

## 8243 MCS-48® INPUT/OUTPUT EXPANDER

- Low Cost
- Simple Interface to MCS-48® Microcomputers
- Four 4-Bit I/O Ports
- AND and OR Directly to Ports
- 24-Pin DIP
- Single 5V Supply
- High Output Drive
- Direct Extension of Resident 8048 I/O Ports

The Intel® 8243 is an input/output expander designed specifically to provide a low cost means of I/O expansion for the MCS-48 family of single chip microcomputers. Fabricated in 5 volts NMOS, the 8243 combines low cost, single supply voltage and high drive current capability.

The 8243 consists of four 4-bit bidirectional static I/O ports and one 4-bit port which serves as an interface to the MCS-48 microcomputers. The 4-bit interface requires that only 4 I/O lines of the 8048 be used for I/O expansion, and also allows multiple 8243's to be added to the same bus.

The I/O ports of the 8243 serve as a direct extension of the resident I/O facilities of the MCS-48 microcomputers and are accessed by their own MOV, ANL, and ORL instructions.

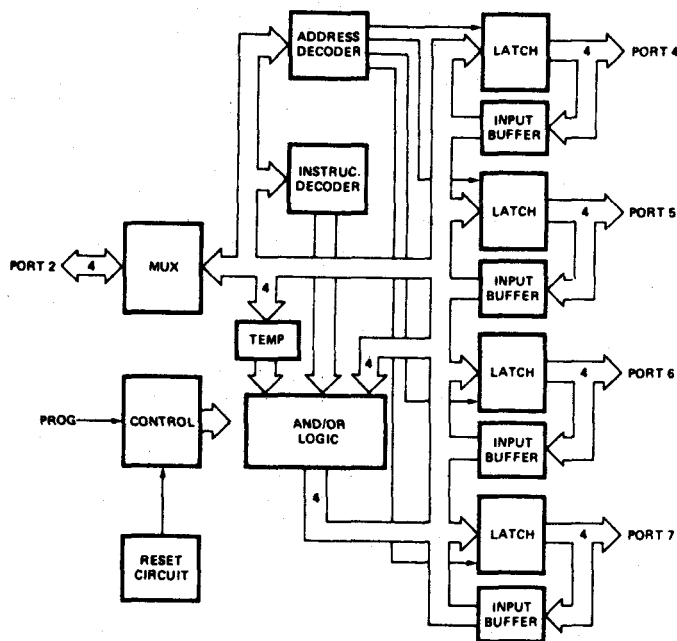


Figure 1. 8243 Block Diagram

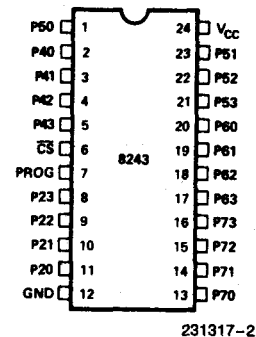


Figure 2. 8243  
Pin Configuration

**Table 1. Pin Description**

| Symbol                                   | Pin No.                           | Function  |
|--|-----------------------------------|---|
| PROG                                     | 7                                 | <b>CLOCK INPUT.</b> A high to low transition on PROG signifies that address and control are available on P20–P23, and a low to high transition signifies that data is available on P20–P23.   |
| CS                                       | 6                                 | <b>CHIP SELECT INPUT.</b> A high on CS inhibits any change of output or internal status.  |
| P20–P23                                  | 11–8                              | Four (4) bit bi-directional port contains the address and control bits on a high to low transition of PROG. During a low to high transition, contains the data for a selected output port if a write operation, or the data from a selected port before the low to high transition if a read operation. |
| GND                                      | 12                                | 0 volt supply.  |
| P40–P43<br>P50–P53<br>P60–P63<br>P70–P73 | 2–5<br>1, 23–21<br>20–17<br>13–16 | Four (4) bit bi-directional I/O ports. May be programmed to be input (during read), low impedance latched output (after write), or a tri-state (after read). Data on pins P20–P23 may be directly written, ANDed or ORed with previous data.  |
| VCC                                      | 24                                | + 5 volt supply.  |

