

## Features

- Operation power supply voltage from 2.3V to 5.5 V
- 8-bit I<sup>2</sup>C-bus GPIO with interrupt and reset
- 5V tolerant I/Os
- Polarity inversion register
- Active LOW interrupt output
- Low current consumption
- 0Hz to 400KHz clock frequency
- Noise filter on SCL/SDA inputs
- Power-on reset
- ESD protection (4KV HBM and 1KV CDM)
- Offered in four different packages: SOIC-16, TSSOP-16 and TQFN 3x3-16, TQFN 4x4-16

## Description

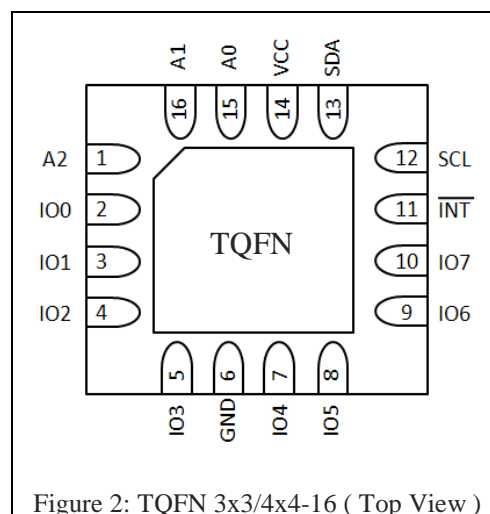
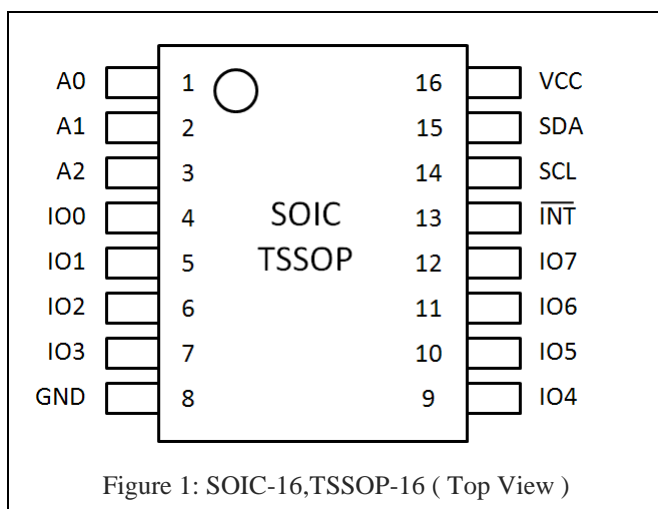
The PI4IOE5V9554 and PI4IOE5V9554A provide 8 bits of General Purpose parallel Input/Output (GPIO) expansion for I<sup>2</sup>C-bus/SMBus applications. It includes the features such as higher driving capability, 5V tolerance, lower power supply, individual I/O configuration, and smaller packaging. It provides a simple solution when additional I/O is needed for ACPI power switches, sensors, push buttons, LEDs, fans, etc.

The PI4IOE5V9554/PI4IOE5V9554A consist of an 8-bit register to configure the I/Os as either inputs or outputs, and an 8-bit polarity register to change the polarity of the input port register data. The data for each input or output is kept in the corresponding Input port or Output port register. All registers can be read by the system master.

The PI4IOE5V9554/PI4IOE5V9554A open-drain interrupt output is activated and indicate to the system when any input state has changed. The power-on reset sets the registers to their default values and initializes the device state machine.

Three hardware pins (A0, A1, A2) vary the fixed I<sup>2</sup>C-bus address and allow up to eight devices to share the same I<sup>2</sup>C-bus/SMBus. The PI4IOE5V9554A is identical to the PI4IOE5V9554 except that the fixed I<sup>2</sup>C-bus address is different allowing up to sixteen of these devices (eight of each) on the same I<sup>2</sup>C-bus/SMBus

## Pin Configuration



## Pin Description

Table 1: Pin Description

Pin		Name	Type	Description
SOIC16 TSSOP16	TQFN16			
1	15	A0	I	Address input 0
2	16	A1	I	Address input 1
3	1	A2	I	Address input 2
4	2	IO0	I/O	input/output 0
5	3	IO1	I/O	input/output 1
6	4	IO2	I/O	input/output 2
7	5	IO3	I/O	input/output 3
8	6	GND	G	Supply ground
9	7	IO4	I/O	input/output 4
10	8	IO5	I/O	input/output 5
11	9	IO6	I/O	input/output 6
12	10	IO7	I/O	input/output 7
13	11	$\overline{\text{INT}}$	O	Interrupt output (open drain)
14	12	SCL	I	Serial clock line
15	13	SDA	I	Serial data line
16	14	VCC	P	Supply voltage

\* I = Input; O = Output; P = Power; G = Ground

### Maximum Ratings

Power supply.....	-0.5V to +6.0V
Voltage on an I/O pin.....	GND-0.5V to +6.0V
Input current.....	±20mA
Output current on an I/O pin.....	±50mA
Supply current.....	±160mA
Ground supply current.....	200mA
Total power dissipation.....	400mW
Operation temperature.....	-40~85°C
Storage temperature.....	-65~150°C
Maximum Junction temperature, T <sub>j(max)</sub> .....	125°C

**Note:**

Stresses greater than those listed under 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 reliability.

### Static characteristics

V<sub>CC</sub> = 2.3 V to 5.5 V; GND = 0 V; T<sub>amb</sub> = -40 °C to +85 °C; unless otherwise specified.

Table 2: Static characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>Power supply</b>						
V <sub>CC</sub>	Supply voltage		2.3	-	5.5	V
I <sub>CC</sub>	Supply current	Operating mode; V <sub>CC</sub> = 5.5 V; no load; f <sub>SCL</sub> = 100 kHz	-	104	175	μA
I <sub>sb</sub>	Standby current	Standby mode; V <sub>CC</sub> = 5.5 V; no load; V <sub>I</sub> = GND; f <sub>SCL</sub> = 0 kHz; I/O = inputs	-	500	700	uA
		Standby mode; V <sub>CC</sub> = 5.5 V; no load; V <sub>I</sub> = V <sub>CC</sub> ; f <sub>SCL</sub> = 0 kHz; I/O = inputs	-	0.25	1	μA
V <sub>POR</sub>	Power-on reset voltage <sup>[1]</sup>		-	1.16	1.41	V
<b>Input SCL, input/output SDA</b>						
V <sub>IL</sub>	Low level input voltage		-0.5	-	+0.3V <sub>CC</sub>	V
V <sub>IH</sub>	High level input voltage		0.7V <sub>CC</sub>	-	5.5	V
I <sub>OL</sub>	Low level output current	V <sub>OL</sub> = 0.4V; V <sub>CC</sub> = 2.3V	3	6	-	mA
I <sub>L</sub>	Leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND	-1	-	1	μA
C <sub>i</sub>	Input capacitance	V <sub>I</sub> = GND	-	6	10	pF

