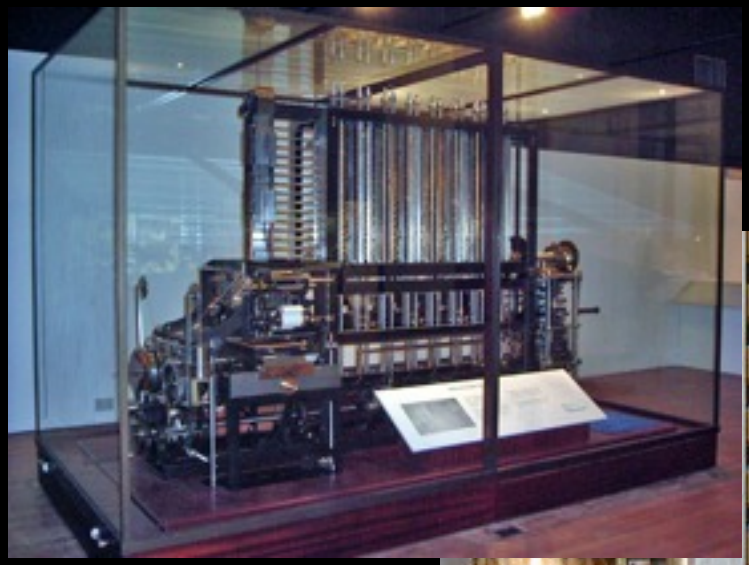
Interrupts & Using ICs

Press Play: Interactive Device Design | May 4, 2010

Before Integrated Circuits

Mechanical Computing

1849

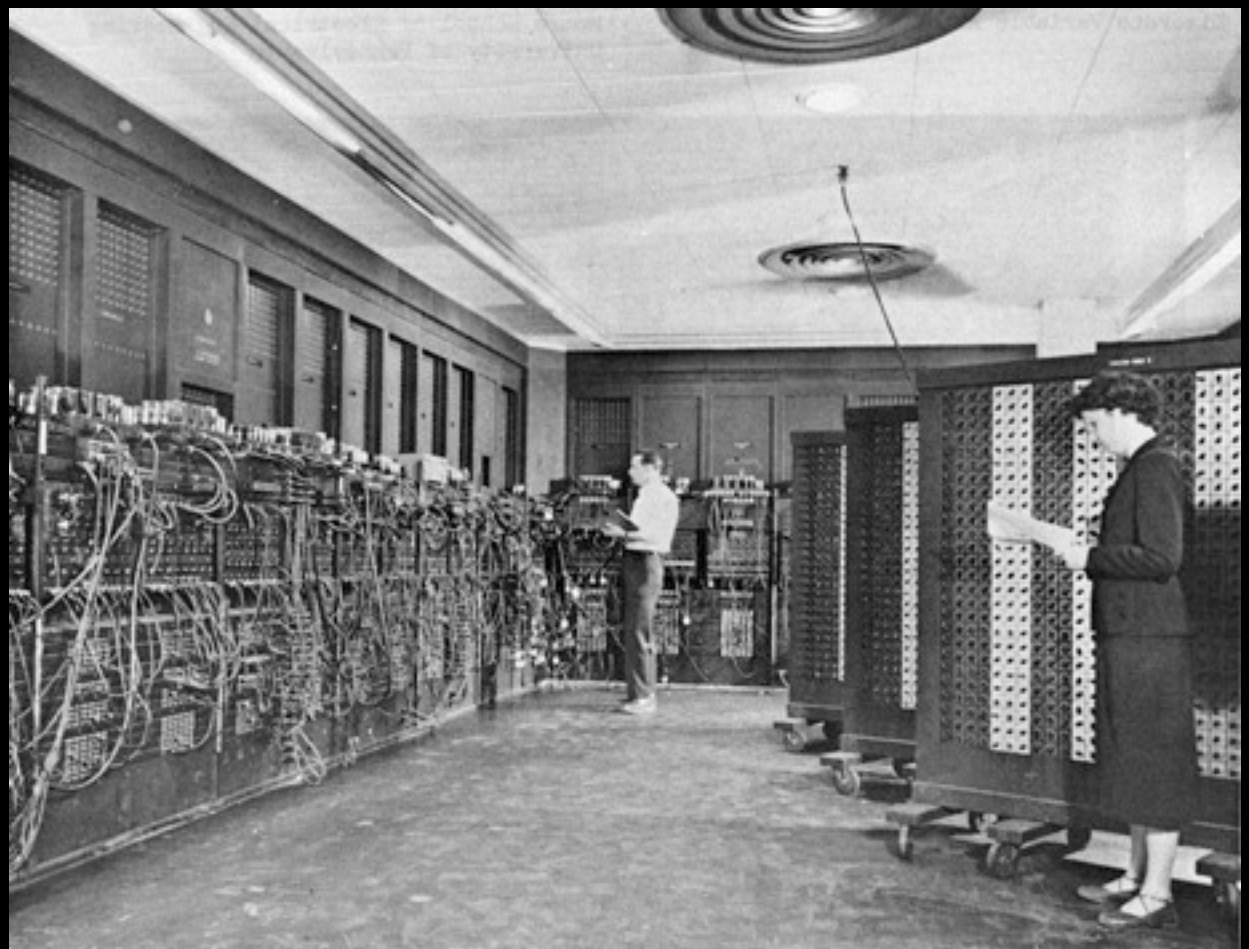


Wikimedia, by Joe D in January 2005.

Wikimedia, Carsten Ullrich, 2005

Before Integrated Circuits

Vacuum Tubes



Wikimedia, US Army Photo

1945

Before Integrated Circuits

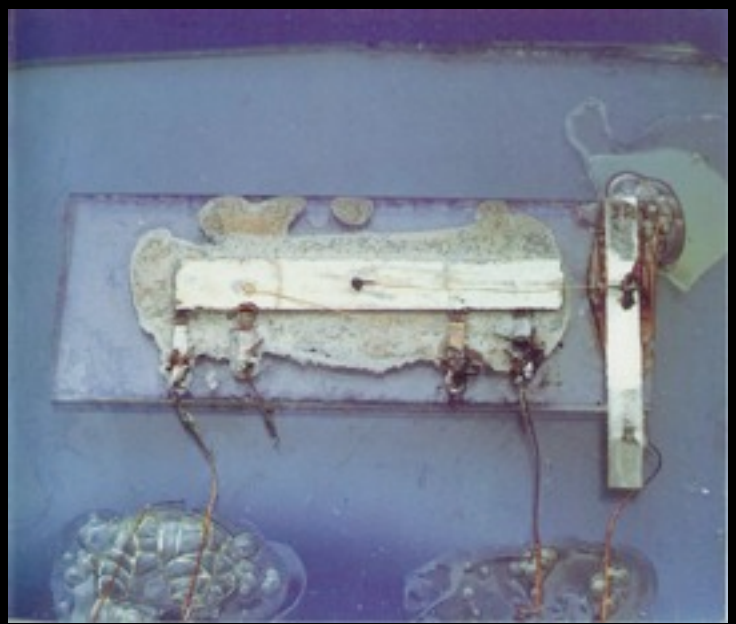
Transistors

1947

1955

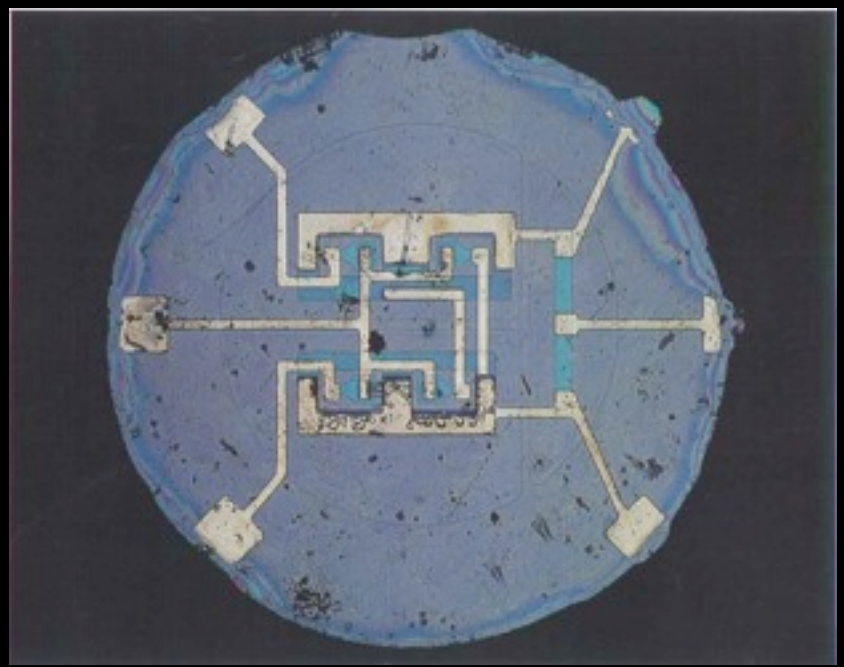
Integrated Circuits

Multiple Components on a Single Substrate



STATE OF THE ART ©Copyright Stan Augarten

1958

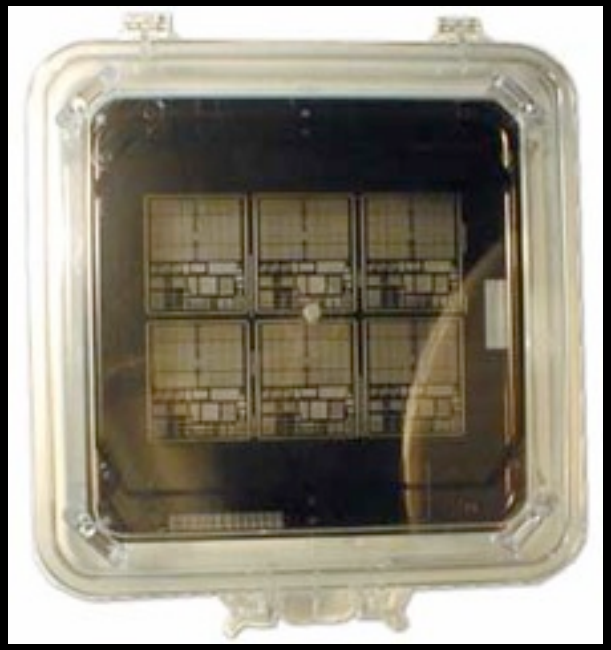


STATE OF THE ART ©Copyright Stan Augarten

1961

Integrated Circuits Manufacturing

Similar to Silkscreening



Analog vs Digital

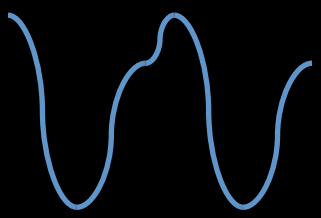
"Real World" vs "Computer World"

