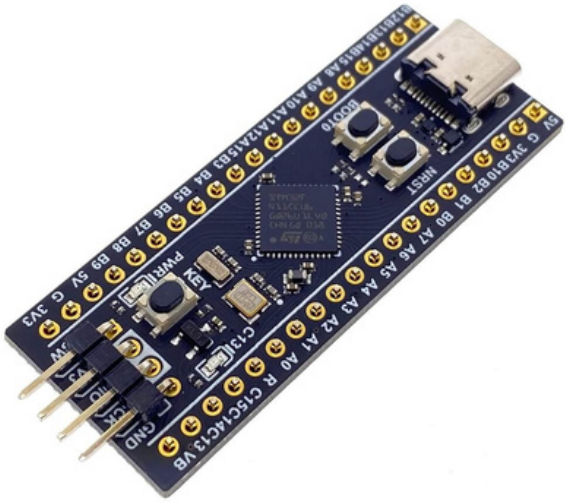
# Development Kit of

# STM32

# Documentation



## List of Contents



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- DC Motor (with L293D driver)
- Servo Motor
- Stepper Motor
- IR Sensor
- PIR Sensor
- Ultrasonic (HC-SR04)
- Bluetooth (HC-05/HC-06)
- Seven Segment Display
- RFID (EM18)

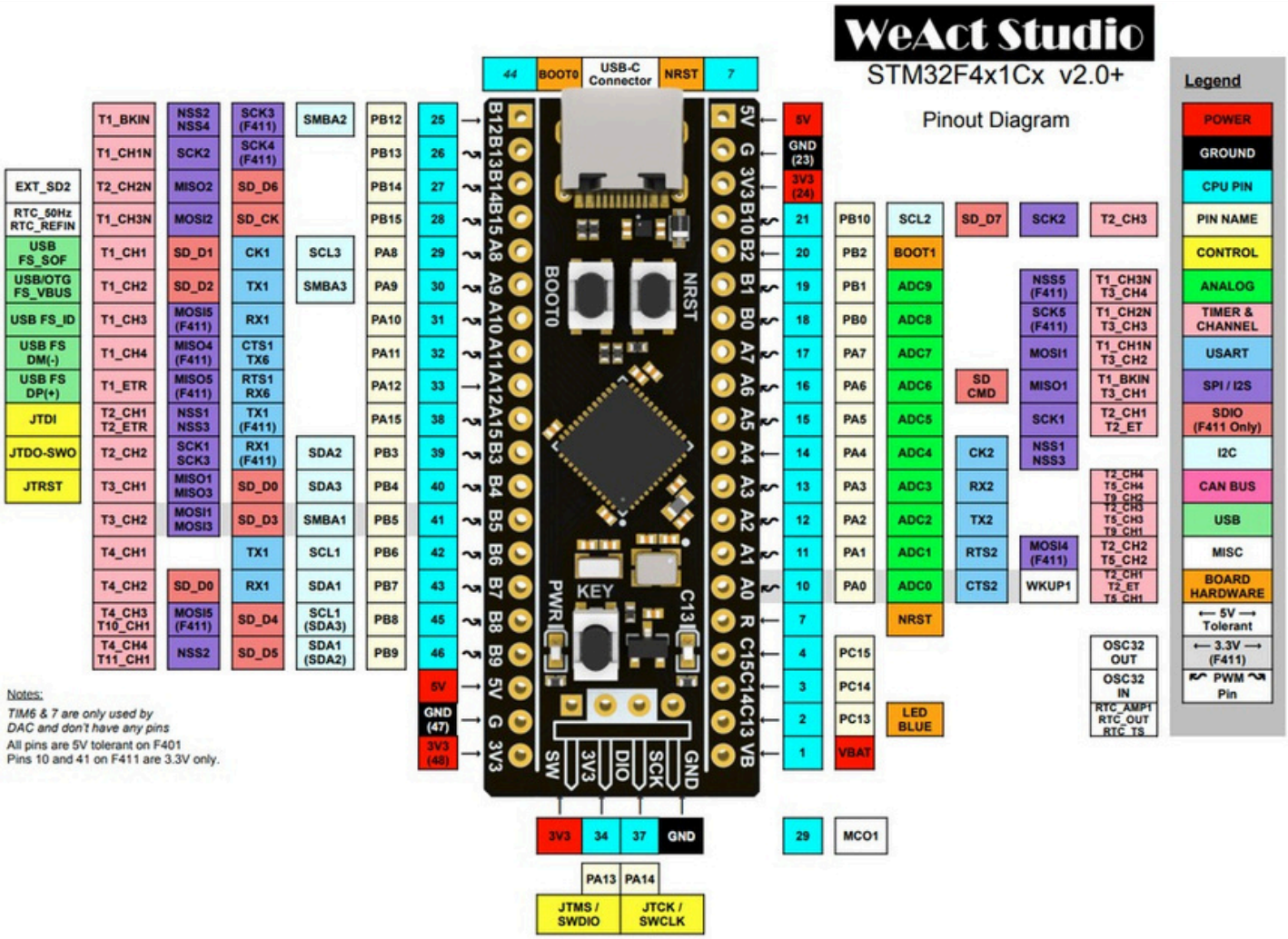
# 1. Description of STM32 Blue Pill

## Introduction

The STM32 Blue Pill is a low-cost ARM Cortex-M3 32-bit microcontroller board based on the STM32F103C8T6 chip.

It operates at 72 MHz with 64 KB Flash and 20 KB SRAM. The board provides multiple communication interfaces like USART, SPI, I2C, USB, and CAN.
Unlike 8-bit boards like Arduino Nano, the Blue Pill offers faster performance, more memory, and additional peripherals, making it suitable for embedded systems, IoT, and robotics projects.