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>I/Os</b>						
V <sub>IL</sub>	Low level input voltage		-0.5	-	+0.81	V
V <sub>IH</sub>	High level input voltage		+1.8	-	5.5	V
I <sub>OL</sub>	Low level output current	VCC = 2.3V; V <sub>OL</sub> = 0.5V <sup>[2]</sup>	8	10	-	mA
		VCC = 2.3V; V <sub>OL</sub> = 0.7V <sup>[2]</sup>	10	13	-	mA
		VCC = 3.0V; V <sub>OL</sub> = 0.5V <sup>[2]</sup>	8	14	-	mA
		VCC = 3.0V; V <sub>OL</sub> = 0.7V <sup>[2]</sup>	10	19	-	mA
		VCC = 4.5V; V <sub>OL</sub> = 0.5V <sup>[2]</sup>	8	17	-	mA
		VCC = 4.5V; V <sub>OL</sub> = 0.7V <sup>[2]</sup>	10	24	-	mA
V <sub>OH</sub>	High level output current	I <sub>OH</sub> = -8mA; VCC = 2.3V <sup>[3]</sup>	1.8	-	-	V
		I <sub>OH</sub> = -10mA; VCC = 2.3V <sup>[3]</sup>	1.7	-	-	V
		I <sub>OH</sub> = -8mA; VCC = 3.0V <sup>[3]</sup>	2.6	-	-	V
		I <sub>OH</sub> = -10mA; VCC = 3.0V <sup>[3]</sup>	2.5	-	-	V
		I <sub>OH</sub> = -8mA; VCC = 4.5V <sup>[3]</sup>	4.1	-	-	V
		I <sub>OH</sub> = -10mA; VCC = 4.5V <sup>[3]</sup>	4.0	-	-	V
I <sub>LI</sub>	Low level input leakage current	VCC = 3.6V; V <sub>I</sub> = VCC	-1	-	1	uA
I <sub>L</sub>	Leakage current	VCC = 5.5V; V <sub>I</sub> = GND			-100	uA
C <sub>i</sub>	Input capacitance		-	3.7	10	pF
C <sub>o</sub>	Output capacitance		-	3.7	10	pF
<b>Interrupt <math>\overline{\text{INT}}</math></b>						
I <sub>OL</sub>	Low level output current	V <sub>OL</sub> = 0.4V	3	-	-	mA
<b>Select inputs A0,A1,A2</b>						
V <sub>IL</sub>	Low level input voltage		-0.5	-	+0.81	V
V <sub>IH</sub>	High level input voltage		+1.8	-	5.5	V
I <sub>L</sub>	Input leakage current		-1	-	1	μA

Note:  
 [1]: VCC must be lowered to 0.2 V for at least 20us in order to reset part.  
 [2]: Each I/O must be limited to a maximum current of 25mA and the device must be limited to a maximum current of 100mA.  
 [3]: The total current sourced by all I/Os must be limited to 85mA.

## Dynamic Characteristics

Table 3: Dynamic characteristics

Symbol	Parameter	Test Conditions	Standard mode I <sup>2</sup> C		Fast mode I <sup>2</sup> C		Unit
			Min	Max	Min	Max	
f <sub>SCL</sub>	SCL clock frequency		0	100	0	400	kHz
t <sub>BUF</sub>	bus free time between a STOP and START condition		4.7	-	1.3	-	μs
t <sub>HD;STA</sub>	hold time (repeated) START condition		4.0	-	0.6	-	μs
t <sub>SU;STA</sub>	set-up time for a repeated START condition		4.7	-	0.6	-	μs
t <sub>SU;STO</sub>	set-up time for STOP condition		4.0	-	0.6	-	μs
t <sub>VD;ACK</sub> <sup>[1]</sup>	data valid acknowledge time		-	3.45	-	0.9	μs
t <sub>HD;DAT</sub> <sup>[2]</sup>	data hold time		0	-	0	-	ns
t <sub>VD;DAT</sub>	data valid time		-	3.45	-	0.9	ns
t <sub>SU;DAT</sub>	data set-up time		250	-	100	-	ns
t <sub>LOW</sub>	LOW period of the SCL clock		4.7	-	1.3	-	μs
t <sub>HIGH</sub>	HIGH period of the SCL clock		4.0	-	0.6	-	μs
t <sub>f</sub>	fall time of both SDA and SCL signals		-	300	-	300	ns
t <sub>r</sub>	rise time of both SDA and SCL signals		-	1000	-	300	ns
t <sub>SP</sub>	pulse width of spikes that must be suppressed by the input filter		-	50	-	50	ns
<b>Port timing</b>							
t <sub>v(Q)</sub>	Data output valid time <sup>[3]</sup>		-	200	-	200	ns
t <sub>su(D)</sub>	Data input set-up time		100	-	100	-	ns
t <sub>h(D)</sub>	Data input hold time		1	-	1	-	us
<b>Interrupt timing</b>							
t <sub>v(INT)</sub>	Valid time on pin $\overline{\text{INT}}$		-	4	-	4	us
t <sub>rec(INT)</sub>	Reset time on pin $\overline{\text{INT}}$		-	4	-	4	us

Note:

[1]: t<sub>VD;ACK</sub> = time for acknowledgement signal from SCL LOW to SDA (out) LOW.

[2]: t<sub>VD;DAT</sub> = minimum time for SDA data out to be valid following SCL LOW.

[3]: t<sub>v(Q)</sub> measured from 0.7V<sub>CC</sub> on SCL to 50% I/O output.

