Marc Eberhard – OMB-5


# Analog/Digital & Serial/Parallel

Communication and Connection

Marc Eberhard – OMB-5

# Content

Analog/Digital and Serial/Parallel

## Analog / Digital

- Basics of Analog and Digital
- ADC / DAC Ports

## Parallel / Serial

- Basics of Parallel and Serial
- Comparison

Example – 7-Segment-Display and Shift Register


# Analog / Digital

Communication and Connection

# Analog / Digital

Communication and Connection



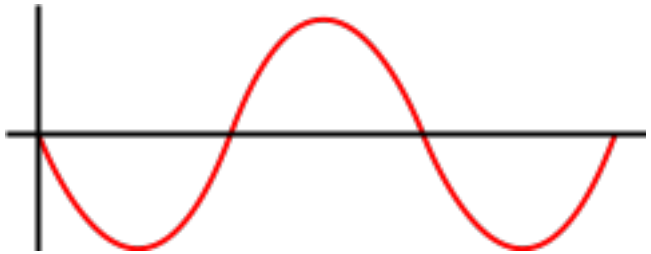
Marc Eberhard – OMB-5

** Sparkfun, „Analog vs. Digital“ https://learn.sparkfun.com/tutorials/analog-vs-digital/all, Accessed, 30. Apr 2021*

# Analog / Digital

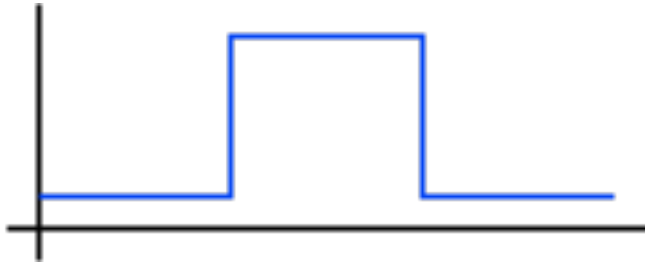
Communication and Connection

## ANALOG



Values between e. g. 0 V and 3,3 V

## DIGITAL



Only discrete values ( 1/0 :: ON/OFF :: HIGH/LOW )

Marc Eberhard – OMB-5

* *Elektronik Kompendium, „Analog und Digital (Übertragungstechnik)“ https://www.elektronik-kompendium.de/sites/kom/2405151.htm, Accessed, 30. Apr 2021*

# Analog / Digital

Communication and Connection

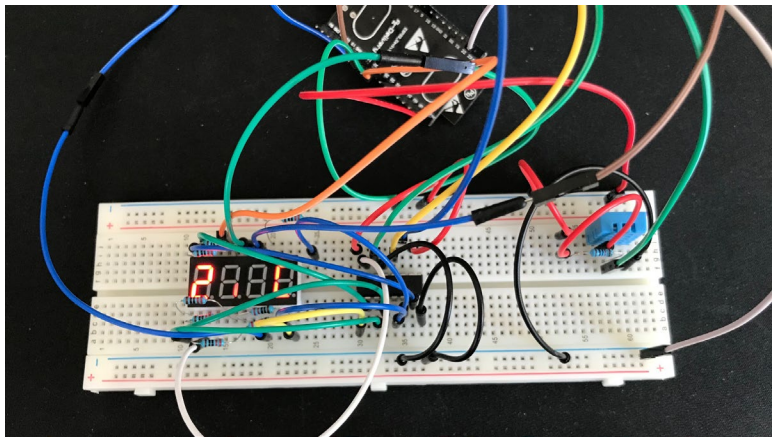
## ANALOG

Most of the electronic components are inherently analog

- Resistors, capacitors, diodes, transistors, …
- Sensors like temperature, humidity, …

## DIGITAL

ESP works internal only with digital values.





* Sparkfun, „Analog vs. Digital“ https://learn.sparkfun.com/tutorials/analog-vs-digital/all, Accessed, 30. Apr 2021

# Analog / Digital – **ADC and DAC**

Communication and Connection

ESP works internal only with digital values.

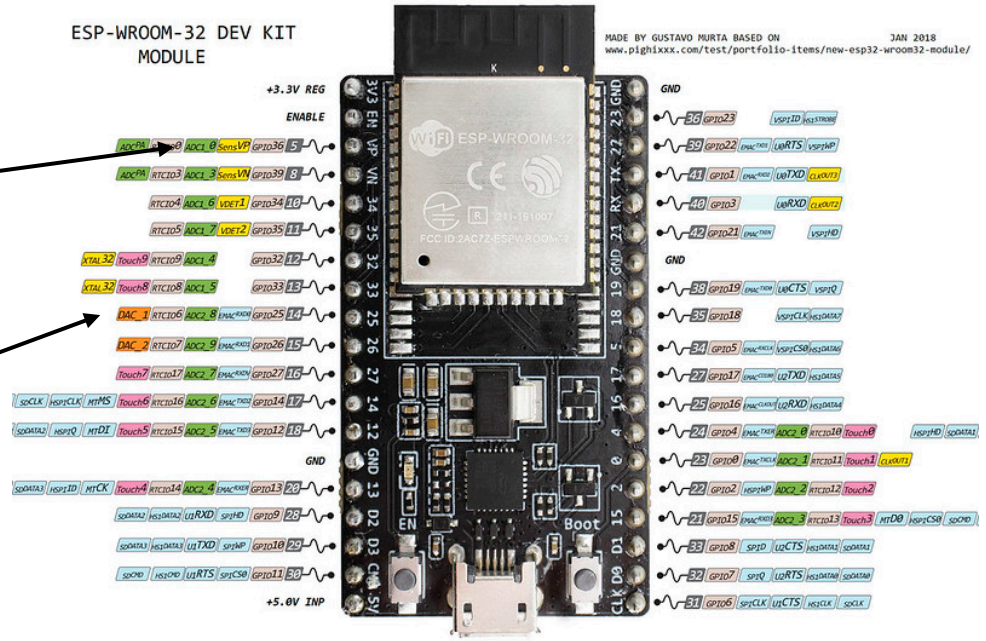
→ Analog values needs to be converted.

