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Arduino Mega

What is an Arduino Mega?

- The Arduino Mega is a microcontroller development board designed for hobbyists and novices
- It has a custom coding interface (IDE) for creating, uploading, and troubleshooting code
- Multiple online tutorials are available for complex code and advanced development

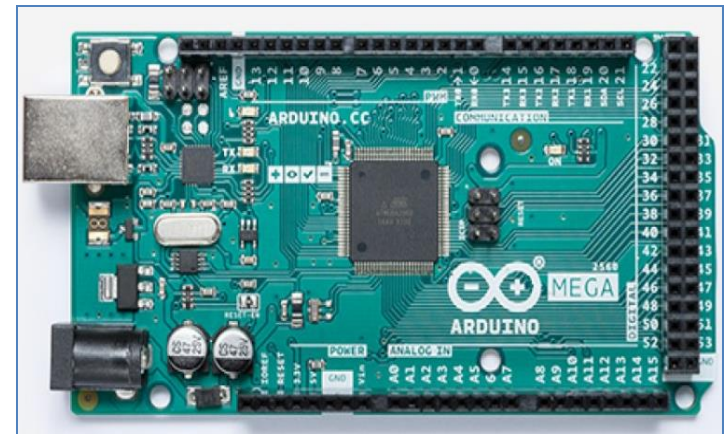


Figure 1: Arduino Mega Development Board



What is a microcontroller?

- A microcontroller (MCU) is an integrated circuit that acts as a tiny computer
- It contains a processor that can send and receive input, memory to store information, and programmable input and output (I/O) pins for working with external devices such as sensors and switches



Figure 2: ATmega2560 microchip



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What is a development board?

- Commercially available printed circuit board (PCB) designed to make it easier to interface with a microcontroller
- Provides minimum hardware for connecting external devices such as a USB adaptor and integrated circuits for voltage regulation
- Provides basic logic for programming and interacting with the device
- Useful for small project design and development

