5.3 Ignition misfires (uneven running detection)

"Jerking" or a reduced performance is the noticeable result of malfunctions in the engine running. These malfunctions are caused by errors in the ignition system and in the mixture preparation, but also by mechanical damage in the engine.
The results of combustion malfunctions and ignition misfires are:

- the engine loses power
- the quality of the exhaust gas deteriorates
- unburned fuel gets into the exhaust gas system and overheats, damaging the catalyst
- the unburned fuel can cause flooding of the cylinder. This will weaken the oil film or wash it away completely.
  This will produce mixed friction, increased wear, and thus damage to the pistons, piston rings and cylinders.

For this reason, the engine running is monitored permanently for misfires and uneven running.

Monitoring
To detect misfires, the uneven running of the engine is monitored by registering the rotational speed of the crankshaft.

Using a toothed wheel on the crankshaft ("increment wheel" or "crankshaft sensor wheel") and the position of the camshaft, it is possible to attribute ignition misfires to an individual cylinder ("cylinder-selective"). This toothed wheel is divided into sectors. The breakdown corresponds to the working cycles per crankshaft rotation.
In a 4-cylinder engine there are two sectors, in a 6-cylinder engine there are three, and in an 8-cylinder engine there are four. The cycle time for each sector is recorded based on the engine speed and the time of the ignition.

- If there are no misfires, the times are the same for all sectors.
- If misfires occur in a cylinder, the rotational speed in the allocated sector will decrease and the cycle time for this sector will increase.

To compensate for small errors/tolerances in the toothed wheel, a sensor adaptation takes place during driving in the deceleration phase. Errors that are detected and confirmed are recorded and indicated by the malfunction indicator lamp (MIL).

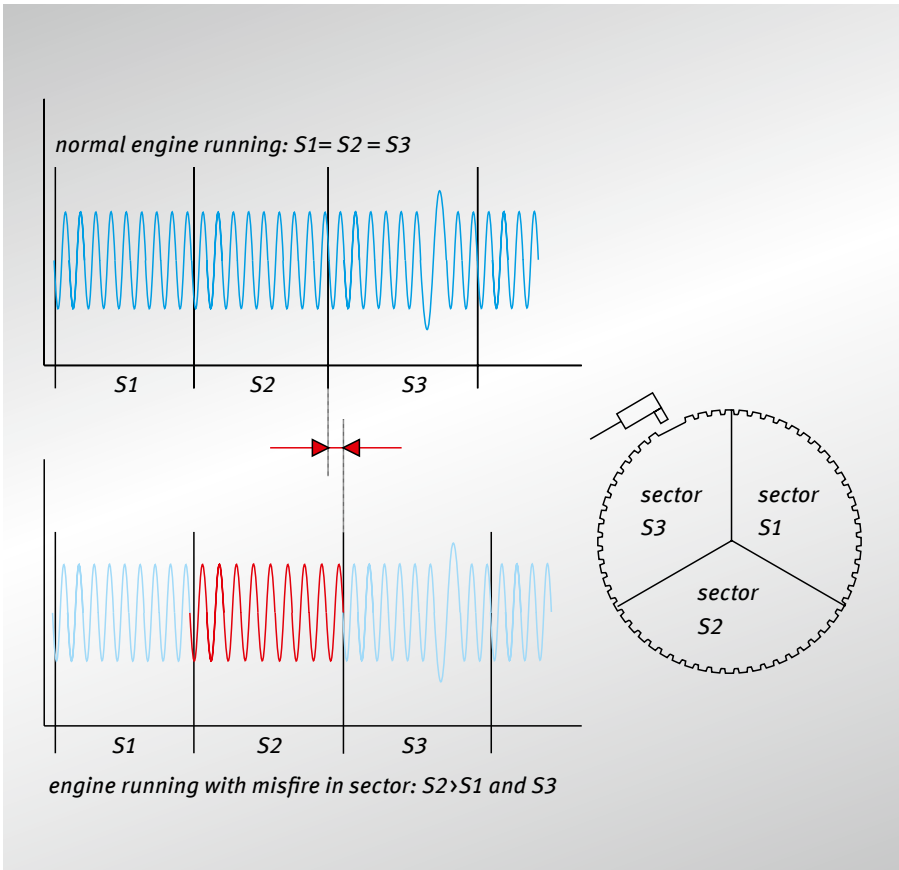

Fig. 51: misfire detection in the S2 sector (6-cylinder engine)

Not every misfire will cause the MIL to light up directly. For this reason the consecutive misfires are counted and evaluated according to their ability to cause damage.

For this purpose, all misfires that occur within 200 rotations are evaluated.
The MIL is blinking. The vehicle can only be driven as far as the closest workshop, and with limited power.

Misfires that damage the catalytic converter
This is the case after a misfire rate of 2%. For this purpose, all misfires that occur within 1000 rotations are evaluated.
The MIL will go on (continuously lit) only if the error is detected again in the subsequent driving cycle. This will confirm ("debounce") the error.