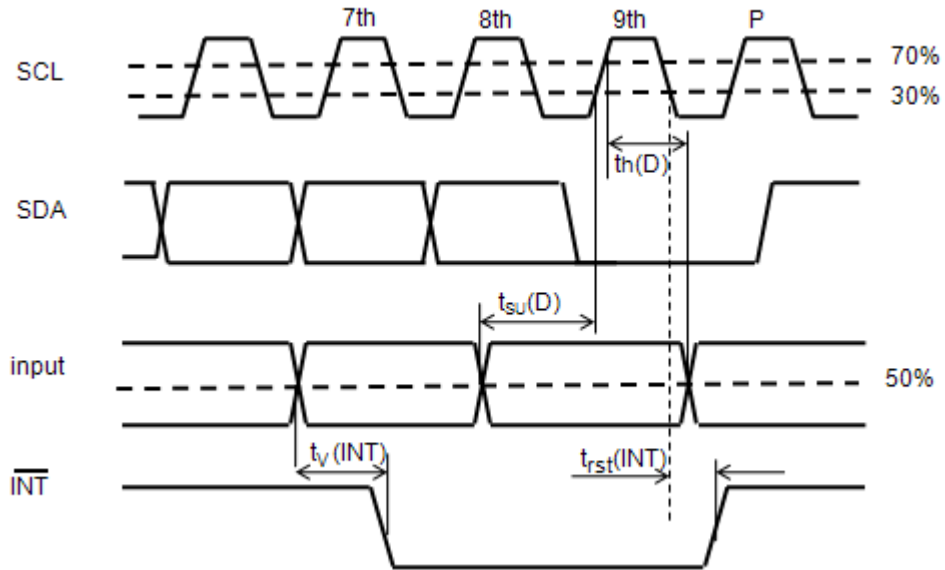
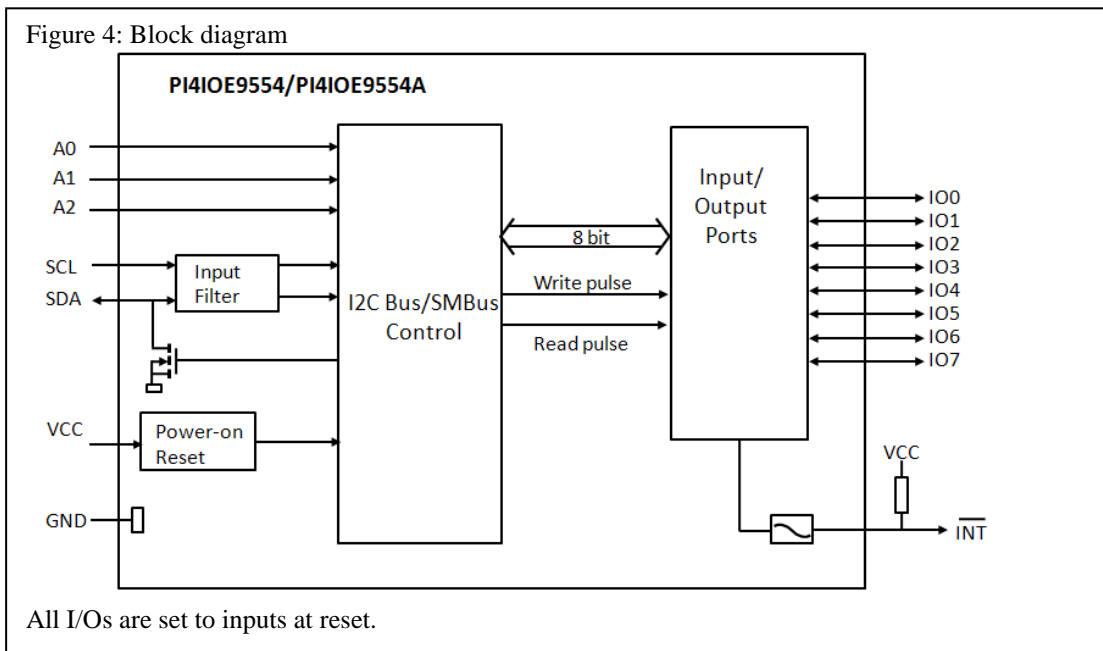


Figure 3: timing parameters for INT signal

**PI4IOE5V9554/PI4IOE5V9554A Block Diagram**



## Details Description

### a. Device address

Following a START condition the bus master must output the address of the slave it is accessing. The address of the PI4IOE5V9554/54A is shown below. To conserve power, no internal pull-up resistors are incorporated on the hardware selectable address pins and they must be pulled HIGH or LOW.

Table 4: Device address Byte

	b7(MSB)	b6	b5	b4	b3	b2	b1	b0
PI4IOE5V9554	0	1	0	0	A2	A1	A0	R/W
PI4IOE5V9554A	0	1	1	1	A2	A1	A0	R/W

Note: Read "1", Write "0"

### b. Register description

#### i. Command byte

The command byte is the first byte to follow the address byte during a write transmission. It is used as a pointer to determine which of the following registers will be written or read.

Table 5: Command byte

Command	Protocol	Function
0	Read byte	Input port register
1	Read/write byte	Output port register
2	Read/write byte	Polarity Inversion register
3	Read/write byte	Configuration register

#### ii. Register 0: Input port register

This register is a read-only port. It reflects the incoming logic levels of the pins, regardless of whether the pin is defined as an input or an output by Register 3. Writes to this register have no effect.

The default 'X' is determined by the externally applied logic level, normally '1' when no external signal externally applied because of the internal pull-up resistors.

Table 6: Input port register

Bit	7	6	5	4	3	2	1	0
Symbol	I7	I6	I5	I4	I3	I2	I1	I0

#### iii. Register 1: Output port register

This register reflects the outgoing logic levels of the pins defined as outputs by Register 3. Bit values in this register have no effect on pins defined as inputs. Reads from this register return the value that is in the flip-flop controlling the output selection, **not** the actual pin value.

Table 7: Output port register

Bit	7	6	5	4	3	2	1	0
Symbol	O7	O6	O5	O4	O3	O2	O1	O0
Default	1	1	1	1	1	1	1	1

**iv. Register 2: Polarity inversion register**

This register allows the user to invert the polarity of the Input Port register data. If a bit in this register is set (written with ‘1’), the corresponding Input Port data is inverted. If a bit in this register is cleared (written with a ‘0’), the Input Port data polarity is retained.

Table 8: Polarity inversion register

Bit	7	6	5	4	3	2	1	0
Symbol	N7	N6	N5	N4	N3	N2	N1	N0
Default	0	0	0	0	0	0	0	0

**v. Register 3: Configuration register**

This register configures the directions of the I/O pins. If a bit in this register is set, the corresponding port pin is enabled as an input with high-impedance output driver. If a bit in this register is cleared, the corresponding port pin is enabled as an output. At reset, the I/Os are configured as inputs with a weak pull-up to VCC.

Table 9: Configuration register

Bit	7	6	5	4	3	2	1	0
Symbol	C7	C6	C5	C4	C3	C2	C1	C0
Default	1	1	1	1	1	1	1	1



**c. Power-on reset**

When power is applied to VCC, an internal Power-On Reset (POR) holds the PI4IOE5V9554/PI4IOE5V9554A in a reset condition until VCC has reached VPOR. At that point, the reset condition is released and the PI4IOE5V9554/PI4IOE5V9554A registers and state machine will initialize to their default states. Thereafter, VCC must be lowered below 0.2 V to reset the device.

For a power reset cycle, VCC must be lowered below 0.2 V and then restored to the operating voltage.

