINE COOLANT SYSTEM MONITORING

7.15 General description

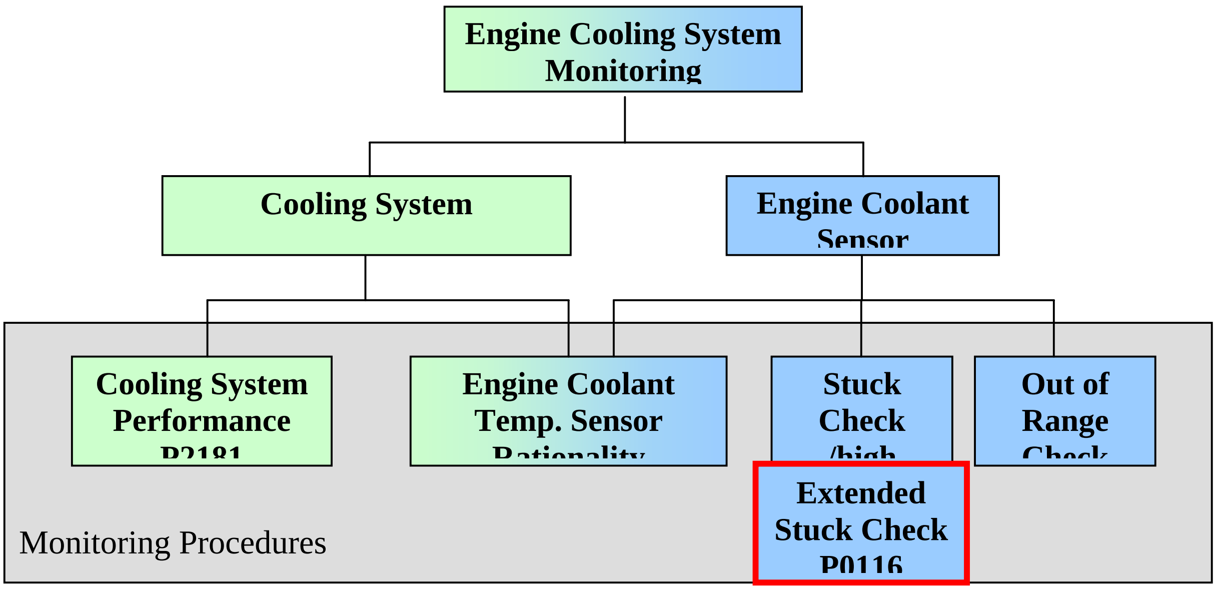
The engine cooling system consists of five main parts.
1. The Engine Cooler
2. The Engine Coolant Temperature Sensor
3. The Thermostat Valve
4. The small Cooling Circuit
5. The large Cooling Circuit

During heating up the Engine the coolant flows first inside the small cooling circuit. After the coolant reach a sufficient temperature the thermostat valve will open the large cooling circuit to integrate the engine cooler.
The engine coolant temperature sensor measures a mixed temperature between the coolant coming from the small and large cooling circuit.

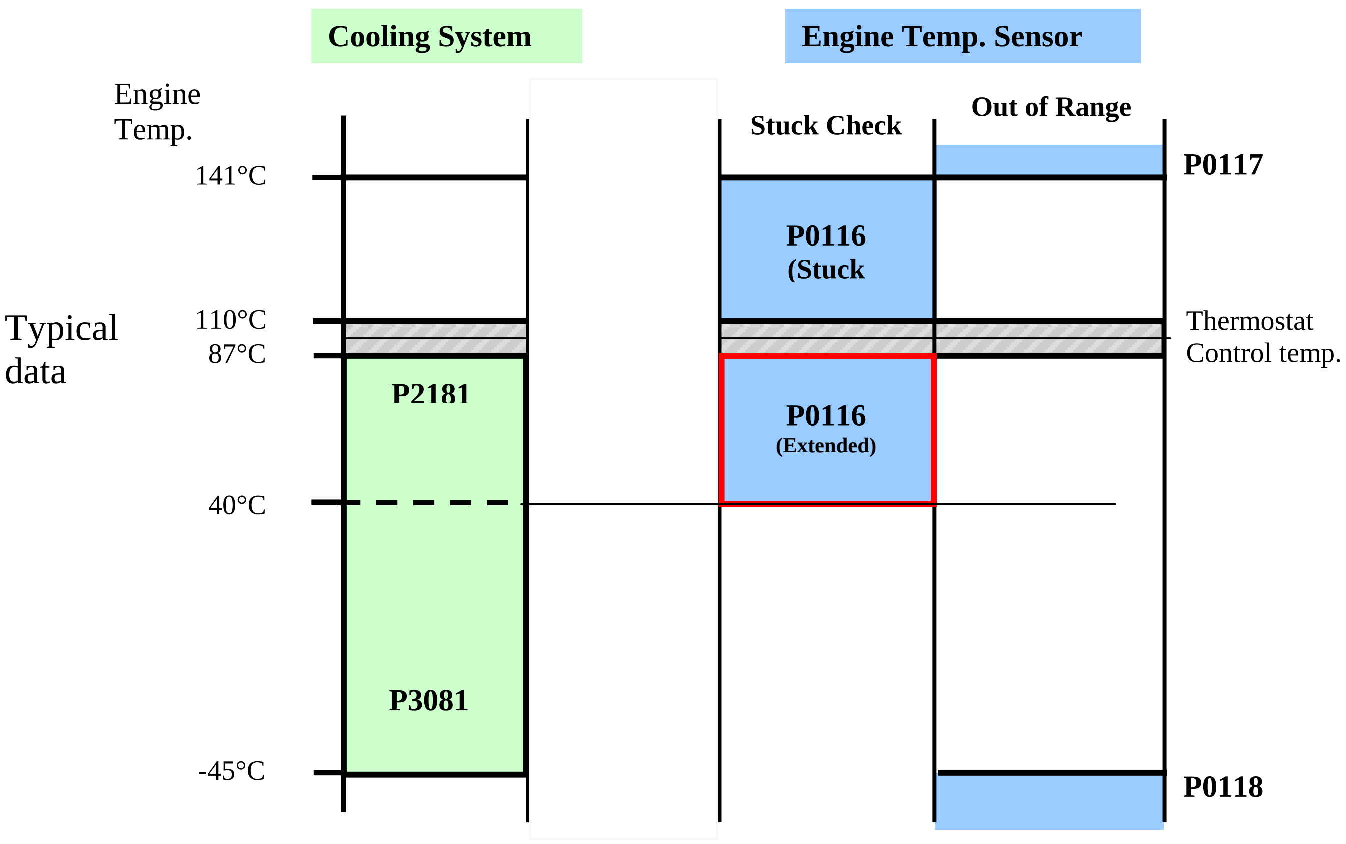


7.16 Monitor Functional Description

The engine cooling system monitor strategy consists of two main diagnostic parts.

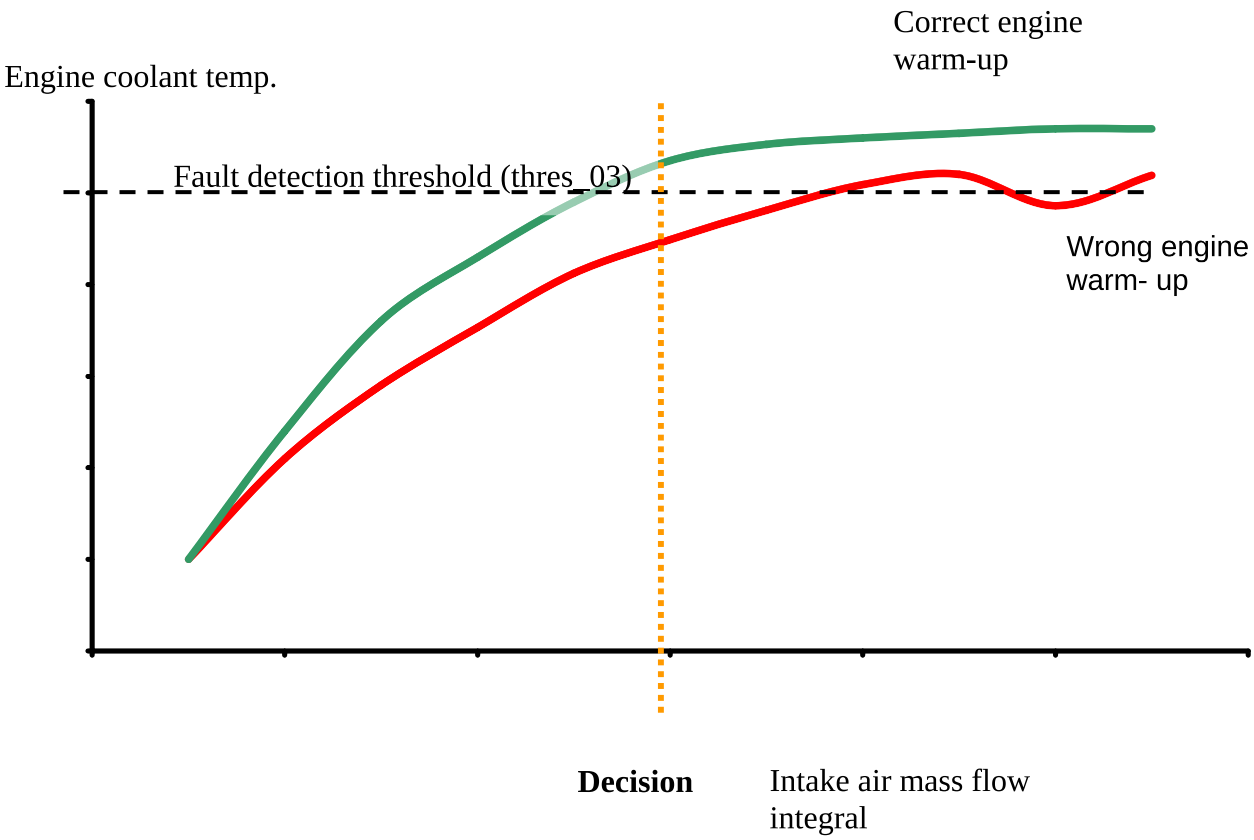


Each engine cooling monitoring function has its own special engine temperature range in which it will be enabled.