Misfires that cause the exhaust gas limits to increase more than 150%
This is the case after a misfire rate of 2%. For this purpose, all misfires that occur within 1000 rotations are evaluated.
The MIL will go on (continuously lit) only if the error is detected again in the subsequent driving cycle. This will confirm ("debounce") the error.

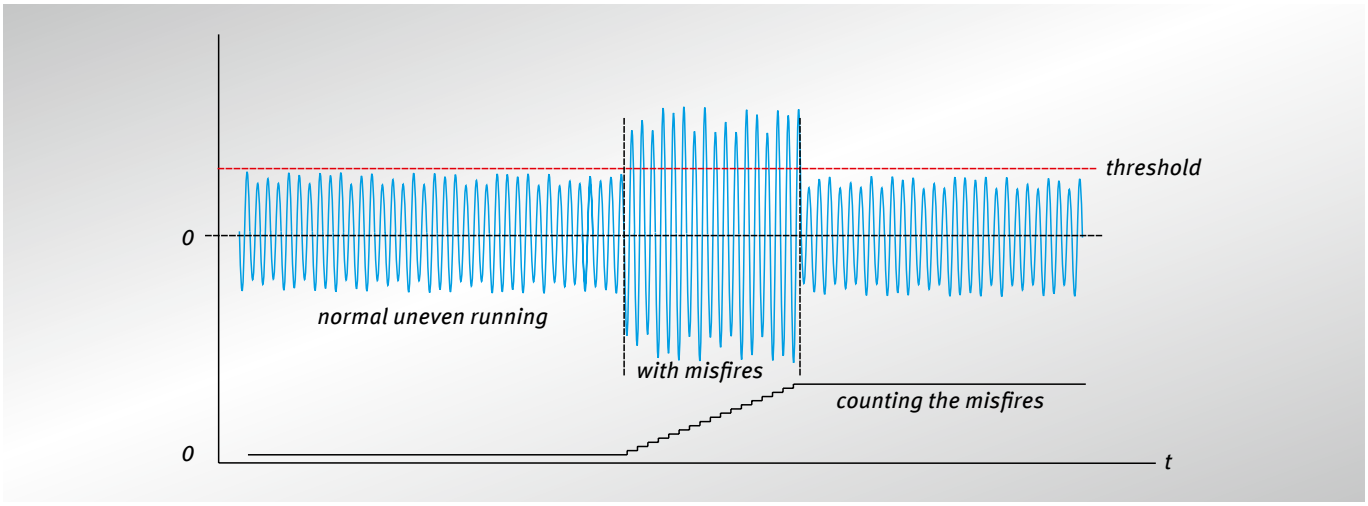

Fig. 52: counting the misfires for the evaluation

Important note:
In one variant of the monitoring the current rotational speed curves are compared with the recorded characteristic curves of the engine. A sudden change in these curves and an exceeding of the exhaust gas limits are detected and indicated as a misfire.

5.3.1 Monitoring

Monitoring occurs permanently. Outside influences can be misinterpreted as combustion misfires. To prevent this, the vehicle speed and body acceleration are also taken into account. This way changes in the rotational speed of the crankshaft, that come through the drive train, are detected and not registered as errors.

For this reason the detection of combustion misfires can be suppressed by the engine management when certain conditions occur:

- falling below/exceeding a certain speed threshold (cut•off, speed limitation, deceleration)
- high jumps in speed (gear shifts)
- the time after engine start (up to 5 seconds)
- the time after the air conditioning is switched on (up to 5 seconds)
- below a load threshold (road resistance)
- detection of a bad road surface (potholes, wheelspins)
- external cylinder - selective ignition interventions (knock control)

Possible fault codes

P0300	random/multiple cylinder	misfire detected
P0301	cylinder 1	misfire detected
⋮		
P0312	cylinder 12	misfire detected
P0313	ignition misfire detected	when fuel is too low
P0314	single cylinder (cylinder not specified)	misfire
P0320	ignition/distributor engine speed input circuit	malfunction
P0321	ignition/distributor engine speed input circuit	range/performance
P0322	ignition/distributor engine speed input circuit	no signal
P0323	ignition/distributor engine speed input circuit	intermittent
P0324	knock control system error	
P0325	knock sensor 1 circuit (bank 1 or single sensor)	malfunction
P0326	knock sensor 1 circuit (bank 1 or single sensor)	range/performance
P0327	knock sensor 1 circuit (bank 1 or single sensor)	low input
P0328	knock sensor 1 circuit (bank 1 or single sensor)	high input
P0329	knock sensor 1 circuit (bank 1 or single sensor)	input intermittent
⋮		
P0334	knock sensor 2 circuit (bank 2)	input intermittent
P0335	crankshaft position sensor a circuit	malfunction
P0336	crankshaft position sensor a circuit	range/performance
P0337	crankshaft position sensor a circuit	low input
P0338	crankshaft position sensor a circuit	high input
P0339	crankshaft position sensor a circuit	intermittent
P0340	camshaft position sensor a circuit (bank 1 or single sensor)	malfunction
P0341	camshaft position sensor a circuit (bank 1 or single sensor)	range/performance
P0342	camshaft position sensor a circuit (bank 1 or single sensor)	low input
P0343	camshaft position sensor a circuit (bank 1 or single sensor)	high input
P0344	camshaft position sensor a circuit (bank 1 or single sensor)	intermittent
⋮		
P0349	camshaft position sensor a circuit (bank 2)	intermittent
P0350	ignition coil primary/secondary circuit	malfunction
P0351	ignition coil a primary/secondary circuit	malfunction
⋮		
P0362	ignition coil I primary/secondary circuit	malfunction
P0365	camshaft position sensor b circuit (bank 1)	malfunction
P0369	camshaft position sensor b circuit (bank 1)	intermittent
P0370	timing reference high resolution signal a	malfunction
P0371	timing reference high resolution signal a	too many pulses
P0372	timing reference high resolution signal a	too few pulses
P0373	timing reference high resolution signal a	intermittent/ erratic pulses
P0374	timing reference high resolution signal a	no pulse
⋮		
P0379	timing reference high resolution signal b	no pulses
P0385	crankshaft position sensor b circuit	malfunction
⋮		
P0394	camshaft position sensor b circuit (bank 2)	intermittent

