https://www.halvorsen.blog

Arduino and DAC

Digital to Analog Converter (DAC)

Hans-Petter Halvorsen

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Introduction

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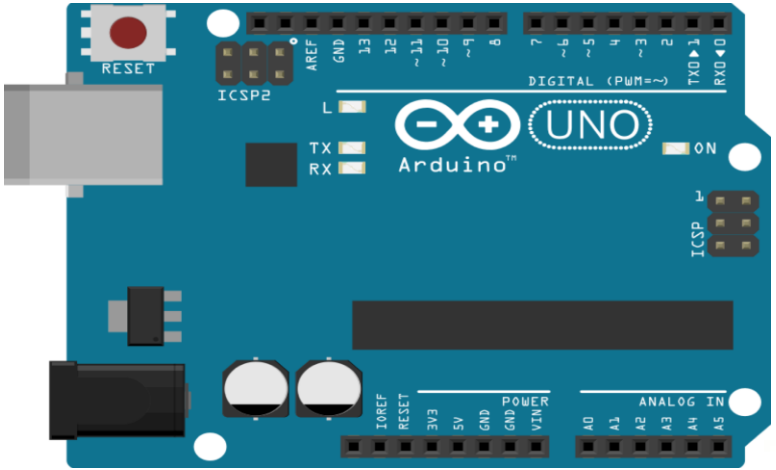
DAC

- DAC – Digital to Analog Converter
- A DAC IC (Integrated Circuit) is used to convert from a Digital Signal to an Analog Signal
- Different terms used: DAC, D/A, D2A, D-to-A
- In this tutorial a MCP4911 IC will be used, but lots of similar ICs can be used

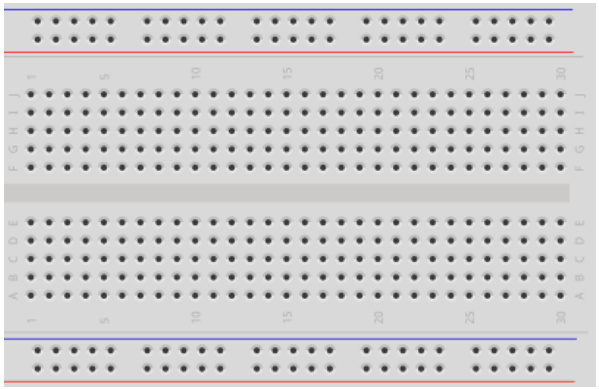
Why DAC?

- **Arduino UNO** R3 has no Analog Output channels
- We can then use the **SPI** bus (or I2C bus) available on the Arduino together with a commercial DAC chip to create our own Analog Out signal
- In this Tutorial I will use a **MCP4911** DAC chip (but many other similar chips exists)

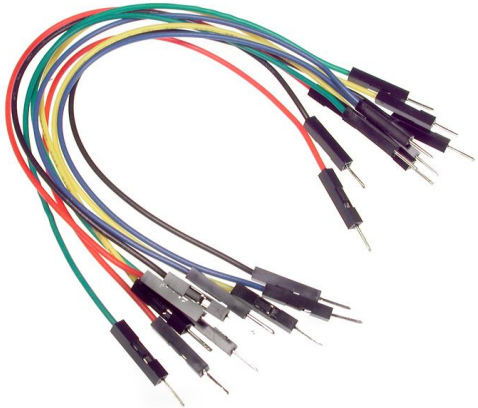
Equipment



Arduino



Breadboard



Wires

MCP4911 DAC

Arduino

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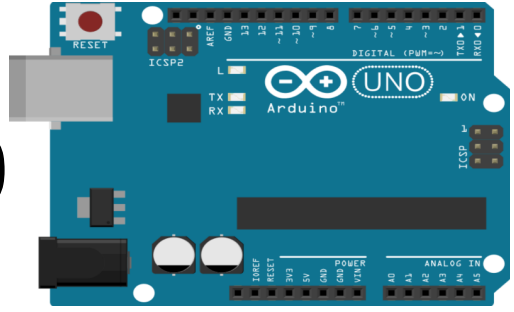
Arduino