## Pin Diagram




## Specifications

- MCU: STM32F103C8T6 (ARM Cortex-M3, 32-bit, 72 MHz)
- Flash Memory: 64 KB (sometimes 128 KB on clones)
- SRAM: 20 KB
- Operating Voltage: 3.3V (5V tolerant I/O pins)
- GPIO: 37
- Communication Interfaces: - 3x USART - 2x I²C - 3x SPI - USB 2.0 FS - CAN bus
- Timers: 4 (16-bit), 1 (SysTick)
- ADC: 10 channels, 12-bit
- PWM: Multiple pins supported
- Power Supply: via USB, 5V pin, or 3.3V regulator

## Applications

- Robotics and Automation
- IoT Devices
- Industrial Control Systems
- Data Acquisition

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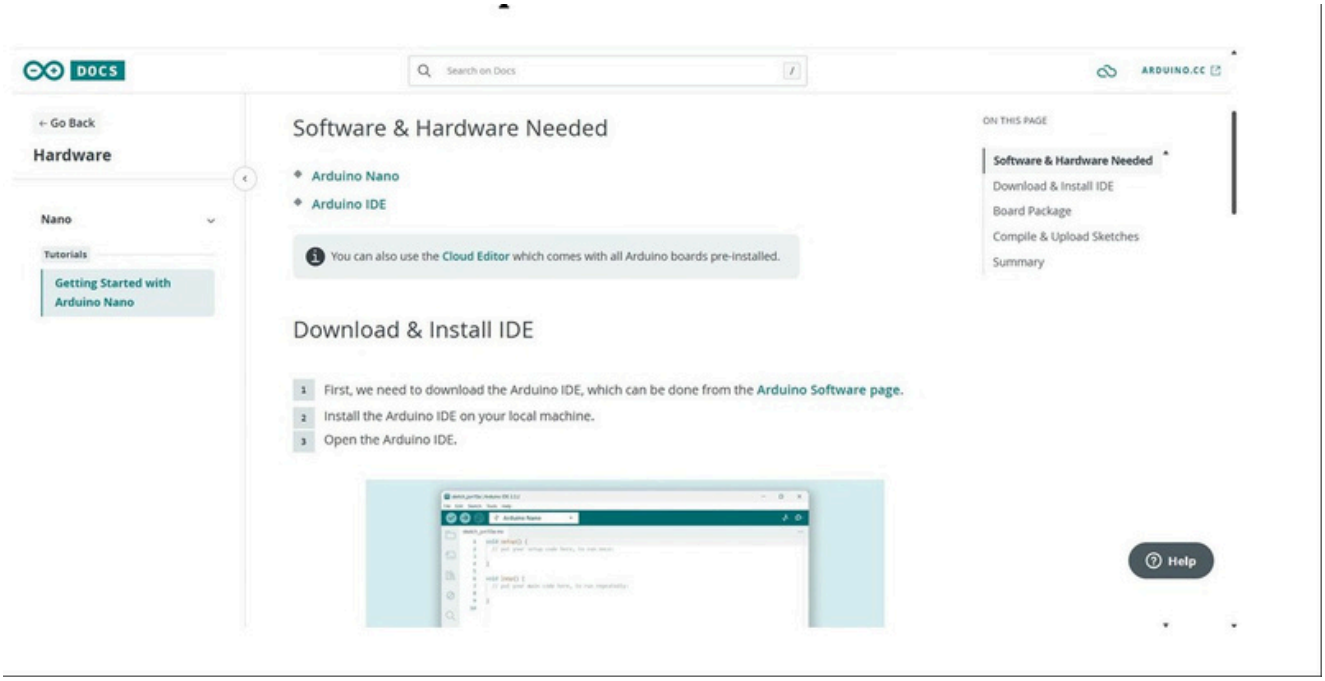
Motor Control
Sensor Interfaces

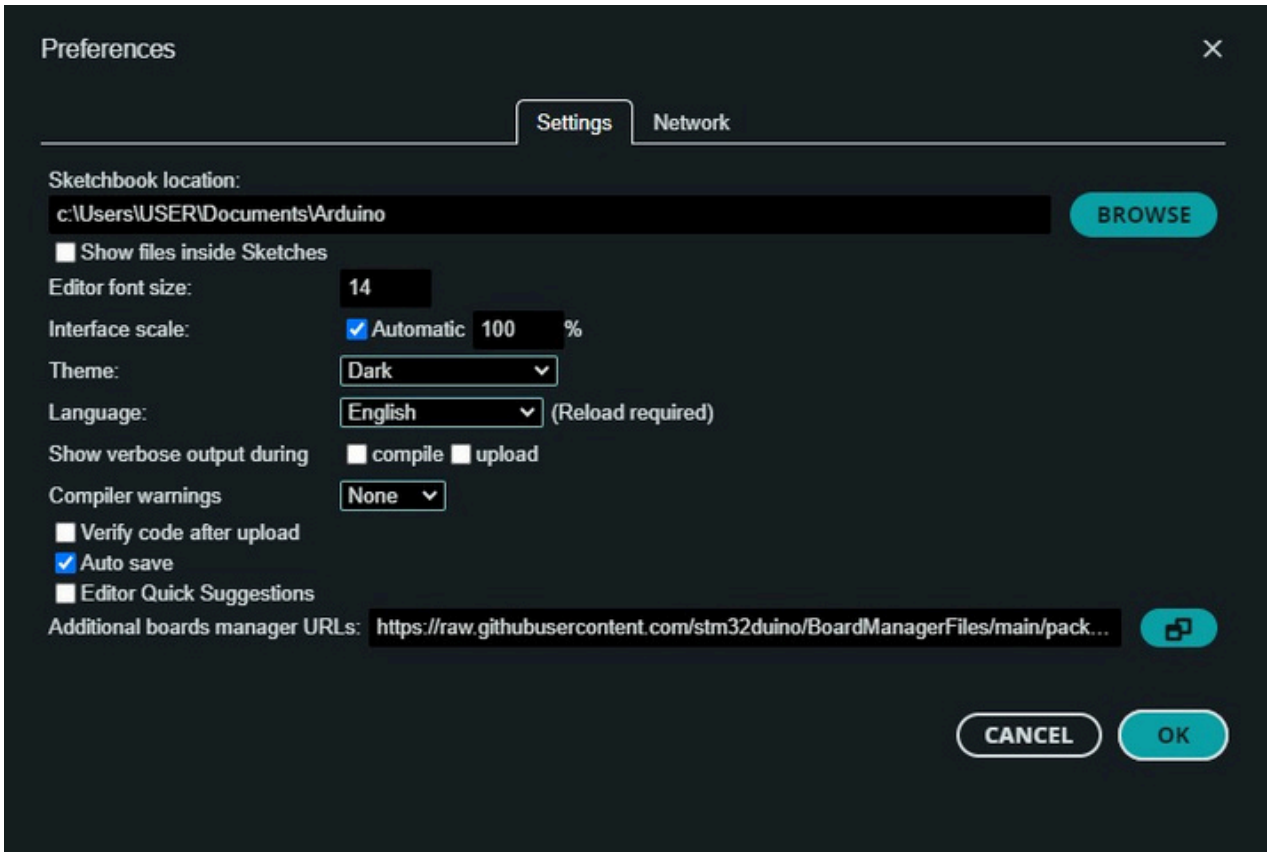
## Material Required

STM32 Blue Pill Board
USB to Serial Adapter
Jumper Wires
Power Supply (5V via USB or external source)

