8-Bit I2C-Bus and SMBus I/O Port with Reset

Description

The DIODES PI4IOE5V9557 provide 8 bits of General Purpose parallel Input/Output (GPIO) expansion for I²C-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 PI4IOE5V9557 consists 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. 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 power-on reset sets the registers to their default values and initializes the device state machine. The RESET pin causes the same reset/default I/O input configuration to occur without de-powering the device, holding the registers and I²C-bus state machine in their default state until the RESET input is once again HIGH.

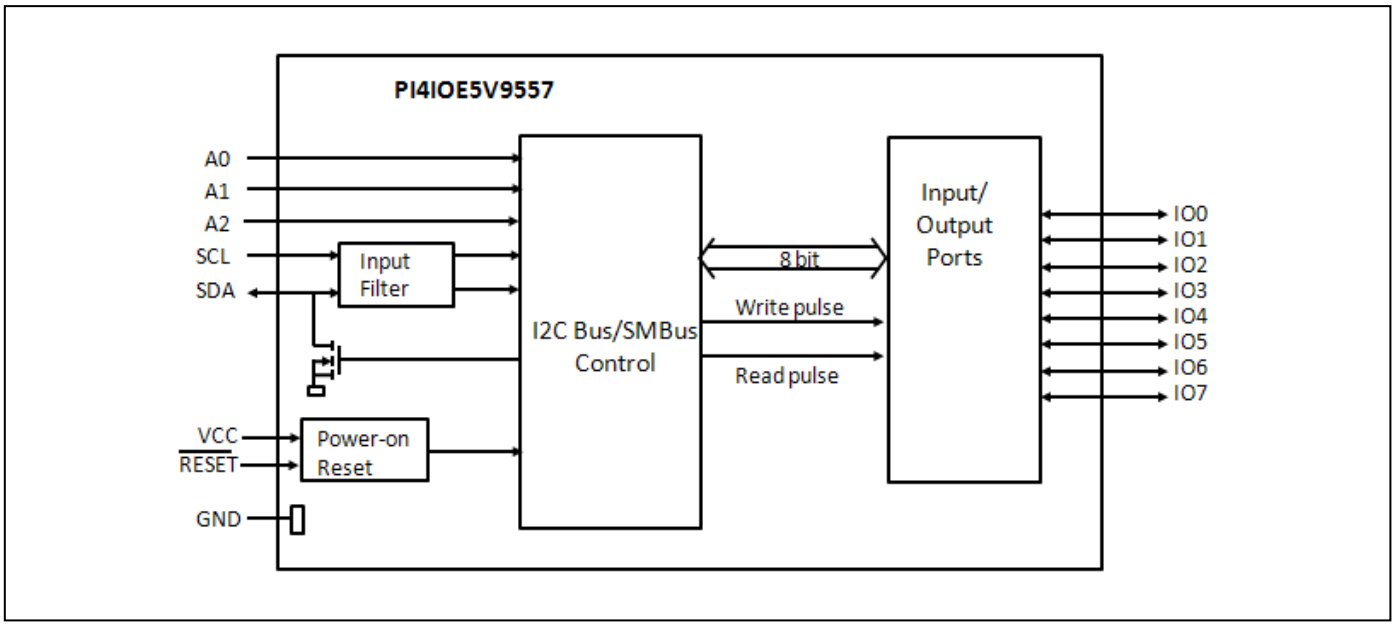
Three hardware pins (A0, A1, A2) vary the fixed I²C-bus address and allow up to eight devices to share the same I²C-bus/SMBus.

Features

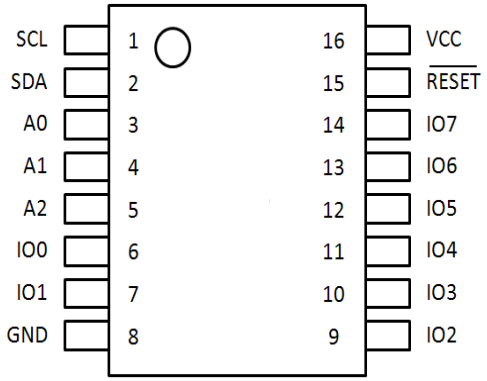
- Operation power supply voltage from 2.3V to 5.5V
- 8-bit I²C-bus GPIO with interrupt and reset
- 5V tolerant I/Os
- Polarity inversion register
- Active LOW Reset Pin
- Low current consumption
- 0Hz to 400KHz clock frequency
- Noise filter on SCL/SDA inputs
- Power-on reset
- ESD protection (4KV HBM and 1KV CDM)
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.
  https://www.diodes.com/quality/product-definitions
- Packaging (Pb-free & Green available):
  - 16-pin, 173mil wide, TSSOP (L)

