

2009 ENGINE PERFORMANCE

Self Diagnosis - Theory & Operation - X6 (N63)

DIAGNOSTIC TROUBLE CODE INDEX

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DTC	Definition
<u>P0420, P0430</u>	Catalyst Monitoring
<u>P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P1396</u>	Misfire Monitoring
<u>P0440</u>	EVAP Canister Purge Solenoid (CPS) Functional Check
<u>P0442, P0456, P1434, P1447, P1448, P1449</u>	EVAP System Leak Measurement (Module DM-TL)
<u>P1434, P1447, P1448, P1449</u>	Monitoring function - EVAP Pump Current Diagnosis
<u>P2418, P2419, P2420</u>	EVAP - DMTL Valve Electrical Check
<u>P240A, P240B, P240C</u>	EVAP - DMTL Heater Electrical Check
<u>P2400, P2401, P2402</u>	DMTL Pump Electrical Check
<u>P0444, P0458, P0459</u>	EVAP - Purge Control Valve Electrical Check
<u>P0171, P0174, P0172, P0175</u>	Fuel System Monitoring Lambda Adaptation
<u>P2096, P2098, P2097, P2099</u>	Fuel System Trim Control Plausibility Monitoring
<u>P119D, P119E</u>	Diagnosis of Injector Aging
<u>P302A, P302B, P302C, P302D, P3283, P3285, P3284, P3286</u>	Monitoring function - High Pressure Fuel Control System
<u>P303A, P303B, P303C, P303D</u>	Monitoring function - Fuel Pressure Range Check
<u>P0192, P3250, P0193, P3251</u>	Fuel Rail Pressure Sensor Electrical Check
<u>P0003, P1281, P0004, P1282</u>	Volume Control Valve Electrical Check
<u>P10C3, P10C2, P10C1</u>	Volume Control Valve Relay Output Electrical Check
<u>P140E, P142E, P142F</u>	Injection Deactivation
<u>P0462, P2067, P0463, P2068</u>	Fuel Level Sensor Electrical Circuit Continuity Check
<u>P144B</u>	Fuel Level Sensor Signal Correlation Check
<u>P0131, P0151, P0132, P0152</u>	Upstream Oxygen Sensor - Short Circuit Monitoring
<u>P112C, P112D, P2626, P2629, P2243, P2247</u>	Upstream Oxygen Sensor - Open Circuit Monitoring
<u>P3022, P3023, P3024, P3025</u>	Upstream Oxygen Sensor - Signal Controller Monitoring
<u>P2414, P2415</u>	Upstream Oxygen Sensor - Signal Activity Check
<u>P0040</u>	Upstream Oxygen Sensor - Swapped Sensors Check

<u>P2195, P2197, P2196, P2198</u>	Upstream Oxygen Sensor - Active Signal Check (Shift to lean/rich)
<u>P0133, P0153</u>	Upstream Oxygen Sensor - Signal Dynamic Monitoring (Slow Response)
<u>P2297, P2298</u>	Upstream Oxygen Sensor - Signal Monitoring During DFCO
<u>P3026, P3027, P0135, P0155, P165F, P166F</u>	Upstream Oxygen Sensor - Heater Monitoring
<u>P0030, P0050, P0031, P0051, P0032, P0052</u>	Upstream Oxygen Sensor - Heater Circuit Monitoring
<u>P0137, P157, P0138, P158, P0140, P0160</u>	Downstream Oxygen Sensor - Circuit Monitoring
<u>P013E, P014A</u>	Downstream Oxygen Sensor - Signal Dynamic Check During DFCO
<u>P013A, P013C</u>	Downstream Oxygen Sensor - Dynamic/Transition Time in Sensor Midpoint Range Monitoring
<u>P114A, P114C, P114B, P114D</u>	Downstream Oxygen Sensor - Signal Activity Check
<u>P2270, P2272, P2271, P2273, P0041</u>	Downstream Oxygen Sensor - Signal Check (Stuck lean/rich, Swap)
<u>P0141, P0161</u>	Downstream Oxygen Sensor - Heater Plausibility Monitoring
<u>P0036, P0056, P0037, P0057, P0038, P0058</u>	Downstream Oxygen Sensor - Heater Circuit Monitoring
<u>P0128</u>	Thermostat Monitoring
<u>P0597, P0598, P0599</u>	Thermostat Electrical Check (Comprehensive component attendant to thermostat)
<u>P0117, P0118</u>	Engine Coolant Temperature Electrical Check
<u>P3198</u>	Engine Coolant Temperature Gradient Diagnosis
<u>P3199</u>	Engine Coolant Temperature Stuck Diagnosis
<u>P316A</u>	Engine Coolant Temperature Stuck in Range Diagnosis
<u>P00B4, P00B3</u>	Radiator Outlet Temperature Electrical Check
<u>P3197</u>	Radiator Outlet Temperature Gradient Diagnosis
<u>P316C, P00B2</u>	Radiator Outlet Temperature Plausibility Diagnosis
<u>P1561, P1562</u>	Cold Start Emission Reduction Strategy Monitoring
<u>P0012, P0022, P0015, P0025</u>	Variable Camshaft Timing (Vanos) (detection of mechanical IVVT error)
<u>P0340, P0345, P0365, P0390</u>	Camshaft Monitoring function - Diagnosis of Signal Plausibility
<u>P1300, P139A, P130A, P139B</u>	Camshaft Monitoring function - Diagnosis of Period Length
<u>P13B0, P13B1, P13B2, P13B3</u>	Camshaft Monitoring function - Diagnosis of Synchronization state
<u>P0017</u>	Monitoring function - Crankshaft Camshaft Synchronization

<u>P13B4, P13B5, P13B6, P13B7</u>	Crankshaft Camshaft Monitoring function - Diagnosis of Mechanical Reference Position
<u>P13BA, P13BB, P13BC, P13BD</u>	Crankshaft Camshaft Monitoring function - Diagnosis of Mechanical Chain Jump
<u>P0335, P0336, P0370, P138F</u>	Crankshaft Position Sensor (CRK)
<u>P0010, P0020, P2088, P2092, P2089, P2093, P0013, P0023, P2090, P2094, P2091, P2095</u>	Camshaft Position Actuator Electrical Check
<u>P0072, P0073</u>	CAN based Ambient Air Temperature Signal Diagnosis
<u>P0071</u>	Ambient Air Temperature (AAT) Signal Plausibility Check
<u>P113C, P11B2, P111E, P117F, P111F, P118F</u>	Intake Air Temperature Sensor Plausibility Diagnosis
<u>P0112, P00AC, P0113, P00AD</u>	Intake Air Temperature Sensor Electrical Check
<u>P10B8, P10B9, P10B0, P10B2, P10B1, P10B3</u>	Charge Air Cooler Temperature Plausibility Diagnosis
<u>P10B4, P10B5, P10B6, P10B7</u>	Charge Air Cooler Temperature Gradient Diagnosis
<u>P007C, P00A2, P007D, P00A3</u>	Charge Air Cooler Temperature Sensor Electrical Check
<u>P2100, P210A</u>	Electronic Throttle Control (ETC) Power Stage Diagnosis (H-bridge)
<u>P11AA, P11AB, P16D0, P16D1</u>	Electronic Throttle Control (ETC) Motor Control Performance
<u>P1417, P1455</u>	Electronic Throttle Control (ETC) Composite Error
<u>P1632, P16AA, P1633, P16AB, P169B, P169C, P16BC, P16BD, P16BE, P16BF, P16CA, P16CB, P16CC, P16CD</u>	Monitoring function - ETC Adaptation Diagnosis
<u>P16BA, P16BB, P169A, P16AD</u>	Monitoring function - ETC Start Check
<u>P0121, P0226, P0221, P212B</u>	Throttle Position Sensor (TPS) Plausibility Check
<u>P115F, P117E</u>	Throttle Position Sensor (TPS) Ratio Check
<u>P0122, P0227, P0123, P0228, P0222, P212C, P0223, P212D</u>	Throttle Position Sensor Electrical Check
<u>P164C, P1625, P1224</u>	Pedal Position Sensor
<u>P0506, P0507, P1561, P1562</u>	Idle Speed Control Rationality Diagnosis
<u>P00BC, P00BE, P00BD, P00BF, P112E, P11B0, P112F, P11B1</u>	Mass Air Flow and Manifold Absolute Pressure Plausibility Diagnosis
<u>P12B8, P12B9, P12A8, P12B6, P12A9, P12B7, P12A4, P12A6, P12A5, P12A7</u>	Ambient Pressure, Boost Pressure and Manifold Absolute Pressure
<u>P119B, P11AF, P119A, P11AE</u>	Manifold Absolute Pressure Sensor Electrical Check
<u>P10C7, P10C8</u>	Mass Air Flow Sensor Internal Error Diagnosis
<u>P0102, P010C, P0103, P010D</u>	Temperature Sensor Diagnosis Electrical Check
<u>P00BC, P00BE, P00BD, P00BF</u>	Temperature Sensor Diagnosis Range Check
<u>P0102, P010C, P0103, P010D</u>	Mass Air Flow Sensor Diagnosis Electrical Check

<u>P00BC, P00BE, P00BD, P00BF</u>	Mass Air Flow Sensor Diagnosis Range check
<u>P0503</u>	Vehicle Speed Sensor Signal Plausibility Check
<u>P0500</u>	Vehicle Speed Sensor Signal Check
<u>P0326, P0327, P0328, P135B, P1327, P1328, P135F, P1329, P1330, P033B, P033C, P033D</u>	Knock Sensor (KS)
<u>P0237, P0241, P0238, P0242</u>	Supercharger Boost Sensor Electrical Check
<u>P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P310B, P310E, P311B, P311E, P312B, P312E, P313B, P313E</u>	Injector Valve Diagnosis Electrical Check
<u>P10A5, P10A8, P10BA, P10BD, P10A6, P10A9, P10BB, P10BE, P10A7, P10AA, P10BC, P10BF</u>	Injector Power Stage Diagnosis
<u>P2228, P2229</u>	Ambient Pressure Sensor Electrical Check
<u>P321E, P321F</u>	Ambient Pressure Sensor Rationality Check

1.1 CATALYST MONITORING

P0420/P0430

1.1.1 DIAGNOSTIC OVERVIEW

Catalyst monitoring is based on the monitoring of the oxygen storage capability (OSC) by comparing the signals of the O2 sensor upstream and downstream of the catalyst.

The engine control stimulates the regular lambda oscillations of the exhaust gas. These oscillations are needed for best possible catalyst conversion. They are damped by the storage activity of the catalyst. The amplitude of the remaining lambda oscillations downstream the catalyst indicates the oxygen storage capability.

The efficiency of the catalyst system is tested during steady state driving by cycling the air fuel ratio LEAN and then RICH for a calibratable number of cycles while monitoring the OSC.

Prior to the catalyst test the canister purge valve is closed or opened with low canister purge value. This is to eliminate the influence of canister vapors on the downstream sensor during the test.

1.1.2 MONITORING FUNCTION

If all monitoring conditions are fulfilled, then a special defined A/F-modulation will be done.

The first lean to rich cycle of the test is only used to establish an average voltage value of the downstream sensor voltage. During subsequent cycles the calculation of the OSC is based on the accumulated value of the difference between the average value of the previous lean to rich cycle and the measured instantaneous voltage during the current lean to rich cycle.

The relation of the deviation between the current downstream-sensor-signal to the average value of the downstream-sensor-signal is a lead for catalyst condition.

The catalyst system is considered malfunctioning, if after a specified number of monitoring cycles the average

of the accumulated deviation exceeds a threshold. The corresponding fault code is stored.

1.1.3 VALIDATION OF THE CALCULATED SENSOR SIGNALS (O2_CAT_I) OF ONE PERIOD

1. monitoring two cross criteria (calculated sensor signal has to cross the mean value characteristic curve twice)
2. monitoring of delta threshold for minimum and maximum of trim control set-point (O2 _CAT is a calculated value, taking O2 rear signal as a basis)
3. difference of mean value of the calculated sensor signals related to one period to the next one $[(O2_CAT_MV_n) - (O2_CAT_MV_{n-1})]$

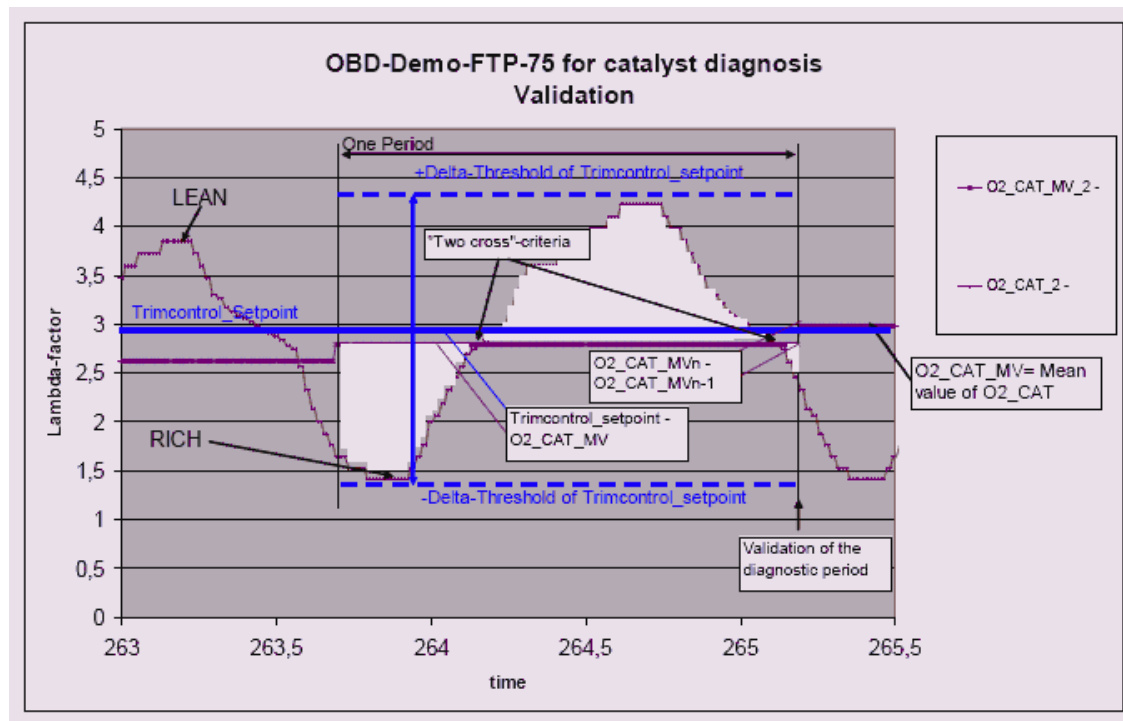


Fig. 1: Validation Of Calculated Sensor Signals Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

1.2 HEATED CATALYST MONITORING

A heated catalyst is not embedded.

1.3 MISFIRE MONITORING

P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P1396

1.3.1 MONITORING FUNCTION

The method of engine misfire detection is based on evaluating the engine speed fluctuations. The engine torque is a function of engine speed, engine load and the moment of inertia.

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

It is also an influence of the load torque, such as the influences of different road surface, e.g. pavement, potholes etc. If the mean engine speed is measured, influences caused by road surfaces have to be eliminated.

This method consists of following main parts:

Data acquisition:

The duration of the crankshaft segments is measured continuously for every combustion cycle.

Segment time adaptation (P1396):

Within a defined engine speed range and during fuel cut-off, the segment time adaptation, instead of the misfire detection, is carried out. This is done in three engine speed ranges. If the segment time adaptation is out of the maximum adaptation range, failure P1396 is stored.

With progressing adaptation the sensitivity of the misfire detection is increasing. The adaptation values are stored and taken into consideration for the calculation of the engine roughness.

Calculation of the engine roughness:

The engine roughness is derived from the differences of the segment durations.

Different statistical methods are used to distinguish between normal changes of the segment duration and the changes due to misfiring.

Correction of the engine roughness value:

The adaption during firing operation (fuel-on adaption) learns systematic differences of the calculated engine roughness between the individual cylinders depending on the current operating point of the engine.

The learned fuel-on adaptation values are used to correct the engine roughness values to improve the overall signal-to-noise range.

Determination of misfiring:

Misfire detection is performed by comparing the engine roughness threshold value with the engine roughness value. If the threshold is exceeded, single misfire is detected. The decision, whether the threshold shortfall of the irregular running is evaluated, depends on the monitoring conditions.

1.3.2 STATISTICS, FAULT PROCESSING

Emission Limit:

If the sum of cylinder(s) misfire counters within 1000 revolutions is 4 times exceeding a predetermined value during a driving cycle, or during the first 1000 revolutions, the fault code for emission relevant misfiring is temporary stored. If the following driving cycle is also above the emission limits, the MIL will be switched on and a cylinder selective or global fault will be stored.

Catalyst Damage:

If the weighted sum of cylinder(s) misfire counters within 200 revolutions is exceeding a predetermined value the fault code for catalyst damage relevant misfiring is stored and the cylinder with the highest rate will be switched off and the MIL will be switched on immediately. If two cylinders are switched off and the misfire rate is still above the damage limits, MIL is flashed immediately. If one of the cylinder selective counters is exceeding the predetermined threshold the following measures take place:

1. The lambda closed loop system is switched to open-loop condition.
2. The cylinder individual fault code is stored or if multiple cylinders, then the global fault code is set.
3. Fuel supply of the misfiring cylinder(s) is cut-off (per customer request)
4. No downstream fuel trim.

All misfire counters are reset after each interval.

1.4 EVAPORATIVE SYSTEM (EVAP)

1.4.1 EVAP CANISTER PURGE SOLENOID (CPS) FUNCTIONAL CHECK

P0440

1.4.1.1 Monitoring function

The diagnosis is used for the functional test of the CP solenoid (CPS).

The test consists of two checks.

The first check of the CPS is based on the active charcoal filter (ACF) amount. The "canister load diagnosis" is calculated permanently during tank purge.

If amount is above threshold ok is detected.

If amount is below threshold, the next step will be performed.

During the next check, the CPS is evaluated based on manifold pressure deviation, while motor is running in idle speed. The CPS is opened for a short time and the manifold pressure is monitored during the CPS opening. Additionally the deviation of lambda-controller (rich mixture) is monitored.

After this check has been enabled it is requested during each idle speed phase as long as the monitoring conditions are met. This is repeated as long as a result has been reached. This check is not bound to one idle speed phase, but can be distributed to several idle speed phases.

If the CPS is detected to be not ok three times, the error is set.

1.4.2 EVAP SYSTEM LEAK MEASUREMENT (MODULE DM-TL)

P0442, P0456, P1434, P1447, P1448, P1449

1.4.2.1 Monitoring function - Leak Detection

P0442, P0456

The evaporative system monitoring permits the detection of leaks in the evaporative system with a diameter of 0.02 inches and up.

By means of a Diagnostic Module Tank Leakage (DM-TL), an electrical actuated pump located at the atmospheric connection of the evaporative canister, a pressure test of the evaporative system is performed in the following order:

During the Reference Leak Measurement, the electrical actuated pump delivers through the reference restriction.

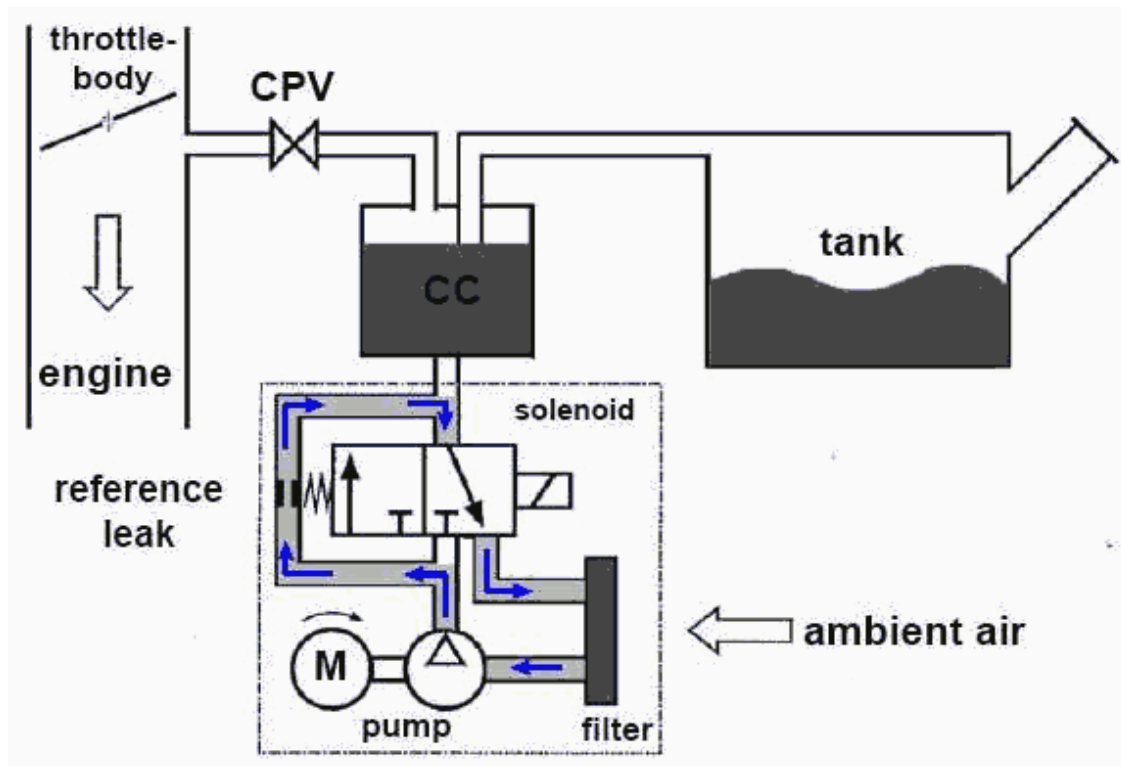


Fig. 2: EVAP System Monitoring Function Diagram - Leak Detection
Courtesy of BMW OF NORTH AMERICA, INC.

During the Leak Measurement, the electrically actuated pump delivers through the charcoal canister into the fuel-tank system. The pressure in the evaporative system may be up to 2.5 kPa depending on the fuel level in the tank. The engine-management system measures the pump's electrical current consumption. A comparison of

the currents of the reference leak measurement and the leak measurement is an indication of the leakage in the tank.

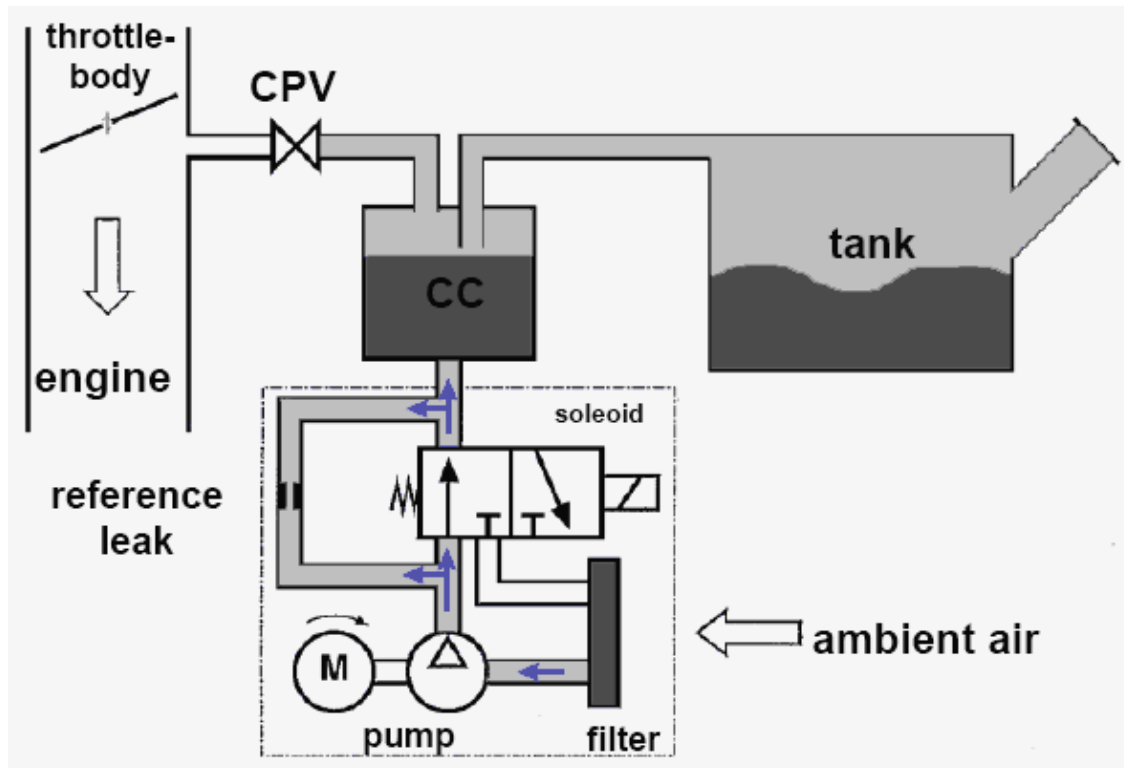


Fig. 3: EVAP System Monitoring Function Diagram - Leak Detection
Courtesy of BMW OF NORTH AMERICA, INC.