# 2. Installing Arduino IDE for STM32

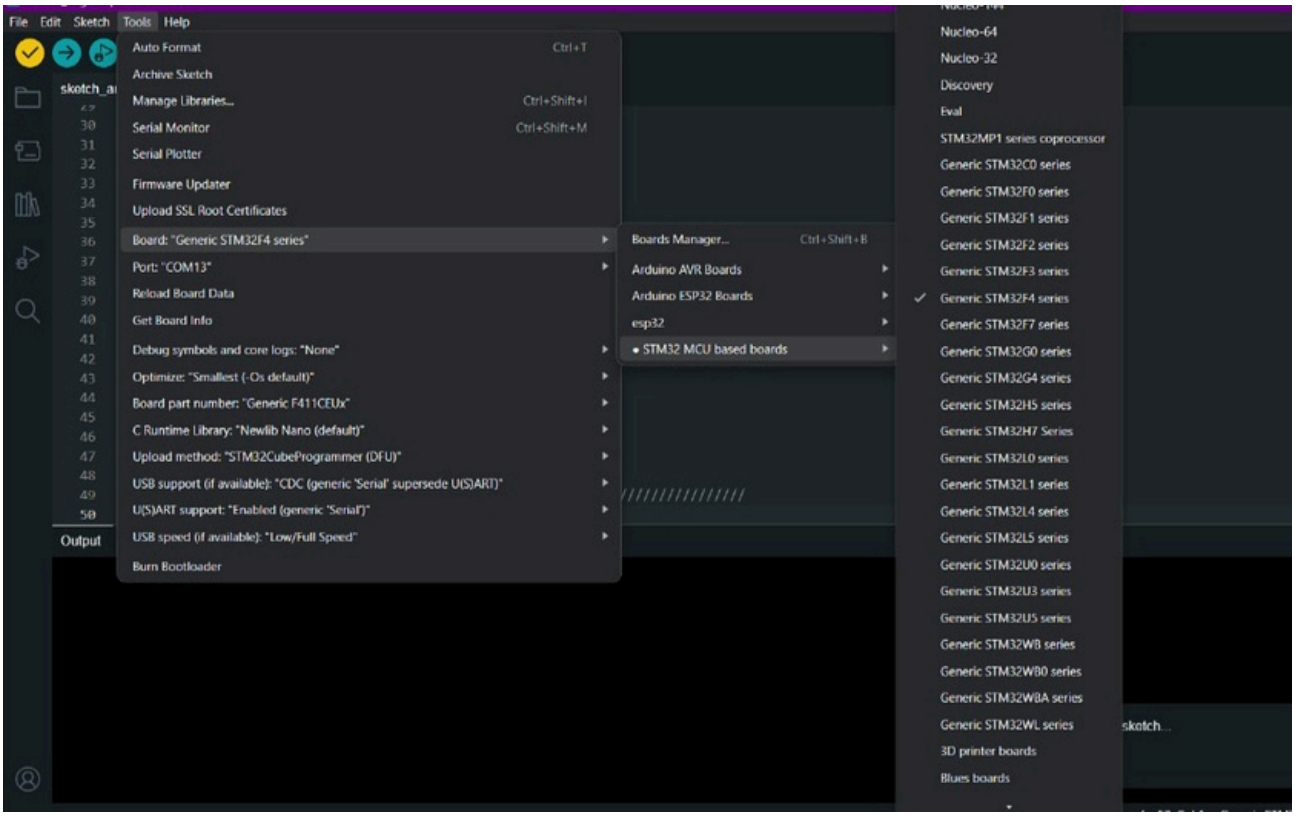



**Step 1: Install Arduino IDE (latest version).**




**Step 2: Go to File → Preferences → Additional Board Manager URLs.**

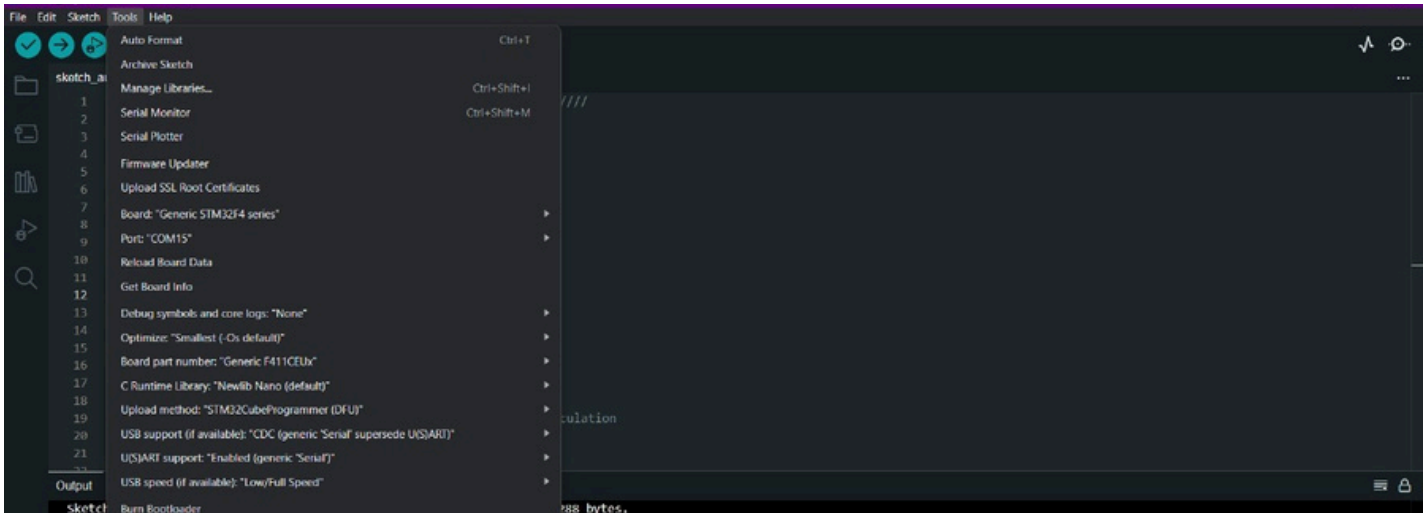
**Step 3: Add the STM32 package URL:**
**https://github.com/stm32duino/BoardManagerFiles/raw/main/package_stmicroelectroni cs_index.json**




