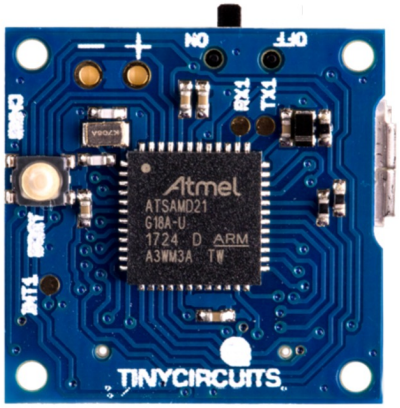
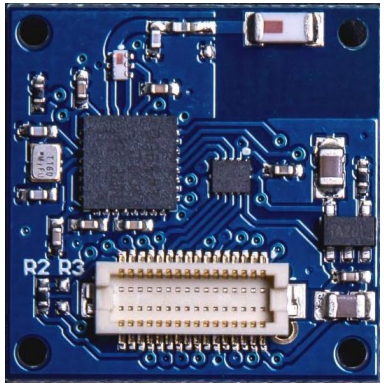
CSE190 Fall 2022



Lecture 5

GPIO (cont.) and Time



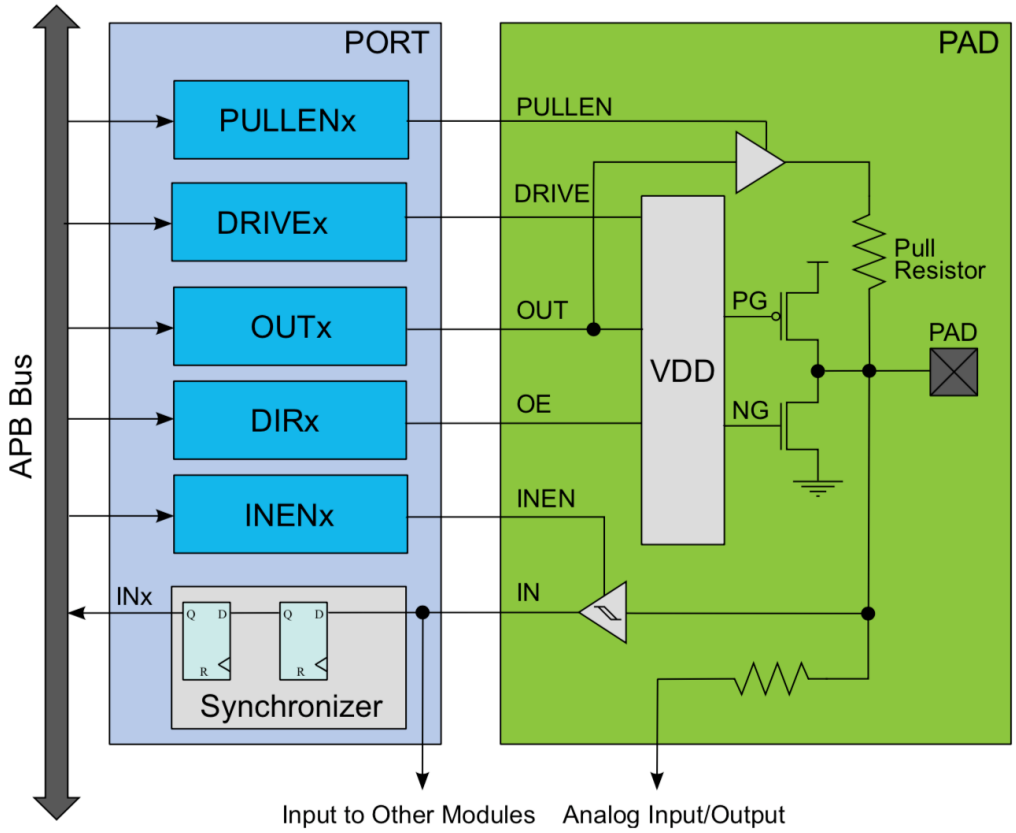
Wireless Embedded Systems

Aaron Schulman

Topology of a GPIO pin

Functional Description

Figure 23-2. Overview of the PORT



GPIO Configurations

23.6.3.1 Pin Configurations Summary

Table 23-2. Pin Configurations Summary

DIR	INEN	PULLEN	OUT	Configuration
0	0	0	X	Reset or analog I/O: all digital disabled
0	0	1	0	Pull-down; input disabled
0	0	1	1	Pull-up; input disabled
0	1	0	X	Input
0	1	1	0	Input with pull-down
0	1	1	1	Input with pull-up
1	0	X	X	Output; input disabled
1	1	X	X	Output; input enabled