**d. Interrupt output**

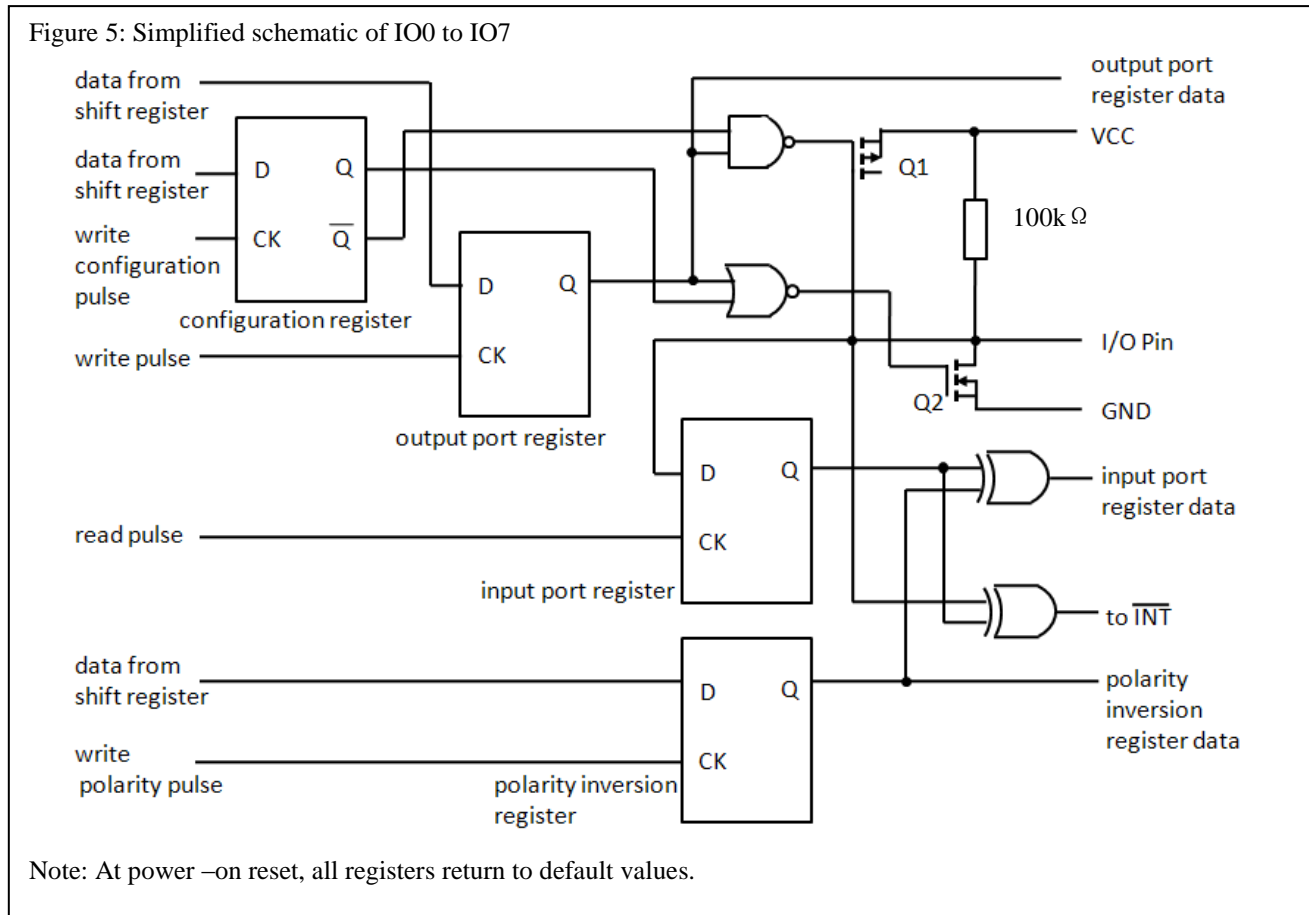
The open-drain interrupt output is activated when one of the port pins change state and the pin is configured as an input. The interrupt is deactivated when the input returns to its previous state or the Input Port register is read.

Note that changing an I/O from an output to an input may cause a false interrupt to occur if the state of the pin does not match the contents of the Input Port register.

**e. I/O port**

When an I/O is configured as an input, FETs Q1 and Q2 are off, creating a high-impedance input with a weak pull-up (100 kΩ typ.) to VCC. The input voltage may be raised above VCC to a maximum of 5.5V.

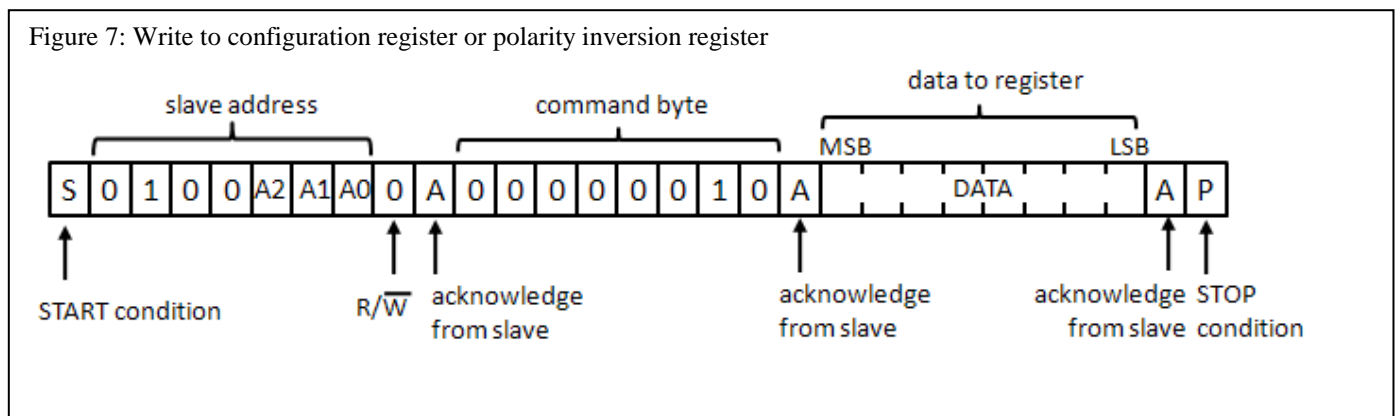
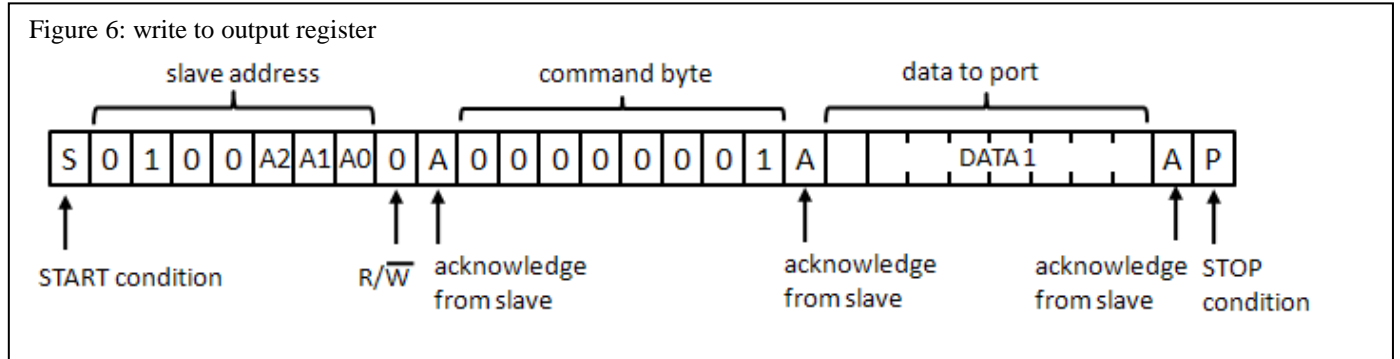
If the I/O is configured as an output, then either Q1 or Q2 is enabled, depending on the state of the Output Port register. Care should be exercised if an external voltage is applied to an I/O configured as an output because of the low-impedance paths that exist between the pin and either VCC or GND.



