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MOTOROLA
Semiconductor Products Inc.

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Application Note

# INTERFACING AND CONTROLLING DIGITAL TEMPERATURE DATA USING THE MC6800

The MC6821 and the MC6800 coupled with a suitable digital temperature device make a valuable tool for maintaining a stable temperature in various control applications. Upper and lower temperature bounds may be set within the software providing a variable temperature window. The microprocessor can check the temperature preset by boundaries and send external signals to regulate the thermionic device. An overall system block diagram is shown in Figure 1.

Eight bits of temperature data are handwired to the MC6821 PIA. The MC6821 provides the universal means of interfacing peripheral equipment to the MC6800 MPU through two 8-bit bidirectional lines. Normally no external logic is required for interfacing to most peripheral devices.

The MC6821 is programmed by the MC6800 MPU. In this system PIA Port B was used which consists of eight lines which may be programmed as an input or output depending on how the PIA is programmed. The MC6821 is internally addressed in order to configure the data and control lines. Table 1 shows the internal addressing for the MC6821.

To set the direction of the data lines the Data Direction Register must be accessed by writing a "0" into bit 2 of the Control Register. This selects the Data Direction Register and now the corresponding address for this register (see Table 1) may be written to configure the individual lines as inputs or outputs. A Data Direction Register bit set at "0" makes the corresponding line an input and a "1" makes the corresponding line an output.

In order to access the Peripheral Register it is necessary to write a "1" into bit 2 of the Control Register. This selects the Peripheral Register which means the lines set as outputs may be written into the lines set as inputs may be read from.

**TABLE 1 – INTERNAL ADDRESSING**

| | | Control Register Bit | | |
|---|---|---|---|---|
| RS1 | RS0 | CRA-2 | CRB-2 | Location Selected |
| 0 | 0 | 1 | X | Peripheral Register A |
| 0 | 0 | 0 | X | Data Direction Register A |
| 0 | 1 | X | X | Control Register A |
| 1 | 0 | X | 1 | Peripheral Register B |
| 1 | 0 | X | 0 | Data Direction Register B |
| 1 | 1 | X | X | Control Register B |

X = Don't Care

For example, assume the PIA is at address location $5000 and PIA port B bits PB0 through PB7 are to be outputs. A possible software approach would be:

| | |
|---|---|
| CLRA | Clear accumulator A insuring bit 2 contains a zero. |
| STAA $5003 | This stores a zero into bit 2 of the Control Register and selects the Data Direction Register. |
| LDAA #$FF | Load accumulator A with all ones. |
| STAA $5002 | This makes PB0 through PB7 outputs. |
| LDAA #$04 | Puts a "1" into bit 2. |
| STAA $5003 | Stores a "1" into bit 2 of control register allowing data to be written to PB0 to PB7. |
| LDAA #$OF | |
| STAA $5002 | This would put the actual bit pattern output "0001111" on the PB0 through PB7 lines. |