Analog

Digital

ADCs and DACs

Converting from Analog to Digital, and Back again



ADC

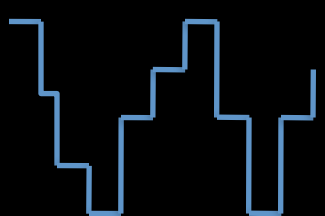
Microchip
MCP3208

0xFF,
0x12,
0x0F,
0xB2,
...

0xFF,
0x12,
0x0F...

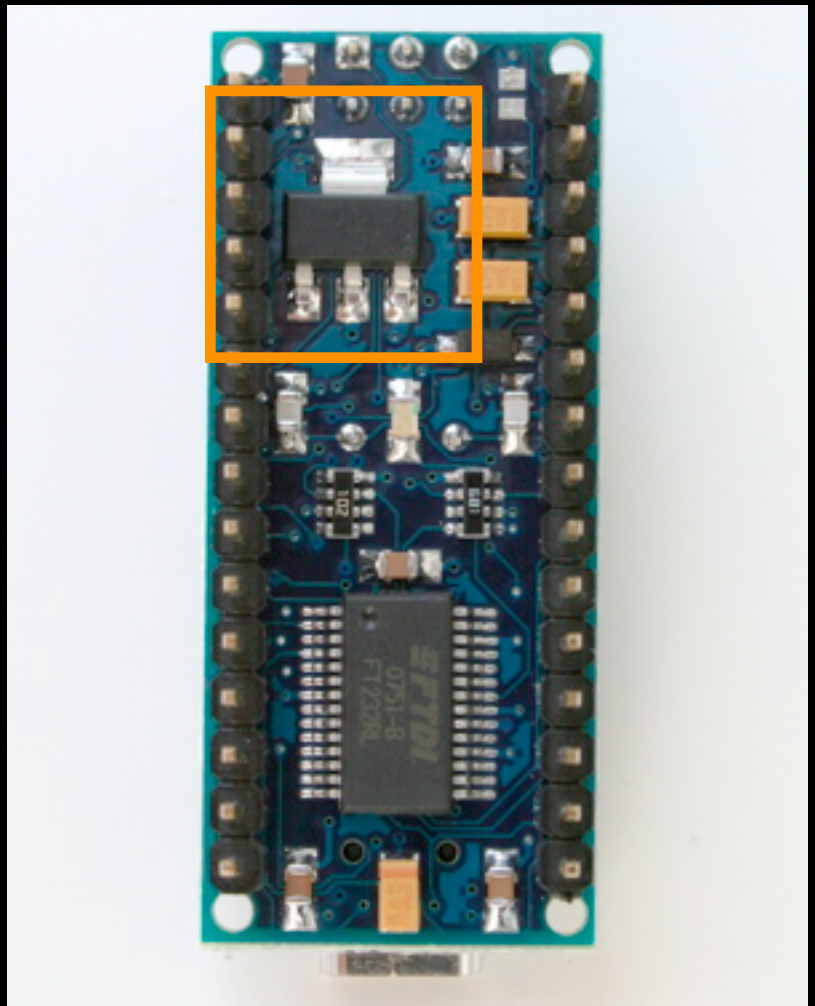
DAC

Analog Devices
AD420



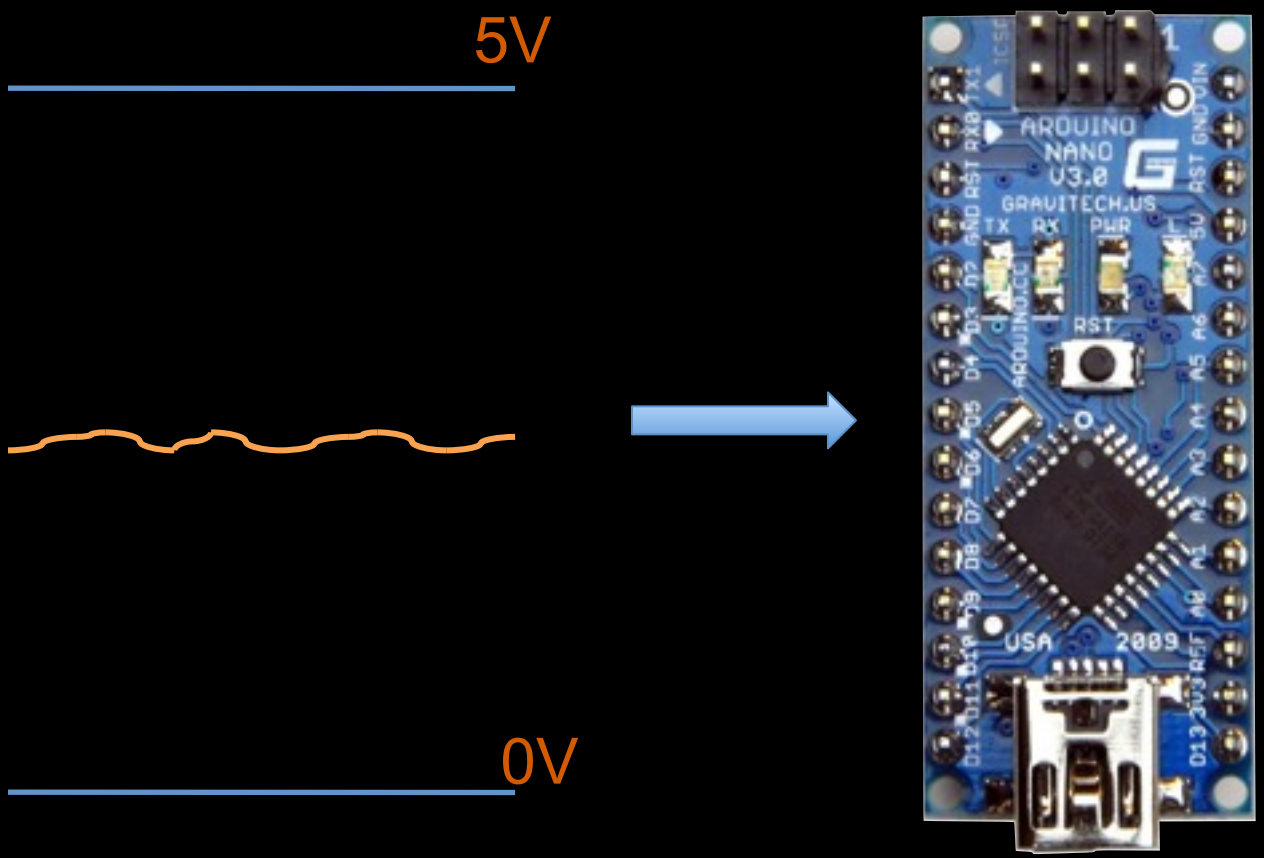
Analog ICs

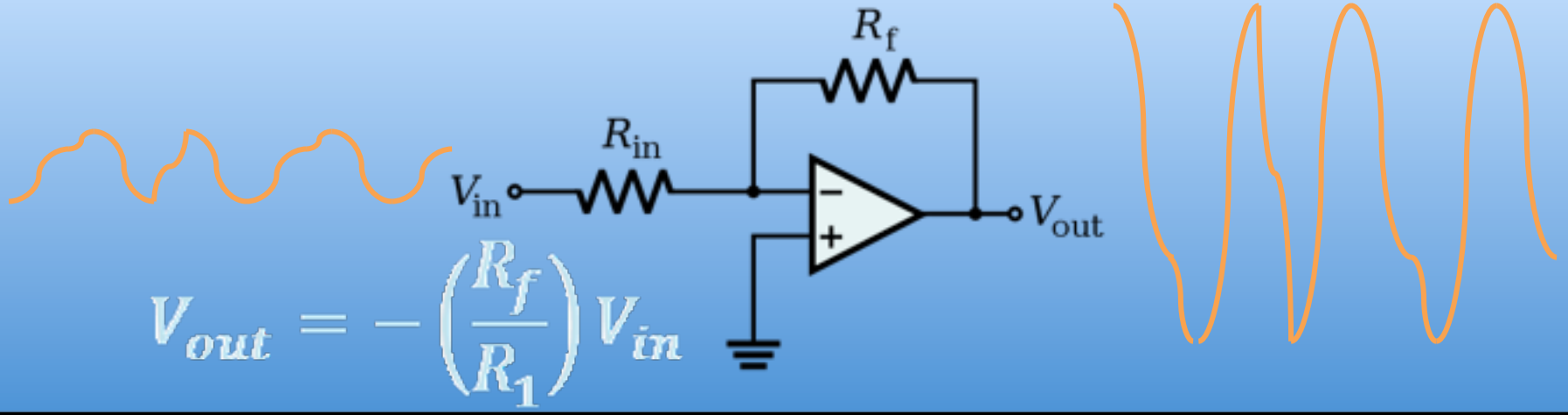
You have already used a few!