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Block Diagram



Pin Configuration



Pin Description

Pin#	Name	Type	Description
1	SCL	I	Serial clock line
2	SCA	I	Serial data line
3	A0	I	Address input 0
4	A1	I	Address input 1
5	A2	I	Address input 2
6	IO0	I/O	input/output 0 (open-drain)
7	IO1	I/O	input/output 1
8	GND	G	Supply ground
9	IO2	I/O	input/output 2
10	IO3	I/O	input/output 3
11	IO4	I/O	input/output 4
12	IO5	G	input/output 5
13	IO6	I/O	input/output 6
14	IO7	I/O	input/output 7
15	$\overline{\text{RESET}}$	I	Active LOW reset input
16	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℃
Storage Temperature	-65~150℃
Maximum Junction Temperature j (Max.)	125℃

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

VCC = 2.3V to 5.5V; GND = 0V; Tamb= -40°C to +85°C; unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Power supply						
V_{CC}	Supply voltage		2.3		5.5	V
I_{CC}	Supply current	Operating mode; VCC = 5.5V; no load; f_{SCL} = 100kHz		19	25	μA
I_{stb}	Standby current	Standby mode; VCC = 5.5V; no load; V_I = GND; f_{SCL} = 0 kHz; I/O = inputs		0.25	1	uA
		Standby mode; VCC = 5.5V; no load; V_I = VCC; f_{SCL} = 0kHz; I/O = inputs		0.25	1	μA
ΔI_{stb}	Additional standby current	Standby mode; VCC = 5.5V; every LED I/O at V_I = 4.3V; f_{SCL} = 0kHz;		0.8	1	mA
V_{POR}	Power-on reset voltage (1)			1.16	1.41	V
Input SCL, input/output SDA						
V_{IL}	Low level input voltage		-0.5		+0.3VCC	V
V_{IH}	High level input voltage		0.7VCC		5.5	V
I_{OL}	Low level output current	V_{OL} = 0.4V; VCC = 2.3V	3			mA
I_L	Leakage current	V_I = VCC or GND	-1		1	μA
C_I	Input capacitance	V_I = GND		6	10	pF
I/Os						
V_{IL}	Low level input voltage		-0.5		+0.81	V
V_{IH}	High level input voltage		+1.8		5.5	V
I_{OL}	Low level output current	VCC = 2.3V; V_{OL} = 0.5V[2]	8	10		mA
I_{OH}	High level output current	Except pin IO0; V_{OH} = 2.4V[3]	4			mA
		Pin IO0; V_{OH} = 4.6V[3]			1	uA
		Pin IO0; V_{OH} = 3.3V[3]			1	uA
I_{LI}	Low level input leakage current	VCC = 5.5V; V_I = GND	-1		1	μA
C_i	Input capacitance			3.7	10	pF
C_o	Output capacitance			3.7	10	pF
Select inputs A0,A1,A2 and $\overline{RESET}$						
V_{IL}	Low level input voltage		-0.5		+0.81	V
V_{IH}	High level input voltage		+1.8		5.5	V
I_L	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. The total mount sunk by all I/Os must be limited to 100mA and 25 mA per bit.
3. The total current sourced by all I/Os must be limited to85mA and 20mA to bit

Dynamic Characteristics

Symbol	Parameter	Test Conditions	Standard Mode I²C		Fast Mode I²C		Unit
			Min	Max	Min	Max	
f_{SCL}	SCL clock frequency		0	100	0	400	kHz
t_{BUF}	bus free time between a STOP and START condition		4.7		1.3		µs
$t_{HD;STA}$	hold time (repeated) START condition		4.0		0.6		µs
$t_{SU;STA}$	set-up time for a repeated START condition		4.7		0.6		µs
$t_{SU;STO}$	set-up time for STOP condition		4.0		0.6		µs
$t_{VD;ACK}$(1)	data valid acknowledge time			3.45		0.9	µs
$t_{HD;DAT}$(2)	data hold time		0		0		ns
$t_{VD;DAT}$	data valid time			3.45		0.9	us
$t_{SU;DAT}$	data set-up time		250		100		ns
t_{LOW}	LOW period of the SCL clock		4.7		1.3		µs
t_{HIGH}	HIGH period of the SCL clock		4.0		0.6		µs
t_f	fall time of both SDA and SCL signals			300		300	ns
t_r	rise time of both SDA and SCL signals			1000		300	ns
t_{SP}	pulse width of spikes that must be suppressed by the input filter			50		50	ns
Port Timing							
$t_{v(Q)}$	Data output valid time(3)	Pin IO0		250		250	ns
		Pin IO1 to IO7		200		200	ns
$t_{su(D)}$	Data input set-up time		0		0		ns
$t_{h(D)}$	Data input hold time		200		200		ns
Reset Timing							
$t_{w(rst)}$	Reset pulse width		25		25		ns
$t_{rec(rst)}$	Reset recovery time		0		0		ns
t_{rst}	Reset time		1		1		us