Arduino Development Boards

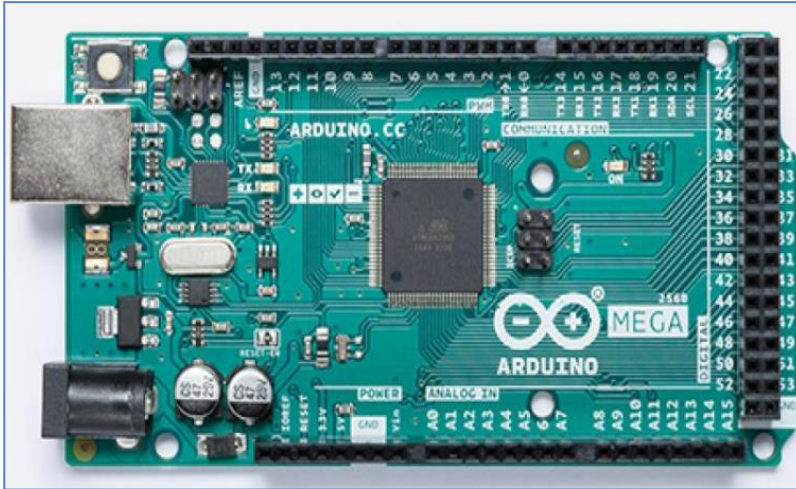


Figure 3: Arduino Mega microcontroller



Figure 5: Arduino Teensy microcontroller

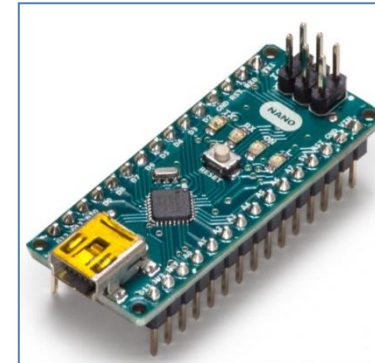


Figure 4: Arduino Nano microcontroller

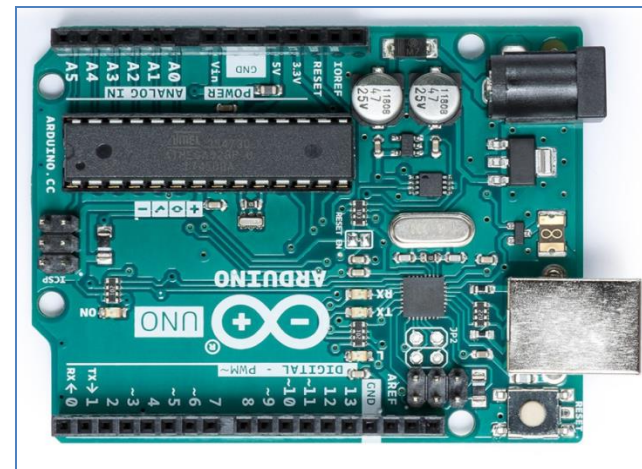


Figure 6: Arduino Uno microcontroller

Other Development Boards

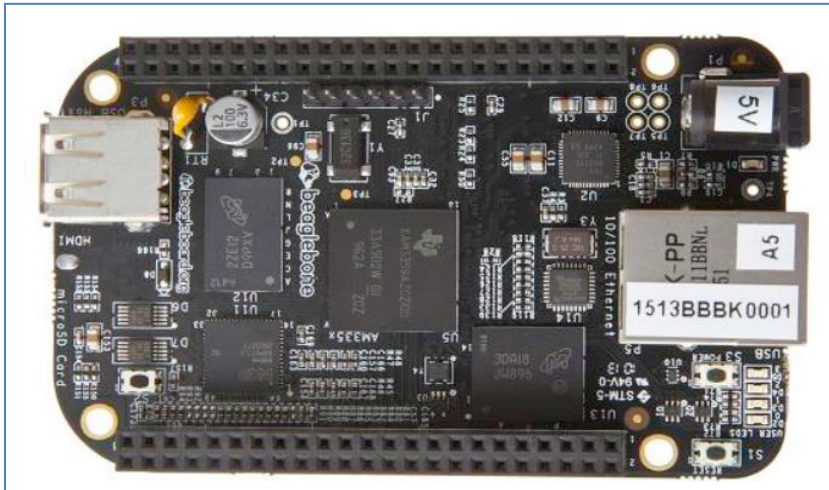


Figure 7: BeagleBone microcontroller



Figure 8: Raspberry Pi microcontroller

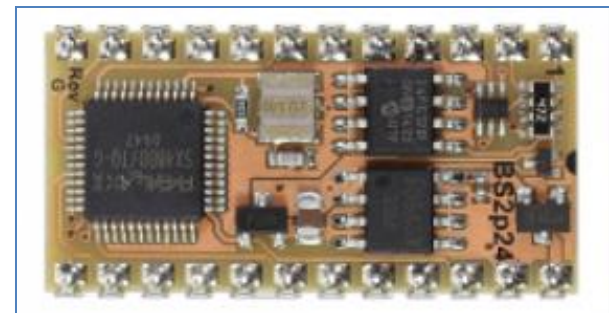


Figure 9: Basic Stamp microcontroller

Arduino Mega Specifications

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16-channel 10-bit
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g
Operating Temperature	-40°C to 85°C

Figure 10: Arduino Mega specifications

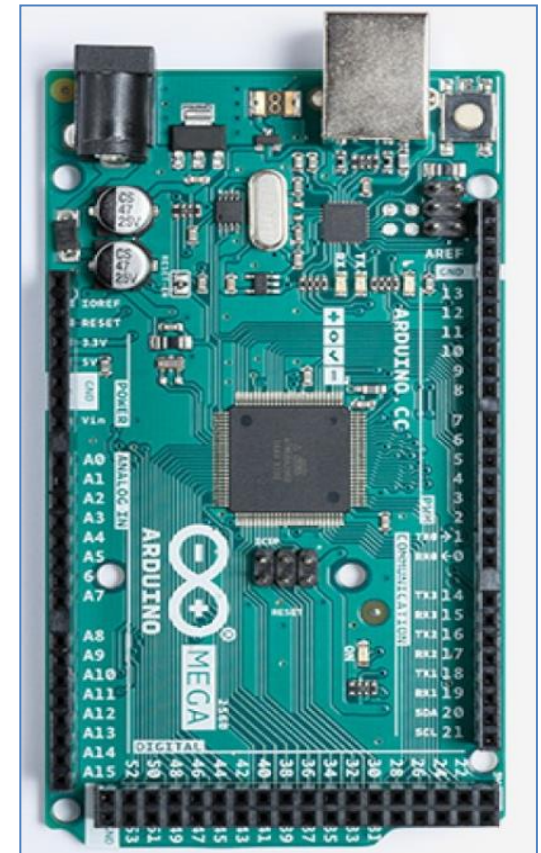


Figure 11: Arduino Mega microcontroller

Powering the Arduino

- The Mega can be powered via USB, battery or AC-to-DC wall adapter
- Recommended supply of 7-12 VDC
- Pin specific:
 - VIN: Provides power via an external supply
 - 5V: Provides a steady 5V supply through the voltage regulator
 - 3V3: Supplies 3.3 V with a maximum current draw of 50 mA
 - All of the I/O pins operate at 5 V and can provide or receive 20 mA (maximum 40 mA)

