ABSTRACT

Toyota succeeded in the fall of 1984 in manufacturing a complex engine and transmission control system using a newly developed single-chip microcomputer. This microcomputer, equipped with an 8K-byte ROM (Read Only Memory) and a 256-byte RAM (Random Access Memory), a powerful real time processing function, and a high-speed optimum instruction set, is better suited for automobiles. Application of the latest CMOS technology has enabled lower power consumption and improved noise immunity. The new system, which includes a new function; the electronic spark advance with knock control in addition to the conventional sophisticated system, has greatly improved the performance and driveability of vehicles. The newly designed electronic control unit (ECU) has been greatly improved in reliability and has not changed in its size with the adoption of the highly integrated new microcomputer, which is due to the fact that it uses fewer LSIs (Large Scale Integrated circuits) than the conventional ECU, although it includes the great additional function.

The functions of the microcomputer based engine control system have increased steadfastly because they have such desirable potentials as lower fuel consumption, lower emission, and better driveability. The engine control systems themselves have become more versatile with the installation of multiple valves and turbochargers, and are being expanded into more sophisticated control systems such as engine and transmission control system.

These changes have demanded that the ECU and the microcomputer which is the heart of an ECU have higher capabilities and increased flexibility. This paper describes the single-chip microcomputer developed through the cooperation of Toyota, Nippondenso, and Toshiba, and the '85 model total engine and transmission control system with newly developed knock control which has incorporated the above mentioned single-chip microcomputer.

OUTLINE OF THE SYSTEM

This system has been adopted in the '85 model Celica Supra and Cressida with a 2.8 liter 6-cylinder DOHC engine. This system is equipped with the knock control function in addition to the multiple control functions adopted from the '83 model such as fuel injection, electronic spark advance, EGR (exhaust gas recirculation), idle speed control, self-diagnosis, self-adaptive control, backup circuit for CPU failure, and a complex control which works together with an electronic controlled transmission (ECT) system. The system schematic is shown in Figure 1.

The knock control function makes it possible to maintain the optimum ignition timing control under condition without being limited by the situations which often induce knocking, or by the lowest octane commercial gasoline.

KNOCK CONTROL SYSTEM

The knock sensor, a resonance type piezo-electric device, is mounted on the engine block. The resonance frequency (fo) is 7.5 kHz, and the resonance gain (Q) is 38 dB.

Inside the ECU, knock sensor signals are sent to the general purpose 4-bit single-chip microcomputer with a built-in A/D converter. The knock sensor signal is picked up between 10° ATDC and 90° ATDC by crank angle to reduce the seating noise of the intake and exhaust valves and ignition noise, and is evaluated at four levels at each cylinder, and the knock level signal is sent to the main microcomputer. When there is no knocking within the knock control range, a preset amount of spark advance compensation is selected, while spark delay compensation at five levels is determined by the level and frequency of knocking when knocking is detected. Through changing the amount of spark delay compensation depending on