Note:
1. $t_{VD;ACK}$ = time for acknowledgement signal from SCL LOW to SDA (out) LOW.
2. $t_{VD;DAT}$ = minimum time for SDA data out to be valid following SCL LOW.
3. $t_{v(Q)}$measured from 0.7VCC on SCL to 50% I/O output.

Figure 1: Simplified Schematic of IO0

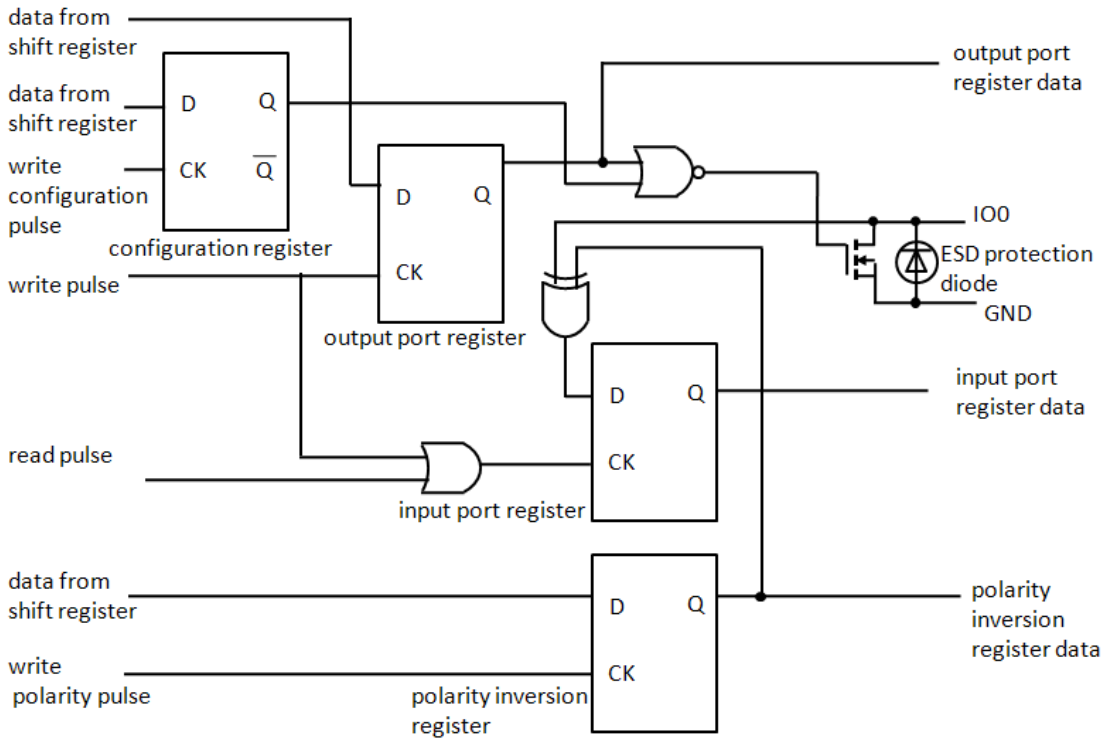
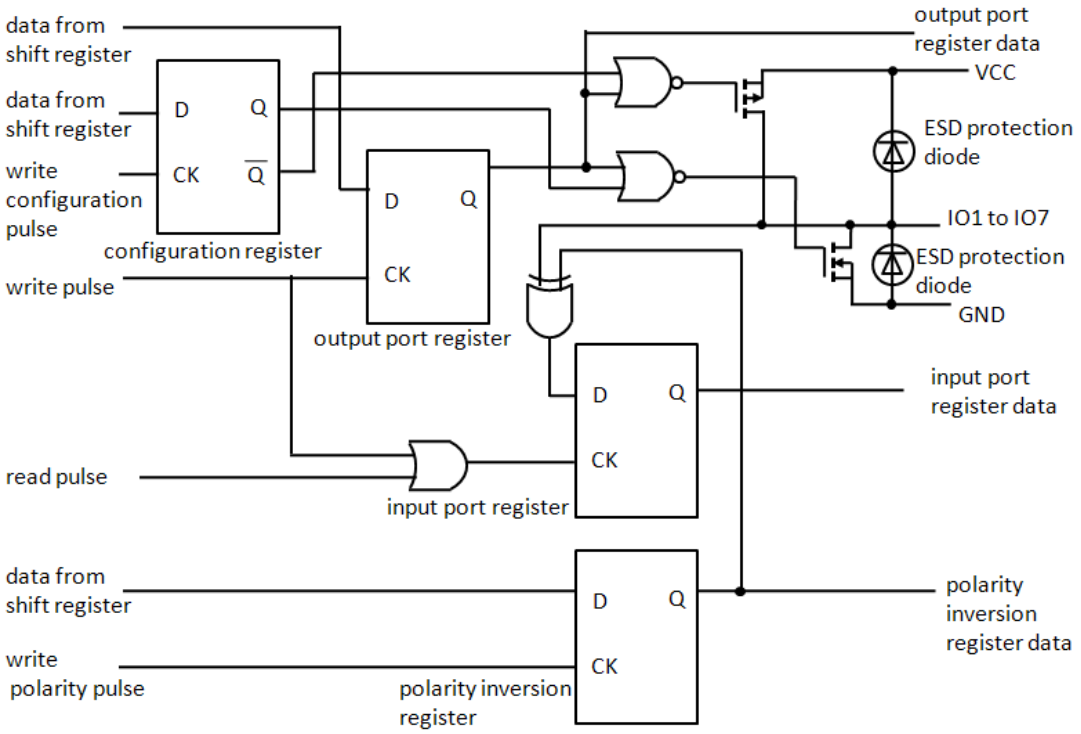


