Torque Based Electronic Throttle Control (ETC)

Overview

The torque based ETC is a hardware and software strategy that delivers an engine output torque (via throttle angle) based on driver demand (pedal position). It uses an electronic throttle body throttle actuator control (TAC), the PCM, and an accelerator pedal assembly to control the throttle opening and engine torque.

Torque based ETC enables aggressive automatic transmission shift schedules (earlier upshifts and later downshifts). This is possible by adjusting the throttle angle to achieve the same wheel torque during shifts, and by calculating this desired torque, the system prevents engine lugging (low RPM and low manifold vacuum) while still delivering the performance and torque requested by the driver. It also enables many fuel economy/emission improvement technologies such as variable camshaft timing (VCT), which delivers same torque during transitions.

The torque based ETC system illuminates a powertrain malfunction indicator (wrench) on the instrument panel cluster (IPC) when a concern is present. Concerns are accompanied by diagnostic trouble codes (DTCs) and may also illuminate the malfunction indicator lamp (MIL).

Electronic Throttle Body Throttle Actuator Control (TAC)

For additional information on the electronic throttle body TAC, refer to Engine Control Components in this section.

Electronic Throttle Body Throttle Position Sensor

There is one reference voltage and one signal return circuit between the PCM and the electronic throttle body throttle position sensor. The reference voltage and the signal return circuits are shared with the reference voltage and signal return circuits used by the accelerator pedal position (APP) sensor. On some vehicles, there is one digital throttle position signal circuit. For all others, there are 2 analog throttle position (TP) signal circuits for redundancy. The redundant analog TP signals are required for increased monitoring reasons. The first analog TP signal (TP1) has a negative slope (increasing angle, decreasing voltage) and the second TP signal (TP2) has a positive slope (increasing angle, increasing voltage). The TP2 signal reaches a limit of approximately 4.5 volts at approximately 45 degrees of throttle angle.

For additional information on the electronic throttle body throttle position sensor, refer to Engine Control Components in this section.

Accelerator Pedal Position (APP) Sensor

For additional information on the APP sensor, refer to Engine Control Components in this section.

Electronic Throttle Control (ETC) System Strategy

The ETC strategy was developed to improve fuel economy and to accommodate variable camshaft timing. This is possible by not coupling the throttle angle to the driver pedal position. Uncoupling the throttle angle (produce engine torque) from the pedal position (driver demand) allows the powertrain control strategy to optimize fuel control and transmission shift schedules while delivering the requested wheel torque.

The ETC monitor system is distributed across 2 processors within the PCM: the main powertrain control processor unit (CPU) and a separate monitoring processor. The primary monitoring function is carried out by the independent plausibility checker software, which resides on the main processor. It is responsible for determining the driver demanded torque and comparing it to an estimate of the actual torque delivered. If the generated torque exceeds driver demand by a specified amount, appropriate corrective action is taken.

ETC System Failure Mode and Effects Management:

Effect	Failure Mode

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No Effect On Driveability	A loss of redundancy or loss of a non critical input could result in a concern that does not affect driveability. The powertrain malfunction indicator (wrench) illuminates, but the MIL does not illuminate in this mode. However, cruise control and power take off (PTO) may be disabled. A DTC sets to indicate the component or circuit with the concern.
Delayed APP Sensor Response With Brake Override	This mode is caused by the loss of one APP sensor input due to sensor, wiring, or PCM concerns. The system is unable to verify the APP sensor input and driver demand. The throttle plate response to the APP sensor input is delayed as the accelerator pedal is applied. The engine returns to idle RPM whenever the brake pedal is applied. The powertrain malfunction indicator (wrench) illuminates, but the MIL does not illuminate in this mode. An APP sensor related DTC sets.
Time Based Driver Demand With Brake Override	This mode is caused by the loss of one brake pedal position (BPP) and one APP sensor input or both APP sensor inputs due to sensor, wiring, or PCM concerns. The system is unable to determine driver demand. There is no response when the accelerator pedal is applied. The engine returns to idle RPM whenever the brake pedal is applied. When the brake pedal is released, the PCM slowly increases the APP signal to a fixed value. The powertrain malfunction indicator (wrench) illuminates, but the MIL does not illuminate in this mode. An APP or BPP sensor related DTC sets.
RPM Guard With Pedal Follower	In this mode, torque control is disabled due to the loss of a critical sensor or PCM concern. The throttle is controlled in pedal follower mode as a function of the APP sensor input only. A maximum allowed RPM is determined based on the position of the accelerator pedal (RPM Guard). If the actual RPM exceeds this limit, spark and fuel are used to bring the RPM below the limit. The powertrain malfunction indicator (wrench) and the MIL illuminate in this mode and a DTC for an ETC related component sets. The EGR and VCT outputs are set to default values and cruise control is disabled.
RPM Guard With Default Throttle	In this mode, the throttle plate control is disabled due to the loss of both TP sensor inputs, loss of throttle plate control, stuck throttle plate, significant processor concerns, or other major electronic throttle body concern. The spring returns the throttle plate to the default (limp home) position. A maximum allowed RPM is determined based on the position of the accelerator pedal (RPM Guard). If the actual RPM exceeds this limit, spark and fuel are used to bring the RPM below the limit. The powertrain malfunction indicator (wrench) and the MIL illuminate in this mode and a DTC for an ETC related component sets. The EGR and VCT outputs are set to default values and cruise control is disabled.