## FUNCTIONAL DESCRIPTION

### General Operation

The 8243 contains four 4-bit I/O ports which serve as an extension of the on-chip I/O and are addressed as ports 4–7. The following operations may be performed on these ports:

- Transfer Accumulator to Port
- Transfer Port to Accumulator
- AND Accumulator to Port
- OR Accumulator to Port

All communication between the 8048 and the 8243 occurs over Port 2 (P20–P23) with timing provided by an output pulse on the PROG pin of the processor. Each transfer consists of two 4-bit nibbles.

The first containing the "op code" and port address and the second containing the actual 4-bits of data. A high to low transition of the PROG line indicates that address is present while a low to high transition indicates the presence of data. Additional 8243's

may be added to the 4-bit bus and chip selected using additional output lines from the 8048/8748/8035.

### Power On Initialization

Initial application of power to the device forces input/output ports 4, 5, 6, and 7 to the tri-state and port 2 to the input mode. The PROG pin may be either high or low when power is applied. The first high to low transition of PROG causes device to exit power on mode. The power on sequence is initiated if V<sub>CC</sub> drops below 1V.

| Address |     | Instruction Code |
|---------|-----|------------------|
| P21     | P20 |                  |
| 0       | 0   | Port 4           |
| 0       | 1   | Port 5           |
| 1       | 0   | Port 6           |
| 1       | 1   | Port 7           |

### Write Modes

The device has three write modes. MOVD Pi, A directly writes new data into the selected port and old data is lost. ORLD Pi, A takes new data, OR's it with the old data and then writes it to the port. ANLD Pi, A takes new data, AND's it with the old data and then writes it to the port. Operation code and port address are latched from the input port 2 on the high to low transition of the PROG pin. On the low to high transition of PROG, data on port 2 is transferred to the logic block of the specified output port.

After the logic manipulation is performed, the data is latched and output. The old data remains latched until new valid outputs are entered.

### Read Mode

The device has one read mode. The operation code and port address are latched from the input port 2 on the high to low transition of the PROG pin. As soon as the read operation and port address are decoded, the appropriate outputs are tri-stated, and the input buffers switched on. The read operation is terminated by a low to high transition of the PROG pin. The port (4, 5, 6 or 7) that was selected is switched to the tri-stated mode while port 2 is returned to the input mode.

Normally, a port will be in an output (write mode) or input (read mode). If modes are changed during operation, the first read following a write should be ignored; all following reads are valid. This is to allow the external driver on the port to settle after the first read instruction removes the low impedance drive from the 8243 output. A read of any port will leave that port in a high impedance state.

## ABSOLUTE MAXIMUM RATINGS\*

Ambient Temperature Under Bias ..... 0°C to 70°C  
 Storage Temperature ..... -65°C to +150°C  
 Voltage on Any Pin  
     With Respect to Ground ..... -0.5V to +7V  
 Power Dissipation ..... 1W

*\*Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

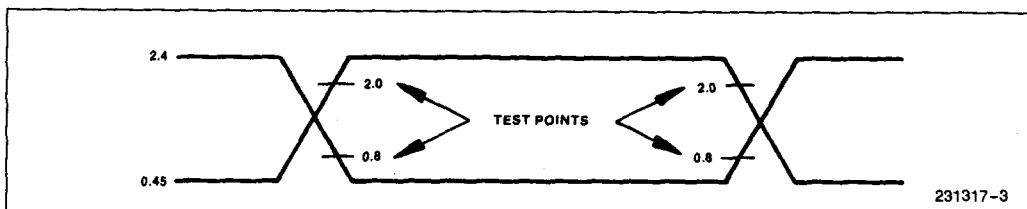
## D.C. CHARACTERISTICS $T_A = 0^\circ\text{C to } 70^\circ\text{C}, V_{CC} = 5V \pm 10\%$