Figure 2: Simplified Schematic of IO1 to IO7



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 PI4IOE5V9557 is shown in. 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 1: Device Address

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

Note: Read "1", Write "0"

b. Control Register

Following the successful acknowledgement of the slave address, the bus master will send a byte to the PI4IOE5V9557, which will be stored in the control register. This register can be written and read via the I2C-bus.

Table 2: Control Register

	b7(MSB)	b6	b5	b4	b3	b2	b1	b0
Address Byte	0	0	0	0	0	0	D1	D0

Table 3: D0 and D1 Definition

D1	D0	Name	Access	Description
0	0	Register 0	Read-only	Input port register
0	1	Register 1	Read/write	Output port register
1	0	Register 2	Read/write	Polarity inversion register
1	1	Register 3	Read/write	Configuration register

c. Register Description

i. 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 the Configuration register. Writes to this register have no effect.

Table 4: Input Port Register

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

ii. Register 1: Output Port Register

This register reflects the outgoing logic levels of the pins defined as outputs by the Configuration register. Bit values in this register have no effect on pins defined as inputs. In turn, reads from this register reflect the value that is in the flip-flop controlling the output selection, not the actual pin value.

Table 5: Output Port Register

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

iii. Register 2: Polarity Inversion Register

This register enables polarity inversion of pins defined as inputs by the Configuration register. If a bit in this register is set (written with logic 1), the corresponding port pin's polarity is inverted. If a bit in this register is cleared (written with logic 0), the corresponding port pin's original polarity is retained.

Table 6: Polarity Inversion Register

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

iv. 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.

Table 7: 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

d. Power-on Reset

When power is applied to VCC, an internal Power-On Reset (POR) holds the PI4IOE5V9557 in a reset condition until VCC has reached VPOR. At that point, the reset condition is released and the PI4IOE5V9557 registers and I2C-bus/SMBus state machine will initialize to their default states. Thereafter, VCC must be lowered below 0.2 V to reset the device.

e. $\overline{\text{RESET}}$ Input

A reset can be accomplished by holding the RESET pin LOW for a minimum of tw(rst). ThePI4IOE5V9557 registers and SMBus/I2C-bus state machine will be held in their default state until the RESET input is once again HIGH. This input requires a pull-up resistor to VCC if no active connection is used.

i. Bus Transactions

Data is transmitted to the PI4IOE5V9557 registers using Write Byte transfers. Data is read from the PI4IOE5V9557 registers using Read and Receive Byte transfers.