**Step 4: Open Tools → Board → Board Manager, search for "STM32" and install the package by STMicroelectronics.**

**Step 5: Install required drivers (ST-LINK, CH340 for USB, or USB DFU drivers).**

**Download CH340 Driver:**
**https://drive.google.com/file/d/1JNB9n2InM8JCi14wzXzv3ECKrWqyHnfU/view**




**Step 6: Select your board (Generic STM32F4 series) and Upload Method (Serial / ST-LINK / DFU).**

**Step 7: Verify COM port detection under Tools → Port.**

# 3. Examples

## 1 . LED

A **Light Emitting Diode (LED)** is one of the most widely used semiconductor devices that emits either **visible light** or **invisible infrared light** when it is **forward biased**. Remote controls, for example, generate invisible **infrared light**.

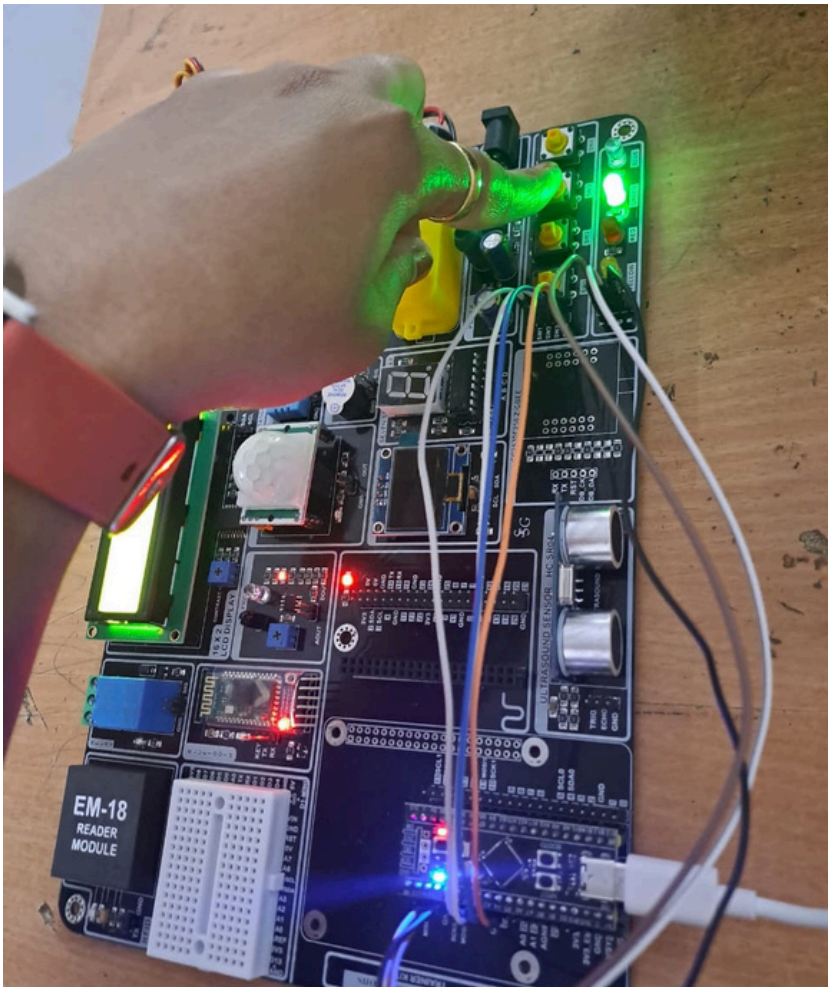
The LED converts **electrical energy into light energy** through a process called **electroluminescence**. When a voltage is applied across the LED, electrons and holes recombine in the semiconductor material, releasing energy in the form of photons (light).

### Connections of LEDs & Switch with STM32

| STM32 PINS | LED PINS |
|---|---|
| PC13 | Y |
| PC14 | R |
| PC15 | G |
| PB0 | B |

| STM32 PINS | SWITCH PINS |
|---|---|
| PA0 | SW1 |
| PA1 | SW2 |
| PA2 | SW3 |
| PA3 | SW4 |

***NOTE: Used same led pin for switch code***




## 2. OLED (Organic Light Emitting Diode)

An**OLED** isa display technology made from **organic materials** that emit light when current flows through them. Unlike LCDs, OLEDs don’t need a backlight because they are **self-emissive**. This makes them **thinner, lighter, and flexible**, allowing use in curved and foldable screens.

OLEDs provide **bright colors, deep blacks, wide viewing angles, fast response, and low power use**.

