

# Z86093

## ROMLESS CMOS 8-BIT Z8<sup>®</sup> MCU

### FEATURES

| Device | ROM (KB) | RAM* (Bytes) | Speed (MHz) |
|--------|----------|--------------|-------------|
| Z86093 | N/A      | 236          | 16          |

Note: \*General-Purpose

- 40-Pin DIP, 44-Pin PLCC and QFP Packages
- 3.0- to 5.5-Volt Operating Range
- Available Temperature Ranges:  
S = 0°C to 70°C  
E = -40°C to +105°C
- 32 Input/Output Lines
- Six Vectored, Prioritized Interrupts from Six Different Sources
- Two On-Chip Analog Comparators
- Two Programmable 8-Bit Counter/Timers, Each with Two 6-Bit Programmable Prescaler
- Power-On Reset (POR)
- Low-Power Consumption
- Expanded Register File (ERF)
- Programmable Interrupt Polarity
- Optional Features Required Selections:
  - ROM Protect - Disabled
  - RAM Protect - Disabled
  - WDT - Enabled by Software Only
  - Autolatches - Enabled
  - Clock Source - Crystal, Ceramic Resonator, LC, or External Clock Drive

### GENERAL DESCRIPTION

The Z86093 is a ROMless member of Zilog's Z8<sup>®</sup> MCU single-chip family with 236 bytes of general purpose RAM. It is available in a 40-pin DIP package, 44-pin PLCC package, and 44-pin QFP package. The Z86093 offers the use of external memory which enables this Z8<sup>®</sup> MCU to be used where code flexibility is required. Zilog's CMOS MCUs offer fast execution, efficient use of memory, sophisticated interrupts, input/output bit manipulation capabilities, and easy hardware/software system expansion along with low cost and low power consumption.

The Z86093 features an Expanded Register File (ERF) to allow access to register-mapped peripheral and I/O circuits. Four basic address spaces are available to support this wide range of configurations: Program Memory, Register File, Data Memory, and ERF. The Register File is composed of 236 bytes of general-purpose registers, four

I/O port registers, and 15 control and status registers. The ERF consists of three control registers.

For applications demanding powerful I/O capabilities, the Z86093's 32 input and output lines are grouped into four ports, and are configurable under software control to provide timing, status signals, parallel I/O with or without handshake, and address/data bus for interfacing external memory.

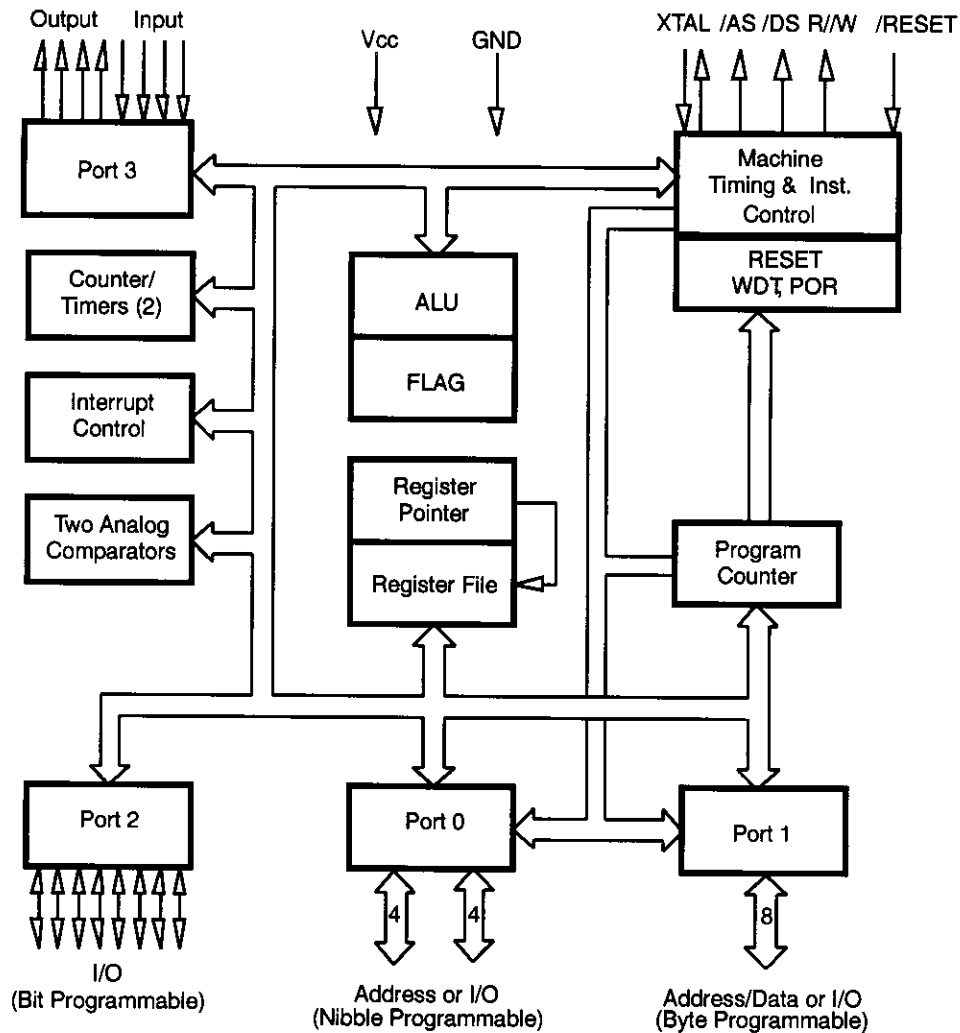
Two on-chip counter/timers, with a large number of user selectable modes, off-load the system of administering real-time tasks such as counting/timing and I/O data communications. Additionally, two on-chip comparators process analog signals with a common reference voltage (Figure 1).

**GENERAL DESCRIPTION (Continued)**

**Notes:** All signals with a preceding front slash, "/", are active Low. For example, B/W (WORD is active Low); /B/W (BYTE is active Low, only).

Power connections follow conventional descriptions below:

| Connection | Circuit         | Device          |
|------------|-----------------|-----------------|
| Power      | V <sub>CC</sub> | V <sub>DD</sub> |
| Ground     | GND             | V <sub>SS</sub> |



**Figure 1. Functional Block Diagram**

## PIN DESCRIPTION

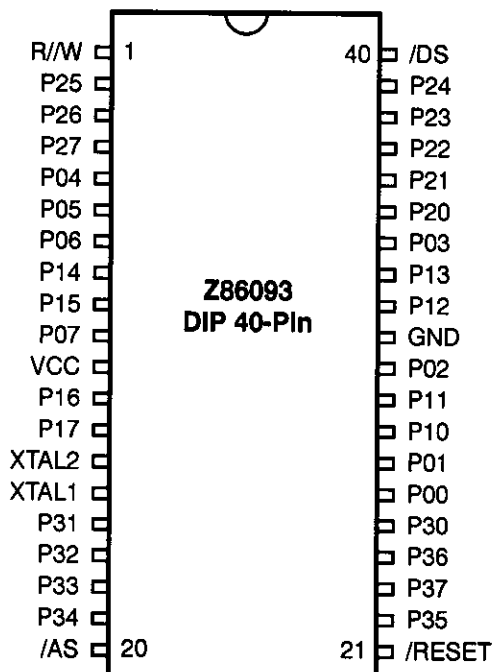


Figure 2. 40-Pin DIP Assignments

Table 1. 40-Pin Dual-In-Line Package Pin Identification

| Pin # | Symbol          | Function                  | Direction |
|-------|-----------------|---------------------------|-----------|
| 1     | R/W             | Read/Write                | Output    |
| 2-4   | P25-27          | Port 2, Pins 5,6,7        | In/Output |
| 5-7   | P04-06          | Port 0, Pins 4,5,6        | In/Output |
| 8-9   | P14-15          | Port 1, Pins 4,5          | In/Output |
| 10    | P07             | Port 0, Pin 7             | In/Output |
| 11    | V <sub>CC</sub> | Power Supply              |           |
| 12-13 | P16-17          | Port 1, Pins 6,7          | In/Output |
| 14    | XTAL2           | Crystal, Oscillator Clock | Output    |
| 15    | XTAL1           | Crystal, Oscillator Clock | Input     |
| 16-18 | P31-33          | Port 3, Pins 1,2,3        | Input     |
| 19    | P34             | Port 3, Pin 4             | Output    |
| 20    | /AS             | Address Strobe            | Output    |

