Gearbox Academy Kits Documentation

This is a documentation of the components contained in the Gearbox Academy Kits. This provides an easier-to-go reference and review while doing the projects. The microcontrollers contained in the kits are raspberry pi pico and esp32.

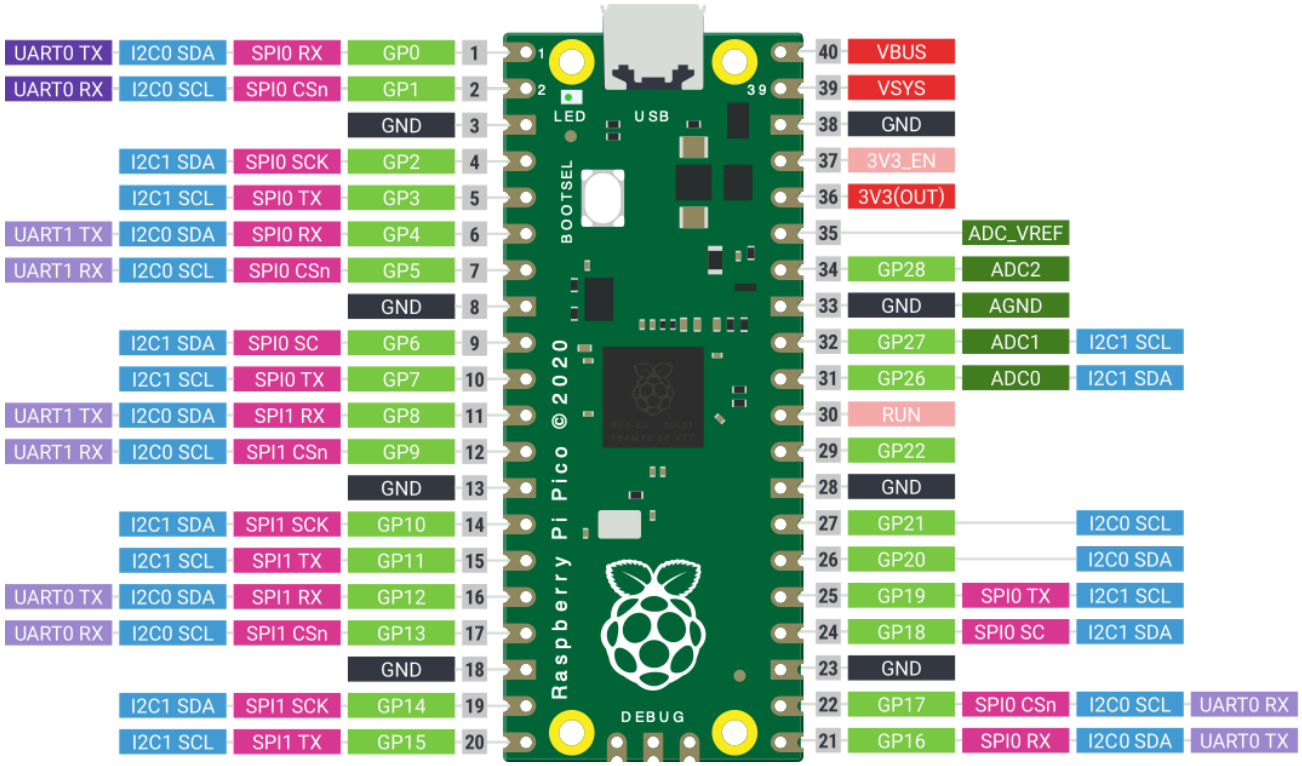
1. Raspberry Pi Pico -> RP2040

A low cost, high-performance microcontroller board built around Raspberry Pi's very own chip - the RP2040.
This is an RP2040-based microcontroller board meaning the RP2040(black chip at the center of the board) is the ‘brain’ of the whole board. The most important pins are the general purpose pins(denoted as gp and in green) which are programmable, meaning you have to specify the pins in the code to provide the logic. For example in the code to blink an LED, I’ll have to specify pin gp2(there are 26 programmable pins) to light the LED. The programmable ones are gp0 - gp22 and gp26 - gp28). Other important pins are GND providing ground, VBUS and VSYS that provides 5V output, 3V3 pin providing 3.3V maximum output voltage. Some pins also have other capabilities i.e gp0 and gp1 have UART TX and UART RX capabilities, meaning they are Universally Asynchronous Transmitter and Receiver pins. The Pico is powered by USB cable, which is used to power the board.