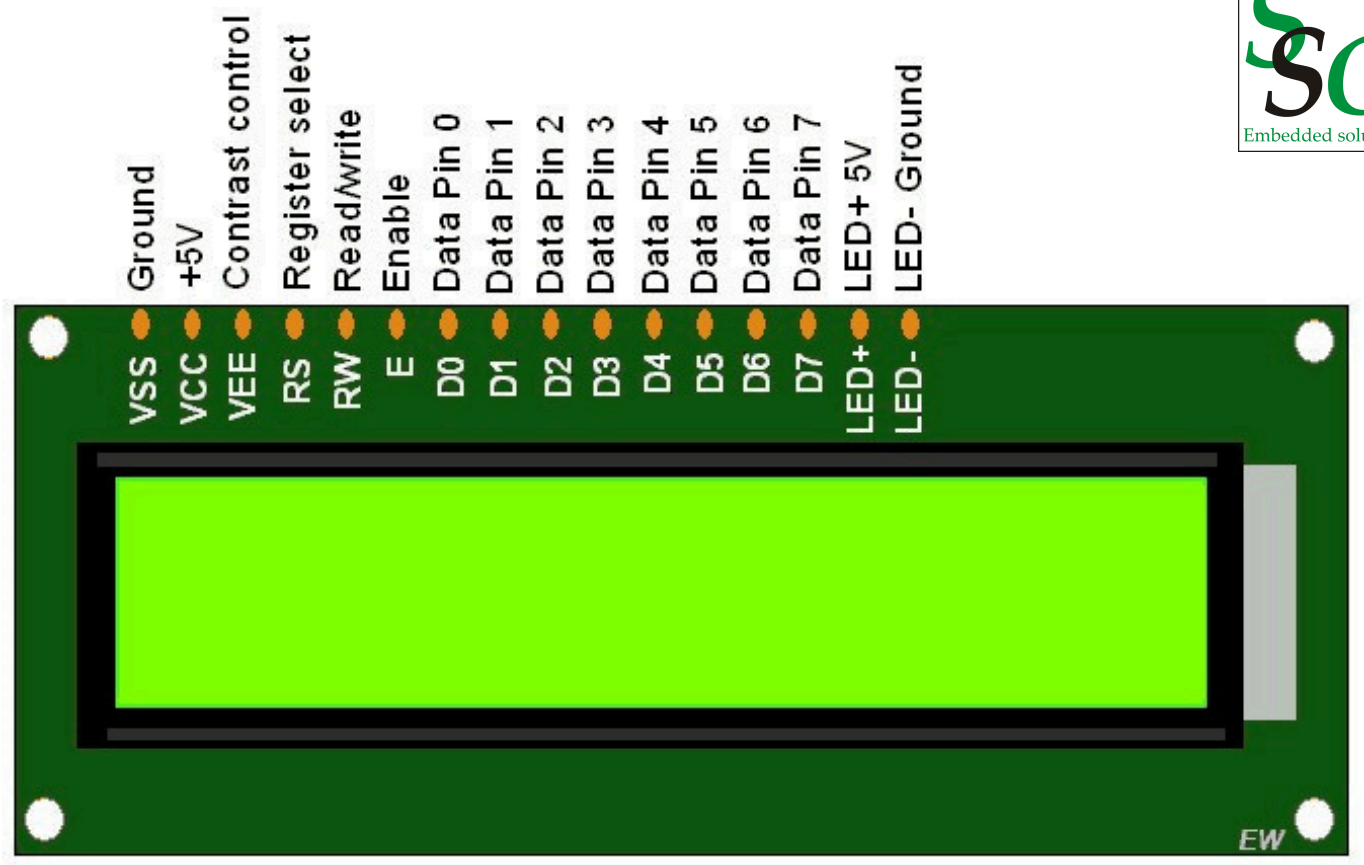
They are commonly used in **smartphones, TVs, laptops, smartwatches, digital displays, automotive dashboards, and AR/VR headsets**.


## Connections of OLED with LEDs

| STM32 | OLED PINS |
|---|---|
| PB9 | SDA |
| PB8 | SCL |

## 3. LCD (Liquid Crystal Display)

An **LCD** is a widely used electronic display module found in devices such as **mobile phones, calculators, computers, and TVs**. It is often preferred over multi-segment LEDs and seven-segment displays because it can show **custom characters, symbols, and animations** with ease. LCDs are also **inexpensive, programmable, and versatile**.




## Features of LCD

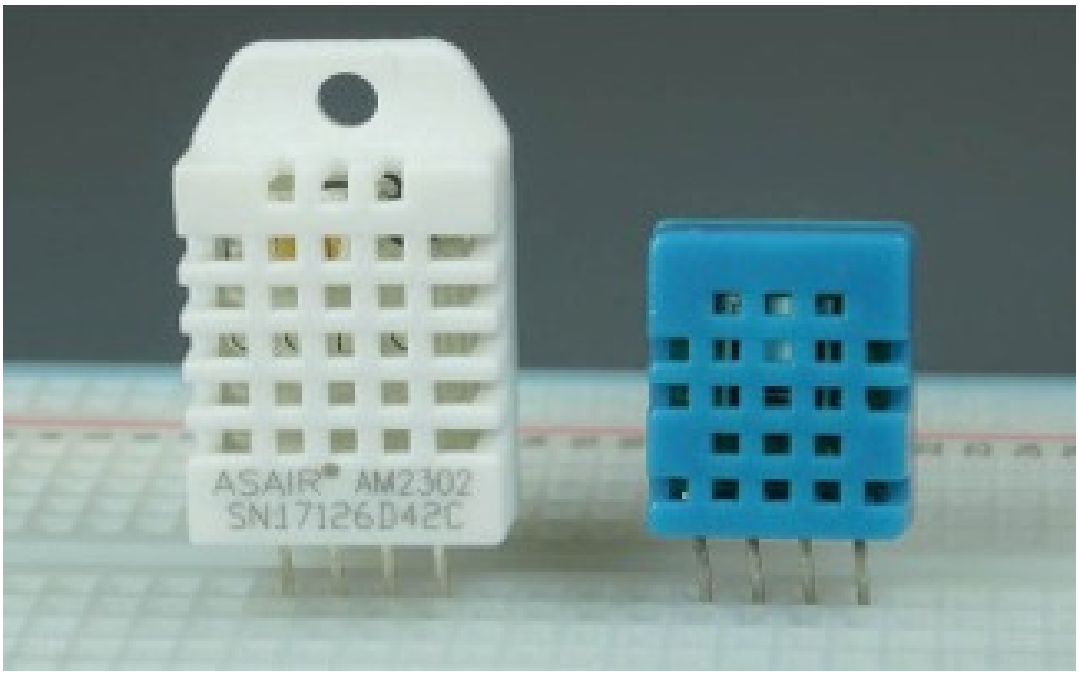
- Operating voltage: **4.7V – 5.3V**
- Two display rows, each supporting **16 characters**
- Low current consumption (**~1mA without backlight**)
- Each character is displayed in a **5×8 pixel matrix**
- Supports **alphabets, numbers, and symbols**
- Can operate in **4-bit or 8-bit mode**

### Connections of LCD with STM32

| STM32 PINS | LCD PINS |
|---|---|
| PB9 | SDA |
| PB8 | SCL |

# 4. DHT-11

The DHT11 and DHT22 sensors are used to measure temperature and relative humidity. These sensors contain a chip that does analog to digital conversion and spit out a digital signal with the temperature and humidity. This makes them very easy to use with any microcontroller.