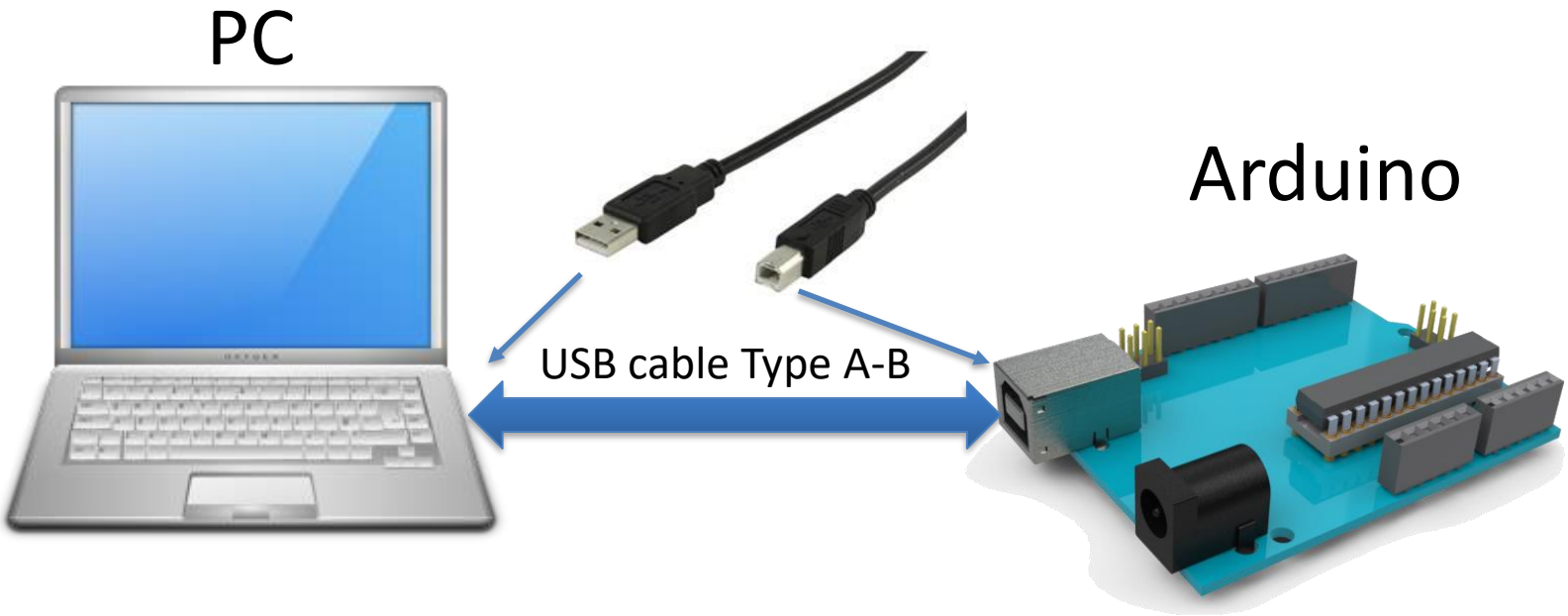
- Arduino is an open-source electronics platform based on easy-to-use hardware and software.
- It's intended for anyone making interactive projects, from kids to grown-ups.
- You can connect different Sensors, like Temperature, etc.
- It is used a lots in Internet of Things projects
- Homepage: https://www.arduino.cc

Arduino

- Arduino is a Microcontroller
- Arduino is an open-source platform with Input/Output Pins (Digital In/Out, Analog In and PWM)
- Price about $20
- Arduino Starter Kit ~$40-80
  with Cables, Wires, Resistors, Sensors, etc.