Table 1. 40-Pin Dual-In-Line Package Pin Identification

| Pin # | Symbol | Function              | Direction |
|-------|--------|-----------------------|-----------|
| 21    | /RESET | Reset                 | Input     |
| 22    | P35    | Port 3, Pin 5         | Output    |
| 23    | P37    | Port 3, Pin 7         | Output    |
| 24    | P36    | Port 3, Pin 6         | Output    |
| 25    | P30    | Port 3, Pin 0         | Input     |
| 26-27 | P00-01 | Port 0, Pin 0,1       | In/Output |
| 28-29 | P10-11 | Port 1, Pin 0,1       | In/Output |
| 30    | P02    | Port 0, Pin 2         | In/Output |
| 31    | GND    | Ground                |           |
| 32-33 | P12-13 | Port 1, Pin 2,3       | In/Output |
| 34    | P03    | Port 0, Pin 3         | In/Output |
| 35-39 | P20-24 | Port 2, Pin 0,1,2,3,4 | In/Output |
| 40    | /DS    | Data Strobe           | Output    |

PIN DESCRIPTION (Continued)

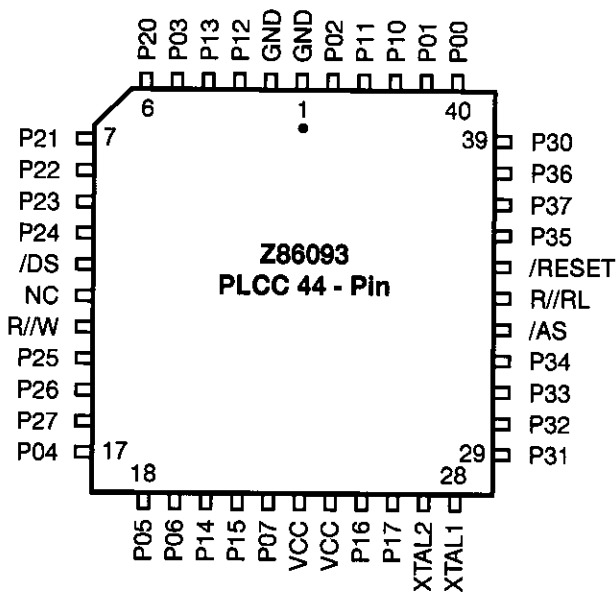


Figure 3. 44-Pin PLCC Pin Assignments

Table 2. 44-Pin PLCC Pin Identification

| Pin # | Symbol          | Function               | Direction |
|-------|-----------------|------------------------|-----------|
| 1-2   | GND             | Ground                 |           |
| 3-4   | P12-13          | Port 1, Pins 2,3       | In/Output |
| 5     | P03             | Port 0, Pin 3          | In/Output |
| 6-10  | P20-24          | Port 2, Pins 0,1,2,3,4 | In/Output |
| 11    | /DS             | Data Strobe            | Output    |
| 12    | N/C             | Not Connected          |           |
| 13    | R//W            | Read/Write             | Output    |
| 14-16 | P25-27          | Port 2, Pins 5,6,7     | In/Output |
| 17-19 | P04-06          | Port 0, Pins 4,5,6     | In/Output |
| 20-21 | P14-15          | Port 1, Pins 4,5       | In/Output |
| 22    | P07             | Port 0, Pin 7          | In/Output |
| 23,24 | V <sub>CC</sub> | Power Supply           |           |
| 25-26 | P16-17          | Port 1, Pins 6,7       | In/Output |

Table 2. 44-Pin PLCC Pin Identification

| Pin # | Symbol | Function                  | Direction |
|-------|--------|---------------------------|-----------|
| 27    | XTAL2  | Crystal, Oscillator Clock | Output    |
| 28    | XTAL1  | Crystal, Oscillator Clock | Input     |
| 29-31 | P31-33 | Port 3, Pins 1,2,3        | Input     |
| 32    | P34    | Port 3, Pin 4             | Output    |
| 33    | /AS    | Address Strobe            | Output    |
| 34    | R//RL  | ROM/ROMless Control       | Input     |
| 35    | /RESET | Reset                     | Input     |
| 36    | P35    | Port 3, Pin 5             | Output    |
| 37    | P37    | Port 3, Pin 7             | Output    |
| 38    | P36    | Port 3, Pin 6             | Output    |
| 39    | P30    | Port 3, Pin 0             | Input     |
| 40-41 | P00-01 | Port 0, Pins 0,1          | In/Output |
| 42-43 | P10-11 | Port 1, Pins 0,1          | In/Output |
| 44    | P02    | Port 0, Pin 2             | In/Output |

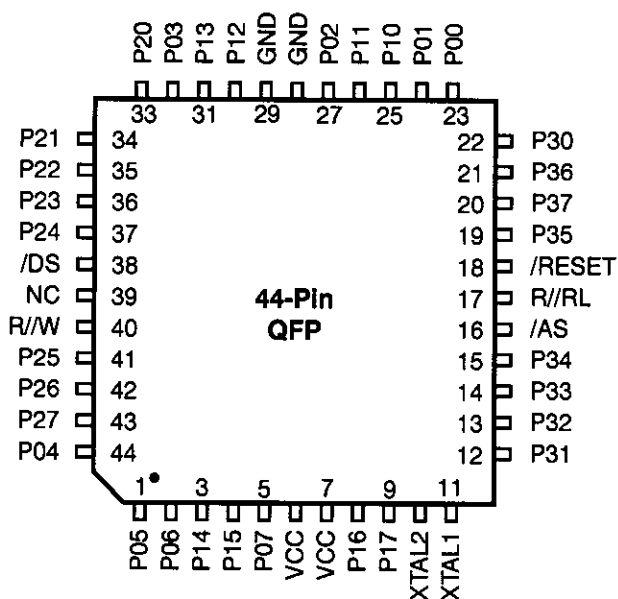


Figure 4. 44-Pin QFP Pin Assignments

Table 3. 44-Pin QFP Pin Identification

| Pin # | Symbol          | Function                  | Direction |
|-------|-----------------|---------------------------|-----------|
| 1-2   | P05-06          | Port 0, Pins 5,6          | In/Output |
| 3-4   | P14-15          | Port 1, Pins 4,5          | In/Output |
| 5     | P07             | Port 0, Pin 7             | In/Output |
| 6-7   | V <sub>CC</sub> | Power Supply              |           |
| 8-9   | P16-17          | Port 1 Pins 6,7           | In/Output |
| 10    | XTAL2           | Crystal, Oscillator Clock | Output    |
| 11    | XTAL1           | Crystal, Oscillator Clock | Input     |
| 12-14 | P31-33          | Port 3, Pins 1,2,3        | Input     |
| 15    | P34             | Port 3, Pin 4             | Output    |
| 16    | /AS             | Address Strobe            | Output    |
| 17    | R//RL           | ROM/ROMless Control       | Input     |
| 18    | /RESET          | Reset                     | Input     |
| 19    | P35             | Port 3, Pin 5             | Output    |
| 20    | P37             | Port 3, Pin 7             | Output    |

Table 3. 44-Pin QFP Pin Identification

| Pin # | Symbol | Function               | Direction |
|-------|--------|------------------------|-----------|
| 21    | P36    | Port 3, Pin 6          | Output    |
| 22    | P30    | Port 3, Pin 0          | Input     |
| 23-24 | P00-01 | Port 0, Pins 0,1       | In/Output |
| 25-26 | P10-11 | Port 1, Pins 0,1       | In/Output |
| 27    | P02    | Port 0, Pin 2          | In/Output |
| 28-29 | GND    | Ground                 |           |
| 30-31 | P12-13 | Port 1, Pins 2,3       | In/Output |
| 32    | P03    | Port 0, Pin 3          | In/Output |
| 33-37 | P20-24 | Port 2, Pins 0,1,2,3,4 | In/Output |
| 38    | /DS    | Data Strobe            | Output    |
| 39    | N/C    | Not Connected          |           |
| 40    | R//W   | Read/Write             | Output    |
| 41-43 | P25-27 | Port 2, Pins 5,6,7     | In/Output |
| 44    | P04    | Port 0, Pin 4          | In/Output |