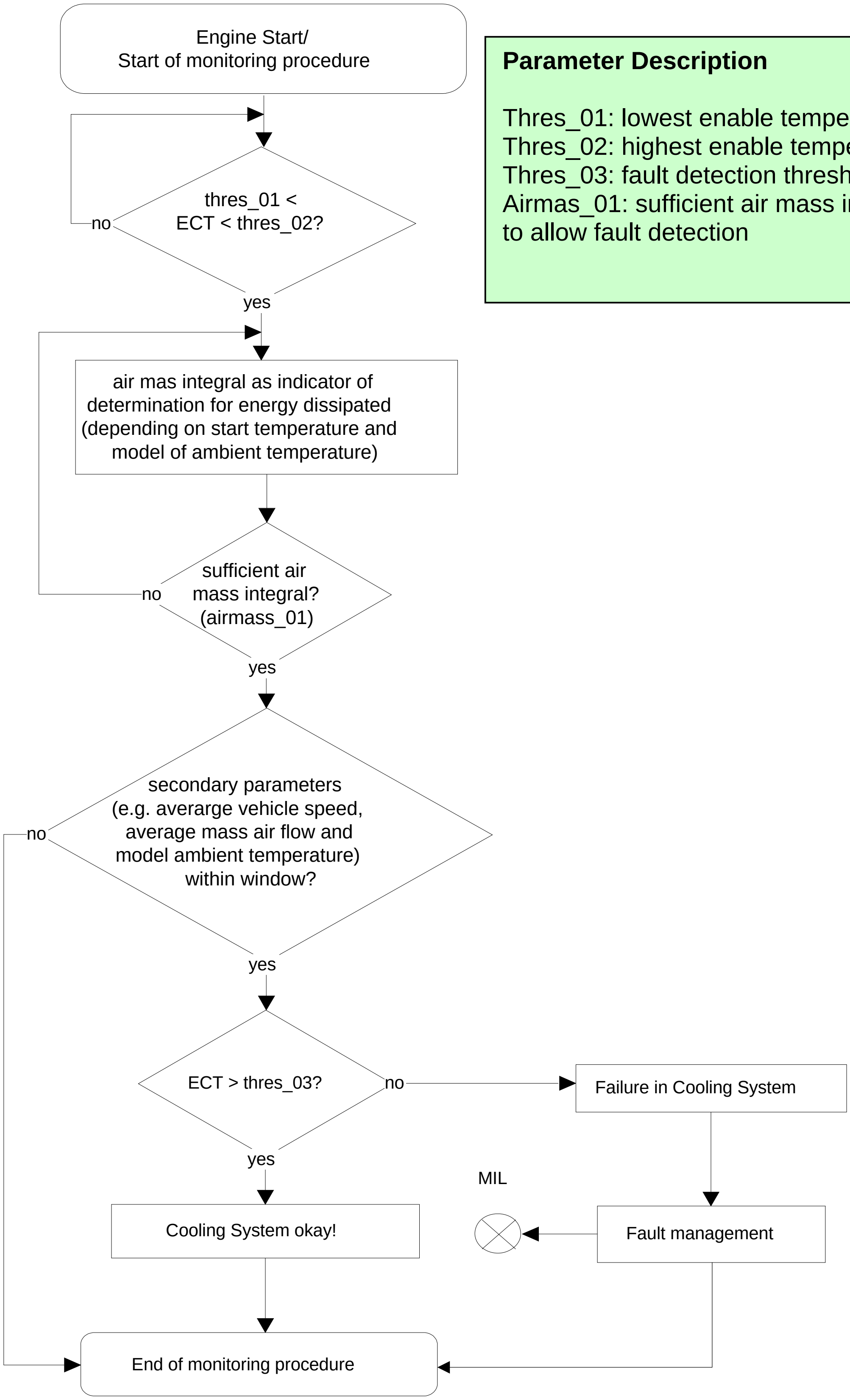


7.16.01 Cooling System Performance (P2081)

In case that the engine coolant temperature does not reach an certain value after a sufficient mass air flow under normal driving conditions, the cooling system performance is considered to be reduced.



Flow Chart Cooling System Performance (P2081)



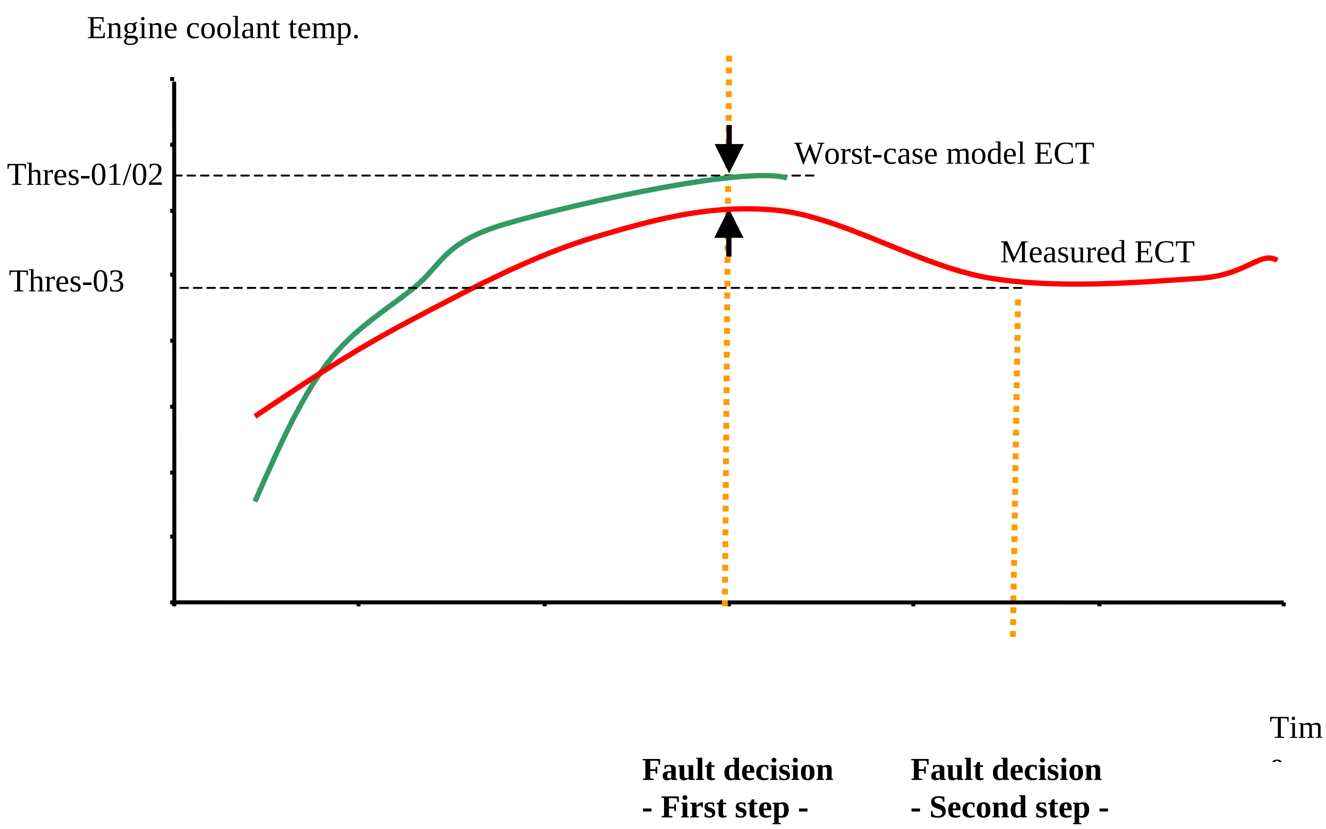
Parameter Description

Thres_01: lowest enable temperature
Thres_02: highest enable temperature
Thres_03: fault detection threshold
Airmas_01: sufficient air mass integral to allow fault detection

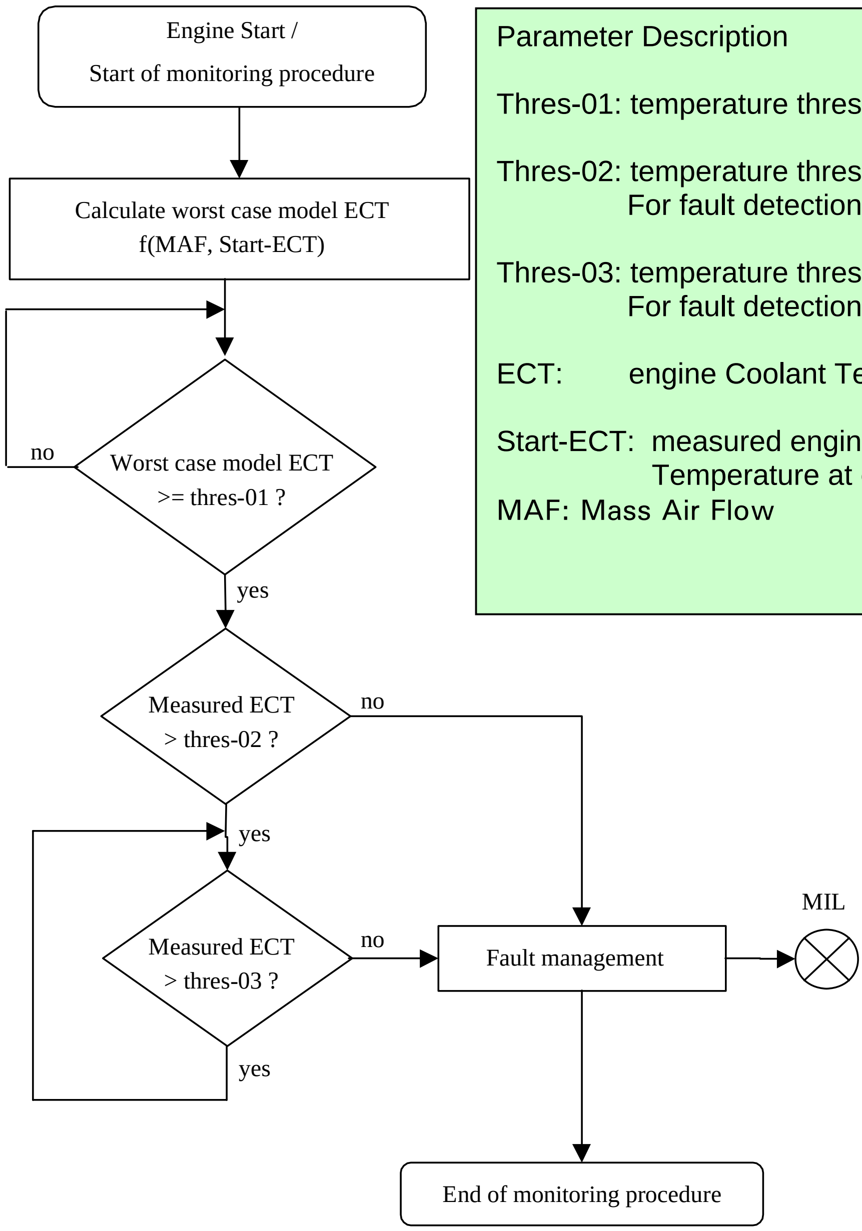
7.16.02 Engine Coolant Temperature Sensor Rationality (P3081)

First Step
In case that the measured engine coolant temperature (ECT) is below a applicable threshold after the worst-case model ECT have firstly reached a further applicable threshold, the cooling system or the temperature sensor is defective.

Second Step
In case that the measured ECT falls below a further applicable threshold after successfully passing the first step, the cooling system or the temperature sensor is defective.