ADC – Analog to Digital Converter (ADC1 und ADC2)

- 16 ADC Pins - Input
- 12 Bit Resolution -> Value between 0-4095
- ADC2 can only be used if no Wifi has been started

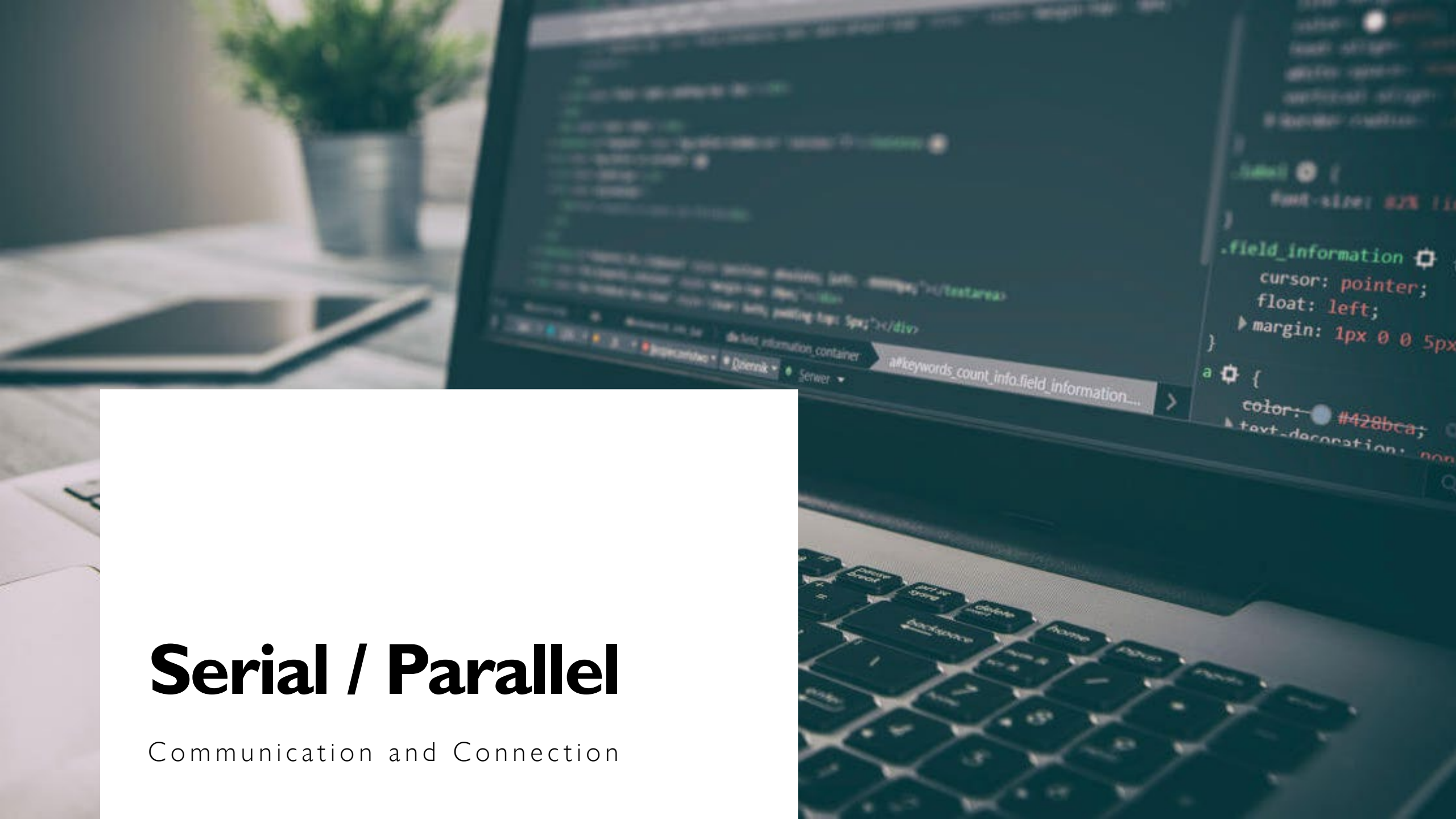
DAC – Digital to Analog Converter

- 2 DAC Pins (25 and 26) - Output
- 8 Bit Resolution -> Value between 0-255




Marc Eberhard – OMB-5

* Flickr, „ESP-WROOM-32 DEVKIT V4 pinout". https://www.flickr.com/photos/jgustavoam/40089095211/in/photostream/, Accessed, 30. Apr 2021
* Random Nerd Tutorials, „ESP32 ADC – Read Analog Values with Arduino IDE". https://randomnerdtutorials.com/esp32-adc-analog-read-arduino-ide//, Accessed, 04. May 2021



