

PCF8574/A 8-Bit Remote I/O Expander

Product Specification

Linear Products

DESCRIPTION

The PCF8574 is a single-chip silicon gate CMOS circuit. It provides remote I/O expansion for the MAB8400 and PCF84CXX microcomputer families via the two-line serial bidirectional bus (I²C). It can also interface microcomputers without a serial interface to the I²C bus (as a slave function only). The device consists of an 8-bit quasi-bidirectional port and an I²C interface.

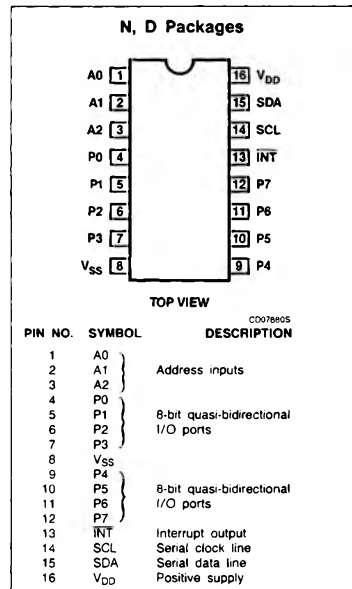
The PCF8574 has low-current consumption and includes latched outputs with high-current drive capability for directly driving LEDs. It also possesses an interrupt line (INT) which is connected to the interrupt logic of the microcomputer on the I²C bus. By sending an interrupt signal on this line, the remote I/O can inform the microcomputer if there is incoming data on its ports without having to communicate via the I²C bus. This means that the PCF8574 can remain a simple slave device.

The PCF8574 and the PCF8574A versions differ only in their slave address, as shown in Figure 9.

FEATURES

- Operating supply voltage: 2.5V to 6V
- Low-standby current consumption: max. 10 μ A
- Bidirectional expander
- Open-drain interrupt output
- 8-bit remote I/O port for the I²C bus
- Peripheral for the MAB8400 and PCF8500 microcomputer families
- Latched outputs with high-current drive capability for directly driving LEDs
- Address by 3 hardware address pins for use of up to 8 devices (up to 16 possible with mask option)

PIN CONFIGURATION



ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
16-Pin Plastic DIP (SOT-38)	-40°C to +85°C	PCF8574PN
16-Pin Plastic DIP (SOT-38)	-40°C to +85°C	PCF8574APN
16-Pin Plastic SO package (SO16L; SOT-162A)	-40°C to +85°C	PCF8574TD
16-Pin Plastic SO package (SO16L; SOT-162A)	-40°C to +85°C	PCF8574ATD

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V _{DD}	Supply voltage range	-0.5 to +7	V
V _I	Input voltage range (any pin)	V _{SS} - 0.5 to V _{DD} + 0.5	V
±I _I	DC current into any input	20	mA
±I _O	DC current into any output	25	mA
±I _{DD} ; I _{SS}	V _{DD} or V _{SS} current	100	mA
P _D	Total power dissipation	400	mW
P _O	Power dissipation per output	100	mW
T _{STG}	Storage temperature range	-65 to +150	°C
T _A	Operating ambient temperature range	-40 to +85	°C