Diagnostic instructions

Misfires can have multiples causes. Therefore, in troubleshooting, the first thing is to read out the fault code memory.

Component	Possible causes/errors	Possible solutions/actions
Fuel system/mixture formation		
fuel	• defective fuel quality, fuel deficiency • soiling, blending with external substances such as diesel in the petrol fuel	• visual inspection, odour check • cleaning of the fuel systems • replacement of the fuel • replace the fuel filter and possibly the injection valves
fuel pumps	• fuel pump delivery rate (prefeeder and main pump) too low • fuel pressure too low	• measure pressure and delivery rate if present as well in the prefeeder pump • replace faulty pump
pressure regulator	• pressure regulator defective, pressure too high/too low - thus injection quantity deviating	• check pressure and regulation function • replace faulty pressure regulator • check fuel system
fuel filter	• clogged fuel filters; flow too	• measure delivery rate behind the filter • replace filter
fuel lines	low fuel lines broken off • in the flow - fuel supply insufficient • in the return - fuel pressure too high	• when delivery rate is insufficient and pressure deviates, visual inspection • align lines and replace if necessary
injection valves	• function errors • incorrect injection times • incorrect injection direction • leaky injection valves	• when the engine is off use a suitable instrument to check the HC value in the intake manifold • check injection times, injection signal and impermeability • clean valves or replace if necessary
Secondary air system		
secondary air system	• damage to the secondary air pump, the lines or in the shut-off valve, and thus leak air in the exhaust manifold	• please refer to Sections 4.4.2 and 4.4.3.
Engine control		
sensors for • rotational speed • camshaft position	• signals insufficient or distances wrong, sensor loose or soiled	• test with scan tool • clean sensors and readjust if necessary • if sensors are faulty, replace them
increment wheel	• loose or damaged	• secure, if faulty, replace • check position of increment wheel and crankshaft/camshaft sensor, and control times. Determine the OT of cylinder 1
catalytic converter	• clogged/plugged • pressure in manifold too high (exhaust gas accumulation)	• test with scan tool (measure voltage curve) • measure exhaust gas back pressure • if faulty, replace
lambda probe	• ageing, short circuit; faulty signal	• test with scan tool • correct line/earthing error • if probe is faulty, replace it

Continued on the next page

Component	Possible causes/errors	Possible solutions/actions
Engine control		
temperature sensors	• sporadically faulty signal	• test with scan tool • check lines and contacts • if faulty, replace sensor
engine control unit	• internal error	• control unit diagnosis, test with scan tool • check status of data, reload if necessary at a contract workshop
Engine		
engine	• damaged, worn	• compression test • pressure loss test • replace defective parts
inlet/outlet valves	• damaged, don't close • wrong setting • faulty control	• compression test • pressure loss test • check basic setting of valves • check control times • correct faulty settings • replace defective parts
Ignition system		
spark plugs	Ignition faulty due to • wrong spark plugs • electrode distance incorrect • burnout • spark plugs oily, carbonised • crack in insulator • oxidation in plug	• check primary and secondary circuits with scan tool, ignition tester, oscilloscope • visual inspection and resistance measurements • correct errors • replace defective parts
components in secondary circuit	Ignition faulty • due to moisture • corrosion • contact and insulation errors	• check primary and secondary circuits with scan tool, ignition tester, oscilloscope • visual inspection and resistance measurements • correct errors • replace defective parts
ignition coils, plugs and wire harness	• voltage supply faulty • short circuit to "plus" (+)/to "earth" • contact error • insulation damage • abrasions and breaks in the • wire harness	• check primary and secondary circuits with scan tool, ignition tester, oscilloscope • visual inspection and resistance measurements • correct errors • replace defective parts

Important note:
After the engine has been worked on, for example, after taking the flywheel out and putting it back, it may be necessary to "teach" the control unit. Modern engine control units have "adaptive storage modules", i.e. some of the map data required for operation must be "learned". The map data will first be recorded during driving and stored in the memory. This may take a few minutes.
For this reason a test drive should be taken and only then should the function be checked again. If this does not happen, an uneven running error will be detected although all the functions are OK.