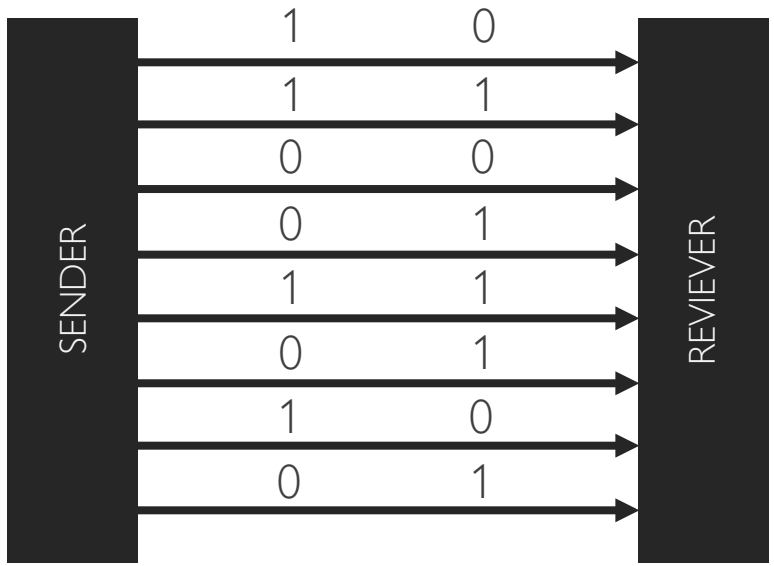

# Serial / Parallel

Communication and Connection

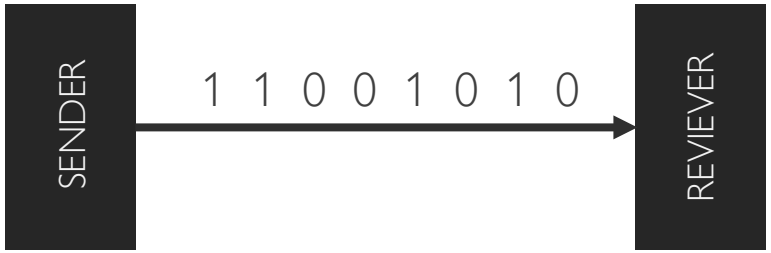
# Serial / Parallel

Communication and Connection

PARALLEL




SERIAL



# Serial / Parallel - **Comparison**

Communication and Connection

## PARALLEL

- 8 bits transferred at one clock pulse.
- Fast in comparison to serial

### Is used when:

- large amount of data is being sent
- the data being sent is time-sensitive
- the data needs to be sent quickly

## SERIAL

- One bit at one clock pulse.
- Slow in comparison to parallel
- Less noise and more reliable

### Is used when:

- there is a long distance

Marc Eberhard – OMB-5

* geeksforgeeks, „Difference between Serial and Parallel Transmission". https://www.geeksforgeeks.org/difference-between-serial-and-parallel-transmission/ , Accessed, 30. Apr 2021
* TechDifferences, „Difference between Serial and Parallel Transmission". https://techdifferences.com/difference-between-serial-and-parallel-transmission.html, Accessed, 01. May 2021
* TotalPhase, „What are the Differences Between Serial and Parallel Communication?". https://www.totalphase.com/blog/2020/10/differences-between-serial-parallel-communication/, Accessed, 04. May 2021

# Serial / Parallel - **Comparison**

Communication and Connection

Marc Eberhard – OMB-5

* geeksforgeeks, „Difference between Serial and Parallel Transmission". https://www.geeksforgeeks.org/difference-between-serial-and-parallel-transmission/ , Accessed, 30. Apr 2021
* TechDifferences, „Difference between Serial and Parallel Transmission". https://techdifferences.com/difference-between-serial-and-parallel-transmission.html, Accessed, 01. May 2021
* TotalPhase, „What are the Differences Between Serial and Parallel Communication?". https://www.totalphase.com/blog/2020/10/differences-between-serial-parallel-communication/, Accessed, 04. May 2021