**f. Bus Transaction**

Data is transmitted to the PI4IOE5V9554/PI4IOE5V9554A registers using the Write mode as shown in Figure 6 and Figure 7.

These devices do not implement an auto-increment function, so once a command byte has been sent, the register which was addressed will continue to be accessed by reads until a new command byte has been sent.



Data is read from the PI4IOE5V9554/PI4IOE5V9554A registers using the Read mode as shown in Figure 8 and Figure 9.

Figure 8: Read from register

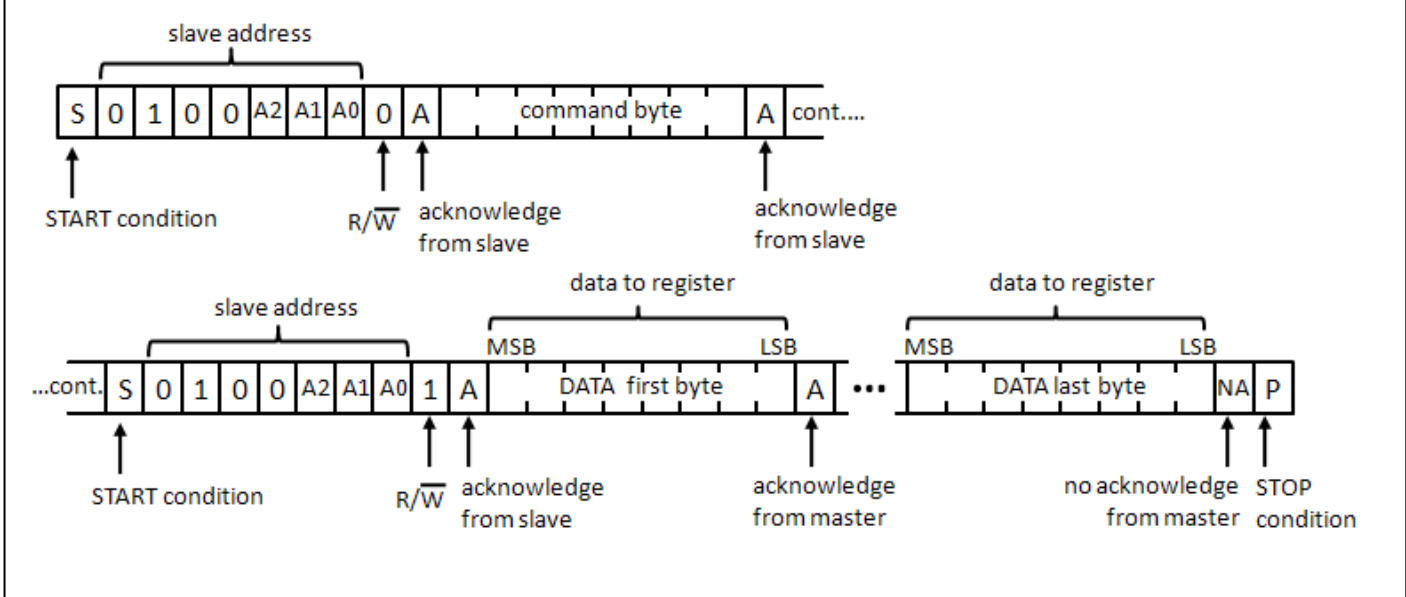
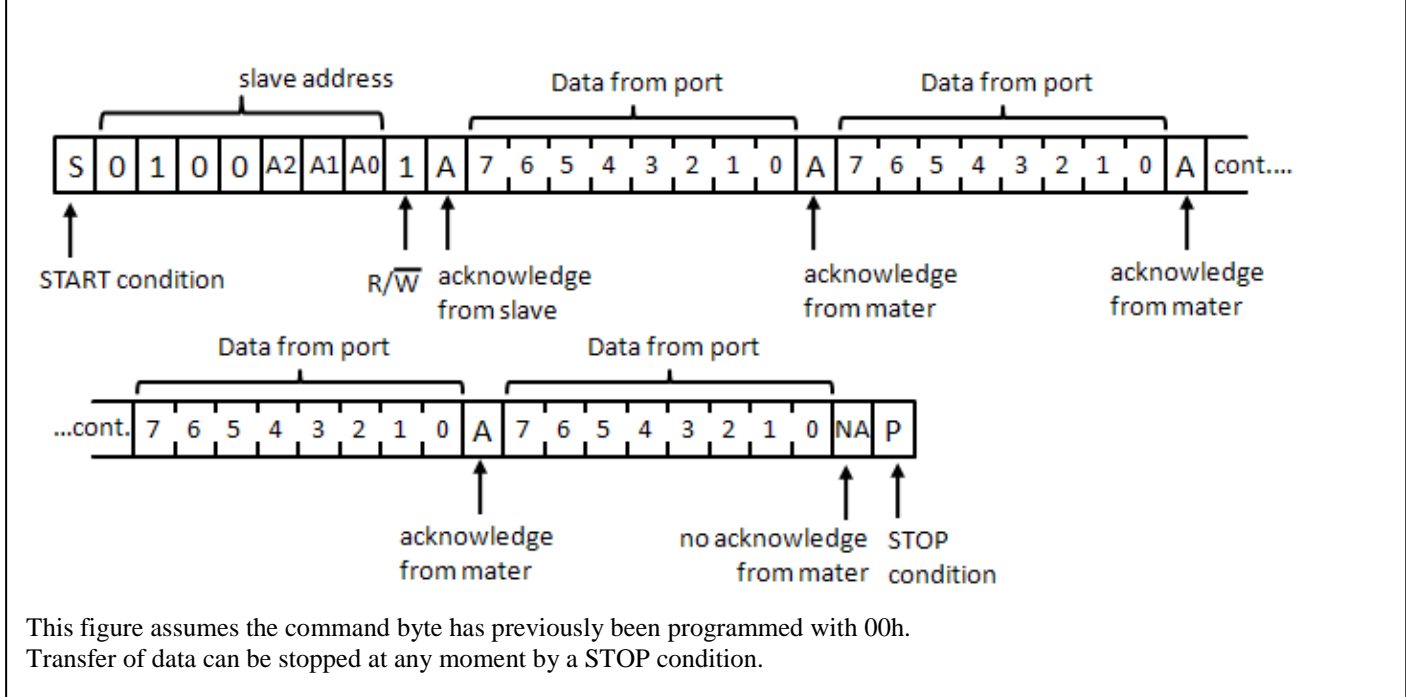