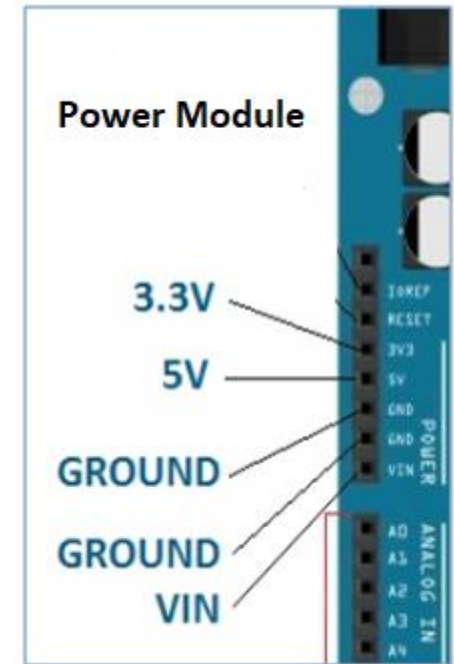


Figure 12: Arduino Mega power module



Memory

- The Mega offers 256 kB of self-programmable flash memory for storing code, with 8 kB dedicated to the bootloader
- It provides 8 kB of static random-access memory (SRAM) for storing variables
- There are 4 kB of electrically erasable programmable read-only memory (EEPROM) that can be used to read or write using the EEPROM library

Interfacing with the Arduino

- Communication with the Mega is achieved using stackable header pins that connect to the internal circuitry of the board.
- Header Pins provide easy access to:
 - Power Inputs/Outputs
 - Analog-to-Digital (ADC) Channels
 - Digital I/O Pins
 - Serial Channels

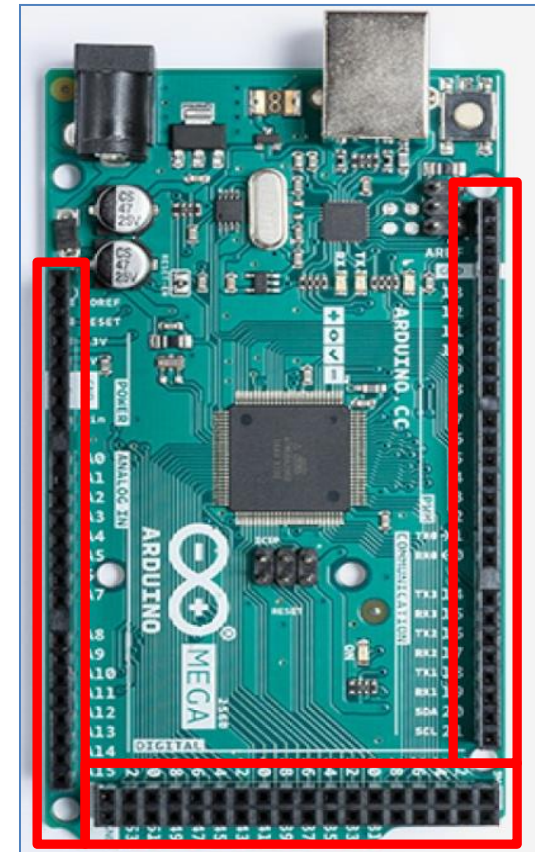


Figure 13: Arduino Mega microcontroller

ADC Channels

- The Mega provides sixteen 5V ADC channels for collecting information from external devices
- Each of the channels can interpret most electric signals below 5V into a digital number called an ADC value
- These values can be saved to variables on the Mega's onboard memory

