

Digital to Analog and Back

- Analog: encoding information using voltage
 - Many sensors use voltage as an output
 - Motors torque is determined by current passing through the motor
- Digital: encoding information with bits

How to move between these?

Digital to Analog Conversion

In class exercise...

(see pencast)

Analog to Digital Conversion

For a given voltage, what is the digital representation of the voltage?

- How would we implement this?

Analog to Digital Conversion

Board exercise...

Analog to Digital Conversion

For a given voltage, what is the digital representation of the voltage?

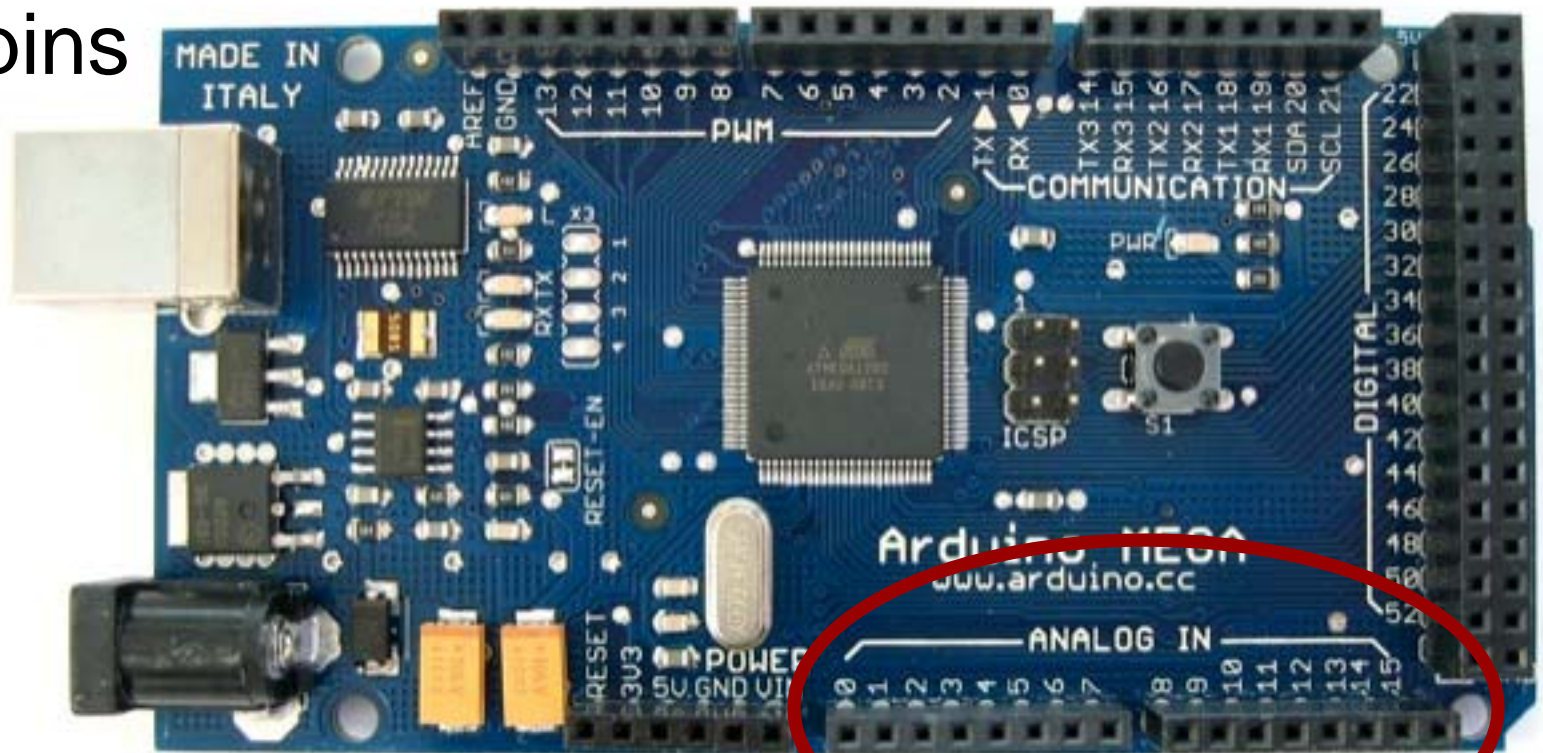
Analog to Digital Conversion

Common approach: successive approximation

1. Set $V_{\text{low}} = 0$; $V_{\text{high}} = 5$
2. Use a D2A converter to produce a voltage guess $V = (V_{\text{low}} + V_{\text{high}})/2$
3. Compare this with the input voltage V_{in}
4. If guess is too low, then set $V_{\text{low}} = V$
5. If guess is too high, then set $V_{\text{high}} = V$
6. Continue with #2 (until $V_{\text{low}} == V_{\text{high}}$)

A2D in the Mega2560

- The mega2560 contains hardware that implements successive approximation
- 16 mega2560 pins can be configured as analog input pins