Connect Arduino to your PC



Arduino Software

Upload Code to Arduino Board

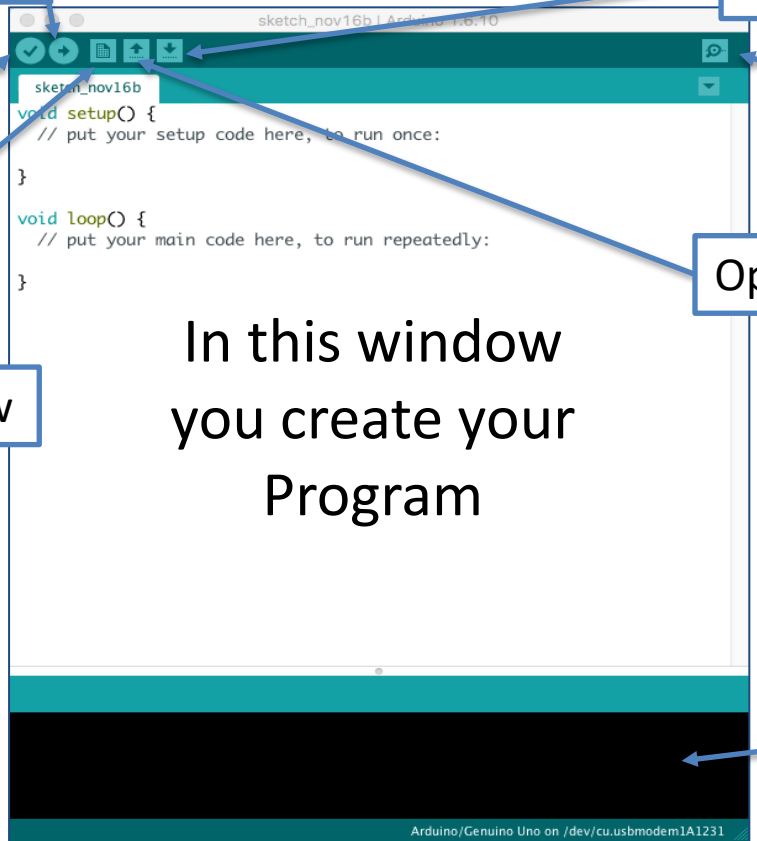
Save

Open Serial Monitor

Compile and Check if Code is OK

Open existing Code

Creates a New Code Window



Error Messages can be seen here

The software can be downloaded for free:

www.arduino.cc

Arduino Programs

All Arduino programs must follow the following main structure:

```
// Initialization, define variables, etc.

void setup()
{
      // Initialization
      ...
}

void loop()
{
      //Main Program
      ...
}
```

DAC

Digital to Analog Converter (DAC)

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DAC

- Lots of different DAC ICs do exist
- IC – Integrated Circuit
- We will use **MCP4911** in this Tutorial

MCP4911

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MCP49xx

MCP49xx is a family of DAC Ics:

- MCP4901: 8-Bit Voltage Output DAC
- MCP4911: 10-BitVoltage Output DAC
- MCP4921: 12-Bit Voltage Output DAC

The different MCP49xx DACs work in the same manner, the only difference is the resolution (8, 10, or 12 resolution)

MCP4911

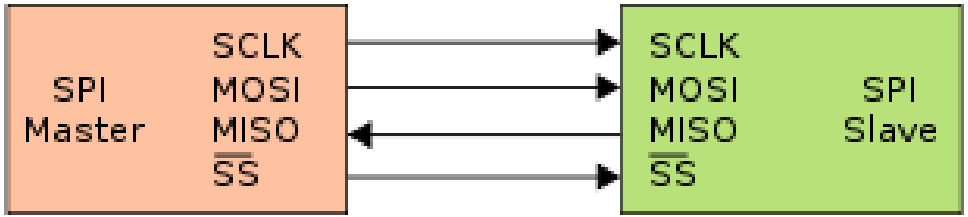
10-Bit Single Output DAC with SPI

- 10-bit resolution (2^10=1024)
- It comes in many packages, the one used in this tutorial is a breadboard-friendly version (8-pin DIP/DIL IC)

https://www.microchip.com/en-us/product/MCP4911

SPI

- Serial Peripheral Interface (SPI)
- SPI is a synchronous serial data protocol used by microcontrollers for communicating with one or more peripheral devices quickly over short distances.

