

# **TB3061**

### **Interrupt-on-Change Operation for Mid-Range Microcontrollers**

Author: Enrique Aleman Microchip Technology Inc.

### OVERVIEW

In various mid-range microcontroller data sheets there is a caution statement in reference to the interrupt-onchange function. It reads something like this:

Note:	If a change on the I/O pin should occur							
	when the read operation is being executed							
	(start of the Q2 cycle), then the RAIF							
	interrupt flag may not get set.							

This technical brief will describe in detail how the IOC interrupt may be missed depending on when the change event takes place in relation to the clock cycle.

Note:	The condition described does not a	affect
	the enhanced mid-range series	s of
	microcontrollers.	

### INTERRUPT-ON-CHANGE OPERATION

The following is a discussion on how the interrupt-onchange operates both when interrupt-on-change occurs when the port is idle and when change occurs when the port is being read/written to.

### **Description of Problem**

The microcontroller does not detect an interrupt-onchange (IOC) on an I/O pin if the IOC occurs when a READ or WRITE instruction on the port is executed.

### **Root Cause**

A READ/WRITE instruction resets the mismatch latch when the change in level occurs between Q2 and Q3.

If there is no READ/WRITE instruction during the change in level, then the interrupt is set as intended.

Figure 1 is a simplified schematic of the input and change capture.

### FIGURE 1: INTERRUPT-ON-PIN CHANGE



### Normal Operation (No Read/Write to Port)

The interrupt detection is done as follows in terms of Q cycles:

- a) If pin changes level during Q1 cycle:
  - Q1 will read the current state of the pin.
  - Since pin level is different from the change latch output, the input to the interrupt latch is now '1' and the interrupt flag is set.



- Change latch will not enable since there is no READ/WRITE instruction.
- During the Interrupt Service Routine a READ instruction on PORTB will enable the change latch and clear the interrupt flag.
- b) If pin changes during Q2, Q3 or Q4 cycles:
- The state of the pin will be read until the next Q1 cycle and the process described in a) above will follow.



# Problem Operation (When change in level occurs during a READ/WRITE instruction)

If the interrupt is occurring during the execution of a READ or WRITE instruction to the port, then there is a risk of not detecting said interrupt:

- a) If pin changes level during Q1 cycle:
  - Q1 will read the current state of the pin.
  - Since pin level is different from the change latch output, the input to the interrupt latch is now '1' and the interrupt flag is set at Q1.
- b) If pin changes level during Q2 cycle:
  - New level is at change latch input.

- At Q3 Change latch is activated due to READ/ WRITE instruction.
- The interrupt latch is activated at the next Q1 instruction, at this time both inputs to the XOR gate are the same so input to interrupt latch is '0' and interrupt flag is not activated.
- c) If pin changes level during Q3 cycle:
  - The same sequence of events as in b) above occurs.
- d) If pin changes level during Q4 cycle:
  - Pin will be read on the following Q1 cycle.
  - The sequence of events as in a) will follow.

	Q2		Q4	Q1	Q2	Q3	Q4
Fosc							
Q1							
Q2		]					
Q3							
Q4							
RD PORT							
PIN LATCH							
CHANGE LATCH	 						
PIN Change on Q1							
IRQ ASSERTED							
PIN Change on Q2							
IRQ ASSERTED		NO IRQ ASSERTED if instruction accesses the Port					
PIN Change on Q3							
IRQ ASSERTED		NO IRQ ASS	SERTED if inst	uction accesse	s the Port		
PIN Change on Q4							
IRQ ASSERTED							

From the above discussion, we can see that the best possible action is to not execute a READ or WRITE instruction to the port when an IOC event is expected.

### FIGURE 3: PROBLEM OPERATION

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NOTES:

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