Specifications:

- RP2040 microcontroller chip designed by Raspberry Pi in the United Kingdom
- Dual-core ARM Cortex M0+ processor, flexible clock running up to 133 MHz
- 264kB of SRAM, and 2MB of on-board Flash memory
- Castellated module allows soldering direct to carrier boards
- USB 1.1 Host and Device support
- Low-power sleep and dormant modes
- Drag & drop programming using mass storage over USB
- 26 multi-function GPIO pins
- 2×SPI, 2×I2C, 2×UART, 3×12-bit ADC, 16×controllable PWM channels
- Accurate clock and timer on-chip
- Temperature sensor
- Accelerated floating point libraries on-chip
- 8×Programmable IO (PIO) state machines for custom peripheral support

Pinout Diagram



RP2040 datasheet link -> Click here
Raspberry Pi Pico datasheet link -> Click here
Official Raspberry Pi Pico Documentation link -> Click here

2. ESP32 Dev Kit Module

ESP32(Espressif Systems) is a series of low-cost, low-power systems on chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth.

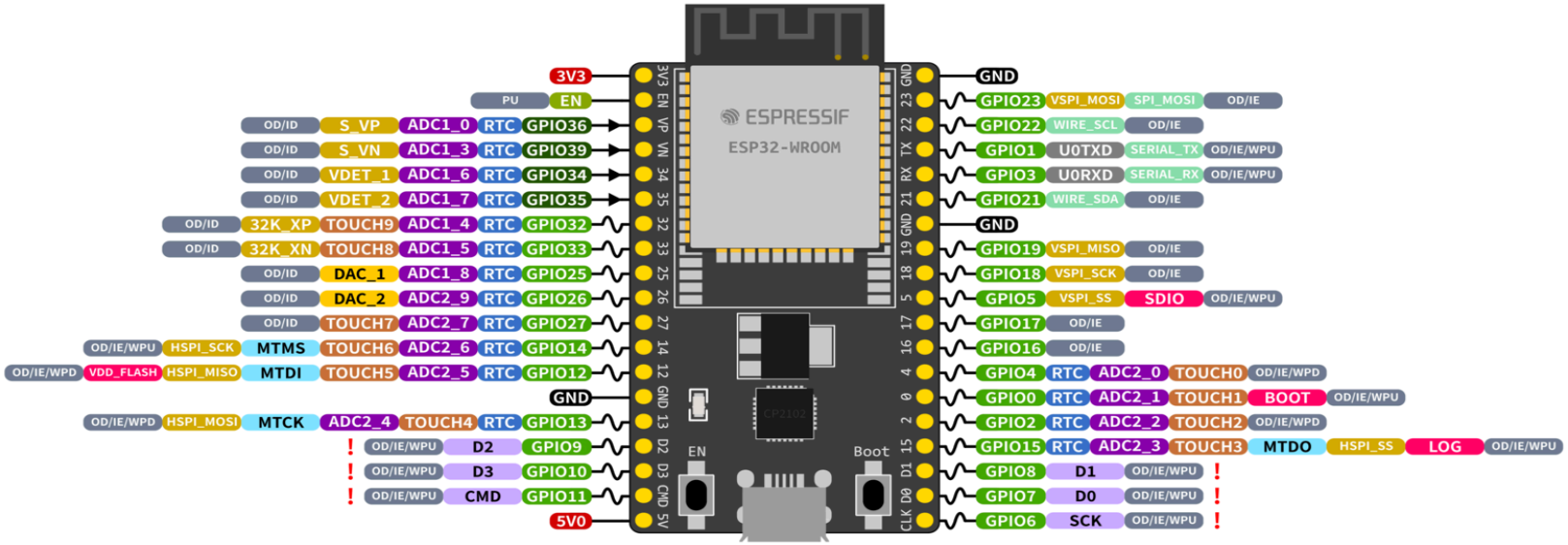
Features of the ESP32 include the following:[3]