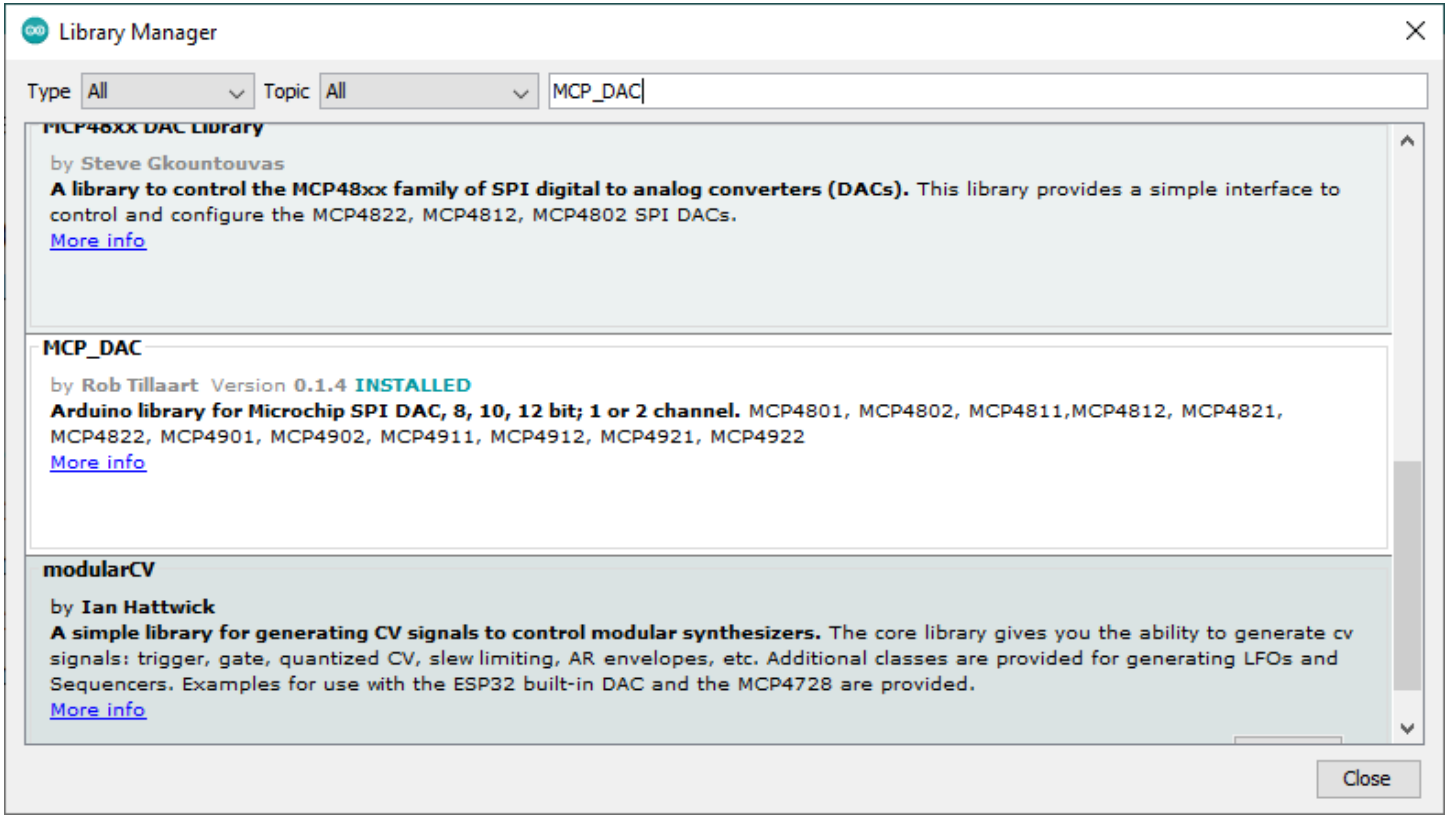


MCP49xx Libraries

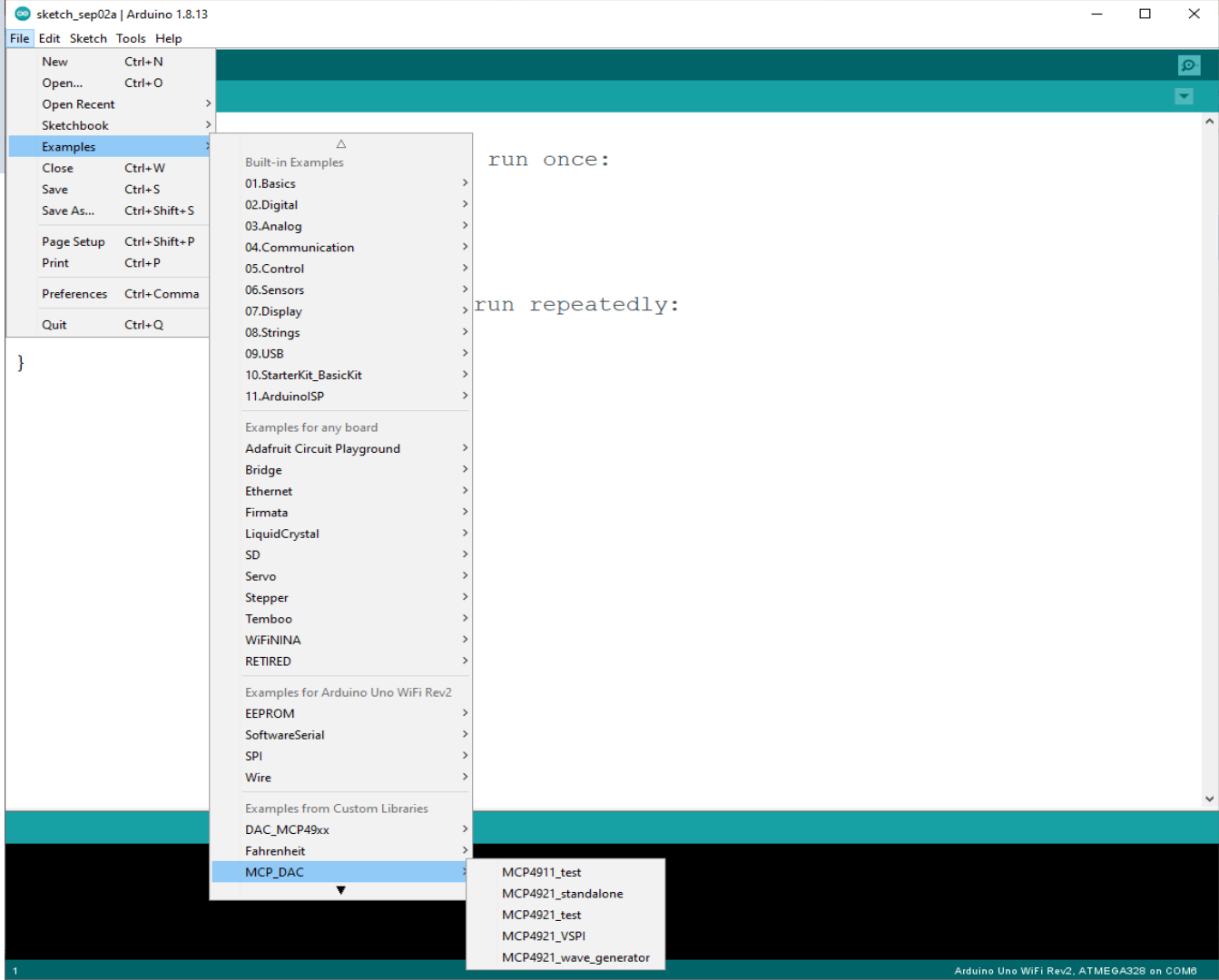
- Different Arduino Libraries for the MCP49xx family exists
- In this tutorial the “**MCP_DAC**” library will be used.
- To use this library, open the **Library Manager** in the Arduino IDE and install it from there.
- https://www.arduino.cc/reference/en/libraries/mcp_dac/