## ABSOLUTE MAXIMUM RATINGS

| Parameter  | Min  | Max                | Units | Notes |
|--|------|--------------------|-------|-------|
| Ambient Temperature under Bias                                   | -40  | +105               | C     |       |
| Storage Temperature  | -65  | +150               | C     |       |
| Voltage on any Pin with Respect to V <sub>SS</sub>               | -0.6 | +7                 | V     | 1     |
| Voltage on V <sub>DD</sub> Pin with Respect to V <sub>SS</sub>   | -0.3 | +7                 | V     |       |
| Voltage on XTAL1 and /RESET Pins with Respect to V <sub>SS</sub> | -0.6 | V <sub>DD</sub> +1 | V     | 2     |
| Total Power Dissipation  |      | 1.21               | W     |       |
| Maximum Allowable Current out of V <sub>SS</sub>                 |      | 220                | mA    |       |
| Maximum Allowable Current into V <sub>DD</sub>                   |      | 180                | mA    |       |
| Maximum Allowable Current into an Input Pin                      | -600 | +600               | μA    | 3     |
| Maximum Allowable Current into an Open-Drain Pin                 | -600 | +600               | μA    | 4     |
| Maximum Allowable Output Current Sunked by Any I/O Pin           |      | 25                 | mA    |       |
| Maximum Allowable Output Current Sourced by Any I/O Pin          |      | 25                 | mA    |       |

### Notes:

1. This applies to all pins except XTAL pins and where otherwise noted.
2. There is no input protection diode from pin to V<sub>DD</sub> and current into pin is limited to ±600 μA
3. This excludes XTAL pins.
4. Device pin is not at an output Low state.

Stresses greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at any condition above those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for an extended period may affect device reliability.

Total power dissipation should not exceed 1.21 W for the package. Power dissipation is calculated as follows:

$$\begin{aligned} \text{Total Power Dissipation} = & V_{DD} \times [ I_{DD} - (\text{sum of } I_{OH}) ] \\ & + \text{sum of } [ (V_{DD} - V_{OH}) \times I_{OH} ] \\ & + \text{sum of } (V_{OL} \times I_{OL}) \end{aligned}$$

## STANDARD TEST CONDITIONS

The characteristics listed below apply for standard test conditions as noted. All voltages are referenced to GND. Positive current flows into the referenced pin (see Figure 7.)

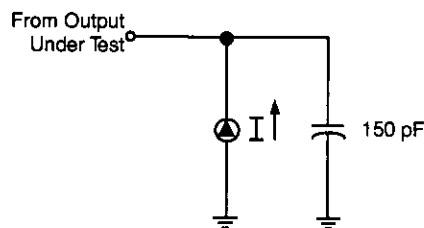


Figure 5. Test Load Diagram

## CAPACITANCE

T<sub>A</sub> = 25°C, V<sub>CC</sub> = GND = 0V, f = 1.0 MHz, Unmeasured pins to GND

| Parameter          | Min | Max   |
|--------------------|-----|-------|
| Input capacitance  | 0   | 12 pF |
| Output capacitance | 0   | 12 pF |
| I/O capacitance    | 0   | 12 pF |

## DC ELECTRICAL CHARACTERISTICS

| Sym                 | Parameter                             | V <sub>CC</sub><br>Note [3] | T <sub>A</sub> = 0° C<br>to +70° C |                      | T <sub>A</sub> = -40° C<br>to +105° C |                      | Typical [1]<br>@ 25° C | Units | Conditions                               | Notes |
|---------------------|---------------------------------------|-----------------------------|------------------------------------|----------------------|---------------------------------------|----------------------|------------------------|-------|--|-------|
|                     |                                       |                             | Min                                | Max                  | Min                                   | Max                  |                        |       |  |       |
| V <sub>CH</sub>     | Clock Input<br>High Voltage           | 3.0V                        | 0.7 V <sub>CC</sub>                | V <sub>CC</sub> +0.3 | 0.7 V <sub>CC</sub>                   | V <sub>CC</sub> +0.3 | 1.8                    | V     | Driven by<br>External Clock<br>Generator |       |
|                     |                                       | 5.5V                        | 0.7 V <sub>CC</sub>                | V <sub>CC</sub> +0.3 | 0.7 V <sub>CC</sub>                   | V <sub>CC</sub> +0.3 | 2.6                    | V     | Driven by<br>External Clock<br>Generator |       |
| V <sub>CL</sub>     | Clock Input<br>Low Voltage            | 3.0V                        | GND-0.3                            | 0.2 V <sub>CC</sub>  | GND-0.3                               | 0.2 V <sub>CC</sub>  | 1.2                    | V     | Driven by<br>External Clock<br>Generator |       |
|                     |                                       | 5.5V                        | GND-0.3                            | 0.2 V <sub>CC</sub>  | GND-0.3                               | 0.2 V <sub>CC</sub>  | 2.1                    | V     | Driven by<br>External Clock<br>Generator |       |
| V <sub>IH</sub>     | Input High<br>Voltage                 | 3.0V                        | 0.7 V <sub>CC</sub>                | V <sub>CC</sub> +0.3 | 0.7 V <sub>CC</sub>                   | V <sub>CC</sub> +0.3 | 1.8                    | V     |  |       |
|                     |                                       | 5.5V                        | 0.7 V <sub>CC</sub>                | V <sub>CC</sub> +0.3 | 0.7 V <sub>CC</sub>                   | V <sub>CC</sub> +0.3 | 2.6                    | V     |  |       |
| V <sub>IL</sub>     | Input Low<br>Voltage                  | 3.0V                        | GND-0.3                            | 0.2 V <sub>CC</sub>  | GND-0.3                               | 0.2 V <sub>CC</sub>  | 1.1                    | V     |  |       |
|                     |                                       | 5.5V                        | GND-0.3                            | 0.2 V <sub>CC</sub>  | GND-0.3                               | 0.2 V <sub>CC</sub>  | 1.6                    | V     |  |       |
| V <sub>OH1</sub>    | Output High<br>Voltage                | 3.0V                        | V <sub>CC</sub> -0.4               |                      | V <sub>CC</sub> -0.4                  |                      | 3.1                    | V     | I <sub>OH</sub> = -2.0 mA                | 8     |
|                     |                                       | 5.5V                        | V <sub>CC</sub> -0.4               |                      | V <sub>CC</sub> -0.4                  |                      | 4.8                    | V     | I <sub>OH</sub> = -2.0 mA                | 8     |
| V <sub>OL1</sub>    | Output Low<br>Voltage                 | 3.0V                        |                                    | 0.6                  |                                       | 0.6                  | 0.2                    | V     | I <sub>OL</sub> = +4.0 mA                | 8     |
|                     |                                       | 5.5V                        |                                    | 0.4                  |                                       | 0.4                  | 0.1                    | V     | I <sub>OL</sub> = +4.0 mA                | 8     |
| V <sub>OL2</sub>    | Output Low<br>Voltage                 | 3.0V                        |                                    | 1.2                  |                                       | 1.2                  | 0.3                    | V     | I <sub>OL</sub> = +6 mA                  | 8     |
|                     |                                       | 5.5V                        |                                    | 1.2                  |                                       | 1.2                  | 0.4                    | V     | I <sub>OL</sub> = +12 mA                 | 8     |
| V <sub>RH</sub>     | Reset Input<br>High Voltage           | 3.0V                        | .8 V <sub>CC</sub>                 | V <sub>CC</sub>      | .8 V <sub>CC</sub>                    | V <sub>CC</sub>      | 1.8                    | V     |  | 13    |
|                     |                                       | 5.5V                        | .8 V <sub>CC</sub>                 | V <sub>CC</sub>      | .8 V <sub>CC</sub>                    | V <sub>CC</sub>      | 2.6                    | V     |  | 13    |
| V <sub>RI</sub>     | Reset Input<br>Low Voltage            | 3.0V                        | GND-0.3                            | 0.2 V <sub>CC</sub>  | GND-0.3                               | 0.2 V <sub>CC</sub>  | 1.1                    | V     |  | 13    |
|                     |                                       | 5.5V                        | GND-0.3                            | 0.2 V <sub>CC</sub>  | GND-0.3                               | 0.2 V <sub>CC</sub>  | 1.6                    | V     |  | 13    |
| V <sub>OLR</sub>    | Reset Output<br>Low Voltage           | 3.0V                        |                                    | 0.6                  |                                       | 0.6                  | 0.3                    | V     | I <sub>OL</sub> = +1.0 mA                | 13    |
|                     |                                       | 5.5V                        |                                    | 0.6                  |                                       | 0.6                  | 0.3                    | V     | I <sub>OL</sub> = +1.0 mA                | 13    |
| V <sub>OFFSET</sub> | Comparator<br>Input Offset<br>Voltage | 3.0V                        |                                    | 25                   |                                       | 25                   | 10                     | mV    |  | 10    |
|                     |                                       | 5.5V                        |                                    | 25                   |                                       | 25                   | 10                     | mV    |  | 10    |
| I <sub>IL</sub>     | Input Leakage                         | 3.0V                        | -1                                 | 2                    | -1                                    | 2                    | 0.004                  | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub>    |       |
|                     |                                       | 5.5V                        | -1                                 | 2                    | -1                                    | 2                    | 0.004                  | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub>    |       |
| I <sub>OL</sub>     | Output<br>Leakage                     | 3.0V                        | -1                                 | 1                    | -1                                    | 2                    | 0.004                  | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub>    |       |
|                     |                                       | 5.5V                        | -1                                 | 1                    | -1                                    | 2                    | 0.004                  | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub>    |       |
| I <sub>IR</sub>     | Reset Input<br>Current                | 3.0V                        | -20                                | -130                 | -18                                   | -130                 | -60                    | μA    |  |       |
|                     |                                       | 5.5V                        | -20                                | -180                 | -18                                   | -180                 | -85                    | μA    |  |       |
| I <sub>CC</sub>     | Supply Current                        | 3.0V                        |                                    | 20                   |                                       | 20                   | 7                      | mA    | @ 16 MHz                                 | 4     |
|                     |                                       | 5.5V                        |                                    | 25                   |                                       | 25                   | 20                     | mA    | @ 16 MHz                                 | 4     |
|                     |                                       | 3.0V                        |                                    | 15                   |                                       | 15                   | 5                      | mA    | @ 12 MHz                                 | 4     |
|                     |                                       | 5.5V                        |                                    | 20                   |                                       | 20                   | 15                     | mA    | @ 12 MHz                                 | 4     |

