

## 4.3 Secondary Air Injection System Monitoring

### 4.3.1 Description

The secondary air injection system consists of an electric pump that is controlled by the ECM via a relay. Air is supplied by the pump to two vacuum operated control valves, one per cylinder bank. From each of the control valves air is delivered to the exhaust ports of the centre two cylinders of each cylinder bank. The vacuum signal is switched via an ECM controlled solenoid valve. A vacuum reservoir ensures that there is always sufficient depression to operate the control valves.

Diagnosis of the secondary air injection system can take place in two steps. There is a passive diagnostic which checks for a lean shift in the signals from the front oxygen sensors during secondary air injection operation and there is an active check, which only runs if the passive check fails to achieve sufficient test results in any drive cycle. The active test has two parts; firstly the secondary air injection pump will be run with the control valves shut. If the valves are leaking or stuck open, the feedback fuelling will shift lean and a fault will be detected. If the valve check is passed, then the valves will be opened and if sufficient secondary airflow exists, then the fuelling will be shifted lean. If the lean shift is less than the required threshold, then a fault is stored.

Additionally, a total absence of secondary injection airflow does not cause the vehicle to exceed the appropriate monitoring threshold. Therefore the system only requires a functional check for the presence of secondary air.

#### Passive Secondary Air Injection Diagnostic

For this test to run the front O<sub>2</sub> sensors must have been ready for operation for longer than a certain time, the secondary air injection system must be operating, the engine speed and load must be within a pre-determined window, engine airflow must be less than an altitude dependent threshold and the ECT must be greater than a threshold.

The front O<sub>2</sub> sensors are monitored over a time period and the minimum voltage value recorded. When a second timer expires, a test counter is incremented and the minimum sensor value is compared with a threshold. If the voltage is less than the threshold then a counter of good test results is incremented. When the test counter reaches a threshold, the number of good test results is compared with a limit value. If the number of good results is greater than the limit then the Secondary Air Injection system is functioning correctly, otherwise a fault is stored and the MIL is illuminated on the next drive cycle, if the fault is again present.

#### Active Secondary Air Injection Diagnostic

If on any drive cycle during which secondary air injection operation has occurred, there are insufficient passive diagnostic test results for fault determination. The system will then attempt to perform an active check of the secondary air injection system. For an active test to occur, the vehicle must be at rest with the engine idling, feedback fuel control enabled, below an altitude threshold, with the engine having been running for longer than a pre-determined time and secondary air injection not operating. If the EVAP canister purge is operating, then it will be ramped down to zero.