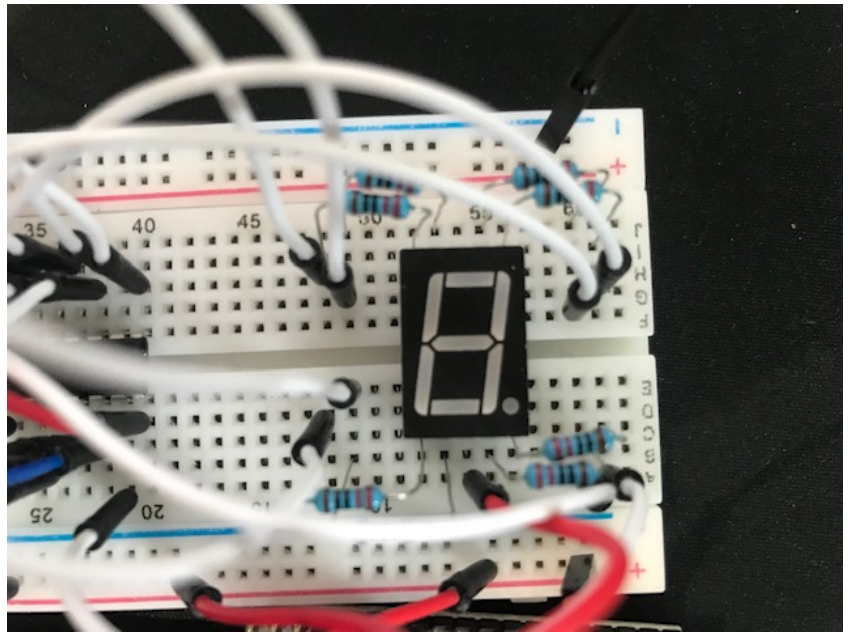

# Example

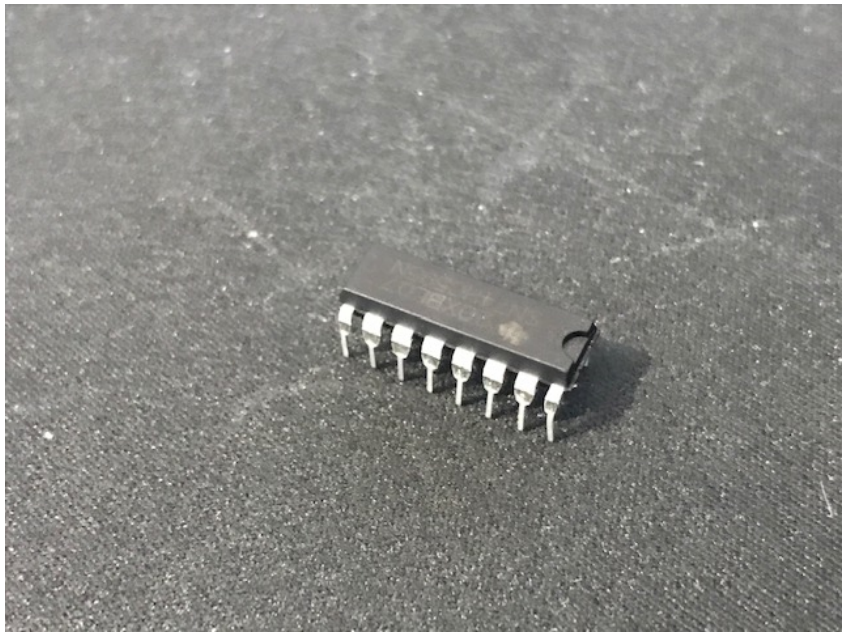
Communication and Connection

# Example

Communication and Connection

## 7 Segment Display with Shift Register





# Example

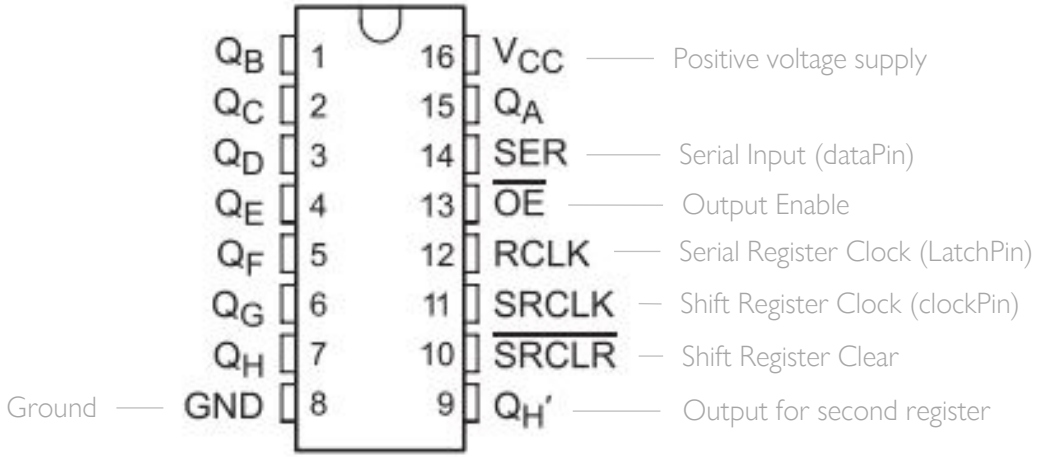
Communication and Connection

## Serial to Parallel Shifting

- With shifting register **74HC595**
- 3 Inputs and 8 Outputs

## Usage

- To less ports
- Seven Segment Display or 8 LEDs

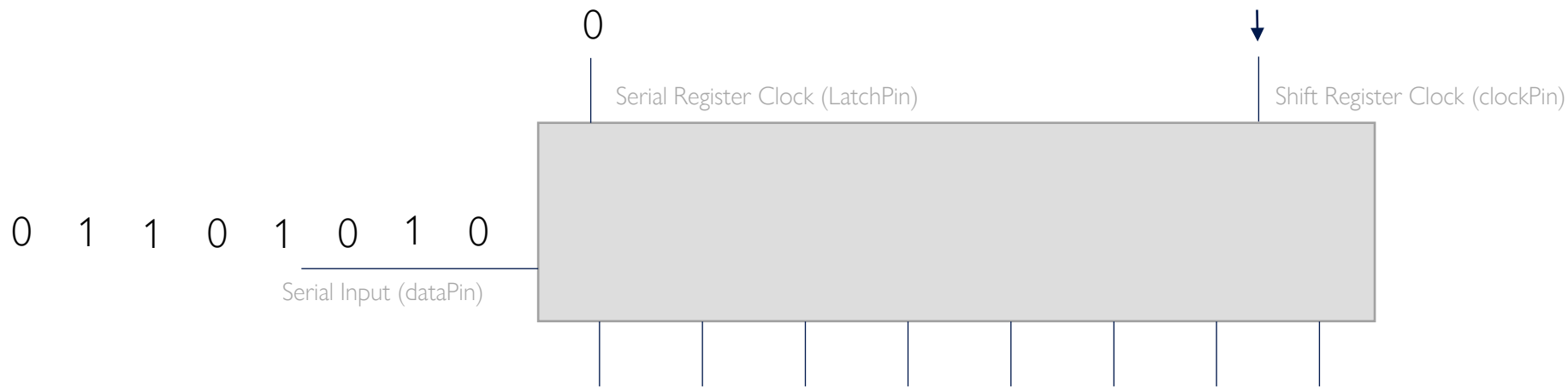



Marc Eberhard – OMB-5

** Microcontroller-blog, „Wie ein 74HC595 Schieberegister mit Arduino funktioniert" http://mikrocontroller-blog.de/tutorials/wie-ein-74hc595-schieberegister-mit-arduino-funktioniert/, Accessed, 30. Apr 2021*