The DHT22 sensor has a better resolution and a wider temperature and humidity measurement range. However, it is a bit more expensive, and you can only request readings with 2 seconds interval.

The DHT33 has a smaller range and it's less accurate. However, you can request sensor readings every second. It's also a bit cheaper.

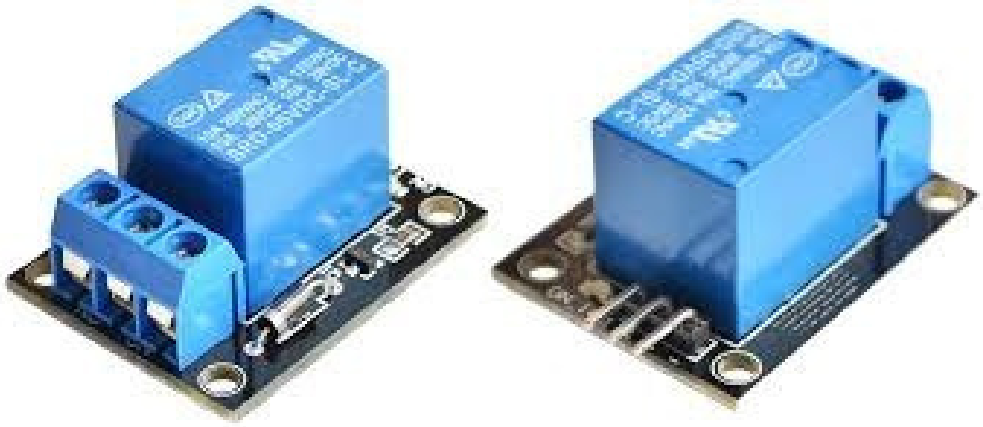
### Connections of DHT sensor with STM32

| STM32 | DHT11 PINS |
|---|---|
| PA0 | DATA |

## 5. RELAY

A **relay** is an electromechanical or electronic switch used to open and close circuits. It works by energizing a coil that changes the state of its contacts.

- **NO (Normally Open):** Contact remains **open** when the relay is not energized. When the coil is energized, the contact **closes**, allowing current to flow.
- **NC (Normally Closed):** Contact remains **closed** when the relay is not energized. When the coil is energized, the contact **opens**, stopping the current flow.



Relays are widely used in **control panels, automation systems, and electronic circuits**. They allow a **low-voltage signal** to control **higher voltages and currents**, making them useful for switching heavy loads safely.

### Connections of Relay with STM32

| STM 32 | Relay PINS |
|---|---|
| PA1 | SIG |

## 6. BUZZER

A buzzer is an electronic device that generates sound by converting electrical energy into sound energy. It typically consists of a piezoelectric crystal, which expands and contracts when an alternating current is applied to it, creating sound waves.


Buzzers are commonly used in a wide range of applications such as alarms, timers, and warning systems. They can also be used in electronic devices such as mobile phones, computers, and other electronic devices to generate different sounds and tones.

## Connections of BUZZER with STM32

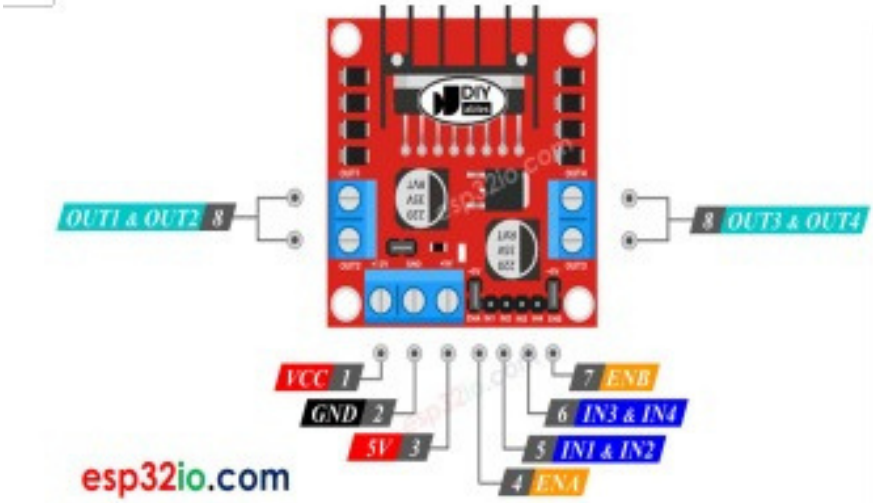
| STM32 | BUZZER PINS |
|---|---|
| PA2 | SIG |

# 7. DC MOTOR

A **DC Motor** is an electromechanical device that converts **direct current (DC) electrical energy** into **mechanical rotational energy**.

### Working Principle

When a **current-carrying conductor** is placed in a **magnetic field**, it experiences a mechanical force that makes it rotate. The **direction of rotation** is determined using **Fleming's Left-Hand Rule**.




### Applications

- Robotics (movement control)
- Toys and hobby projects
- Quadcopters and drones
- CD/DVD drives in computers and laptops
- Small appliances and automation systems

## Connections of DC MOTOR with STM32

| STM32 | DC MOTOR PINS |
|---|---|
| PA0 | M1A |
| PA1 | M2A |
| PA2 | M3A |
| PA3 | M4A |

## 8. SERVO MOTOR

A **Servo Motor** is an electrical device used to **rotate and position objects precisely**, such as in robotic arms, cameras, and automation systems.

It consists of a **DC motor** (sometimes AC motor) combined with a **feedback control system**. The built-in **error-sensing feedback mechanism** continuously monitors the output position and corrects it, ensuring **accurate control of angular velocity and position**.