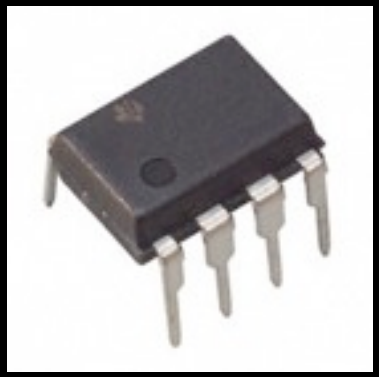


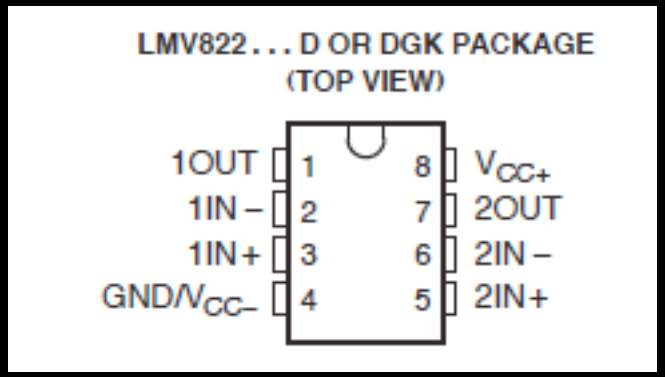
Analog ICs

Operational Amplifier









Texas Instruments
LMV822

Analog ICs

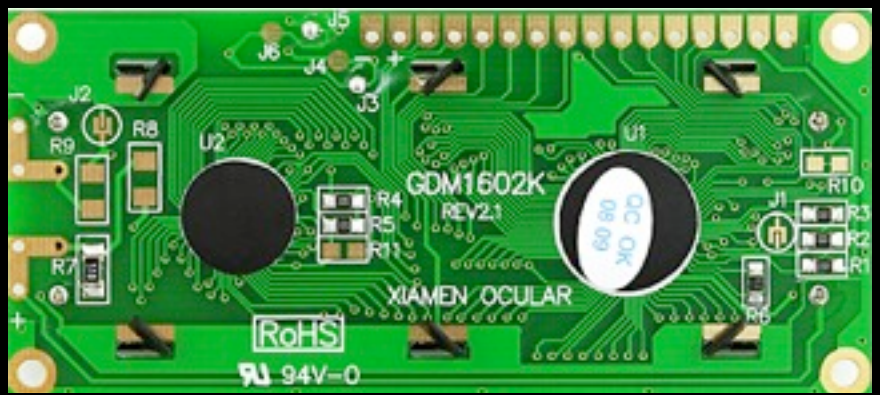
Filter Chips

or

Can design your own with R's and C's

Digital ICs

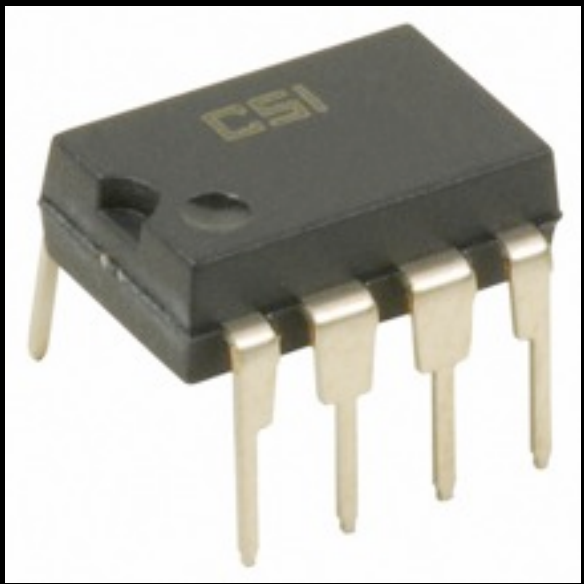
You've already used a ton!



Digital ICs

Memory

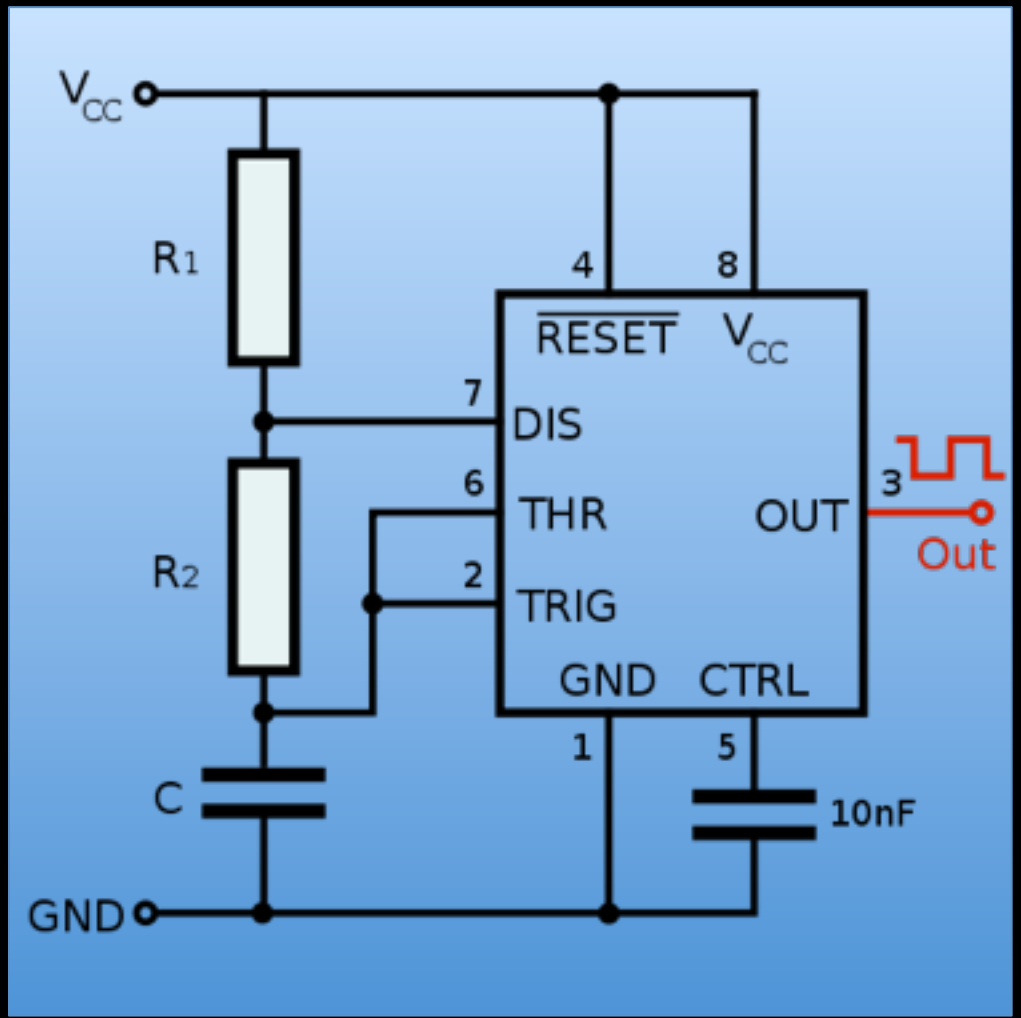
FLASH



EEPROM

Digital ICs

555 Timer



$$f = \frac{1}{\ln(2) \cdot C \cdot (R_1 + 2R_2)}$$

Digital ICs

555 Timer

ASTABLE OPERATION

When the circuit is connected as shown in figure 4 (pin 2 and 6 connected) it triggers itself and free runs as a multivibrator. The external capacitor charges through R_A and R_B and discharges through R_B only. Thus the duty cycle may be precisely set by the ratio of these two resistors.

In the astable mode of operation, C charges and discharges between 1/3 V_{CC} and 2/3 V_{CC}. As in the triggered mode, the charge and discharge times and therefore frequency, are independent of the supply voltage.

Figure 5 shows actual waveforms generated in this mode of operation.