Figure 3: Write to Output Registers

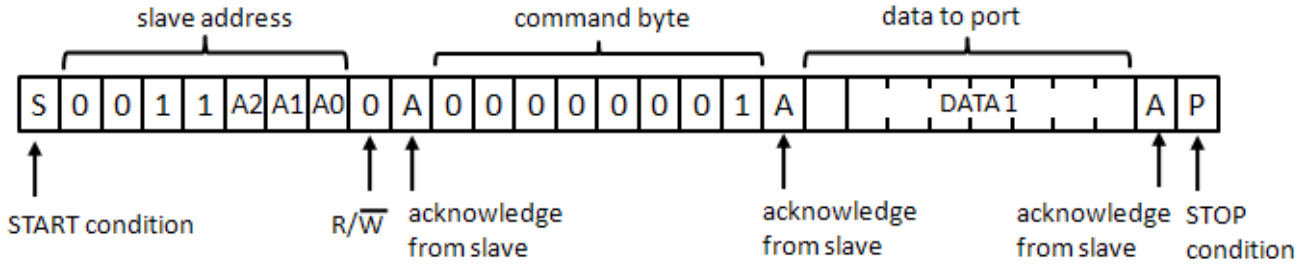


Figure 4: Write to I/O Configuration or Polarity Inversion Registers