# Example

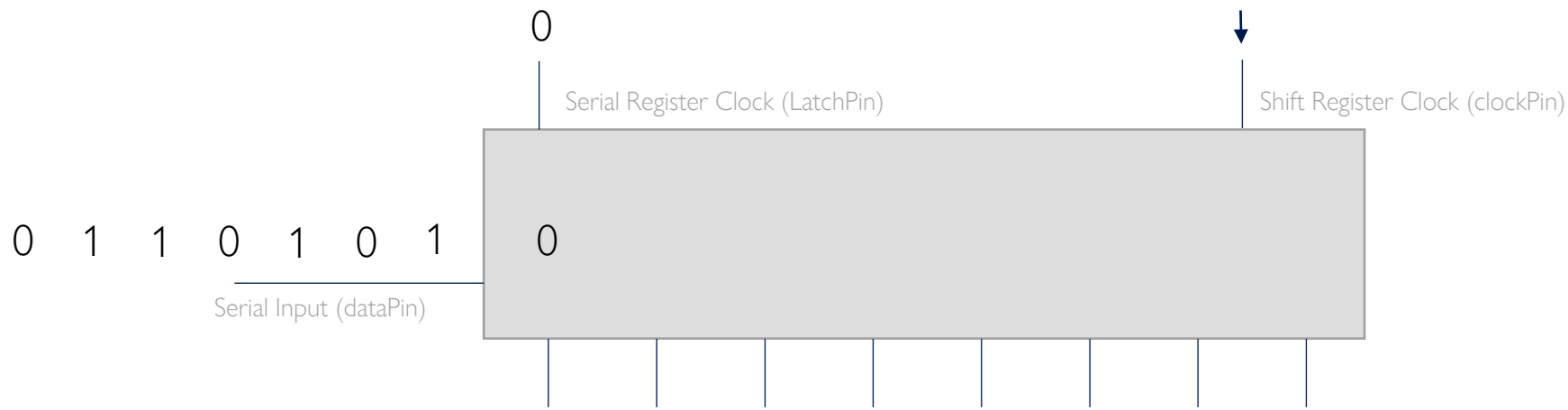
Communication and Connection




Marc Eberhard – OMB-5

# Example

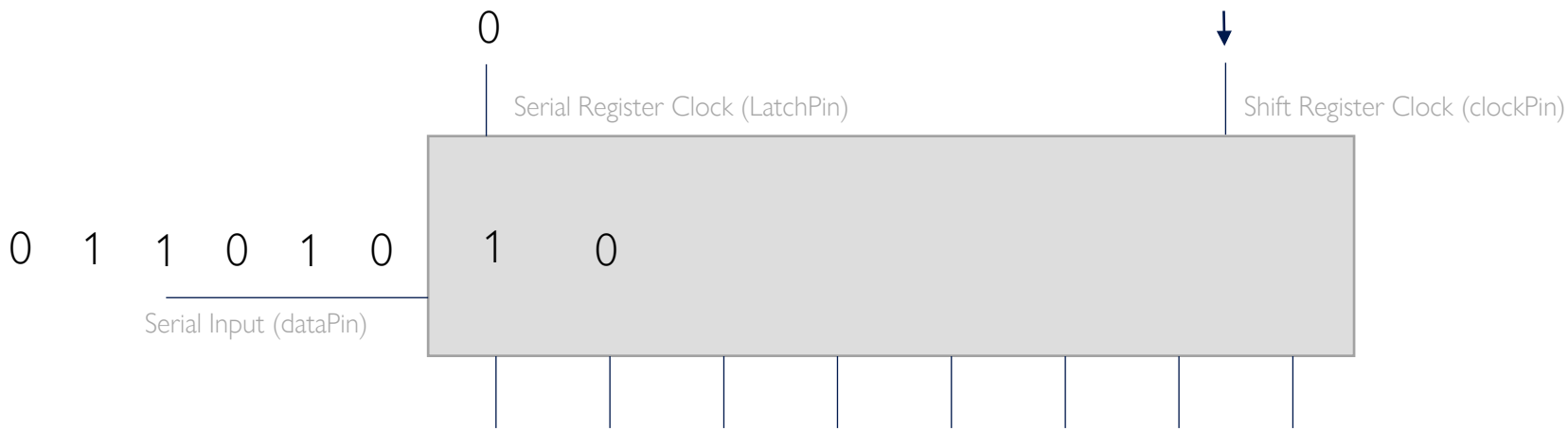
Communication and Connection




Marc Eberhard – OMB-5

# Example

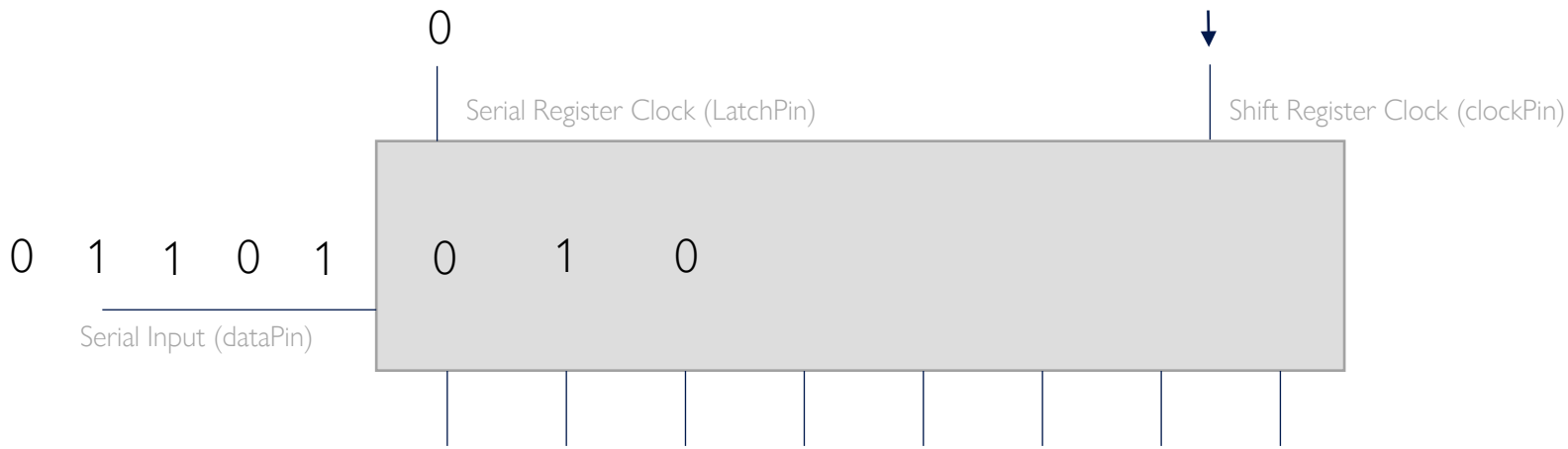
Communication and Connection




Marc Eberhard – OMB-5

# Example

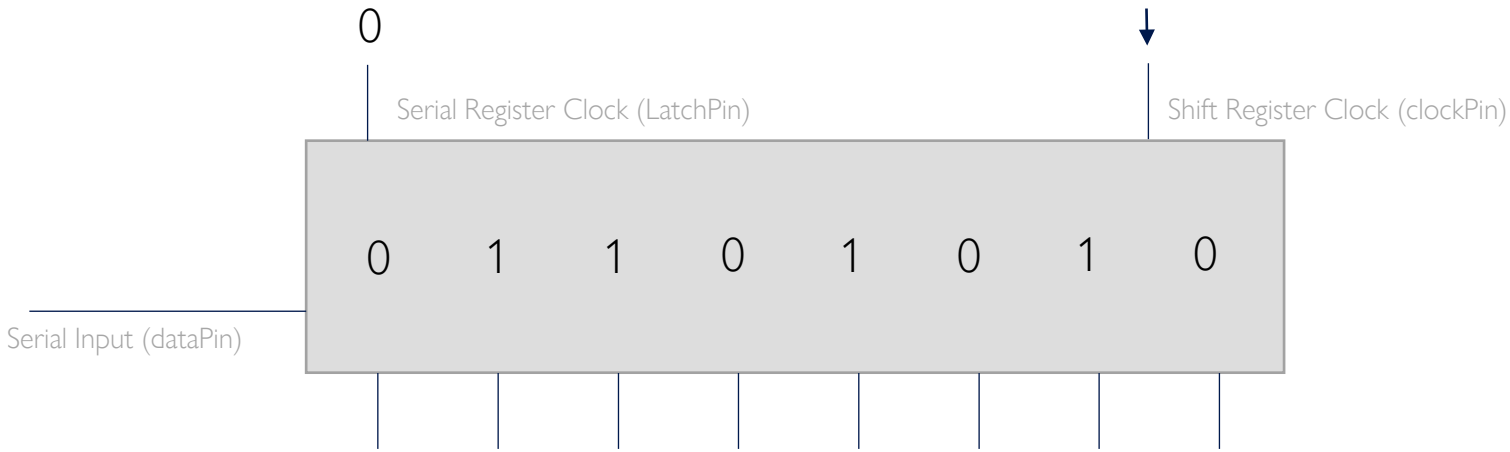
Communication and Connection




Marc Eberhard – OMB-5

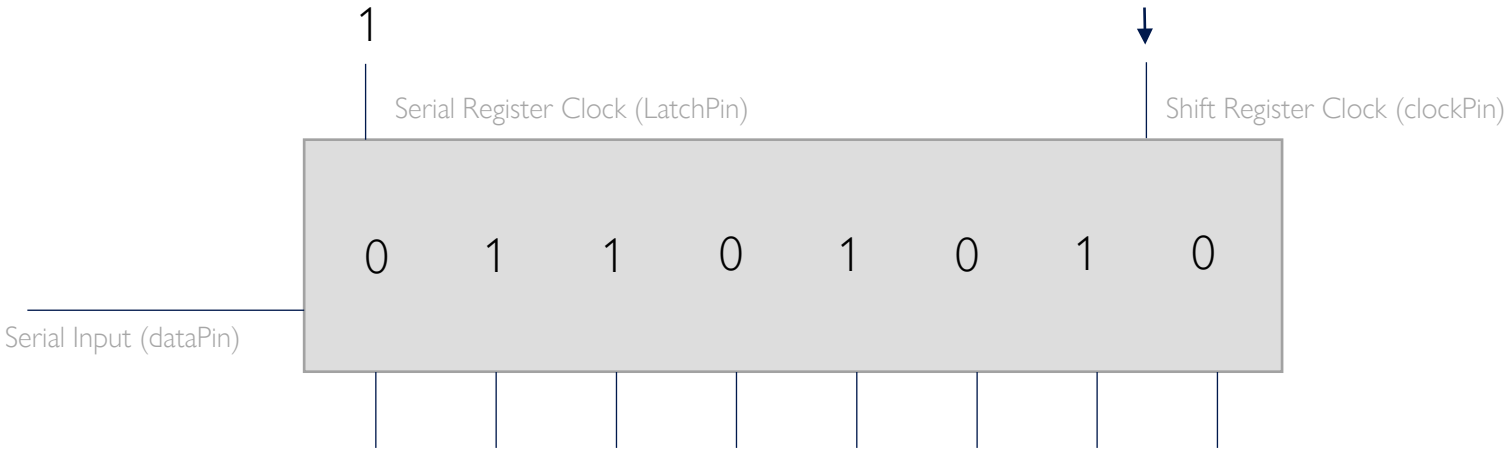
# Example

Communication and Connection



# Example

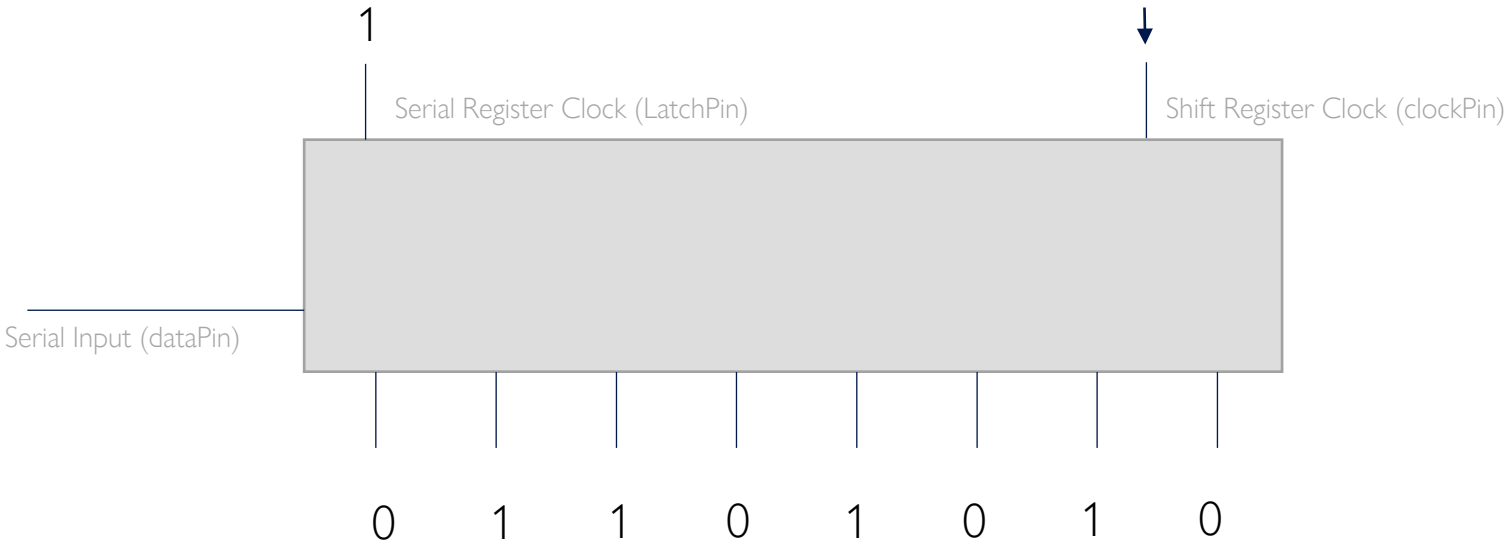