Flow Chart Coolant Temperature Sensor Rationality (P3081)



Parameter Description

Thres-01: temperature threshold

Thres-02: temperature threshold
For fault detection - step 1

Thres-03: temperature threshold
For fault detection – step 2

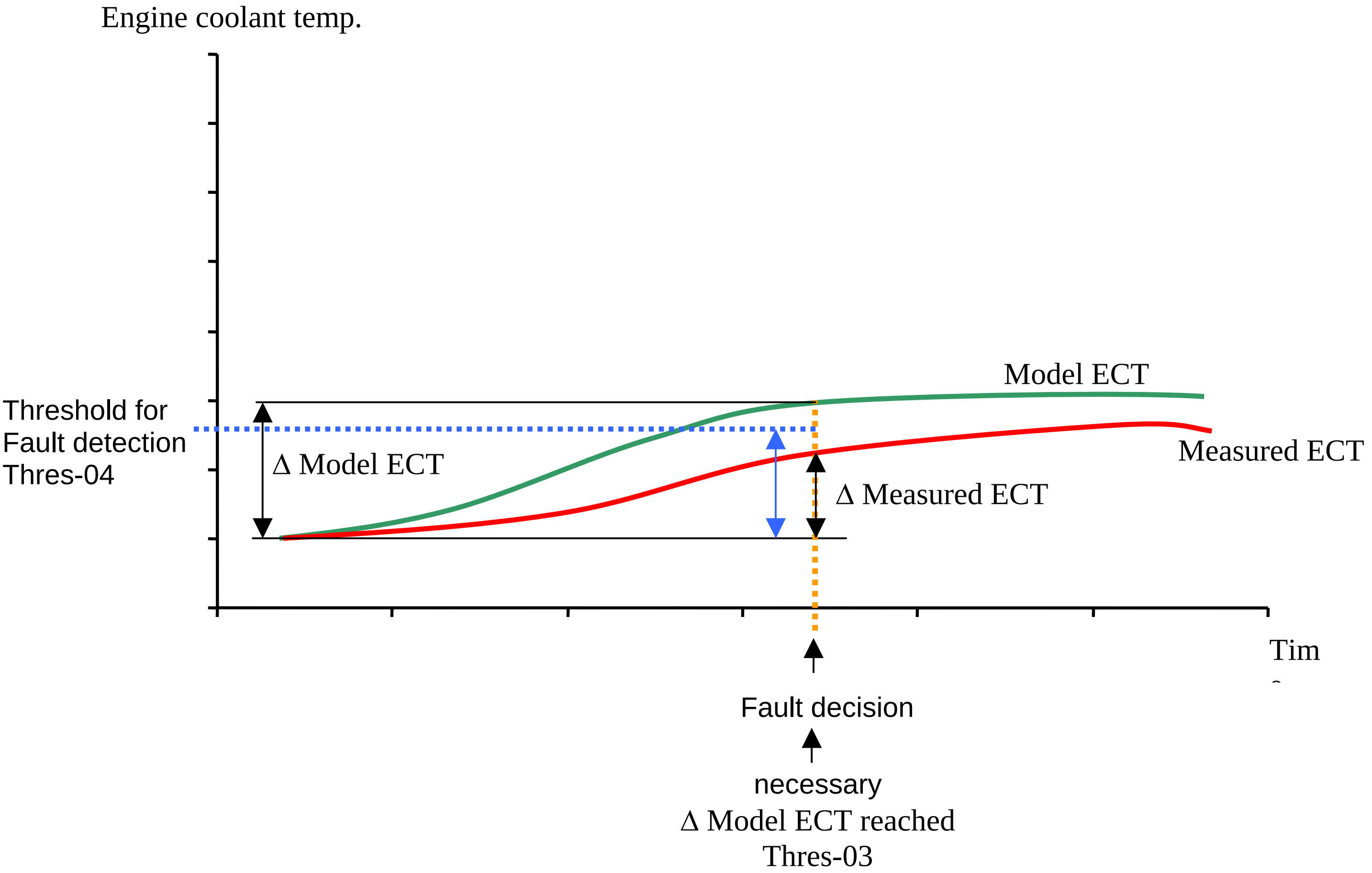
ECT: engine Coolant Temperature

Start-ECT: measured engine coolant
Temperature at engine start

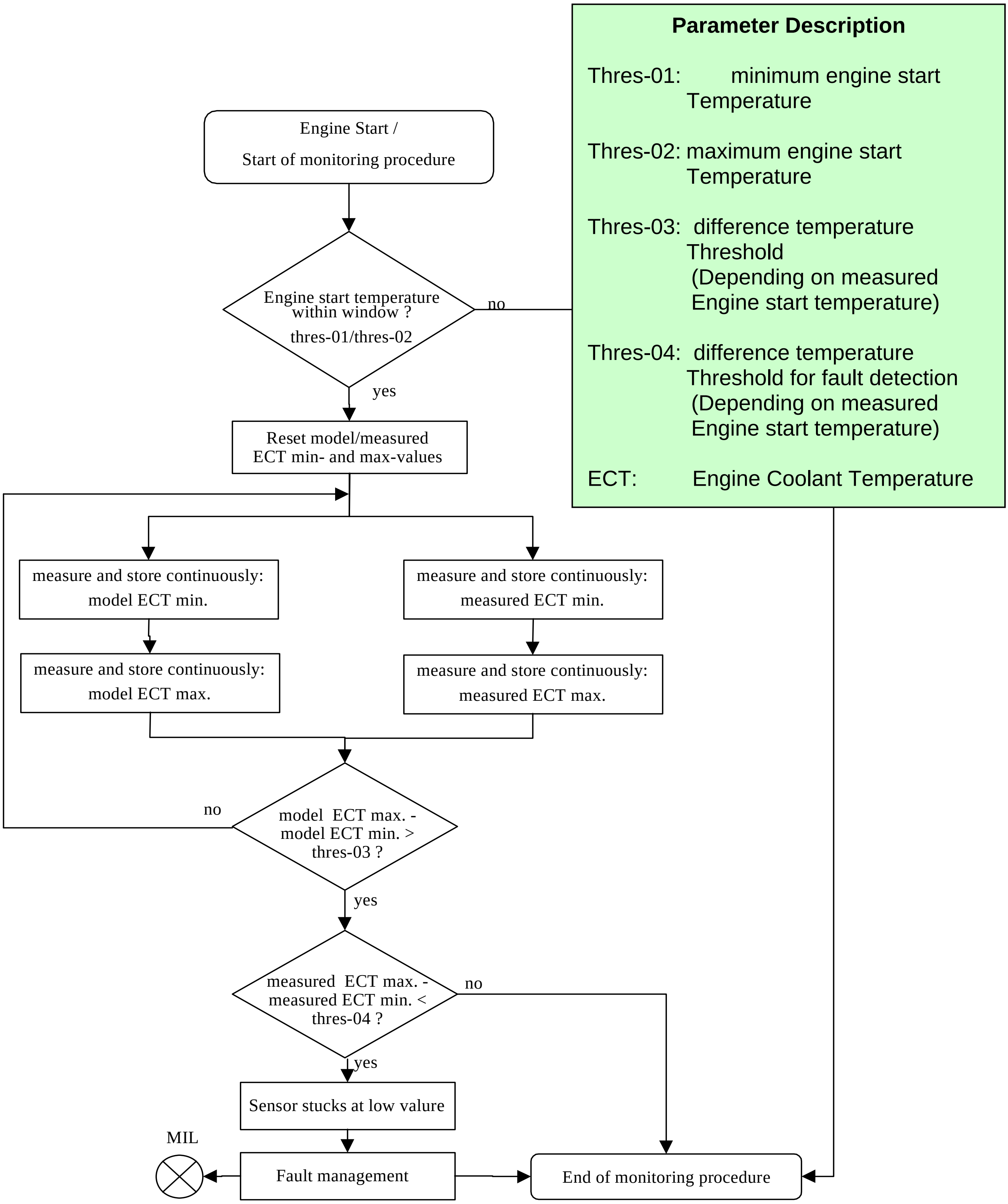
MAF: Mass Air Flow

7.16.03 Engine Coolant Temperature Sensor Stuck Low (P0116)

After engine start the system stores continuously the lowest and highest measured engine coolant temperature (ECT). Simultaneously the system also stores continuously the lowest and highest model ECT.
In case that the difference of the lowest and highest model ECT cross an applicable threshold (dependent on the measured ECT at engine start) and the difference of the lowest and highest measured ECT is below a further applicable threshold, the sensor stuck at low values.

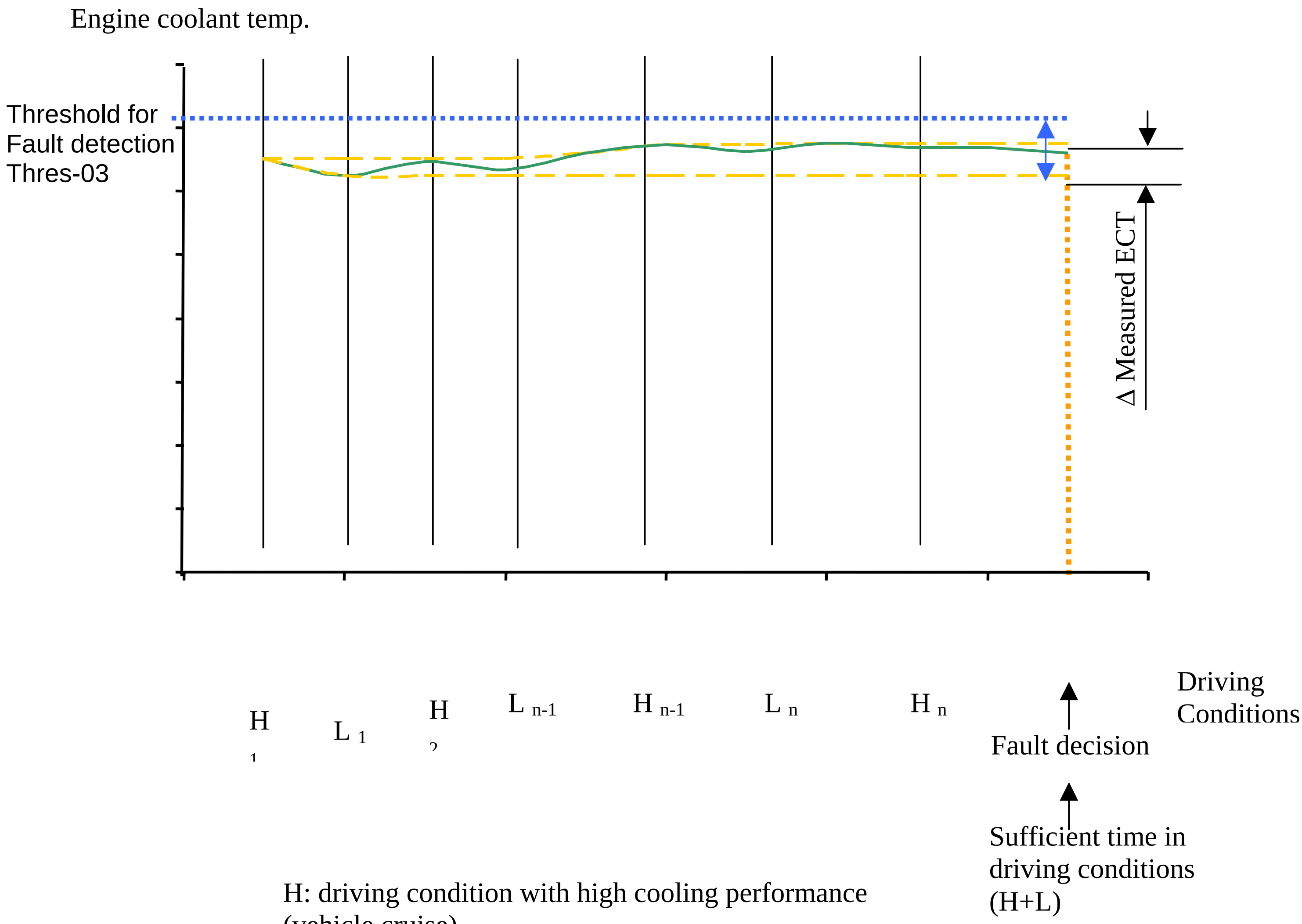


Flow Chart Engine Coolant Temperature Sensor Stuck Low (P0116)