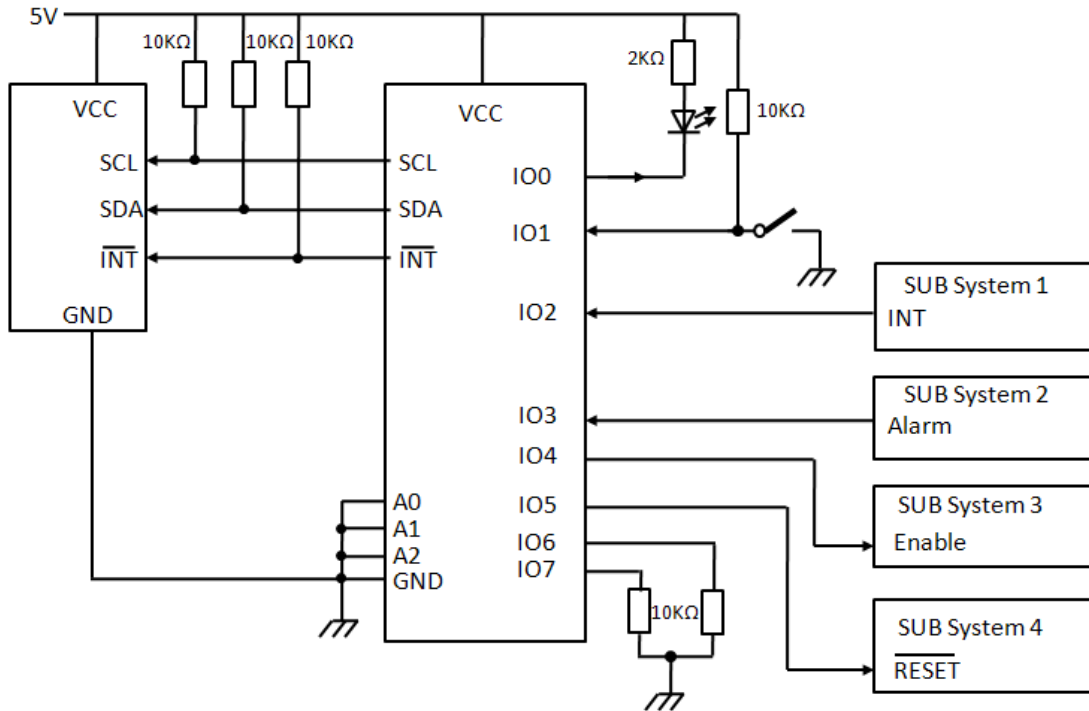
Figure 9: Read input port register



This figure assumes the command byte has previously been programmed with 00h. Transfer of data can be stopped at any moment by a STOP condition.