Install the MCP_DAC Library

Tools -> Manage Libraries…

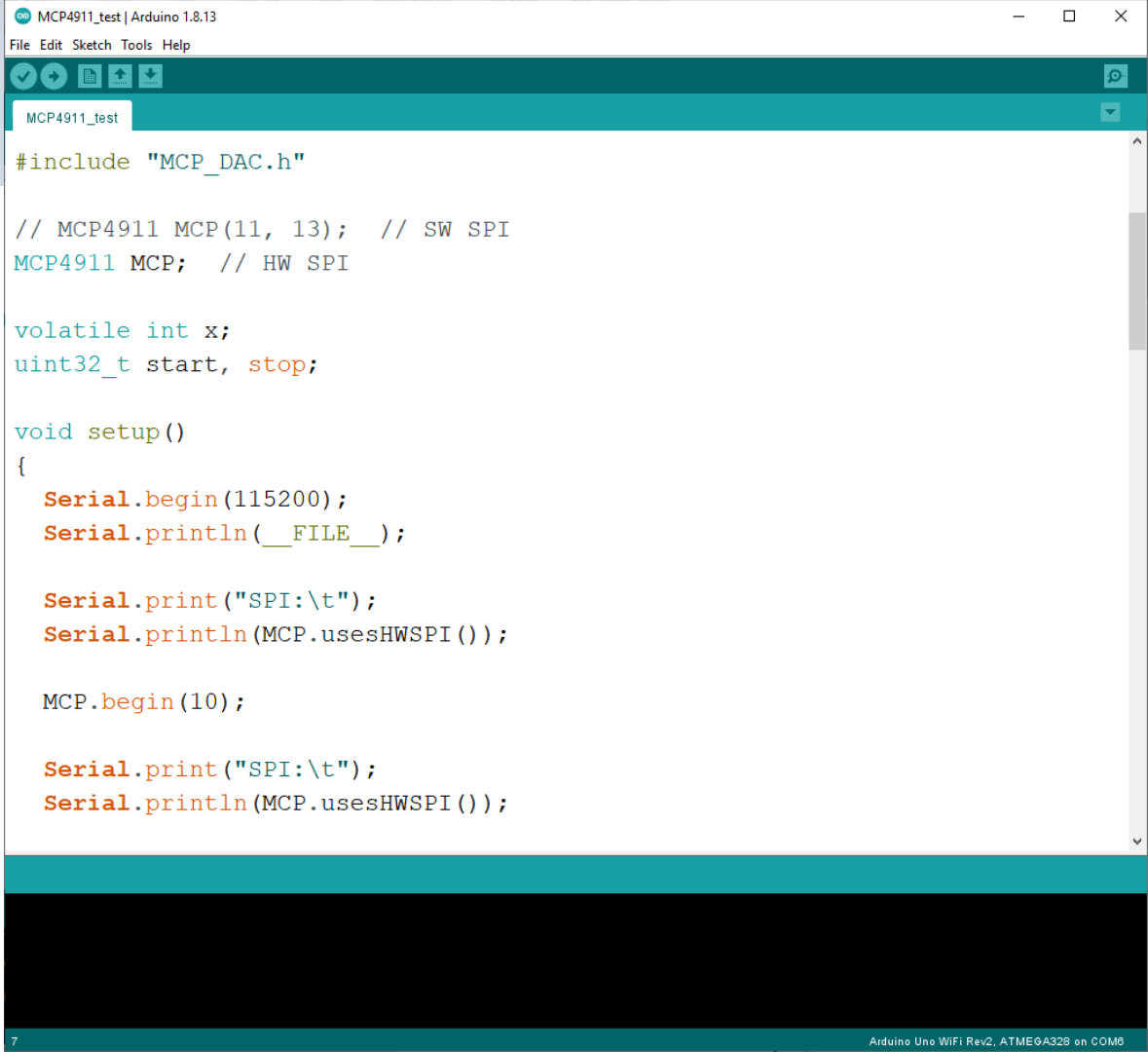


Examples


sketch_sep02a | Arduino 1.8.13
File Edit Sketch Tools Help
New Ctrl+N
Open... Ctrl+O
Open Recent
Sketchbook
Examples
Close Ctrl+W
Save Ctrl+S
Save As... Ctrl+Shift+S
Page Setup Ctrl+Shift+P
Print Ctrl+P
Preferences Ctrl+Comma
Quit Ctrl+Q
run once:
run repeatedly:
}
Built-in Examples
01.Basics
02.Digital
03.Analog
04.Communication
05.Control
06.Sensors
07.Display
08.Strings
09.USB
10.StarterKit_BasicKit
11.ArduinoISP
Examples for any board
Adafruit Circuit Playground
Bridge
Ethernet
Firmata
LiquidCrystal
SD
Servo
Stepper
Temboo
WiFiNINA
RETIRED
Examples for Arduino Uno WiFi Rev2
EEPROM
SoftwareSerial
SPI
Wire
Examples from Custom Libraries
DAC_MCP49xx
Fahrenheit
MCP_DAC
MCP4911_test
MCP4921_standalone
MCP4921_test
MCP4921_VSPI
MCP4921_wave_generator
1
Arduino Uno WiFi Rev2, ATMEGA328 on COM6

Examples

We can use the “MCP4911_test” Example as a starting point for our application.