- Processors:
    - CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
    - Ultra low power (ULP) co-processor
- Memory: 520 KiB RAM, 448 KiB ROM
- Wireless connectivity:
    - Wi-Fi: 802.11 b/g/n
    - Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)
- Peripheral interfaces:
    - 34 × programmable GPIOs
    - 12-bit SAR ADC up to 18 channels
    - 2 × 8-bit DACs
    - 10 × touch sensors (capacitive sensing GPIOs)
    - 4 × SPI
    - 2 × I²S interfaces
    - 2 × I²C interfaces
    - 3 × UART
    - SD/SDIO/CE-ATA/MMC/eMMC host controller
    - SDIO/SPI slave controller
    - Ethernet MAC interface with dedicated DMA and planned IEEE 1588 Precision Time Protocol support[4]
    - CAN bus 2.0

    - Infrared remote controller (TX/RX, up to 8 channels)
    - Pulse counter (capable of full quadrature decoding)
    - Motor PWM
    - LED PWM (up to 16 channels)
    - Ultra low power analog preamplifier
- Security:
    - IEEE 802.11 standard security features all supported, including WPA, WPA2, WPA3 (depending on version)[5] and WLAN Authentication and Privacy Infrastructure (WAPI)
    - Secure boot
    - Flash encryption
    - 1024-bit OTP, up to 768-bit for customers
    - Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)
- Power management:
    - Internal low-dropout regulator
    - Individual power domain for RTC
    - 5 μA deep sleep current
    - Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt.

ESP32-DevKitC

ESPRESSIF



ESP32 Specs

32-bit Xtensa® dual-core @240MHz
Wi-Fi IEEE 802.11 b/g/n 2.4GHz
BLuetooth 4.2 BR/EDR and BLE
520 KB SRAM (16 KB for cache)
448 KB ROM
34 GPIOs, 4x SPI, 3x UART, 2x I2C,
2x I2S, RMT, LED PWM, 1 host SD/eMMC/SDIO,
1 slave SDIO/SPI, TWAI®, 12-bit ADC, Ethernet

PWM Capable Pin
GPIOX GPIO Input Only
GPIOX GPIO Input and Output
DAC_X Digital-to-Analog Converter
DEBUG JTAG for Debugging
FLASH External Flash Memory (SPI)
ADCX_CH Analog-to-Digital Converter
TOUCHX Touch Sensor Input Channel
OTHER Other Related Functions
SERIAL Serial for Debug/Programming
ARDUINO Arduino Related Functions
STRAP Strapping Pin Functions

RTC RTC Power Domain (VDD3P3_RTC)
GND Ground
PWD Power Rails (3V3 and 5V)
! Pin Shared with the Flash Memory *Can't be used as regular GPIO*

GPIO STATE

WPU: *Weak Pull-up (Internal)*
WPD: *Weak Pull-down (Internal)*
PU: *Pull-up (External)*
IE: *Input Enable (After Reset)*
ID: *Input Disabled (After Reset)*
OE: *Output Enable (After Reset)*
OD: *Output Disabled (After Reset)*

ESP32 official Documentation -> Click here
ESP32 Wikipedia Documentation -> Click Here

3. ESP32 Camera Module

ESP32-CAM is a low-cost ESP32-based development board with an onboard camera, small in size. It is an ideal solution for IoT application, prototypes, constructions and DIY projects.

The board integrates WiFi, traditional Bluetooth and low power BLE , with 2 high performance 32-bit LX6 CPUs. It adopts 7-stage pipeline architecture, on-chip sensor, Hall sensor, temperature sensor and so on, and its main frequency adjustment ranges from 80MHz to 240MHz. Fully compliant with WiFi 802.11b/g/n/e/i and Bluetooth 4.2 standards, it can be used as a master mode to build an independent network controller, or as a slave to other host MCUs to add networking capabilities to existing devices.