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BLOCK DIAGRAM

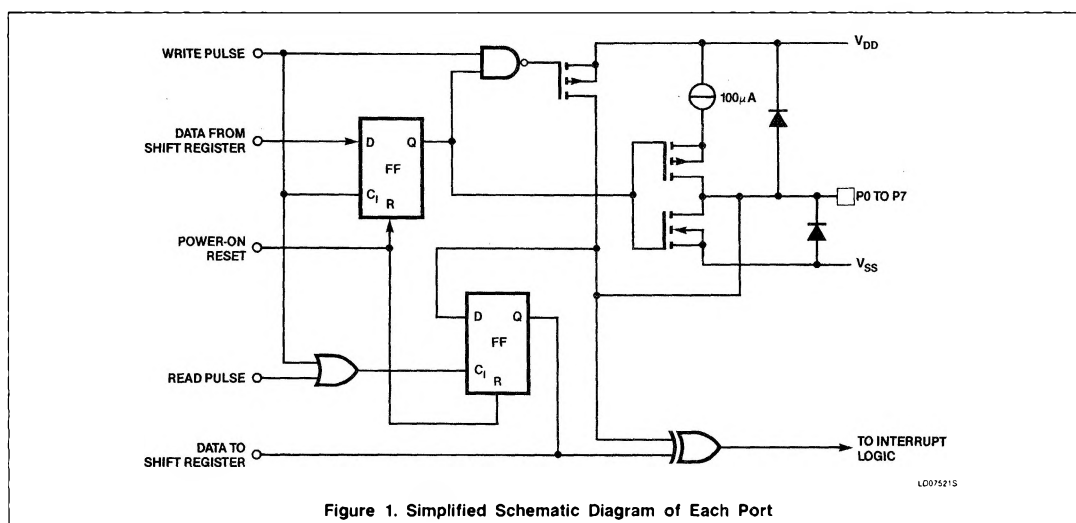
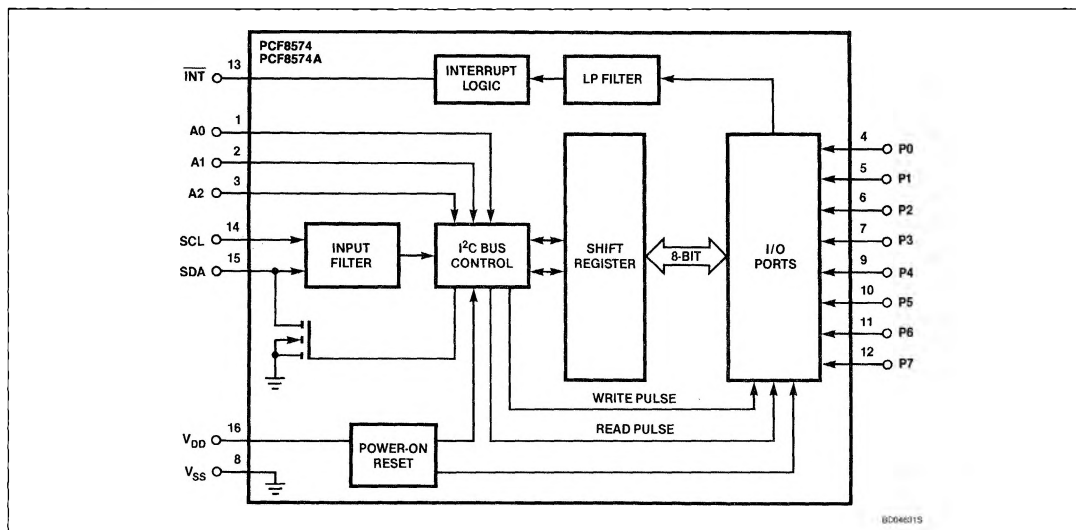


Figure 1. Simplified Schematic Diagram of Each Port

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DC ELECTRICAL CHARACTERISTICS $V_{DD} = 2.5$ to $6V$; $V_{SS} = 0V$; $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise specified.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
Supply (Pin 16)					
V _{DD}	Supply voltage	2.5		6	V
I _{DD}	Supply current at V _{DD} = 6V; no load, inputs at V _{DD} , V _{SS} operating		40	100	μA
I _{DDO}		standby		1.5	10
V _{REF}	Power-on reset voltage level ¹		1.3	2.4	V
Input SCL; Input/output SDA (Pins 14; 15)					
V _{IL}	Input voltage Low	−0.5V		0.3V _{DD}	V
V _{IH}	Input voltage High	0.7V _{DD}		V _{DD} + 0.5	V
I _{OL}	Output current Low at V _{OL} = 0.4V	3			mA
I _{LI}	Input/output leakage current			100	nA
f _{SCL}	Clock frequency (See Figure 6)			100	kHz
t _S	Tolerable spike width at SCL and SDA input			100	ns
C _I	Input capacitance (SCL, SDA) at V _I = V _{SS}			7	pF
I/O ports (Pins 4 to 7; 9 to 12)					
V _{IL}	Input voltage Low	−0.5V		0.3V _{DD}	V
V _{IH}	Input voltage High	0.7V _{DD}		V _{DD} + 0.5V	V
± I _{IHL}	Maximum allowed input current through protection diode at V _I ≥ V _{DD} or ≤ V _{SS}			400	μA
I _{OL}	Output current Low at V _{OL} = 1V; V _{DD} = 2.5V	10	30		mA
−I _{OH}	Output current High at V _{OH} = V _{SS} (current source only)	30	100	300	μA
−I _{OHt}	Transient pull-up current High during acknowledge (see Figure 14) at V _{OH} = V _{SS}		0.5		mA
C _{I/O}	Input/output capacitance			10	pF
Port timing; C _L ≤ 100pF (see Figures 10 and 11)					
t _{PV}	Output data valid			4	μs
t _{PS}	Input data setup	0			μs
t _{PH}	Input data hold	4			μs
Interrupt INT (Pin 13)					
I _{OL}	Output current Low at V _{OL} = 0.4V	1.6			mA
I _{OH}	Output current High at V _{OH} = V _{DD}			100	nA
INT timing; C _L ≤ 100pF (see Figure 11)					
t _{IV}	Input data valid			4	μs
t _{IR}	Reset delay			4	μs
Select Inputs A0, A1, A2 (Pins 1 to 3)					
V _{IL}	Input voltage Low	−0.5V		0.3V _{DD}	V
V _{IH}	Input voltage High	0.7V _{DD}		V _{DD} + 0.5V	V
I _{LI}	Input leakage current at V _I = V _{DD} or V _{SS}			100	nA