DC ELECTRICAL CHARACTERISTICS (Continued)

| Sym              | Parameter                             | V <sub>CC</sub><br>Note [3] | T <sub>A</sub> = 0° C<br>to +70° C |                       | T <sub>A</sub> = -40° C<br>to +105° C |                       | Typical [1]<br>@ 25° C | Units | Conditions   | Notes       |
|------------------|---------------------------------------|-----------------------------|------------------------------------|-----------------------|---------------------------------------|-----------------------|------------------------|-------|--|-------------|
|                  |                                       |                             | Min                                | Max                   | Min                                   | Max                   |                        |       |  |             |
| I <sub>CC1</sub> | Standby<br>Current<br>(HALT Mode)     | 3.0V                        |                                    | 4.5                   |                                       | 4.5                   | 2.0                    | mA    | V <sub>IN</sub> = 0V, V <sub>CC</sub><br>@ 16 MHz              | 4           |
|                  |                                       | 5.5V                        |                                    | 8                     |                                       | 8                     | 3.7                    | mA    | V <sub>IN</sub> = 0V, V <sub>CC</sub><br>@ 16 MHz              | 4           |
|                  |                                       | 3.0V                        |                                    | 3.4                   |                                       | 3.4                   | 1.5                    | mA    | Clock Divide-<br>by-16 @ 16<br>MHz                             | 4           |
|                  |                                       | 5.5V                        |                                    | 7.0                   |                                       | 7.0                   | 2.9                    | mA    | Clock Divide-<br>by-16 @ 16<br>MHz                             | 4           |
| I <sub>CC2</sub> | Standby<br>Current<br>(STOP Mode)     | 3.0V                        |                                    | 8                     |                                       | 8                     | 2                      | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub><br>WDT is not<br>Running | 6,11        |
|                  |                                       | 5.5V                        |                                    | 10                    |                                       | 10                    | 4                      | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub><br>WDT is not<br>Running | 6,11        |
|                  |                                       | 3.0V                        |                                    | 500                   |                                       | 600                   | 310                    | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub><br>WDT is<br>Running     | 6,11,<br>14 |
|                  |                                       | 5.5V                        |                                    | 800                   |                                       | 1000                  | 600                    | μA    | V <sub>IN</sub> = 0V, V <sub>CC</sub><br>WDT is<br>Running     | 6,11,<br>14 |
| V <sub>ICR</sub> | Input Common<br>Mode<br>Voltage Range | 3.0V                        | 0                                  | V <sub>CC</sub> -1.0V | 0                                     | V <sub>CC</sub> -1.5V |                        | V     |  | 10          |
|                  |                                       | 5.5V                        | 0                                  | V <sub>CC</sub> -1.0V | 0                                     | V <sub>CC</sub> -1.5V |                        | V     |  | 10          |



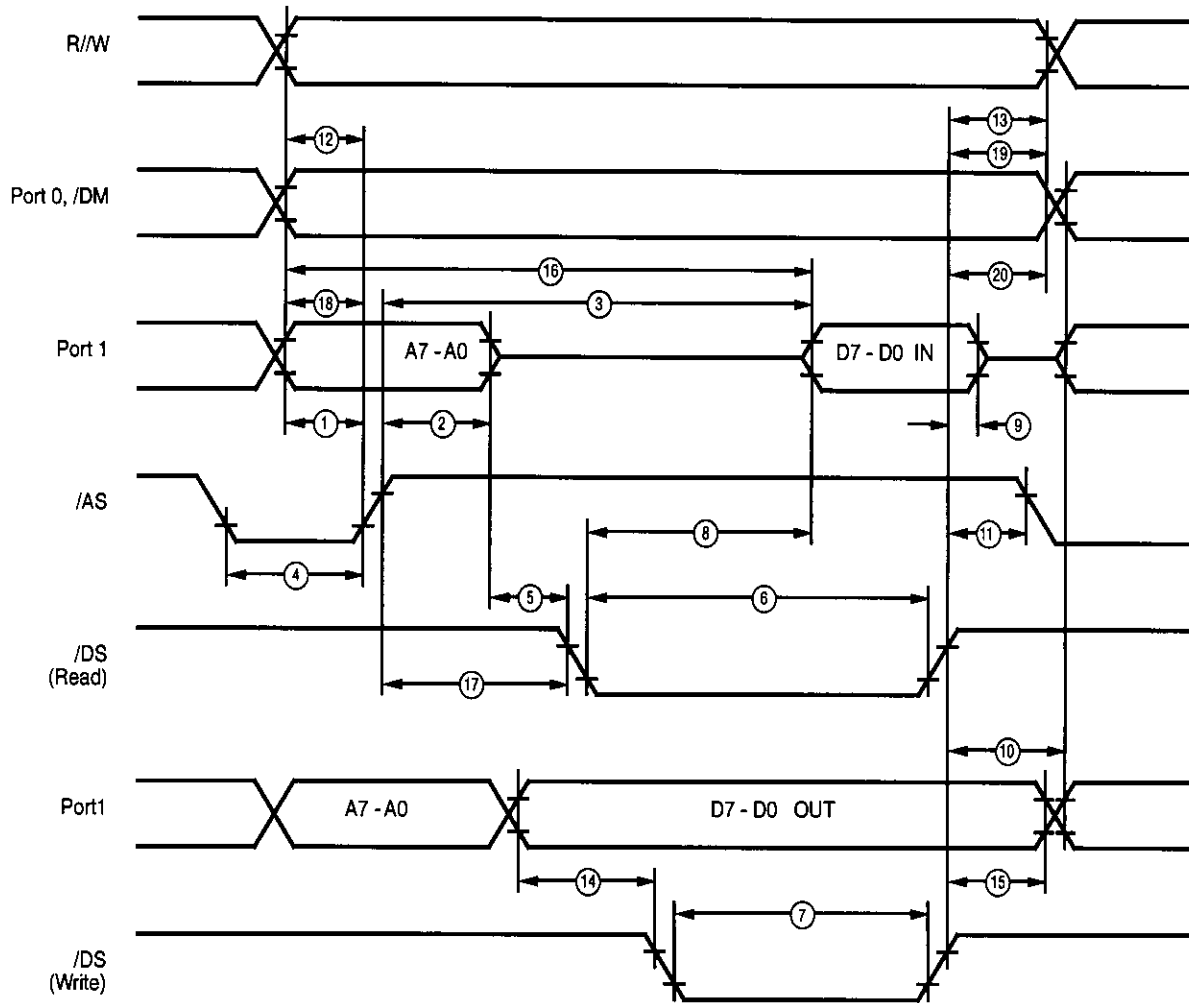
| Sym              | Parameter   | V <sub>CC</sub><br>Note [3] | T <sub>A</sub> = 0° C<br>to +70° C |     | T <sub>A</sub> = -40° C<br>to +105° C |     | Typical [1]<br>@ 25° C | Units | Conditions                             | Notes |
|------------------|---|-----------------------------|------------------------------------|-----|---------------------------------------|-----|------------------------|-------|--|-------|
|                  |   |                             | Min                                | Max | Min                                   | Max |                        |       |  |       |
| I <sub>ALL</sub> | Auto Latch<br>Low Current                               | 3.0V                        | 0.7                                | 8   | 0.7                                   | 10  | 3                      | μA    | 0V < V <sub>IN</sub> < V <sub>CC</sub> | 9     |
|                  |   | 5.5V                        | 1.4                                | 15  | 1.4                                   | 20  | 5                      | μA    | 0V < V <sub>IN</sub> < V <sub>CC</sub> | 9     |
| I <sub>ALH</sub> | Auto Latch<br>High Current                              | 3.0V                        | -0.6                               | -5  | -0.6                                  | -7  | -3                     | μA    | 0V < V <sub>IN</sub> < V <sub>CC</sub> | 9     |
|                  |   | 5.5V                        | -1.0                               | -8  | -1.0                                  | -10 | -6                     | μA    | 0V < V <sub>IN</sub> < V <sub>CC</sub> | 9     |
| V <sub>LV</sub>  | V <sub>CC</sub> Low<br>Voltage<br>Protection<br>Voltage |                             |                                    |     | 2.0                                   | 3.3 | 2.8                    | V     | 4 MHz max<br>Int. CLK Freq.            | 7,15  |
|                  |   |                             | 2.2                                | 3.1 |                                       |     | 2.8                    | V     | 6 MHz max<br>Int. CLK Freq.            | 7,14  |
| V <sub>OH</sub>  | Output High<br>Voltage<br>(Low EMI<br>Mode)             | 3.0V                        | V <sub>CC</sub> -0.4               |     | V <sub>CC</sub> -0.4                  |     | 3.1                    | V     | I <sub>OH</sub> = -0.5 mA              |       |
|                  |   | 5.0V                        | V <sub>CC</sub> -0.4               |     | V <sub>CC</sub> -0.4                  |     | 4.8                    | V     | I <sub>OH</sub> = -0.5 mA              |       |
| V <sub>OL</sub>  | Output Low<br>Voltage<br>(Low EMI<br>Mode)              | 3.0V                        |                                    | 0.6 |                                       | 0.6 | 0.2                    | V     | I <sub>OL</sub> = 1.0 mA               |       |
|                  |   | 5.0V                        |                                    | 0.4 |                                       | 0.4 | 0.1                    | V     | I <sub>OL</sub> = 1.0 mA               |       |