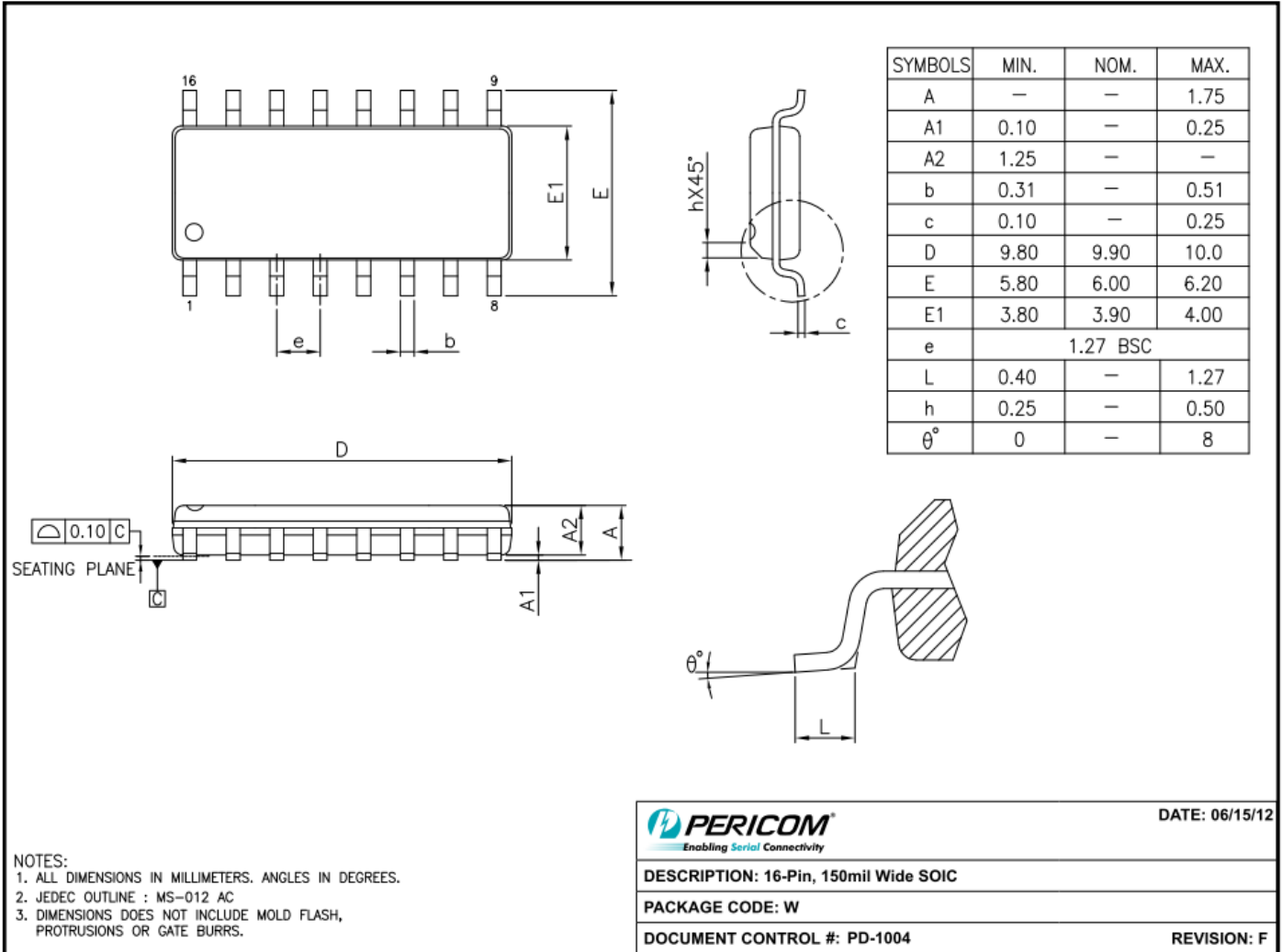
### Application design-in information

Figure 10: Typical application

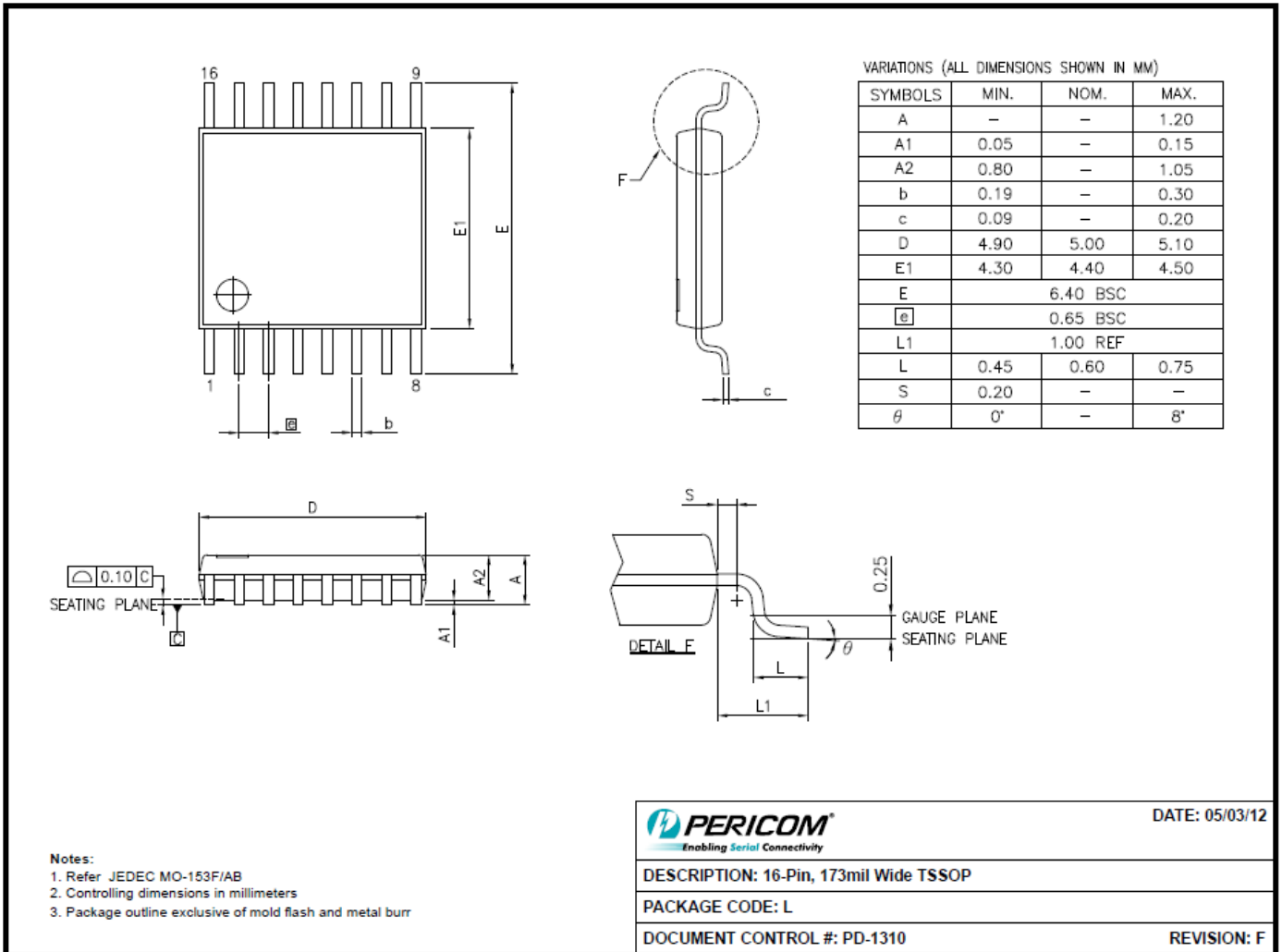


Device address configured as 0100100x for this example.  
 IO0, IO4, IO5 configured as outputs.  
 IO1, IO2, IO3 configured as inputs.  
 IO6, IO7 are not used and must be configured as outputs.

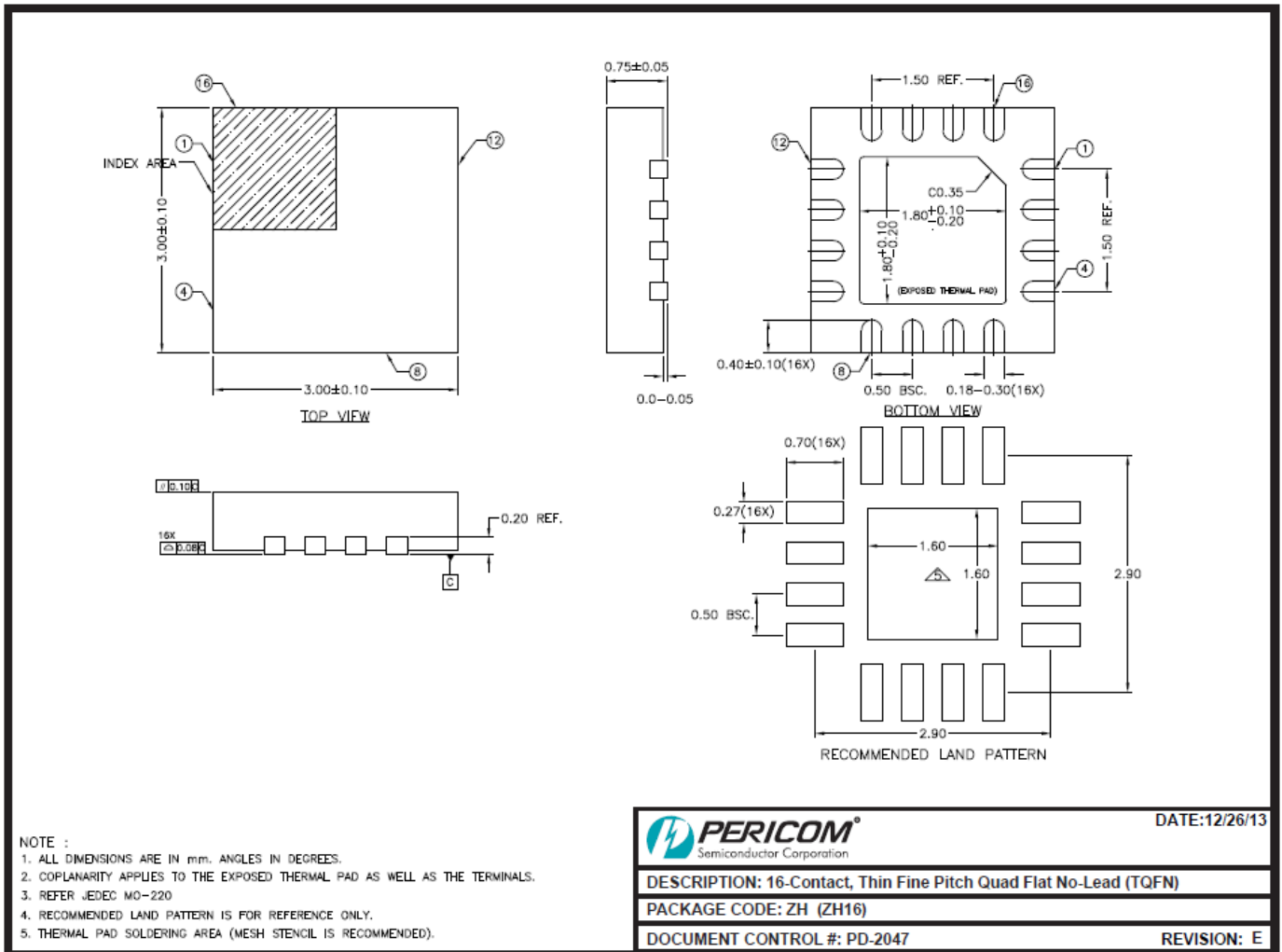
**Mechanical Information**  
**SOIC-16(W)**