A fun extra feature: Drive Strength

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
I_{OL}	Output low-level current	V_{DD}=1.62V-3V, PORT.PINCFG.DRVSTR=0	-	-	1	mA
		V_{DD}=3V-3.63V, PORT.PINCFG.DRVSTR=0	-	-	2.5	
		V_{DD}=1.62V-3V, PORT.PINCFG.DRVSTR=1	-	-	3	
		V_{DD}=3V-3.63V, PORT.PINCFG.DRVSTR=1	-	-	10	
I_{OH}	Output high-level current	V_{DD}=1.62V-3V, PORT.PINCFG.DRVSTR=0	-	-	0.70	
		V_{DD}=3V-3.63V, PORT.PINCFG.DRVSTR=0	-	-	2	
		V_{DD}=1.62V-3V, PORT.PINCFG.DRVSTR=1	-	-	2	
		V_{DD}=3V-3.63V, PORT.PINCFG.DRVSTR=1	-	-	7	

What time is the Apple Watch tracking?

How often | *Granularity*

Clock (all the time | sec)
Alarm (all the time | sec)
Stopwatch (when open | msec)
Sync (all the time | sec)
UI (when open | msec)
Buzzer (when buzzing | msec)
WiFi (when communicating | usec)

Why do we need timers?

- In general, why do we need timers?
  - What time is it now?
  - How much time has elapsed since I last checked?
  - Let me know when this much time passes.
  - When did this external input occur?

What peripherals do we use to track time?

(all the time | sec) - [Alarm, Sync]

32-bit Real time clock (RTC) peripheral with interrupts

(when open/buzzing | msec) - [Stopwatch, UI, Buzzer]

Processor's *timer* peripheral with interrupts

(when communicating | usec) - [WiFi]

WiFi chip's internal timer peripheral with interrupts

What peripherals do we use to track time?

(all the time | sec) - [Alarm, Sync]

32-bit Real time clock (RTC) peripheral with interrupts

The term is used to avoid confusion with ordinary hardware clocks which are only signals that govern digital electronics, and do not count time in human units.

(when open/buzzing | msec) - [Stopwatch, UI, Buzzer]

Processor's *timer* peripheral with interrupts

(when communicating | usec) - [WiFi]

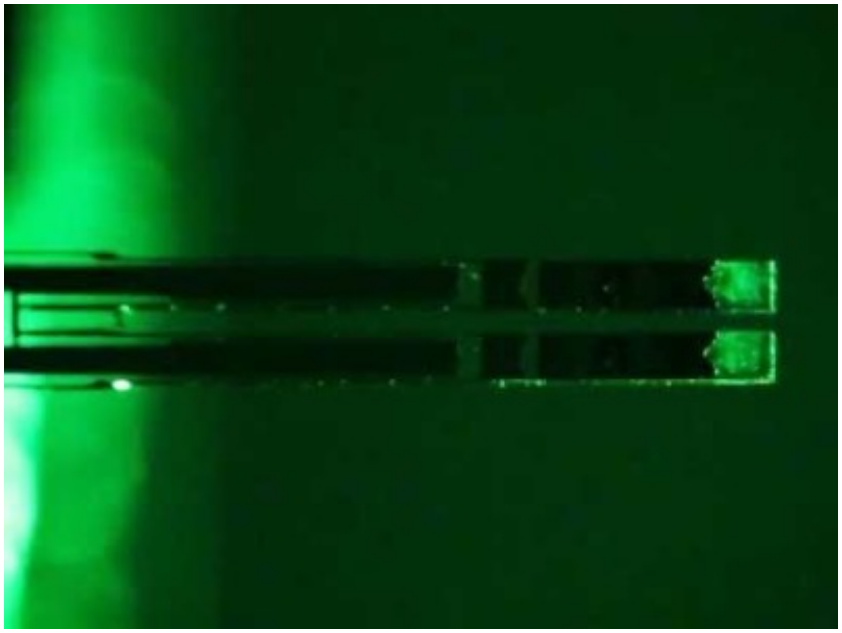
WiFi chip's internal timer peripheral with interrupts

Why do we need timers?

In the first project, what do we need timers for?

- Determining when to change LEDs
  - 20 Hz means change bits every 50 milliseconds
  - How to measure 50 ms?
  - Option 1: Use the timer hardware to let you know when 50 ms has passed.
  - Option 2: Count how many processor cycles it would take to equal 50 ms.

What is measuring the time?
Oscillators (generally, crystal oscillators)



Video: Crystal oscillators "go to war"