| Symbol    | Parameter                           | Min  | Typ | Max            | Units         | Test Conditions                  |
|-----------|-------------------------------------|------|-----|----------------|---------------|----------------------------------|
| $V_{IL}$  | Input Low Voltage                   | -0.5 |     | 0.8            | V             |                                  |
| $V_{IH}$  | Input High Voltage                  | 2.0  |     | $V_{CC} + 0.5$ | V             |                                  |
| $V_{OL1}$ | Output Low Voltage Ports 4-7        |      |     | 0.45           | V             | $I_{OL} = 4.5 \text{ mA}^*$      |
| $V_{OL2}$ | Output Low Voltage Port 7           |      |     | 1              | V             | $I_{OL} = 20 \text{ mA}$         |
| $V_{OH1}$ | Output High Voltage Ports 4-7       | 2.4  |     |                | V             | $I_{OH} = 240 \mu\text{A}$       |
| $I_{IL1}$ | Input Leakage Ports 4-7             | -10  |     | 20             | $\mu\text{A}$ | $V_{IN} = V_{CC} \text{ to } 0V$ |
| $I_{IL2}$ | Input Leakage Port 2, CS, PROG      | -10  |     | 10             | $\mu\text{A}$ | $V_{IN} = V_{CC} \text{ to } 0V$ |
| $V_{OL3}$ | Output Low Voltage Port 2           |      |     | 0.45           | V             | $I_{OL} = 0.6 \text{ mA}$        |
| $I_{CC}$  | $V_{CC}$ Supply Current             |      | 10  | 20             | mA            |                                  |
| $V_{OH2}$ | Output Voltage Port 2               | 2.4  |     |                | V             | $I_{OH} = 100 \mu\text{A}$       |
| $I_{OL}$  | Sum of all $I_{OL}$ from 16 Outputs |      |     | 72             | mA            | 4.5 mA Each Pin                  |

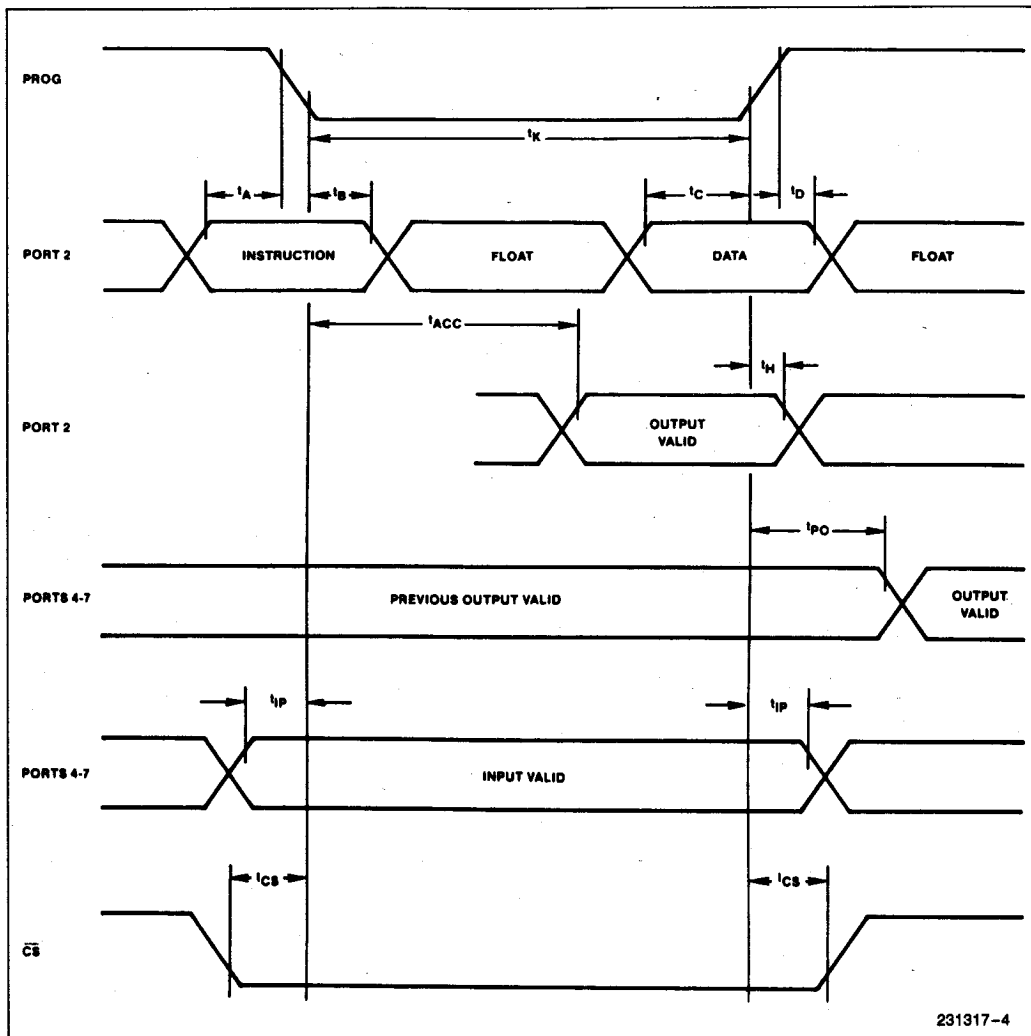
\*See following graph for additional sink current capability.

