



I2C 2005-1 Demonstration Board GPIO

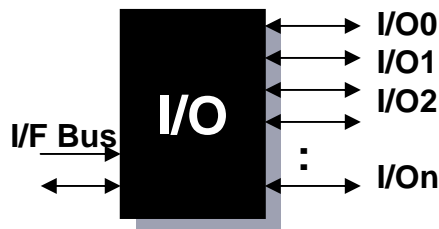
Oct, 2006

I/O Expanders



- ▶ I/O ports selection: 4, 8, 16, and 40 bits
- ▶ Output driver selection – Quasi, Totem-pole, open drain – All can sink 20 mA to 25 mA
- ▶ Each port programmable as input or output
- ▶ Bus Interface: I²C (100/400/1000kHz), SPI
- ▶ More features (unique for each device):
 - HW reset, Interrupt output, output enable
 - 64 I²C slave addresses (1MHz device)
 - Integrated EEPROM, 5-bit MUX/1-bit latch

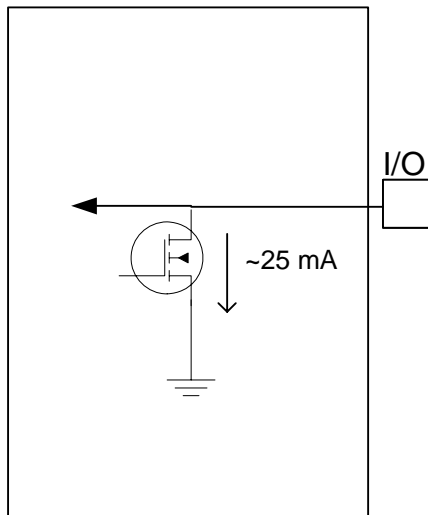
Device	#Outputs	Input/Output Types				VCC Range
		OD	QSI	IPU	PP	
PCA9536/7	4			x	x	2.3 - 5.5
PCA9500/1/2	8		x	x		3.0 - 3.6
PCA9534/8	8				x	2.3 - 5.5
PCA9554(A)	8			x	x	2.3 - 5.5
PCA9557	8				x	2.3 - 5.5
PCA9558	8	x				2.3 - 5.5
PCF8574	8		x	x		2.3 - 5.5
PCA9670/4(A)	8					2.3 - 5.5
PCA9535/9	16				x	2.3 - 5.5
PCA9555	16			x	x	2.3 - 5.5
PCF8575	16		x	x		2.3 - 5.5
PCF8575C	16	x				2.3 - 5.5
PCA9673/5(A)	16					2.3 - 5.5
PCA9506	40				x	2.3 - 5.5
PCA9698	40	x	x		x	2.3 - 5.5