Communication and Connection




Marc Eberhard – OMB-5

# Example

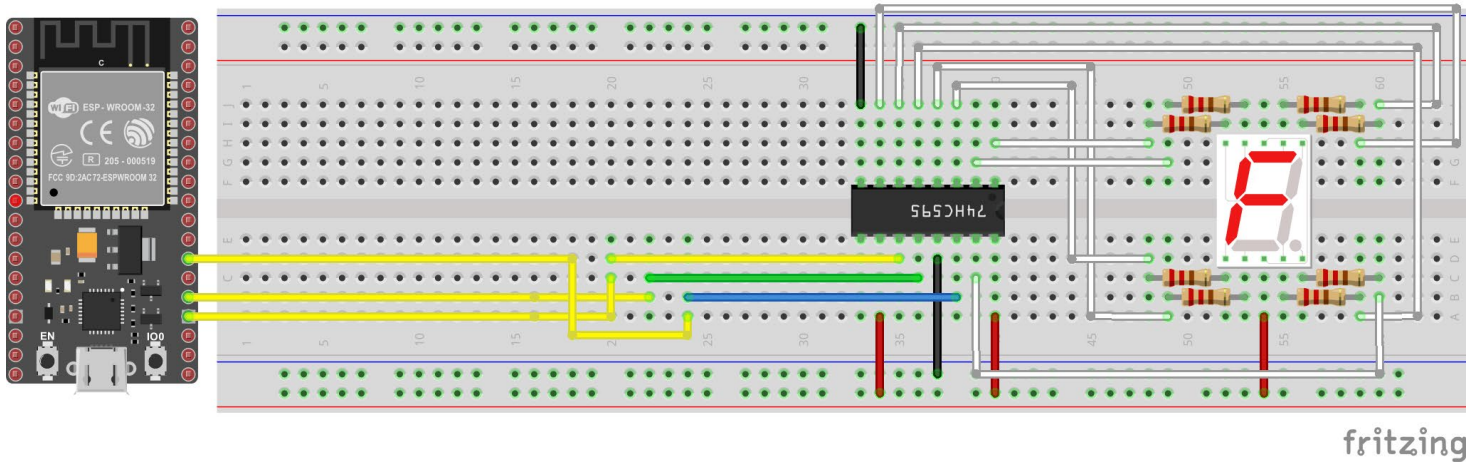
Communication and Connection



# Example

Communication and Connection

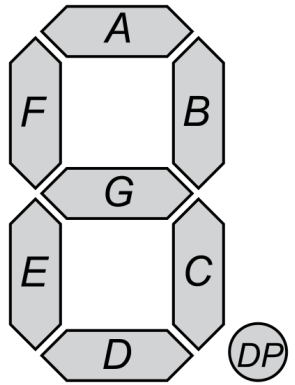
## Serial to Parallel Shifting



# Example - **Code**

Communication and Connection

```
#include <Arduino.h>

int dataPin = 15; // Pin to DS of 74HC595 (Pin14)
int latchPin = 2; // Pin to ST_CP of 74HC595 (Pin12)
int clockPin = 4; // Pin to SH_CP of 74HC595 (Pin11)

byte num[] = {
    B00111111, // 0
    B00000110, // 1
    B01011011, // 2