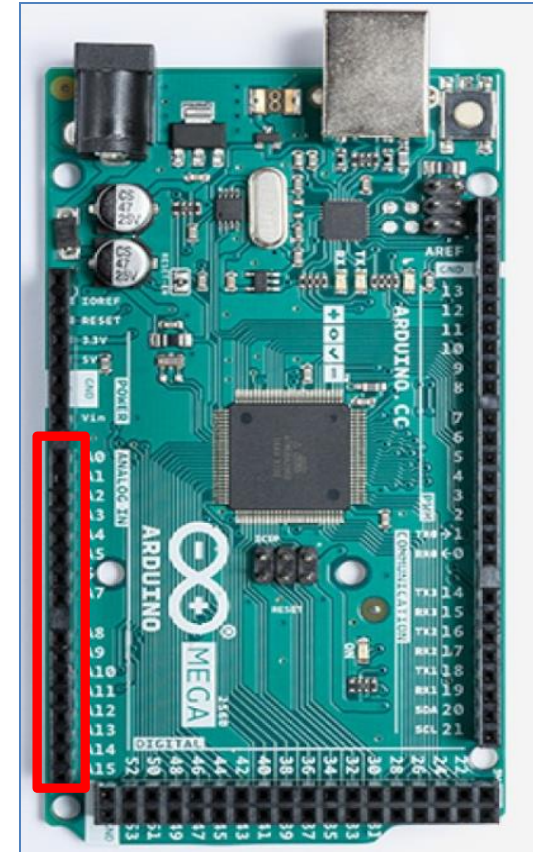


Figure 14: Arduino Mega microcontroller

Digital Input/Output

- The Mega provides 54 digital input/output (I/O) channels
- These allow for digital communication with external devices such as LEDs or switches
- Some channels have dedicated functions such as serial communication, pulse-width modulation (PWM) output, and interrupts

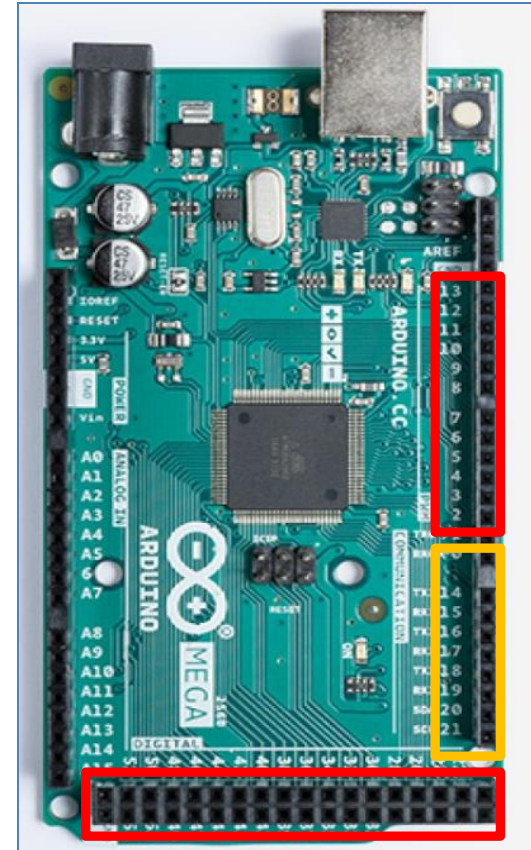


Figure 15: Arduino Mega microcontroller



More Digital I/O Features

- For hardware serial (UART), there are 4 pairs of RX and TX pins to receive and transmit TTL serial data
- SPI is available for MISO, MOSI, SCK and CS using the SPI library
- TWI for SDA and SCL is available using the Wire library with a 5V I²C bus on pins 20 and 21
- The Mega includes 15 PWM pins which provide an 8-bit output using the `analogWrite()` function



Serial Output

Communicating between the computer and Arduino is done by a **serial link**

Creating a serial link allows the computer to receive information stored on the Arduino

It is important that the computer and the Arduino have matching **baud rates**

Baud rates are determined by how many symbols are being transmitted per unit of time

Data transmitted by Serial(note there is no number ie. TX0,RX0) object is transmitted to the USB port

```
void setup () {  
    Serial.begin(9600);  
}
```

Figure 3: Example of setting up a serial link with a 9600 baud rate



Serial Monitor

The **serial monitor** allows users to display text, numbers, and other symbols on the computer screen

It serves as the primary way of viewing your code's output

Can be used to debug code by adding additional serial outputs at key points within the code (such as before and after a series of mathematical operations)

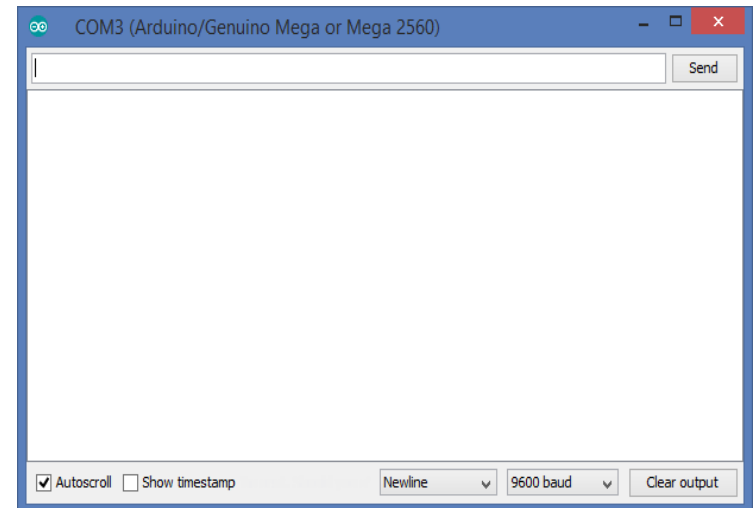


Figure 4: Arduino Serial Monitor display

Arduino Shields

- Shields are modular circuit boards designed to piggyback onto the Arduino in order to increase functionality of the microcontroller
- The MegaSat was designed as a shield to attach directly to the Arduino Mega