The charge time (output HIGH) is given by :

$t1 = 0.693\ (R_A + R_B)\ C$

and the discharge time (output LOW) by :

$t2 = 0.693\ (R_B)\ C$

Thus the total period T is given by :

$T = t1 + t2 = 0.693\ (R_A + 2R_B)\ C$

The frequency of oscillation is then :

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C}$$

The duty cycle is given by : $D = \frac{R_B}{R_A + 2R_B}$

Figure 4

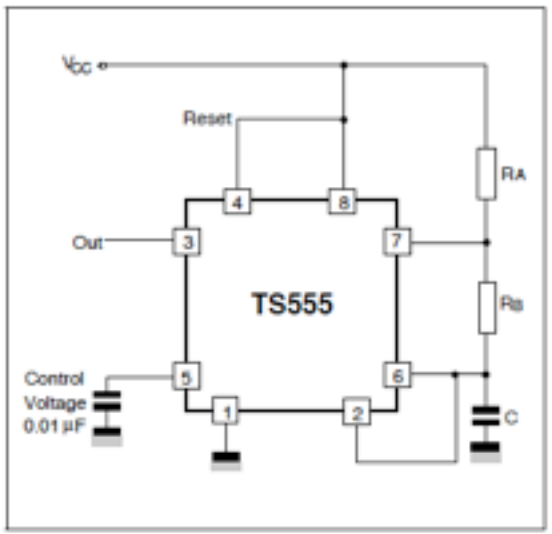
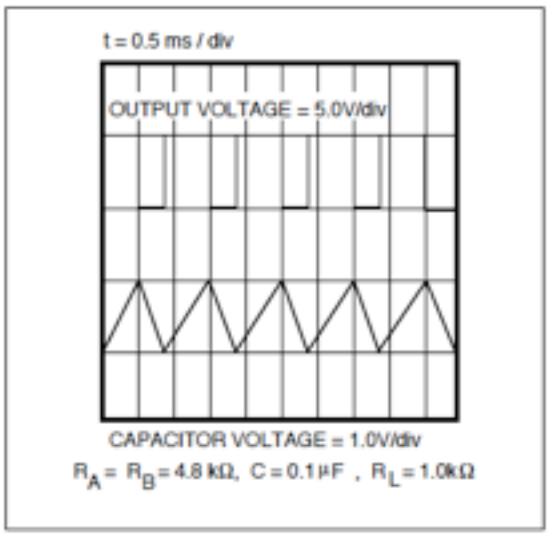


Figure 5



555 Timer Cir

555 Timers are fun and a great way to start learning electronics

Learning

The 555 timer is a simple integrated circuit that can be used to make many different electronic circuits. With this information you will learn how how the 555 works and will have the experience to build some of the circuits below.

- 1. An Overview
- 2. Pin Configuration
- 3. Inside The 555
- 4. Operating Modes
- 5. Using The Output
- 6. Calculator
- 7. Common Mistakes
- 8. 555 Datasheets

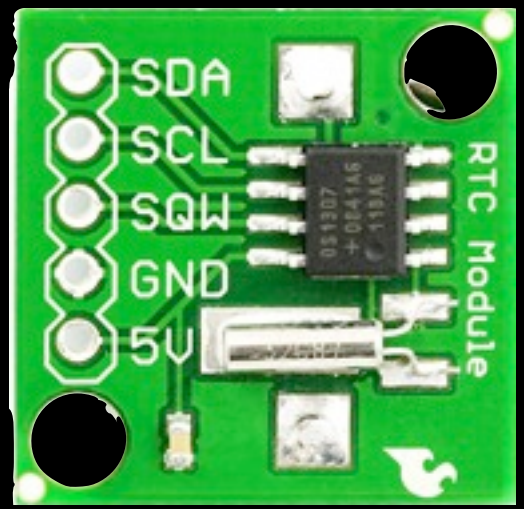
Fun Circuits

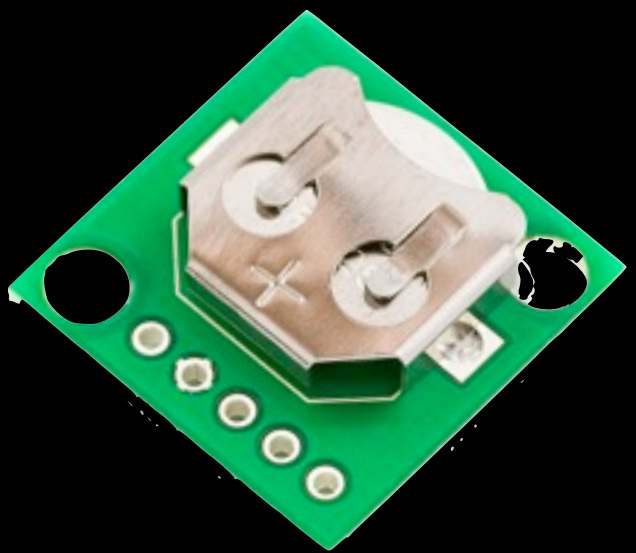
The following are complete electronic circuits that you can build, they all utilize the 555 Timer circuit.

- 3x3x3 LED Cube
- 555 Amplifier
- Automatic Curtain Closer
- Bike Turning Signal
- Bi-Polar LED Driver
- Latch
- LED Dice
- LED Dimmer
- Light Detector
- Machine Gun
- Siren 100dB
- Stepper Motor Controller
- Stun Gun
- Ticking Bomb
- Tilt Switch

Digital ICs

Real-Time Clocks





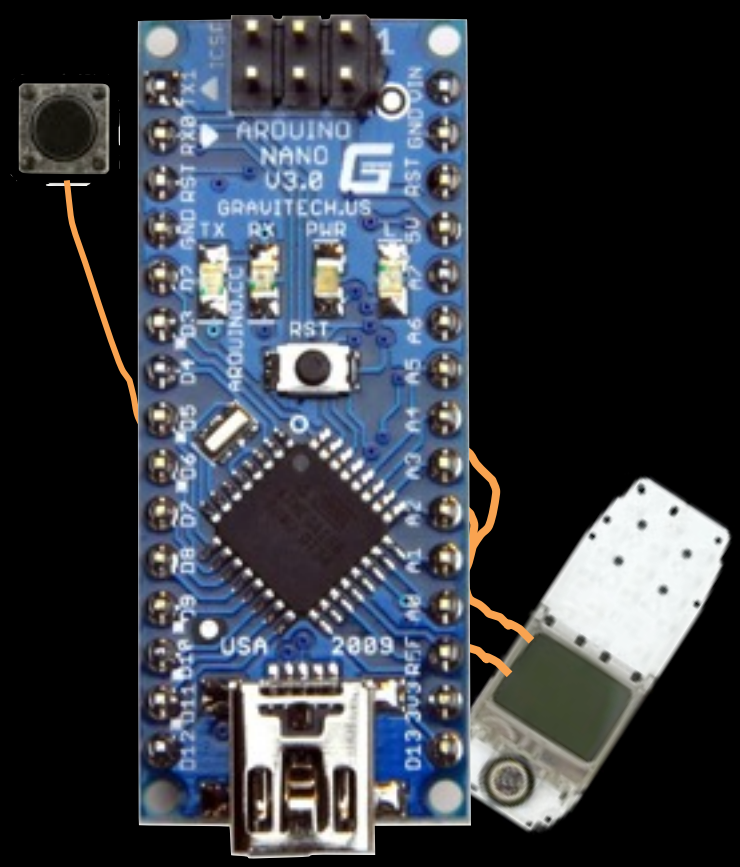
- Seconds, minutes, hours, date, month, and year
- Battery lasts for 7-9 years
- Keeps track of leap years!