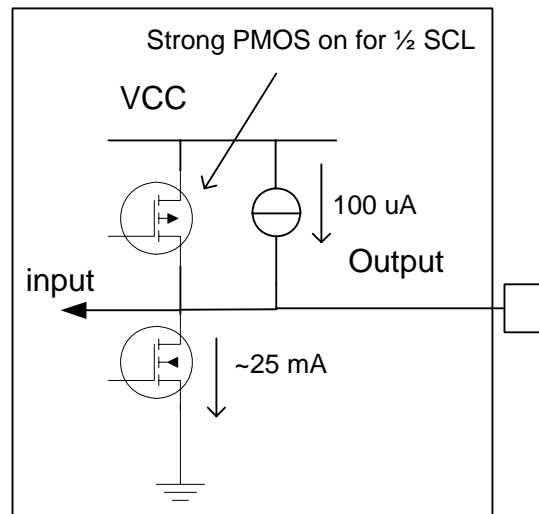
APPLICATIONS

Computing Communications Consumer Medical

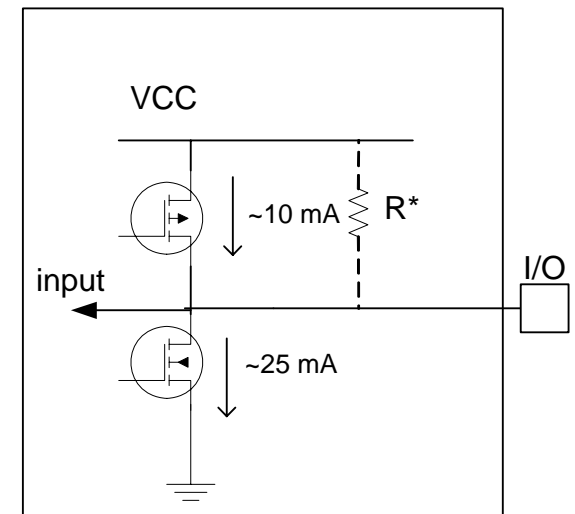
Flexible I/Os



Open Drain I/O

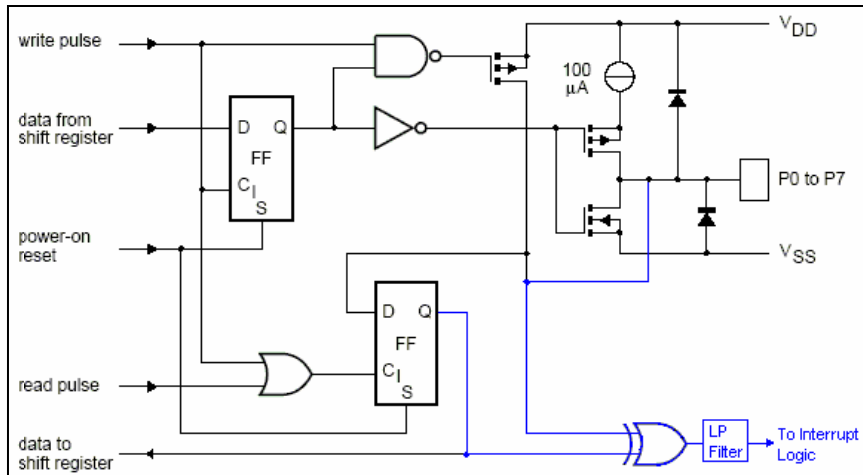


Quasi Bidirectional I/O



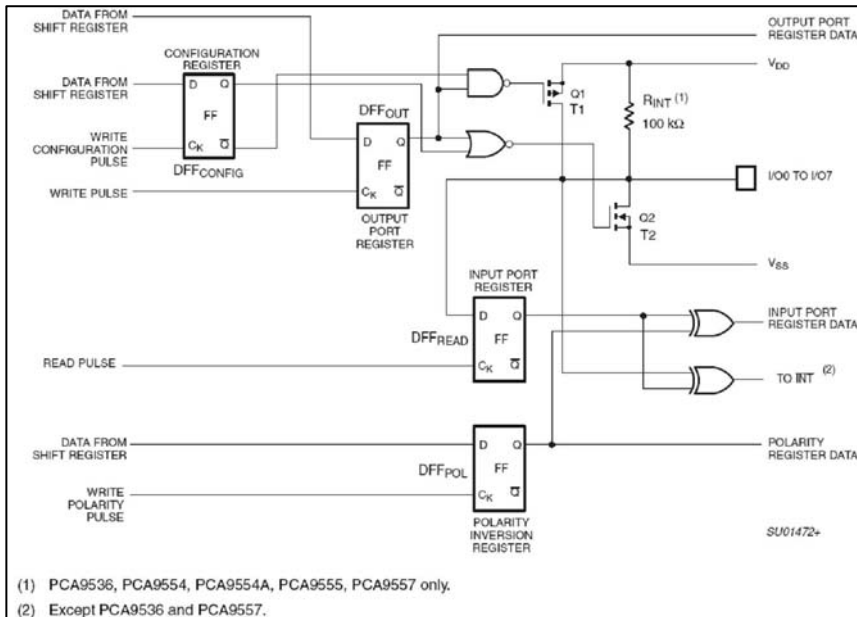
Totem-pole I/O

Totem Pole and Quasi-output I/O Expanders



QUASI OUTPUT I/O EXPANDERS

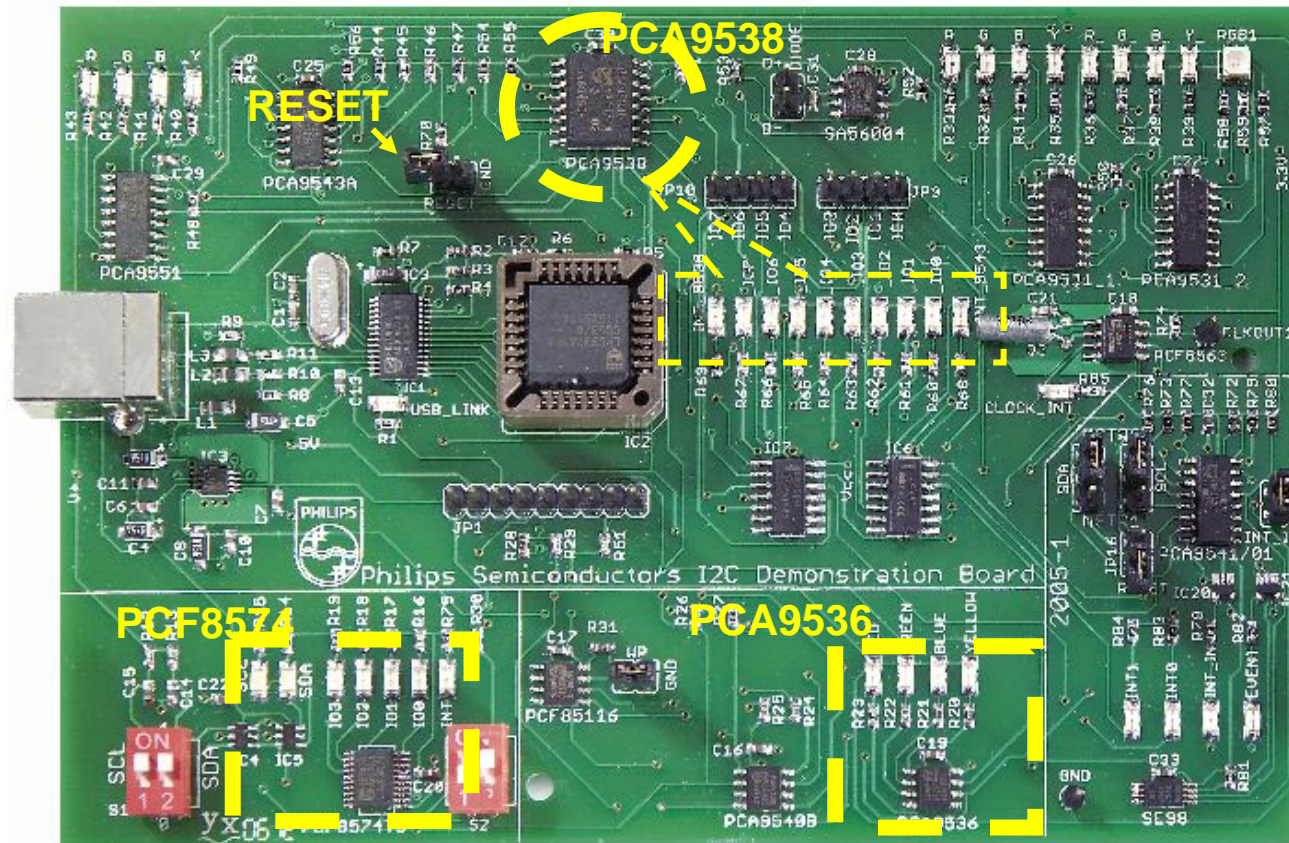
- I/O: strong pull-down, weak pull-up
- 25 mA sink capability, no source capability
- Configuration register: NO
- Switch from output to input: I/O must be written with “1” to be used as an input
- Programming: Address + Data



TOTEM POLE I/O EXPANDERS

- I/O: strong pull down, strong pull up
- 25 mA sink, 10 mA source capability
- Configuration register: YES
- Switch from output to input: program the configuration register accordingly
- Programming: Address + Command + Data