7.16.04 Engine Coolant Temperature Sensor Stuck High (P0116)

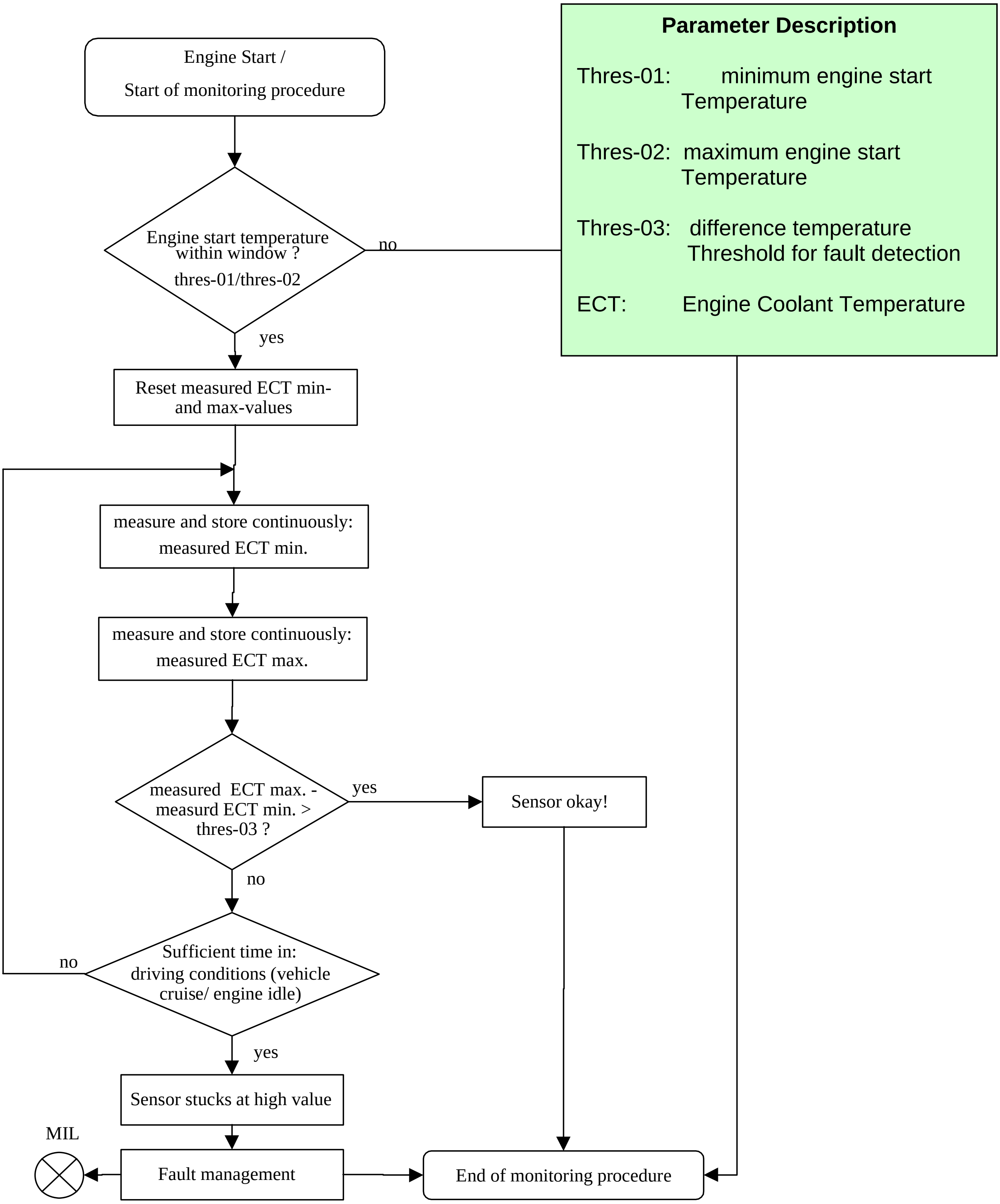
After engine start the system stores continuously the lowest and highest ECT above the thermostat control temperature for a driving cycle. In case that after several driving conditions the different between ECT max and ECT min is lower than the threshold the sensor stuck at high values.



H: driving condition with high cooling performance (vehicle cruise)

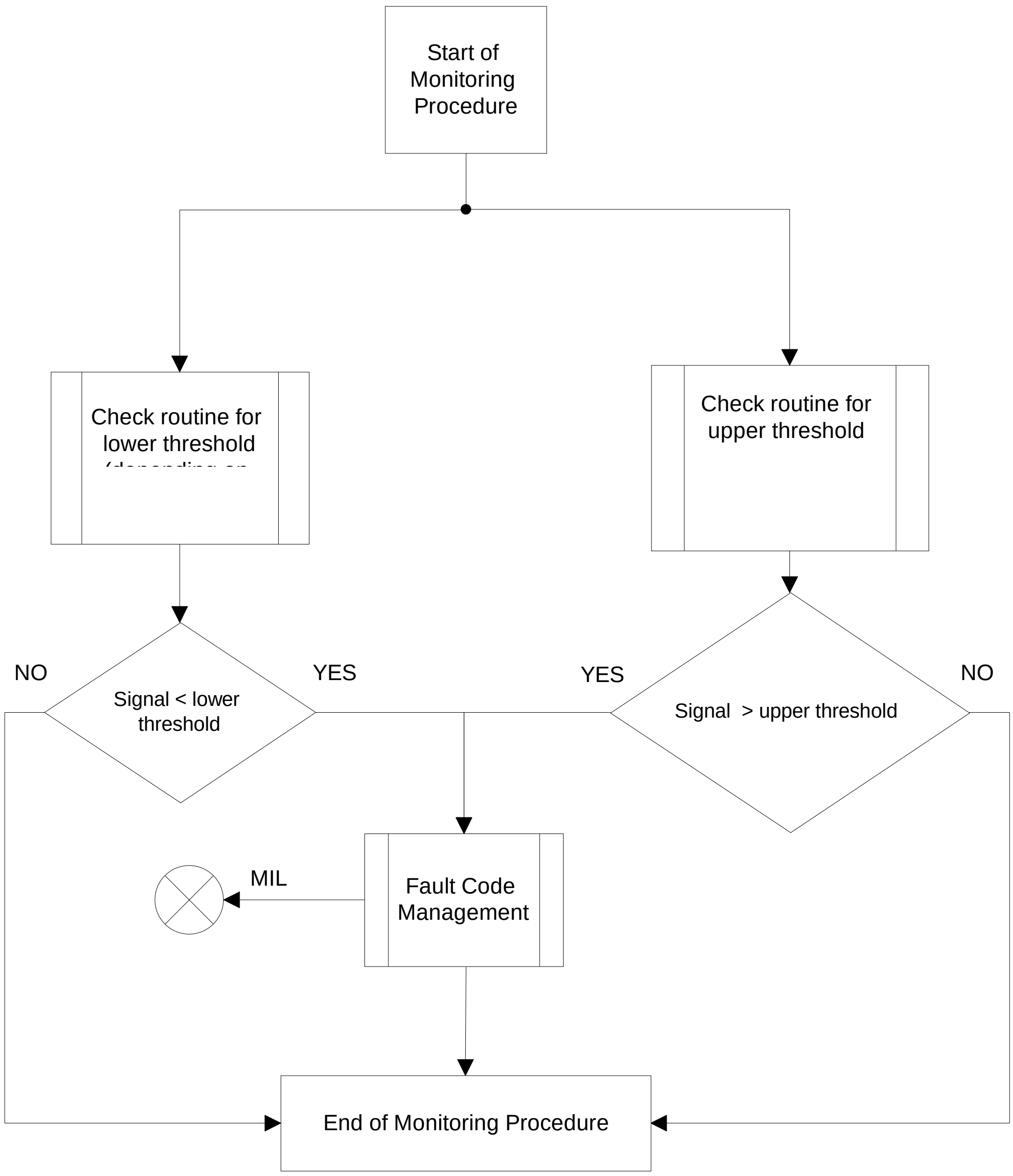
L: driving conditions with low cooling performance (idle)

Flow Chart Engine Coolant Temperature Sensor Stuck High (P0116)



7.16.05 Engine Coolant Temperature Sensor Out of Range Check (P0118 / P0117)

The signal of Engine Coolant Temperature Sensor is evaluated and considered to be electrically out of range if either the upper or the lower thresholds is exceeded.



10. COLD START EMISSION REDUCTION STRATEGY MONITORING

Not applicable

11. AIR CONDITIONING (A/C) SYSTEM COMPONENT MONITORING

Not applicable

12. VARIABLE VALVE TIMING AND/OR CONTROL (VVT) SYSTEM MONITORING

Not applicable

13. DIRECT OZON REDUCTION (DOR) SYSTEM MONITORING

Not applicable

14. PARTICULATE MATER (PM) TRAP MONITORING

Not applicable

15. COMPREHENSIVE COMPONENTS MONITORING

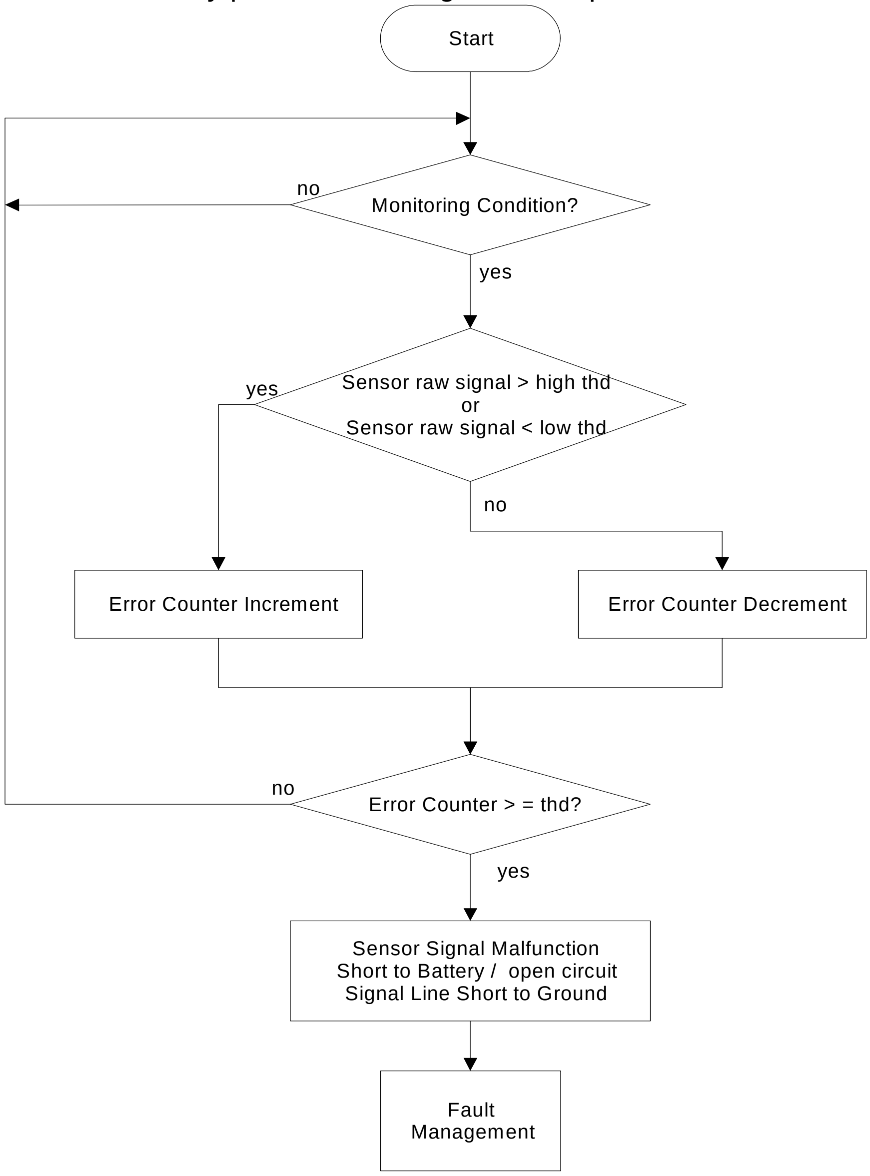
Sensors that can affect emissions or used to monitor or enable monitors for other components/ systems are monitored for open circuit, short to ground and/ or short to battery voltage, using high and low voltage signal limits.