It is a closed loop system where it uses negative feedback to control motion and final

position of the shaft.It is not used for continuous rotation like conventional AC/DC

motors.It has rotation angle that varies from 0° to 380°.

## Connections of SERVO MOTOR with STM32

| STM32 | SERVO MOTOR PINS |
|---|---|
| PA0 | CTRL |

# 9. STEPPER - MOTOR

A **Servo Motor** is a special type of motor used for **precise control of angular position, velocity, and acceleration**. It is a **closed-loop system** that uses **negative feedback** to continuously adjust and control the motion of its shaft.

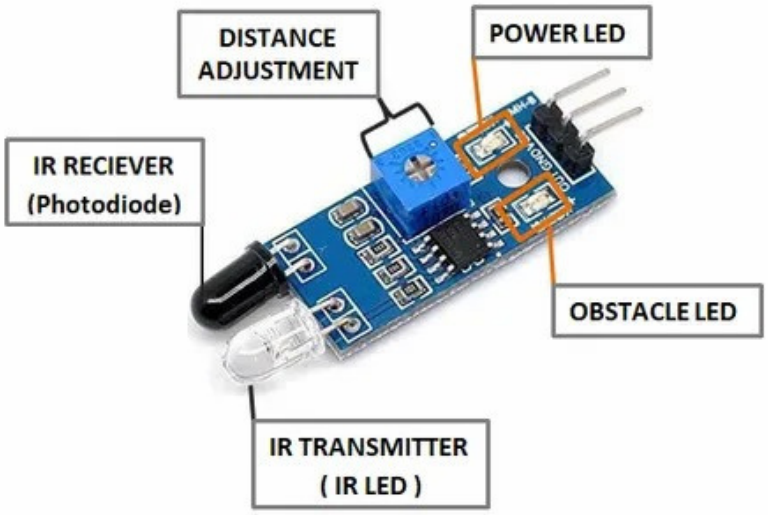
Unlike conventional AC/DC motors, a servo motor is **not designed for continuous rotation**. Instead, it operates within a limited angle range, typically **0° to 180°** (some extended types up to **360° or more**).

## Connections of STEPPER MOTOR with STM32

| STM32 | STEPPER PINS |
|---|---|
| PA0 | B1 |
| PA1 | B2 |
| PA2 | B3 |
| PA3 | B4 |

# 10. IR SENSOR

An **Infrared (IR) Sensor** is an electronic device that uses **infrared light** to detect objects, measure heat, or sense motion in its surroundings. All objects emit some form of **thermal radiation** in the infrared spectrum, which is invisible to the human eye but can be detected by IR sensors.




An IR sensor mainly consists of:

- **IR LED (Emitter):** Emits infrared light.
- **IR Photodiode (Detector):** Detects the reflected IR light. Its resistance and output voltage change depending on the amount of IR light received.

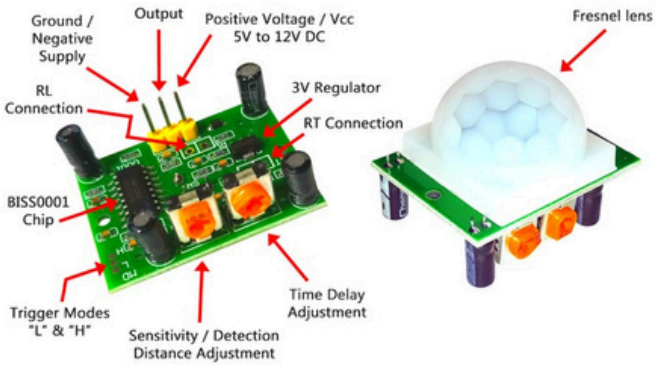
This combination allows IR sensors to detect objects, measure distance (basic level), and sense motion.

## Connections of IR SENSOR with STM32

| STM32 | IR PINS |
|---|---|
| PA0 | DOUT,B-LED |

# 11. PIR SENSOR

A **PIR sensor** is an electronic device that detects **infrared (IR) radiation** emitted by objects. It is mainly used in **motion detection systems**, **security alarms**, and **automatic lighting applications**. PIR sensors are popular because they are simple, low-cost, and reliable for detecting human presence or movement.




**Pin Configuration** (3 Pins)

- **Pin 1 (VCC):** Connects to the **+5V DC supply**
- **Pin 2 (OUT):** Output pin, carries the detected IR signal to a microcontroller or amplifier
- **Pin 3 (GND):** Connects to **ground**

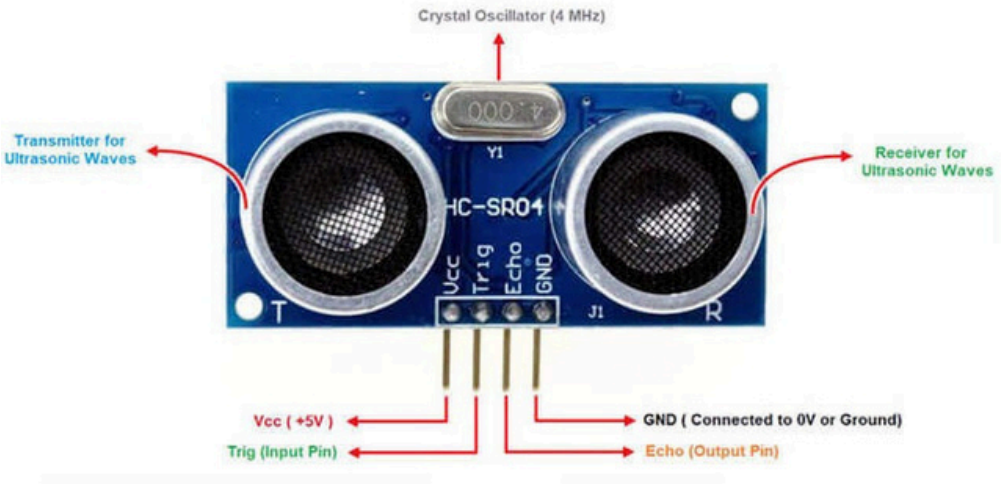
*(In some PIR sensors, resistors like 100K or 47K are internally connected for stability.)*

### Connections of PIR SENSOR with STM32

| STM32 | PIR PINS |
|---|---|
| PA0 | OUT |

## 12. ULTRASONIC SENSOR

The **HC-SR04 ultrasonic module** works on the principle of SONAR and RADAR to measure distance. It can detect objects from **2 cm up to 400 cm**. The sensor consists of an ultrasonic transmitter, receiver, and a control circuit. When a **trigger pulse** is applied, the transmitter generates eight pulses of ultrasound at 40 kHz, which travel through the air and get reflected back as an echo when they hit an object.