## A.C. CHARACTERISTICS $T_A = 0^\circ\text{C to } 70^\circ\text{C}, V_{CC} = 5V \pm 10\%$

| Symbol    | Parameter                         | Min | Max | Units | Test Conditions |
|-----------|-----------------------------------|-----|-----|-------|-----------------|
| $t_A$     | Code Valid Before PROG            | 100 |     | ns    | 80 pF Load      |
| $t_B$     | Code Valid After PROG             | 60  |     | ns    | 20 pF Load      |
| $t_C$     | Data Valid Before PROG            | 200 |     | ns    | 80 pF Load      |
| $t_D$     | Data Valid After PROG             | 20  |     | ns    | 20 pF Load      |
| $t_H$     | Floating After PROG               | 0   | 150 | ns    | 20 pF Load      |
| $t_K$     | PROG Negative Pulse Width         | 700 |     | ns    |                 |
| $t_{CS}$  | CS Valid Before/After PROG        | 50  |     | ns    |                 |
| $t_{PO}$  | Ports 4-7 Valid After PROG        |     | 700 | ns    | 100 pF Load     |
| $t_{LP1}$ | Ports 4-7 Valid Before/After PROG | 100 |     | ns    |                 |
| $t_{ACC}$ | Port 2 Valid After PROG           |     | 650 | ns    | 80 pF Load      |