0.02 inch diagnosis, very small leak:

P0456

The first step of the diagnosis is the reference measurement, the result of the pump reference current is stored (picture in chapter a). After the solenoid switches, the venting system is pressurized (picture in chapter b). In the small leak measurement the small leak threshold is reached, if the leak is smaller than 0.04 inch and then the small leak measurement phase follows. When the DM-TL current reaches the reference current within the very small leak time, the system is tight (leak smaller than 0.02 inch), otherwise a very small leak between 0.02 - 0.04 inches is detected.

0.04 inch diagnosis, small leak:

P0442

The first step of the diagnosis is also the reference measurement, the result of the pump reference is stored (picture in chapter a). After the solenoid switches, the venting system is pressurized (picture in chapter b). In the small leak phase (time) the pump current must reach the small leak threshold 1:

Small leak threshold 1 = idle current pump + K1 x (reference current - idle current). Factor K1 is between 0.16

and 0.28 depending on the characteristic current value of the pump (reference current - idle current), this value is various in every pump.

If the small leak threshold 1 is not reached in the small leak time, the small leak threshold 2 must be reached in an additional time small leak threshold 2 = reference current pump - $K_2 \times$ (reference current - idle current). Factor K_2 is between 0.60 and 0.80 depending on the characteristic current value of the pump (reference current - idle current).

If the small leak threshold 2 is also not reached, a leak > 0.04 inches is detected.

In the diagram below is the typical current of a tight system, a 0.02 inch leak, and a leak > 0.04 inches.

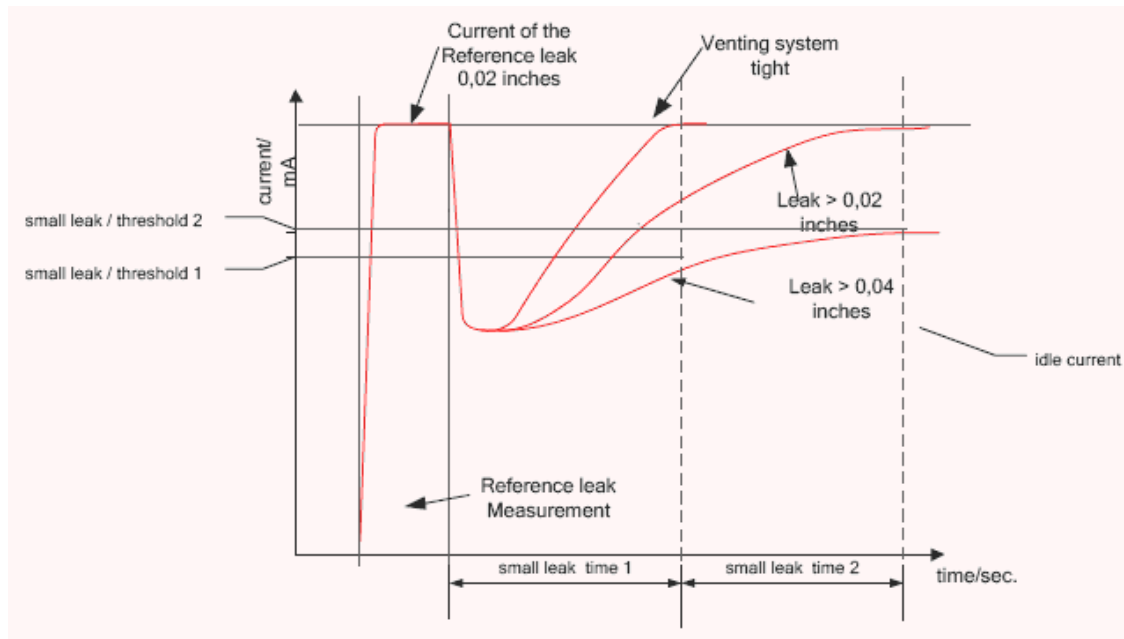


Fig. 4: Current And Time Diagram (Small Leak)
Courtesy of BMW OF NORTH AMERICA, INC.

- After the test the remaining pressure in the evaporative system is bled off through the charcoal canister by switching off the pump and solenoid.

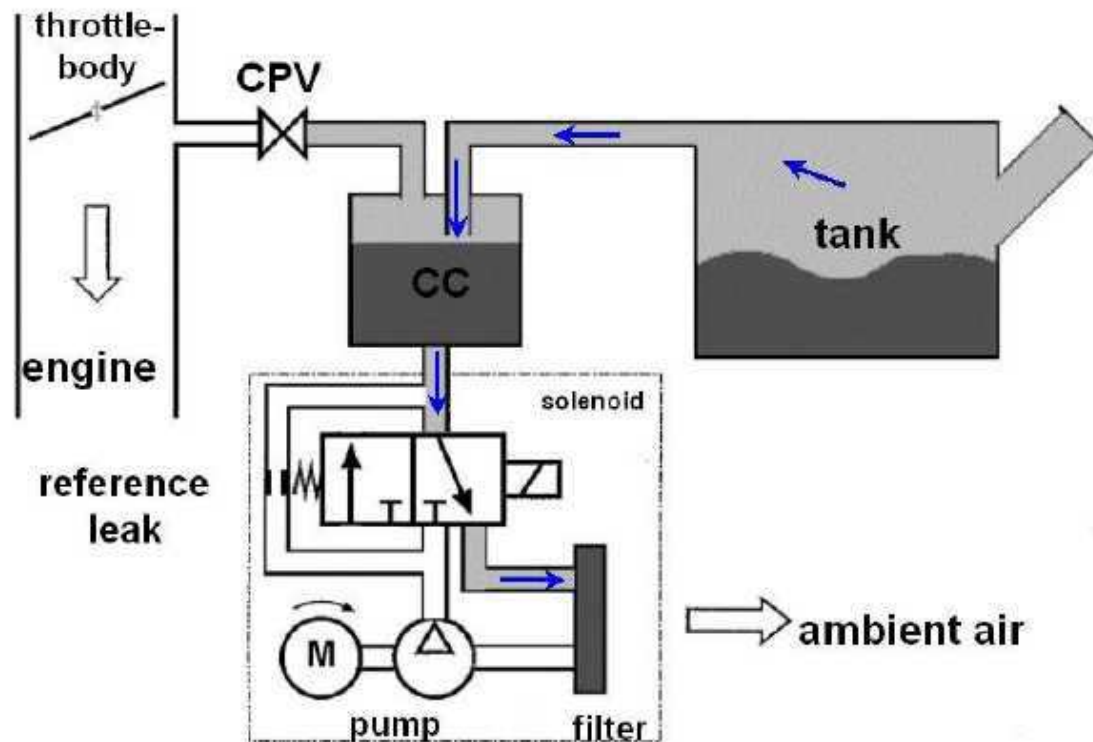


Fig. 5: Evaporative System Function Diagram (Small Leak)

Courtesy of BMW OF NORTH AMERICA, INC.

1.4.2.2 Diagnosis Frequency and MIL Illumination

Diagnosis Frequency and MIL illumination - no refueling detected, leak > 0.04 inches

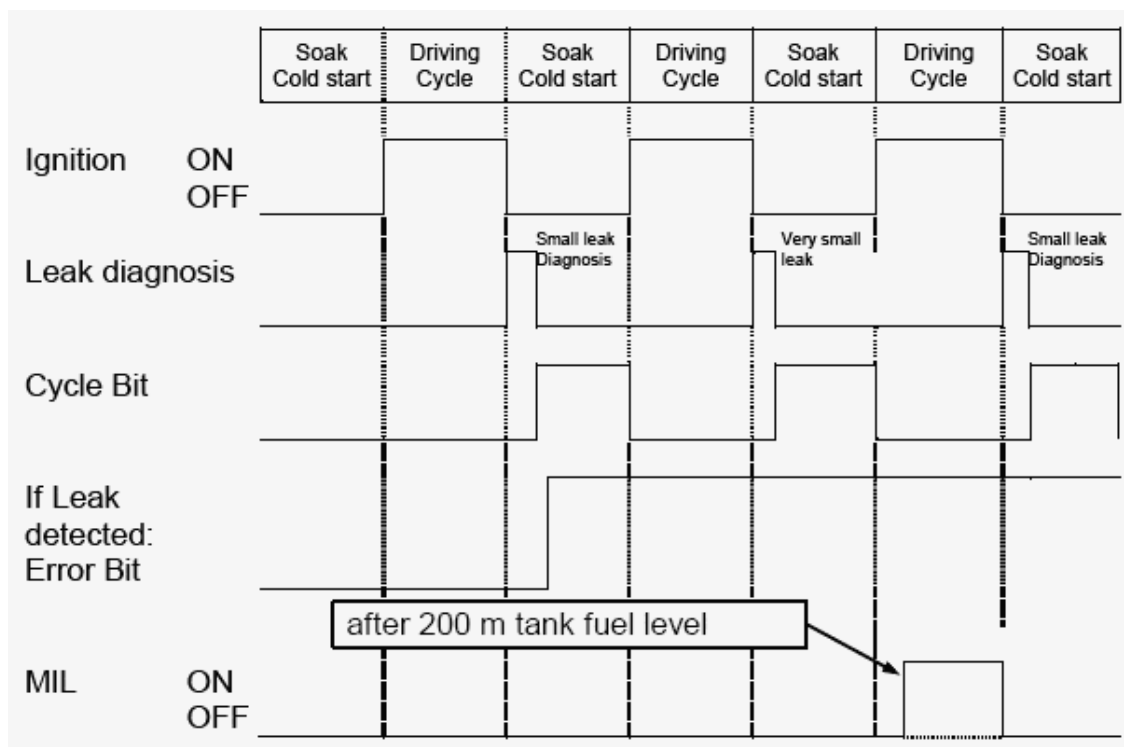


Fig. 6: Blinking Pattern Of Malfunction Indicator Light (No Refueling Detected)
 Courtesy of BMW OF NORTH AMERICA, INC.

Diagnosis Frequency and MIL illumination - after refueling detected, leak > 0.02 inches

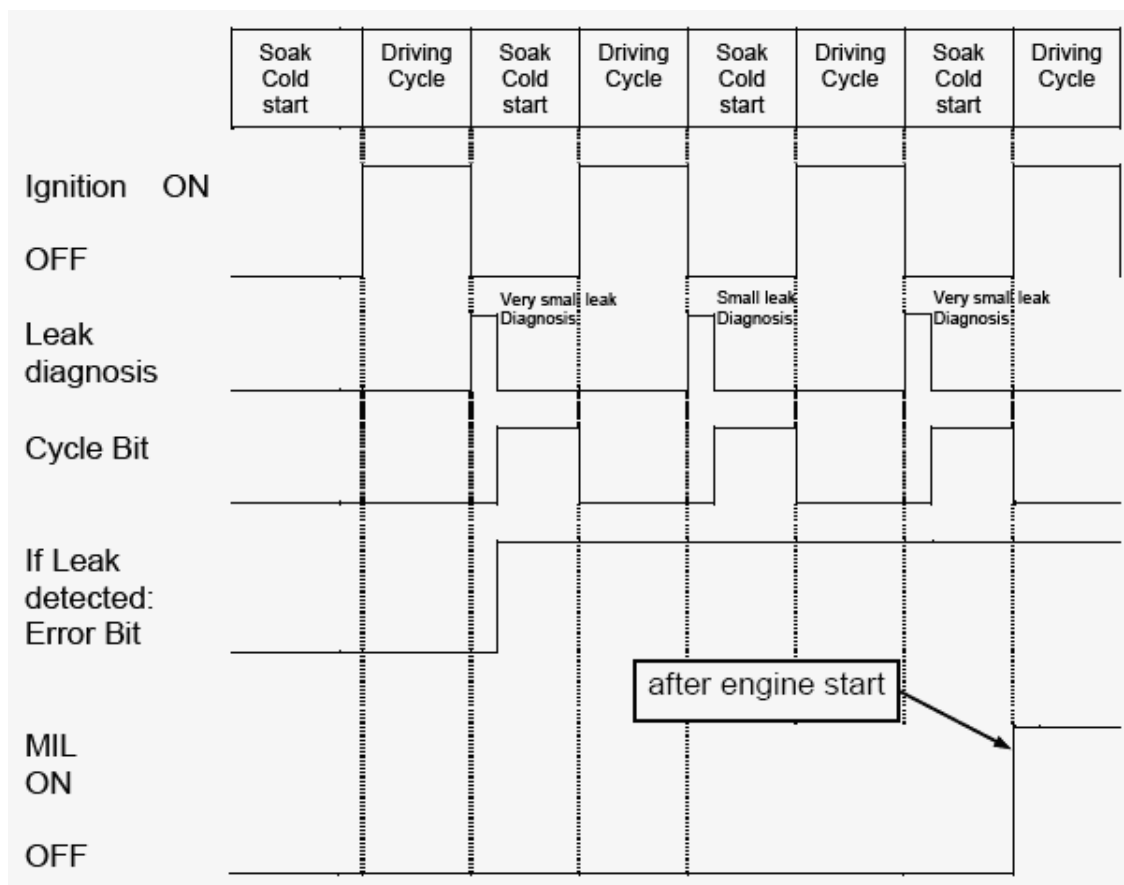


Fig. 7: Blinking Pattern Of Malfunction Indicator Light (After Refueling Detected)
 Courtesy of BMW OF NORTH AMERICA, INC.

1.4.3 EVAP PUMP CURRENT (COMPREHENSIVE COMPONENT, APPENDANT TO EVAP)

1.4.3.1 Monitoring function - Pump Current Diagnosis

P1434, P1447, P1448, P1449

In the reference measurement phase the current of the DM-TL is checked, if the current consumption is smaller than 15 mA a defect pump/motor is detected, and P1448 is stored. If a current consumption of bigger than 40 mA is measured also a defect pump/motor is detected, and the P1449 is stored.

After the reference measurement the electrical solenoid is switched and the venting system is tight. The solenoid is checked by comparison of the reference current and the idle current immediately after the solenoid has switched.

If the difference between the two currents (reference current - idle current) < 2 mA is not reached, the DTC P1447 is stored.

The P1434 fault code is set, if current fluctuations (caused by humidity in the DM-TL) > 1 mA are detected.

1.4.4 EVAP ELECTRICAL CHECKS (COMPREHENSIVE COMPONENT, APPENDANT TO EVAP)

1.4.4.1 EVAP - DMTL Valve Electrical Check

P2418, P2419, P2420

1.4.4.2 EVAP - DMTL Heater Electrical Check

P240A, P240B, P240C

1.4.4.3 EVAP - DMTL Pump Electrical Check

P2400, P2401, P2402

1.4.4.4 EVAP - Purge Control Valve Electrical Check

P0444, P0458, P0459

1.5 SECONDARY AIR SYSTEM MONITORING

No Secondary Air System built in.

1.6 FUEL SYSTEM MONITORING

1.6.1 LAMBDA ADAPTATION

P0171/P0174, P0172/P0175

1.6.1.1 Monitoring function

The fuel system diagnosis uses two different monitors. The first one is the evaluation of the percentage of the long term fuel adaption. The other one is the evaluation of the percentage of the physical limits of the short term fuel trim.

The monitoring of the short term fuel trim is active during all engine states except during deceleration fuel cut-off. The evaluation of the long term fuel trim is active during its learning process and is not active during canister purge phases of the evaporative system. Because of this an additional learning process can be started in case of large deviations of the short term fuel trim and the evaluation can run. After the enable conditions are met different counters are started for both evaluations. If no condition is present the end diagnostic counter will decrement from a calibratable value to zero and a passing decision is made.

If a lean condition is present and total fuel control is above the calibratable threshold two timers are started. If the lean threshold counter exceeds the calibratable threshold before the reset timer has decrement from calibratable threshold to zero a lean error is set.

If a rich condition is present and total fuel control is below the calibratable threshold two timers are started. If the rich threshold counter exceeds the calibratable threshold before the reset timer has decremented from a calibratable threshold to zero a rich error is set.

The time counters are increased while "lambda controller" or "lambda adaptation" exceed minimum or maximum threshold.

The error is detected as soon as one of the time counters reaches its maximum value.

1.6.1.2 Similar conditions function

When the engine management system recognizes a failure in the misfire or fuel systems, the engine management system is required to record the conditions present when the fault occurred. These conditions recorded include engine speed, engine load (MAF), and warm up status of the first event that resulted in the storage of a code. These conditions stored are referred to as **similar conditions** .

If the similar conditions are met without a failure in the misfire or fuel system, the flag will be set to 1. If this flag is set, the driving cycle counter for that failure can be decrement.

The code and stored freeze frame conditions may be erased if similar conditions are not encountered during the next 80 driving cycles which immediately following the initial detection of the malfunction.

The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceeding the thresholds of the fuel system diagnostic.

Variable list:

VARIABLE LIST REFERENCE

T_SUM_MIN	Time counter sum below threshold
T_SUM_MAX	Time counter sum above threshold
LAM.	Short term fuel trim
ADAP.	Long term fuel adaption
CTR_LAM_LIM_AD_REQ	counter sum above or below threshold

1.6.2 TRIM CONTROL PLAUSIBILITY MONITORING

P2096/P2098, P2097/P2099

1.6.2.1 Monitoring function

The trim control plausibility monitoring detects a high deviation of the I-share of lambda trim control. If it exceeds given thresholds the following malfunction is detected:

- o fuel trim above limit

If the above mentioned malfunction is detected, the corresponding fault code is stored.

AIR FUEL MIXTURE SPECIFICATION

	B1S1	B2S1
air fuel mixture too rich	P2097	P2099

1.6.3 DIAGNOSIS OF INJECTOR AGING

P119D/P119E

1.6.3.1 Monitoring function

A small proportion of the short term fuel deviation is used for diagnostic injector aging and is stored as injector adaption value in a separate map. The values of the separate map will be renewed every time the mileage achieves 497 miles.

A fault is stored if the injector adaption exceeds a calibratable minimum or maximum threshold.

1.6.4 HIGH PRESSURE FUEL CONTROL SYSTEM

1.6.4.1 Monitoring function - High Pressure System

High pressure system diagnosis: P302A/P302B, P302C/P302D, Fuel mass plausibility check: P3283/P3285, P3284/P3286

For gasoline direct fuel injection a high pressure fuel control system is necessary for fuel preparation and metering as shown in **Fig. 8**. The low fuel pressure from the fuel pump module within the tank is increased by the high pressure fuel pump and adjusted to a desired set-point fuel pressure.

The high pressure fuel system consists of a common fuel rail for all high pressure Piezo-injection valves, a fuel rail pressure sensor, a high pressure fuel pump with a built-in fuel volume control valve and overpressure-valve.

In dependence of engine load and engine speed, high pressure has to be adjusted to values between 5 and 20 MPa. Therefore the fuel pressure in the rail is measured and controlled with help of the fuel volume control valve. According to the desired fuel-mass and fuel pressure set-point value the pre-control calculates the driver-signal for the fuel volume control valve. This calculated driver-signal is additionally controlled by a closed loop control using the measured fuel pressure and the desired set-point value as input.

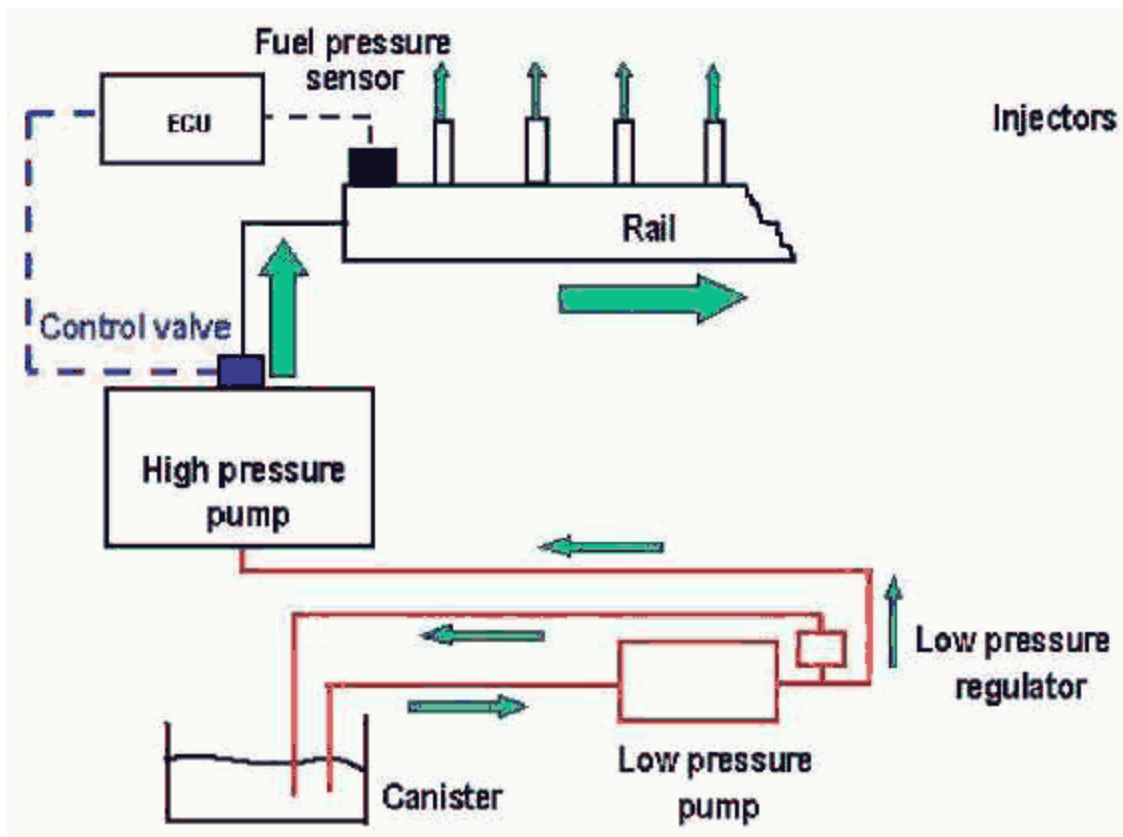


Fig. 8: Overview Of Low And High Pressure System Diagram
 Courtesy of BMW OF NORTH AMERICA, INC.

The high pressure system diagnosis consists of a rationality check and analyses in principle the difference between the measured fuel pressure and the set-point fuel pressure and the output of the pressure controller. If an adjustable limit is reached, additionally the output of the long term fuel trim and the lambda controller is taken into account.

The pressure deviation is defined as the difference of the set-point and the measured value. (Which means a pressure higher than the set-point leads to a negative deviation and vice versa).