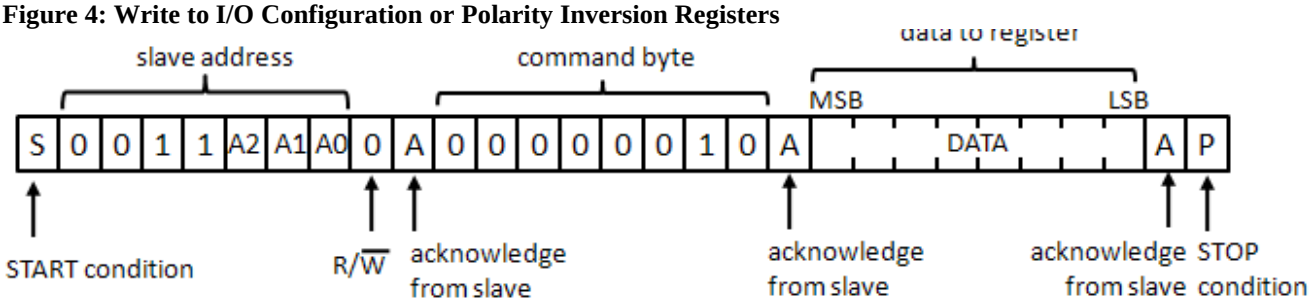


Figure 5: Read from Register

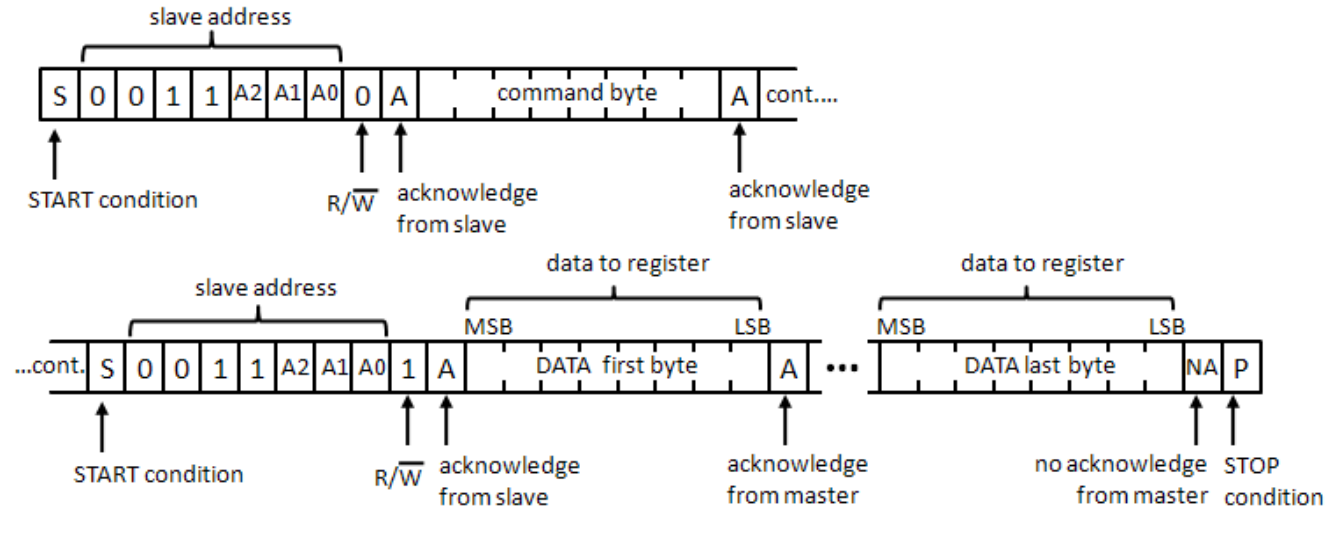
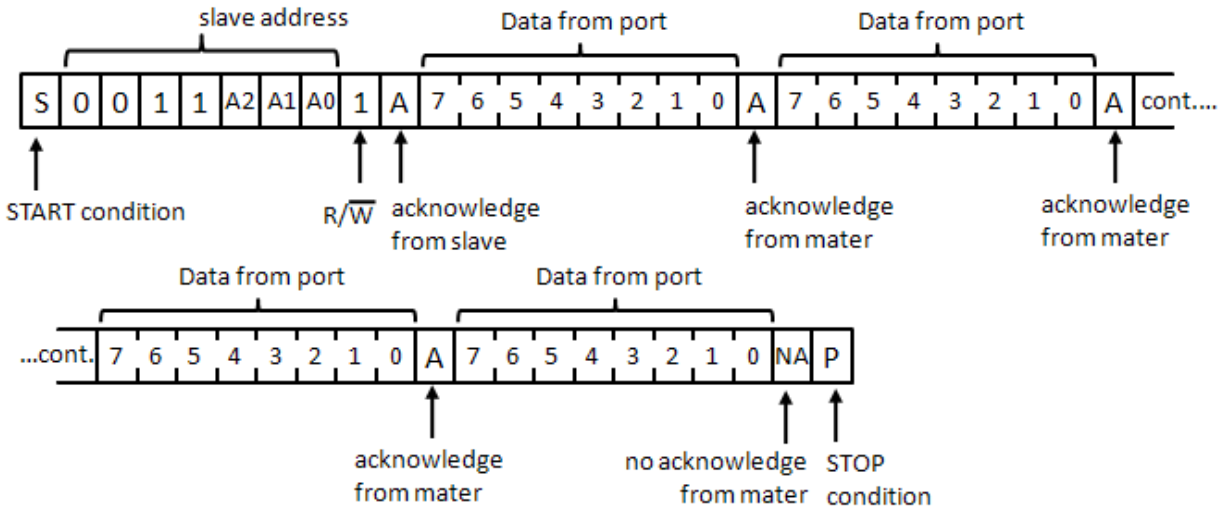