NOTE:1. The power-on reset circuit resets the I²C bus logic with $V_{DD} < V_{REF}$ and sets all ports to logic 1 (input mode with current source to V_{DD}).

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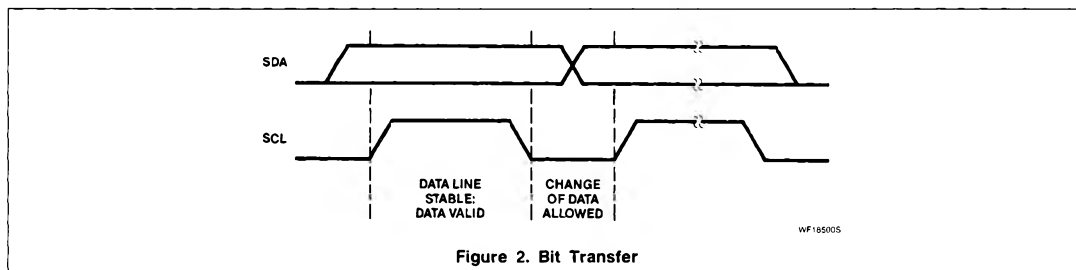
CHARACTERISTICS OF THE I²C BUS

The I²C bus is for 2-way, 2-line communication between different ICs or modules. The two lines are a serial data line (SDA) and a

serial clock line (SCL). Both lines must be connected to a positive supply via a pull-up resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

Bit Transfer

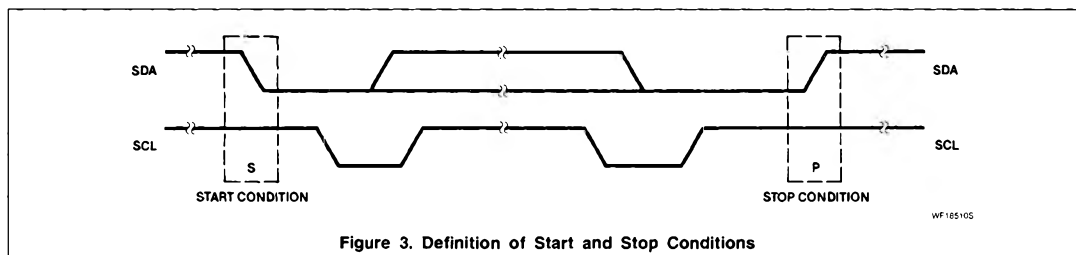
One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the High period of the clock pulse, as changes in the data line at this time will be interpreted as control signals.

**Start and Stop Conditions**

Both data and clock lines remain High when the bus is not busy. A High-to-Low transition

of the data line while the clock is High is defined as the start condition (S). A Low-to-

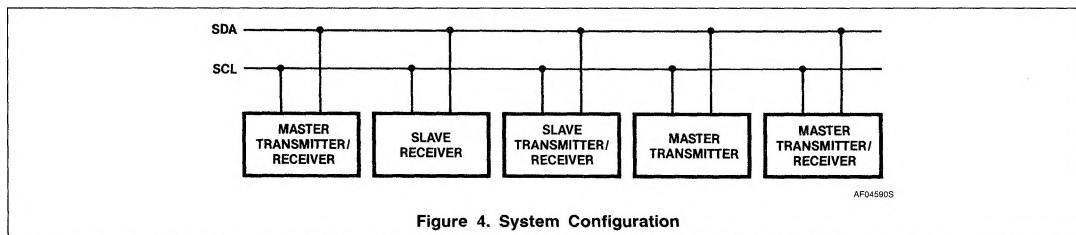
High transition of the data line while the clock is High is defined as the stop condition (P).