DS1307

http://www.sparkfun.com/products/99

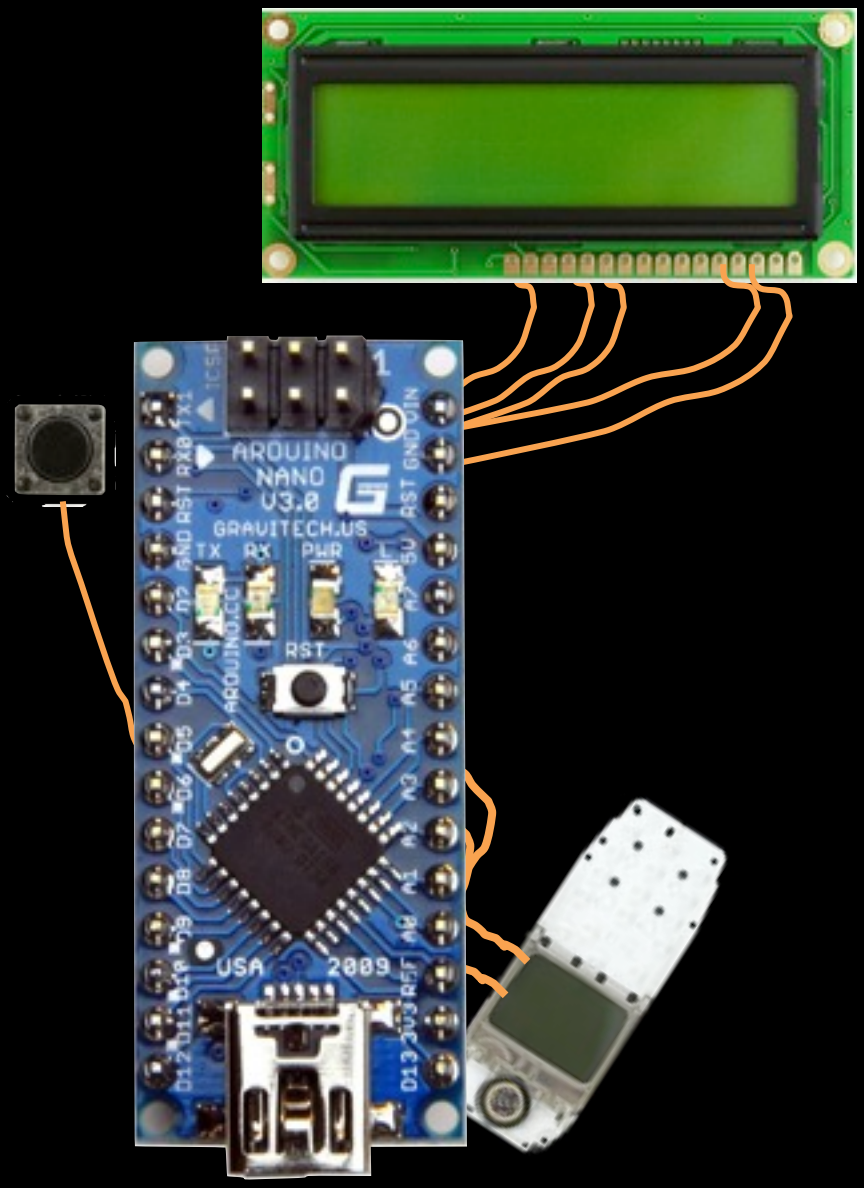
Digital ICs

Saving Pins



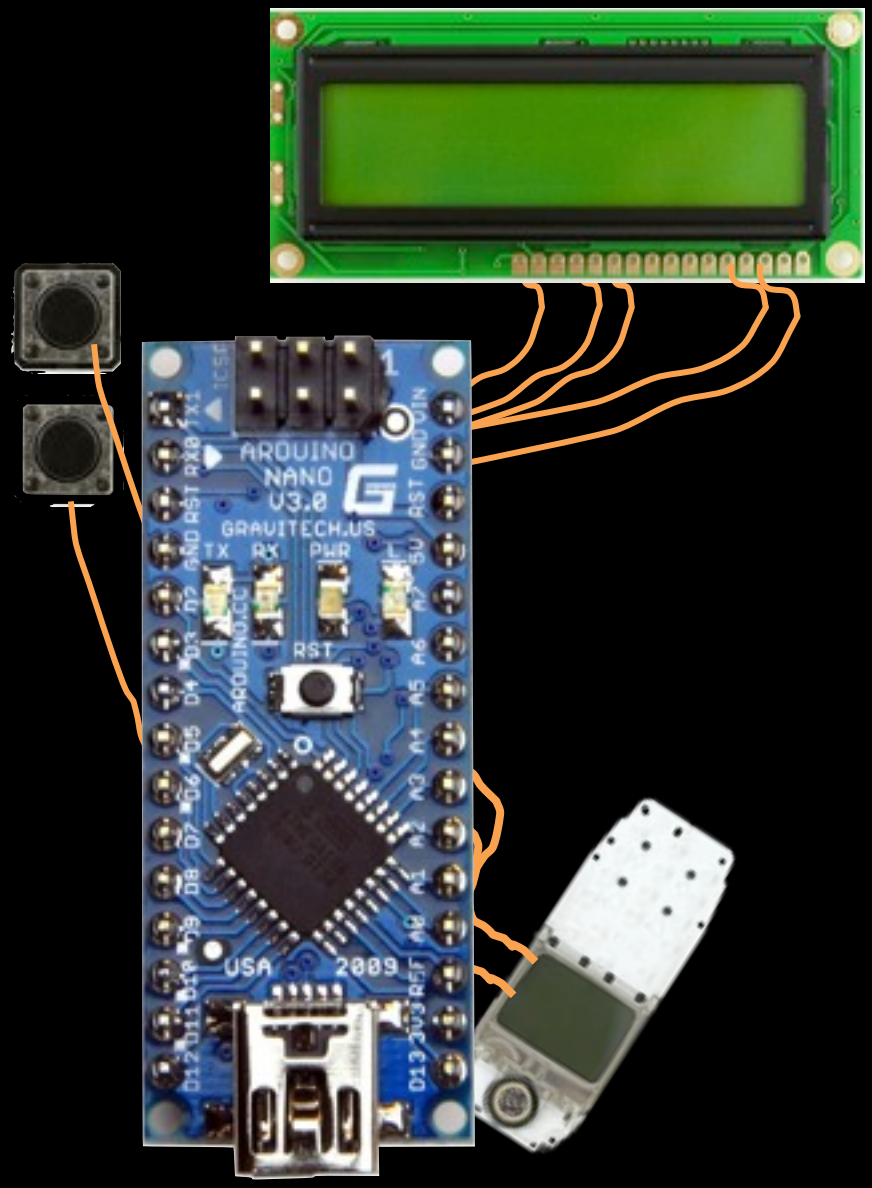
Digital ICs

Saving Pins



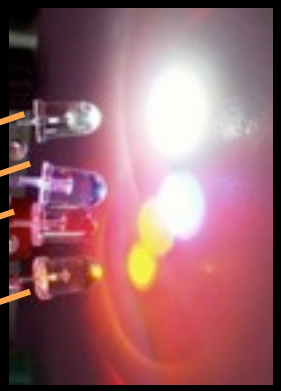
Digital ICs

Saving Pins



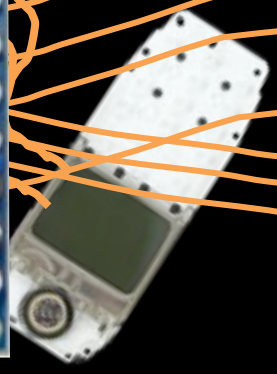
Digital ICs

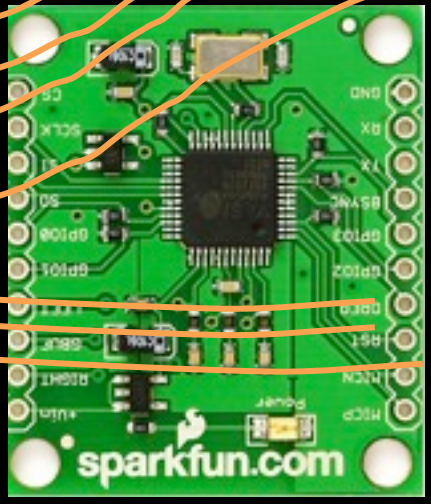
Saving Pins

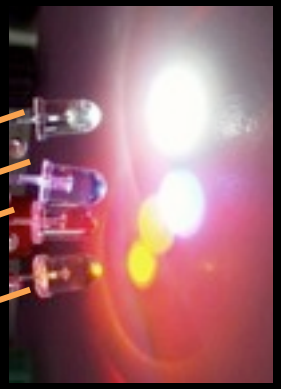