A not adjustable fuel rail pressure (to high) is detected if the pressure deviation or the output of the pressure controller is below a calibrated (negative) threshold and one of the output values of the lambda control (which are lambda controller and long term fuel trim) is below a calibrated (negative) threshold. (Which means the air fuel ratio tends to be too rich without correction). If these conditions are fulfilled for a calibrated period of time, a malfunction is detected and a maximum fault high pressure system monitoring is set.

A not adjustable fuel rail pressure (to low) is detected if the pressure deviation or the output of the pressure controller is above a calibrated threshold and one of the output values of the lambda control is above a calibrated threshold. (Which means the air fuel ratio tends to be too lean without correction). If these conditions are fulfilled for a calibrated period of time, a malfunction is detected and a minimum fault high pressure system monitoring is set.

The fuel mass plausibility diagnosis checks the plausibility of the high pressure sensor signal.

A too high pressure sensor signal is detected if the pressure deviation or the output of the pressure controller is below a calibrated (negative) threshold and one of the output values of the lambda control (which are lambda controller and long term fuel trim) is above a calibrated threshold. (Which means the air fuel ratio tends to be too lean without correction). If these conditions are fulfilled for a calibrated period of time, a malfunction is detected and a maximum fault high pressure sensor monitoring is set.

A too low pressure sensor signal is detected if the pressure deviation or the output of the pressure controller is above a calibrated threshold and one of the output values of the lambda control (which are lambda controller and long term fuel trim) is below a (negative) calibrated threshold. (Which means the air fuel ratio tends to be too rich without correction). If these conditions are fulfilled for a calibrated period of time, a malfunction is detected and a minimum fault high pressure sensor monitoring is set.

1.6.4.2 Monitoring function - Pressure Range Check

P303A/P303B, P303C/P303D

Additionally the pressure is monitored regarding the absolute range of the pressure values. If the pressure value is below a calibrated threshold, a minimum fault code is stored (P303C/P303D). If the pressure value is above a calibrated threshold, a maximum fault code is stored (P303A/P303B).

1.6.5 FUEL REGULATORS/VALVES/SENSORS (COMPREHENSIVE COMPONENT, APPENDANT TO FUEL SYSTEM)

1.6.5.1 Monitoring function

The diagnosis of the fuel rail pressure sensor consists of electrical checks (signal range checks):

If the measured voltage from the fuel rail pressure sensor exceeds the upper calibration limit, a short circuit to battery or cable breakage is detected and a maximum fault is set.

If the measured voltage from the fuel rail pressure sensor exceeds the lower calibration limit, a short circuit to ground is detected and a minimum fault is set.

1.6.5.2 Fuel Rail Pressure Sensor Electrical Check

P0192/P3250, P0193/P3251

1.6.5.3 Volume Control Valve Electrical Check

P0003/P1281, P0004/P1282

1.6.5.4 Volume Control Valve Relay Output Electrical Check

P10C3, P10C2, P10C1

1.6.6 INJECTION DEACTIVATION

P140E, P142E, P142F

1.6.6.1 Monitoring function

The injection deactivation is a diagnosis to protect the catalysts from overheating. In fact it is an additional fuel pressure diagnosis with a very short diagnostic time and an early reaction with deactivation of some injectors. Additional there is an evaluation of the fuel tank level. If the tank level is low there will be a change of the DTC to provide better information's for the workshop.

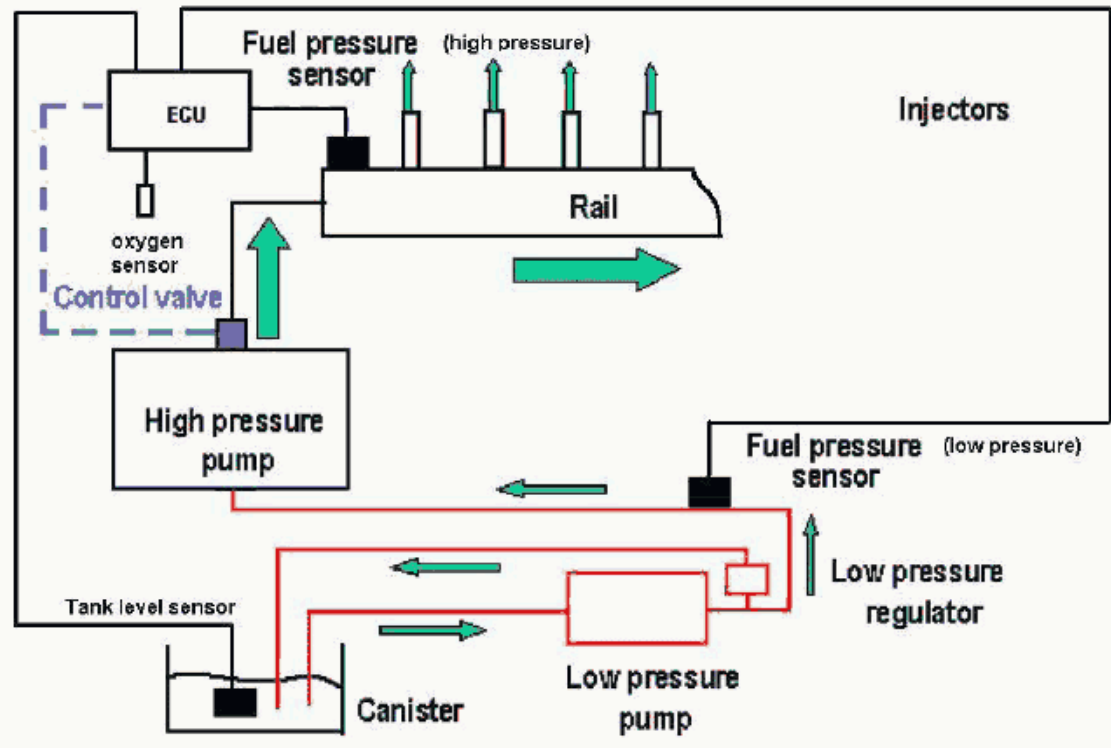


Fig. 9: Overview Of Low And High Pressure System Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

The diagnosis evaluates first an air-fuel deviation. This check analyses the difference between the measured air fuel ratio and the set-point air fuel ratio and analyses the short term fuel trim. Both checks detect only the lean side of mixture. If a lean deviation occurs the diagnosis compares the difference between measured pressure and the set-point of the high pressure and the absolute value of the high pressure sensor with a threshold or checks the absolute value of the low pressure sensor. Then a DTC is set and the reaction is the shut-off of an amount of injectors. This reaction avoids overheating of the catalysts. The decision of which DTC is stored will be affected by the fuel tank level (= 0 litre).

1.6.7 FUEL LEVEL SENSOR (FLS) (COMPREHENSIVE COMPONENT, APPENDANT TO FUEL SYSTEM)

1.6.7.1 Monitoring overview

The diagnosis of the fuel level sensor signal consists of a circuit continuity check and a correlation check.

1.6.7.2 Fuel Level Sensor Electrical Circuit Continuity Check

P0462/P2067, P0463/P2068

1.6.7.2.1 Monitoring function

The signal of the fuel level sensor is monitored concerning the valid range. This range depends on the used fuel level sensor.

If the left or right fuel level sensor signal is above the upper threshold, a short circuit plus is detected. If the left or right fuel level sensor signal is below the lower threshold, an appropriate fault code for the left or right sensor is set.

FUEL LEVEL SENSOR FUNCTION CHART

FLS electrical short-circuit to battery left/right	P0463/P2068
FLS electrical short-circuit to ground left/right	P0462/P2067

1.6.7.2.2 FLS Diagnosis Frequency of FLS Circuit Continuity Check

Short circuit battery

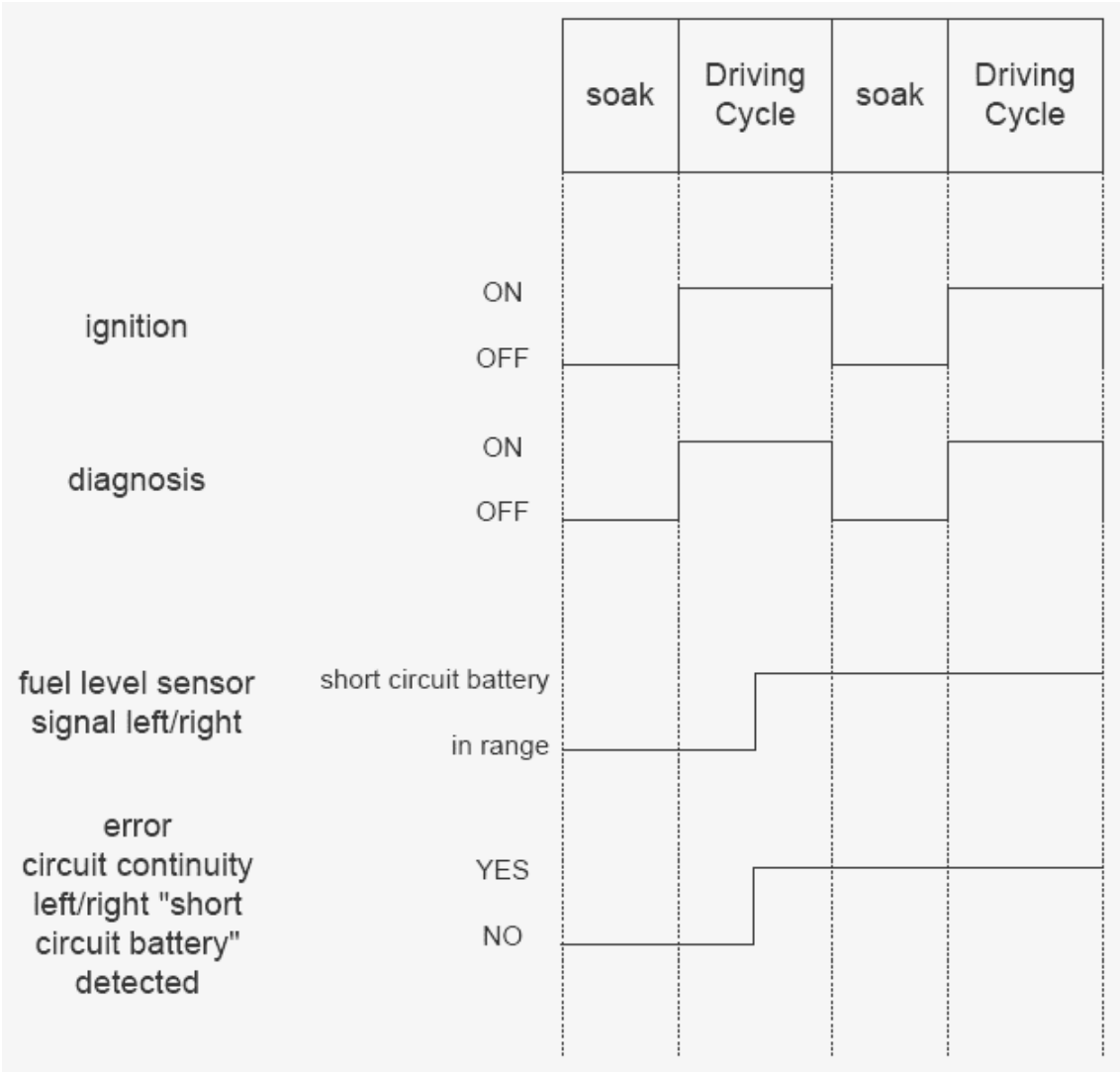


Fig. 10: Blinking Pattern Of Fuel Level Sensor - Short Circuit Battery
Courtesy of BMW OF NORTH AMERICA, INC.

Short circuit ground

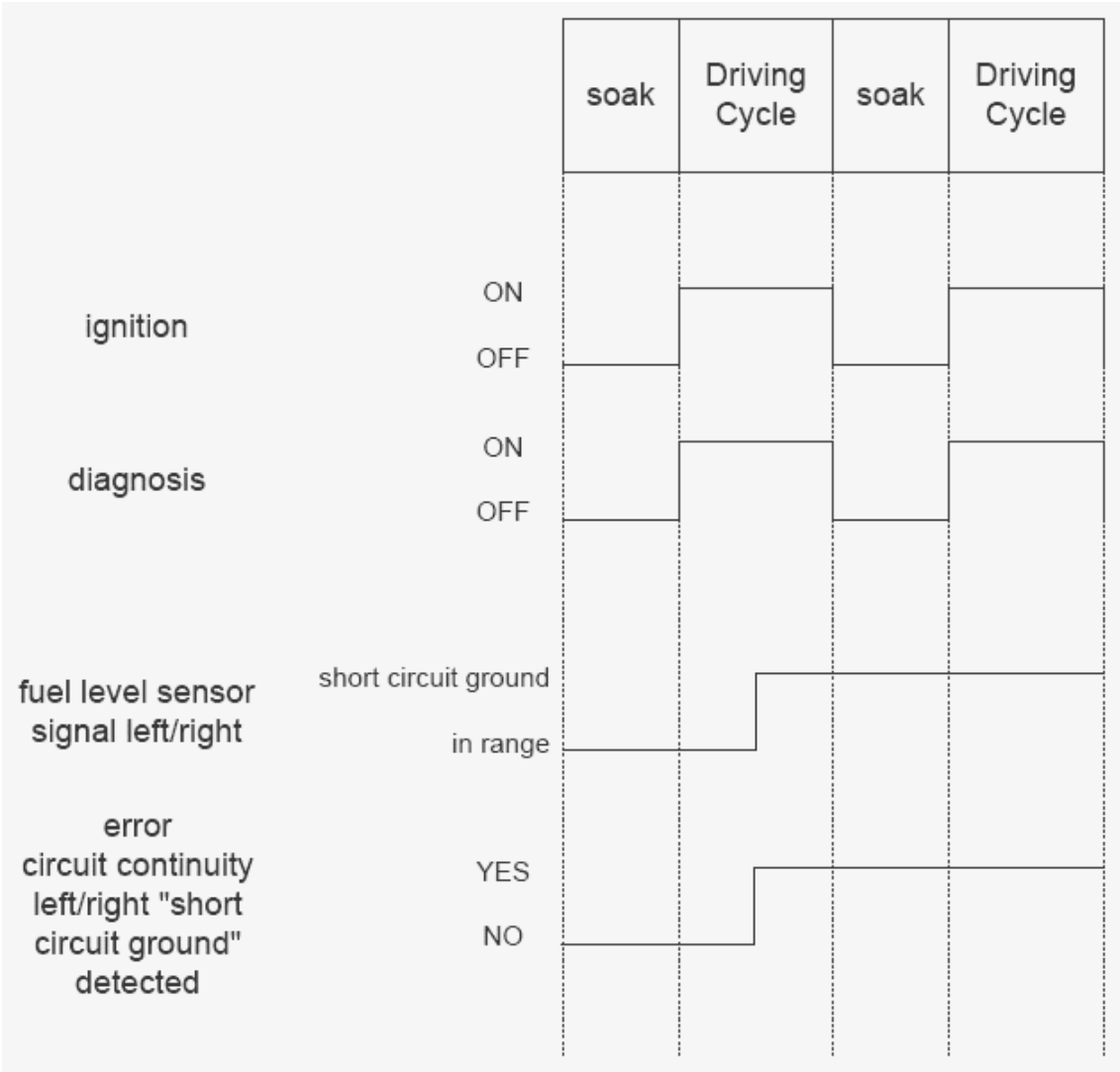


Fig. 11: Blinking Pattern Of Fuel Level Sensor - Short Circuit Ground
Courtesy of BMW OF NORTH AMERICA, INC.

1.6.7.3 Fuel Level Sensor Signal Correlation Check

P144B

1.6.7.3.1 Monitoring function

The engine management system has the capability to calculate (sum up) the fuel consumption. For the fuel level sensor correlation check, this calculated consumption is compared with the decreasing of the fuel level signal. When the calculated value for fuel consumption reaches an appropriate and predetermined value (e.g. five gallons), the calculated fuel consumption is compared to the difference of the fuel level as indicated by the fuel level sensors (between starting calculation and current). In case the difference is greater than the applicable threshold value, a fuel level sensor fault is detected and an appropriate fault code is set.

If a fault is present, the OBD II EVAP leak monitor will run using a substitute value of 85% total fuel tank volume.

The 85% substitute value will assure that in every case the required 0.020 inch leak is detected by the OBD II system.

MONITORING FUNCTION CHART

fuel-signal correlation	P144B
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1.6.7.3.2 FLS Diagnosis Frequency of FLS Correlation Check

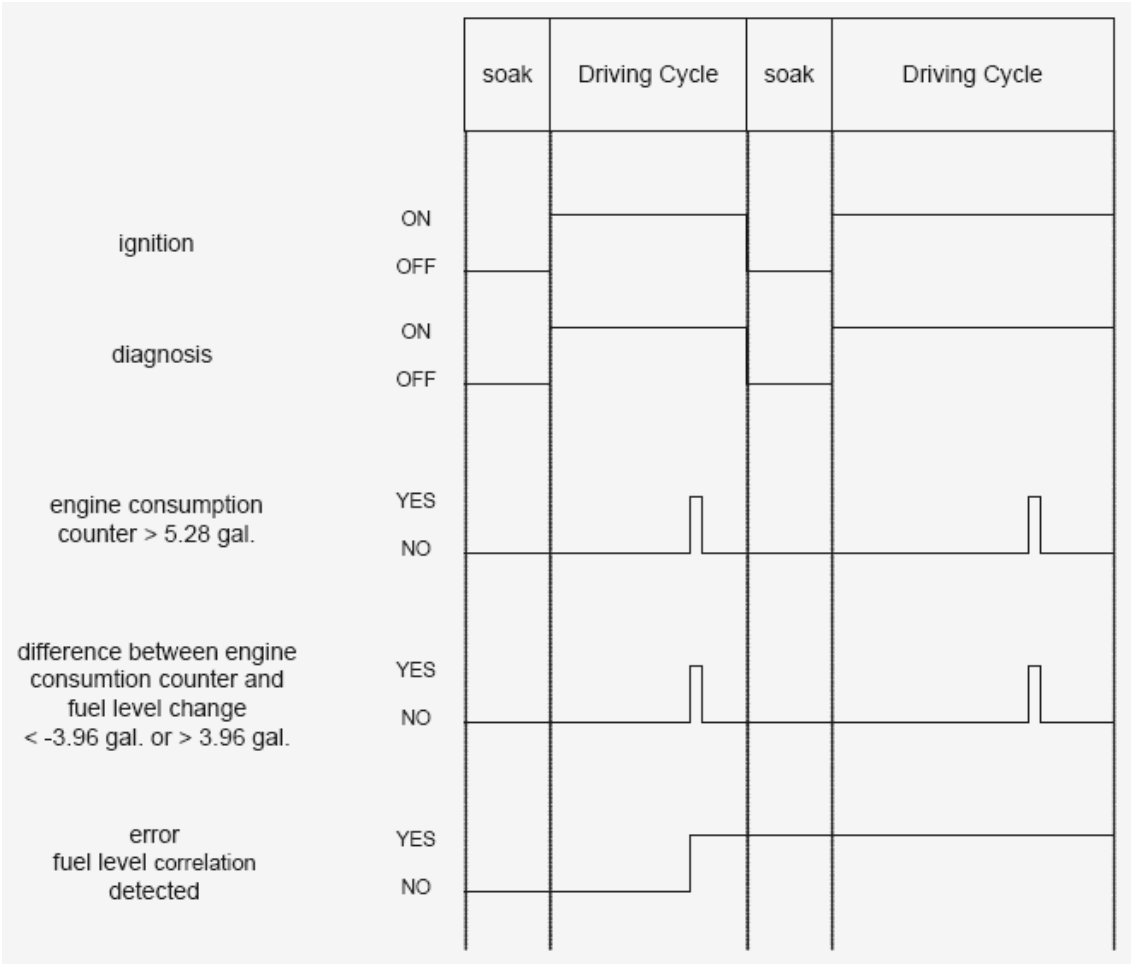


Fig. 12: Blinking Pattern Of Fuel Level Sensor
Courtesy of BMW OF NORTH AMERICA, INC.

1.7 OXYGEN SENSOR MONITORING LINEAR UPSTREAM/BINARY DOWNSTREAM

1.7.1 UPSTREAM OXYGEN SENSOR MONITORING (LINEAR)

1.7.1.1 Upstream Oxygen Sensor - Short Circuit Monitoring

P0131/P0151, P0132/P0152

1.7.1.1.1 Monitoring function

The oxygen sensor circuit monitoring detects the following malfunctions by evaluating the error information received from oxygen sensor microcontroller:

- short circuit of sensor signal to battery voltage
- short circuit of sensor signal to ECU ground

If one of the above mentioned malfunctions is detected, the corresponding fault code is stored.

BATTERY VOLTAGE SPECIFICATION

	B1S1	B2S1
short circuit to ground	P0131	P0151
short circuit to battery voltage	P0132	P0152

1.7.1.2 Upstream Oxygen Sensor - Open Circuit Monitoring

P112C/P112D, P2626/P2629, P2243/P2247

1.7.1.2.1 Monitoring function

The oxygen sensor circuit monitoring detects the following malfunctions by evaluating the error information received from oxygen sensor monitoring functions:

VOLTAGE REFERENCE CHART

	B1S1	B2S1
reference voltage failure - (UN)	P2243	P2247
virtual ground failure - (VM) and pumping current failure - (IP)	P112C	P112D
trim current failure - (IA)	P2626	P2629

If one of the above mentioned malfunctions is detected, the corresponding fault code is stored.

1.7.1.2.2 Monitoring description

This function determines, if an open circuit in any of the four electric lines (Reference Voltage, Virtual Ground, Pumping Current and Trim Current) is present in the **w**ide **r**ange **a**ir **f**uel (WRAF) sensor.

This function shall be triggered only if one of the following diagnosis is active (to set the readiness bit), which are 'UPSTREAM OXYGEN SENSOR - SIGNAL MONITORING DURING FUEL CUT-OFF' and 'UPSTREAM OXYGEN SENSOR - HEATER MONITORING'. The function shall go to the state = "active" only if one of the above diagnosis detected a fault.

1.7.1.3 Upstream Oxygen Sensor - Signal Controller Monitoring

P3022/P3023, P3024/P3025

1.7.1.3.1 Monitoring function

This function will detect an error during the initialization and/or operation of a WRAF sensor controller through SPI communication. Information communicated from the Basic Software (BSW) is used for initialization and communication between application software (ASW) and the controller. This is used to determine if the function is working properly.

After an ECU reset, the WRAF sensor controller is started and the diagnosis determines the time until the initialization, has been performed in the allowed time. If not successful, then a DTC will be stored. If this is successful, then the difference is checked between the present error counter and the stored value of this error counter at ECU reset, (switching from Key "OFF" to Key "ON") or at clearing error memory and after each function call, in case a difference between both counters was found.

If there is a difference, another counter is incremented. If this counter is higher than a threshold, a SPI communication error is stored.

COMMUNICATION ERROR CHART

	B1S1	B2S1
Communication error	P3022	P3023
Initialization error	P3024	P3025

All of the above checks are performed internal to the ECU.

1.7.1.4 Upstream Oxygen Sensor - Signal Activity Check

P2414/P2415

1.7.1.4.1 Monitoring function

The oxygen sensor signal activity check monitors if the sensor is attached to the exhaust pipe and whether the exhaust is sampled correctly (no leakage). A malfunction is detected if the oxygen sensor voltage is above a threshold (shows too lean mixture in part load or full load)

If the above mentioned malfunction is detected, the corresponding fault code is stored.

MONITORING FUNCTION CHART

B1S1	B2S1
P2414	P2415

1.7.1.5 Upstream Oxygen Sensor - Swapped Sensors Check

P0040

1.7.1.5.1 Monitoring description

This function will detect if the Oxygen Sensor wire harness has been cross connected, i.e., Bank 1 with Bank 2. This is performed by the use of the output of the fuel correction (lambda controller) of each bank. If this control

is on opposite limit at bank 1 and bank 2, the sensors are swapped and the corresponding fault code is stored.

