



## CUSTOMER PROCUREMENT SPECIFICATION

# Z86E22

## CMOS Z8® OTP MICROCONTROLLER

### GENERAL DESCRIPTION

The Z86E22 microcontroller (MCU) introduces the next level of sophistication to single-chip architecture. The Z86E22 is a member of the Z8 single-chip microcontroller family with 8 Kbytes of EPROM and 236 bytes of general purpose RAM.

The Z86E22 is a pin compatible, One-Time-Programmable (OTP) version of the Z86C21. The Z86E22 contains 8 Kbytes of EPROM memory in place of the 8 Kbyte of ROM on the Z86C21.

The MCU is housed in a 40-pin DIP, and is manufactured in CMOS technology. The MCU can address both external memory and preprogrammed ROM which enables this Z8 microcomputer to be used in high volume applications or where code flexibility is required.

Zilog's CMOS microcontroller offers 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 Z86E22 architecture is based on Zilog's 8-bit microcontroller core. The device offers a flexible I/O scheme, an efficient register and address space structure, multiplexed capabilities between address/data, I/O, and a number of ancillary features that are useful in many industrial and advanced scientific applications.

The device applications demand powerful I/O capabilities. The Z86E22 fulfills this with 32 pins dedicated to input and output. These lines are grouped into four ports. Each port consists of eight lines, and is configurable under software

control to provide timing, status signals, serial or parallel I/O with or without handshake, and an address/data bus for interfacing external memory.

There are three basic address spaces available to support this wide range of configuration: Program Memory, Data Memory and 236 General-Purpose registers.

To unburden the program from coping with real-time problems such as counting/timing and serial data communication, the Z86E22 offers two on-chip counter/timers with a large number of user selectable modes, and an asynchronous receiver/transmitter (UART) (see Functional Block Description).

The Z86E22 is a low EMI noise, low Halt current version of the Z86E21. Rated at no more than 4 MHz, the Z86E22 has a Halt current of 1.5 mA or less.

In ROM Protect Mode, the instructions LDC, LDCI, LDE and LDEI are disabled when reading address locations 0000H to 1FFFH.

#### Notes:

All Signals with a preceding front slash, "/", are active Low, e.g.: B/W (WORD is active Low); /B/W (BYTE is active Low, only).

Power connections follow conventional descriptions below:

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

### PRODUCT RECOMMENDATIONS

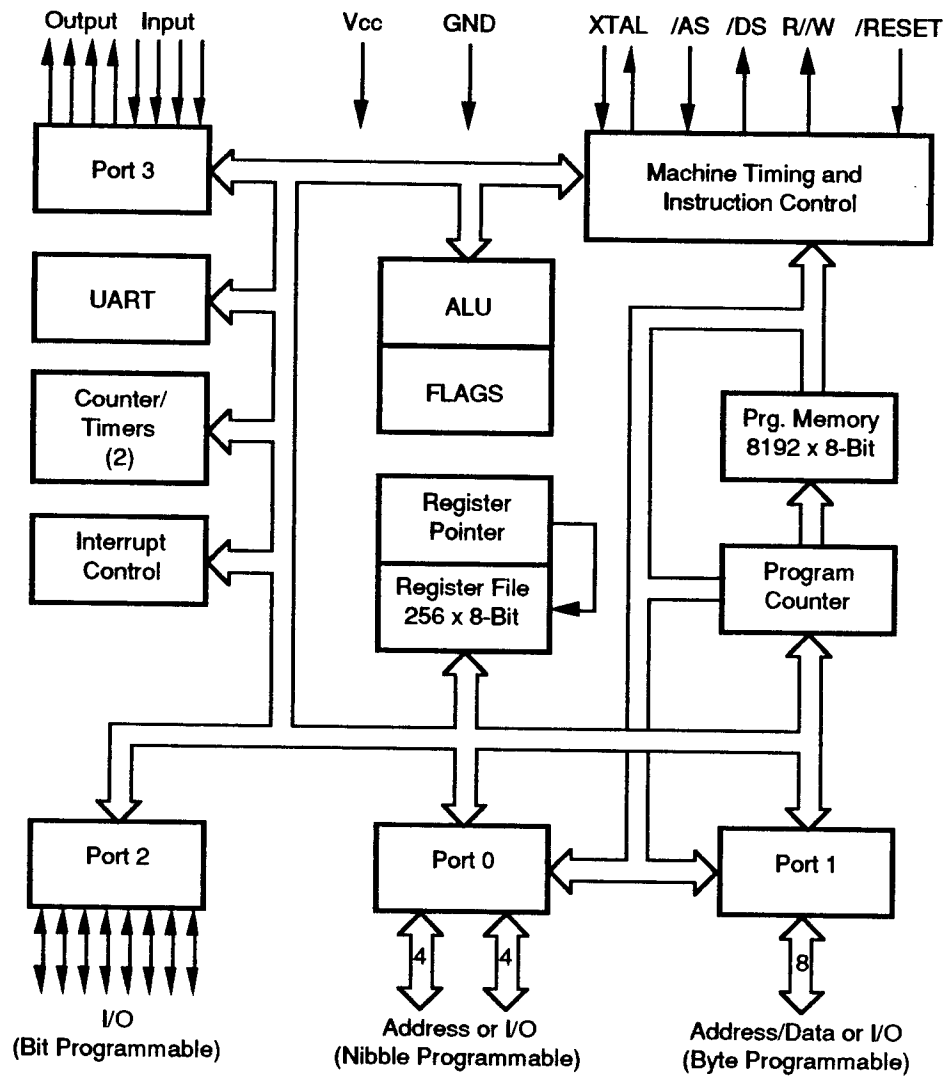
Zilog recommends the following programming equipment for use with this One-Time-Programmable product:

| Device | Zilog Support Tool                                              | Recommended Revision Level |          |
|--------|-----------------------------------------------------------------|----------------------------|----------|
|        |                                                                 | Hardware                   | Software |
| Z86E22 | Z86C1200ZEM ICEBOX™ Emulator* (*Does not support 4K/8K option.) | B                          | 1.5      |
| Z86E22 | Data I/O Unisite Programmer* (*Does not support option bits.)   |                            | 3.7      |

Some non-Zilog programmers may have different programming waveforms, voltages and timings and not all programmers may meet the programming requirements of Zilog's One-Time-Programmable products.

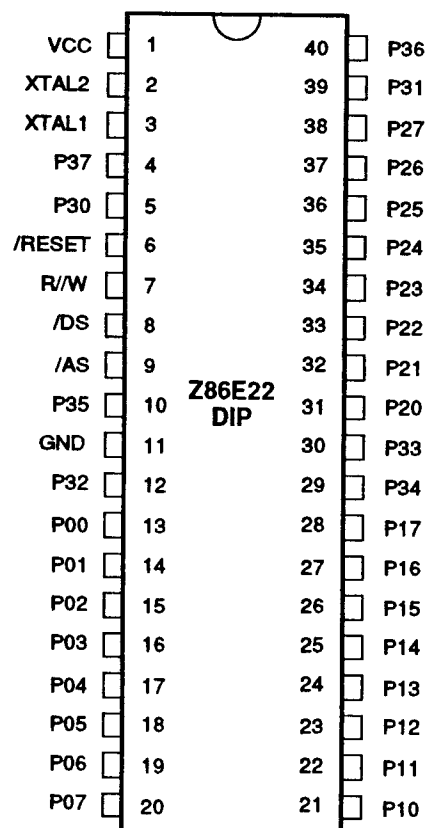
If difficulty is encountered in programming a Zilog OTP product, please contact your local Zilog sales office.

## GENERAL DESCRIPTION (Continued)



Functional Block Diagram

## PIN DESCRIPTION



### Standard Mode Pin Assignments

## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Description       | Min  | Max  | Units |
|-----------|-------------------|------|------|-------|
| $V_{CC}$  | Supply Voltage*   | -0.3 | +7.0 | V     |
| $T_{STG}$ | Storage Temp      | -65  | +150 | C     |
| $T_A$     | Oper Ambient Temp |      | †    | C     |

### Notes:

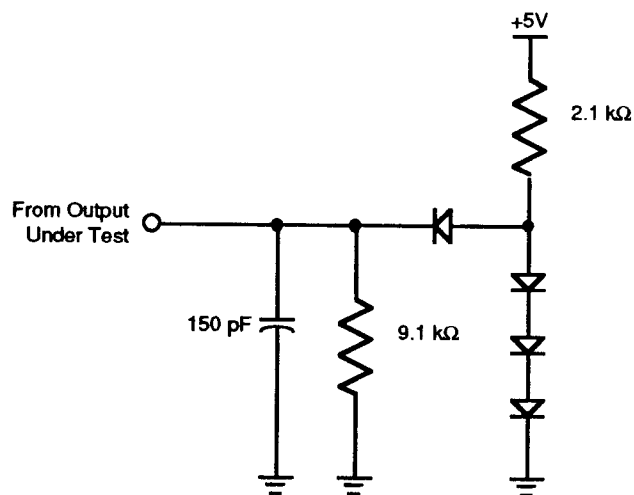
\* Voltages on all pins with respect to GND.  
13.0 V Maximum on P30-P33.

