ECE 372A Fall 2015 - Lecture 3

Garrett Vanhoy

September 1, 2015

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Outline

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

I/O Ports

Reference Material

Section 12 in the PIC32MX Family Reference Manual
Section 12 in the PIC32MX Data Sheet

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Common Problems in Circuity

Non-Idealities

- Digital inputs are still analog signals. Thus, there is noise.

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
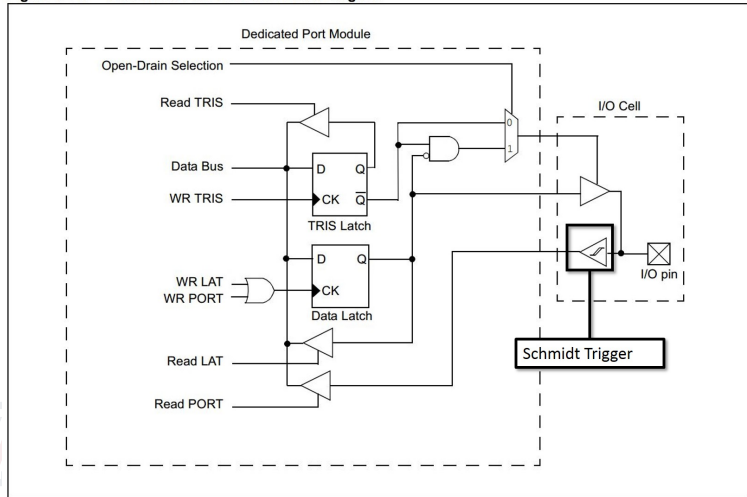"Bouncing" in Circuits
Floating pins

Common Problems in Circuity

Non-Idealities

- Digital inputs are still analog signals. Thus, there is noise.
- Some circuity does not provide "clean" outputs.

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Common Problems in Circuity

Non-Idealities

- Digital inputs are still analog signals. Thus, there is noise.

- Some circuity does not provide "clean" outputs.

- Every pin is an antenna and has its own capacitance, a pin can read '1' even though it's not connected to anything at all!

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications
Input noise
"Bouncing" in Circuits
Floating pins

Getting "rid" of Noise

Figure 12-1: Dedicated Port Structure Block Diagram

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Schmitt Trigger

Purpose of a Schmidt Trigger

- Digital inputs may be read as '0' or '1', but how do we define these?

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Schmidt Trigger

Purpose of a Schmidt Trigger

- Digital inputs may be read as '0' or '1', but how do we define these?

- We must "nullify" noise and other transient events to get meaningful inputs

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Schmitt Trigger

Purpose of a Schmidt Trigger

- Digital inputs may be read as '0' or '1', but how do we define these?

- We must "nullify" noise and other transient events to get meaningful inputs

- We define a region for "logic high" and a region for "logic low"

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Schmitt Trigger

.8 Vdd

.2 Vdd

0V

Figure: Analog input to a pin

1

0

Figure: Digitized input read by microcontroller

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Schmitt Trigger

Figure: Analog input to a pin

Figure: Digitized input read by microcontroller

Pin Considerations
Open-Drain Collector Configuration
Change Notifications
Input noise
"Bouncing" in Circuits
Floating pins
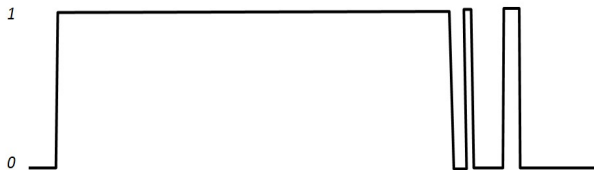
Bouncing Circuits

Video

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Debouncing

Bouncing in Circuits

- Switches in circuits do not make "clean" contact right away. The voltage will sometimes bounce until a solid connection is made.

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Debouncing

Bouncing in Circuits

- Switches in circuits do not make "clean" contact right away. The voltage will sometimes bounce until a solid connection is made.

- How can we correct this?