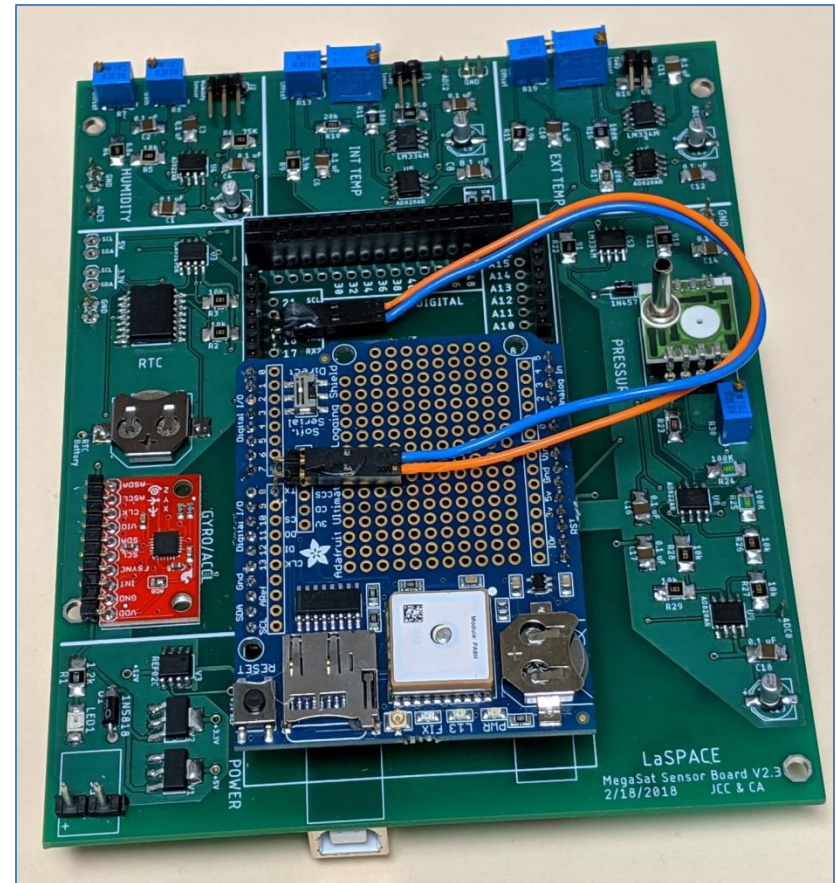


Figure 16: MegaSat prototype shield connected to an Arduino Mega



Troubleshooting

- Power
 - Supplying less than 7 V may cause the 5 V pins to drop too low which can create instability
 - Supplying over 20 V may damage the voltage regulator and cause the circuit to overheat
- Connections
 - Refer to datasheets to ensure proper wiring
- Programming
 - Ensure correct libraries, keywords, pin selection, syntax (more details provided in coding lecture)



Prototyping with Arduino

- Arduino Playground is a great place to start
 - Sample code
 - Project ideas
 - Community forums to share and explore
- Visit <https://playground.arduino.cc/>



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Useful References

- <https://www.microchip.com/wwwproducts/en/ATmega2560>
- <https://www.raspberrypi.org/products/raspberry-pi-zero/>
- <https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/>
- <https://beagleboard.org/bone>
- <https://www.parallax.com/catalog/microcontrollers/basic-stamp>
- <https://store.arduino.cc/arduino-mega-2560-rev3>
- <https://www.arduino.cc/en/products/compare>
- https://www.digikey.com/product-detail/en/adafruit-industries-llc/3295/1528-1787-ND/6238007?WT.srch=1&gclid=Cj0KCQjA_s7fBRDrARIsAGEvF8QAFYj_JyCsqkJJ1XszRI-9ANImmMkU4PB0q9k-idBikTjR7K_eDMaAoA-EALw_wcB
- <https://www.engineersgarage.com/blogs/comparison-between-serial-communication-protocols-spi-i2c-uartusrt-0>
- www.circuitstoday.com
- <https://learn.sparkfun.com/tutorials/arduino-shields/all>
- <http://blog.sparkfuneducation.com/a-guide-to-development-boards-for-educators-microprocessors-vs-microcontrollers>