Secondary Air Injection System Operation

When the engine is started, the engine control module checks the engine coolant temperature and if it is below 55° C, the ECM grounds the electrical connection to the coil of the secondary air injection (SAI) pump relay.

A 12V battery supply is fed to the inertia switch via fuse 13 in the engine compartment fusebox. When the inertia switch contacts are closed, the feed passes through the switch and is connected to the coil of the Main relay. An earth connection from the Main relay coil is connected to the ECM. When the ECM completes the earth path, the coil energises and closes the contacts of the Main relay.

The Main and Secondary Air Injection (SAI) pump relays are located in the engine compartment fusebox. When the contacts of the Main relay are closed, a 12V battery supply is fed to the coil of the SAI pump relay. An earth connection from the coil of the SAI pump relay is connected to the ECM. When the ECM completes the earth path, the coil energises and closes the contacts of the SAI pump relay to supply 12V to the SAI pump via fusible link 2 in the engine compartment fusebox. The SAI pump starts to operate, and will continue to do so until the ECM switches off the earth connection to the coil of the SAI pump relay.

The SAI pump remains operational for a period determined by the ECM and depends on the starting temperature of the engine, or for a maximum operation period determined by the ECM if the target engine coolant temperature has not been reached in the usual time.

When the contacts of the main relay are closed, a 12V battery supply is fed to the SAI solenoid valve via Fuse 2 in the engine compartment fusebox.

The ECM grounds the electrical connection to the SAI vacuum solenoid valve at the same time as it switches on the SAI pump motor. When the SAI vacuum solenoid valve is energised, a vacuum is provided to the operation control ports on both of the vacuum operated SAI control valves at the exhaust manifolds. The control vacuum is sourced from the intake manifold depression and routed to the SAI control valves via a vacuum reservoir and the SAI vacuum solenoid valve.

The vacuum reservoir is included in the vacuum supply circuit to prevent vacuum fluctuations caused by changes in the intake manifold depression affecting the operation of the SAI control valves.

When a vacuum is applied to the control ports of the SAI control valves, the valves open to allow pressurised air from the SAI pump to pass through to the exhaust ports in the cylinder heads for combustion.

When the ECM has determined that the SAI pump has operated for the desired duration, it switches off the earth paths to the SAI pump relay and the SAI vacuum solenoid valve. With the SAI vacuum solenoid valve de-energised, the valve closes, cutting off the vacuum supply to the SAI control valves. The SAI control valves close immediately and completely to prevent any further pressurised air from the SAI pump entering the exhaust manifolds.

The engine coolant temperature sensor incurs a time lag in respect of detecting a change in temperature and the SAI pump automatically enters a 'soak period' between operations to prevent the SAI pump overheating. The ECM also compares the switch off and start up temperatures, to determine whether it is necessary to operate the SAI pump. This prevents the pump running repeatedly and overheating on repeat starts.

Other factors which may prevent or stop SAI pump operation include the prevailing engine speed / load conditions.