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Debouncing Circuitry
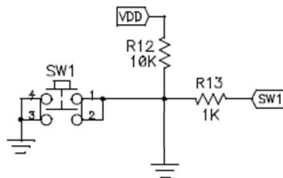
Figure: Input pin configuration

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins
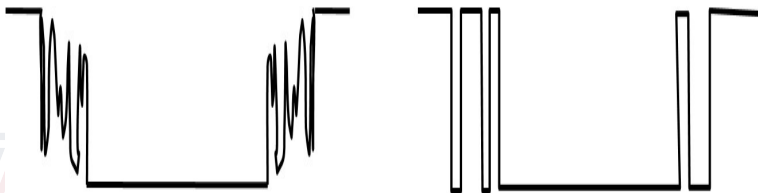
Debouncing Circuitry
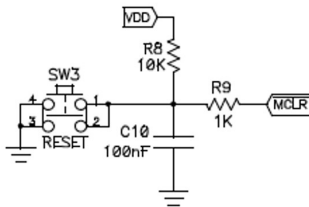
Figure: Hardware Debouncing by Capacitor

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Pull-Up and Pull-Down Resistors

A Disconnected Pin

- If a pin is not connected to anything and is put into input mode, what value will be read if a volt meter is attached to the pin?

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Pull-Up and Pull-Down Resistors

A Disconnected Pin

- If a pin is not connected to anything and is put into input mode, what value will be read if a volt meter is attached to the pin?

- This is called a "floating pin." You cannot assume it is '0' or 'ground.' It acts as an antenna and it *can* vary wildly.

THE UNIVERSITY
OF ARIZONA

Pin Considerations
Open-Drain Collector Configuration
Change Notifications

Input noise
"Bouncing" in Circuits
Floating pins

Pull-Up and Pull-Down Resistors

A Disconnected Pin

- If a pin is not connected to anything and is put into input mode, what value will be read if a volt meter is attached to the pin?

- This is called a "floating pin." You cannot assume it is '0' or 'ground.' It acts as an antenna and it *can* vary wildly.

- Pull-up and Pull-down resistors make the state of the pin defined without any input.

THE UNIVERSITY
OF ARIZONA

Outline

THE UNIVERSITY
OF ARIZONA

Interfacing with Other Digital Devices

PIC32MX and Other Devices

- PIC32MX uses 5V as its power source. Other devices can use 3.3V, 2V, 12V, etc..

12V "high",
0V "low"

5V "high",
0V "low"

Other Device

PIC32MX

THE UNIVERSITY
OF ARIZONA

Interfacing with Other Digital Devices

PIC32MX and Other Devices

- PIC32MX uses 5V as its power source. Other devices can use 3.3V, 2V, 12V, etc..
- The best the PIC32MX can do is set a pin to its V_{dd}. How can it control these devices?

12V "high", 0V "low"

5V "high", 0V "low"

Other Device

PIC32MX

THE UNIVERSITY
OF ARIZONA
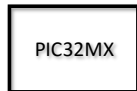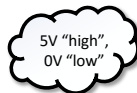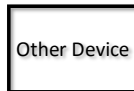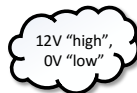
Interfacing with Other Digital Devices

Open-Drain Collector

- When the switch is open, the pull-up resistor causes the output to be 5V.

- This way, 3.3V or V_{dd} is not logic high. Logic high is done with high impedance.
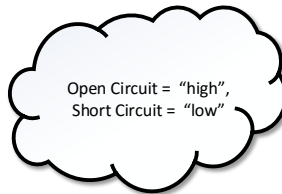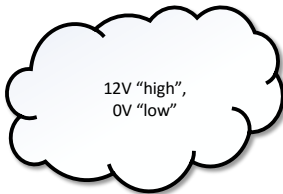

THE UNIVERSITY
OF ARIZONA
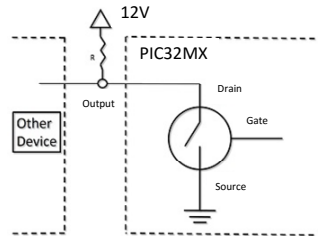
Interfacing with Other Digital Devices

Open-Drain Collector

- When the switch is closed, the current flows through the microcontroller to ground. The output is then logic low.

- Logic low is done with low impedance.
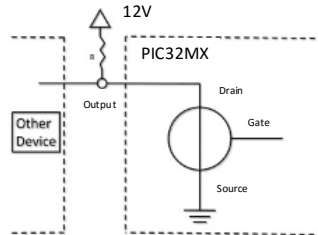
Interfacing with Other Digital Devices

12V "high",
0V "low"

Open Circuit = "high",
Short Circuit = "low"

Other Device

PIC32MX

THE UNIVERSITY
OF ARIZONA

Usages of ODC

One Note on ODC...

- ODC is an OUTPUT mode. It is so that the microcontroller can control another device.

THE UNIVERSITY
OF ARIZONA

Usages of ODC

One Note on ODC...

- ODC is an OUTPUT mode. It is so that the microcontroller can control another device.
- ODC is part of a serial communications protocol called I2C as well.

