

This paper will describe outstanding characteristics of a new 16-bit microcomputer, jointly developed by the Toyota, Nippondenso, Toshiba and Motorola, followed by the description of an advanced engine and transmission control system utilizing this microcomputer.

3. Development Goals

Toyota has modified and improved the custom designed 8-bit microcomputer series in current use and begun manufacturing a 2nd generation microcomputer, which was first used in the 1991 model year.

The 2nd generation microcomputers have been enhanced in a number of significant ways, as follows:

- Increase internal clock (12MHz to 16MHz)
- Increase of internal memory capacity up to 16 kilobytes (KB) ROM
- Addition of a serial I/O with direct memory access function to facilitate high-speed data communication between single-chip microcomputers
- Addition of a built-in analog-to-digital (A/D) converter
- Applying 1.5 μ design rules

The 2nd generation microcomputers fully satisfy all functional requirements for the combined engine and transmission control systems that are currently in mass production.

However, requirements are expected to increase sharply, with respect to the variety of functions to be provided by the combined engine and transmission control system, and this will create the need for a new microcomputer, functioning at an even higher level than the 2nd generation 8-bit microcomputers. In order for this new microcomputer to accomplish both current and future requirements, a number of functions must be enhanced, including significant

increases in operational processing speed, reduction of load on the central processing unit (CPU) for interrupt processing, high-speed and high-precision I/O ports, improved interface functions, and a large memory.

Thorough consideration has been given to design and manufacturing changes that would be required to guarantee the high reliability established by the previous 8-bit microcomputer series. The market record of the 1989 model vehicles has been outstanding ---- absolutely no defects have emerged, and the highest possible quality record has been achieved. Any new microcomputer must provide reliability comparable with this record.

On the basis of the requirements described above, the following eight targets were set for the development of the new microcomputer:

- 16-bit data length
- Increased CPU speed
- Development of intelligent functions for high-speed I/O ports
- Improvement of data communication between microcomputers
- Large memory on chip
- Wide operational temperature and voltage range
- To adopt single-chip architecture
- High reliability

It was assumed that this microcomputer, satisfying the above requirements, would continue to represent state-of-the-art technology for even 3 to 5 years after its development in real-time control systems in automobiles.

Table 1 compares the 8-bit microcomputer in current use with the new 16-bit microcomputer.

4. Features of the New 16-bit Microcomputer

A block diagram of the new 16-bit microcomputer