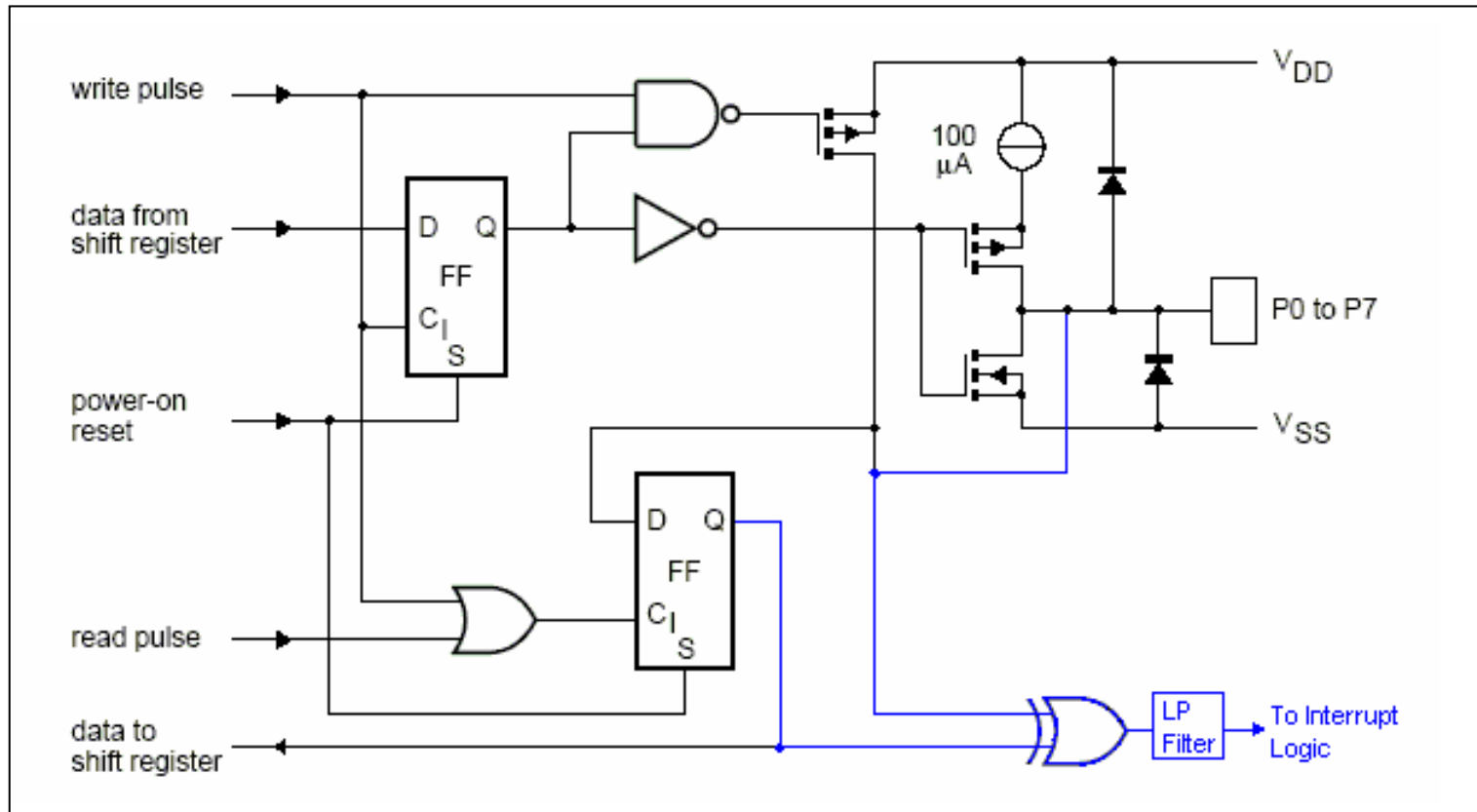
Demonstration Board GPIO Hardware Introduction