Digital ICs

Saving Pins

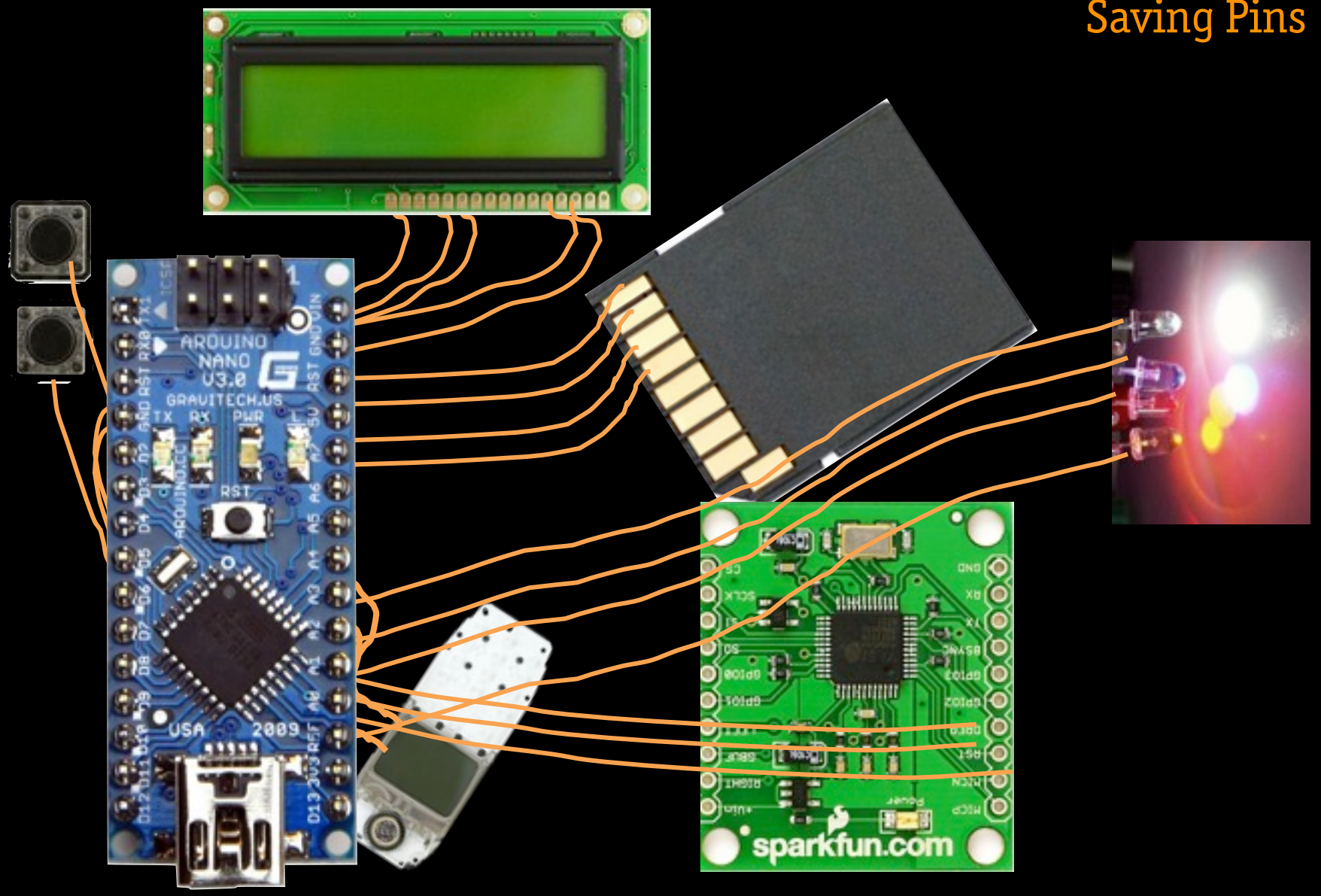






Digital ICs

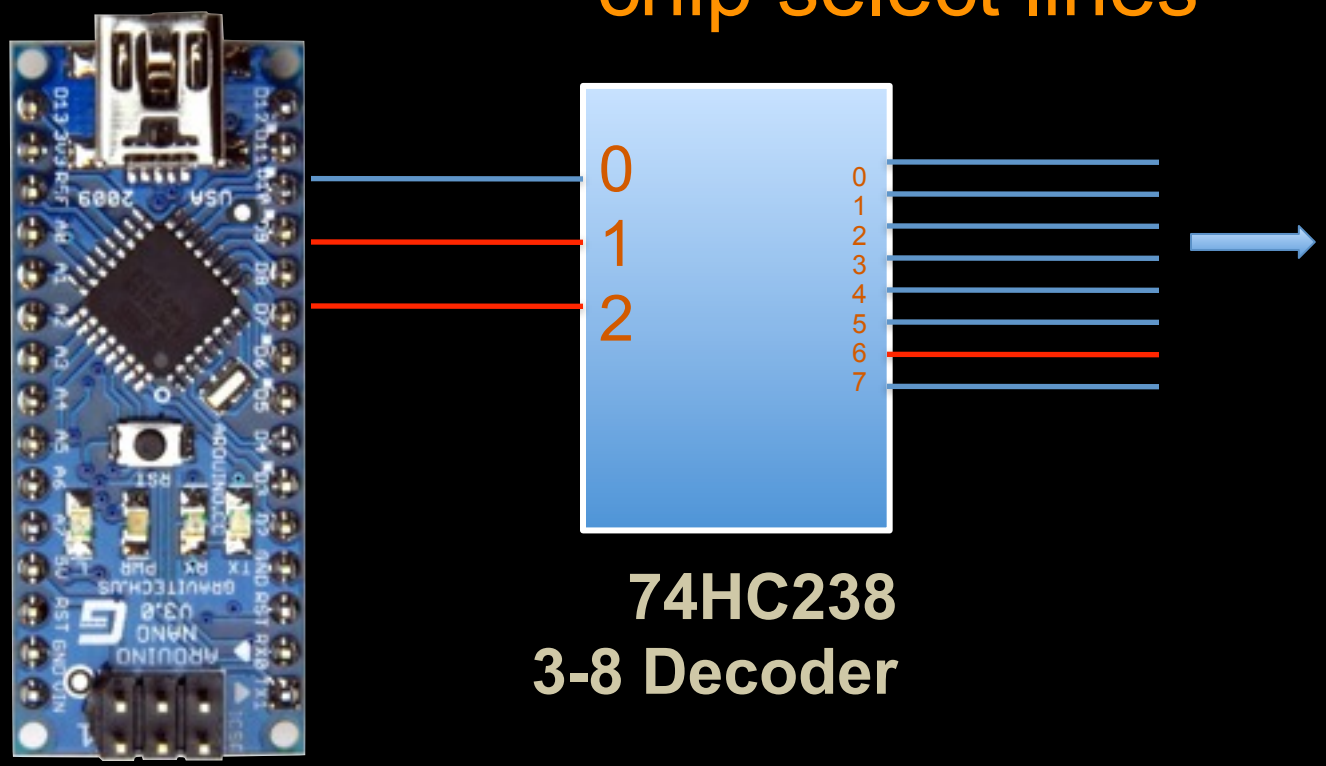
Saving Pins



Digital IC's

Decoder

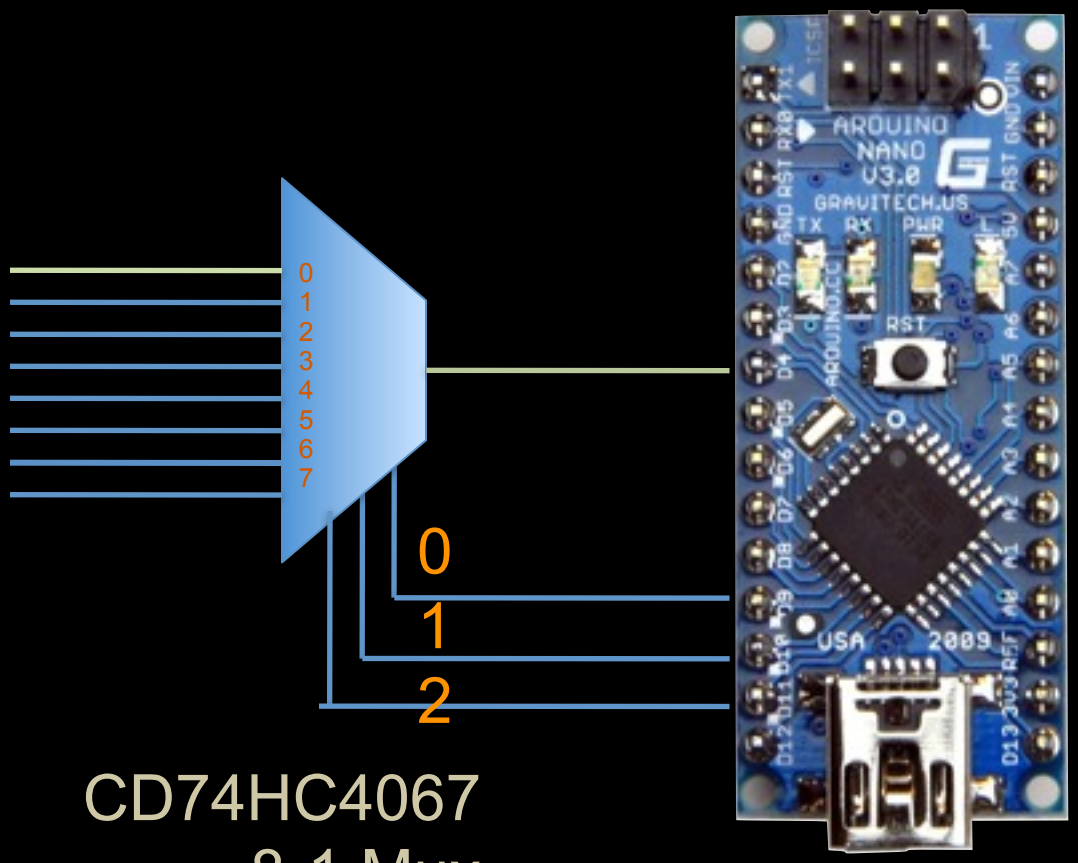
chip select lines



74HC238
3-8 Decoder

Digital IC's

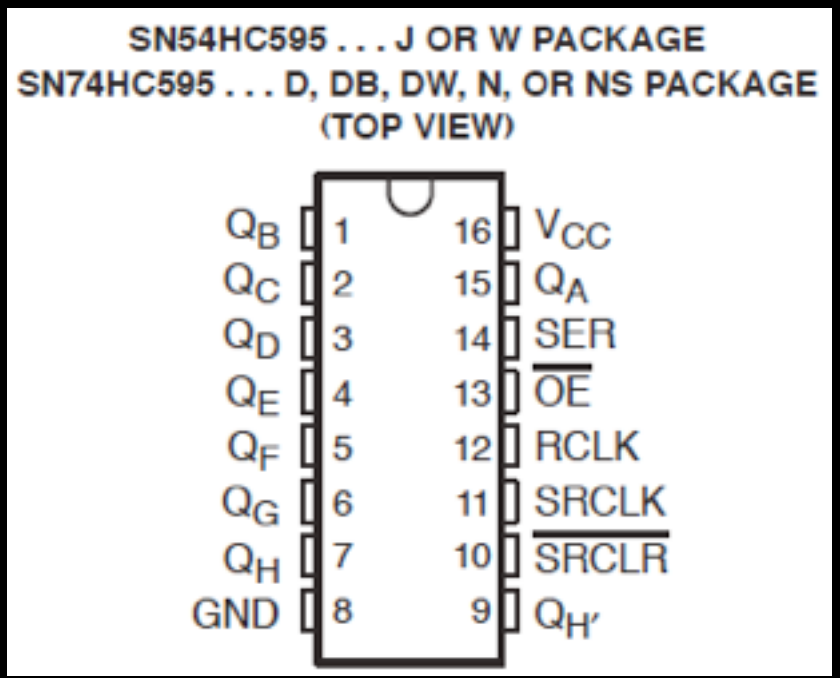
Multiplexer



CD74HC4067
8-1 Mux
(works for Analog too)