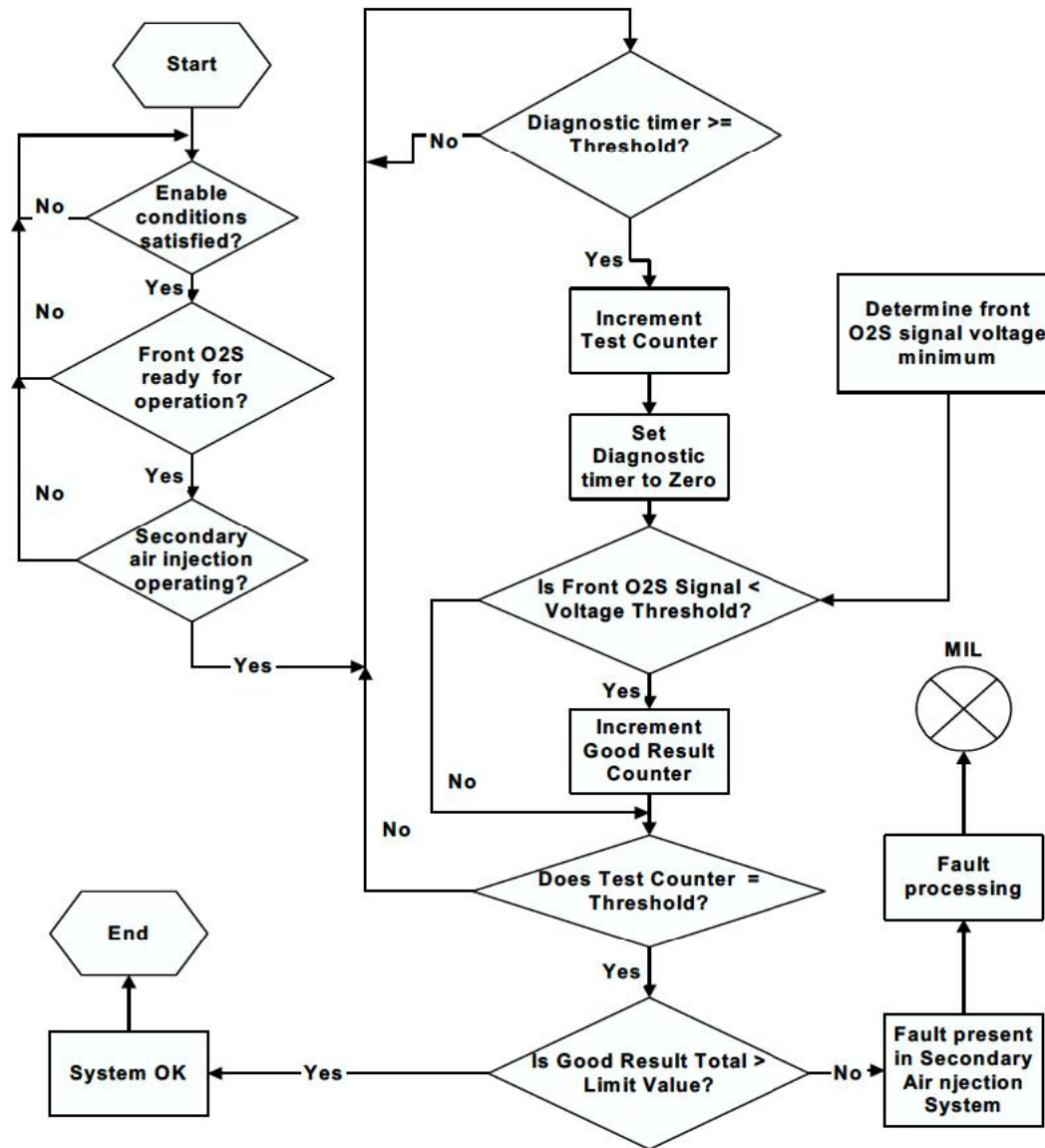


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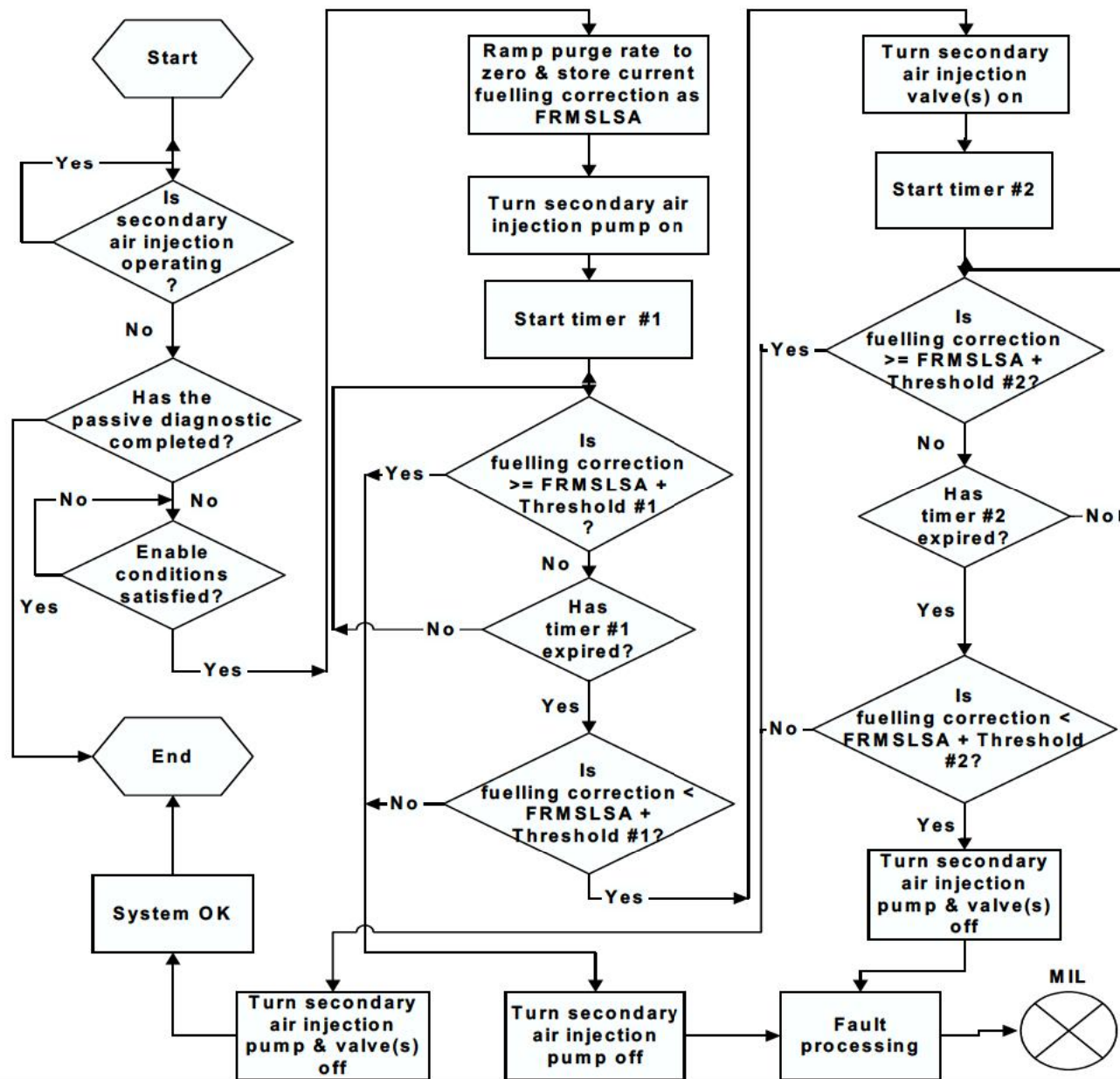
The active test is in two parts. First the current feedback correction factor is recorded and the secondary air injection pump turned on, but with the control valves shut. If the fuelling enriches by more than a threshold, then the valves are leaking or stuck open, but if after a timer has elapsed the feedback correction is below the threshold, then the system proceeds with a flow check.