† See Ordering Information

Stresses greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; 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.

## 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 (Test Load Diagram).



Test Load Diagram

## DC CHARACTERISTICS

| Sym       | Parameter                | $T_A = 0^{\circ}\text{C}$<br>to $+70^{\circ}\text{C}$ |          | Typical<br>at<br>$25^{\circ}\text{C}$ | Units         | Conditions                                             |
|-----------|--------------------------|-------------------------------------------------------|----------|---------------------------------------|---------------|--------------------------------------------------------|
|           |                          | Min                                                   | Max      |                                       |               |                                                        |
|           | Max Input Voltage        |                                                       | 7        |                                       | V             | $I_{IN} = 250\ \mu\text{A}$                            |
|           | Max Input Voltage        |                                                       | 13       |                                       | V             | P30-P33 Only                                           |
| $V_{OH}$  | Clock Input High Voltage | 3.8                                                   | $V_{CC}$ |                                       | V             | Driven by External Clock Generator                     |
| $V_{OL}$  | Clock Input Low Voltage  | -0.03                                                 | 0.8      |                                       | V             | Driven by External Clock Generator                     |
| $V_{IH}$  | Input High Voltage       | 2.0                                                   | $V_{CC}$ |                                       | V             |                                                        |
| $V_{IL}$  | Input Low Voltage        | -0.3                                                  | 0.8      |                                       | V             |                                                        |
| $V_{OH}$  | Output High Voltage      | 2.4                                                   |          |                                       | V             | $I_{OH} = -2.0\ \text{mA}$                             |
| $V_{OL}$  | Output Low Voltage       |                                                       | 0.4      |                                       | V             | $I_{OL} = +2.0\ \text{mA}$                             |
| $V_{RH}$  | Reset Input High Voltage | 3.8                                                   | $V_{CC}$ |                                       | V             |                                                        |
| $V_{RI}$  | Reset Input Low Voltage  | -0.03                                                 | 0.8      |                                       | V             |                                                        |
| $I_{IL}$  | Input Leakage            | -10                                                   | 10       |                                       | $\mu\text{A}$ | $0\text{V} < V_{IN} < +5.25\text{V}$                   |
| $I_{OL}$  | Output Leakage           | -10                                                   | 10       |                                       | $\mu\text{A}$ | $0\text{V} < V_{IN} < +5.25\text{V}$                   |
| $I_{IR}$  | Reset Input Current      |                                                       | -50      |                                       | $\mu\text{A}$ | $V_{CC} = +5.25\text{V}, V_{RL} = 0\text{V}$           |
| $I_{CC}$  | Supply Current           |                                                       | 25       | 13.5                                  | mA            | 4 MHz                                                  |
| $I_{CC1}$ | Standby Current          |                                                       | 5        | 1.5                                   | mA            | HALT Mode $V_{IN} = 0\text{V}, V_{CC} @ 4\ \text{MHz}$ |
| $I_{CC2}$ | Standby Current          |                                                       | 10       | 1.5                                   | $\mu\text{A}$ | STOP Mode $V_{IN} = 0\text{V}, V_{CC} @ 4\ \text{MHz}$ |

### Notes:

$I_{CC2}$  requires loading TMR (F1H) with any value prior to STOP execution.