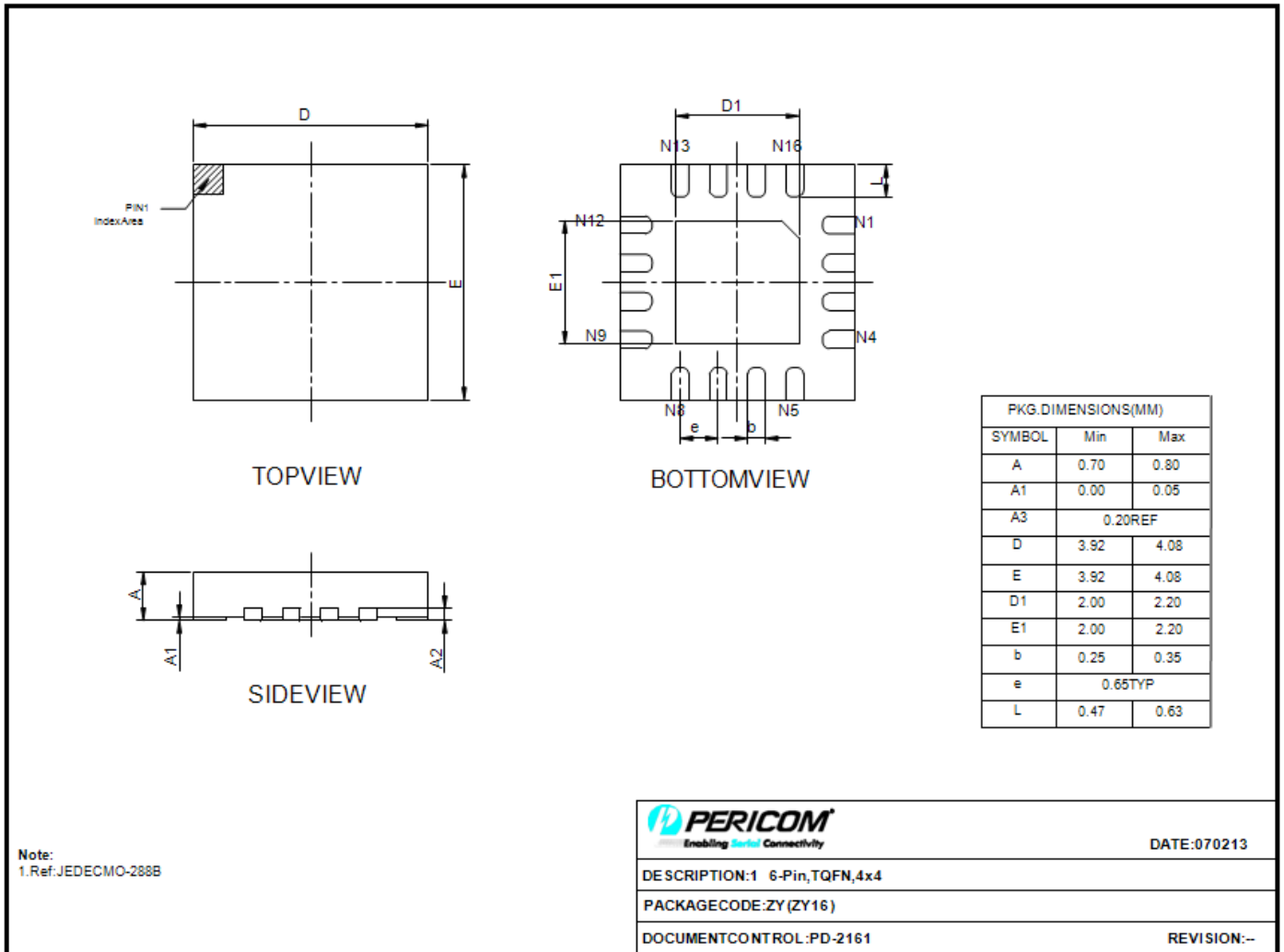
TSSOP-16(L)



TQFN 3x3-16(ZH)



TQFN 4x4-16(ZY)



## Ordering Information

Part No.	Package Code	Package
PI4IOE5V9554WE, PI4IOE5V9554AWE	W	16-Pin,150 mil Wide SOIC
PI4IOE5V9554WEX, PI4IOE5V9554AWEX	W	16-Pin,150 mil Wide SOIC,Tape & Reel
PI4IOE5V9554LE, PI4IOE5V9554ALE	L	Lead free and Green 16-pin TSSOP16(173mil wide)
PI4IOE5V9554LEX, PI4IOE5V9554ALEX	L	Lead free and Green 16-pin TSSOP16(173mil wide), Tape & Reel
PI4IOE5V9554ZHEX, PI4IOE5V9554AZHEX	ZH	Lead free and Green 16-pin TQFN3.0x3.0 , Tape & Reel
PI4IOE5V9554ZYEX, PI4IOE5V9554AZYEX	ZY	Lead free and Green 16-pin TQFN4.0x4.0 , Tape & Reel

**Note:**

- E = Pb-free and Green
- Adding X Suffix= Tape/Reel

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