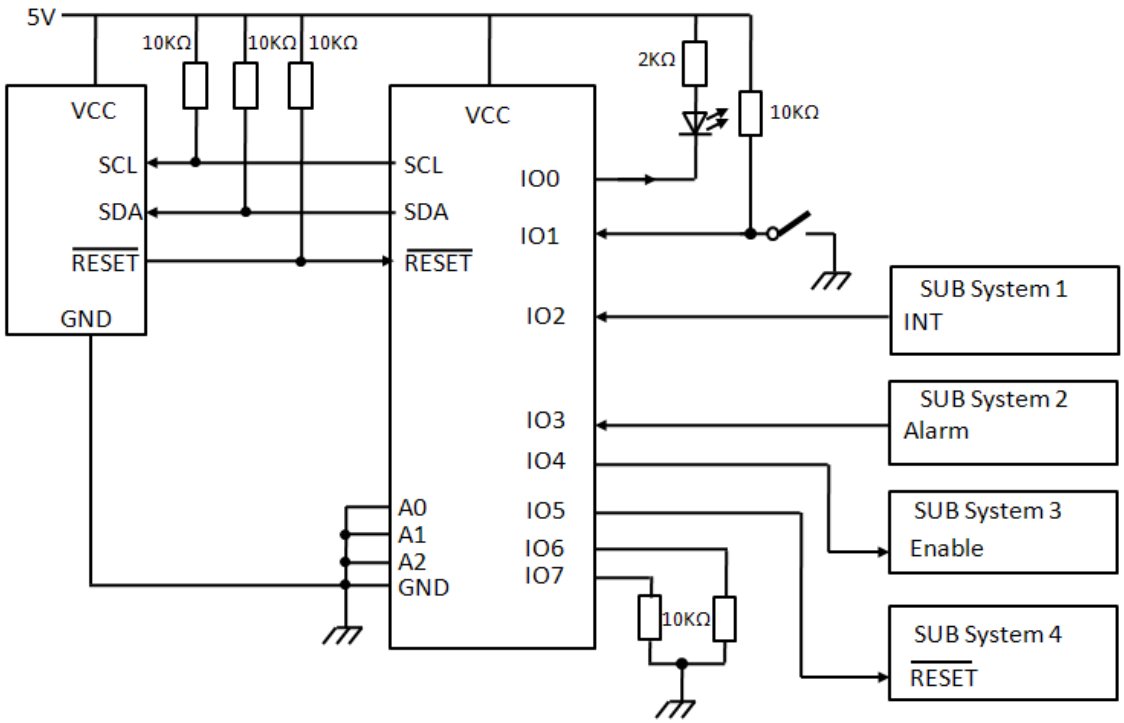
Figure 6: Read Input Port Register



Note: 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. When this occurs, data present at the last acknowledge phase is valid (output mode). Input data is lost.

Application Design-in Information

Figure 7: Typical Application



Device address configured as 0011100x for this example.
IO0, IO4, IO5 configured as outputs.
IO1, IO2, IO3 configured as inputs.
IO6, IO07 are not used.

Minimizing ICC when the I/Os are used to control LEDS

When the I/Os are used to control LEDs, they are normally connected to VCC through a resistor as shown in Figure 11. Since the LED acts as a diode, when the LED is off the I/O V_I is about 1.2 V less than VCC. The supply current, ICC, increases as V_I becomes lower than VCC.

Designs need minimize current consumption, such as battery power applications, should consider maintaining the I/O pins greater than or equal to VCC when the LED is off. Figure 11 shows a high value resistor in parallel with the LED. Figure 12shows VCC less than the LED supply voltage by at least 1.2 V. Both of these methods maintain the I/O V_I at or above VCC and prevent additional supply current consumption when the LED is off.

Figure 8: High value resistor in parallel with the LED

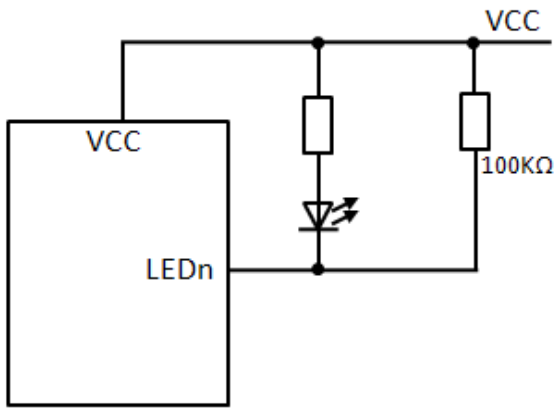
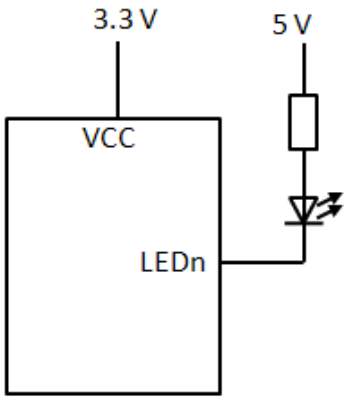


