

For example, in systems which use multiple single-chip microcomputers for engine and transmission control, a good deal of data is used in common by the two systems, such as engine speed data and throttle opening data. Use of the DMAC in these cases enables one microcomputer to utilize the data collected by another microcomputer by simply reading its own memory, which vastly facilitates high-speed processing.

#### Serial Input/Output Port (SIO)

SIO is used for the serial transmission of data to and from other microcomputers or to and from peripheral devices. Individual buffer registers have been provided for transmission and reception, so that the transmission and reception areas can function independently. Two full duplex transmission modes are provided, i. e., an asynchronous mode and a synchronous mode. Two check functions have been added to increase the reliability of received data and to ensure that no malfunctions have occurred due to noise. Furthermore, data can be transmitted with the SIO reception or transmission area using the DMA function described above.

#### Serial Extension Interface (SEI)

SEI is used for serial transmission between independent peripheral devices. Fig. 6 shows an example of the interface used with an external A/D converter. When the SEI is informed via the end of conversion (EOC) line that the A/D conversion has been completed, data is moved from the buffer register to the shift register, and the shift is commenced. The shift clock is output in 16 bits, the same length as

an interrupt request and a DMA request are issued simultaneously, and received data is transmitted to the internal RAM. In other words, even if the CPU does not activate the A/D converter at each individual operation, A/D conversion data can be received through interrupt processing.

#### Programmable Interrupt Controller (PIC)

The PIC is used to establish priority control in cases where interrupt requests overlap, or where an interrupt request overlap with the processing of another interrupt. There are 31 independent causes of interrupts, including FTI, SIO, non-maskable interrupts (NMI) and software interrupts. The priority order for interrupts is programmable, and seven different levels can be set. The addition of the context switch function has reduced interrupt overhead time to a mere 2.5  $\mu$ sec.

#### Instruction Set

The instruction set for this microcomputer is a superset of the MC68000 instruction set.

Six new instructions have been added to specifically address the requirements of this automotive application. Four of these instructions (SETB, CLRB, BRSET, BRCLR) are bit operation instructions and have been widely used in the previous and current 8-bit microcomputer solutions. In the current engine control applications, these instructions often represent 15 to 20 percent of the total number of instructions in a given program. Without these instructions, use of a similar programming approach could increase the size of program memory by as much as 10 to 15 percent. The