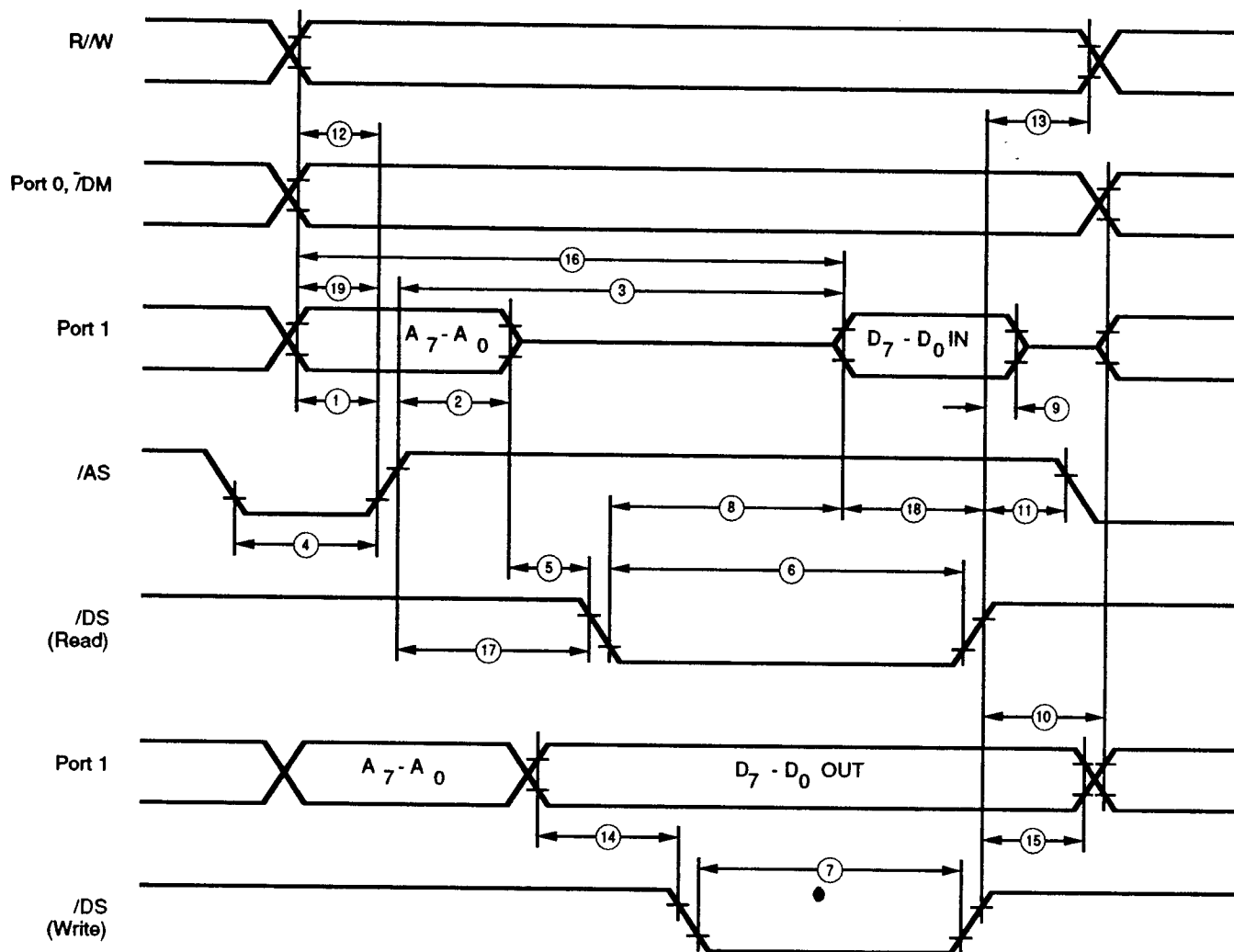
Use this sequence:

LD TMR,#00

NOP

## AC CHARACTERISTICS

### External I/O or Memory Read or Write Timing Diagram



External I/O or Memory Read/Write Timing

## AC CHARACTERISTICS

### External I/O or Memory Read and Write Timing Table

| No | Symbol    | Parameter                                  | $T_A = 0^\circ\text{C to } 70^\circ\text{C}$<br>4 MHz |     | Units | Notes   |
|----|-----------|--------------------------------------------|-------------------------------------------------------|-----|-------|---------|
|    |           |                                            | Min                                                   | Max |       |         |
| 1  | TdA(AS)   | Address Valid to /AS Rise Delay            | 50                                                    |     | ns    | [2,3]   |
| 2  | TdAS(A)   | /AS Rise to Address Float Delay            | 60                                                    |     | ns    | [2,3]   |
| 3  | TdAS(DR)  | /AS Rise to Read Data Req'd Valid          |                                                       | 320 | ns    | [1,2,3] |
| 4  | TwAS      | /AS Low Width                              | 80                                                    |     | ns    | [2,3]   |
| 5  | TdAZ(DS)  | Address Float to /DS Fall                  | 0                                                     |     | ns    |         |
| 6  | TwDSR     | /DS (Read) Low Width                       | 250                                                   |     | ns    | [1,2,3] |
| 7  | TwDSW     | /DS (Write) Low Width                      | 160                                                   |     | ns    | [1,2,3] |
| 8  | TdDSR(DR) | /DS Fall to Read Data Req'd Valid          |                                                       | 200 | ns    | [1,2,3] |
| 9  | ThDR(DS)  | Read Data to /DS Rise Hold Time            | 0                                                     |     | ns    | [2,3]   |
| 10 | TdDS(A)   | /DS Rise to Address Active Delay           | 80                                                    |     | ns    | [2,3]   |
| 11 | TdDS(AS)  | /DS Rise to /AS Fall Delay                 | 70                                                    |     | ns    | [2,3]   |
| 12 | TdR/W(AS) | R/W Valid to /AS Rise Delay                | 50                                                    |     | ns    | [2,3]   |
| 13 | TdDS(R/W) | /DS Rise to R/W Not Valid                  | 60                                                    |     | ns    | [2,3]   |
| 14 | TdDW(DSW) | Write Data Valid to /DS Fall (Write) Delay | 50                                                    |     | ns    | [2,3]   |
| 15 | TdDS(DW)  | /DS Rise to Write Data Not Valid Delay     | 80                                                    |     | ns    | [2,3]   |
| 16 | TdA(DR)   | Address Valid to Read Data Req'd Valid     |                                                       | 410 | ns    | [1,2,3] |
| 17 | TdAS(DS)  | /AS Rise to /DS Fall Delay                 | 80                                                    |     | ns    | [2,3]   |

#### Notes:

[1] When using extended memory timing add 2 TpC.

[2] Timing numbers given are for minimum TpC.

[3] See clock cycle dependent characteristics table.

#### Clock Dependent Formulas

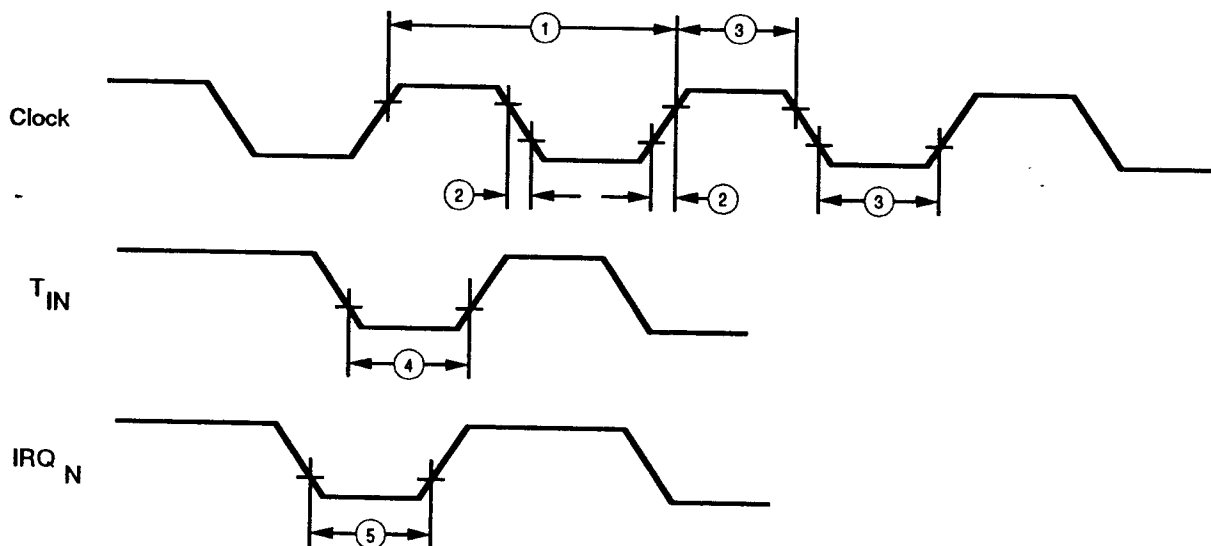
| Number | Symbol    | Equation              |
|--------|-----------|-----------------------|
| 1      | TdA(AS)   | $0.2T_{pC} + 0.32$    |
| 2      | TdAS(A)   | $0.295T_{pC} - 3.25$  |
| 3      | TdAS(DR)  | $1.19T_{pC} + 6.14$   |
| 4      | TwAS      | $0.33T_{pC} - 1.65$   |
| 6      | TwDSR     | $1.165T_{pC} - 10.56$ |
| 7      | TwDSW     | $0.635T_{pC} + 1.67$  |
| 8      | TdDSR(DR) | $0.985T_{pC} - 42.5$  |
| 10     | TdDS(A)   | $0.4T_{pC}$           |
| 11     | TdDS(AS)  | $0.295T_{pC} - 3.14$  |
| 12     | TdR/W(AS) | $0.2T_{pC}$           |
| 13     | TdDS(R/W) | $0.4T_{pC} - 15$      |
| 14     | TdDW(DSW) | $0.2T_{pC}$           |
| 15     | TdDS(DW)  | $0.44T_{pC} - 19$     |
| 16     | TdA(DR)   | $2T_{pC} - 20$        |
| 17     | TdAS(DS)  | $45.5T_{pC} - 10.7$   |
| 18     | TsDI(DS)  | $0.4T_{pC} - 10$      |
| 19     | TdDM(AS)  | $0.45T_{pC} - 26.3$   |