Examples

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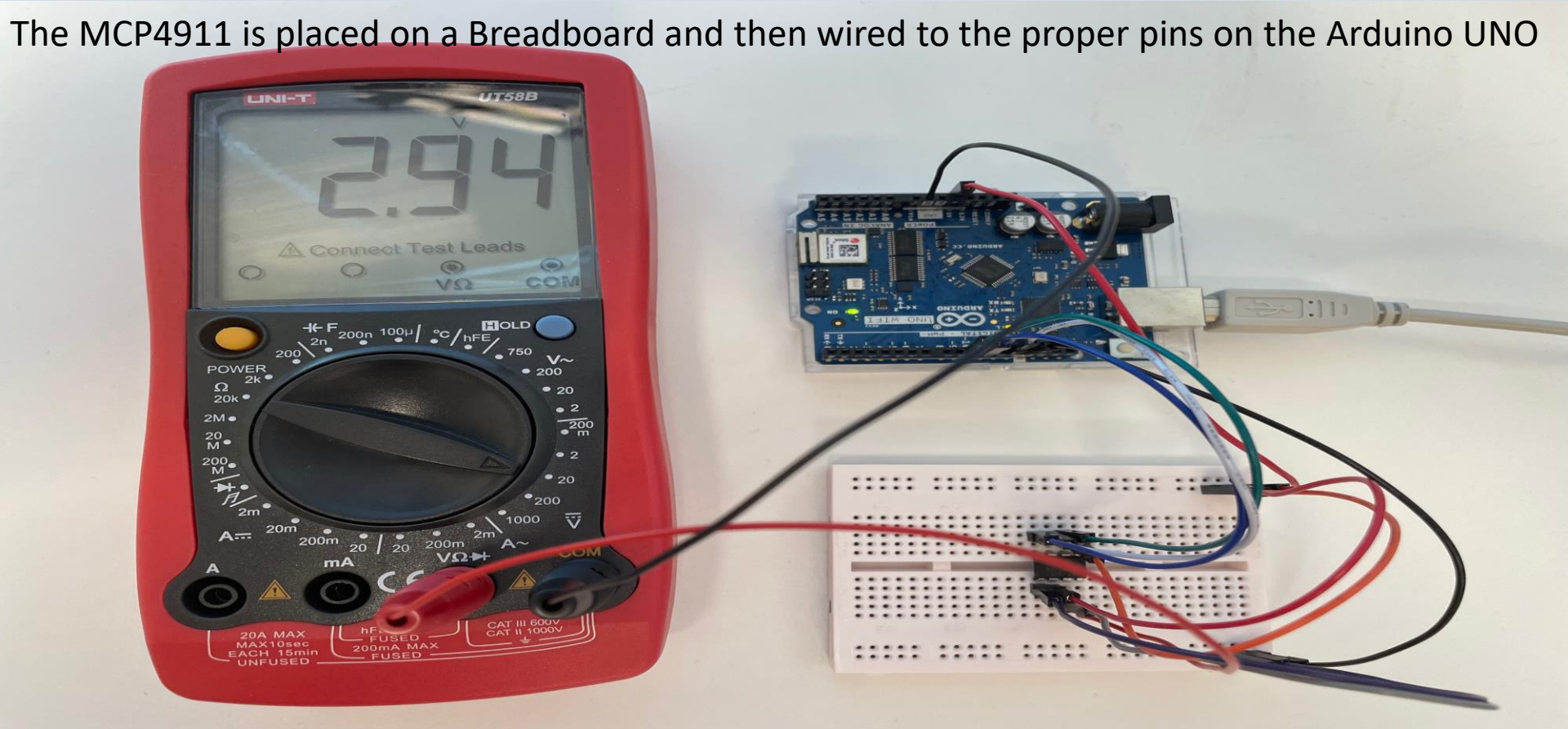
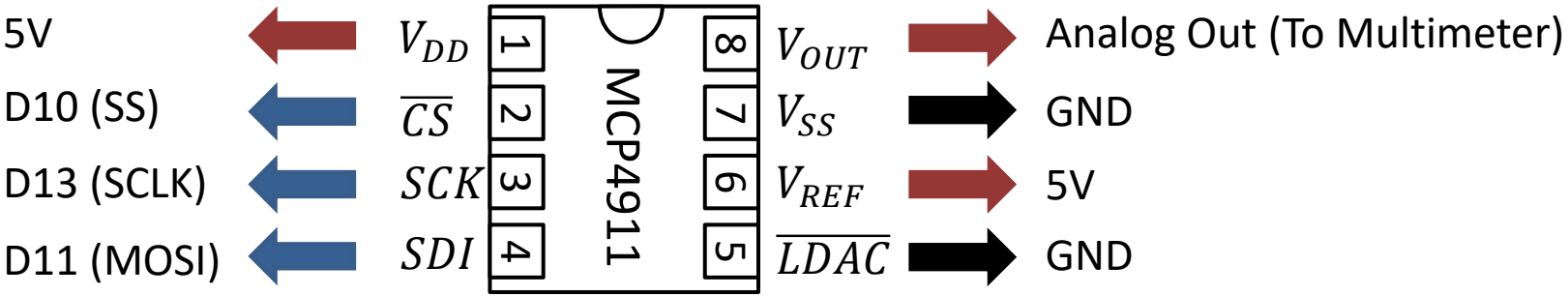
Hardware Wiring

The MCP4911 is placed on a Breadboard and then wired to the proper pins on the Arduino UNO