**Notes:**

- Typicals are at V<sub>CC</sub> = 5.0V and 3.3V.
- GND = 0V.
- The V<sub>DD</sub> voltage specification of 3.0V guarantees 3.3V ±0.3V with typicals at V<sub>CC</sub>=3.3V, and the V<sub>DD</sub> voltage specification of 5.5V guarantees 5.0V ±0.5V with typicals at V<sub>CC</sub>=5.0V.
- All outputs unloaded, I/O pins floating, inputs at rail.
- CL1 = CL2 = 10 pF.
- Same as note [4] except inputs at V<sub>CC</sub>.
- The V<sub>LV</sub> voltage increases as the temperature decreases and will overlap lower V<sub>CC</sub> operating region.
- Standard Mode (not Low EMI).
- Auto Latch (Mask Option) selected.
- For analog comparator, inputs when analog comparators are enabled.
- Clock must be forced Low, when XTAL 1 is clock-driven and XTAL2 is floating.
- Excludes clock pins.
- Z86093 only.
- 0°C to 70°C (standard temperature).
- 40°C to 150°C (extended temperature).

**AC ELECTRICAL CHARACTERISTICS**

External I/O or Memory Read and Write Timing Table



**Figure 6. External I/O or Memory Read and Write Timing Table**

**AC CHARACTERISTICS**

External I/O or Memory Read and Write Timing Table (SCLK/TCLK = XTAL/2)

| No | Symbol    | Parameter                                  | Note<br>[3] | T <sub>A</sub> =0°C to 70°C |     |     |     | T <sub>A</sub> = -40°C to +105°C |     |     |     | Units | Notes |
|----|-----------|--|-------------|-----------------------------|-----|-----|-----|----------------------------------|-----|-----|-----|-------|-------|
|    |           |  |             | V <sub>CC</sub>             | Min | Max | Min | Max                              | Min | Max | Min |       |       |
| 1  | TdA(AS)   | Address Valid to /AS Rise Delay            | 3.0         | 35                          |     | 25  |     | 35                               |     | 25  |     | ns    | 2     |
|    |           |  | 5.5         | 35                          |     | 25  |     | 35                               |     | 25  |     | ns    | 2     |
| 2  | TdAS(A)   | /AS Rise to Address Float Delay            | 3.0         | 45                          |     | 35  |     | 45                               |     | 35  |     | ns    | 2     |
|    |           |  | 5.5         | 45                          |     | 35  |     | 45                               |     | 35  |     | ns    | 2     |
| 3  | TdAS(DR)  | /AS Rise to Read Data Req'd Valid          | 3.0         |                             | 250 |     | 180 |                                  | 250 |     | 180 | ns    | 1,2   |
|    |           |  | 5.5         |                             | 250 |     | 180 |                                  | 250 |     | 180 | ns    | 2     |
| 4  | TwAS      | /AS Low Width                              | 3.0         | 55                          |     | 40  |     | 55                               |     | 40  |     | ns    | 2     |
|    |           |  | 5.5         | 55                          |     | 40  |     | 55                               |     | 40  |     | ns    | 2     |
| 5  | TdAS(DS)  | Address Float to /DS Fall                  | 3.0         | 0                           |     | 0   |     | 0                                |     | 0   |     | ns    |       |
|    |           |  | 5.5         | 0                           |     | 0   |     | 0                                |     | 0   |     | ns    |       |
| 6  | TwDSR     | /DS (Read) Low Width                       | 3.0         | 200                         |     | 135 |     | 200                              |     | 135 |     | ns    | 1,2   |
|    |           |  | 5.5         | 200                         |     | 135 |     | 200                              |     | 135 |     | ns    | 1,2   |
| 7  | TwDSW     | /DS (Write) Low Width                      | 3.0         | 110                         |     | 80  |     | 110                              |     | 80  |     | ns    | 1,2   |
|    |           |  | 5.5         | 110                         |     | 80  |     | 110                              |     | 80  |     | ns    | 1,2   |
| 8  | TdDSR(DR) | /DS Fall to Read Data Req'd Valid          | 3.0         |                             | 150 |     | 75  |                                  | 150 |     | 75  | ns    | 1,2   |
|    |           |  | 5.5         |                             | 150 |     | 75  |                                  | 150 |     | 75  | ns    | 1,2   |
| 9  | ThDR(DS)  | Read Data to /DS Rise Hold Time            | 3.0         | 0                           |     | 0   |     | 0                                |     | 0   |     | ns    | 2     |
|    |           |  | 5.5         | 0                           |     | 0   |     | 0                                |     | 0   |     | ns    | 2     |
| 10 | TdDS(A)   | /DS Rise to Address Active Delay           | 3.0         | 45                          |     | 50  |     | 45                               |     | 50  |     | ns    | 2     |
|    |           |  | 5.5         | 55                          |     | 50  |     | 55                               |     | 50  |     | ns    | 2     |
| 11 | TdDS(AS)  | /DS Rise to /AS Fall Delay                 | 3.0         | 30                          |     | 35  |     | 30                               |     | 35  |     | ns    | 2     |
|    |           |  | 5.5         | 45                          |     | 35  |     | 45                               |     | 55  |     | ns    | 2     |
| 12 | TdR/W(AS) | R/W Valid to /AS Rise Delay                | 3.0         | 45                          |     | 25  |     | 45                               |     | 25  |     | ns    | 2     |
|    |           |  | 5.5         | 45                          |     | 25  |     | 45                               |     | 25  |     | ns    | 2     |
| 13 | TdDS(R/W) | /DS Rise to R/W Not Valid                  | 3.0         | 45                          |     | 35  |     | 45                               |     | 35  |     | ns    | 2     |
|    |           |  | 5.5         | 45                          |     | 35  |     | 45                               |     | 35  |     | ns    | 2     |
| 14 | TdDW(DSW) | Write Data Valid to /DS Fall (Write) Delay | 3.0         | 55                          |     | 25  |     | 55                               |     | 25  |     | ns    | 2     |
|    |           |  | 5.5         | 55                          |     | 25  |     | 55                               |     | 25  |     | ns    | 2     |
| 15 | TdDS(DW)  | /DS Rise to Write Data Not Valid Delay     | 3.0         | 45                          |     | 35  |     | 45                               |     | 35  |     | ns    | 2     |
|    |           |  | 5.5         | 45                          |     | 35  |     | 45                               |     | 35  |     | ns    | 2     |
| 16 | TdA(DR)   | Address Valid to Read Data Req'd Valid     | 3.0         |                             | 310 |     | 230 |                                  | 310 |     | 230 | ns    | 1,2   |
|    |           |  | 5.5         |                             | 310 |     | 230 |                                  | 310 |     | 230 | ns    | 1,2   |
| 17 | TdAS(DS)  | /AS Rise to /DS Fall Delay                 | 3.0         | 65                          |     | 45  |     | 65                               |     | 45  |     | ns    | 2     |
|    |           |  | 5.5         | 65                          |     | 45  |     | 65                               |     | 45  |     | ns    | 2     |
| 18 | TdDM(AS)  | /DM Valid to /AS Fall Delay                | 3.0         | 35                          |     | 30  |     | 35                               |     | 30  |     | ns    | 2     |
|    |           |  | 5.5         | 35                          |     | 30  |     | 35                               |     | 30  |     | ns    | 2     |