Corresponding fault code:

P0040

1.7.1.6 Upstream Oxygen Sensor - Active Signal Check (Shift to lean/rich)

P2195/P2197, P2196/P2198

1.7.1.6.1 Monitoring description

This function shall deliver information indicating that the sensor characteristic line has a shift to lean (Characteristic Shift Down) or to rich, which shall be done by summarizing all similar failure symptoms of this kind.

In dependence of the shift strength there are three different paths followed by this diagnosis:

1. **Strong shift to lean/rich:** If the lambda sensor upstream shows a rich signal while downstream lambda sensor signal is lean (or vice versa) and additionally the lambda controller goes to its limit, this error is recognized by the upstream sensor plausibility check.
2. **Middle strong shift to lean/rich:** If the trim controller goes to its limit but the lambda controller does not, the downstream oxygen sensor **signal activity check** (P114A, P114B, P114C, P114D) recognizes that the system has a problem and a failure code is stored. Referring to this failure entry, the **DOWNSTREAM ACTIVE TEST** is triggered. It detects that the problem is in the upstream oxygen sensor, which is showing a characteristic line shift to lean or to rich. The appropriate DTC will be stored along with the downstream sensor signal activity check DTC.
3. **Mild shift to lean/rich:** The trim controller I-share goes to its limit but the lambda controller does not. The trim control plausibility monitoring (P2096, P2097, P2098, P2099) recognizes that the system has a problem and a failure code is stored. Referring to this failure entry, the **DOWNSTREAM ACTIVE TEST** is triggered. It detects that the problem is in the upstream oxygen sensor, which is showing a characteristic line shift to lean or to rich. The appropriate DTC will be stored along with the fuel correction DTC.

1.7.1.7 Upstream Oxygen Sensor - Signal Dynamic Monitoring (Slow Response)

P0133/P0153

1.7.1.7.1 Monitoring function

The oxygen sensor signal dynamic monitoring detects greater deviations of the dynamic behavior of the sensor signal compared to the nominal behavior, controlled by the lambda controller.

The change of the dynamic behavior is caused by problems of the electrical connection (e.g. open circuit), extreme aging of the sensor or a low sensor temperature which slows down the sensor compared to the nominal behavior.

The monitoring is based on an amplitude criterion, i.e. the relation between the amplification of the oxygen

sensor and the model is monitored and detects the following malfunction:

- sensor signal too slow

If the above mentioned malfunction is detected, the corresponding fault code is stored.

MONITORING FUNCTION CHART

B1S1	B2S1
P0133	P0153

1.7.1.8 Upstream Oxygen Sensor - Signal Monitoring During DFCO

P2297, P2298

1.7.1.8.1 Monitoring function

The oxygen sensor signal monitoring during deceleration detects if the oxygen sensor signal is not plausible during fuel cut-off. A malfunction is detected if the oxygen sensor voltage is outside the "normal operating voltage range during DFCO (deceleration fuel cut off)" (see **Fig. 13** below).

If the oxygen sensor signal voltage is within the range "operating voltage during DFCO not plausible" (see **Fig. 13** below) the signal is not plausible. If the above mentioned malfunction is detected, the corresponding fault code is stored.

MONITORING FUNCTION CHART

B1S1	B2S1
P2297	P2298

If the oxygen sensor signal voltage is above a threshold during fuel cut-off or below a threshold then the open circuit diagnostic function is triggered (see chapter '**UPSTREAM OXYGEN SENSOR - OPEN CIRCUIT MONITORING**'). The fault processing continues in this function.

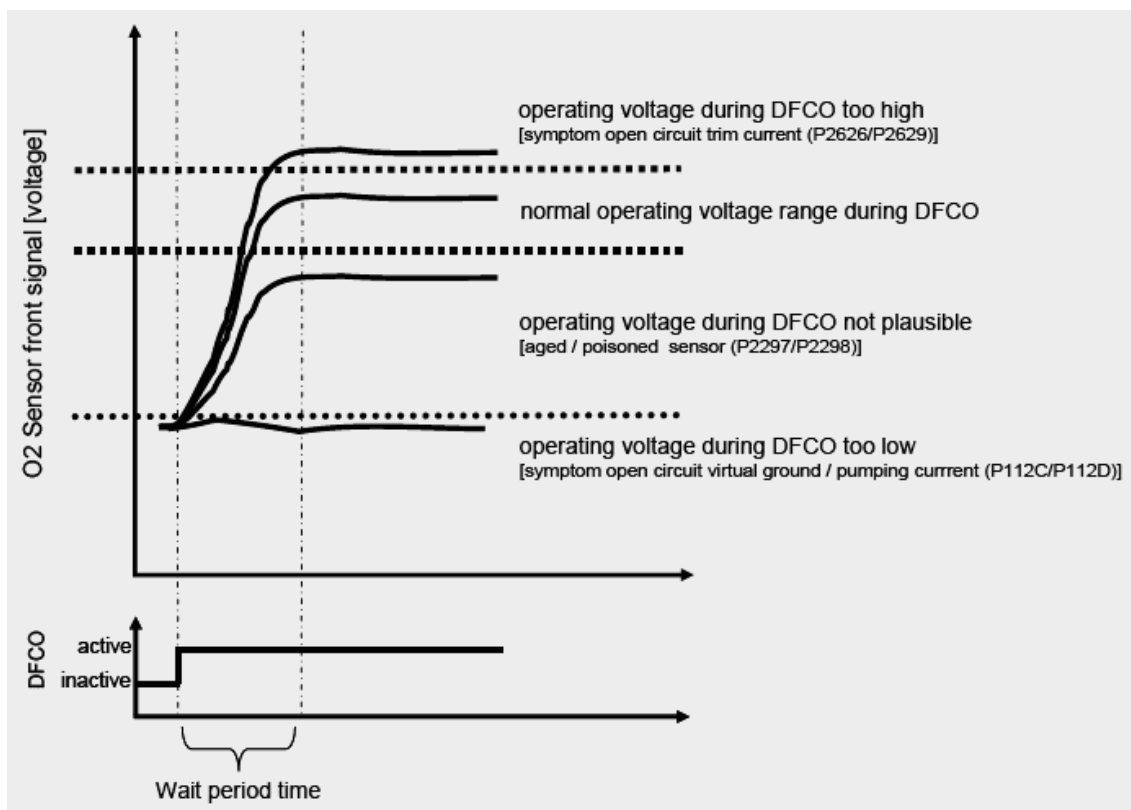


Fig. 13: O2 Sensor Front Signal Voltage And Time Graph
 Courtesy of BMW OF NORTH AMERICA, INC.

1.7.1.9 Upstream Oxygen Sensor - Heater Monitoring

P3026/P3027, P0135/P0155, P165F/P166F

1.7.1.9.1 Diagnostic overview

The purpose of this function is to detect oxygen sensor heater failures that would lead to an increase in emissions beyond the thresholds stated in the appropriate regulations.

The diagnosis shall be carried out by determining whether the measured oxygen sensor ceramic temperature falls below set limits over a number of measurement cycles. The evaluations of the diagnosis cycle are determined after the completion of a limited number of monitoring cycles.

Deviations in the oxygen sensor ceramic temperature or the oxygen sensor not being operatively ready in a timely manner (because of a too low temperature) can lead to an increase in emissions above the applicable standards or prevent the sensor signal from being used as a diagnostic system monitoring device. Deviations may occur due to, for example, ageing of the heater element, defective wiring, increased heater circuit connector contact resistance, defective heater driver etc.

1.7.1.9.2 Monitoring function

The diagnosis strategy is based on a statistical evaluation of the oxygen sensor ceramic temperature over a pre-

defined number of monitoring cycles.

The oxygen sensor ceramic temperature shall be obtained indirectly via the measured internal resistance of the sensor.

If the sensor is not ready after a defined time (e.g. 30 sec after start)* the sensor is set to forced readiness mode and the Upstream Oxygen Sensor Heater Monitoring is started.

Three cases can appear:

- sensor temperature is invalid (no measurement of sensor temperature possible because of an ECU internal (electrical) failure)

--> P165F/P166F is stored
- sensor temperature is below a threshold

--> normal failure detection time
- sensor temperature is below a threshold for sensor activation

--> immediate failure storing

A low sensor temperature can be caused by a weak heater or a open circuit in the temperature measurement line (line UN). After a low sensor temperature has been detected, the general temperature failure is stored (P3026/P3027). Then the open circuit diagnosis is triggered to check, if an open circuit in line UN is present. If there is an open circuit, then open circuit fault code (P2243/P2247) is stored (see chapter '**OXYGEN SENSOR MONITORING - OPEN CIRCUIT**' and picture below). If there is no open circuit present, then the heater fault code is stored (P0135/P0155).

)* For exact values please have a look at the summary table!

SENSOR TEMPERATURE SPECIFICATION

	B1S1	B2S1
sensor temperature too low	P3026	P3027
heater power too low	P0135	P0155
sensor temperature invalid	P165F	P166F

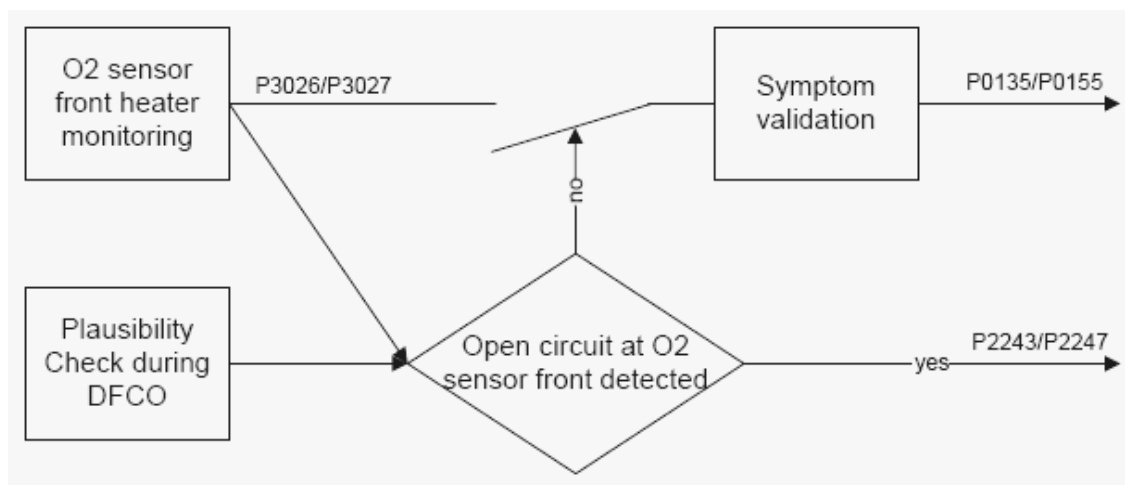


Fig. 14: O2 Sensor Front Heater Monitoring Function Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

1.7.1.10 Upstream Oxygen Sensor - Heater Circuit Monitoring

P0030/P0050, P0031/P0051, P0032/P0052

1.7.1.10.1 Monitoring function

The oxygen sensor heater circuit monitoring detects the following malfunctions by evaluating the error information received from the power stage:

- Heater O2 sensor front short circuit to battery voltage
- Heater O2 sensor front short circuit to ground
- Heater O2 sensor front open circuit

If one of the above mentioned malfunctions is detected, the corresponding fault code is stored.

MONITORING FUNCTION CHART

	B1S1	B2S1
short circuit to ground	P0031	P0051
short circuit to battery voltage	P0032	P0052
open circuit	P0030	P0050

1.7.2 DOWNSTREAM OXYGEN SENSOR MONITORING (BINARY)

1.7.2.1 Downstream Oxygen Sensor - Circuit Monitoring

P0137/P157, P0138/P158, P0140/P0160

1.7.2.1.1 Monitoring function

The oxygen sensor electrical monitor detects the following malfunctions:

- O2 Sensor rear signal short circuit to battery voltage
- O2 Sensor rear signal short circuit to ground
- O2 Sensor rear signal open circuit

If one of the above mentioned malfunctions is detected, the corresponding fault code is stored.

MONITORING FUNCTION CHART

	B1S2	B2S2
short circuit to ground	P0137	P0157
short circuit to battery voltage	P0138	P0158
open circuit	P0140	P0160

1.7.2.2 Downstream Oxygen Sensor - Signal Dynamic Check During DFCO

P013E/P014A

1.7.2.2.1 Monitoring function

Sensor signal dynamic monitoring is performed at fuel cut-off during coasting conditions. To enable the diagnosis the voltage of the O2 sensor rear has to be above a threshold before entering DFCO (deceleration fuel cut-off).

After entering DFCO the signal falls from fuel trim correction set-point (e.g. 0.68 V) to a voltage near 0 mV. A malfunction is detected, if the sensor signal is not below a threshold after a short time on DFCO. This short time is needed to guarantee a completely purged exhaust pipe.

If this malfunction is detected, the corresponding fault code is stored.

MONITORING FUNCTION CHART

	B1S2	B2S2
failure during fuel cut-off	P013E	P014A

1.7.2.3 Downstream Oxygen Sensor - Dynamic/Transition Time in Sensor Midpoint Range Monitoring

P013A/P013C

1.7.2.3.1 Monitoring function

This function monitors the transition time in sensor midpoint range of the downstream sensor voltage. When a fuel cut-off phase starts, the following steps will be executed:

- sensor voltage must be above a threshold (signal must be rich enough, to measure the transition time)

Remark: Usually the signal starts at fuel trim control set-point (e.g. 0.68 V)

- sensor voltage value is stored (= "start-value")

- transition time measurement is started, when the signal is at 70% of start value

Remark: The measurement start and stop-value are relative to the start value, to measure always the transition time around the sensor midpoint range

- transition time measurement is finished, when the signal is at 38% of start value
- measured transition time is corrected over mass air flow

The transition time is represented by a cycle counter. This transition time is measured over a defined number of fuel cut-off phases. The minimum value after the defined number of fuel cut-off phases is compared with a failure threshold.

If this value is above a threshold, a malfunction is detected and the corresponding fault code is stored.

TRANSITION TIME REFERENCE

	B1S2	B2S2
transition time in the midpoint range too high	P013A	P013C

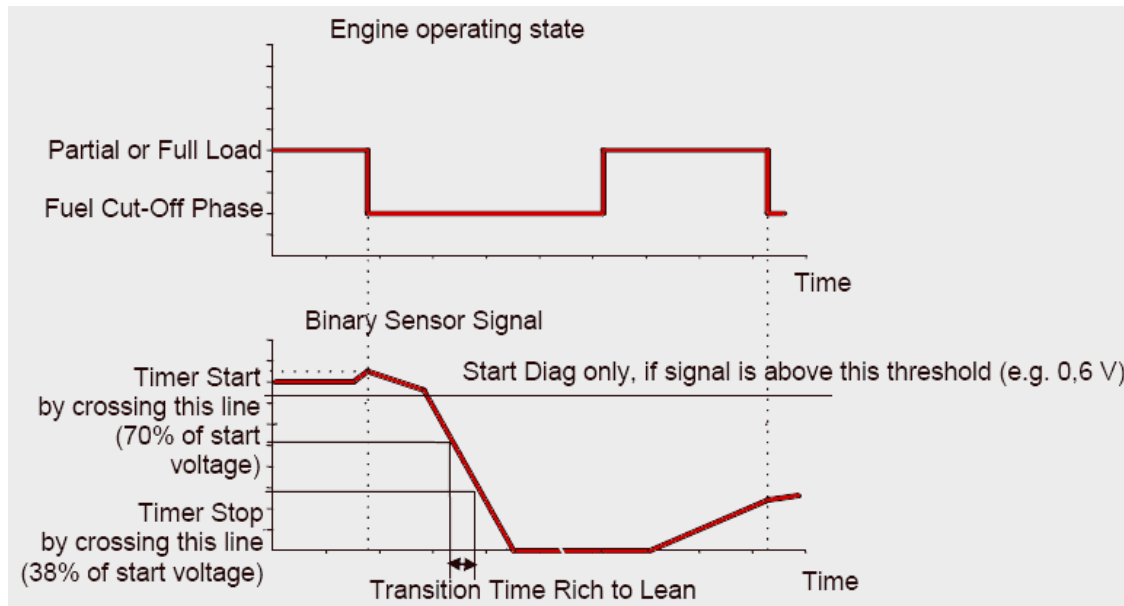


Fig. 15: Transition Time And Voltage Graph
Courtesy of BMW OF NORTH AMERICA, INC.

1.7.2.4 Downstream Oxygen Sensor - Signal Activity Check

P114A/P114C, P114B/P114D

1.7.2.4.1 Monitoring function

The diagnosis monitors the downstream sensor voltage during active fuel trim controller p-share. If the fuel trim control is active, the downstream sensor voltage has to be in range between a maximum and minimum

threshold. If all monitoring conditions are fulfilled a mass air flow integral is incremented (MAF_1, see picture below). After reaching its threshold the integral is reset and incremented again as long as the conditions are fulfilled.

If the voltage is outside the mentioned band of maximum and minimum threshold)*, a second mass air flow integral is incremented simultaneously (MAF_2, see picture below). If this integral is over a threshold before the first integral reaches its limit, a malfunction is detected.

This fault will be stored too, if the downstream sensor voltage does not switch to rich before the integral reaches a threshold after a fuel cut-off phase

If one of the above mentioned malfunctions is detected, the corresponding fault code is stored. Referring to this failure entry the "**DOWNSTREAM ACTIVE TEST**" is triggered to decide the root cause of the downstream sensor behavior (see chapter "**DOWNSTREAM OXYGEN SENSOR - SIGNAL CHECK**").

DOWNSTREAM SENSOR VOLTAGE CHART

	B1S2	B2S2
downstream sensor voltage too low	P114B	P114D
downstream sensor voltage too high	P114A	P114C

)* For exact values of thresholds etc. please have a look at the summary table!

1.7.2.5 Downstream Oxygen Sensor - Signal Check (Stuck lean/rich, Swap)

P2270/P2272, P2271/P2273, P0041

1.7.2.5.1 Monitoring function

Downstream Active Test:

This monitor is an enhancement of the Downstream Oxygen Sensor - Signal activity check and the Trim Control Plausibility Monitoring. Its purpose is to determine, why the rear sensor signal is not plausible.

The monitor will only be enabled, if a fuel correction fault was detected and a malfunction code is stored (P2096 - P2097 - P2098 - P2099)

OR

if the rear sensor signal activity check has detected, that the rear sensor signal is very rich or very lean and the corresponding malfunction fault code is stored (P114A - P114B - P114C - P114C)

If one of the listed fault codes is stored, this diagnosis will be enabled to determine if the root cause of the malfunction is due to a stuck signal or characteristic line shift of the upstream O2 sensor or due to a stuck signal or a system malfunction (i.e. vacuum leak, injector, etc.) of the downstream O2 sensor.

If it has been determined that the upstream O2 signal was the root cause of the fuel correction fault, the appropriate DTC will be stored along with the fuel correction or with the downstream sensor signal activity DTC (see chapter **UPSTREAM OXYGEN SENSOR - ACTIVE SIGNAL CHECK (SHIFT TO LEAN/RICH)**).

If it has been determined that the downstream sensor signal was the root cause of the fuel correction fault, the appropriate DTC (see table below) will be stored along with the fuel correction or with the downstream sensor signal activity DTC.

This function will also detect, if the oxygen sensor wire harness has been cross connected, i.e., Bank 1 with Bank 2. When this failure is present, the downstream sensor voltages of bank 1 and 2 are on opposite limits.

If one of the above mentioned malfunctions is detected, the corresponding fault code is stored.

DOWNSTREAM SENSOR STUCK RICH CHART

	B1S2	B2S2
downstream sensor stuck rich	P2271	P2273
downstream sensor stuck lean	P2270	P2272
downstream sensors interchanged		P0041

1.7.2.6 Downstream Oxygen Sensor - Heater Plausibility Monitoring

P0141/P0161

1.7.2.6.1 Monitoring function

For proper function of the oxygen sensor, the sensor element must be heated.

A non functioning heater delays the sensor readiness for closed loop control and thus influences emissions.

The monitoring strategy is based on the comparison of the O2 sensor resistance to a threshold in conditions where the exhaust temperature is low enough to cause an increase of internal resistance in cases where the heating power is insufficient.

The cooling energy of the exhaust gas is calculated and compared to a calibrated threshold, and the diagnosis is activated if the cumulated cooling energy is equal or exceeds the threshold.

Then the O2 sensor resistance is compared to a threshold, and if the resistance higher than the threshold, an O2 sensor heater malfunction is detected and the corresponding fault code is stored.

Corresponding fault code:

FAULT CODE REFERENCE

O2 sensor heater rear bank 1 too weak	P0141
---------------------------------------	-------

1.7.2.7 Downstream Oxygen Sensor - Heater Circuit Monitoring

P0036/P0056, P0037/P0057, P0038/P0058

1.7.2.7.1 Monitoring function

The purpose of this monitor is to detect errors within the O2 Sensor Heater Circuit. The signal for the O2 sensor heater is pulse-width modulated. The signal of the power stage is monitored internally by the integrated circuit (IC). This IC can distinguish between three symptoms:

- Heater O2 sensor rear short circuit to battery voltage
- Heater O2 sensor rear short circuit to ground
- Heater O2 sensor rear open circuit

If one of the above mentioned symptoms is present, a malfunction is detected and the corresponding fault code is stored.

BATTERY VOLTAGE SPECIFICATION

	B1S2	B2S2
short circuit to ground	P0037	P0057
short circuit to battery voltage	P0038	P0058
open circuit	P0036	P0056

1.7.3 CLOSED LOOP LAMBDA CONTROL - ENABLE CONDITIONS

Closed loop lambda control is enabled (with a delay) at the start of a driving cycle and can be temporary or permanently deactivated during the driving cycle. The turn-on delay at the start of a driving cycle is described by the following enable conditions:

- the upstream oxygen sensor operability is detected i.e. the upstream HO2'S operating temperature has been reached
- a calibrated delay time, after end of engine start, has elapsed

Only for linear Lambda Sensor - Disable conditions

- the A/F ratio set-point value lies below oxygen sensor's measurable limit

Closed loop lambda operation is further deactivated during a driving cycle when any of the following conditions are fulfilled:

- during fuel cut-off or cylinder shut-off and immediately afterwards till a calibrated integrated mass air flow threshold is exceeded
- the mass air flow is below a calibrated threshold that leads to the minimum possible injection time

1.8 EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

An Exhaust Gas Recirculation (EGR) System is not built in.

1.9 POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

The PCV-architecture of the turbo charged new 8-cylinder engine N63 is designed as a two way ventilation system. This two way ventilation system is designed in two separate connections between crankcase and intake manifold (please see **Fig. 16**).

Connection (1) is used at part load and ends after the turbo charger in the intake manifold. The PCV-valve used in this path is fastened directly to the crankcase. A disconnection or leakage in this part of the PCV-System is indicated by a rough or stalling engine and will result in reaction within fuel system (fuel trim deviation) or misfire system. In both cases a fault code will be stored.