Quasi Bi-directional I/O Port Structure



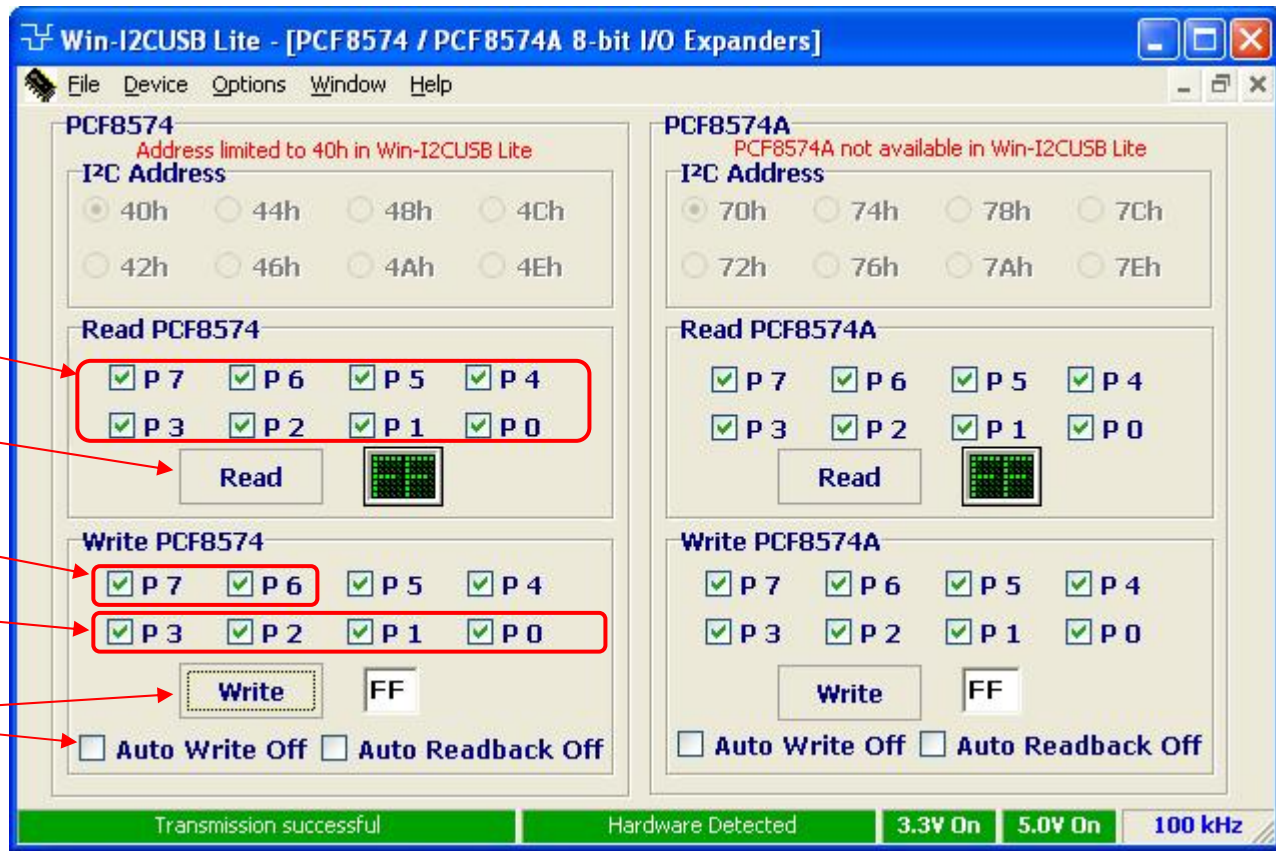
Quasi Bi-directional I/O Port Structure



Exercise

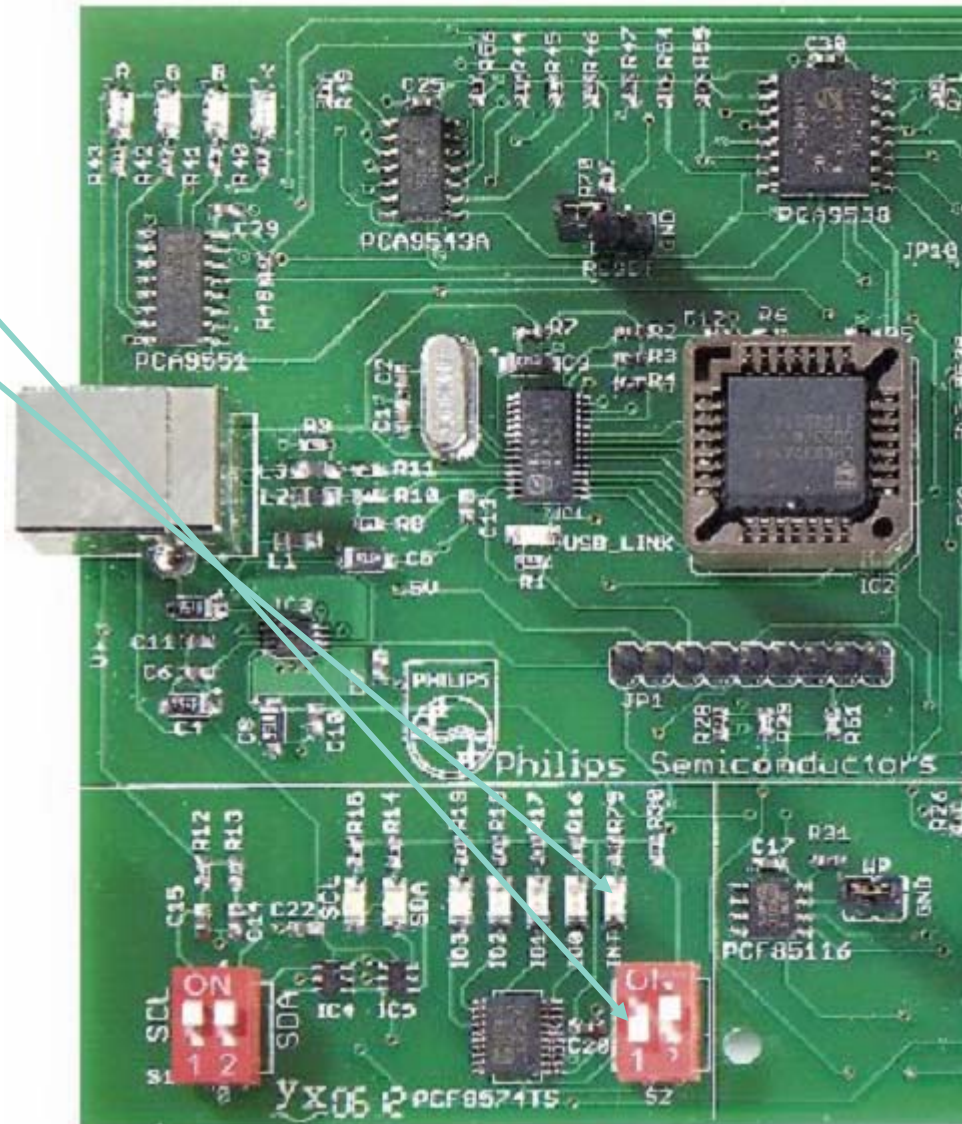
Objective: to understand the operation of the quasi bidirectional port structure

We will use the PCF8574 interface found in Win-I2CUSB Lite



Exercise

1. Set all the port pins high using Win-I2CUSB Lite
2. Change the state of switch 1 on S2.
3. The INT LED should illuminate
4. Change the state of the switch. The LED should turn off.
5. Turn the INT LED again by changing the switch.
6. Using Win-I2CUSB Lite. Read the PCF8574. What happened to the Interrupt?
7. Turn the INT LED again by changing the switch. Write to the PCF8574. What happened to the Interrupt?