    B01001111, // 3
    B01100110, // 4
    B01101101, // 5
    B01111101, // 6
    B00000111, // 7
    B01111111, // 8
    B01101111  // 9
};
```




Order: DP G F E D C B A

* Wikipedia, https://en.wikipedia.org/wiki/File:7_Segment_Display_with_Labeled_Segments.svg, Accessed 04. May 2021

# Example - **Code**

Communication and Connection

```
void setup()
{
    // set pins to output
    pinMode(latchPin, OUTPUT);
    pinMode(clockPin, OUTPUT);
    pinMode(dataPin, OUTPUT);
}
```

```
void loop()
{
    for (int i = 0; i < 10; i++)
    {
        writeData(~num[i]); // Send data
        delay(1000);
        writeData(0xff);   // Clear display
    }
}
```

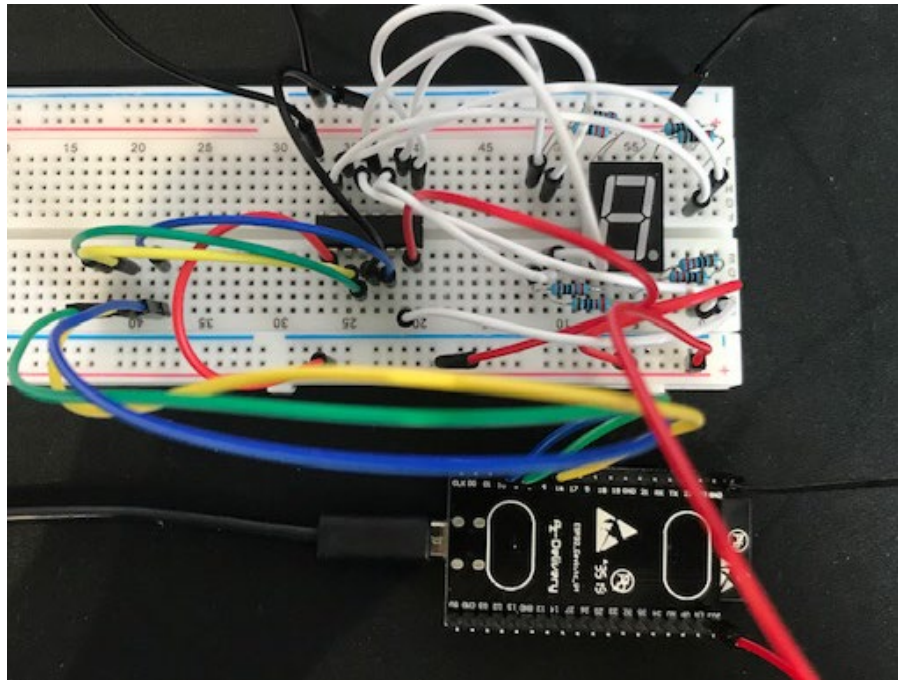
# Example - **Code**

Communication and Connection

```
void writeData(int value)
{
    // Set latchPin low
    digitalWrite(latchPin, LOW);

    // Send serial data
    shiftOut(dataPin, clockPin, LSBFIRST, value);

    // Set latchPin to high
    digitalWrite(latchPin, HIGH);

}
```

# Example

Communication and Connection



Marc Eberhard – OMB-5


# Thank You!

Analog/Digital & Serial/Parallel

Marc Eberhard – OMB-5