## WAVEFORMS



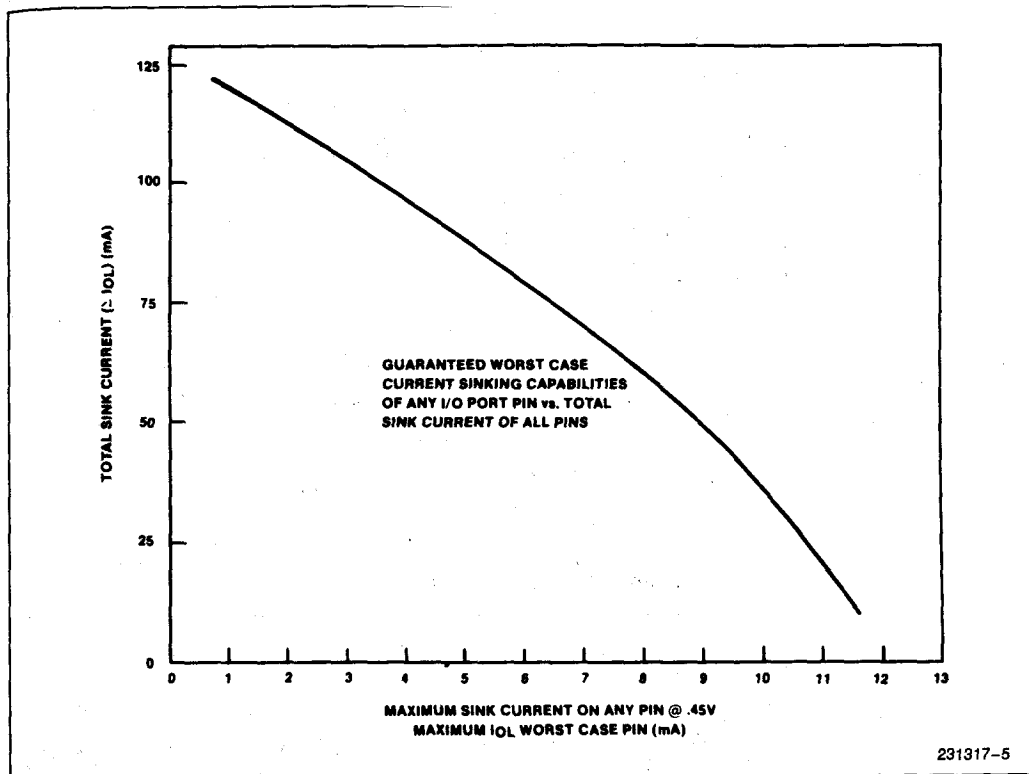


Figure 3

### Sink Capability

The 8243 can sink 5 mA @ 0.45V on each of its 16 I/O lines simultaneously. If, however, all lines are not sinking simultaneously or all lines are not fully loaded, the drive capability of any individual line increases as is shown by the accompanying curve.

For example, if only 5 of the 16 lines are to sink current at one time, the curve shows that each of those 5 lines is capable of sinking 9 mA @ 0.45V (if any lines are to sink 9 mA the total  $I_{OL}$  must not exceed 45 mA or five 9 mA loads).

Example: How many pins can drive 5 TTL loads (1.6 mA) assuming remaining pins are unloaded?

$$I_{OL} = 5 \times 1.6 \text{ mA} = 8 \text{ mA}$$

$$\epsilon I_{OL} = 60 \text{ mA from curve}$$

$$\# \text{ pins} = 60 \text{ mA} \div 8 \text{ mA/pin} = 7.5 \approx 7$$

In this case, 7 lines can sink 8 mA for a total of 56 mA. This leaves 4 mA sink current capability which can be divided in any way among the remaining 8 I/O lines of the 8243.

Example: This example shows how the use of the 20 mA sink capability of Port 7 affects the sinking capability of the other I/O lines.

An 8243 will drive the following loads simultaneously.

2 loads—20 mA @ 1V (port 7 only)

8 loads—4 mA @ 0.45V

6 loads—3.2 mA @ 0.45V

Is this within the specified limits?

$$\epsilon I_{OL} = (2 \times 20) + (8 \times 4) + (6 \times 3.2) = 91.2 \text{ mA. From the curve: for } I_{OL} = 4 \text{ mA, } \epsilon I_{OL} \approx 93 \text{ mA. Since } 91.2 \text{ mA} < 93 \text{ mA the loads are within specified limits.}$$

Although the 20 mA @ 1V loads are used in calculating  $\epsilon I_{OL}$ , it is the largest current required @ 0.45V which determines the maximum allowable  $\epsilon I_{OL}$ .