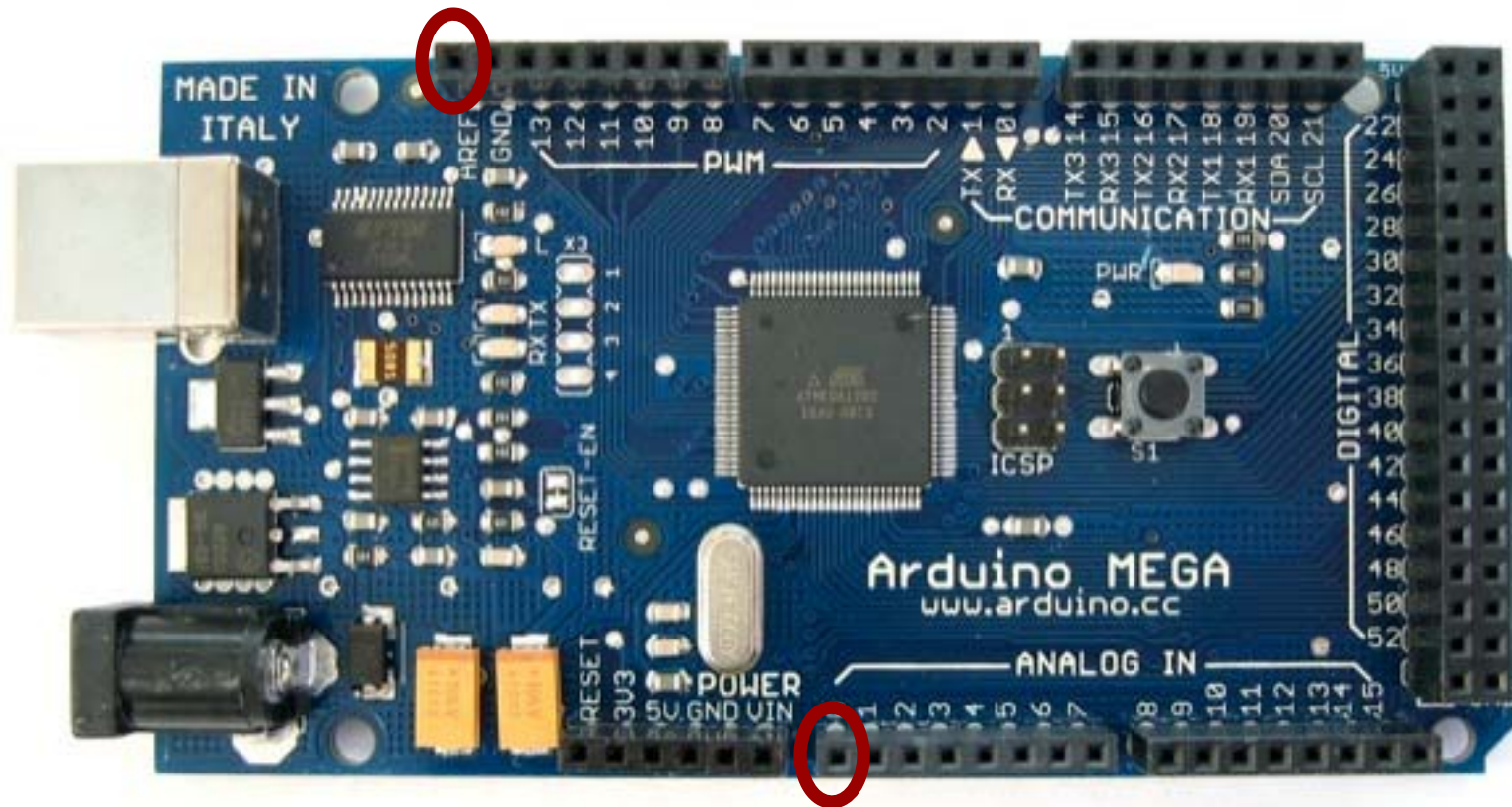


Systems: Analog/Digital

Mega2560: The Connections

AREF: (for our purposes) connect to +5V

- ADC will measure voltages between 0 and AREF



Connect input analog signal to the appropriate ADC pin

A Code Example: Configuration (do this once)

```
// Initialize adc
adc_set_reference(ADC_REF_AREF);           // Use the AREF reference pin
adc_set_adlar(0);                          // For our purposes, always use 0
adc_set_prescalar(ADC_PRESCALAR_128);     // Necessary with 16MHz clock
                                           // and 10 bit resolution

// Turn on ADC Converter
adc_set_enable(ADC_ENABLE);
```

A Code Example: Use

```
uint16_t val;

// Can do the following an arbitrary number of times

adc_set_channel(ADC_CHANNEL_0);          // ADC0
// Actually start a conversion
adc_start_conversion();

<Could go off and do something else for a while>

val = adc_read(); // Read the analog value
```

Analog Conversion Notes

- All functions are provided in oulib
- See OULib documentation for the definition of constants
- Can get to the example code from the Atmel HowTo
www.cs.ou.edu/~fagg/classes/general/atmel

Analog Conversion Notes

- Setting the maximum voltage:

```
adc_set_reference(ADC_REF_AREF);           // Use the AREF reference pin
```

- Can also used a fixed voltage (+2.56V):

```
adc_set_reference(ADC_REF_2p56V);
```

Analog Conversion Notes

- Determining how fast the conversion requires:

```
adc_set_prescalar(ADC_PRESCALAR_128); // Necessary with 16MHz clock  
                                        // and 10 bit resolution
```

- Conversion requires:

$128 * 15 / 16000000$ seconds

- Can convert faster, but may not get the full 10-bit resolution

Analog Conversion Notes

- Reading out the value:

```
val = adc_read();           // Read the analog value
```

- Blocks until conversion is complete
- Will return a value between 0 and 0x3FF (1023)