THE UNIVERSITY
OF ARIZONA

Outline

1. Pin Considerations
   - Input noise
   - "Bouncing" in Circuits
   - Floating pins

2. Open-Drain Collector Configuration

3. Change Notifications

THE UNIVERSITY
OF ARIZONA

Change Notification

Transient Events

- Our current way of observing change is to have an "if" statement in the code and check the status of a register.

THE UNIVERSITY
OF ARIZONA

Change Notification

Transient Events

- Our current way of observing change is to have an "if" statement in the code and check the status of a register.

- What if a device changes its output as a short pulse, too quick for the program to see?

THE UNIVERSITY
OF ARIZONA

Change Notification

Transient Events

- Our current way of observing change is to have an "if" statement in the code and check the status of a register.

- What if a device changes its output as a short pulse, too quick for the program to see?

- Create a circuit that detects this change and let the program handle it when it can.

THE UNIVERSITY
OF ARIZONA

Change Notification Implementation

CN interrupt if:

- CN is enabled
- ANY change takes place in the logic value of the input pin.
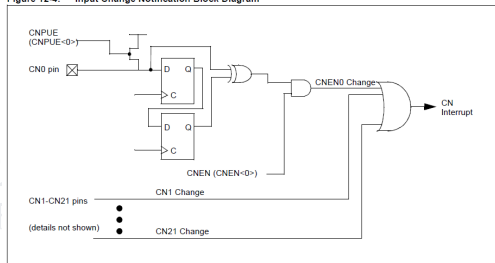

Figure 12-4: Input Change Notification Block Diagram
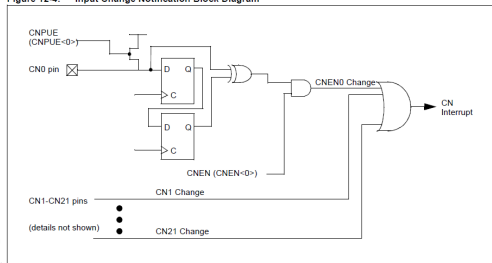
Change Notification Implementation

Pull-Up and Pull-Down

- The CN0PUE and CN0PDE act as "weak" internal pull-up and pull-down resistors respectively.
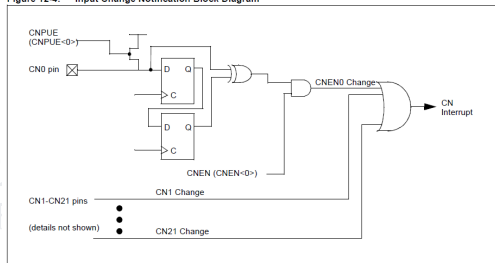

Figure 12-4: Input Change Notification Block Diagram

Change Notification Implementation

Pull-Up and Pull-Down

- The CN0PUE and CN0PDE act as "weak" internal pull-up and pull-down resistors respectively.
- When using CN in your projects, use this instead of creating an external pull-up resistor.

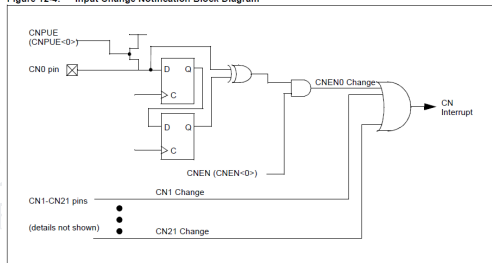Figure 12-4: Input Change Notification Block Diagram

Change Notification Implementation

Pull-Up and Pull-Down

- The CN0PUE and CN0PDE act as "weak" internal pull-up and pull-down resistors respectively.
- When using CN in your projects, use this instead of creating an external pull-up resistor.
- DO NOT use both internal and external pull-up resistors.

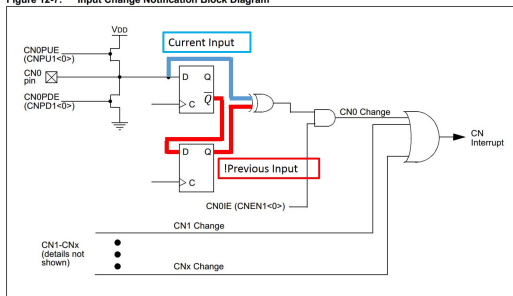Figure 12-4: Input Change Notification Block Diagram

Change Notification Implementation

The Circuit

- Exclusive OR gate is active only when the inputs are different

Figure 12-7: Input Change Notification Block Diagram

Change Notification Implementation

Interfacing with External LEDs

1. Using CN vs non-CN
2. Floating Pin Voltage

THE UNIVERSITY
OF ARIZONA