ESP32 documentation -> Click here
ESP32 Project -> Click here

4. 9V Battery and Battery Holder

This 9V battery holder allows your battery to snap in tight and holds it in place, which is great in situations where you don't want the battery just hanging. It also has three mounting holes so you can attach it securely to your enclosure.
Battery specifications:

Model: 6LR61

Size: 9v

Jacket: Aluminium Foil battery

Compliance: CE ROHS

Capacity: 270ohm,24h/d,720minutes

Chemistry: Alkaline MO2

Height: 48.5mm

Diameter: 17.5mm

Shelf Life: 10 years

Application: Transistor radios MP3,Electronic Toys and so on.

5. OLED Display(1.54”)

This general-purpose 1.54 inch OLED Display Module offers 16 Grayscale White with a 128x64 resolution and optional SPI or I2C interfacing.
Specifications:

- Operating voltage: 3.3V / 5V
- Communication Interface: SPI / I2C
- Driver: SSD1309
- Resolution: 128 × 64 pixels
- Pixel size: 0.254 × 0.254(mm)
- Display color: 1.54inch OLED Module: White
- Pixel size: 0.254 × 0.254(mm)

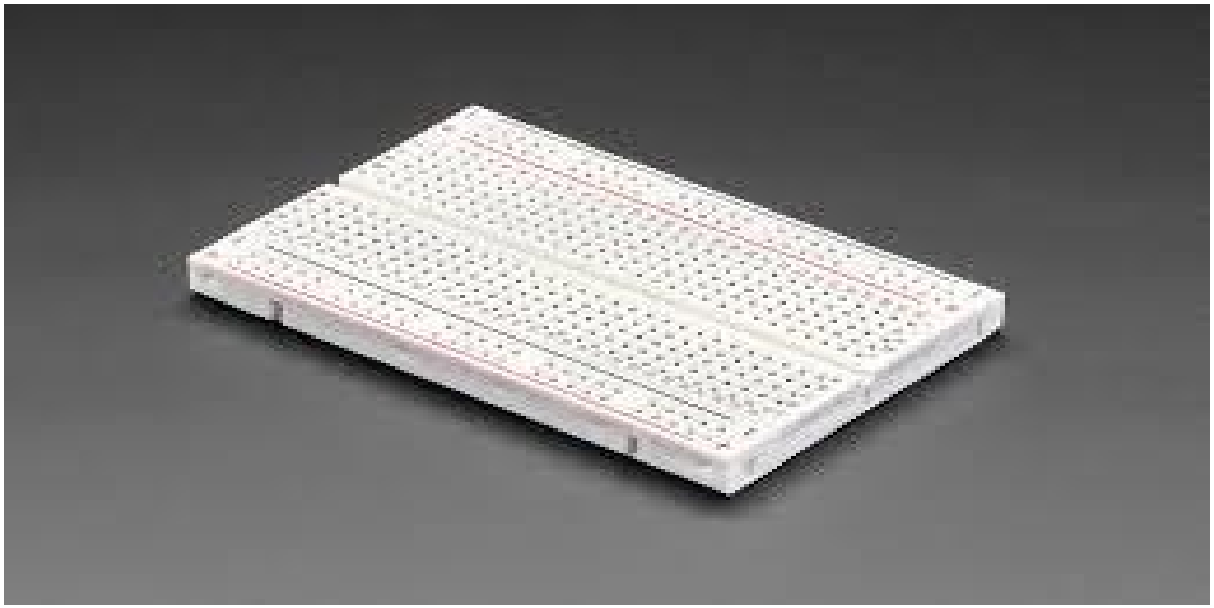
- Display size: 35.05 × 17.52mm
- Module size: 43 × 37.5(mm)