Part load:

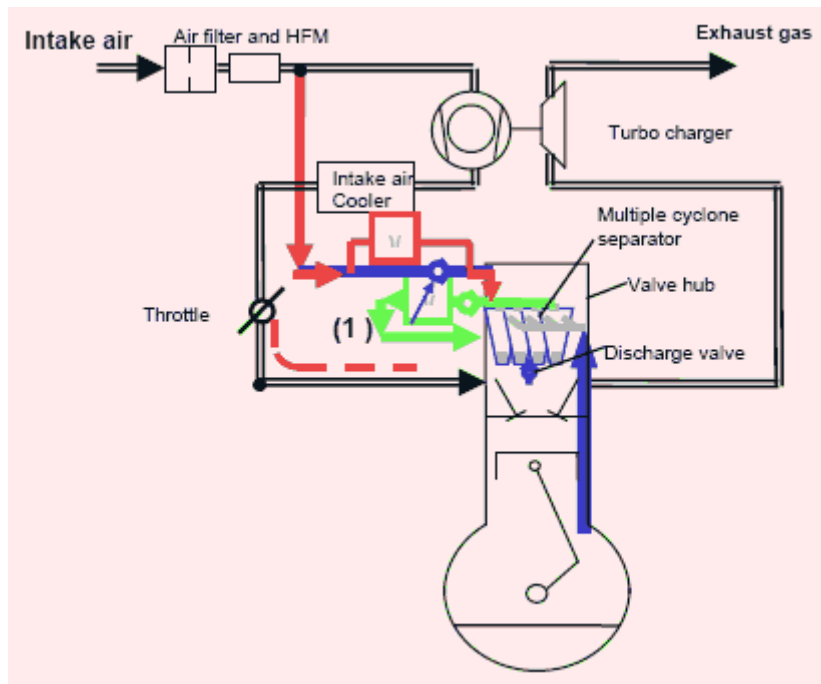


Fig. 16: Positive Crankcase Ventilation System Diagram (Part Load)
Courtesy of BMW OF NORTH AMERICA, INC.

Connection (2) is used at high load and ends before the turbo charger in the intake manifold. A disconnection of the end of the line, which is fixed to the crank case, including a separate check valve, isn't possible without demolition of the concerned parts. The connection fixed to the air duct can be removed.

A disconnection of this end of line is indicated by a rough or stalling engine and will result in reaction within fuel system (fuel trim deviation), air mass flow plausibility or misfire system. In all cases a fault code will be stored

Full load:

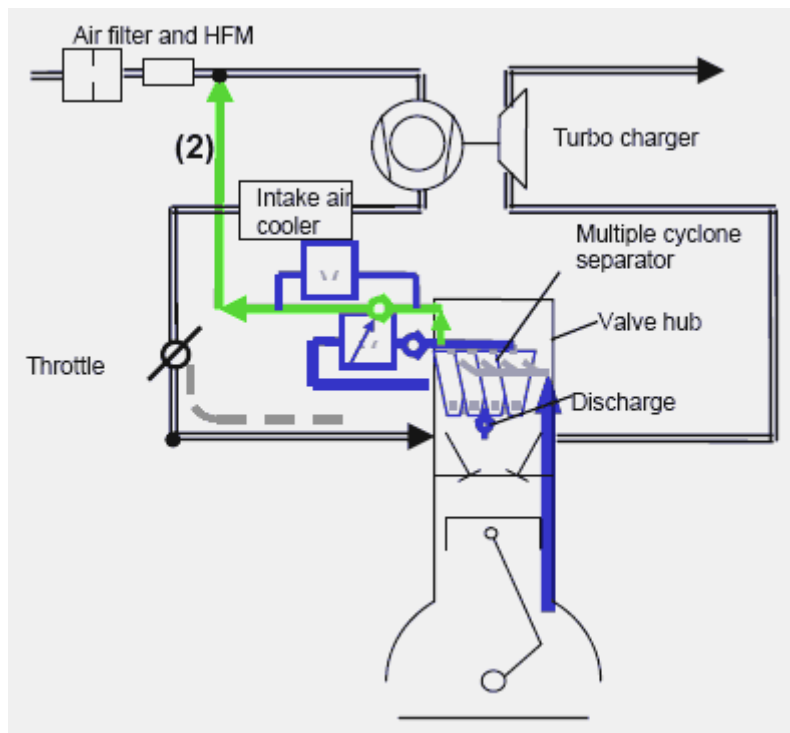


Fig. 17: Positive Crankcase Ventilation System Diagram (Full Load)
Courtesy of BMW OF NORTH AMERICA, INC.

1.10 ENGINE COOLING SYSTEM MONITORING

1.10.1 THERMOSTAT MONITORING

P0128

1.10.1.1 Monitoring function

The coolant thermostat monitoring is done to detect a slow warm-up due to heat losses through thermostat and radiator. It is based on the comparison of the measured ECT sensor signal and the calculated ECT model (TCO_SUB).

The ECT model calculation is depending on engine load and ambient air temperature.

A malfunctioning coolant thermostat is detected, if the calculated ECT model has exceeded the threshold 1 (P0128) and the measured ECT sensor signal remains below threshold 2 (P0128).

Before a malfunctioning coolant thermostat is entered into failure memory, the conditions concerning low load, coasting duration and low vehicle speed, intake air temperature during the monitoring are checked. If the monitoring conditions are met, the coolant thermostat is entered into failure memory. Otherwise the coolant thermostat monitoring is inhibited for this driving cycle.

Example of Monitoring Method:

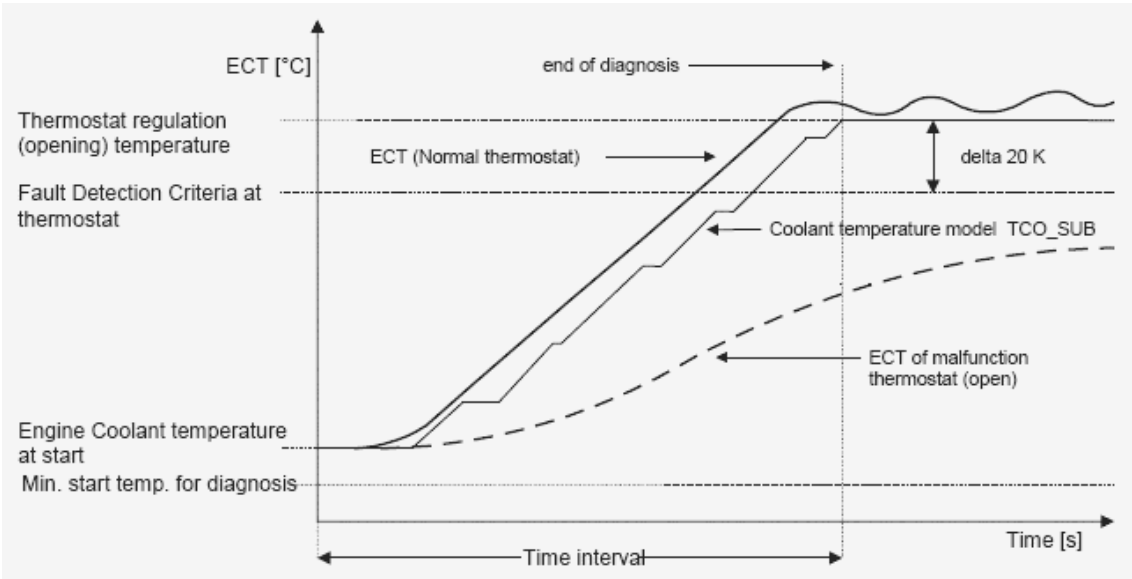


Fig. 18: Thermostat Temperature And Voltage Graph
Courtesy of BMW OF NORTH AMERICA, INC.

A comparison between the measured engine coolant temperature (ECT) and the fault detection criteria temperature is done after a specific time interval. The interval itself is based on the engine coolant temperature model.

As soon as the model temperature exceeds 94°C and all other monitoring conditions are fulfilled at the same time, a valid diagnosis occurs.

At that time, if the measured engine coolant temperature is higher than Fault detection criteria (thermostat regulation temperature -20 Kelvin), the thermostat is concluded as normal thermostat.

On the contrary, if the measured coolant temperature is lower than Fault detection criteria (thermostat regulation temperature -20 Kelvin), the thermostat is concluded as opened stuck thermostat.

The thermostat regulation (opening) temperature is determined by the hardware. It is normally 105°C ±4 Kelvin. The fault detection criteria for the thermostat is therefore 81°C.

THERMOSTAT REGULATION TEMPERATURE CHART

thermostat regulation temperature	105°C ±4 K
fault detection criteria at thermostat (thermo. reg. temp. -20 K)	81°C

1.10.1.2 Thermostat Electrical Check (Comprehensive component attendant to thermostat)

P0597, P0598, P0599

1.10.2 ENGINE COOLANT TEMPERATURE (ECT) MONITORING

1.10.2.1 Engine Coolant Temperature Electrical Check

P0117, P0118

1.10.2.1.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults of the sensor signal. The input signal is analog from a NTC and has to be in a calibratable range. Short circuit to ground can be detected immediately. Short circuit to voltage battery or open circuit is detected, if conditions of intake air temperature and time after start are fulfilled. If an error symptom is detected, the error counter is de-bounced.

Error Symptoms:

- Short circuit to voltage battery or open circuit
- Short circuit to ground

1.10.2.2 Engine Coolant Temperature Gradient Diagnosis

P3198

1.10.2.2.1 Monitoring function

The purpose of this diagnosis is to detect an implausible gradient on the engine coolant temperature signal. The diagnostic function checks whether the difference between one measured engine coolant temperature value and the succeeding value is too high.

Error Symptom:

- Engine coolant temperature signal gradient error

1.10.2.3 Engine Coolant Temperature Stuck Diagnosis

P3199

1.10.2.3.1 Monitoring function

The purpose of this diagnosis is to detect a stuck coolant temperature signal. The diagnostic function checks if after a variation of the calculated coolant temperature also a variation of the measured coolant temperature is detected. The range of required variation depends on engine coolant temperature at engine start.

For RBM handling the Cold Start Denominator will be considered.

Error Symptom:

- Engine coolant temperature signal stuck error

1.10.2.4 Engine Coolant Temperature Stuck in Range Diagnosis

P316A

1.10.2.4.1 Monitoring function

The purpose of this diagnosis is to detect a engine coolant temperature signal that is stuck in high range. The diagnostic function checks if after a certain time the engine has been stopped, the engine coolant temperature has reached a plausible (low) value, i.e. the engine has cooled down.

If the measured engine coolant temperature at engine start is above a calibratable threshold and the diagnosis conditions are fulfilled, the error is set. The threshold depends on intake air temperature at start and the time engine was stopped.

For RBM handling the Cold Start Denominator will be considered.

Error Symptom:

- Engine coolant temperature signal stuck in range error

1.10.3 RADIATOR OUTLET TEMPERATURE (ROT) MONITORING

1.10.3.1 Radiator Outlet Temperature Electrical Check

P00B4, P00B3

1.10.3.1.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults of the sensor signal. The input signal is analog from a NTC and has to be in a calibratable range. Short circuit to ground can be detected immediately. Short circuit to voltage battery or open load is detected, if conditions of intake air temperature and time after start are fulfilled. If an error symptom is detected, the error counter is de-bounced.

Error Symptoms:

- Short circuit to voltage battery or open circuit
- Short circuit to ground

1.10.3.2 Radiator Outlet Temperature Gradient Diagnosis

P3197

1.10.3.2.1 Monitoring function

The purpose of this diagnosis is to detect an implausible gradient on the radiator outlet temperature signal. The diagnostic function checks whether the difference between one measured radiator outlet temperature value and the succeeding value is too high.

Error Symptom:

- Radiator outlet temperature signal gradient error

1.10.3.3 Radiator Outlet Temperature Plausibility Diagnosis

P316C, P00B2

1.10.3.3.1 Monitoring function

The diagnosis is based on monitoring the alternation of radiator outlet temperature signal, positive and negative changes in three phases.

Just after start, if ECT and IAT are below an adjustable threshold, a too high ROT can be detected by comparison of ECT at start and ROT at start.

During warm - up phase (long term check, with no error detection) the diagnosis will only run if ECT at start and IAT lies within a tunable range after engine start. Minimum and maximum ROT are continuously updated from engine start, after first being initialized to ROT at power up. The difference between these two values is also calculated. When this value exceeds a minimum threshold then the diagnosis is finished with a positive rationality check result.

After opening of thermostat, the long term check with error detection starts. The error detection is based on a change of radiator outlet temperature after the opening temperature of the thermostat is reached and following the vehicle/engine is driven under certain conditions (vehicle speed, part load, engine speed, opening of thermostat) for a delay time. However, should one condition drop below the threshold or the engine exit part load state during this tunable period, then the timer is reinitialized/incremented.

For RBM handling the Cold Start Denominator will be considered.

- Radiator outlet temperature too high after start
- Radiator outlet temperature is not plausible

1.10.3.3.2 Monitoring conditions

- battery voltage in range
- engine coolant temperature at start in range
- intake air temperature at start in range
- engine speed above threshold
- engine coolant temperature above threshold
- engine state part load
- vehicle speed above threshold
- for certain time and additional waiting time

Input parameters for monitoring

- engine coolant temperature

- radiator outlet temperature
- engine speed
- intake air temperature
- vehicle speed
- actuation pulse-width modulation of thermostat

1.10.3.3.3 Flowchart: ROT Plausibility Diagnosis

The engine off time is calculated using a relative time counter obtained from the instrumentation via CAN message. The difference in value of the relative time counter at last engine stop and at current engine start is compared to the corresponding values of ECT. An error is detected when engine off time is adjudged too small after a relatively large drop in ECT, or, conversely, when engine off time is too large after a small drop in ECT.

Error Symptoms

- engine off time not plausible to ECT (Symptom 3)

1.11 COLD START EMISSION REDUCTION STRATEGY MONITORING

All parameters, that are relevant during the cat heating phase, are monitored by standard monitoring functions:

e.g. MSD80-N54

Relevant Components during Cat Heating Phase						Impact of faulty Component on Cat Heating Parameter				
Comp./ System	Parameter	needed for	Component Diagnosis	Diagnosis during Cat Heating	Emission Impact > 1,5xGW	Idle Speed	Ignition Angle	Engine Lambda	Transmission Shifting Point	Camshaft Position
Secondary Air	Secondary Air Mass	Enrichment exhaust gas	Secondary Air diagnosis	Yes	Yes, dep. to variant and emission class			X		
Injection Valve	Injection time	Enrichment lambda_engine = 1 Enrichment lambda_engine > 1	Output stage diagnosis	Yes	none	X	X	X		
			Mistfire detection	Yes						
			Fuel supply diagnosis	no						
Mass Air Flow Sensor	Air Mass - Input for maps	Larger overlap, VANOS End position	Air mass flow sensor diagnosis	Yes	none	X	X	X		
			Air mass model diagnosis	Yes						
			Fuel supply diagnosis	no						
Throttle Position	Angle	Mass Air flow	Power stage, accelerator pedal diagnosis	Yes	none	X	X	X		
Valvetronic	Valve Lift	Load control	Valvetronic electrical / mechanical diagnosis Air mass model diagnosis	Yes Yes	none	X	X	X		
Phase Sensor (Camshaft)	Valve overlap	Larger overlap	RPM sensor diagnosis	Yes	none					X
Camshaft Position Actuator	Valve overlap	Larger overlap	Output Stage diagnosis	Yes	none					X
			Camshaft position actuator	Yes						
RPM Sensor	Engine Speed	Idle speed increase	RPM sensor diagnosis	Yes	none	X				
Idle Speed	Engine Speed	EVAP, Camshaft Position	Idle speed diagnosis	Yes	none	X				X
CAN-Communication with Transmission	CAN-bus	Shifting point	Timeout CAN-message	Yes	none	X			X	
Coolant Temperature Sensor	Temperature	Input for maps	Electrical plausibility	Yes	Yes	X	X	X	X	X
ECM	Signals	Calculation	Stack signal self check	no Yes	- - -					
Ignition	Ignition angle	Optimum retarded ignition	Mistfire detection	Yes	Yes, dep. to emission class		X			

Fig. 19: Illustration Standard Monitoring Functions During Cat Heating - Overview
Courtesy of BMW OF NORTH AMERICA, INC.

To fulfill the legal requirements, the monitoring of the idle speed is now extended to the cold start phase. In

case of an error, the specific DTC's:

- P1561 Cold Start Idle Air Control System RPM lower than expected
- P1562 Cold Start Idle Air Control System RPM higher than expected

are set. Look at illustration *Idle speed control*

During cat heating, it is essential to make sure, that enough thermal energy is applied to the catalyst to heat it up as quick as possible.

Therefore it is target to limit the ignition timing to the earliest possible value during the cat heating phase.

If there would be a demand for more torque and therefore for an advanced ignition timing beyond the limits, the engine would be allowed to stall instead of fulfilling the demand.

The torque limits are calibrated the way that the emissions stay below 1.5 times of the limits.

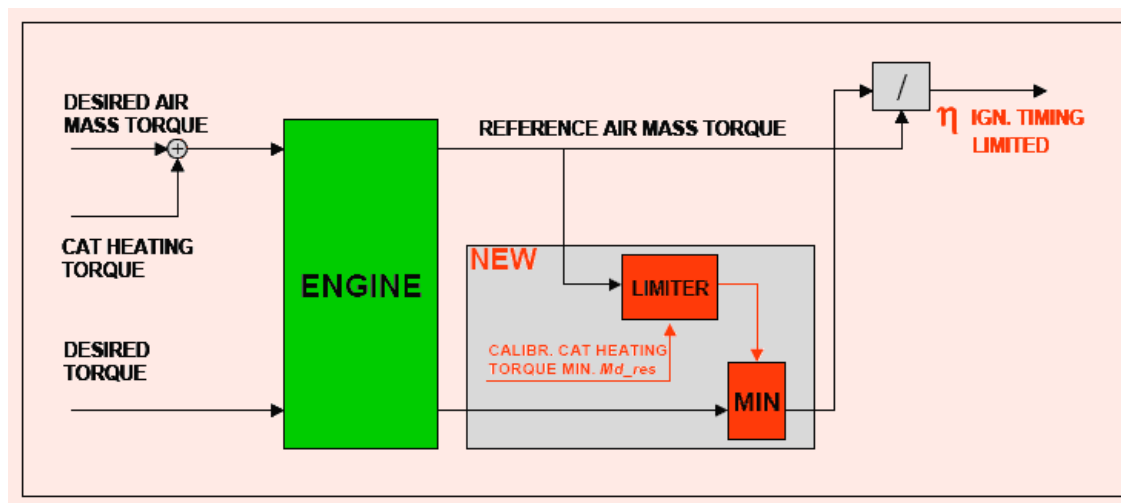


Fig. 20: Illustration Control Of Air Mass Torque During Cat Heating
Courtesy of BMW OF NORTH AMERICA, INC.

Known System:

During normal driving, the ignition timing desired torque corresponds to the air mass desired torque, which determines the ignition timing. During the cat heating phase, the cat heating torque is added to the air mass desired torque, resulting in a higher reference air mass torque.

The efficiency, desired torque divided by the reference torque, determines the ignition timing.

New System (BMW-development):

The earliest possible ignition timing is determined by the limitation of the torque reserve to a minimum value during the cat heating phase. For this, the required minimum cat heating torque is subtracted from the reference air mass torque. The thus reduced efficiency leads to a safe ignition retard and limits the ignition timing during

the cat heating measures.

Limitation of ignition timing to the earliest possible ignition timing during the cat heating phase by limitation of torque reserve to the minimum required torque reserve.

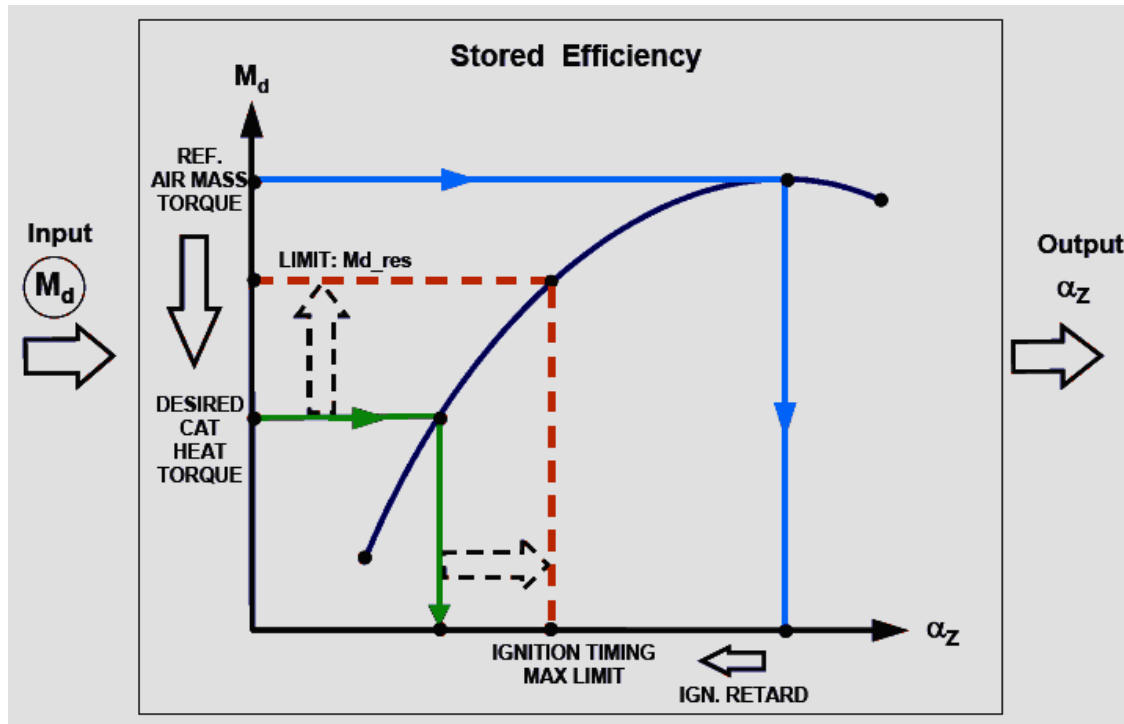


Fig. 21: Illustration Diagram Torque Characteristic Line And Ignition Timing
Courtesy of BMW OF NORTH AMERICA, INC.

The maximum ignition timing after cold start with new BMW method:

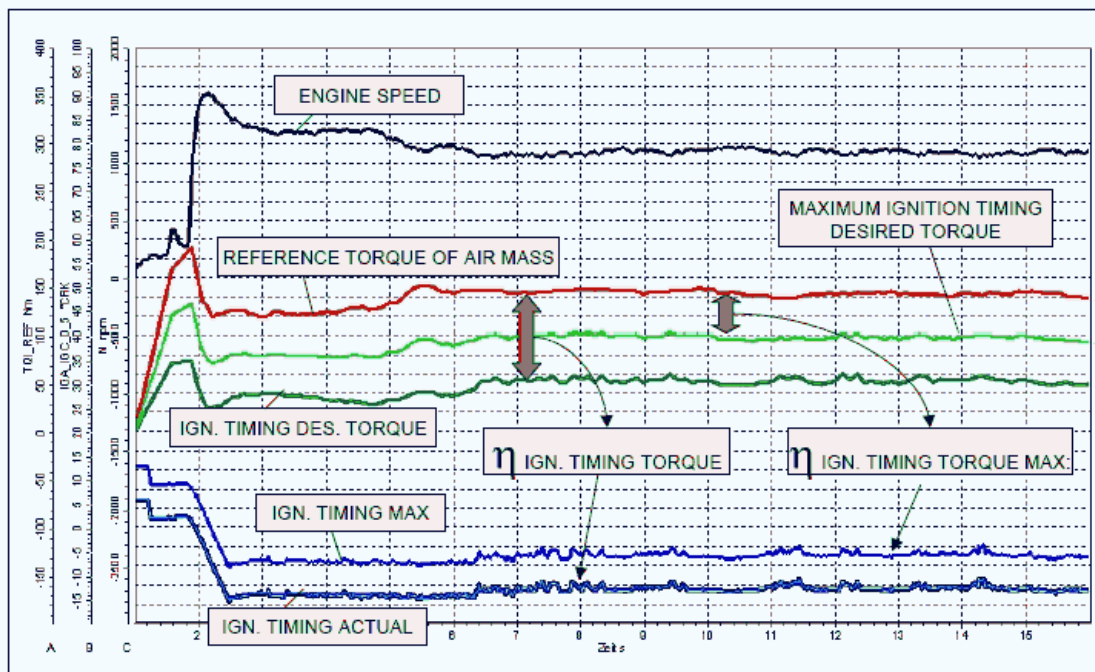


Fig. 22: Illustration Measuring Data
Courtesy of BMW OF NORTH AMERICA, INC.

