

ALGONQUIN COLLEGE

CST8227 INTERFACING

Lecture 1

Agenda: Introduction

- Lab #1 discussion
- Lab #2 discussion
- Teensyduino data sheets/reference pages https://pjrc.com/teensy/teensyduino.html
- Arduino reference http://arduino.cc/en/Reference/HomePage
- Half-kay Bootloader
- Reading schematics
- Datasheets
- What's that part?
- Circuit Theory



Microcontroller

- a processor and memory on a single chip.
- The I/O *pins* are often generically referred to as General Purpose Input Output pins (GPIO)
- The I/O ports can be interfaced to a variety of sensors and actuators.
- A port is a grouping of several inputs (i.e. 32-bit port).
- The port pins can be configured to be either inputs or outputs which makes them bidirectional ports.
- As computer engineers, you are familiar with binary 1's and 0's.
- In a computer, binary 1's and 0's are realized with two voltage levels, commonly the highest voltage available in the system and the lowest voltage available in the system.
- In the case of Teensy and therefore the ARM processor on board, these voltages are 3.3 volts and 0 volts (GND).



Microcontroller Memory

There are three pools of memory in the microcontroller used on current Arduino boards:

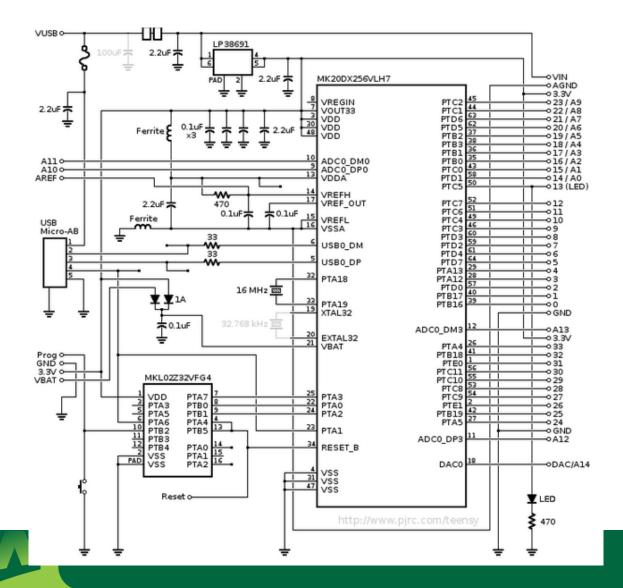
- Flash memory (program space), is where the Arduino sketch is stored. Flash memory is non-volatile (the information persists after the power is turned off).
- SRAM (static random access memory) is where the sketch creates and manipulates variables when it runs. SRAM is volatile and will be lost when the power is cycled.
- EEPROM is memory space that programmers can use to store long-term information.
 EEPROM memory is non-volatile (the information persists after the power is turned off).
 Configuration data is stored here, such as frequency, serial numbers, etc.



What is Teensyduino?

- Teensyduino is an Arduino "clone"
- USB-based microcontoller development system
- an open-source platform used for electronics experimenting and prototyping.
- The Arduino learning platform involves a microcontroller and an IDE (Integrated Development Environment).
- You can upload your code from your computer used to write and upload computer code to the microcontroller using a USB cable.

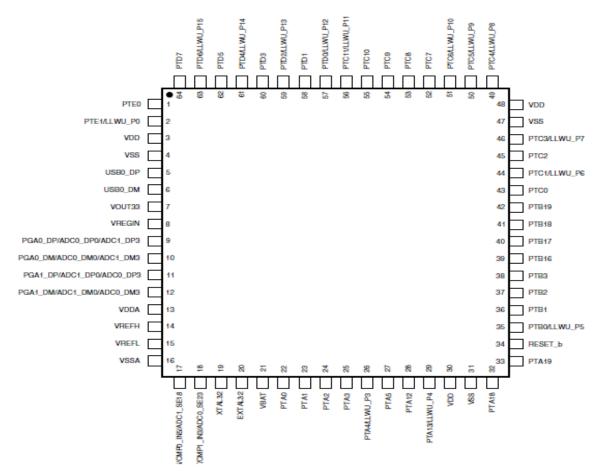




Teensy 3.2 Board Layout



ARM M4 Processor Pinout







How does Teensy compare with Arduino or ARM processors (or Atmega)?

- Teensy and Arduino are breakout boards.
- ARM is a processor a very powerful processor used in about 95% of smart phones (2010 statistic).
- ARM uses RISC architecture.
- Atmega is a brand of processor that uses Harvard architecture
- Teensy and Arduino commonly use processors such as the Atmega, however:
 - http://www.kickstarter.com/projects/paulstoffregen/teensy-30-32-bit-arm-cortex-m4-usable-in-arduino-a



Bootloader

- Generally, a boot loader is a computer program that loads the main operating system for the computer.
- It's only job is to use communication protocols to load other data and programs which are then executed from RAM.
- It allows you to upload code without using any additional hardware.
- In the case of teensy 3.1, the boot loader has already been loaded onto the MINI54T chip which is another microcontroller.
- The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller.
- When the teensy is first used, the bootloader will blink the on-board LED when it starts (i.e. when the board resets).