For the second part of the active diagnostic the valves are opened and if after a time limit, the feedback has not enriched the fuelling by more than a second threshold, then a problem exists with the system and if it is present again on a subsequent drive cycle, a fault is stored and the MIL illuminated.

### 4.3.2 Passive Secondary Air Injection Diagnostic Monitoring Structure



### 4.3.3 Active Secondary Air Injection Diagnostic Monitoring Structure





### Secondary Air Injection System Monitoring Operation

Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
<b>Secondary Air Injection Pump Relay</b>	P0418	circuit continuity - short to battery positive	voltage - drive on	voltage > 1/2 * Battery positive	engine speed	> 80 rpm	immediately/	two driving
		circuit continuity - short to ground	voltage - drive off	voltage < 1/3 * Battery positive	battery voltage	7.5V < B+ < 17V	continuous	cycles
		circuit continuity - open circuit	voltage - drive off	1/3 * Battery positive < voltage < 2/3 * Battery positive				
<b>Secondary Air Injection Valve Vacuum Solenoid Drive</b>	P0412	circuit continuity - short to battery positive	voltage - drive on	voltage > 1/2 * Battery positive	engine speed	> 80 rpm	immediately/	two driving
					battery voltage	7.5V < B+ < 17V	continuous	cycles
	P0414 P0413	circuit continuity - short to ground circuit continuity - open circuit	voltage - drive off voltage - drive off	voltage < 1/3 * Battery positive 1/3 * B+ < voltage < 2/3 * Battery positive				
<b>Secondary Air Injection System (Passive Test)</b> Bank 1 Bank 2		the front O2S voltage Minimum value is sampled over a time of 0.100 sec .If this value is greater than a threshold, then the system is ok	system is OK if:- bank 1 O2S Value  and bank 2 O2S Value	< 0.501 V (for > 55 times in 80 Samples)  < 0.399 V (for > 55 times in 80 samples)	engine speed engine load engine airflow ECT front O2S  secondary air time after engine start altitude factor	520 < rpm < 2520 1.5 < TL ms < 4.0 < 55.56 g/sec > 8 °C ready for operation for > 10.0 sec operating < 655 sec  > 0.711	14 sec/ once per driving cycle	two driving cycles
	P1412 P1415							
			valve check:- run the secondary air	change in fuelling correction	• 0.05	vehicle speed engine state secondary air	= 0 mph Idle not operating, but	10.5 sec/ once per driving cycle



Secondary Air Injection System Monitoring Operation								
Component/ System	Fault Codes	Monitoring Strategy Description	Malfunction Criteria	Threshold value	Secondary Parameter	Enable Conditions	Time Required	MIL Illumination
(Active Test)								
Bank 1 Bank 2	P1413 P1416	injection pump with the control valves shut and monitor the Fuelling Correction			injection  fuel system status passive secondary air diagnostic altitude factor	has operated this drive cycle Closed loop  not completed		
Bank 1 Bank 2	P1414 P1417	flow check:- if the valve check is successful, continue running the pump, but with the valves open and monitor the Fuelling correction.	change in fuelling correction	< 0.08	time after engine start  purge status  active test counter	> 0.711 > 580 sec  ramped to zero & wait 3.0 sec > 0		

If the above table does not include details of the following enabling conditions: - IAT, ECT, vehicle speed range, and time after engine start-up then the state of these parameters has no influence upon the execution of the monitor.