Figure 9: Device supplied by a lower voltage

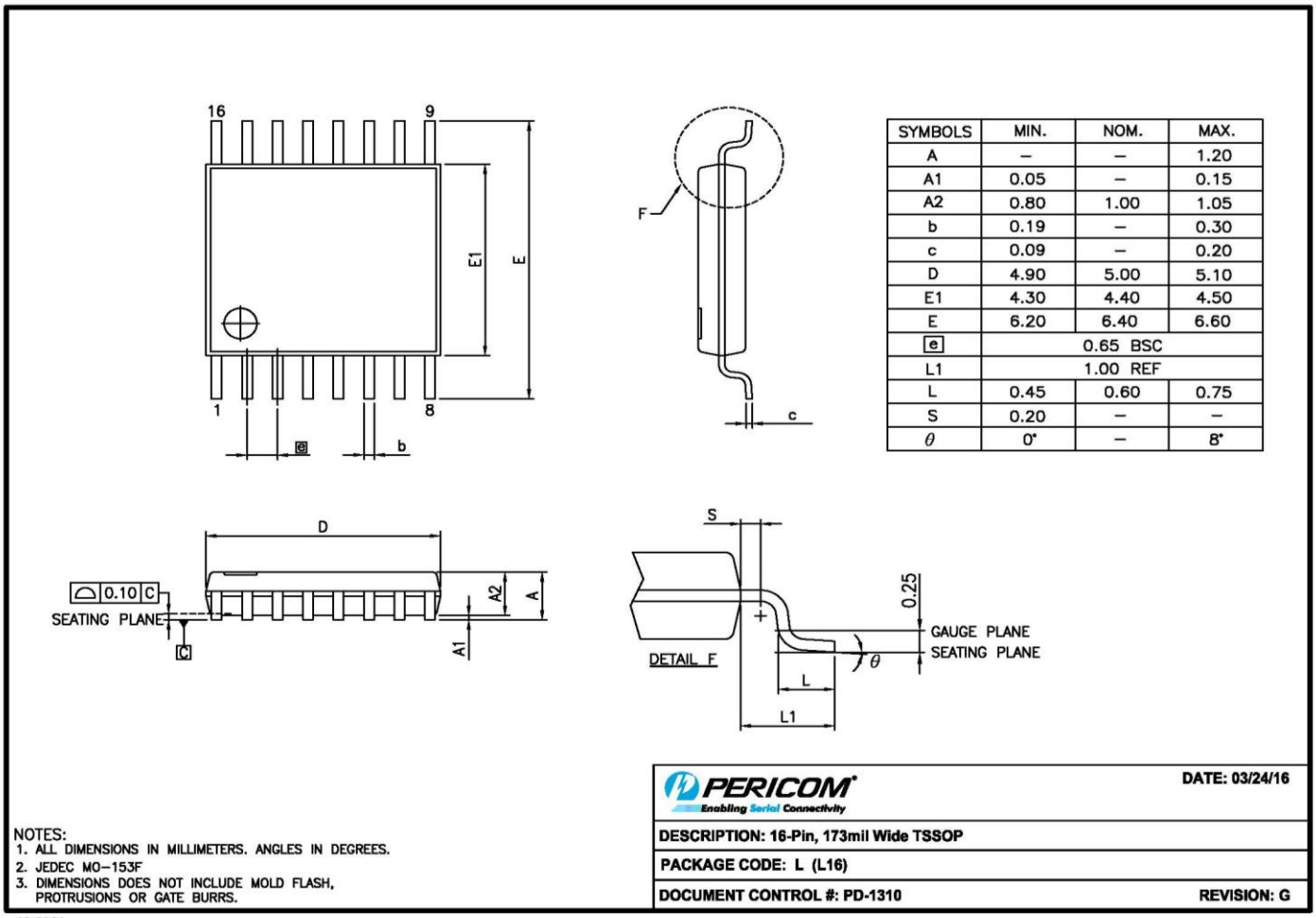


Part Marking

Z: Die Rev
Y: Date Code (Year)
W: Date Code (Workweek)
1st X: Assembly Site Code
2nd X: Fab Site Code
Bar above fab code means Cu wire

Packaging Mechanical

TSSOP-16(L)



SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.20
A1	0.05	–	0.15
A2	0.80	1.00	1.05
b	0.19	–	0.30
c	0.09	–	0.20
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e		0.65 BSC	
L1		1.00 REF	
L	0.45	0.60	0.75
S	0.20	–	–
θ	0°	–	8°

NOTES:
1. ALL DIMENSIONS IN MILLIMETERS. ANGLES IN DEGREES.
2. JEDEC MO-153F
3. DIMENSIONS DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

PERICOM Enabling Serial Connectivity — DATE: 03/24/16

DESCRIPTION: 16-Pin, 173mil Wide TSSOP

PACKAGE CODE: L (L16)

DOCUMENT CONTROL #: PD-1310 — REVISION: G

16-0061

For latest package info.

please check: http://www.diodes.com/design/support/packaging/pericom-packaging/packaging-mechanicals-and-thermal-characteristics/

Ordering Information

Part Number	Package Code	Package Description
PI4IOE5V9557LEX	L	16-pin, 173mil wide (TSSOP)

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
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