**AC CHARACTERISTICS** (Continued)

| No | Symbol   | Parameter            | Note<br>[3]<br>V <sub>CC</sub> | T <sub>A</sub> =0°C to 70°C |               | T <sub>A</sub> = -40°C to +105°C |               | Units | Notes |
|----|----------|----------------------|--------------------------------|-----------------------------|---------------|----------------------------------|---------------|-------|-------|
|    |          |                      |                                | 12 MHz<br>Min               | 16 MHz<br>Max | 12 MHz<br>Min                    | 16 MHz<br>Max |       |       |
| 19 | TdDs(DM) | /DS Rise to DM       | 3.0                            | 45                          | 35            | 45                               | 35            | ns    | 2     |
|    |          | Valid Delay          | 5.5                            | 45                          | 35            | 45                               | 35            | ns    | 2     |
| 20 | ThDS(AS) | /DS Valid to Address | 3.0                            | 45                          | 35            | 45                               | 35            | ns    | 2     |
|    |          | Valid Home Time      | 5.5                            | 45                          | 35            | 45                               | 35            | ns    |       |

**Notes:**

1. When using extended memory timing add 2 TpC.
2. Timing numbers given are for minimum TpC.
3. The V<sub>CC</sub> voltage specification of 3.0V guarantees 3.3V ± 0.3V, and the V<sub>DD</sub> voltage specification of 5.5V guarantees 5.0V ± 0.5V.

**Standard Test Load**

All timing references use 0.7 V<sub>CC</sub> for a logic 1 and 0.2 V<sub>CC</sub> for a logic 0.

## AC ELECTRICAL CHARACTERISTICS

## Additional Timing Diagram

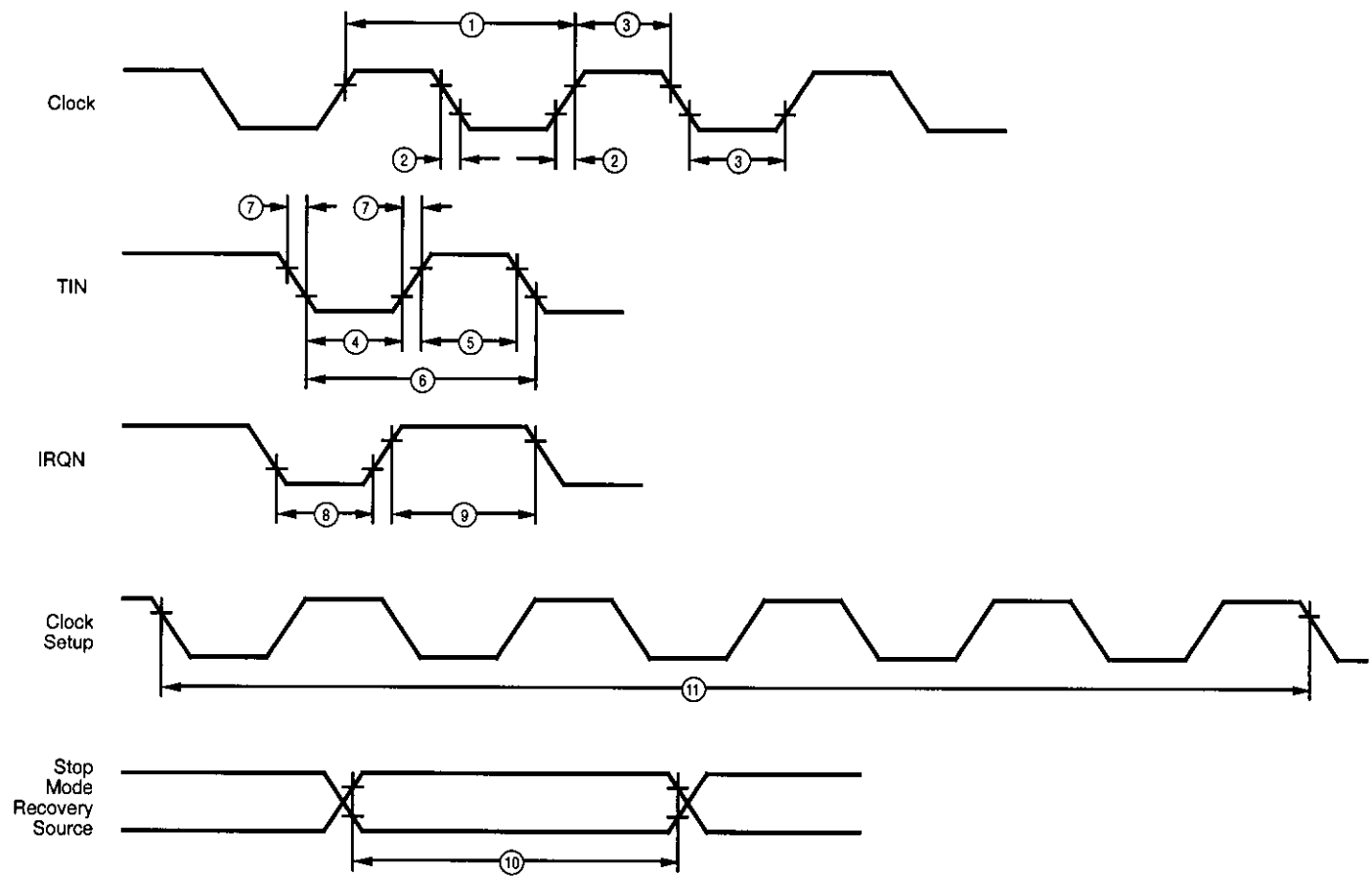


Figure 7. Additional Timing

## AC CHARACTERISTICS

Additional Timing Table (SCLK/TCLK = XTAL/2)