Totem Pole I/O Expanders

Totem-pole General Purpose IO Expanders – In a nutshell

- 4, 8, 16 and 40-bit Totem-pole output drivers that can sink up to 25 mA each and source up to 10 mA each
- 2.3 V to 5.5 V power supply with 5 V tolerant IOs
- Four register types allow control and monitoring of the IOs:
 - The Configuration register defines the data direction
 - The Output Port register controls the state of an output ('0' or '1')
 - The Input register reads the state of the device pin when used as input or output
 - The Polarity Inversion register allows inversion of the pin state when reading the IOs
- Power-On Reset (POR) resets the state machines allowing to power up the device to a known state
- An active low reset pin (when available) allows to asynchronously set the device to the POR state
- An active low interrupt pin (when available) allows the controller to monitor a logic change in the pins that are configured as inputs

Totem Pole General Purpose IO Expanders – Selection Table

Device	I/O	Address (#pins)	INT	RESET	V _{DD} (v)	Freq (kHz)	I/O Sink Bit Total (mA)	Source (mA)	Inter. Pull Ups (kΩ)	Packages	# pins
PCA9534	8	0100xxx (3)	Yes	No	2.3 5.5	0 400	25 100	10	No	SO, TSSOP, HVQFN	16
PCA9535	16	0100xxx (3)	Yes	No	2.3 5.5	0 400	25 100	10	No	SO, TSSOP, HVQFN	24
PCA9536	4	1000001 (0)	No	No	2.3 5.5	0 400	25 100	10	100 kΩ	SO, TSSOP	8
PCA9537	4	1001001 (0)	Yes	Yes	2.3 5.5	0 400	25 100	10	No	TSSOP	10
PCA9538	8	11100xx (2)	Yes	Yes	2.3 5.5	0 400	25 100	10	No	SO, TSSOP, HVQFN	16
PCA9539	16	11101xx (2)	Yes	Yes	2.3 5.5	0 400	25 100 / octal	10	No	SO, TSSOP, HVQFN	24
PCA9554	8	0100xxx (3)	Yes	No	2.3 5.5	0 400	25 100	10	100 kΩ	DIP, SO, SSOP, TSSOP, HVQFN	16
										SSOP	20
PCA9554A	8	0111xx (3)	Yes	No	2.3 5.5	0 400	25 100	10	100 kΩ	DIP, SO, SSOP, TSSOP, HVQFN	16
										SSOP	20
PCA9555	16	0100xxx (3)	Yes	No	2.3 5.5	0 400	25 100 / octal	10	100 kΩ	DIP, SO, SSOP, TSSOP, HVQFN	24
PCA9557	8	0011xxx (3)	No	Yes	2.3 5.5	0 400	25 100	10	100 kΩ	SO, TSSOP, HVQFN	16
PCA9558	8	100111x (1)	No	Yes	3.0 3.6	10 400	4 32	0.1	Weak	TSSOP	28
PCA9698	40	xxxxxxx (3)	Yes	Yes	2.3 5.5	1000	25 1000	10	No	TSSOP, HVQFN	56

Device Hardware and Register definition

Configuration Register

Allows to configure the I/O as:

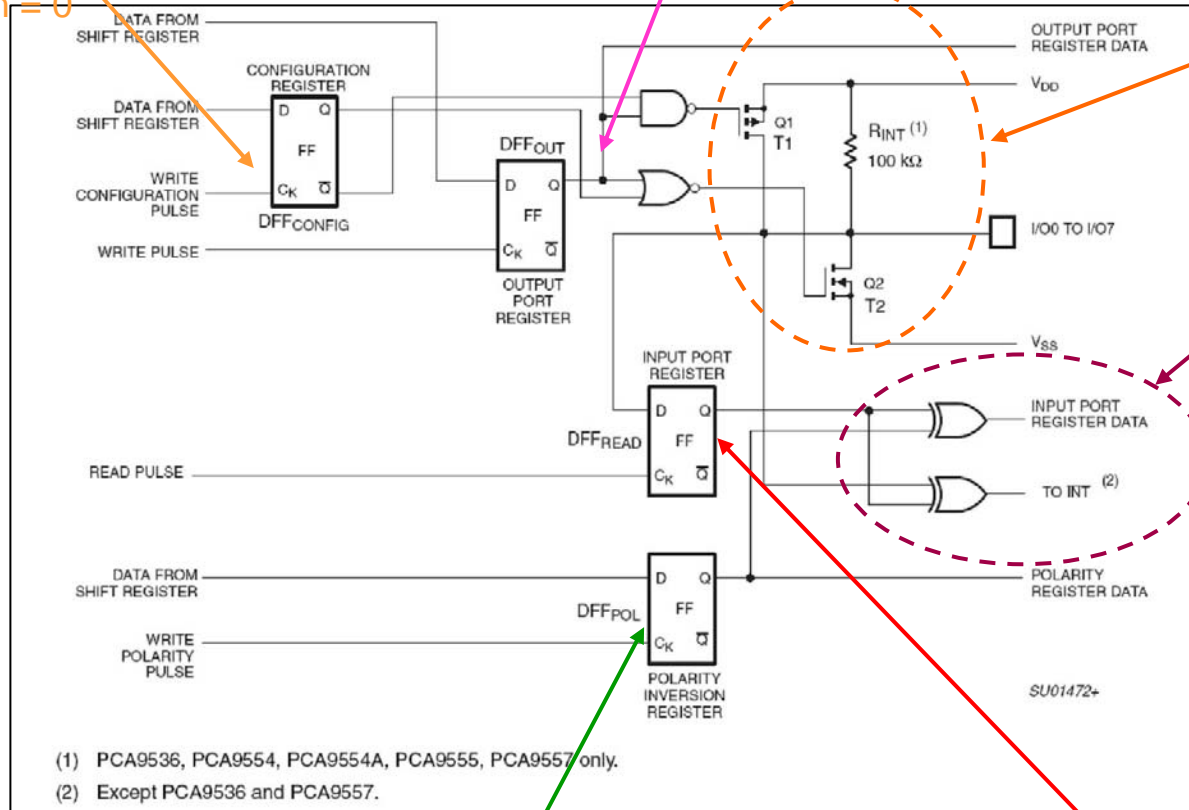
- input when = 1
- output when = 0

Output Port Register:

Allows to force an output port to 0 or 1

Totem Pole I/O structure

Interrupt circuitry



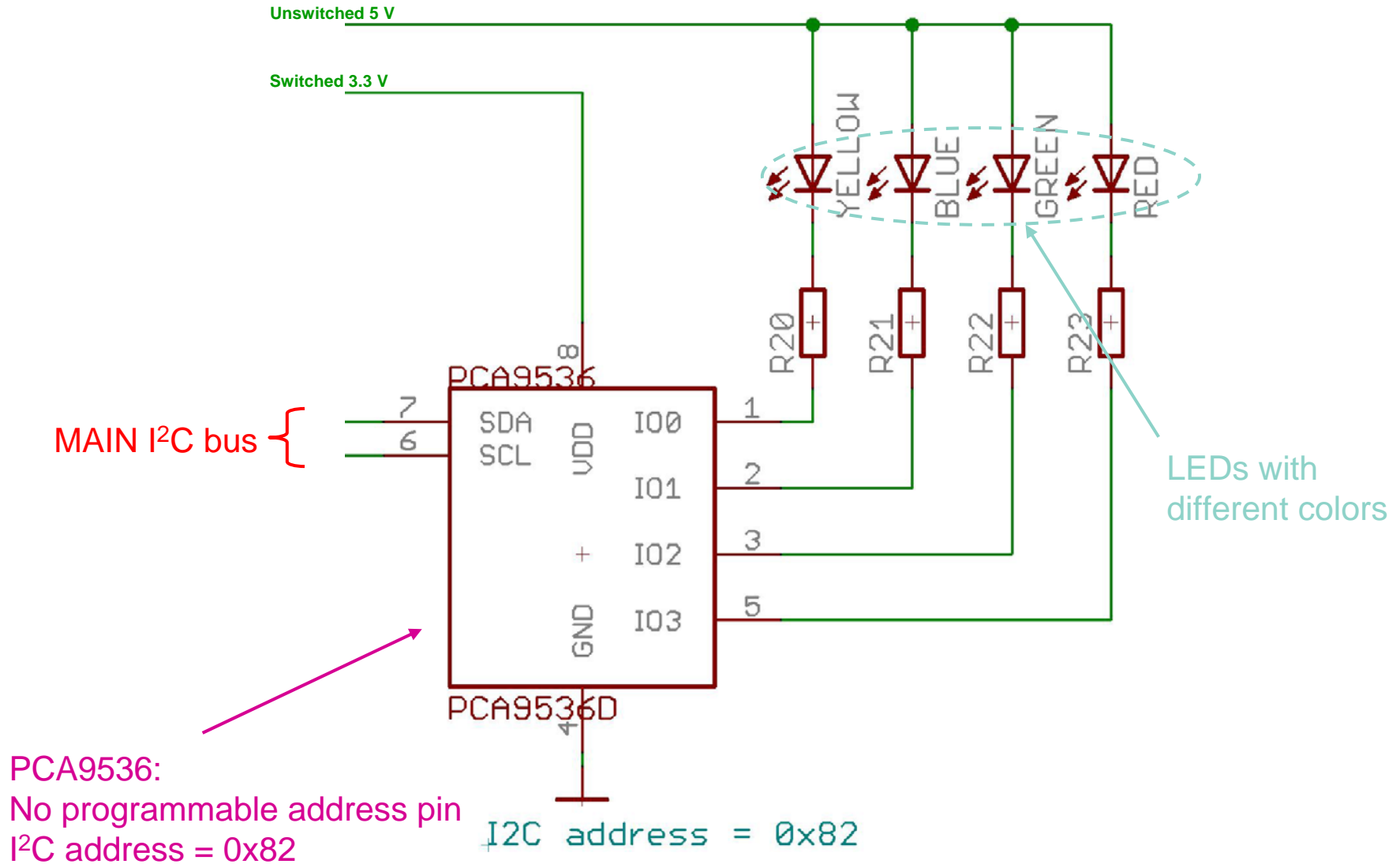
Polarity Inverter Register

Polarity is retained when = 0
Polarity is inverted when = 1

Input Port Register

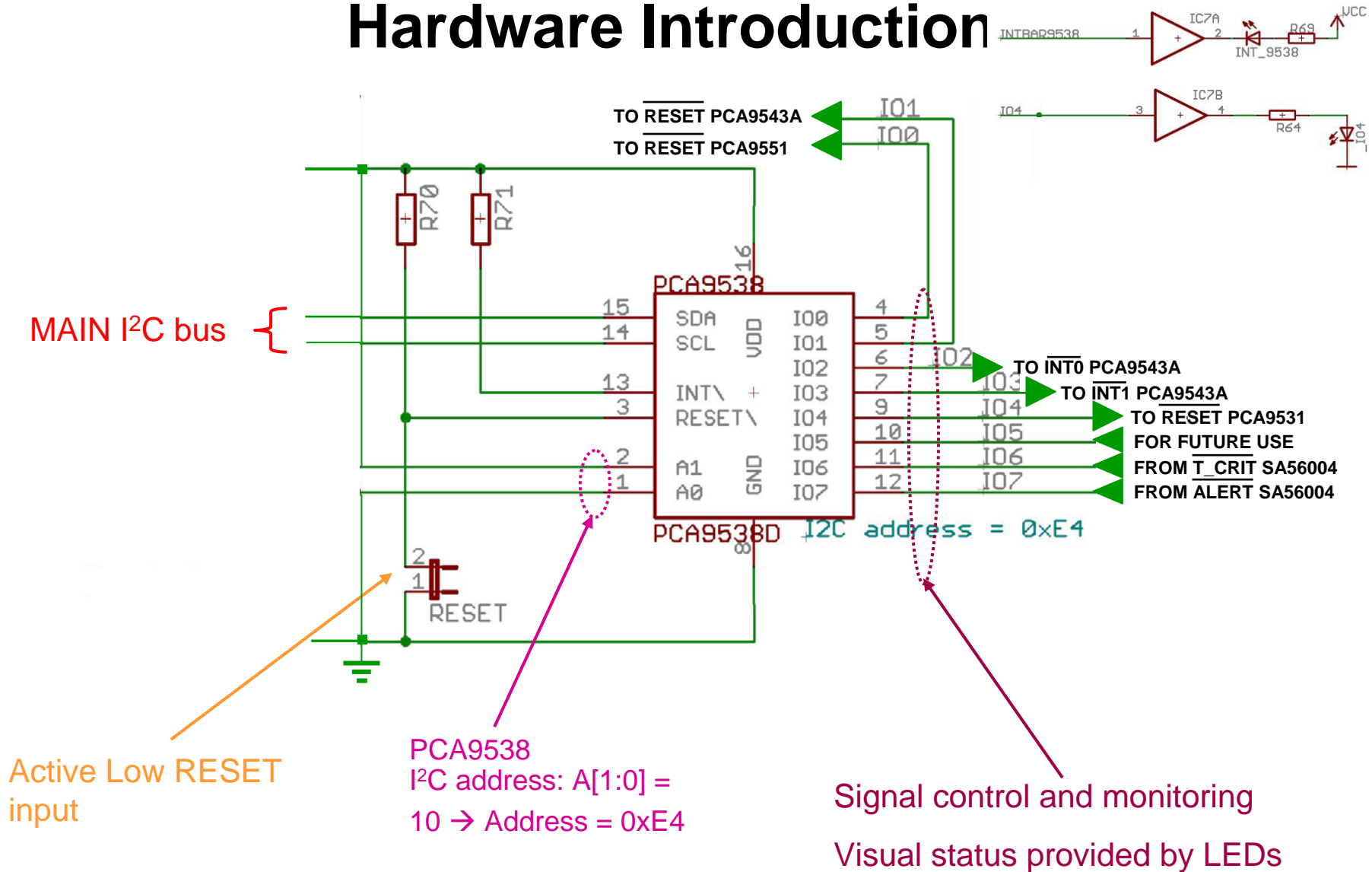
Demonstration Board: PCA9536