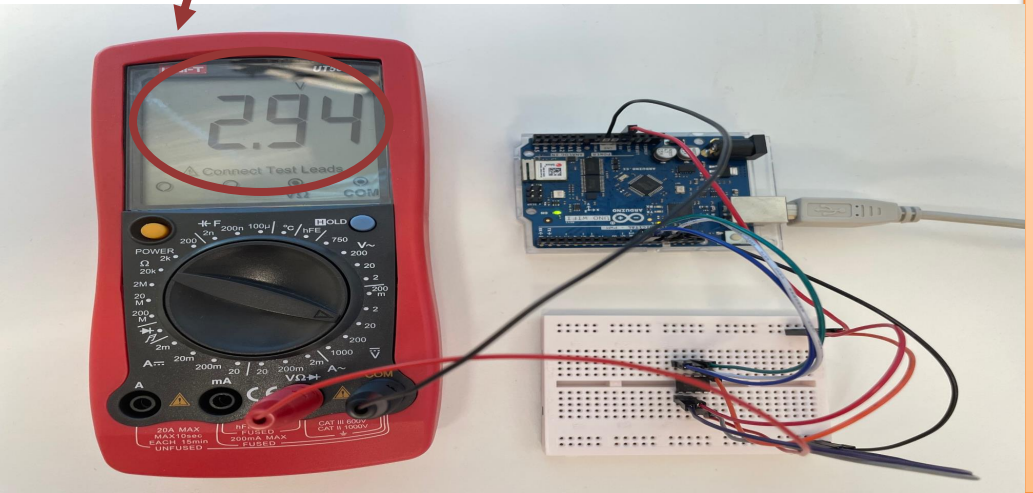
Hardware Wiring



Arduino Example

Use a Multimeter and observe the Analog Output Value

Note! The “analogWrite()” function has been renamed to just “write()”.




```
#include "MCP_DAC.h"

MCP4911 MCP(11, 13);
uint16_t value = 0;

void setup()
{
  MCP.begin(10);
  delay(100);
}

void loop()
{
  value = 0;
  MCP.write(value, 0);
  delay(5000);

  value = 512;
  MCP.write(value, 0);
  delay(5000);
}
```

Example #2

Here a separate function is created and used.

Use a Multimeter and observe the Analog Output Value

```
#include "MCP_DAC.h"

MCP4911 MCP(11, 13);
uint16_t value = 0;

void setup()
{
  MCP.begin(10);
  delay(100);
}

void loop()
{
  WriteDAC(0);
  WriteDAC(128);
  WriteDAC(255);
  WriteDAC(512);
  WriteDAC(1023);
}

void WriteDAC(uint16_t value)
{
  MCP.write(value, 0);
  delay(5000);
}
```

Example #2b

Here a separate function is created and used.

In addition, a For Loop has been used.

Use a Multimeter and observe the Analog Output Value.

```
#include "MCP_DAC.h"

MCP4911 MCP(11, 13);
uint16_t value = 0;

void setup()
{
  MCP.begin(10);
  delay(100);
}

void loop()
{
  for (int i=0; i<1024; i=i+50)
  {
    WriteDAC(i);
    delay(100);
  }
}

void WriteDAC(uint16_t value){
  MCP.write(value, 0);
  delay(5000);
}
```

Example #3

In this Example the Values are also written to the **Serial Monitor**.

```
#include "MCP_DAC.h"

MCP4911 MCP(11, 13);

void setup()
{
  Serial.begin(9600);
  MCP.begin(10);
  delay(100);
}

void loop()
{
  WriteDAC(0);
  WriteDAC(1);
  WriteDAC(2);
  WriteDAC(3);
  WriteDAC(4);
  WriteDAC(5);
}
```

```
void WriteDAC(float voltValue)
{
  uint16_t adcValue;
  adcValue = (voltValue*1023)/5;
  if (adcValue < 0)
  {
    adcValue = 0;
  }
  if (adcValue > 1023)
  {
    adcValue = 1023;
  }
  Serial.print("V=");
  Serial.print(voltValue);
  Serial.print(", ADC=");
  Serial.println(adcValue);
  MCP.write(adcValue, 0);
  delay(5000);
}
```

Summary

- Arduino UNO R3 has no Analog Output pins, only Analog Input pins and Digital Input/Output pins
- Now you have learned how you can extend the Arduino UNO R3 with Analog Output
- Good Luck with your Arduino Projects

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