### NOTE:

A 10 K $\Omega$  to 50 K $\Omega$  pullup resistor to +5V should be added to 8243 outputs when driving to 5V CMOS directly.

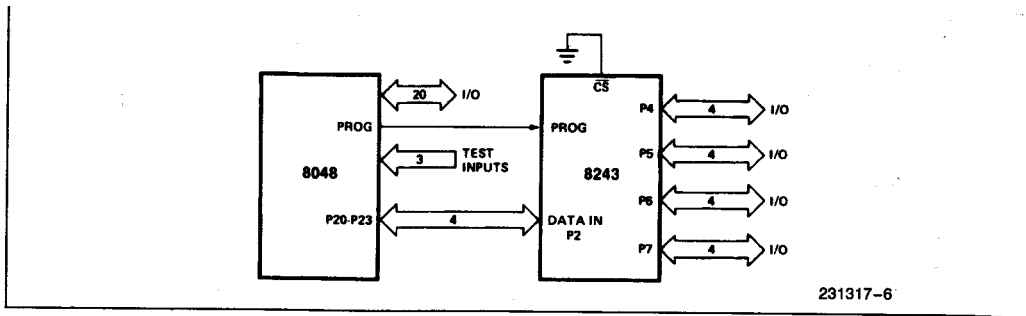


Figure 4. Expander Interface

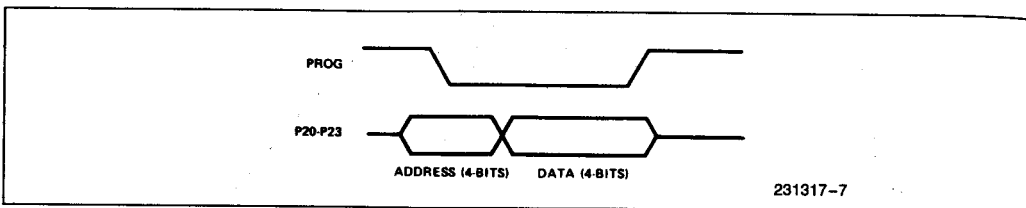


Figure 5. Output Expander Timing

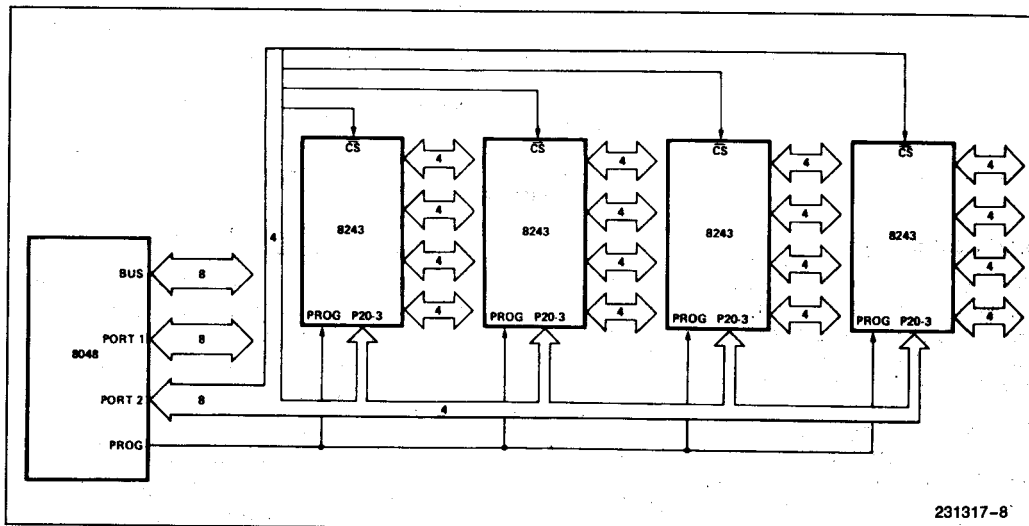


Figure 6. Using Multiple 8243's