Actuators that can affect emissions or used to monitor or enable monitors for other components/systems are monitored by power stage checks for open circuit, short to ground and/ or short to battery voltage.

For some of the sensors and actuators, rationality and/or functional checks are included to ensure proper operation of the components. This is accomplished through the use of a model or other sensor inputs. If a component does not function as expected or the integrity is in question (values are not with-in a threshold) it is considered out of range or not rational.

15.01 Electrical checks for Sensor signals

Sensor signals out of a defined range are regarded as circuit malfunctions shorted to battery plus, shorted to ground or open circuit.



15.02 Electrical checks for Actuators

The output stages are integrated in manufacturer specific IC's. The IC has a binary diagnostic line. Invalid actuator output signals at power stage are regarded as circuit malfunctions shorted to battery plus, shorted to ground or open circuit. If the control line of one stage has a different activation signal than the output line, the logic circuit inside the IC detects a malfunction. The logic circuit within the IC can separate the type of fault to a short circuit to minus, an open line, or a short circuit to plus. The check result will be sent to the ECM via diagnosis line.

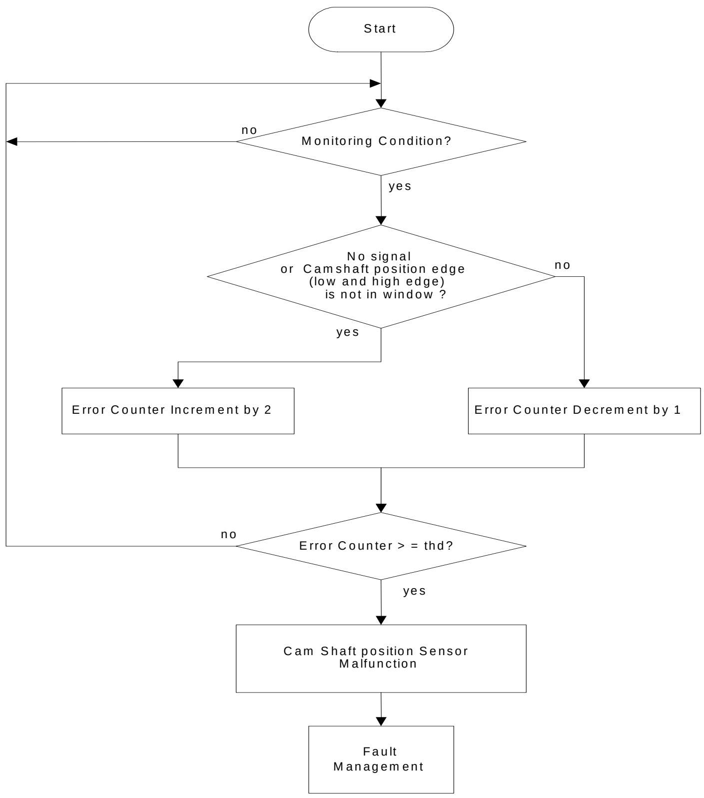
15.03 Camshaft position sensor and variable valve actuator

The variable valve control mostly consists of a camshaft actuator and a position sensor for each camshaft. Intake and exhaust camshafts can be adjusted continuously. The variable valve actuator is controlled by a PWM signal to adjust the required oil pressure for proper camshaft positioning.
While the engine is running, for each camshaft sensor, a counter is incremented with every signal edge detected.

15.03.01 Signal activity and rationality check

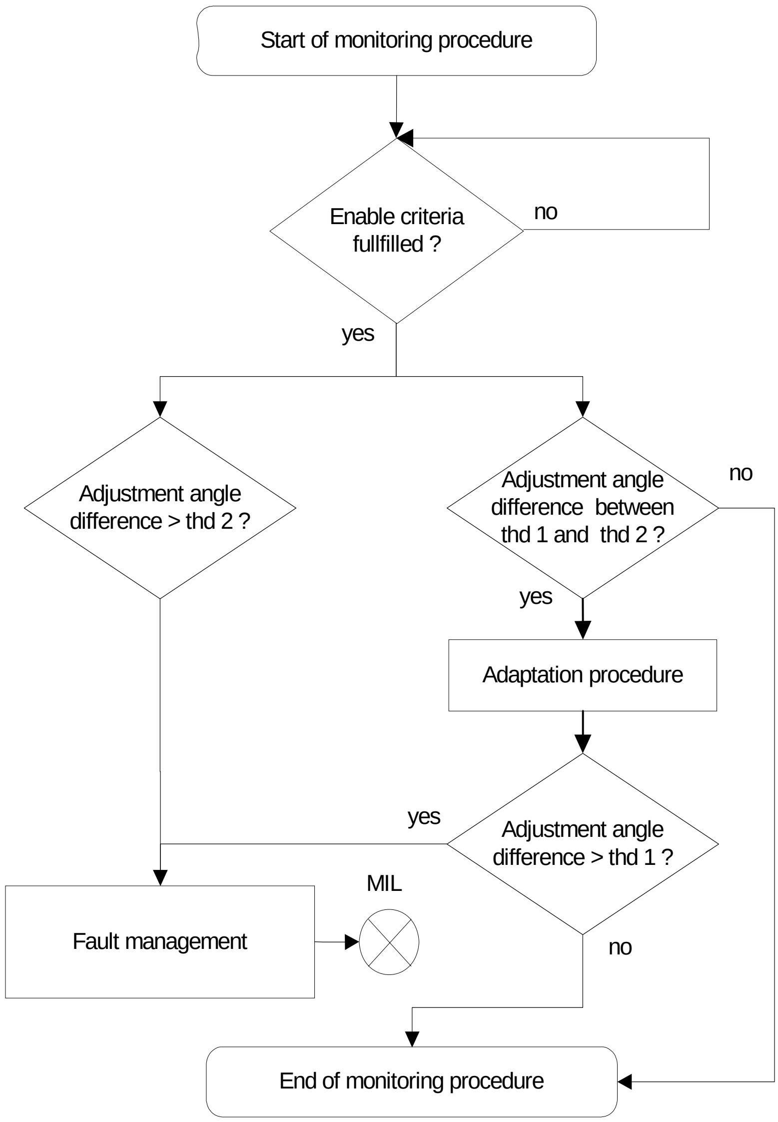
Signal activity check
The monitor checks at every crankshaft revolution, if the camshaft signal edge count has changed at least once. If the signal edge count has not changed for a number of crankshaft revolutions the fault management will be triggered.

Rationality check
The monitor compares the period between camshaft signal edges to a minimum time, and to a modeled value derived from the mechanical design of the camshaft target wheel, and time periods measured between previous signal edges.
An error counter is incremented, if the period between camshaft signal edges is smaller than the calibrated minimum threshold, or does not fit within a window range around the modeled value. Exceeds the error counter a calibrated threshold; the fault code management will be triggered.



15.04 Variable valve actuator functional check

At engine operation the actual camshaft position has to follow the given set point in a certain amount of time, below a defined adjustment angle difference threshold (thd1).
Does the continuously monitored adjustment angle difference exceed thd1 and falls below thd2, an adaptation procedure will be executed, once per given set point, to reduce the difference below thd1. Is the adaptation process unsuccessful to reduce the adjustment angle difference below thd1 the fault management will be triggered?
Exceeds the adjustment angle difference thd2; the fault management will be triggered.



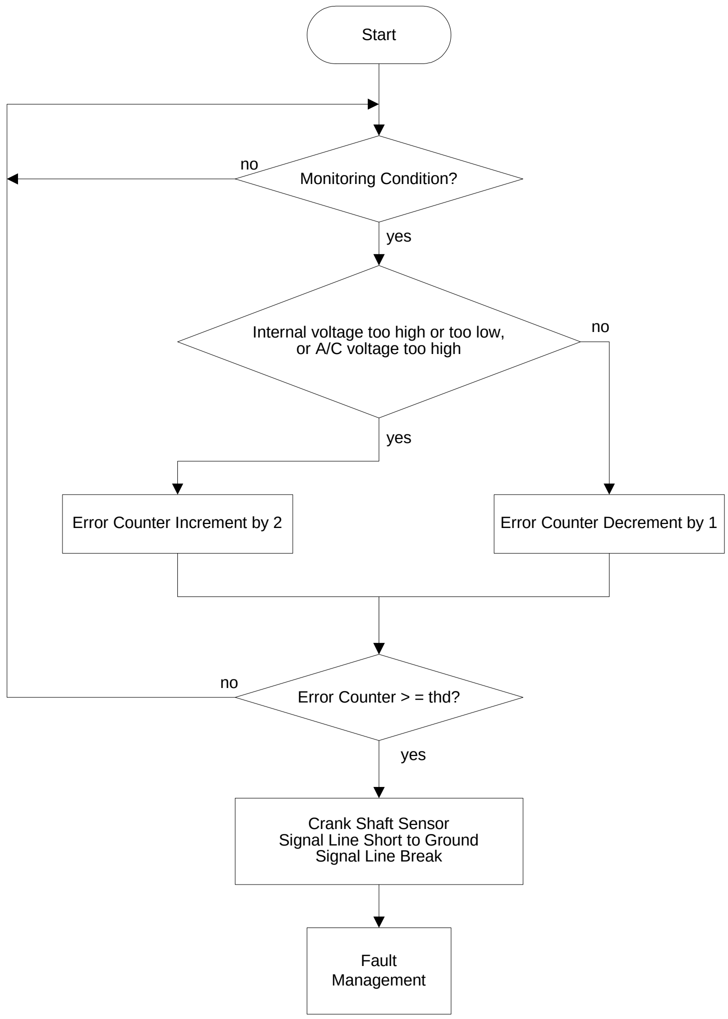
15.05 Engine speed sensor

The electrical load of the crankshaft position sensor consists of two serial resistors inside the ECU. The connecting line between the two resistors is also connected to a voltage divider, biasing the crankshaft signal to 2,5 Volts. With a perfectly symmetrical circuit of the crankshaft sensor, the voltage at that connection (bias node) is supposed to be 2.5 V DC at all engine speed conditions.