1.12 AIR CONDITIONING (A/C) SYSTEM COMPONENT MONITORING

The BMW air conditioning system is not OBD-relevant.

1.13 CAMSHAFT AND CRANKSHAFT SENSOR INCLUDING VALVE TIMING

1.13.1 CAMSHAFT SENSOR

1.13.1.1 Variable Camshaft Timing (Vanos) (detection of mechanical IVVT error)

P0012/P0022, P0015/P0025

The BMW-Vanos is a combined hydraulic and mechanical camshaft control unit, managed by the ECU. The double Vanos allows the engine to control valve-timing continuously for both intake and exhaust camshafts. The electronically control of the Vanos positions is dependant on engine speed, load and temperature.

The diagnosis is monitoring the correct mechanical function of the variable camshaft timing. The diagnosis carries out a continuous rationality check of the Vanos function. If a malfunction is detected, an error bit will be set and sent to the Error management module. This module produces the final information for setting the corresponding DTC.

The diagnostic strategy for inlet and exhaust camshaft is identical.

1.13.1.2 Monitoring function

In this diagnosis module the difference between the actual and target position of the Vanos units ("control deviation") is checked. If the calculated difference between these two positions exceeds the established threshold, a counter is started. The counter is incremented twice per crank revolution (but not exceeding 10 msec-rates).

If the counter exceeds a limit (also adjustable), a rationality fault (DTC) is stored.

The control deviation diagnosis has got an interface to the Rate-Based Monitoring module.

A. In-use monitor performance Ratio:

The incrementing of the numerator, denominator, and the ratio calculation for the Variable Camshaft Timing monitor is executed by the Rate-Based Monitoring module. Like all monitors for which a standardized track and report in-use performance is required, the Variable Camshaft Timing monitor reports to the RBM-module via status flags.

B. Conditions for incrementing the Numerator:

The numerator is incremented if and only if the monitor is not inhibited due to stored faults and the diagnostic has been performed and a fault would have been detected.

C. Conditions for incrementing the Denominator:

The denominator is incremented if the monitor is not inhibited due to stored faults, the general driving conditions have been fulfilled and all additional physical conditions for incrementing have been fulfilled.

1.13.2 CAMSHAFT POSITION SENSOR (CMP)

The purpose of the diagnosis is to detect when the camshaft reference position is outside the designed range relative to the engine position from crankshaft and to detect a signal which is not valid.

The diagnostic strategy for inlet and exhaust camshaft is identical.

1.13.2.1 Diagnostic overview

The detection of each camshaft position is done by an active hall sensor and a cam wheel, "3 asymmetric teeth". The camshaft sensor delivers 3 high and 3 low phases of different length per 720°CRK. The high or low level of the signal at the reference gap of the crankshaft signal determines the position of the engine within the combustion cycle. With that information, a engine position is calculated from the crankshaft position sensor within a range from 0 to 720 °CRK.

The following malfunctions are detected:

INTAKE AND EXHAUST REFERENCE

		intake	exhaust
o CMP sensor signal	bank 1	P0340	P0365
plausibility	bank 2	P0345	P0390

○ CMP sensor signal segment period	bank 1	P1300	P130A
	bank 2	P139A	P139B
○ CMP sensor signal loss of synchronization	bank 1	P13B0	P13B2
	bank 2	P13B1	P13B3
○ CMP sensor signal reference to CRK position	bank 1	P13B4	P13B6
	bank 2	P13B5	P13B7
○ CMP sensor signal jump of chain	bank 1	P13BA	P13BC
	bank 2	P13BB	P13BD

1.13.2.2 Monitoring function - Diagnosis of Signal Plausibility

P0340/P0345, P0365/P0390

The monitor checks once per combustion cycle the edge counter of the camshaft. If the edge counter has not changed during the last cycle, a cycle counter is incremented. When the counter reaches a threshold, the error CAM_plaus is delivered to the error management.

1.13.2.3 Monitoring function - Diagnosis of Period Length

P1300/P139A, P130A/P139B

The monitor checks at every edge of the CMP signal the length of the last signal period. If the difference to the designed length exceeds a max value, the corresponding de-bounce counter is incremented. When the counter reaches a threshold the error CAM_period is delivered to the error management.

1.13.2.4 Monitoring function - Diagnosis of Synchronization state

P13B0/P13B1, P13B2/P13B3

The camshaft signal acquisition synchronizes on the camshaft sensor signal by evaluating the pattern of the measured long and short periods of the signal. Synchronization is lost if the last measured period does not fit to the pattern. After synchronization has been established, the monitor checks at every new signal edge whether the camshaft is still synchronized or not. If the camshaft is not synchronized, the corresponding de-bounce counter is incremented. If the camshaft is still synchronized, the de-bounce counter is incremented. When the counter reaches a threshold, the error CAM_sync is delivered to the error management.

1.13.3 CRANKSHAFT/CAMSHAFT

1.13.3.1 Monitoring function - Crankshaft Camshaft Synchronization

P0017

The diagnosis is performed at every edge of the selected camshaft signal and at the reference gap of the CKP sensor signal. The distance (in crankshaft degrees) between events is compared to the stored camshaft signal

pattern. For each signal edge the distance must fit to the designed position in the pattern plus/minus a tolerance. The tolerance is expanded by the range of the variable valve timing, when the camshaft is not in lock position.

The following malfunctions are detected:

- for synchronization selected CMP sensor signal not valid P0017

The monitor eliminates with every event the edges from the list of all 6 cam edges, which are not inside the pattern. If a calibrated number of camshaft signal edges were detected and the list of remaining signal edges contains at least one edge, the camshaft signal is valid for synchronization. If no edge is left in the list, synchronization failed and is started again. If a calibrated number of synchronizations failed, the error is delivered to the error management. Afterwards, and only if synchronization fails with the intake camshaft, the same procedure is started with another camshaft.

1.13.3.2 Monitoring function - Diagnosis of Mechanical Reference Position

P13B4/P13B5, P13B6/P13B7

The monitor checks at least once per driving cycle the position of the camshaft signal edges compared to the crankshaft position while the camshaft is in lock position (VANOS passive).

The deviation of all camshaft edges compared to the designed position is averaged. Each time the deviation of one of the camshaft signal edges exceeds a max value, the corresponding de-bounce counter is incremented. When the counter reaches a threshold the error CAM_ref_crk_cam is delivered to the error management.

1.13.3.3 Monitoring function - Diagnosis of Mechanical Chain Jump

P13BA/P13BB, P13BC/P13BD

The diagnosis is performed after the reference position adaptation. The learned position of each camshaft signal edge is stored in the non volatile RAM of the ECU as an adaptation value. Before storing the value, the new adapted value is compared with the stored value. If the deviation exceeds a max value, the error CAM_one_tooth_off is delivered to the error management and the new value is not stored in RAM. With this diagnosis a chain jump of the timing chain is detected.

The diagnosis of the mechanical chain jump has got an interface to the Rate-Based Monitoring module.

A. In-use monitor performance Ratio:

The incrementing of the numerator and denominator for the diagnosis of chain jump is executed by the Rate-Based Monitoring module. Like all monitors for which a standardized track and report in-use performance is required, the diagnosis monitor reports to the RBM-module via status flags.

B. Conditions for incrementing the Numerator:

The numerator is incremented if and only if the monitor is not inhibited due to stored faults and the diagnostic has been performed and a fault would have been detected.

C. Conditions for incrementing the Denominator:

The denominator is incremented with every driving cycle.

1.13.4 CRANKSHAFT POSITION SENSOR (CRK)

The purpose of this diagnostic is to check the integrity of the crankshaft sensor signal and/or electrical malfunctions. (Open line, SCG, SCVB)

1.13.4.1 Diagnostic overview

The detection of crankshaft position is done by an active hall sensor and a crank wheel, "e.g. 60 minus 2 teeth". A reference gap, "e.g. of two teeth" allows the detection of the top dead center of cylinder 0. The crankshaft sensor delivers a certain number of high and low phases per 360°CRK. The transition from high to low is a falling edge; from low to high is a rising edge. Only the falling edges are counted. The difference between two falling edges is 6° CRK.

The following malfunctions are detected:

CRK SENSOR SIGNAL REFERENCE

○ missing CRK sensor signal	P0335
○ no plausible CRK signal	P0336
○ wrong tooth number	P0370
○ wrong tooth period	P0370
○ sync error	P138F

A teeth counter is incremented at every falling edge of the CRK sensor signal. If plus or minus two teeth are detected during the last 360° CRK at the reference gap, the tooth number de-bounce counter will be incremented. If the counter exceeds a limit, a CRK tooth error is delivered to the error management.

If more than two teeth plus or minus are detected the CRK loses synchronization and a CRK sync de-bounce counter will be incremented. If the counter exceeds a limit, a CRK sync error is delivered to the error management.

The detection of a tooth period error is done by an acceptance window. The expected tooth period is multiplied and divided with an engine speed dependency factor. The result is a bottom and a top limit of tooth period, in which the transition from high to low of the electrical signal has to occur. If a tooth period is not valid, the tooth period error de-bounce counter will be incremented. If the counter exceeds a limit, a CRK tooth per error is delivered to the error management.

Detection of implausible crankshaft signal is based on the detection of CAM signals without receiving correct CRK signal. If 12 or more CAM edges are detected (eg. 2 working cycles), without valid synchronization of the crankshaft, then CRK plaus error is detected and delivered to the error management. If no CRK signal at all is received, the symptom is "missing signal", else the symptom is "implausible signal".

1.13.4.2 Monitoring function - Missing CRK Sensor Signal

P0335

Detection of missing crankshaft signal is based on the detection of CAM signals without any CRK signal. If no CRK signal at all is received and if 12 or more CAM edges are detected, the symptom is "missing signal".

1.13.4.3 Monitoring function - No plausible CRK Signal

P0336

Detection of implausible crankshaft signal is based on the detection of CAM signals without receiving correct CRK signal. If 12 or more CAM edges are detected (eg. 2 working cycles), without valid synchronization of the crankshaft, then "no plausible CRK signal" is detected and delivered to the error management.

1.13.4.4 Monitoring function - Wrong Tooth Number

P0370

A teeth counter is incremented at every falling edge of the CRK sensor signal. If plus or minus two teeth are detected during the last 360° CRK. In this case the de-bounce counter will be incremented. If the counter exceeds a limit, a "CRK tooth number" error is delivered to the error management.

1.13.4.5 Monitoring function - Sync Error

P138F

If more than two teeth plus or minus are detected, the reference gap position is ambiguous and CRK loses synchronization. In that case a CRK sync de-bounce counter will be incremented. If the counter exceeds a limit, a "CRK sync" error is delivered to the error management.

1.13.4.6 Monitoring function - Tooth Period

P0370

The detection of a tooth period error is done by an acceptance window. The expected tooth period is multiplied and divided with an engine speed dependency factor. The result is a bottom and a top limit of tooth period, in which the destination of two falling edges of the electrical signal has to occur. If a tooth period is not valid, the tooth period error de-bounce counter will be incremented. If the counter exceeds a limit, a "CRK tooth per" error is delivered to the error management.

1.13.5 CAMSHAFT POSITION ACTUATOR ELECTRICAL CHECK

P0010/P0020, P2088/P2092, P2089/P2093,

P0013/P0023, P2090/P2094, P2091/P2095

1.14 COMPREHENSIVE COMPONENT MONITORING OBD II SIEMENS VDO

FUNCTION DEFINITION

1.14.1 STRATEGY

Principle:

- **Sensors** that can affect emissions or are used to monitor other component/system are monitored for circuit continuity and short to battery voltage and/or to ground using high and low voltage signal limit.
- **Actuators** that can affect emissions or are used to monitor other component/system are monitored by power stage voltage check for valid signals.
- For some of sensors or actuators, plausibility checks are included to ensure proper operation of the components.

1.14.1.1 Monitoring strategy for sensors

Sensor signals out of a defined range are regarded as circuit malfunctions shorted to BATT, GND or Open circuit.

1.14.1.2 Monitoring strategy for actuators

Invalid actuator output signals at power stage are regarded as circuit malfunctions shorted to BATT, GND or Open circuit.

1.14.1.3 Rationality check

Components are checked for the integrity of their values. This is accomplished by 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 within a threshold) it is considered out of range/plausible.

1.14.2 AMBIENT AIR TEMPERATURE (AAT) MONITORING

1.14.2.1 CAN based Ambient Air Temperature Signal Diagnosis

P0072, P0073

1.14.2.1.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal is a CAN message of instrument cluster. If an error is detected by the instrument cluster, the error symptom is sent via CAN to the ECU. The ECU then de-bounces the error and stores it in the error management.

Error Symptoms

- short circuit to battery or open line
- short circuit to ground

1.14.2.2 Ambient Air Temperature (AAT) Signal Plausibility Check

1.14.2.2.1 Monitoring function

In order to monitor the ambient air temperature (AAT), a cross-check using different temperature sensors is realized. For the temperature sensors to indicate a similar value, it is essential that the engine/vehicle has been cooled down for a minimum amount of time.

Error detection:

If the absolute temperature difference [1]

(ambient air temperature (AAT) - intake air temperature at throttle (IAT_THR)

AND

the absolute temperature difference [2]

(ambient air temperature (AAT) - engine coolant temperature (ECT)) exceed a threshold, the ambient air temperature sensor has a malfunction.

Otherwise the sensor works properly.

In other words: For error detection, the differences between the sensor values (as shown below) are compared to threshold values.

IF

$|AAT - IAT_THR| > THD1$

&

$|AAT - ECT| > THD2$

THEN

ERR_AAT = 1

ELSE

ERR_AAT = No

1.14.3 INTAKE AIR TEMPERATURE (IAT) MONITORING

1.14.3.1 Intake Air Temperature Sensor Plausibility Diagnosis

P113C/P11B2, P111E/P117F, P111F/P118F

1.14.3.1.1 Monitoring function

This diagnosis checks IAT integrity for a plausible range and signal stuck.

For the range detection, IAT has to be within coolant temperature and ambient temperature window. If IAT is outside of the range plus an offset, the error symptom is set and the error counter is de-bounced.

If the vehicle was driven with a certain vehicle speed for a calibratable time (IAT sensor cool down) and afterwards the vehicle was in idle for a calibratable time (IAT sensor hot up), the IAT signal must have moved. If the signal has not moved after a calibratable number of cool down/hot up phases, a stuck intake air temperature signal is detected and the error is de-bounced.

For RBM handling the Cold Start Denominator will be considered.

Error Symptoms:

- Signal too high
- Signal too low
- Signal not plausible

1.14.3.2 Intake Air Temperature Sensor Electrical Check

P0112/P00AC, P0113/P00AD

1.14.3.2.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal is analog from a NTC and has to be in a calibratable range. Short circuit to ground can be detected immediately, short circuit to voltage battery or open load after a delay time. If an error symptom is detected, the error counter is de-bounced.

Error Symptoms:

- Short circuit to voltage battery or open load
- Short circuit to ground

1.14.4 CHARGE AIR COOLER TEMPERATURE (CACT) SENSOR MONITORING

1.14.4.1 Charge Air Cooler Temperature Plausibility Diagnosis

P10B8/P10B9, P10B0/P10B2, P10B1/P10B3

1.14.4.1.1 Monitoring function

This diagnosis checks charge air temperature integrity for a plausible range and signal stuck.

For the range detection, charge air temperature has to be within coolant temperature and ambient temperature

window. If charge air temperature is outside of the range plus an offset, the error symptom is set and the error counter is de-bounced.

If the vehicle was driven with a certain vehicle speed and load (mass air flow) for a calibratable time (charge air temperature sensor hot up) and afterwards the vehicle was in idle for a calibratable time (charge air temperature sensor cool down), the charge air temperature signal must have moved. If the signal has not moved after a calibratable number of cool down/hot up phases, a stuck charge air temperature signal is detected and the error is de-bounced.

For RBM handling the Cold Start Denominator will be considered.

Error Symptoms:

- Signal too high
- Signal too low
- Signal not plausible

1.14.4.2 Charge Air Cooler Temperature Gradient Diagnosis

P10B4/P10B5, P10B6/P10B7

1.14.4.2.1 Monitoring function

The purpose of this diagnosis is to detect an implausible jump discontinuity or implausible gradient or implausible offset on the intake air temperature signal. If a jump discontinuity is located, the error is not de-bounced and is registered in error management. If an implausible gradient or offset is detected, the error is de-bounced.

Error Symptoms:

- Signal gradient not plausible
- Signal too high

1.14.4.3 Charge Air Cooler Temperature Sensor Electrical Check

P007C/P00A2, P007D/P00A3

1.14.4.3.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal is analog from a NTC and has to be in a calibratable range. Short circuit to ground can be detected immediately, short circuit to voltage battery or open load after a delay time. If an error symptom is detected, the error counter is de-bounced.

Error Symptoms:

- Short circuit to voltage battery or open load

- Short circuit to ground

1.14.5 ELECTRONIC THROTTLE CONTROL MONITOR (ETC)

1.14.5.1 Electronic Throttle Control (ETC) Power Stage Diagnosis (H-bridge)

P2100/P210A

1.14.5.1.1 Monitoring function

The ETC - H-Bridge IC continually checks the ETC, if there is a short circuit to battery voltage or ground. In addition the IC is able to detect over-temperature. This is performed internally to the ECU.

1.14.5.2 Electronic Throttle Control (ETC) Motor Control Performance

P11AA/P11AB, P16D0/P16D1

1.14.5.2.1 Monitoring function

This diagnosis is able to detect a too slow or jammed actuator.

One part of the diagnosis checks, whether the pulse width modulation signal (PWM) used to control the throttle flap, exceeds the permissible maximum value for longer than the designated time. If this time is exceeded, the appropriate DTC will be stored.

The second part of the diagnosis checks, whether the difference between the actual throttle value and the set-point value exceeds the allowed value

[f(throttle position gradient)]. If such behaviour is detected, a DTC is stored.

1.14.5.3 Electronic Throttle Control (ETC) Composite Error

P1417, P1455

If

P11AA active OR

P16D0 active OR

P2100 active OR

P16BA active OR

P1632 active OR

P1633 active OR

P169A active OR

P169B active OR

P16BC active OR

P16BE active OR

P16CA active OR

P16CC active OR

P0121 active OR

P0122 active OR

P0123 active OR

P0221 active OR

P0222 active OR

P0223 active OR

P115F active

then

the composite error P1417 will be stored.

If

P11AB active OR

P16D1 active OR

P210A active OR

P16BB active OR

P16AA active OR

P16AB active OR

P16AD active OR

P169C active OR

P16BD active OR

P16BF active OR

P16CB active OR

P16CD active OR

P0226 active OR

P0227 active OR

P0228 active OR

P212B active OR

P212C active OR

P212D active OR

P117E active

then

the composite error P1455 will be stored.

1.14.5.4 Electronic Throttle Control (ETC) Adaption and Start Check

1.14.5.4.1 Monitoring function - ETC Adaptation Diagnosis

P1632/P16AA, P1633/P16AB, P169B/P169C, P16BC/P16BD,

P16BE/P16BF, P16CA/P16CB, P16CC/P16CD

At initial engine start and/or component change, the characteristic sensor values for the limp-home position and the lower mechanical stop are learned within an adaptation routine. The values are stored at the end of the driving cycle in the non-volatile memory.

If the adaption conditions are not fulfilled or one of the adaption steps can not be ended successfully, the corresponding errors (DTC's) are stored.

1.14.5.4.2 Monitoring function - ETC Start Check

P16BA/P16BB, P169A/P16AD

The diagnosis is performed at the beginning of every driving cycle at ignition "Key ON" position, but is stopped without error entry, if the enable conditions are not fulfilled.

It checks, whether the values at limp-home position are in range and if the throttle flap reaches a defined set-point in a certain time.

1.14.5.4.3 Description Adaption Function

The TPS adaptation includes the following functions:

- Adaptation and check of the limp-home position
- Adaptation and check of the lower mechanical stop
- Lower return spring check
- Adaptation of the amplifier amplification (TPS 1 channel)
- Upper return spring check

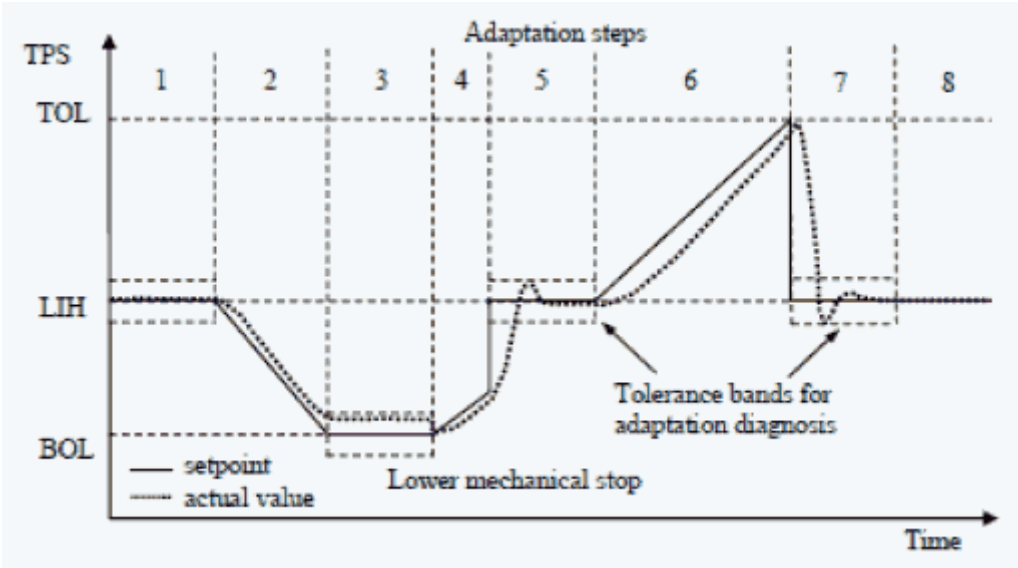


Fig. 23: TPMS Adaptation And Time Graph
Courtesy of BMW OF NORTH AMERICA, INC.

The state variable TPS_AD_STEP indicates the following adaptation steps:

TPS ADAPTATION FUNCTION CHART

Steps	TPS_AD_STEP	Note
1	AD_LH_POS	Adaptation and check of the limp-home position
2	AD_GO_BOL	Throttle flap drives in the lower mechanical stop
3	AD_BOL_POS	Adaptation and check of the lower mechanical stop
4	AD_GO_LiH	Throttle flap drives in a position below throttle flap LIH
5	AD_SPR_CHK_1	Check of the lower return spring

6	AD_GO_ToL	Throttle drives in a position above throttle flap LIH
7	AD_SPR_CHK_2	Check of the upper return spring
8	AD_END	Successful adaptation end

1.14.5.4.4 Description Start Check Function

- Limp-home position check
- Adaptation of the limp-home position
- Upper return spring check

The start check is only carried out when the adaptation conditions are maintained otherwise it will be ignored **without** error entry.