#### Standard Test Load

All timing references use 2.0V for a logic 1 and 0.8V for a logic 0.

## AC CHARACTERISTICS

### Additional Timing Diagram



Additional Timing

## AC CHARACTERISTICS

### Additional Timing Table

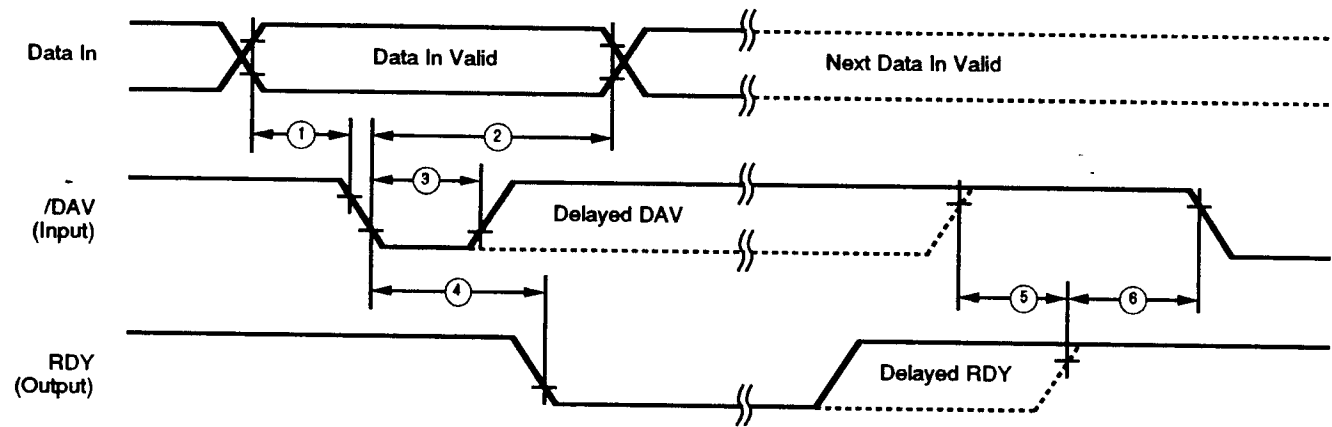
| No | Symbol               | Parameter                          | $T_A = 0^\circ\text{C to } 70^\circ\text{C}$<br>4 MHz |     | Units | Notes |
|----|----------------------|------------------------------------|-------------------------------------------------------|-----|-------|-------|
|    |                      |                                    | Min                                                   | Max |       |       |
| 1  | $T_{pC}$             | Input Clock Period                 | 250                                                   |     | ns    | [1]   |
| 2  | $T_{rC}, T_{fC}$     | Clock Input Rise & Fall Times      |                                                       | 25  | ns    | [1]   |
| 3  | $T_{wC}$             | Input Clock Width                  | 100                                                   |     | ns    | [1]   |
| 4  | $T_{wTinL}$          | Timer Input Low Width              | 75                                                    |     | ns    | [2]   |
| 5  | $T_{wTinH}$          | Timer Input High Width             | $2.5T_{pC}$                                           |     |       | [2]   |
| 6  | $T_{pTin}$           | Timer Input Period                 | $4T_{pC}$                                             |     |       | [2]   |
| 7  | $T_{rTin}, T_{fTin}$ | Timer Input Rise & Fall Times      | 100                                                   |     | ns    | [2]   |
| 8A | $T_{wIL}$            | Interrupt Request Input Low Times  | 70                                                    |     | ns    | [2,4] |
| 8B | $T_{wIL}$            | Interrupt Request Input Low Times  | $2.5T_{pC}$                                           |     |       | [2,5] |
| 9  | $T_{wIH}$            | Interrupt Request Input High Times | $2.5T_{pC}$                                           |     |       | [2,3] |