15.05.01 Electrical check

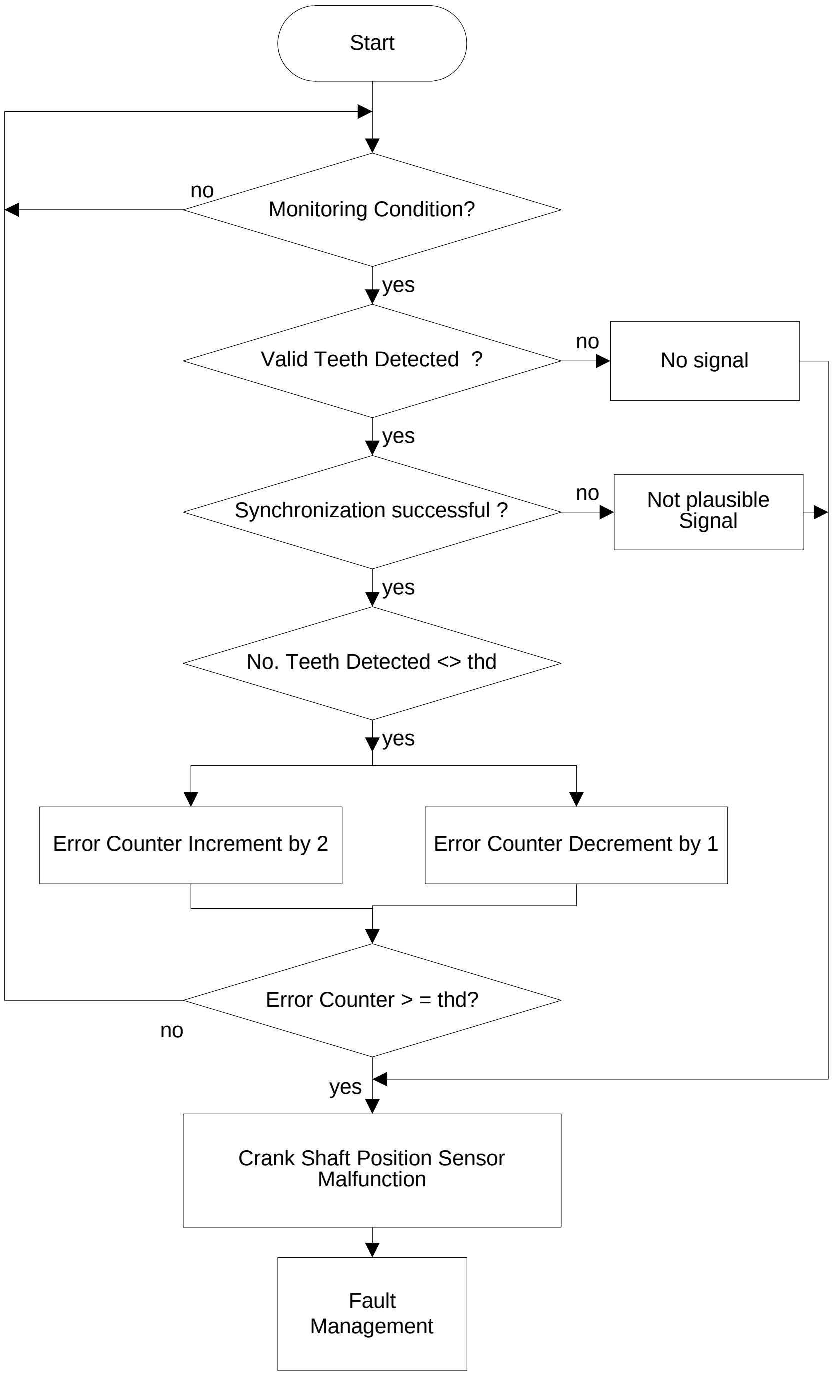
The voltage at the bias node is sampled at a high frequency, and the minimum and maximum voltage sampled are stored. Each time when a number of samples have been taken, the minimum and maximum voltage of that sampling period are compared against thresholds to detect a short circuit to ground or to battery voltage. Furthermore, the A/C portion of the voltage sampled is calculated and compared against a third threshold. This allows detecting a strongly asymmetric circuit, indicating one open signal line of the crankshaft sensor.

Exceeds the error counter a calibrated threshold; the fault code management will be triggered.



15.05.02 Signal activity and rationality check

At engine start, signal edges are counted on one selected camshaft while crankshaft synchronization is not yet established. Synchronization is established as soon as one valid crankshaft reference gap is detected. A malfunction of the crankshaft sensor is detected when the counter of the camshaft edges reaches a calibrated threshold. A fault code for no signal is set if no crankshaft teeth have been detected, otherwise a fault code for implausible signal is set.

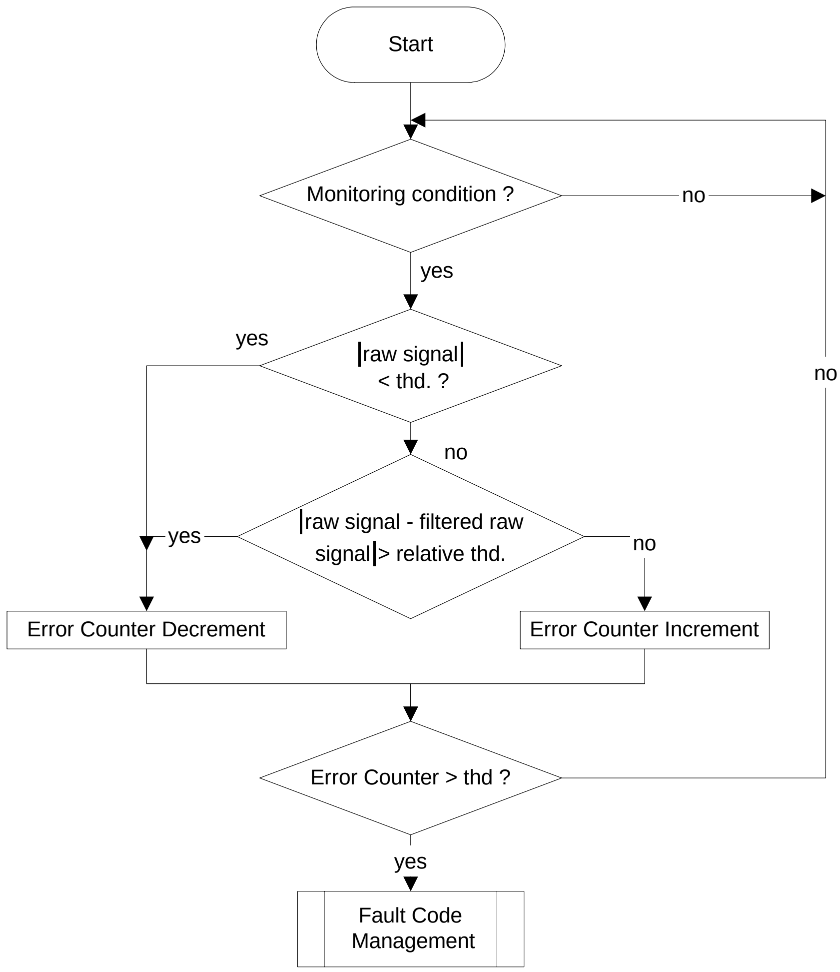


15.06 Knock sensor

The knock sensor is based on the piezo-electric principle. The engine noise will be transformed into a voltage raw signal.

15.06.01 Signal activity check

The raw signal will be checked for its frequency and magnitude of deflection. Insufficient magnitude will increment the error counter. The absolute difference between raw signal and filtered signal will be compared against a relative threshold. Exceeds the difference the threshold the error counter will be incremented. Exceeds the error counter the threshold the failure management will be triggered.

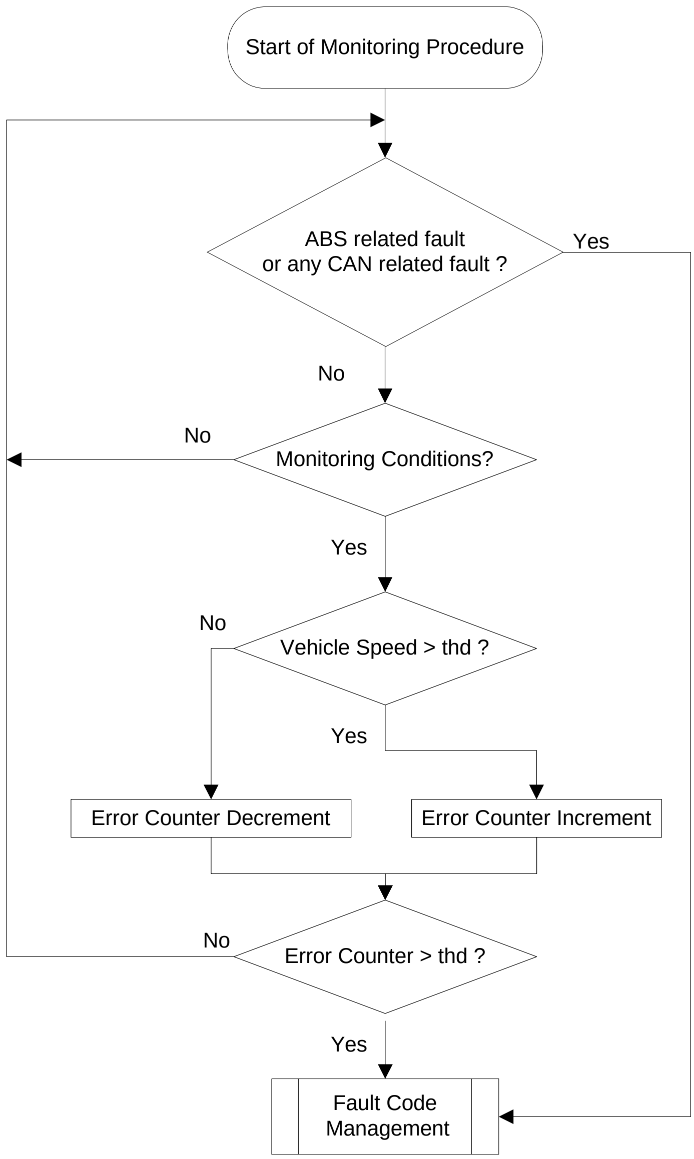


15.07 Vehicle speed sensor

The vehicle speed signal is derived from the ABS wheel speed sensor and is made available via CAN to the ECU.

15.07.01 Rationality check

Provided no ABS and /or CAN related faults are present, the vehicle speed signal will be checked against an upper threshold. Exceeds the VS signal the upper threshold the error counter will be incremented. Exceeds the error counter the threshold the failure management will be triggered.