Digital IC's

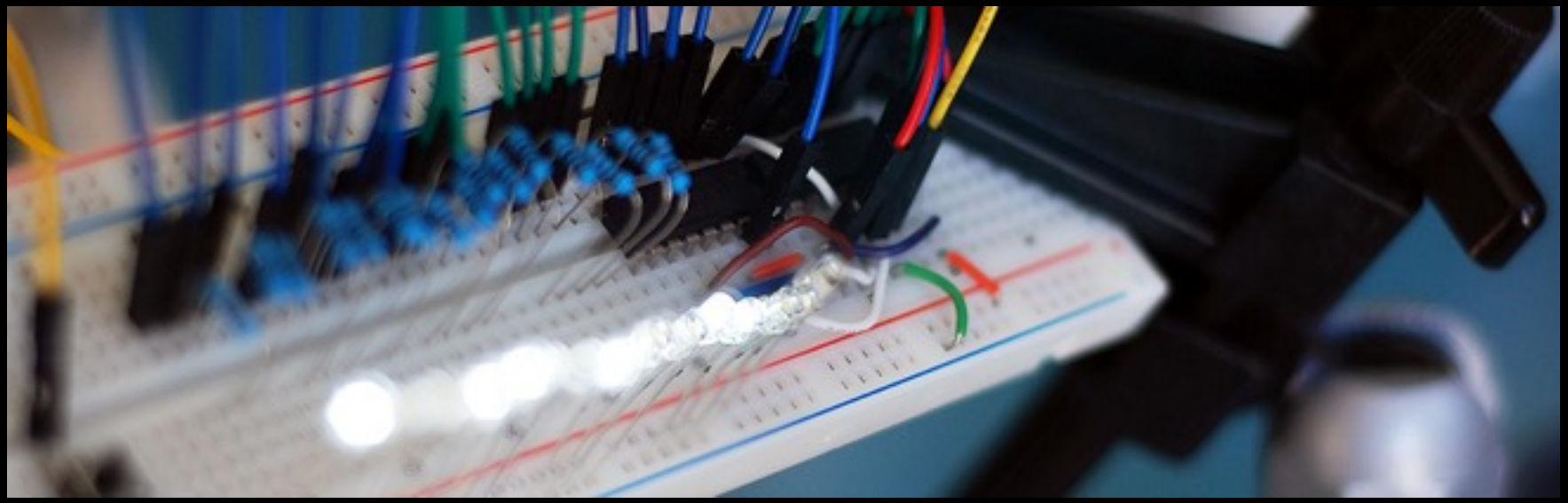
Shift Register



- Data is read in on the serial (SER) input line
- Data is shifted once with each clock cycle (SCLK).
- The "register clock" (RCLK) acts as a clutch, and holds current values when set LOW.

Digital IC's

Shift Register



http://bildr.org/2011/02/74hc595/

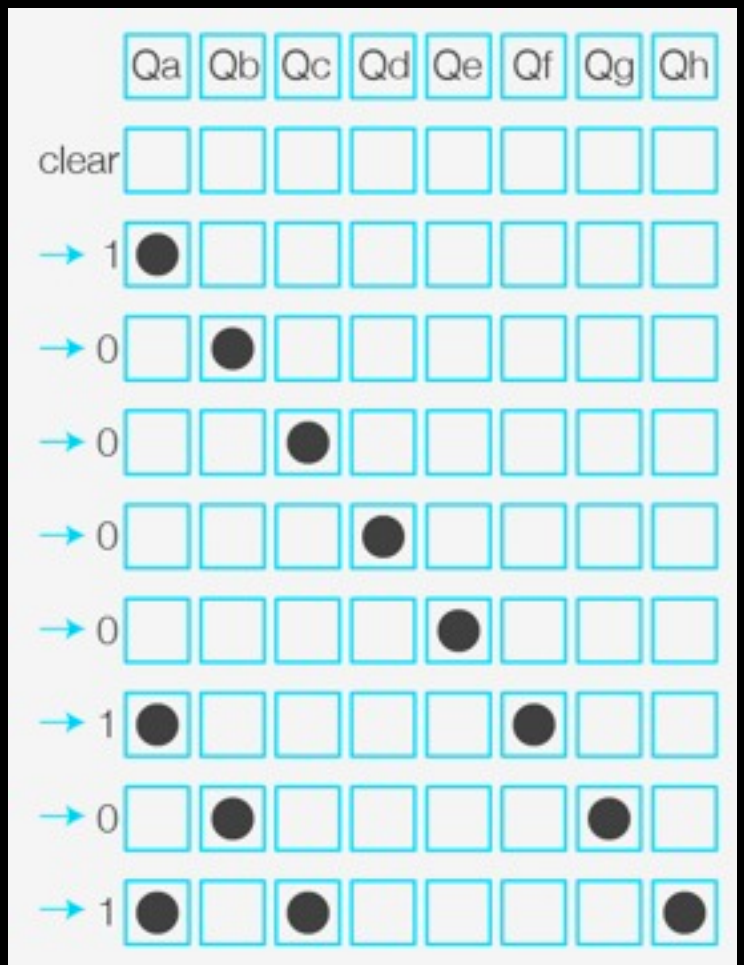
Say you want to control a huge number of LEDs with your Arduino

Digital IC's

Shift Register

To turn on the 1st, 3rd, and 8th LED:

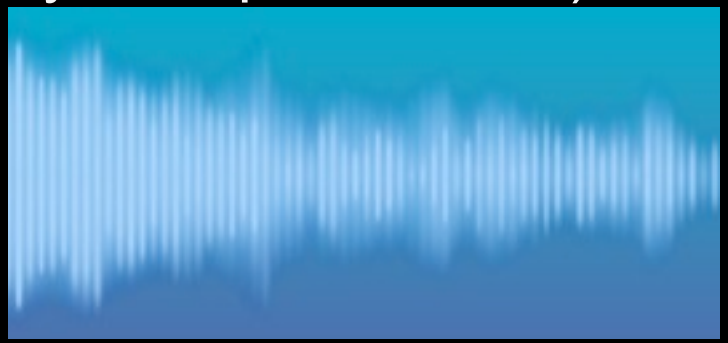
- Pull SRCLR low to clear the register
- Pull RCLK low to clutch the output
- Pulse SER 1, 0, 0, 0, 0, 1, 0, 1 with each CLK pulse
- Pull RCLK high to turn on the LEDs



Integrated Circuits...

So many more!

- Specialized Processors (like your Mp3 Decoder)
- Digital Signal Processors



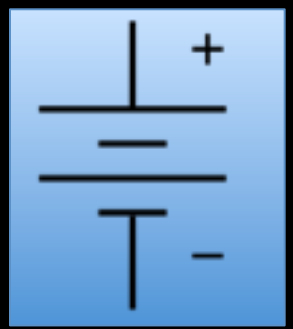
- 7-Segment Display Driver (MC14489B)

- Check out SparkFun's General IC's page for more!

Choosing ICs

Voltage & Current

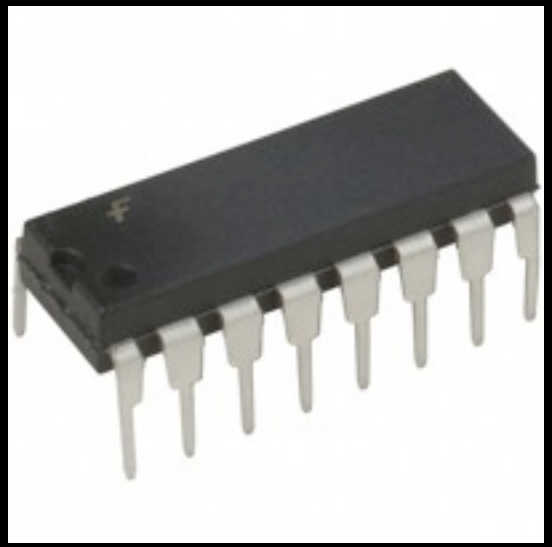
Choosing parts with the same operating voltage will save major headaches and components!



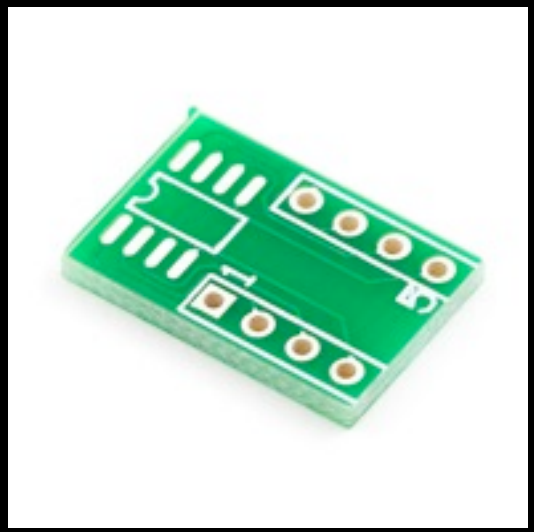
Keep your power source in mind.. USB, batteries, and voltage regulators can only provide so much current.