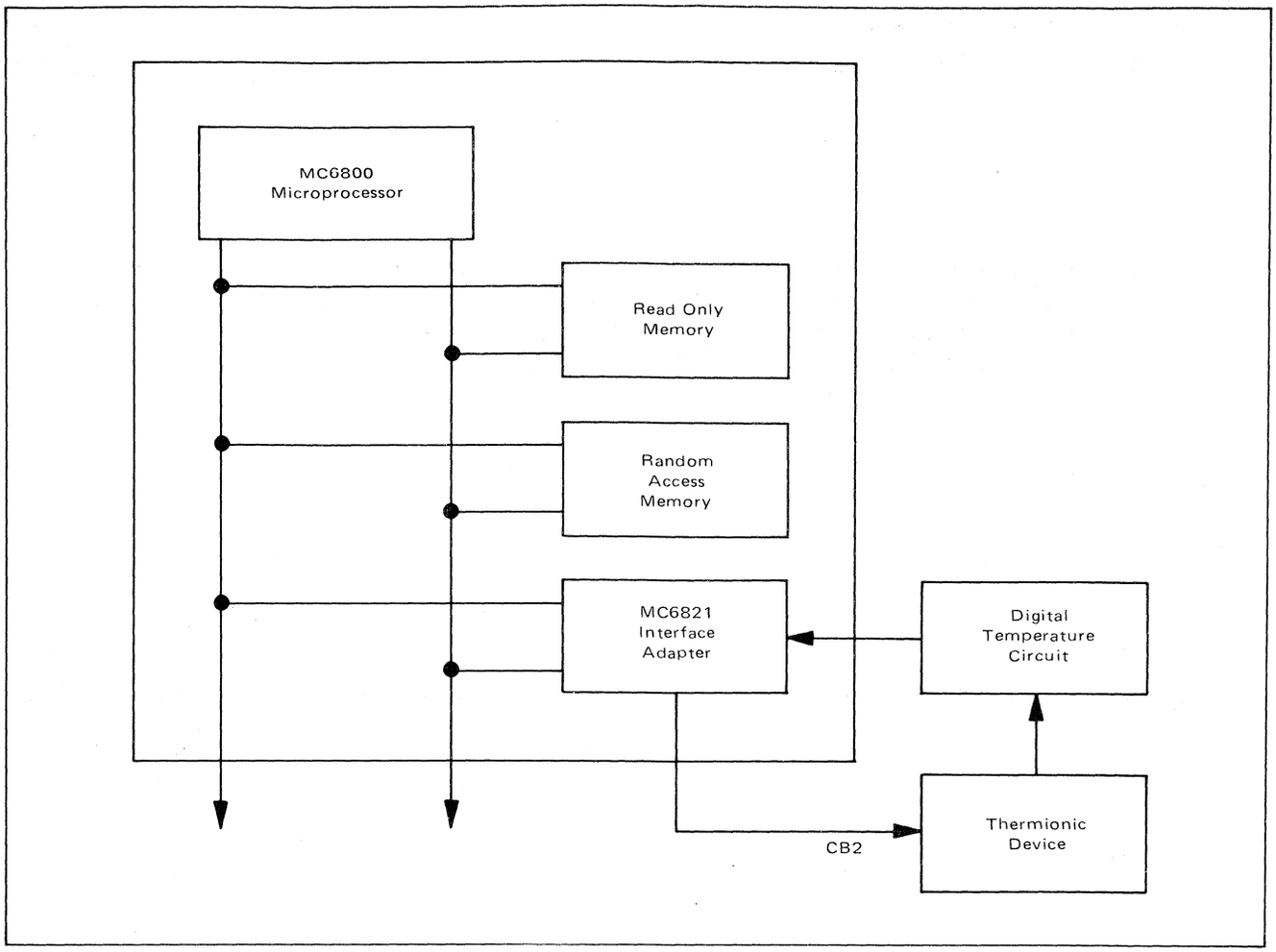


**FIGURE 1. System Block Diagram**

### Temperature Control System

The software which monitors the digital temperature data and decides if it is too high or too low is shown in Figure 2.

The upper and lower temperatures may be easily changed within the software for a variable temperature window. The Software Interrupt Command (SWI) causes a system interrupt if the temperature extends above or below the "window." In the software example, the temperatures were set for 27°C and 17°C. The software monitors the incoming temperature and goes to SWI if the temperature is equal to or greater than 27°C or equal to or less than 17°C. If a device such as an oven were to be turned on/off, the control bits CA2 (CB2) could be set accordingly to control the device. As shown in Figure 3, bits 3, 4 and 5 of the Control Register can be configured to Set/Reset CA2. For example, the instructions below would manipulate CA2.

To turn CA2 on:

| | |
|---|---|
| LDAA #$3C | Load accumulator A with 0011 1100 CA2 goes high |
| STAA $5001 | Store accumulator A into the Control Register. |

To turn CA2 off:

| | |
|---|---|
| LDAA #$34 | Load accumulator A with 0011 0100 CA2 goes low |
| STAA $5001 | Store accumulator A into the Control Register. |

The data input to the MC6821 PIA is not necessarily restricted to digital temperature data. Any device which provides or accepts digital data can be interfaced to the MC6800 MPU through the MC6821 PIA. Manipulation of the software allows for a variety of applications.

| NAM | TEMPS |
|---|---|
| CLRA | Insures a '0' in bit 2. |
| STAA $5003 | Stores a '0' in bit 2 of the Control Register which selects the Data Direction Register. |
| STAA $5002 | Stores all zeros into the Data Direction Register making PIA Port B. PBO to PB7 lines all inputs. This will input the digital temperature data from the temperature device. |
| LDAA #$04 | Puts a '1' in bit 2. |
| STAA $5003 | Stores a '1' in bit 2 of the Control Register which selects the Output Register. The P0 to PB7 may be read at $5002 for the data being applied to them. |
| LBL1/LDAA #$27 | The upper temperatures limit. |
| LDAB $5002 | Load in the digital temperature data which is on the PB0 to PB7 lines. |
| CBA | Compare the temperatures. |
| BLE ALERT | If equal to or greater then 27 interrupt. |
| LDAA #$17 | Lower temperature limit. |
| LDAB $5002 | Input temperature from sense circuit. |
| CBA | Compare the temperatures. |
| BGE ALERT | If equal to or less than 17 go to location ALERT and SWI. |
| BRA LBL1 | Branch back if within temperature window. |
| ALERT/SWI | Software Interrupt |