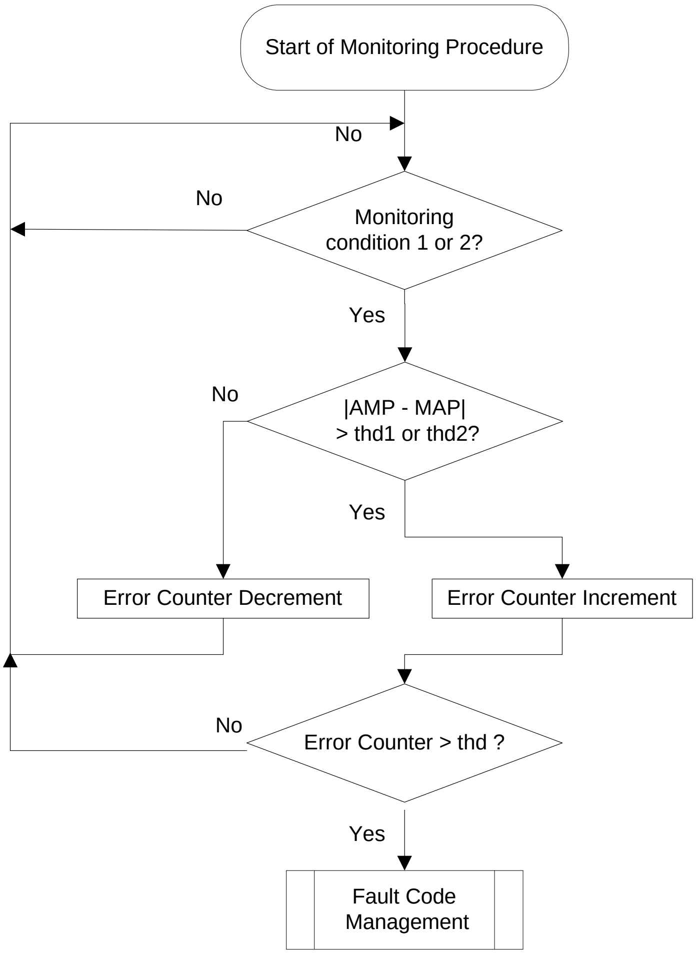


15.08 MAP and altitude sensor

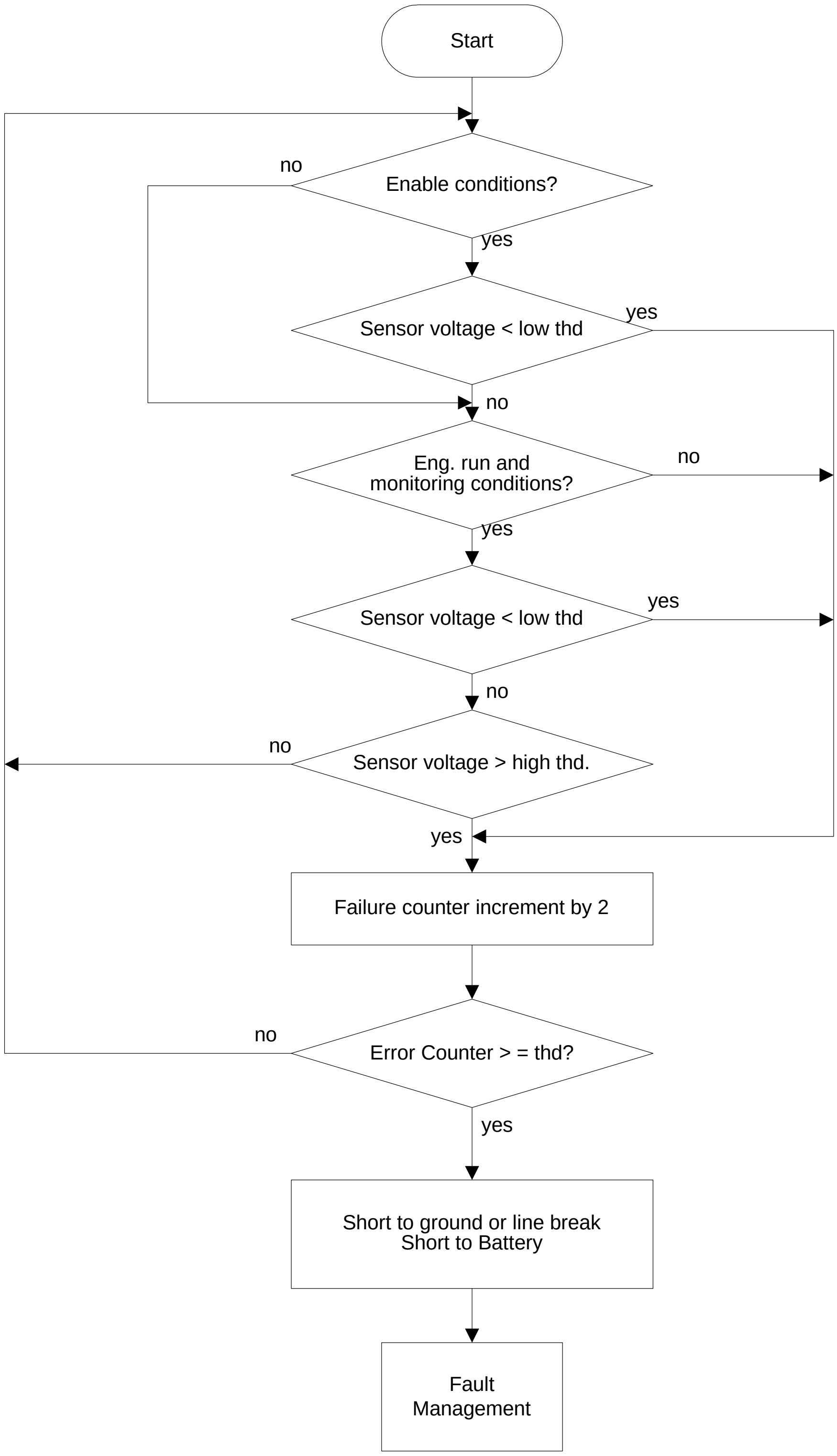
The pressure value delivered by the ambient pressure sensor (altitude sensor) is compared to the pressure, measured by the manifold air pressure sensor under conditions where the pressure in the intake manifold is roughly equal to ambient pressure, i.e. before engine start, or at full load conditions.

15.08.01 Rationality check

At engine off, the absolute difference between measured ambient and manifold pressure is compared against threshold1. Under engine full load conditions, the absolute difference between measured ambient and manifold pressures is compared against threshold2. The diagnosis under full load will be enabled by a certain model based pressure ratio at throttle body or the actual throttle position angle and engine speed. If the difference between AMP and MAP exceeds threshold1 during monitoring condition1, or threshold2 during monitoring condition2 a counter will be incremented. Exceeds the error counter a calibrated threshold; the fault code management will be triggered.



Siemens “Simos 6” OBD System Strategy

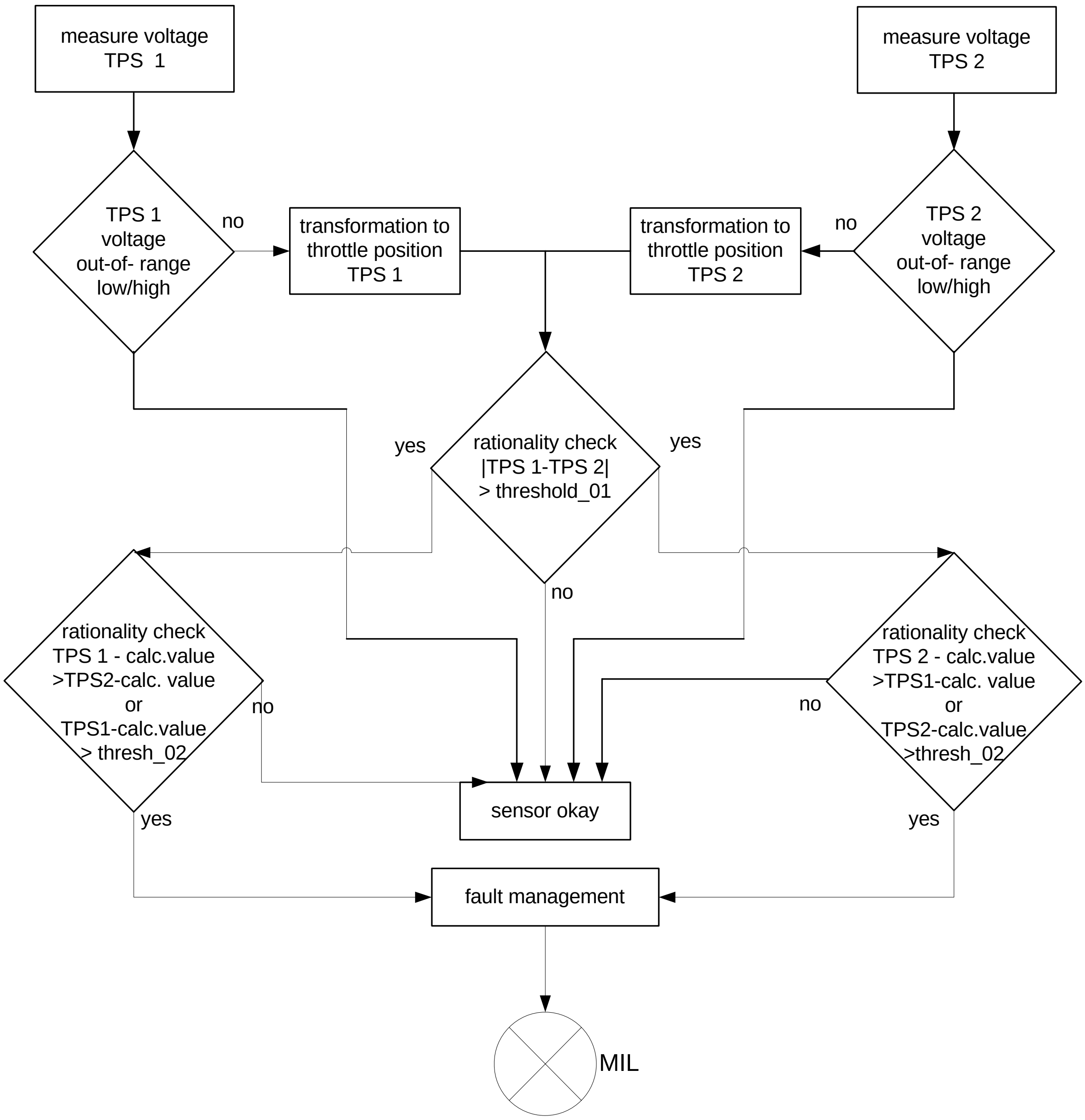


15.2 Throttle position sensor (throttle unit with E-gas actuator)

The throttle body consists of two potentiometers (reversed voltage logic). During the first start, the potentiometer characteristics are adapted and stored.

15.2.1 Rationality check

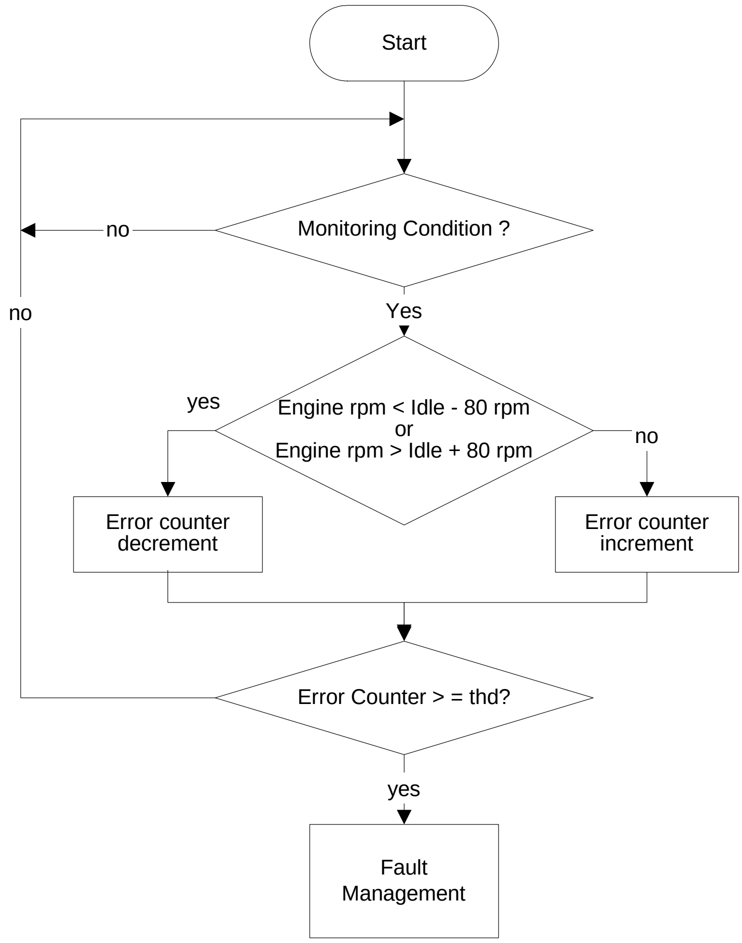
The diagnostic monitors the corrected values of potentiometer 1 and 2. In the case of a higher difference than a threshold value both signals are compared to the engine load to determine and disable the faulty one. A fault code will be stored and the MIL will be illuminated.