Halfkay Bootloader and Teensy Loader

- The Teensy Loader program (on your PC) communicates with the HalfKay bootloader (on your Teensy board) when the HalfKay bootloader is running.
- This communication facilitates the uploading of sketches from your PC and ultimately running them.
- HalfKay uses only 2 very simple commands: both are USB control transfers for writing data and rebooting.
- Pressing the onboard "reset" button activates the bootloader. and also executes a Flash memory re-write.
- Pressing the onboard "reset" button causes the Teensy to disconnect the USB connection, then restarts the Halfkay Bootloader, and is ready now to communicate with the Teensy Loader program.
- The Teensy Loader runs automatically when using Verify or Upload within the Arduino software (pressing the "reset" button on the Teensy is not necessary).
- When the Teensy is plugged into your PC, the Teensy appears as an HID (Human Interface Device) – verify this by opening up the "Device Manager" in Windows.
- HID is a sub-category in USB protocol.

https://forum.pjrc.com/threads/24252-Newbie-confused-about-Teensyduino-Teensyloader-and-halfKay





USB pinout

- Teensy uses a standard USB
 5-pin Micro-B cable (type A is for your laptop);
- Which version? Check your computer's system devices in the Device Manager.
- http://www.pjrc.com/store/cable
 e usb micro b.html
- Pinout graphic from <u>https://en.wikipedia.org/wiki/U</u> <u>SB#Pinouts</u>

Pin	Name	Wire color ^[a]	Description
1	V_{BUS}	Red	+5 V
2	D-	White	Data-
3	D+	Green	Data+
4	ID	No wire	On-The-Go ID distinguishes cable ends: • "A" plug (host): connected to GND • "B" plug (device): not connected
5	GND	Black	Signal ground



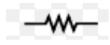
USB – Universal Serial Bus

- a standard developed in the mid-1990s.
- specifies the *physical characteristics of the medium* (such as maximum length of cables,
 gauge of wires, data rates, etc...) and the
 communication protocols permitted between
 computers and electronic devices.
- Standards define The wires (a bus) in a USB connection carry both information signals and a power supply.
- Connectors are referred to as Type A and Type B.
- Type A are the "receptacles", typically what is found on the device providing the power.
- Type B are the "plugs" on the device receiving power.
- See usb.org and http://en.wikipedia.org/wiki/USB
- Of noted interest is the USB specification for HIDs





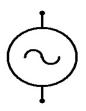
Review What's that part?



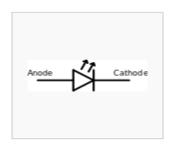
Resistor



Diode



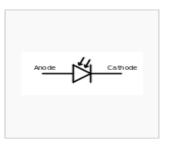
AC Power Supply



LED (light-emitting diode



Battery



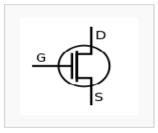
Photodiode (light sensor



What's that part?



capacitor



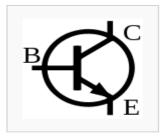
Field Effect Transistor (FET)



Capacitor, polarized



Ground Earth GND



Transistor (Bipolar Junction transistor - BJT



Ground chassis GND



potentiometer



Resistance and other passive two-terminal devices

- You need to be familiar with the characteristics of three common components:
 - 1. Resistors
 - 2. Capacitors
 - 3. Inductors.
- All three share a number of parameters:
 - 1. all are *two-terminal* devices (ie. two connections)
 - 2. all have a *linear* voltage-current response curve
 - 3. all are *passive*; they don't have an (extra) source of power and never
 - 4. Do not generate any power of their own.



Agenda: Basic electronics + calculations

- Voltage, current and resistance.
- Ohm's law
- Kirchoff's Voltage Law
- Kirchoff's Current Law
- Parallel Circuits
- Series Circuits
- Pull-up and pull-down resistors + pushbuttons
- Current and voltage calculations with an LED in the circuit
- You should always use a resistor in series with a LED to make sure it doesn't burn out.
- We will cover the use of Ohm's Law for determining an appropriate resistor value.



Ohm's Law

We will use the following symbols:

V = voltage

I = current

R = resistance

voltage = current * resistance

$$\therefore current = \frac{voltage}{resistance}$$

$$\therefore$$
 resistance = $\frac{voltage}{current}$

Other useful relationships:

- Power = voltage * current
- Now substitute anyone of the Ohm's Laws:

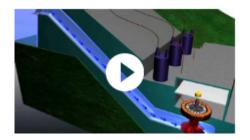
$$\bullet \quad P = V * I = V * \frac{V}{R} = \frac{V^2}{R}$$

•
$$P = V * I = (I * R) * I = I^2 * R$$

Voltage and Current

Voltage:

- the difference in electrical charge that exists between two points.
- Units are volts [V]
- Can be AC (alternating current
 - flows in two directions or DC (direct current)



Current:

- The rate at which current is flowing
- Units are amperes [A]
- Can be AC (alternating current) or DC (direct current – flows in one direction).

https://www.opg.com/generating-power/hydro/how-it-works/Pages/how-it-works.aspx



Some Great Links and Tutorials

- http://www.ladyada.net/learn/arduino/index.html
- http://tronixstuff.com/tutorials/
- http://forum.pjrc.com/forum.php
- http://www.allaboutcircuits.com/vol_1/index.html (electronics)