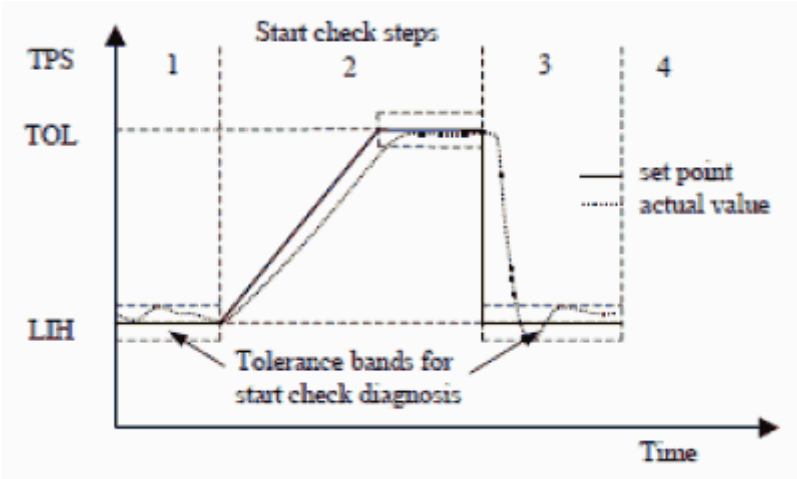


Fig. 24: Start Check Function Graph
Courtesy of BMW OF NORTH AMERICA, INC.

The state variable TPS_AD_STEP indicates the following start check steps:

TPS ADAPTATION FUNCTION CHART

Adap. area	TPS_AD_STEP	Note
1	ST_CHK_LiH	Check and adaptation of the limp-home position
2	ST_GO_TOL	throttle flap goes into a upper position
3	ST_SPR_CHK	Upper return spring and limp-home check
4	ST_CHK_END	End off start check

1.14.5.5 Throttle Position Sensor (TPS) Plausibility Check

1.14.5.5.1 Monitoring function

In case an electrical error (P0122/P0227, P0123/P0228, P0222/P212C, P0223/P212D) or an ratio error (P115F/P117E) at one of the throttle units is detected, the remaining position sensor is checked against a model based on engine temperature, engine load and intake air temperature. If the deviation between model value and measured value exceeds the calibrated threshold, the corresponding error is set.

1.14.5.6 Throttle Position Sensor (TPS) Ratio Check

P115F/P117E

1.14.5.6.1 Monitoring function

The correlation of the two position sensors built into the throttle body is checked by this diagnosis. Therefore the following calculation is made:

$\text{abs}(\text{angle sensor 1} - \text{angle sensor 2}) > \text{threshold}$

If the difference is larger than the threshold, the error is stored in the error memory.

1.14.5.7 Throttle Position Sensor Electrical Check

P0122/P0227, P0123/P0228, P0222/P212C, P0223/P212D

1.14.5.8 Pedal Position Sensor

1.14.5.8.1 Monitoring function - Check of Supply Voltage

P164C, P1625

The supply voltage of the pedal position sensors is monitored for deviation of its nominal value of 5V to ensure that the measured pedal value is correct.

1.14.5.8.2 Monitoring function - Double Error

P1224

The double error is set, if both pedal value sensors are detected as faulty (i.e. by range check error on both sensors, supply voltage error on one and range check error on the other sensor or supply voltage error on both sensors).

1.14.6 IDLE SPEED CONTROL (ISC) ACTUATOR

1.14.6.1 Idle Speed Control Rationality Diagnosis

P0506, P0507, P1561, P1562

1.14.6.1.1 Monitoring function

This diagnosis monitors the stability of the idle speed during cold start and in warm operation.

During cold start:

If the actual idle speed is not within a calibratable range, above or below the idle speed set-point then the failure criteria is fulfilled. The appropriate DTC will be stored.

Warm operation:

If the actual idle speed is not within a calibratable range, above or below the idle speed set-point and the ISC integrator is equal the maximum or minimum threshold limit.

The ISC integrator is a measurement for the regulated deviation to reach the set-point idle speed and is limited to an upper and lower limit.

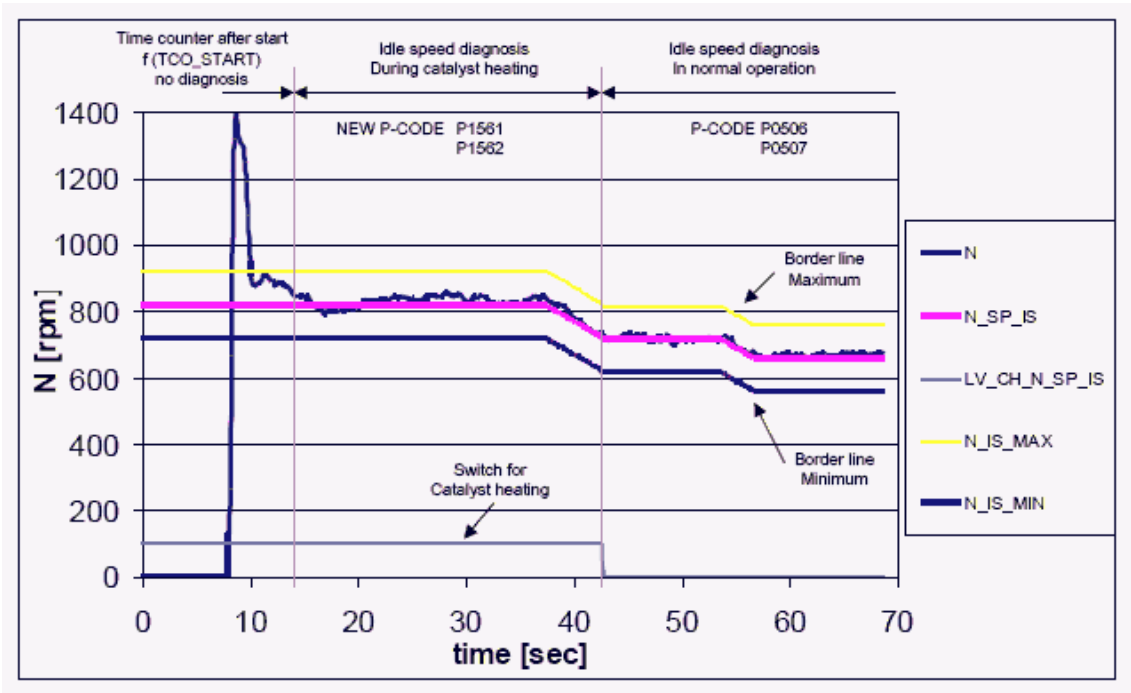


Fig. 25: Idle Speed Control Actuator Function Graph
Courtesy of BMW OF NORTH AMERICA, INC.

Variable list:

EMS PARAMETER DESCRIPTION

EMS Parameter	Description
N	engine speed
N_SP_IS	idle speed setpoint
LV CH N SP IS	catalyst heating by increased idle speed
N_IS_MAX	maximum idle speed
N_IS_MIN	minimum idle speed

1.14.7 MASS AIR FLOW (MAF) AND MANIFOLD ABSOLUTE PRESSURE (MAP) MONITORING

1.14.7.1 Mass Air Flow and Manifold Absolute Pressure Plausibility Diagnosis

MAF: P00BC/P00BE, P00BD/P00BF

MAP: P112E/P11B0, P112F/P11B1

1.14.7.1.1 Monitoring function

Based on the boost pressure sensor upstream of the throttle, the throttle position, cam position and the current engine speed an observer of the manifold pressure and air mass flow values is used. The main function of this observer is to calculate the manifold pressure and the air mass flow in the cylinder. The calculated air mass flow at the throttle depends mainly of the throttle position. The calculated air mass flow into the cylinder depends mainly of the manifold pressure. The main measured value which is used to control this observer is the air mass flow meter, hence an air mass flow control is used.

Two plausibility checks are used:

For the mass air flow plausibility diagnosis, the ratio of the calculated air mass flow at the throttle and the measured air mass flow at the air mass flow meter is calculated. If this ratio exceeds certain calibrated limits, a fault code (MAF) is set.

For the manifold pressure diagnosis the ratio of the resulting air mass flow into the cylinder (based on MAP) and the calculated air mass flow at the throttle are calculated. If this ratio exceeds certain calibrated limits, a fault code (MAP) is set.

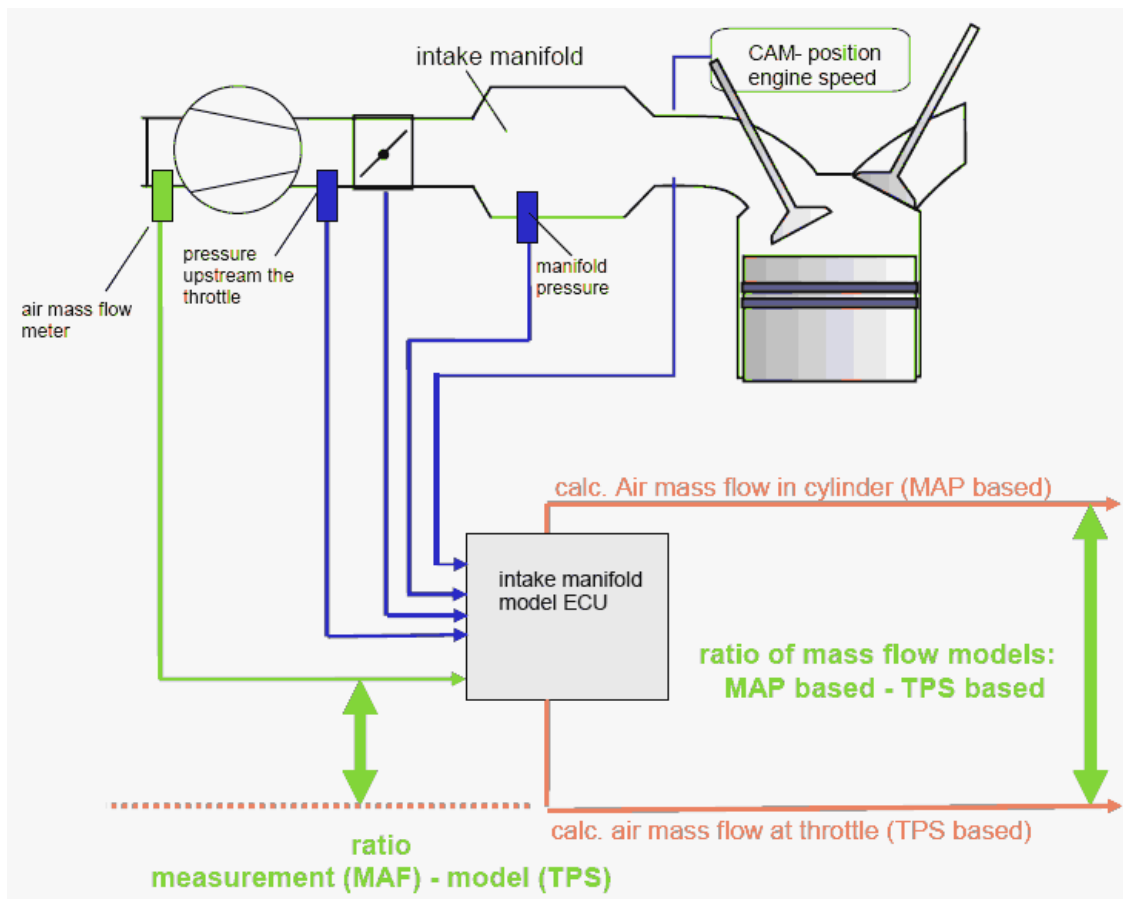


Fig. 26: Mass Air Flow And Manifold Absolute Pressure Monitoring Function Diagram
Courtesy of BMW OF NORTH AMERICA, INC.

In the monitoring conditions a limited dynamic condition is checked for engine speed and engine load. Only under steady state engine operating the diagnosis is possible due to dynamic effects.

To recognize dynamic engine operation (for example engine speed), the actual engine speed is compared with a moving mean value of the engine speed (PT1-behaviour). The difference between the actual engine speed and the moving mean value of the engine speed must not exceed a value, which can be calibrated. Also the time constant T of the PT1 term can be calibrated. The load dynamic is calculated identical to the engine speed dynamic.

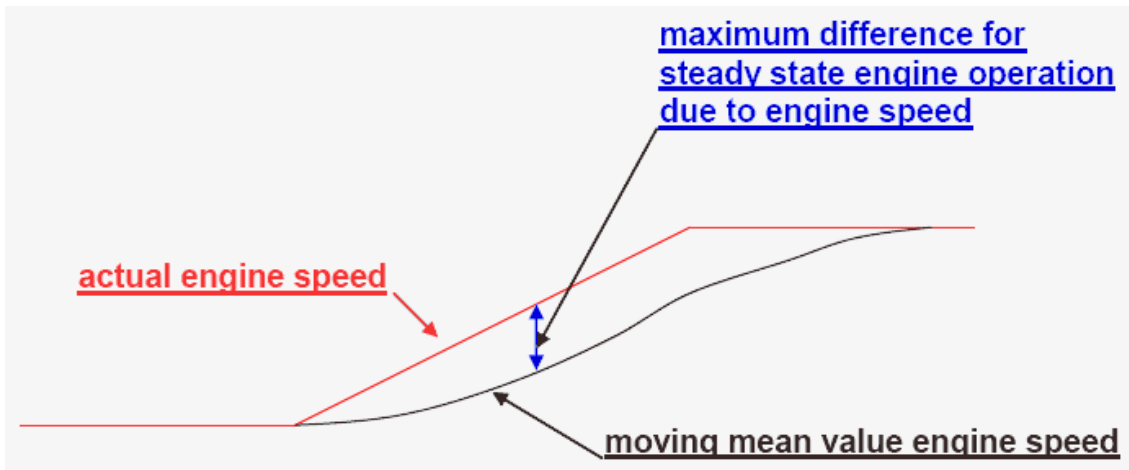


Fig. 27: Checking Difference Between Actual Engine Speed And Moving Mean Value
Courtesy of BMW OF NORTH AMERICA, INC.

1.14.7.2 Ambient Pressure, Boost Pressure and Manifold Absolute Pressure

Ambient Pressure Sensor: P12B8, P12B9

Boost Pressure Sensor: P12A8/P12B6, P12A9/P12B7

Manifold Pressure Sensor: P12A4/P12A6, P12A5/P12A7

1.14.7.2.1 Monitoring function

For the monitoring of the air path pressure sensors (ambient (1x), boost (2x) and manifold (2x)) all measured values are compared to each other. If the engine is not running (engine speed = 0), all sensors must show the sum value.

After a calibratable time after engine stop the mean value of all sensors is taken as reference. If a pressure value is below or above a certain calibratable threshold compared to this mean value, a fault code is set.

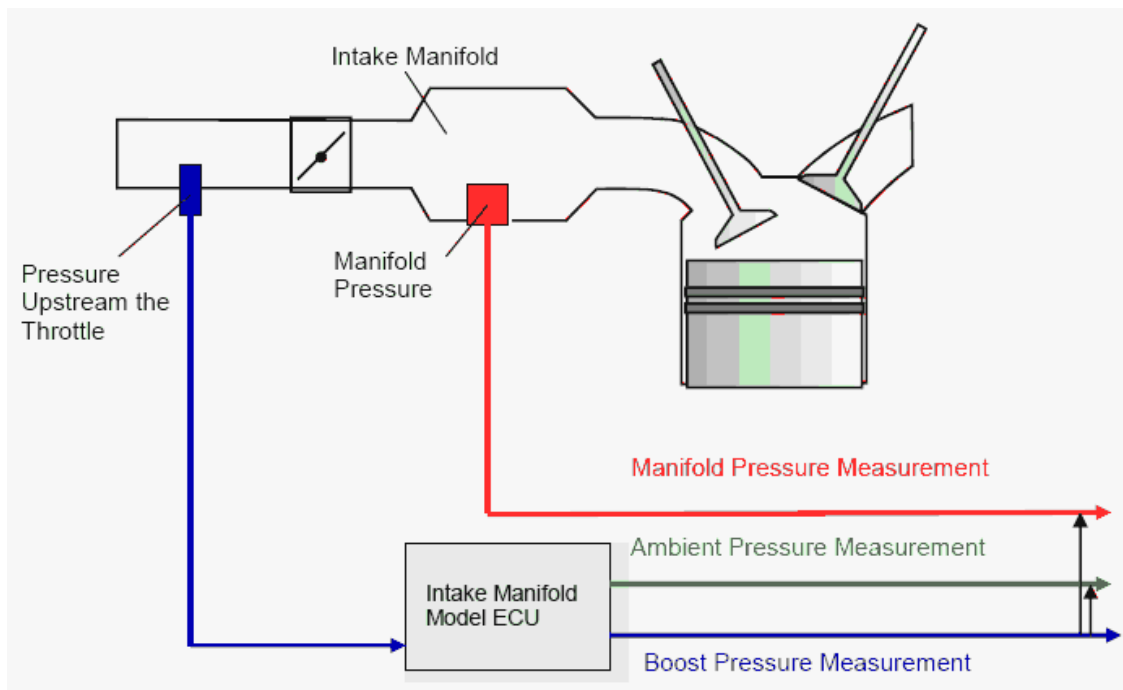


Fig. 28: Ambient Pressure, Boost Pressure And Manifold Absolute Pressure Function Diagram
 Courtesy of BMW OF NORTH AMERICA, INC.

1.14.8 MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR MONITORING

1.14.8.1 Manifold Absolute Pressure Sensor Electrical Check

P119B/P11AF, P119A/P11AE

1.14.8.1.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal is analog and has to be in a calibratable range. If an error symptom is detected, the error counter is de-bounced.

Error Symptoms:

- Short circuit to voltage battery or open load
- Short circuit to ground

1.14.9 MASS AIR FLOW (MAF) SENSOR MONITORING

1.14.9.1 Mass Air Flow Sensor Internal Error Diagnosis

P10C7/P10C8

1.14.9.1.1 Monitoring function

The air-mass meter HFM6 is able to recognize an internal fault. In this case, the HFM6 switches into the fault

mode and remains in it until the internal fault is not longer present. In fault mode the pin state of the air mass flow signal is set to low and the pin state of the temperature intake air signal is set to high.

Error Symptoms

- Self check: internal fault

1.14.9.2 Temperature Sensor Diagnosis Electrical Check

P0102/P010C, P0103/P010D

1.14.9.2.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal from the air-mass meter is digital. Therefore the pin state has to change from low to high and high to low with a certain frequency. If the pin state is not alternating, the error symptom is set and the error counter is de-bounced.

Error Symptoms

- Short circuit to voltage battery or open load
- Short circuit to ground

1.14.9.3 Temperature Sensor Diagnosis Range Check

P00BC/P00BE, P00BD/P00BF

1.14.9.3.1 Monitoring function

This diagnosis checks temperature correction integrity for a plausible range. If the temperature correction signal is outside of the range, the error symptom is set and the error counter is de-bounced.

Error Symptoms

- Signal too high
- Signal too low

1.14.9.4 Mass Air Flow Sensor Diagnosis Electrical Check

P0102/P010C, P0103/P010D

1.14.9.4.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal from the air-mass meter is digital. Therefore the pin state has to change from low to high and high to low with a certain frequency. If the pin state is not alternating, the error symptom is set and the error counter is de-bounced.

Error Symptoms

- Short circuit to voltage battery or open load
- Short circuit to ground

1.14.9.5 Mass Air Flow Sensor Diagnosis Range check

P00BC/P00BE, P00BD/P00BF

1.14.9.5.1 Monitoring function

This diagnosis checks mass air flow for a plausible range. If the air mass flow is outside of the physical range, the error symptom is set and the error counter is de-bounced.

Error Symptoms

- Signal too high
- Signal too low

1.14.10 VEHICLE SPEED SIGNAL

1.14.10.1 Vehicle Speed Sensor Signal Plausibility Check

P0503

1.14.10.1.1 Monitoring function

A vehicle speed signal plausibility error is detected if at calibratable engine speed-, mass air flow- and time thresholds the vehicle speed signal = 0.

Error symptom

MONITORING FUNCTION CHART

vehicle speed not plausible	P0503
-----------------------------	-------

1.14.10.2 Vehicle Speed Sensor Signal Check

P0500

1.14.10.2.1 Monitoring function

A vehicle speed signal error is set if neither a vehicle speed signal is available from ECU-PIN nor a signal is received from CAN (11H/12H).

Error symptom

MONITORING FUNCTION CHART

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1.14.11 KNOCK SENSOR (KS)

P0326, P0327, P0328, P135B, P1327, P1328

P135F, P1329, P1330, P033B, P033C, P033D

1.14.11.1 Monitoring function

The purpose of the diagnosis is to detect faults of the knock sensor. Therefore the signal range and dynamics of a low pass filtered knock signal is checked.

If the signal range exceeds a upper or lower threshold a failure is detected.

An implausible knock signal is detected by using a statistical analysis. The difference between filtered knock signal and raw knock signal is estimated for a certain number of combustion cycles.

All error symptoms are de-bounced.

Error Symptoms

- noise level above valid range
- noise level below valid range
- knock sensor signal not plausible

1.14.12 SUPERCHARGER (SC) BOOST SENSOR (PRESSURE UP THROTTLE - PUT)

1.14.12.1 Supercharger Boost Sensor Electrical Check

P0237/P0241, P0238/P0242

1.14.12.1.1 Monitoring function

The purpose of this diagnosis is to detect electrical faults as defined in OBDI requirements. The input signal is analog and has to be in a calibratable range. If an error symptom is detected, the error counter is de-bounced.