**FIGURE 2. Temperature Control Software**

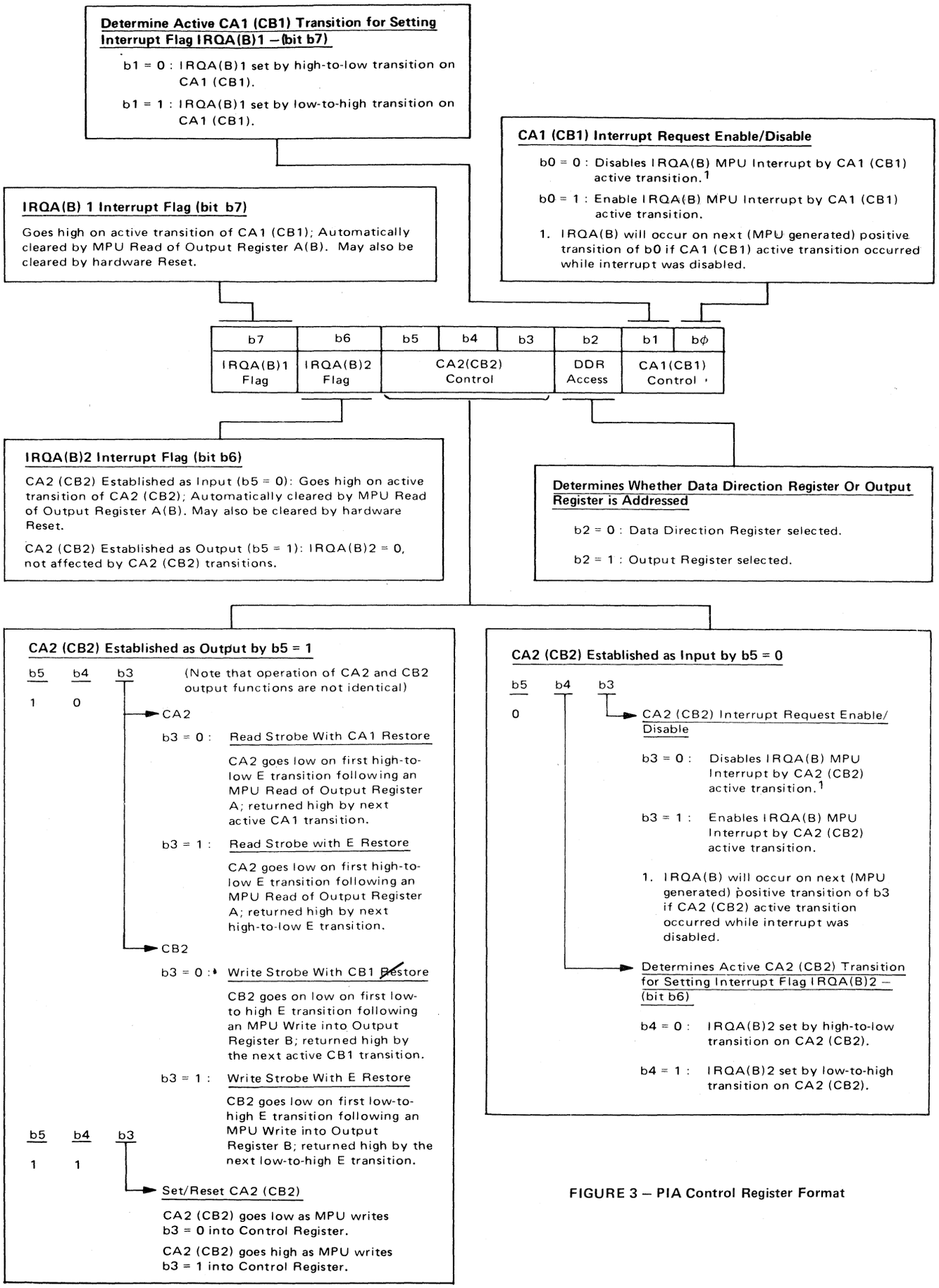


FIGURE 3 – PIA Control Register Format