#### Notes:

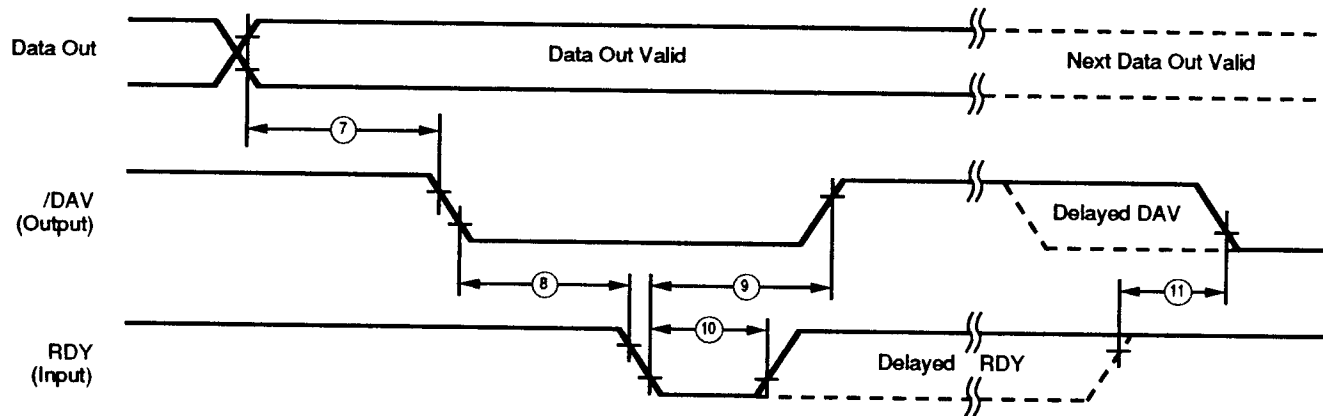
- [1] Clock timing references use 3.8V for a logic 1 and 0.8V for a logic 0.
- [2] Timing references use 2.0V for a logic 1 and 0.8V for a logic 0.
- [3] Interrupt references request via Port 3.
- [4] Interrupt request via Port 3 (P31-P33).
- [5] Interrupt request via Port 30.

**AC CHARACTERISTICS**

Handshake Timing Diagrams



Input Handshake Timing



Output Handshake Timing

## AC CHARACTERISTICS

### Handshake Timing Table

| No | Symbol        | Parameter                  | $T_A = 0^{\circ}\text{C to } 70^{\circ}\text{C}$<br>4 MHz |     | Data<br>Direction |
|----|---------------|----------------------------|-----------------------------------------------------------|-----|-------------------|
|    |               |                            | Min                                                       | Max |                   |
| 1  | TsDI(DAV)     | Data In Setup Time         | 0                                                         |     | IN                |
| 2  | ThDI(DAV)     | Data In Hold Time          | 145                                                       |     | IN                |
| 3  | TwDAV         | Data Available Width       | 110                                                       |     | IN                |
| 4  | TdDAVI(RDY)   | DAV Fall to RDY Fall Delay |                                                           | 115 | IN                |
| 5  | TdDAVIid(RDY) | DAV Rise to RDY Rise Delay |                                                           | 115 | IN                |
| 6  | TdDO(DAV)     | RDY Rise to DAV Fall Delay | 0                                                         |     | IN                |
| 7  | TcLDAVO(RDY)  | Data Out to DAV Fall Delay |                                                           | TpC | OUT               |
| 8  | TcLDAVO(RDY)  | DAV Fall to RDY Fall Delay | 0                                                         |     | OUT               |
| 9  | TdRDY0(DAV)   | RDY Fall to DAV Rise Delay |                                                           | 115 | OUT               |
| 10 | TwRDY         | RDY Width                  | 110                                                       |     | OUT               |
| 11 | TdRDY0d(DAV)  | RDY Rise to DAV Fall Delay |                                                           | 115 | OUT               |

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