| No | Symbol       | Parameter                                  | Note<br>[3]<br>V <sub>CC</sub> | T <sub>A</sub> = 0°C to +70°C |      |        |      | T <sub>A</sub> = -4 0°C to +105°C |      |        |      | Units | Notes    |
|----|--------------|--|--------------------------------|-------------------------------|------|--------|------|-----------------------------------|------|--------|------|-------|----------|
|    |              |  |                                | 12 MHz                        |      | 16 MHz |      | 12 MHz                            |      | 16 MHz |      |       |          |
| 1  | TpC          | Input Clock Period                         | 3.0V                           | 83                            | DC   | 62.5   | DC   | 83                                | DC   | 62.5   | DC   | ns    | 1,7      |
|    |              |  | 5.5V                           | 83                            | DC   | 62.5   | DC   | 83                                | DC   | 62.5   | DC   | ns    | 1,7      |
|    |              |  | 3.0V                           | 250                           | DC   | 250    | DC   | 250                               | DC   | 250    | DC   | ns    | 1,8      |
|    |              |  | 5.5V                           | 250                           | DC   | 250    | DC   | 250                               | DC   | 250    | DC   | ns    | 1,8      |
| 2  | TrC,TfC      | Clock Input Rise & Fall Times              | 3.0V                           |                               | 15   |        | 15   |                                   | 15   |        | 15   | ns    | 1        |
|    |              |  | 5.5V                           |                               | 15   |        | 15   |                                   | 15   |        | 15   | ns    | 1        |
| 3  | TwC          | Input Clock Width                          | 3.0V                           | 41                            |      | 31     |      | 41                                |      | 31     |      | ns    | 1        |
|    |              |  | 5.5V                           | 41                            |      | 31     |      | 41                                |      | 31     |      | ns    | 1        |
|    |              |  | 3.0V                           | 125                           |      | 125    |      | 125                               |      | 125    |      | ns    | 1,8      |
|    |              |  | 5.5V                           | 125                           |      | 125    |      | 125                               |      | 125    |      | ns    | 1,8      |
| 4  | TwTinL       | Timer Input Low Width                      | 3.0V                           | 100                           |      | 100    |      | 100                               |      | 100    |      | ns    | 1        |
|    |              |  | 5.5V                           | 70                            |      | 70     |      | 70                                |      | 70     |      | ns    | 1        |
| 5  | TwTinH       | Timer Input High Width                     | 3.0V                           | 5TpC                          |      | 5TpC   |      | 5TpC                              |      | 5TpC   |      |       | 1        |
|    |              |  | 5.5V                           | 5TpC                          |      | 5TpC   |      | 5TpC                              |      | 5TpC   |      |       | 1        |
| 6  | TpTin        | Timer Input Period                         | 3.0V                           | 8TpC                          |      | 8TpC   |      | 8TpC                              |      | 8TpC   |      |       | 1        |
|    |              |  | 5.5V                           | 8TpC                          |      | 8TpC   |      | 8TpC                              |      | 8TpC   |      |       | 1        |
| 7  | TrTin, TfTin | Timer Input Rise & Fall Timer              | 3.0V                           |                               | 100  |        | 100  |                                   | 100  |        | 100  | ns    | 1        |
|    |              |  | 5.5V                           |                               | 100  |        | 100  |                                   | 100  |        | 100  | ns    | 1        |
| 8A | TwIL         | Int. Request Low Time                      | 3.0V                           | 100                           |      | 100    |      | 100                               |      | 100    |      | ns    | 1,2      |
|    |              |  | 5.5V                           | 70                            |      | 70     |      | 70                                |      | 70     |      | ns    | 1,2      |
| 8B | TwIL         | Int. Request Low Time                      | 3.0V                           | 5TpC                          |      | 5TpC   |      | 5TpC                              |      | 5TpC   |      |       | 1,3      |
|    |              |  | 5.5V                           | 5TpC                          |      | 5TpC   |      | 5TpC                              |      | 5TpC   |      |       | 1,3      |
| 9  | TwIH         | Int. Request Input High Time               | 3.0V                           | 5TpC                          |      | 5TpC   |      | 5TpC                              |      | 5TpC   |      |       | 1,2      |
|    |              |  | 5.5V                           | 5TpC                          |      | 5TpC   |      | 5TpC                              |      | 5TpC   |      |       | 1,2      |
| 10 | Twsm         | Stop-Mode Recovery Width Spec              | 3.0V                           | 12                            |      | 12     |      | 12                                |      | 12     |      | ns    |          |
|    |              |  | 5.5V                           | 12                            |      | 12     |      | 12                                |      | 12     |      | ns    |          |
| 11 | Tost         | Oscillator Startup Time                    | 3.0V                           |                               | 5TpC |        | 5TpC |                                   | 5TpC |        | 5TpC |       | 4        |
|    |              |  | 5.5V                           |                               | 5TpC |        | 5TpC |                                   | 5TpC |        | 5TpC |       | 4        |
| 12 | Twdt         | Watch-Dog Timer Delay Time before time-out | 3.0V                           | 7                             |      | 7      |      | 7                                 |      | 7      |      | ms    | 0, 0 [5] |
|    |              |  | 5.5V                           | 3.5                           |      | 3.5    |      | 3.5                               |      | 3.5    |      | ms    | 0, 0 [5] |
|    |              |  | 3.0V                           | 14                            |      | 14     |      | 14                                |      | 14     |      | ms    | 0, 1 [5] |
|    |              |  | 5.5V                           | 7                             |      | 7      |      | 7                                 |      | 7      |      | ms    | 0, 1 [5] |
|    |              |  | 3.0V                           | 28                            |      | 28     |      | 28                                |      | 28     |      | ms    | 1, 0 [5] |
|    |              |  | 5.5V                           | 14                            |      | 14     |      | 14                                |      | 14     |      | ms    | 1, 0 [5] |
|    |              |  | 3.0V                           | 112                           |      | 112    |      | 112                               |      | 112    |      | ms    | 1, 1 [5] |
|    |              |  | 5.5V                           | 56                            |      | 56     |      | 56                                |      | 56     |      | ms    | 1, 1 [5] |

| No | Symbol | Parameter               | Note<br>[3]<br>V <sub>CC</sub> | T <sub>A</sub> = 0°C to +70°C |     |        |     | T <sub>A</sub> = -40°C to +105°C |     |        |     | Units | Notes |
|----|--------|-------------------------|--------------------------------|-------------------------------|-----|--------|-----|----------------------------------|-----|--------|-----|-------|-------|
|    |        |                         |                                | 12 MHz                        |     | 16 MHz |     | 12 MHz                           |     | 16 MHz |     |       |       |
|    |        |                         |                                | Min                           | Max | Min    | Max | Min                              | Max | Min    | Max |       |       |
| 13 | TPOR   | Power-On Reset<br>Delay | 3.0V                           | 3                             | 24  | 3      | 24  | 3                                | 25  | 3      | 25  | ms    |       |
|    |        |                         | 5.5V                           | 1.5                           | 13  | 1.5    | 13  | 1                                | 14  | 1      | 14  | ms    |       |

**Notes :**

1. Timing Reference uses 0.7 V<sub>CC</sub> for a logic 1 and 0.2 V<sub>CC</sub> for a logic 0.
2. Interrupt request via Port 3 (P31-P33).
3. Interrupt request via Port 3 (P30).
4. SMR-D5 = 0.
5. Reg. WDTMR.
6. The V<sub>CC</sub> voltage specification of 3.0V guarantees 3.3V ± 0.3V, and the V<sub>DD</sub> voltage specification of 5.5V guarantees 5.0V ± 0.5V.
7. Standard Oscillator mode, Pcon RegD7=1.
8. Maximum frequency for external XTAL Clock is 4MHz when using low EMI oscillator mode, Pcon Reg D7=0.