**System Configuration**

A device generating a message is a "transmitter"; a device receiving a message is the

"receiver". The device that controls the message is the "master" and the devices which

are controlled by the master are the "slaves".



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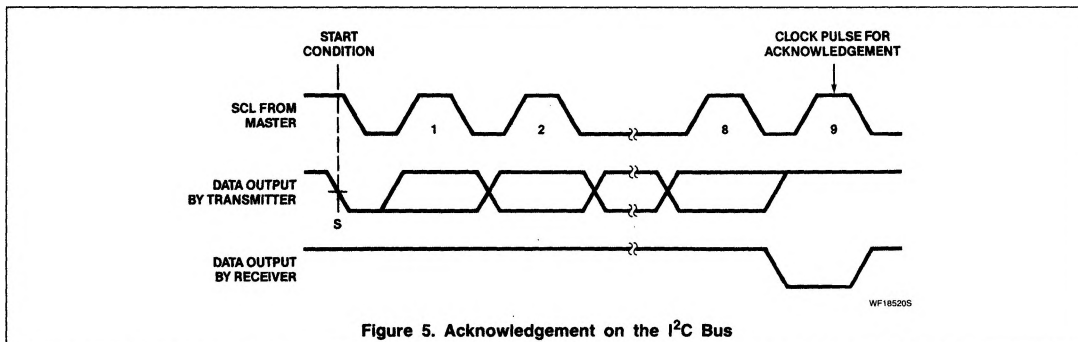
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Acknowledge

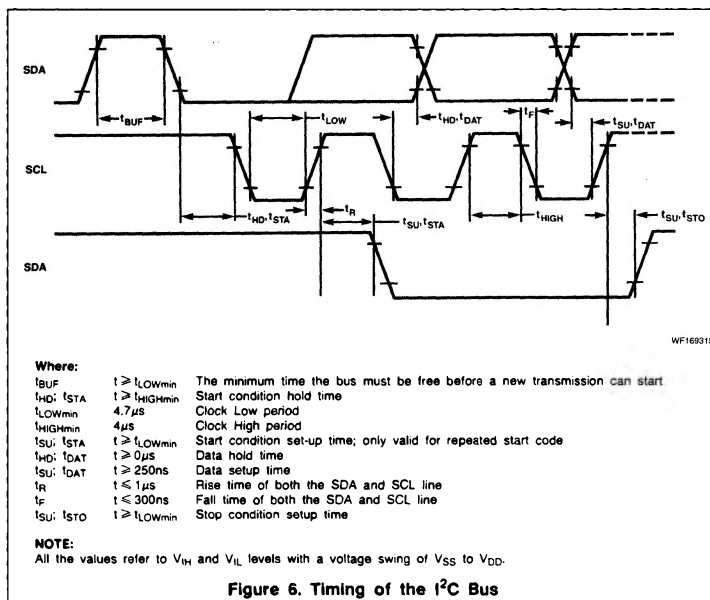
The number of data bytes transferred between the start and stop conditions from transmitter to receiver is not limited. Each byte of eight bits is followed by one acknowledge bit. The acknowledge bit is a High level put on the bus by the transmitter whereas the master generates an extra acknowledge re-

lated clock pulse. A slave receiver which is addressed must generate an acknowledge after the reception of each byte. Also, a master must generate an acknowledge after the reception of each byte that has been clocked out of the slave transmitter. The device that acknowledges has to pull down the SDA line during the acknowledge clock pulse, so that the SDA line is stable Low

during the High period of the acknowledge. Related clock pulse, setup and hold times must be taken into account. A master receiver must signal an end of data to the transmitter by *not* generating an acknowledge on the last byte that has been clocked out of the slave. In this event the transmitter must leave the data line High to enable the master to generate a stop condition.