Choosing ICs

Packaging



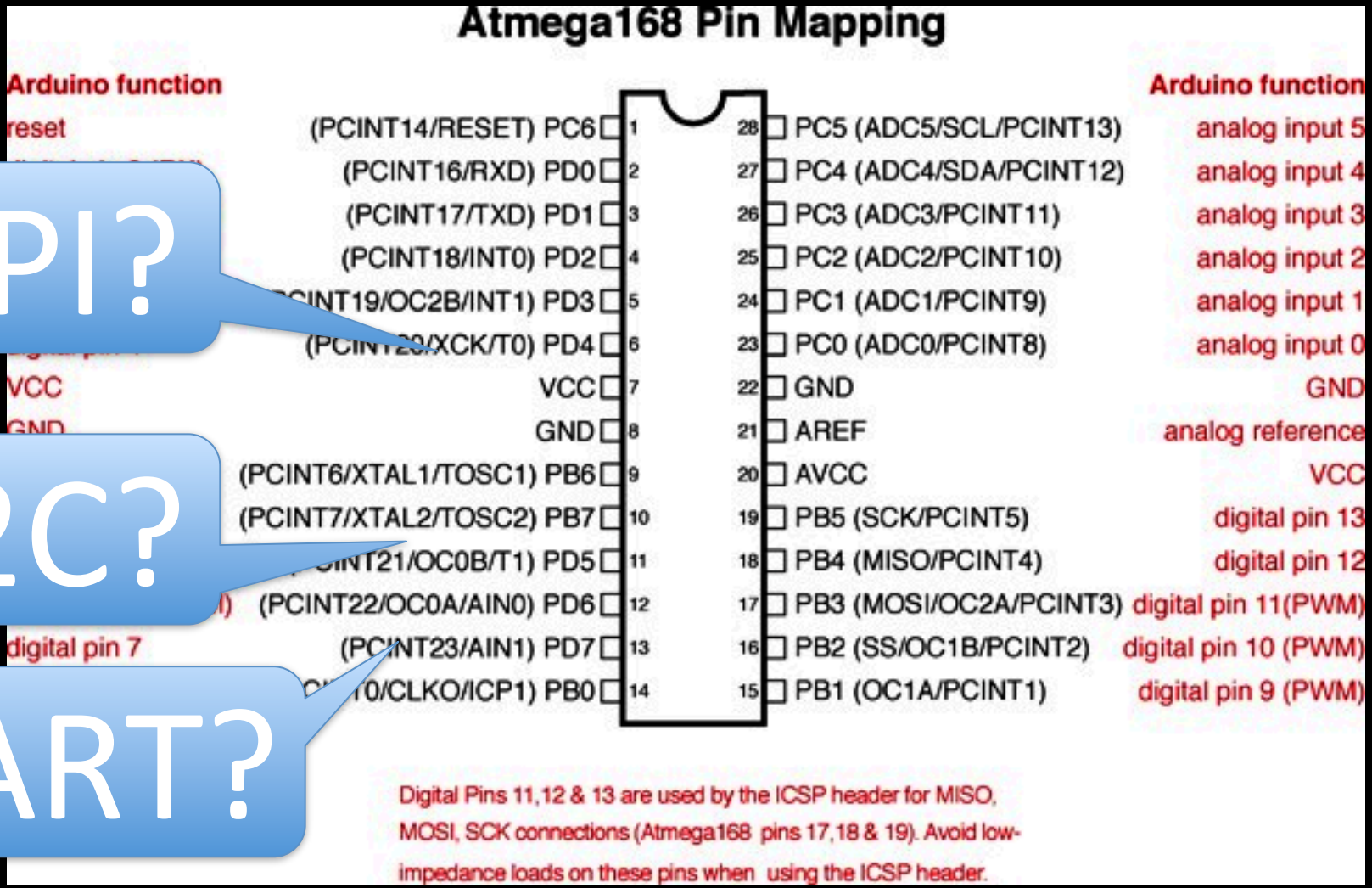
16-DIP



8-SOIC to DIP Adapter

Choosing ICs

Communication Interface



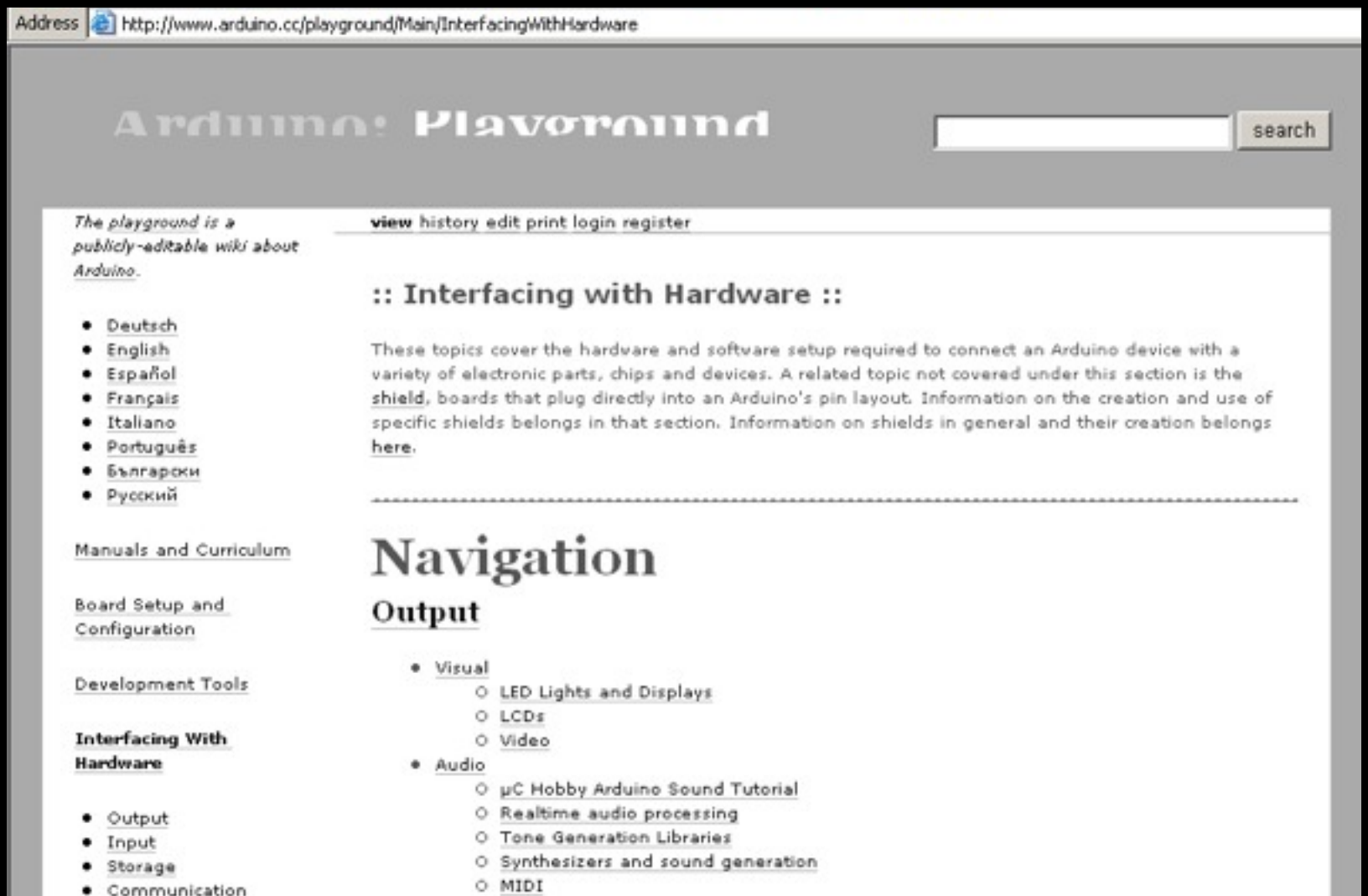
SPI?

I2C?

UART?

Choosing ICs

Community Support



Lab 6 Preview:

Using the MP3 Decoder Chip

Debouncing

Interrupt Handlers

Lab 6 Preview

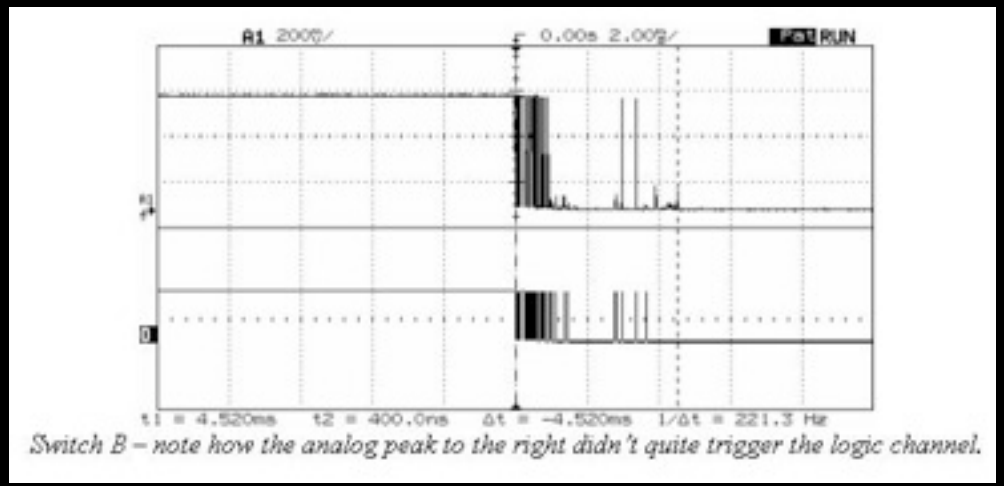
Interrupts

Write a special function ("Interrupt Service Routine") that gets called exactly when the button is pressed.

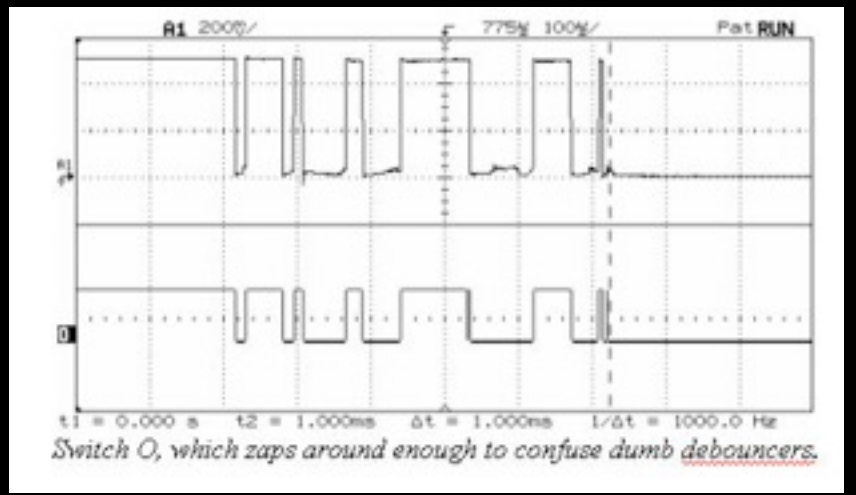
Lab 6 Preview

Debouncing

What happens when you press the button?



Switch B – note how the analog peak to the right didn't quite trigger the logic channel.



Switch O, which zaps around enough to confuse dumb debouncers.