The **Echo pin** of the sensor goes high until the reflected signal is received. The duration of this high state corresponds to the total travel time of the sound wave. Since the wave travels to the object and back, the time is divided by two, and using the known speed of sound, the exact distance of the object can be calculated.

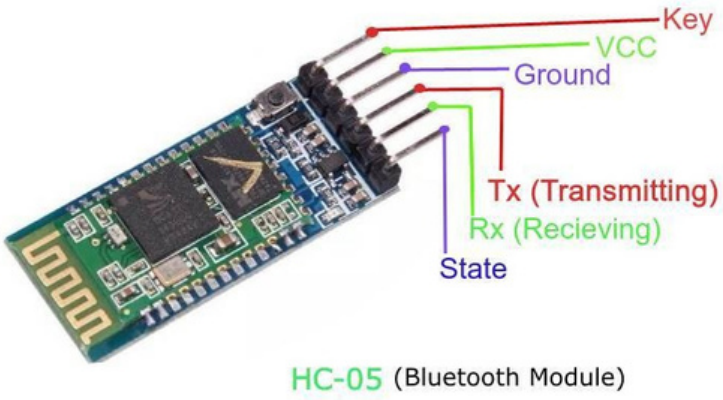
### Connections of ULTRASONIC SENSOR with STM32

| STM32 | ULTRASONIC PINS |
|---|---|
| PA1 | TRIG |
| PA0 | ECHO |

## 13. BLUETOOTH

Bluetooth is a **wireless communication technology** used in devices like **headsets, game controllers, keyboards, mice, and other consumer electronics**. It works within a range of **up to 100 meters**, depending on environment and hardware conditions.

It follows the **IEEE 802.15.1 standard** for building **Wireless Personal Area Networks (PANs)** and uses **Frequency-Hopping Spread Spectrum (FHSS)** to send data securely. The module communicates with microcontrollers through **serial communication (USART)**, making it simple to use with Arduino or STM32.




HC-05 (Bluetooth Module)

## Connecting Bluetooth Module (HC-05/HC-06)

1. Install a **Bluetooth Terminal app** on your smartphone.
2. Turn on the **Bluetooth** of your phone.
3. Search for available devices and select the module name (e.g., **HC-05** or **HC-06**).
4. If prompted for a password, enter **1234** (default).
5. Once paired, open the **Bluetooth Terminal app**.
6. Go to the list of paired devices and select the same module (HC-05/HC-06).
7. After a successful connection, you can start sending and receiving data wirelessly.

### Connections of BLUETOOTH with STM32

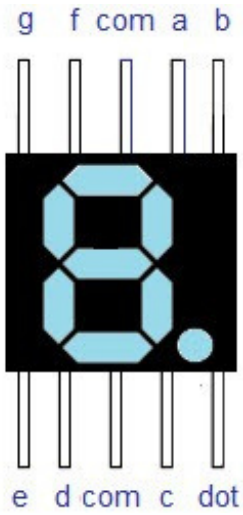
| STM32 PINS | BLUETOOTH PINS |
|---|---|
| PA10 | TX |
| PA9 | RX |

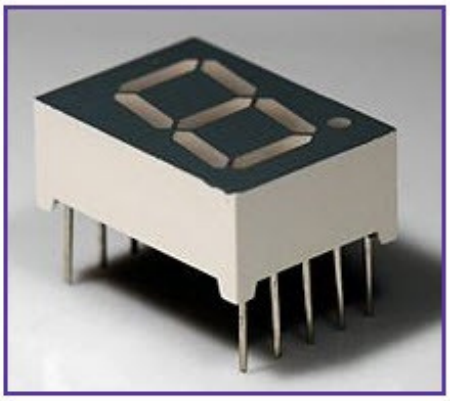
## 14. SEVEN SEGMENT DISPLAY

A **Seven Segment Display (SSD)** is a simple electronic display device used to show **numerical digits (0–9)** and a few characters like **A, B, C, E, F, H**. It is made up of **8 LEDs** — seven LEDs form the segments labeled **a–g**, and one LED is used for the **decimal point (dp)**. By turning ON or OFF different segments, digits and characters can be displayed.

Each SSD has **10 pins**:

8 pins for the segments (a–g + dp) and 2 pins as **common terminals (COM)**. The COM pins are internally shorted, so you only need to use one of them.



### Types of Seven Segment Displays

- **Common Anode (CA):** All anodes are connected together at the COM pin. Segments light up when their cathode is connected to **GND**.
- **Common Cathode (CC):** All cathodes are connected together at the COM pin. Segments light up when their anode is connected to **VCC**.

[Connections of SEVEN SEGMENT DISPLAY with STM32]

| STM32 PINS | SSD PINS |
|---|---|
| PA0 | A |
| PA1 | B |
| PA2 | C |
| PA3 | D |

## 15. RFID (EM-18)

**RFID (Radio Frequency Identification)** is a **wireless identification technology** that uses **radio waves** to detect and identify the presence of RFID tags. Similar to a barcode reader, it is used to identify people, objects, or goods. However, unlike barcodes, RFID does not require direct optical scanning. The RFID tag only needs to be within the **reader's range** to be detected.

Unlike barcodes that can get damaged or unreadable, RFID tags are generally more **durable and reliable**. Each RFID tag carries a **unique ID**, making the system highly secure and efficient.


## Applications of RFID

- **Attendance systems**: Each person is assigned a unique RFID tag for identification.
- **Access control**: Used in companies to allow only authorized employees.
- **Asset and goods tracking**: Helpful in inventory management and logistics.
- **Automated toll collection**: RFID tags on vehicles enable quick toll payments without stopping.

## Connections of RFID with STM 32

| STM32 | RFID |
|---|---|
| PA10 | TX |