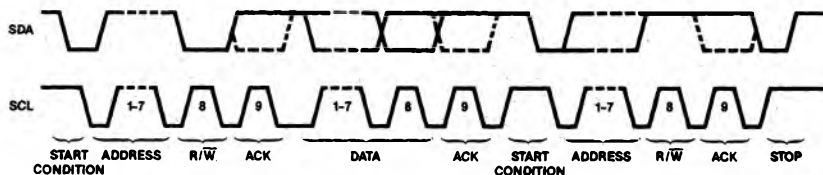
Figure 5. Acknowledgement on the I²C Bus**Timing Specifications**

Masters generate a bus clock with a maximum frequency of 100kHz. Detailed timing is shown in Figure 6.

Figure 6. Timing of the I²C Bus

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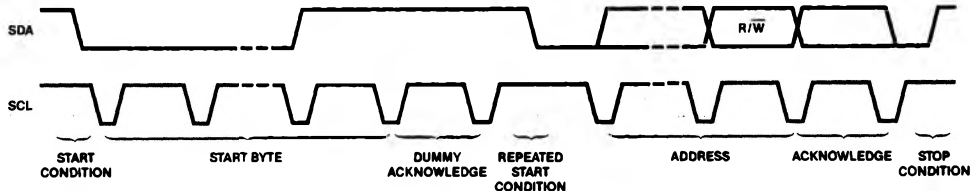


WF18540B

Where:

Clock t_{LOWmin}	4.7 μs
$t_{HIGHmin}$	4 μs
The dashed line is the acknowledgement of the receiver	
Mark-to-space ratio	1:1 (Low-to-High)
Maximum number of bytes	Unrestricted
Premature termination of transfer	Allowed by generation of STOP condition
Acknowledge clock bit	Must be provided by the master

Figure 7. Complete Data Transfer



WF18570S

Where:

Clock t_{LOWmin}	130 $\mu s \pm 25 \mu s$
$t_{HIGHmin}$	390 $\mu s \pm 25 \mu s$
Mark-to-space ratio	1 : 3 (Low-to-High)
Start byte	0000 0001
Maximum number of bytes	6
Premature termination of transfer	not allowed
Acknowledge clock bit	must be provided by master

Figure 8. Complete Data Transfer

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FUNCTIONAL DESCRIPTION

Addressing (See Figures 9, 10 and 11)

Each bit of the PCF8574 I/O port can be independently used as an input or an output.

Input data is transferred from the port to the microcomputer by the READ mode. Output data is transmitted to the port by the WRITE mode.

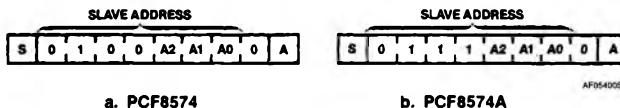


Figure 9. PCF8574 and PCF8574A Slave Address

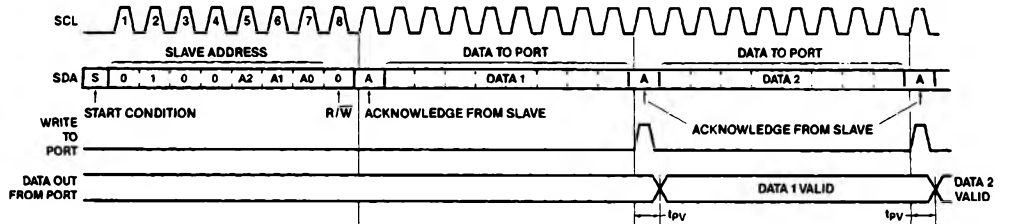
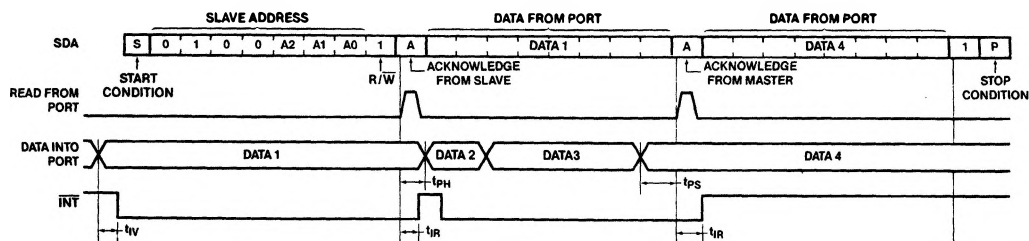


Figure 10. WRITE Mode (Output Port)



NOTE:

A Low-to-High transition of SDA while SCL is High is defined as the stop condition (P). Transfer of data can be stopped at any moment by a stop condition. When this occurs, data present at the last acknowledge phase is valid (output mode). Input data is lost.