15.3 Idle controller

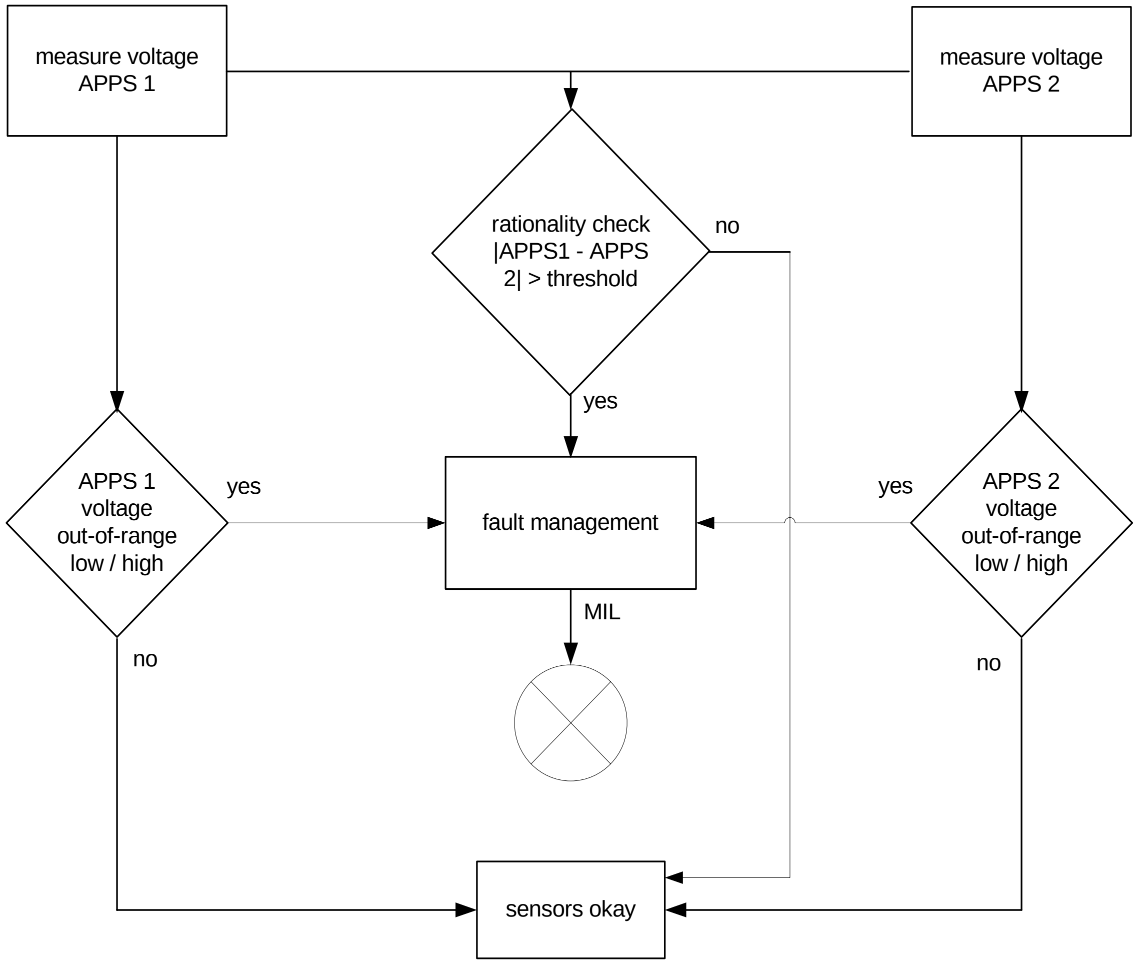
The functionality of the idle controller, to adjust the actual engine speed into its limits, is implemented in the ECU and will be controlled by ignition timing and throttle position.

15.3.1 Out of range check



15.4 Accelerator pedal position sensor

15.4.1 Out of Range / Rationality check



15.5 Injection valve check

Check is performed while using output stage check at low side stage and high side stage according 16.01.02.

15.19 Automatic Transmission Monitor

VW/Audi has different basic Automatic transmission systems. For each of these systems we are providing an OBD II summary table. Common OBD description from VW/Audi table TCM Groups show the references between transmission type and test groups.

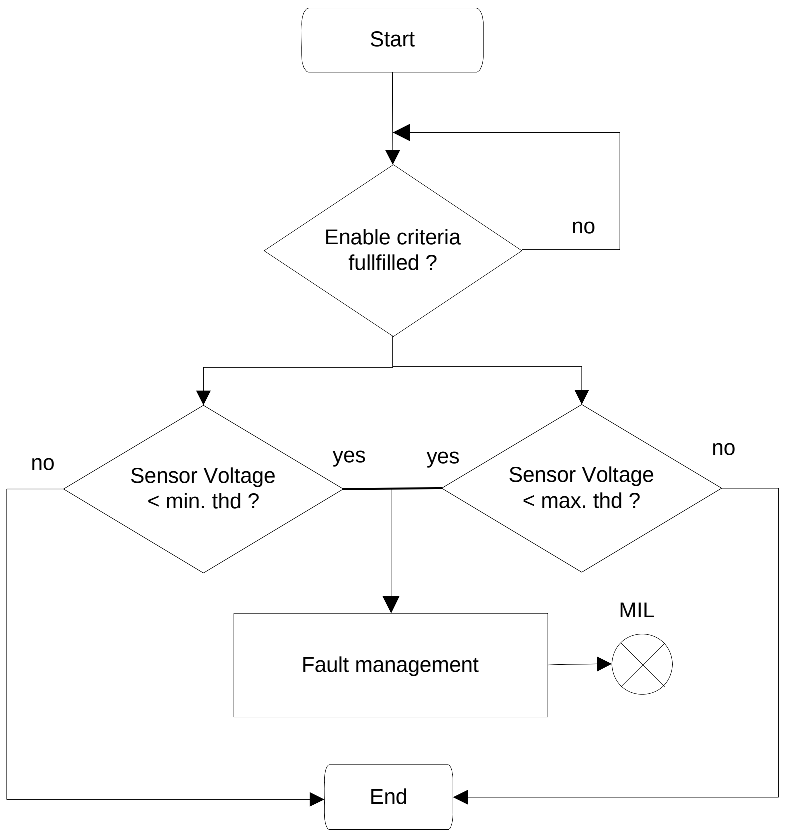
16 OTHER EMISSION CONTROL OR SOURCE SYSTEM MONITORING

.17.01.01 Intake manifold runner flap

The intake manifold runner flap is located in each of the intake manifold channels, close to the intake valve ports. It generates an additional air swirl into the combustion chamber to improve the robustness of the combustion in terms of fuel preparation, especially at engine start and low load conditions. The flaps are mounted on a common metal shaft and will be controlled by a vacuum operated actuator. A solenoid valve will engage the vacuum. At rest position, the spring-loaded actuator keeps the runner flap closing one of the two intake valve ports. The digital operation modes are: runner flap closes port / runner flap opens port, restricted by a mechanical end stop. The actual runner flap position will be sensed by an electric non-contact sensor mounted inline with the runner flap shaft.

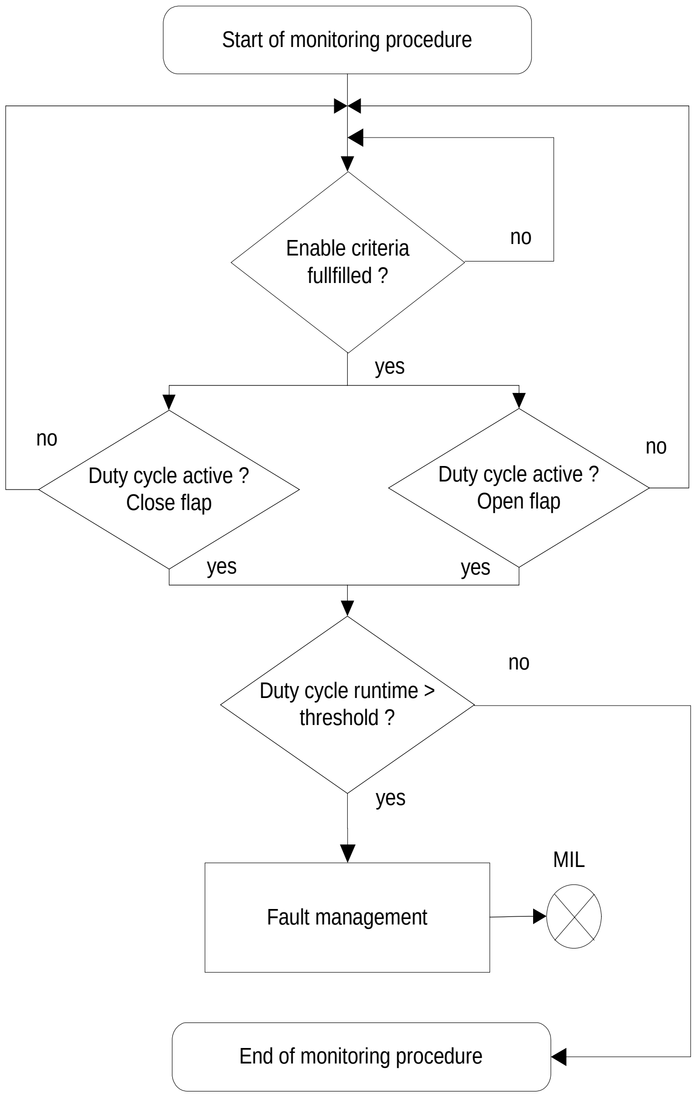
.17.01.02 Out of range low / high

At engine operation the actual runner flap will be monitored continuously for out of range position. Does the electrical signal of the runner flap position sensor enter a predetermined range; the fault management will be triggered.



.17.01.03 Stuck open / close

At engine operation each time the runner flap switches from open to close and vice versa the runtime will be monitored. Exceeds the duty cycle a predetermined time value; the fault management will be triggered.



18. PARAMETERS AND CONDITIONS TO BEGIN CLOSED LOOP OPERATION

General
To prevent damage of the HO2S caused by thermal shock it is necessary to delay the electrical driven heat up until the dew point of the water in the exhaust gas. Basically an exhaust gas temperature model is used to calculate the beginning of closed loop operation using ECT, IAT and MAP.

Conditions for closed loop operation of the first control loop
To guaranty proper Oxygen sensor heat-up the heater starts depending on engine temperature on a low level of heater power. Upon the exhaust temperature reaches a level where no liquid water is expected to be in the exhaust system (dew point exceeded) the heater power is controlled to achieve normal ceramic temperature of the Oxygen sensor. The ceramic temperature has to be > 610 °C for linear sensors. Specific temperatures are mentioned in the individual summary table.

Upon the integrated air mass after engine start exceeds a threshold, calculated at engine start based on engine start temperature and IAT, the due point is exceeded. In that case, the heater power will be increased until the sensor readiness is achieved and the sensor is considered to be ready for closed loop control.

The criteria for sensor readiness of the linear are:

- No fault from: LSU-Heater, LSU-Signals, LSU-IC
- LSU is heated up to a ceramic-temperature of > 610 °C.

Parameters evaluated to begin closed loop (first control loop)

The target is to begin closed loop operation in a very early state after engine start. However closed loop is delayed if engine is operated according the catalyst heat-up strategy. In the table below the importance parameters are listed.

Parameter / System	Condition/Evaluation	Monitor
IC for front O2S	SPI communication	Internal hardware check
Engine Coolant Temperature	At engine start the mass airflow integral threshold to exceed the dew point is calculated.	ECT-monitoring Electrical errors Coolant rationality Cooling system rationality Coolant temperature too low
Intake Air Temperature	At engine start the mass airflow integral threshold to exceed the dew point is calculated.	Monitor for the intake air temperature sensor
Intake Manifold pressure	Calculation of mass air flow integral to exceed the dew point	Monitor for MAP sensor
Throttle position sensor	Calculation of mass air flow integral to exceed the dew point	Monitor for Throttle position sensors
Oxygen Sensor	No fault detected in Oxygen sensor or wiring of the sensor.	Oxygen sensor monitor for the front sensor(s)
O2 Sensor Readiness	Sensor heated up, evaluated based on temperature measurement.	Functional check of the front O2S heater
O2 Sensor Heater	Check of the wiring of the heater	Electrical check of front O2S heater
Engine Coolant Temperature	Minimum ECT to go closed loop depends on ECT at engine start	ECT-monitoring Electrical errors Coolant rationality Cooling system rationality Coolant temperature too low

Under cold start FTP75 conditions (around 20°C) the concept reaches the closed loop condition within 20s to 30s.