Error Symptoms:

- Short circuit to voltage battery or open load
- Short circuit to ground

1.14.13 COMPREHENSIVE COMPONENTS (CC) MONITORING

1.14.13.1 Injector Valve Diagnosis Electrical Check

P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208,

P310B, P310E, P311B, P311E, P312B, P312E, P313B, P313E

1.14.13.2 Injector Power Stage Diagnosis

P10A5, P10A8, P10BA, P10BD,

P10A6, P10A9, P10BB, P10BE,

P10A7, P10AA, P10BC, P10BF

1.14.13.3 Ambient Pressure Sensor Electrical Check

P2228, P2229

1.14.13.4 Ambient Pressure Sensor Rationality Check

P321E, P321F

1.15 LISTING OF ALL ECU INPUT AND OUTPUT SIGNALS

PIN DESCRIPTION

Pin description BMW	BMW N63 E71	Pin	signal naming MSD85	SVDO MSD85	Of relevance
Zundspule Zylinder 8	A_P_ZSZ8	M1_02	ignition coil 3	IGC_3	No
Zundspule Zylinder 6	A_P_ZSZ6	M1_04	ignition coil 4	IGC_4	No
Zundspule Zylinder 7	A_P_ZSZ7	M1_05	ignition coil 6	IGC_6	No
Zundspule Zylinder 5	A_P_ZSZ5	M1_06	ignition coil 1	IGC_1	No
Zundspule Zylinder 4	A_P_ZSZ4	M1_07	ignition coil 2	IGC_2	No
Zundspule Zylinder 3	A_P_ZSZ3	M1_08	ignition coil 5	IGC_5	No
Zundspule Zylinder 2	A_P_ZSZ2	M1_09	ignition coil 7	IGC_7	No
Zundspule Zylinder 1	A_P_ZSZ1	M1_10	ignition coil 0	IGC_0	No
Batterie nach Hauptrelais KL.87/KI.15N	E_U_HR/E_U_K L15N	M2_01	main relay KL.87/KI15N	VB_RLY	No
Mengesteuerventile HDP5 1	A_T_MSV1	M2_02	volume control valve HDP5 pump	VCV_1	Yes

			1		
Masse	Masse	M2_03	power ground	GND	No
Masse	Masse	M2_04	power ground	GND	No
Nockenwellengeber Einlaß 1	E_P_NWGE1	M2_05	camshaft position sensor inlet 1	CAM_IN_1	Yes
Reservepin LSU4.9 für Pumpstrom, Stetige-Lambdas. v Kat 1	reserve (A_I_LSVP1)	M2_06	Spare pin LSU4.9 - pump current output 1	res (LSL_IA_1)	not
Reservepin LSU4.9 für Pumpstrom, Stetige-Lambdas. v Kat 2	E_A_LSVP1	M2_07	Spare pin LSU4.9 - pump current output 2	LSL_IP_1	Yes
Hybrid-Bus CAN-High 1	D_H-CANH	M2_08	Hybrid CAN-High 1	HCAN_H	not
Klopfsensor 2A (Diff.-Signal)	E_A_KS2A	M2_09	knock sensor 2A	KNK_2a	Yes
Klopfsensor 2B (Diff.-Signal)	E_A_KS2B	M2_10	knock sensor 2B	KNK_2b	Yes
Klopfsensor 1A (Diff.-Signal)	E_A_KS1A	M2_11	knock sensor 1A	KNK_1a	Yes
Klopfsensor 1B (Diff.-Signal)	E_A_KS1B	M2_12	knock sensor 1B	KNK_1b	Yes
Wasserpumpe WUP2	A_S_WUP2	M2_13	cooling water pump 2	CWP_2	not
Heizung Lambdasonde hinter Kat 1	A_T_LHH1	M2_14	lambda sensor heater downstream 1	LSH_DOWN_1	Yes
			infinitely variable valve timing exhaust		Yes
Vanos Auslass Bank 1	A_T_NWA1	M2_15	1	VVTI_EX_1	
Vanos Einlass Bank 1	A_T_NWE1	M2_16	infinitely variable valve timing inlet 1	VVTI_IN_1	Yes
Wastegate 1	A_T_WG1	M2_17	wastegate 1	WG_1	No
Ansteuerung Drosselklappe 1 Anschluß 1	A_T_MDK1-1	M2_18	throttle control out 1a	MTC_PWM_1a	Yes
			camshaft		

Nockenwellengeber Auslaß 1	E_P_NWGA1	M2_19	position sensor exhaust 1	CAM_EX_1	Yes
Sensormasse Lambdasonde vor Kat 1	M_LSV1	M2_20	lambda sensor ground upstream 1	LS_UP_VGND_1	Yes
Lineare Lambdasonde/Referenzzelle vor Kat 1	E_A_LSVR1	M2_21	linear lambda sensor upstream 1	LS_UP_1	Yes
Hybrid-Bus CAN-Low 1	D_H-CANL	M2_22	Hybrid CAN-Low 1	HCAN_L	not
Applikations CAN-Low	D_APPL-CANL	M2_23	application CAN-Low	APPL_CAN_L	not
Applikations CAN-High	D_APPL-CANH	M2_24	application CAN-High	APPL_CAN_H	not
Drucksensor nach DK 1	E_A_PNDK1	M2_25	manifold pressure 1 (throttle outlet)	MAP_1	Yes
nicht verbunden	n.c.	M2_26	not connected	n.c.	not
Blow By Heater Relais	A_S_BBH	M2_27	Blowby Heater - relay	BBH_RLY	No
Heizung Lambdasonde vor Kat 1	A_T_LHV1	M2_28	lambda sensor heater upstream 1	LSH_UP_1	Yes
Schutzrelais Mengensteuerventil	A_S_RLYHDP	M2_29	Volume control valve relay	VCV_RLY	Yes
Elektr. Geregelter Thermostat	A_S_KFK	M2_30	el. controlled thermostat	ECT	Yes
Umluftventil 1	A_S_ULV1	M2_31	recirculation air valve 1	RCLV_1	No
Ansteuerung Drosselklappe 1 Anschluß 2	A_T_MDK1-2	M2_32	throttle control out 1b	MTC_PWM_1b	Yes
Digitale Masse	M_DIGITAL	M2_33	ground digital	GND_DIGITAL_M2	No
Masse Lambdasonde hinter Kat 1	M_LSH1	M2_34	ground lambda sensor downstream 1	GND_LS_DOWN_1	Yes
Masse Raildruckfühler 1	M_RDF1	M2_35	ground fuel rail pressure	GND_FPS_H_1	Yes

			1		
Masse Motortemperaturfühler	M_TMOT	M2_36	ground coolant temperature sensor	GND_TCO	Yes
Masse Abgastemperatur 1	M_TAG1	M2_37	ground temperature exhaust gas 1	GND_TEG_1	not
Masse	Drosselklappengeber 1 M_DKG1	M2_38	ground throttle position sensor 1	GND_TPS_1	Yes
Masse Drucksensor nach DK 1	M_PNDK1	M2_39	ground pressure throttle inlet 1	GND_MAP_1	Yes
Masse Signal Reserve	M_RES	M2_40	ground spare	GND_SPARE	Not use
Masse Heißfilmluftmassenmesser 1	M_HFM1	M2_41	ground mass air flow meter 1	GND_D_MAF_1	No
Kurbelwellensensor	E_P_KWG	M2_42	crankshaft position sensor	CRK	Yes
oldruckschalter	E_S_OLD	M2_43	oil pressure switch	POIL_SWI	No
Lambdasonde hinter Kat 1	E_A_LSH1	M2_44	lambda sensor downstream 1	LS_DOWN_1	Yes
Raildruckfühler 1	E_A_RDF1	M2_45	Fuel rail pressure sensor 1	FPS_H_1	Yes
Drosselklappengeber 1 Ausgang 1	E_A_DKG1-1	M2_46	throttle position sensor 1a	TPS_1a	Yes
Drosselklappengeber 1 Ausgang 2	E_A_DKG1-2	M2_47	throttle position sensor 1b	TPS_1b	Yes
Masse Drucksensor vor DK 1	M_PVDK1	M2_48	ground pressure throttle inlet 1	GND_PUT_1	Yes
Temperatursensor vor DK 1	E_A_TVDK1	M2_49	intake air temperature inlet	TIA_IM_1	Yes

			manifold 1		
Temperatur Ansaugluft 1	E_A_TANS1	M2_50	intake air temperature 1	TIA_1	Yes
Bitserielle Schnittstelle	D_BSD	M2_51	bit serial devices	BSD	No
Versorgung Sensoren	TRACK 1	M2_52	supply voltage sensors track1	VCC_SENS_1_M2	No
Versorgung Sensoren	TRACK 2	M2_53	supply voltage sensors track2	VCC_SENS_2_M2	No
Dauerplus Kl.30/Kl30B	E_U_30/30B	M2_54	direct battery Kl.30/Kl.30B	VB	No
Abgastemperatur 1	E_A_TAG1	M2_55	temperature exhaust gas 1	TEG_1	not
NTC-Wasser (Motortemperatur)	E_A_TMOT	M2_56	coolant temperature	TCO	Yes
Drucksensor vor DK 1	E_A_PVDK1	M2_57	pressure upstream throttle inlet 1	PUT_1	Yes
T Ansaugluft HFM 1	E_F_TANS1	M2_58	temperature intake air turbo 1	D_TIA_1	Yes
Luftmasse HFM 1	E_F_HFM1	M2_59	mass air flow meter turbo 1	D_MAF_1	Yes
DMTL Ventil	A_S_DMTLV	M3_01	DMTL valve	DMTLV	Yes
Luftklappe	A_T_LKS (A_S_LKS)	M3_02	air flap	AF	No
Bremslichtschalter	E_S_BLS	M3_03	brakelight switch	BLS	No
FlexRay High	D_FlexRayH	M3_04	FlexRay-High	FLEXRAY_H	not
FlexRay Low	D_FlexRayL	M3_05	FlexRay-Low	FLEXRAY_L	not
Kupplungsschalter	E_S_KUP	M3_06	clutch switch	CLU_SWI	Not use
Automatikstart	A S START	M3_07	start signal	START	No
Haupt-Relais Ansteuerung	A_S_HR	M3_08	main relay	RLY_MAIN	No
DMTL Pumpe	A_S_DMTLP	M3_09	DMTL pump	DMTLP	Yes
Elektr. Lufter getaktet	A_T_ELUE	M3_10	cooling fan	CFA	No

Bremslichttestschalter	E_S_BLTS	M3_11	brakelight test switch	BTS	No
Redundante Zundungsklemme KL15-3	E_S_KL15-3	M3_12	redundant ignition key KL15-3	VB_IGK_3	No
Zundschloss Kl.15	E_S_Kl15WUP	M3_13	ignition key Kl.15	VB_IGK	No
Fahrzeuggeschwindigkeit (ABS)	E_F_DFAHR	M3_14	wheel speed	VS	Yes
DMTL Heizung	A_S_DMTLH	M3_15	DMTL heater	DMTLH	Yes
Motor Drehzahlsignal	A_F_TD	M3_16	engine speed signal	ESS	Yes
(Masse Raildruckfuhler 3)	M_RES (M_RDF3)	M3_17	(ground fuel rail pressure 3)	GND_SPARE (GND_FPS_H_3)	Not use
Masse Pedalwertgeber 1	M_FWG1	M3_18	ground pedal value sensor 1	GND_PVS_1	No
Fahrzeug-CAN-Low	D_FA-CANL	M3_19	vehicle-CAN-Low	CAN_L	No
Fahrzeug-CAN-High	D_FA-CANH	M3_20	vehicle-CAN-High	CAN_H	No
A CAN-Low 1	D_A-CANL	M3_21	A CAN-Low 1	ACAN_L	No
A CAN-High 1	D_A-CANH	M3_22	A CAN-High 1	ACAN_H	No
Masse Pedalwertgeber 2	M_FWG2	M3_23	ground pedal value sensor 2	GND_PVS_2	No
Masse Temperatur Kuhlwasseraustritt	M_TKA	M3_24	ground coolant outlet temperature sensor	GND_TCO_EX	Yes
Abgasklappe 2	A_S_AKL2	M3_25	exhaust flap 2	EF_2	No
(Raildruckfuhler 3)	Res_Analog_1 (E_A_RDF3)	M3_26	(Fuel rail pressure sensor 3)	SPARE_AN_1 (FPS_H_3)	Not use
(Raildruckfuhler 4)	Res_Analog_2 (E_A_RDF4)	M3_27	(Fuel rail pressure sensor 4)	SPARE_AN_2 (FPS_H_4)	Not use
Fahrerwunsch Geber 1	E_A_FWG1	M3_28	pedal value sensor 1	PVS_1	No

Fahrerwunsch Geber 2	E_A_FWG2	M3_29	pedal value sensor 2	PVS_2	No
Temperaturfühler Kuhlwasseraustritt	E_A_TKA	M3_30	coolant outlet temperature	TCO_EX	not
Motor Stop/Start Automatik	A_S_MOT	M3_31	motor stop automatic	MSA	not
Abgasklappe 1	A_S_AKL1	M3_32	exhaust flap 1	EF_1	No
Relais Elektr. Lufter	A_S_ELRLY	M3_33	cooling fan relay	CFA_RLY	No
(Masse Raildruckfühler 4)	M_RES (M_RDF4)	M3_34	(ground fuel rail pressure 4)	GND_SPARE (GND_FPS_H_4)	Not use
Bitserielle Schnittstelle	D_BSD	M3_35	bit serial devices	BSD	No
Wegfahrsperre, EWS4	CAS_BUS	M3_36	imobilizer EWS4	IMOB	No
LIN-Bus	D_LIN	M3_37	lin-bus	LIN	No
Versorgung Sensoren	TRACK 1	M3_38	supply voltage sensors track1	VCC_SENS_1_M3	Yes
Versorgung Sensoren	TRACK 3	M3_39	supply voltage sensors track3	VCC_SENS_3_M3	Yes
EBox-Lufter	A_S_EBOXL	M3_40	cooling fan Ebox	CFA_EBOX	No
Versorgung DI	E_U_DI	M4_01	supply voltage injection	VCC_IV	Yes
Mengesteuerventile HDP5 2	A_T_MSV2	M4_02	volume control valve HDP5 pump 2	VCV_2	Yes
Masse	Masse	M4_03	power ground	GND	No
Masse	Masse	M4_04	power ground	GND	No
Ansteuerung Drosselklappe 2 Anschluß 1	A_T_MDK2-1	M4_05	throttle control out 2a	MTC_PWM_2a	Yes
Wastegate2	A_T_WG2	M4_06	wastegate 2	WG_2	No
			infinitely		

Vanos Einlass Bank 2	A_T_NWE2	M4_07	variable valve timing inlet 2	VVTI_IN_2	Yes
Vanos Auslass Bank 2	A_T_NWA2	M4_08	infinitely variable valve timing exhaust 2	VVTI_EX_2	Yes
Heizung Lambdasonde hinter Kat 2	A_T_LHH2	M4_09	lambda sensor heater downstream 2	LSH_DOWN_2	Yes
Motor Stop/Start Automatik	A_S_MOT	M4_10	motor stop automatic	MSA	Not use
Klopfsensor 3A (Diff.-Signal)	E_A_KS3A	M4_11	knock sensor 3A	KNK_3a	No
Klopfsensor 3B (Diff.-Signal)	E_A_KS3B	M4_12	knock sensor 3B	KNK_3b	No
Klopfsensor 4A (Diff.-Signal)	E_A_KS4A	M4_13	knock sensor 4A	KNK_4a	No
Klopfsensor 4B (Diff.-Signal)	E_A_KS4B	M4_14	knock sensor 4B	KNK_4b	No
Pumpzelle, Stetige-Lambdas. v Kat 2	E_A_LSVP2	M4_15	pump current measurement 2	LSL_IP_2	Yes
Reservepin LSU4.9 für Pumpstrom, Stetige-Lambdas. v Kat 2	reserve (A_I_LSVP2)	M4_16	Spare pin LSU4.9 - pump current output 2	res (LSL_IA_2)	Yes
Nockenwellengeber Einlaß 2	E_P_NWGE2	M4_17	camshaft position sensor inlet 2	CAM_IN_2	Yes
Ansteuerung Drosselklappe 2 Anschluß 2	A_T_MDK2-2	M4_18	throttle control out 2b	MTC_PWM_2b	Yes
Umluftventil 2	A_S_ULV2	M4_19	recirculation air valve 2	RCLV_2	
Soundklappe	A_S_ASK	M4_20	sound flap	SOF	No
Tankentlüftungsventil	A_T_TEV	M4_21	canister purge solenoid	CPS	Yes
Heizung Lambdasonde vor Kat 2	A_T_LHV2	M4_22	lambda sensor heater upstream 2	LSH_UP_2	Yes
Piezo Relais	A_S_DI	M4_23	relay piezo	RLY_HPDI	No
via Rpd auf Masse (Reserve			via Rpd to		Not

Analogeingang)	n.c.	M4_24	GND (spare analog input)	n.c.	used
Drucksensor nach DK 2	E_A_PNDK2	M4_25	pressure throttle outlet 2	MAP_2	Yes
Drosselklappengeber 2 Ausgang 1	E_A_DKG2-1	M4_26	throttle position sensor 2a	TPS_2a	Yes
Druck Kraftstoffpumpe	E_A_KDF	M4_27	Fuel pressure sensor - low pressure	FPS_L	No
Lineare Lambdasonde/Referenzzelle vor Kat 2	E_A_LSVR2	M4_28	linear lambda sensor upstream 2	LS_UP_2	Yes
Sensormasse Lambdasonde vor Kat 2	M_LSV2	M4_29	lambda sensor ground upstream 2	LS_UP_VGND_2	Yes
Nockenwellengeber Auslaß 2	E_P_NWGA2	M4_30	camshaft position sensor exhaust 2	CAM_EX_2	Yes
Masse Heißfilmluftmassenmesser 2	M_HFM2	M4_31	ground mass air flow meter 2	GND_D_MAF_2	No
Masse Signal Reserve	M_RES	M4_32	ground spare	GND_SPARE	Not used
Masse Drucksensor nach Drosselklappe DK 2	M_PNDK2	M4_33	ground pressure throttle inlet 2	GND_MAP_2	Yes
Masse Drosselklappengeber 2	M_DKG2	M4_34	ground throttle position sensor 2	GND_TPS_2	Yes
Masse Kraftstoffdrucksensor für EKP	M_KDF	M4_35	ground fuel pressure fuel pump	GND_FPS_L	No
Masse Raildruckfühler 2	M_RDF2	M4_36	ground fuel rail pressure 2	GND_FPS_H_2	Yes
Masse Lambdasonde hinter Kat 2	M_LSH2	M4_37	ground lambda sensor downstream 2	GND_LS_DOWN_2	Yes

Digitale Masse	M_DIGITAL	M4_38	ground digital	GND_DIGITAL_M4	No
Temperatur Ansaugluft 2	E_A_TANS2	M4_39	intake air temperature 2	TIA_2	Yes
Temperatursensor vor DK 2	E_A_TVDK2	M4_40	intake air temperature inlet manifold 2	TIA_IM_2	Yes
Masse Drucksensor vor DK 2	M_PVDK2	M4_41	ground pressure throttle inlet 2	GND_PUT_2	Yes
Drosselklappengeber 2 Ausgang 2	E_A_DKG2-2	M4_42	throttle position sensor 2b	TPS_2b	Yes
Masse Abgastemperatur 2	M_TAG2	M4_43	ground temperature exhaust gas 2	GND_TEG_2	Not use
Raildruckfuhler 2	E_A_RDF2	M4_44	Fuel rail pressure sensor 2	FPS_H_2	Yes
Lambdasonde hinter Kat 2	E_A_LSH2	M4_45	lambda sensor downstream 2	LS_DOWN_2	Yes
Versorgung DI - Signalpin Wasserpumpe	A_U_WP	M4_46	supply voltage injection - signal out for water pump	CWP_1	not
Luftmasse HFM 2	E_F_HFM2	M4_47	mass air flow meter turbo 2	D_MAF_2	No
T Ansaugluft HFM 2	E_F_TANS2	M4_48	temperature intake air turbo 2	D_TIA_2	Yes
Drucksensor vor Drosselklappe DK 2	E_A_PVDK2	M4_49	pressure throttle inlet 2	PUT_2	Yes
Masse via Rpd	M_RES	M4_50	GND via Rpd	GND	Not use
Abgastemperatur 2	E_A_TAG2	M4_51	temperature exhaust gas 2	TEG_2	Not use
Versorgung Sensoren	TRACK 2	M4_52	supply voltage sensors	VCC_SENS_2_M4	Yes

			track2		
Versorgung Sensoren	TRACK 3	M4_53	supply voltage sensors track3	VCC_SENS_3_M4	Yes
LIN-Bus	D_LIN	M4_54	lin-bus	LIN	No
Einspritzventil Zylinder 8	A_P_EVZ8M	M5_01	injection valve 3	INJ_LOW_8	Yes
Einspritzventil Zylinder 7	A_P_EVZ7M	M5_02	injection valve 6	INJ_LOW_6	Yes
Einspritzventil Zylinder 4	A_P_EVZ4M	M5_03	injection valve 2	INJ_LOW_2	Yes
Einspritzventil Zylinder 8 - Common	A_P_EVZ8P	M5_05	injection valve 3 - Common	INJ_HIGH_3	Yes
Einspritzventil Zylinder 7 - Common	A_P_EVZ7P	M5_06	injection valve 6 - Common	INJ_HIGH_6	Yes
Einspritzventil Zylinder 4 - Common	A_P_EVZ4P	M5_07	injection valve 2 - Common	INJ_HIGH_2	Yes
Einspritzventil Zylinder 2	A_P_EVZ2M	M5_09	injection valve 7		Yes
Einspritzventil Zylinder 2 - Common	A_P_EVZ2P	M5_10	injection valve 7 - Common	INJ_HIGH_7	Yes
Einspritzventil Zylinder 1	A_P_EVZ1M	M5_11	injection valve 0	INJ_LOW_0	Yes
Einspritzventil Zylinder 3 - Common	A_P_EVZ3P	M5_13	injection valve 5 - Common	INJ_HIGH_5	Yes
Einspritzventil Zylinder 5 - Common	A_P_EVZ5P	M5_14	injection valve 1 - Common	INJ_HIGH_1	Yes
Einspritzventil Zylinder 1 - Common	A_P_EVZ1P	M5_15	injection valve 0 - Common	INJ_HIGH_0	Yes
Einspritzventil Zylinder 3	A_P_EVZ3M	M5_17	injection valve 5	INJ_LOW_5	Yes
Einspritzventil Zylinder 5	A_P_EVZ5M	M5_18	injection valve 1	INJ_LOW_1	Yes
Einspritzventil Zylinder 6 - Common	A_P_EVZ6P	M5_19	injection valve 4 - Common	INJ_HIGH_4	Yes
			injection		

Einspritzventil Zylinder 6	A_P_EVZ6M	M5_20	valve 4	INJ_LOW_4	Yes
Masse Kurbelwellengeber	M_KWG	GND_DIGITAL_M2	ground crankshaft position sensor	GND_CRK	Yes
Masse Nockenwellengeber Einlaß 1	M_NWGE1	GND_DIGITAL_M2	ground camshaft position sensor inlet 1	GND_CAM1_IN	Yes
Masse Nockenwellengeber Auslaß 1	M_NWGA1	GND_DIGITAL_M2	ground camshaft position sensor exhaust 1	GND_CAM1_EX	Yes
Masse Nockenwellengeber Einlaß 2	M_NWGE2	GND_DIGITAL_M4	ground camshaft position sensor inlet 2	GND_CAM2_IN	Yes
Masse Nockenwellengeber Auslaß 2	M_NWGA2	GND_DIGITAL_M4	ground camshaft position sensor exhaust 2	GND_CAM2_EX	Yes
Spannungsversorgung 5V DKG 1	A_U_DKG1	VCC_SENS_1_M2	supply voltage TPS 1	TPS_1_VCC	Yes
Spannungsversorgung 5V	RDF1 A_U_RDF1	VCC_SENS_1_M2	supply voltage FUP sensor 1	FPS_H_1_VCC	Yes
Spannungsversorgung 5V PNDK 1	A_U_PNDK1	VCC_SENS_1_M2	supply voltage	PT_OUT_1 MAP_1_VCC	Yes
Spannungsversorgung 5V PVDK 1	A_U_PVDK1	VCC_SENS_1_M2	supply voltage PT_IN_1	PUT_1_VCC	Not used
Spannungsversorgung 5V Pedalwertgeber 1	A_U_FWG1	VCC_SENS_1_M3	supply voltage PVS1	PVS_1_VCC	No
Spannungsversorgung 5V RDF 2	A_U_RDF2	VCC_SENS_2_M4	supply voltage FUP sensor 2	FPS_H_2_VCC	Yes
Yes Spannungsversorgung 5V PNDK 2	A_U_PNDK2	VCC_SENS_2_M4	supply voltage	PT_OUT_2 MAP_2_VCC	Yes
Spannungsversorgung 5V PVDK 2	A_U_PVDK 2	VCC_SENS_2_M4	supply voltage PT_IN_2	PUT_2_VCC	Not used
			supply		

Spannungsversorgung 5V	RDF3 A_U_RDF3	VCC_SENS_3_M3	voltage FUP sensor 3	FPS_H_3_VCC	Yes
Spannungsversorgung 5V	RDF4 A_U_RDF4	VCC_SENS_3_M3	supply voltage FUP sensor 4	FPS_H_4_VCC	Yes
Spannungsversorgung 5V Pedalwertgeber 2	A_U_FWG2	VCC_SENS_3_M3	supply voltage PVS2	PVS_2_VCC	No
Spannungsversorgung Kraftstoffdrucksensor	A_U_KDF	VCC_SENS_3_M4	supply voltage fuel pressure sensor	FPS_L_VCC	Yes
Spannungsversorgung 5V DKG 2	A_U_DKG2	VCC_SENS_3_M4	supply voltage TPS_2	TPS_2_VCC	Yes

1.16 LOCATION OF THE DATA LINK CONNECTOR

Model : X6 xDrive 5.0i



Position OBD II Connector

Fig. 29: Identifying DLC Position

Courtesy of BMW OF NORTH AMERICA, INC.



Fig. 30: Identifying DLC And Removed Cover Location
Courtesy of BMW OF NORTH AMERICA, INC.

The DLC is located at the lower left side of the instrument cluster. There is a cover with the letters "OBD" on it as shown removed above.

1.17 DRAWING AND LOCATION OF THE MIL

Model: X6 xDrive 5.0i



Malfunction Indicator Light

Fig. 31: Identifying Malfunction Indicator Light
Courtesy of BMW OF NORTH AMERICA, INC.