## AC ELECTRICAL CHARACTERISTICS

Additional Timing Table (Divide-By-One Mode, SCLK/TCLK = XTAL)

| No | Symbol          | Parameter                        | V <sub>CC</sub><br>Note [6] | T <sub>A</sub> = 0°C to<br>+70°C |      | T <sub>A</sub> = 40°C to<br>+105°C |      | Units | Notes |
|----|-----------------|----------------------------------|-----------------------------|----------------------------------|------|------------------------------------|------|-------|-------|
|    |                 |                                  |                             | 8 MHz<br>Min                     | Max  | 8 MHz<br>Min                       | Max  |       |       |
| 1  | TpC             | Input Clock Period               | 3.0V                        | 250                              | DC   | 250                                | DC   | ns    | 1,7,8 |
|    |                 |                                  | 5.5V                        | 250                              | DC   | 250                                | DC   | ns    | 1,7,8 |
|    |                 |                                  | 3.0V                        | 125                              | DC   | 125                                | DC   | ns    | 1,7   |
|    |                 |                                  | 5.5V                        | 125                              | DC   | 125                                | DC   | ns    | 1,7   |
| 2  | TrC, TfC        | Clock Input Rise<br>& Fall Times | 3.0V                        |                                  | 25   |                                    | 25   | ns    | 1,7   |
|    |                 |                                  | 5.5V                        |                                  | 25   |                                    | 25   | ns    | 1,7   |
| 3  | TwC             | Input Clock Width                | 3.0V                        | 125                              |      | 125                                |      | ns    | 1,7,8 |
|    |                 |                                  | 5.5V                        | 125                              |      | 125                                |      | ns    | 1,7,8 |
|    |                 |                                  | 3.0V                        | 62                               |      | 62                                 |      | ns    | 1,7   |
|    |                 |                                  | 5.5V                        | 62                               |      | 62                                 |      | ns    | 1,7   |
| 4  | TwTinL          | Timer Input Low Width            | 3.0V                        | 100                              |      | 100                                |      | ns    | 1,7   |
|    |                 |                                  | 5.5V                        | 70                               |      | 70                                 |      | ns    | 1,7   |
| 5  | TwTinH          | Timer Input High Width           | 3.0V                        | 3TpC                             |      | 3TpC                               |      |       | 1,7   |
|    |                 |                                  | 5.5V                        | 3TpC                             |      | 3TpC                               |      |       | 1,7   |
| 6  | TpTin           | Timer Input Period               | 3.0V                        | 4TpC                             |      | 4TpC                               |      |       | 1,7   |
|    |                 |                                  | 5.5V                        | 4TpC                             |      | 4TpC                               |      |       | 1,7   |
| 7  | TrTin,<br>TfTin | Timer Input Rise<br>& Fall Timer | 3.0V                        |                                  | 100  |                                    | 100  | ns    | 1,7   |
|    |                 |                                  | 5.5V                        |                                  | 100  |                                    | 100  | ns    | 1,7   |
| 8A | TwIL            | Int. Request Low Time            | 3.0V                        | 100                              |      | 100                                |      | ns    | 1,2,7 |
|    |                 |                                  | 5.5V                        | 70                               |      | 70                                 |      | ns    | 1,2,7 |
| 8B | TwIL            | Int. Request Low Time            | 3.0V                        | 3TpC                             |      | 3TpC                               |      |       | 1,3,7 |
|    |                 |                                  | 5.5V                        | 3TpC                             |      | 3TpC                               |      |       | 1,3,7 |
| 9  | TwIH            | Int. Request Input<br>High Time  | 3.0V                        | 3TpC                             |      | 3TpC                               |      |       | 1,2,7 |
|    |                 |                                  | 5.5V                        | 3TpC                             |      | 2TpC                               |      |       | 1,2,7 |
| 10 | Twsm            | Stop-Mode Recovery<br>Width Spec | 3.0V                        | 12                               |      | 12                                 |      | ns    | 4     |
|    |                 |                                  | 5.5V                        | 12                               |      | 12                                 |      | ns    | 4     |
| 11 | Tost            | Oscillator Startup Time          | 3.0V                        |                                  | 5TpC |                                    | 5TpC |       | 4,9   |
|    |                 |                                  | 5.5V                        |                                  | 5TpC |                                    | 5TpC |       | 4,9   |

**Notes:**

1. Timing Reference uses 0.7 V<sub>CC</sub> for a logic 1 and 0.2 V<sub>CC</sub> for a logic 0.
2. Interrupt request via Port 3 (P31-P33).
3. Interrupt request via Port 3 (P30).
4. SMR-D5 = 1, POR STOP Mode Delay is on.
5. Reg. WDTMR.
6. The V<sub>CC</sub> voltage specification of 3.0V guarantees 3.3V ± 0.3V, and the V<sub>DD</sub> voltage specification of 5.5V guarantees 5.0V ± 0.5V.
7. SMR D1 = 0.
8. Maximum frequency for external XTAL clock is 4 MHz when using low EMI Oscillator mode Pcon Reg.D7=0.
9. For RC and LC oscillator, and for oscillator driven by clock driver.



Handshake Timing Diagrams

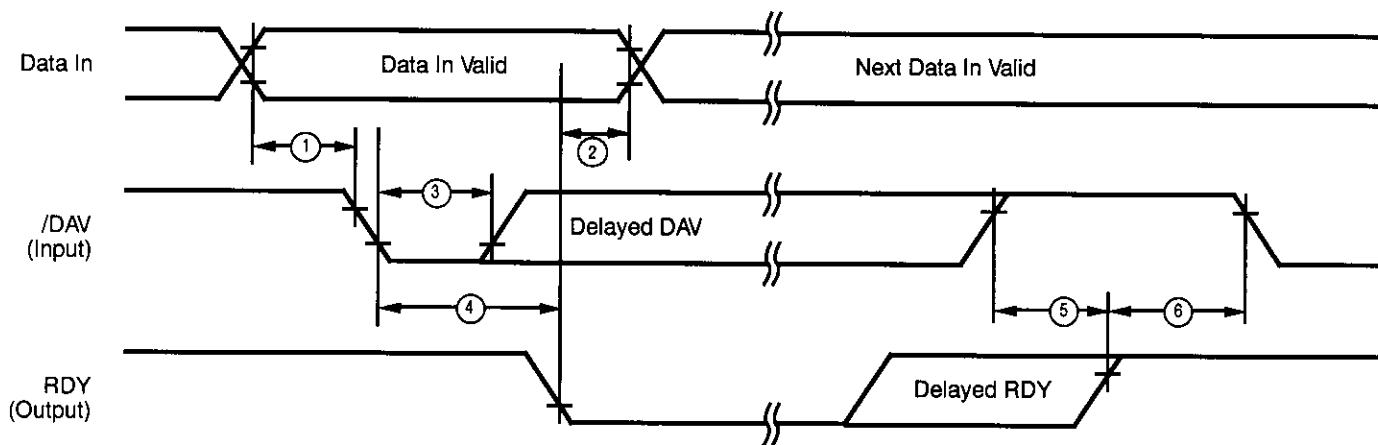


Figure 8. Input Handshake Timing

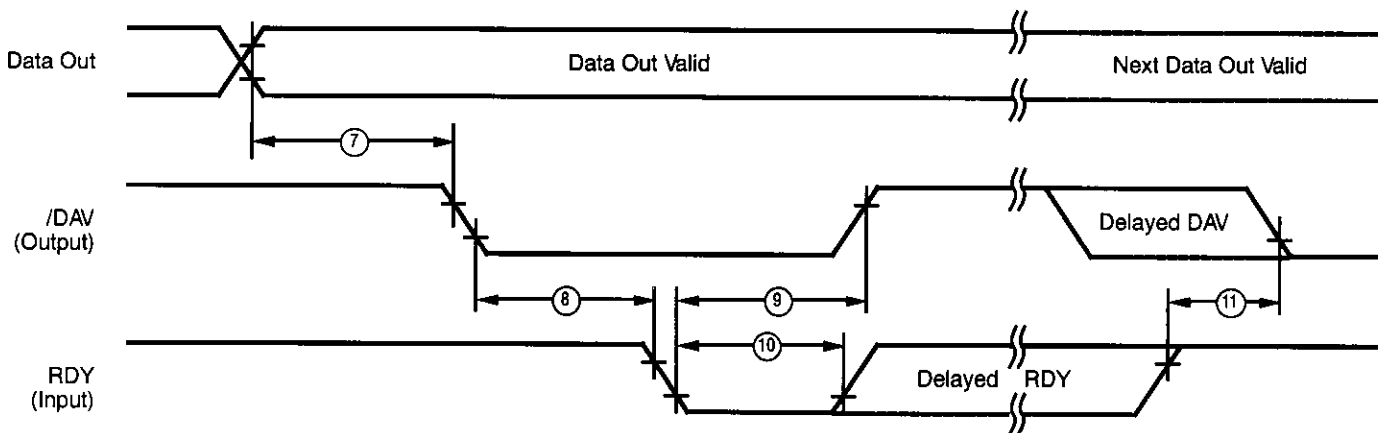


Figure 9. Output Handshake Timing

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**Pre-Characterization Product:**

The product represented by this CPS is newly introduced and Zilog has not completed the full characterization of the product. The CPS states what Zilog knows about this product at this time, but additional features or non-conformance with some aspects of the CPS may be found,

either by Zilog or its customers in the course of further application and characterization work. In addition, Zilog cautions that delivery may be uncertain at times, due to start-up yield issues.

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