Figure 11. READ Mode (Input Port)

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Interrupt (See Figures 12 and 13)

The PCF8574/A provides an open-drain output (INT) which can be fed to a corresponding input of the microcomputer. This gives these chips a type of master function which can initiate an action elsewhere in the system.

An interrupt is generated by any rising or falling edge of the port inputs in the input mode. After time t_{IV} the signal INT is valid.

Resetting and reactivating the interrupt circuit is achieved when data on the port is changed to the original setting or data is read from or written to the port which has generated the interrupt. Resetting occurs as follows:

- In the READ mode at the acknowledge bit after the rising edge of the SCL signal.
- In the WRITE mode at the acknowledge bit after the High-to-Low transition of the SCL signal.

Each change of the ports after the resettings will be detected and after the next rising clock edge, will be transmitted as INT.

Reading from or writing to another device does not affect the interrupt circuit.

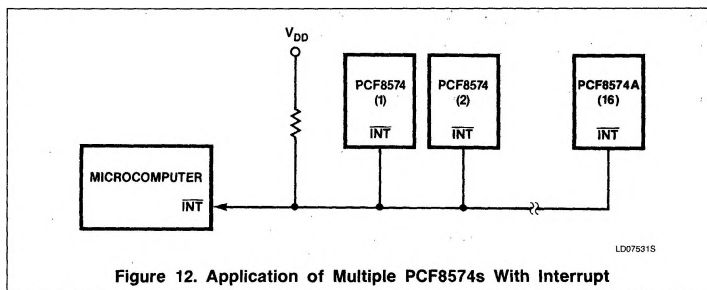


Figure 12. Application of Multiple PCF8574s With Interrupt

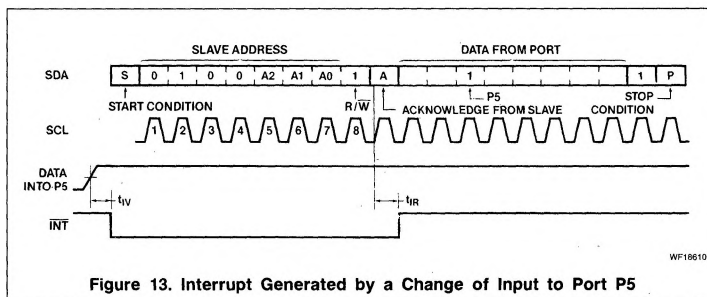


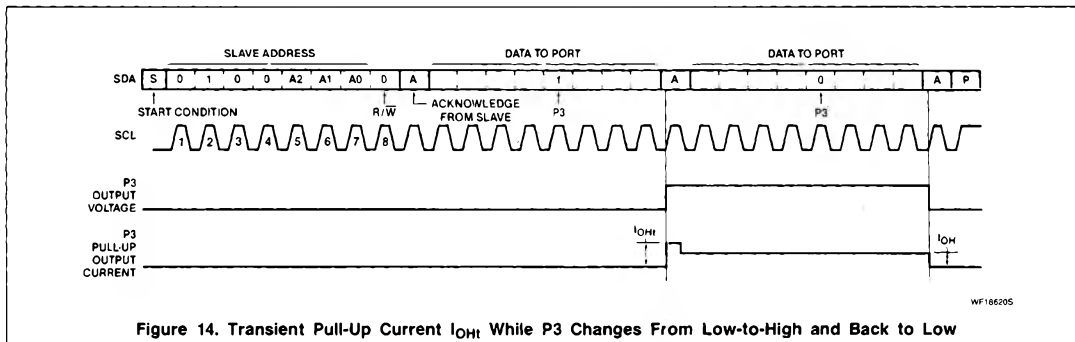
Figure 13. Interrupt Generated by a Change of Input to Port P5

Quasi-Bidirectional I/O Ports (See Figure 14)

A quasi-bidirectional port can be used as an input or output without the use of a control

signal for data direction. The bit designated as an input must first be loaded with a logic 1. In this mode only a current source to V_{DD} is active. An additional strong pull-up to V_{DD} allows fast rising edges into heavily loaded

outputs. These devices turn on when an output changes from Low-to-High, and are switched off by the negative edge of SCL. SCL should not remain High when a short-circuit to V_{SS} is allowed (input mode).

Figure 14. Transient Pull-Up Current I_{OH1} While P3 Changes From Low-to-High and Back to Low