Hardware Introduction

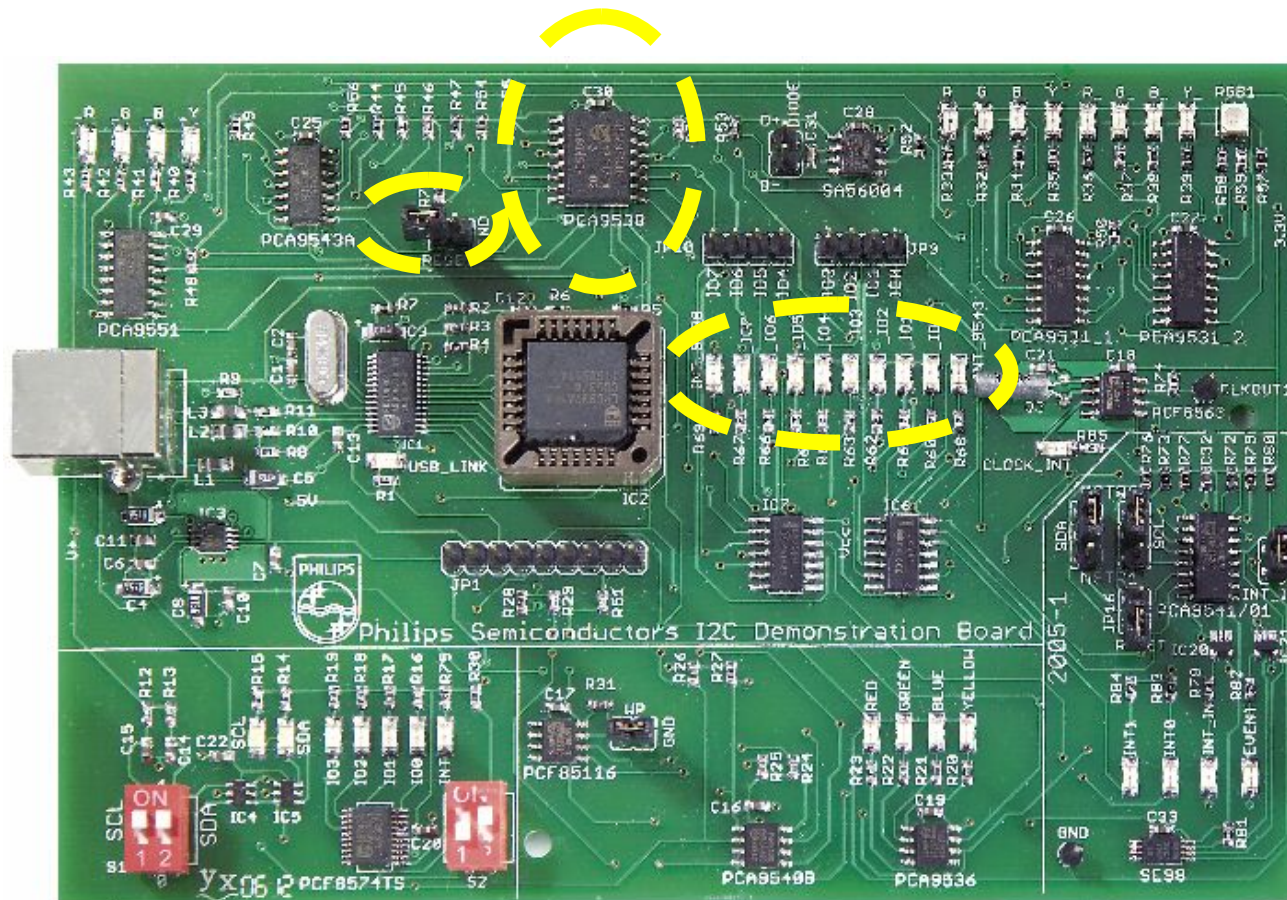


Demonstration Board: PCA9538

Hardware Introduction



Demonstration Board: PCA9538 Hardware Introduction



Training Board: Software Introduction

**Device → LED Blinkers and Dimmers → PCA9531 8-bit LED Dimmer
(or PCA9551 8-bit LED Blinker)**

I2C address:

PCA9536 = 0x82

PCA9538 = 0xE4

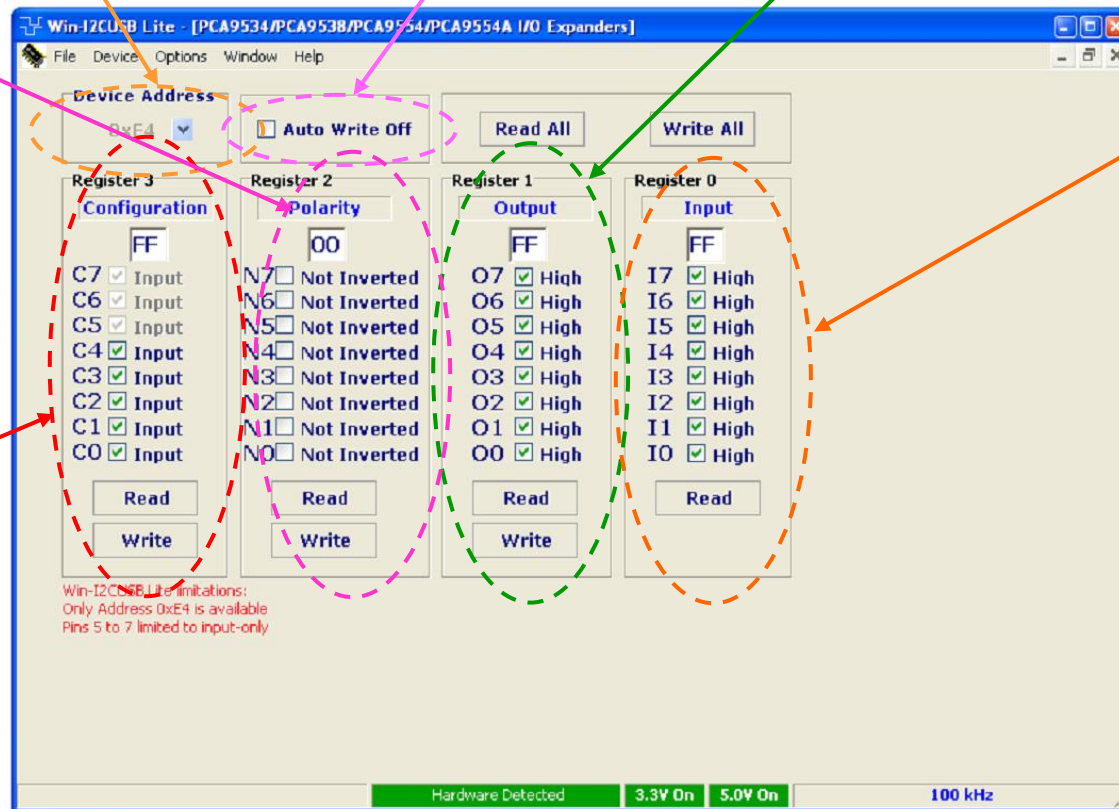
Polarity register-
allowing to invert or
not the logic values
read from the pins

Auto Write Feature

Output register programming
the logic state of the pins
programmed as inputs

- Input register
- reading the IOs
- logic states

Configuration register-programming I/Os as inputs or output



Hands-On 1 : PCA9536 GUI

1. Power sequence the board → Board OFF then ON
2. Open the PCA9536 GUI:
Device → IO Expanders → PCA9536 4-bit I/O Expander

3. Switch ON the 4 LEDs connected to the PCA9536

Configuration register: the 4 I/O's need to be configured as inputs (checked)

Output register: the 4 outputs need to be forced Low

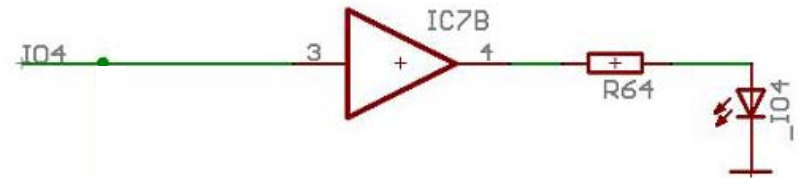
4. Uncheck C0, C1, C2 and C3
Check O0 and O1 in the Output Register (O2 and O3 unchecked)
Check N0 and N2 in the Polarity Register (N1 and N3 unchecked)
Read the Input Register and explain what you see

I0 = Low	→ Inverted Logic state of I/O0
I1 = High	→ Logic state of I/O1
I2 = High	→ Inverted Logic state of I/O2
I3 = Low	→ Logic state of I/O3

Hands-On 2: Using the Expert Mode

- Write the following I²C sequence (Red) using the Expert Mode

- Power sequence the board → Board OFF then ON
- Program PCA9538 I/O0 to I/O4 as output (and be sure that I/O5 to I/O7 are configured as inputs)
- Switch ON PCA9538 I/O0 only and wait 0.5 s
- Switch ON PCA9538 I/O1 only and wait 0.5 s
- Switch ON PCA9538 I/O2 only and wait 0.5 s
- Switch ON PCA9538 I/O3 only and wait 0.5 s
- Switch ON PCA9538 I/O4 only and wait 0.5 s



- Execute it in loop

Hands-On 2: Using the Expert Mode – Solution

Win-I2CUSB Lite - [Solution HOT Totem Pole GPIO.txt]

File Edit Device Options Window Help

GPIO ? Input State unknown Read

Msg #	Start	Address	R/W	Data	Stop	Delay	Notes
1	ST	E4	Write	03,E0	Yes	0	I/O0 to I/O4 programmed as outputs - I/O5 to I/O7 inputs
2	ST	E4	Write	01,01	Yes	500	I/O0 = on
3	ST	E4	Write	01,02	Yes	500	I/O1 = on
4	ST	E4	Write	01,04	Yes	500	I/O2 = on
5	ST	E4	Write	01,08	Yes	500	I/O3 = on
6	ST	E4	Write	01,10	Yes	500	I/O4 = on
7	ST						
8	ST						