6. Breadboard Mini

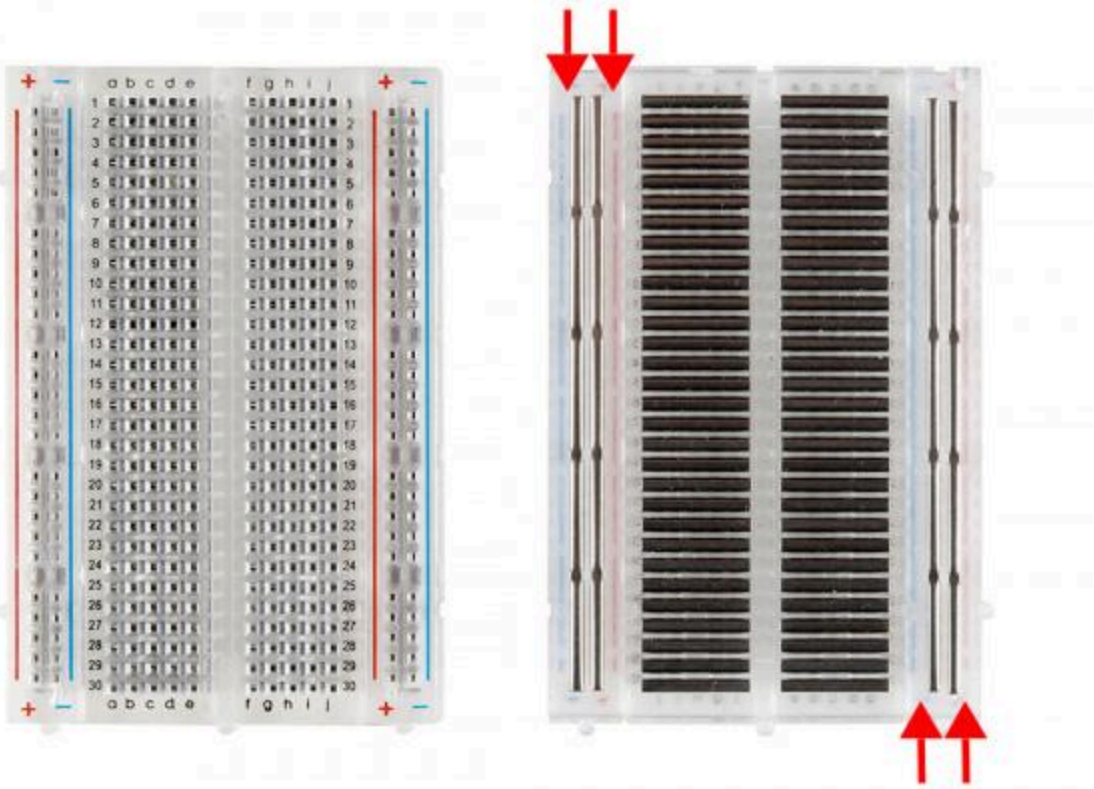
A **breadboard**, **solderless breadboard**, or **protoboard** is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike a perfboard or stripboard,

breadboards do not require soldering or destruction of tracks and are hence reusable. For this reason, breadboards are also popular with students and in technological education.

A breadboard consists of a plastic block holding a matrix of electrical sockets of a size suitable for gripping thin connecting wire, component wires or the pins of transistors and integrated circuits (ICs). The sockets are connected inside the board, usually in rows of five sockets.



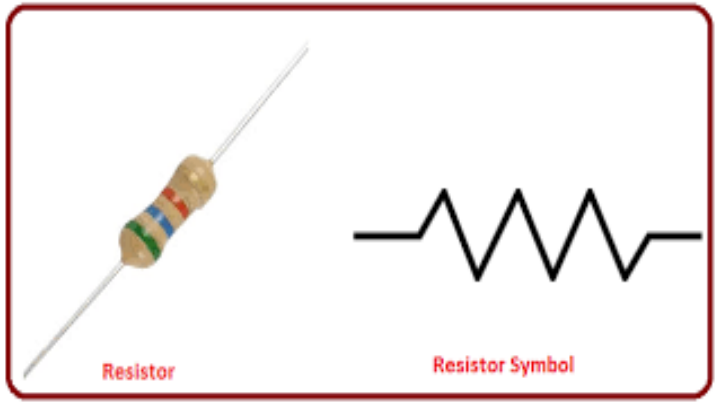
How to use a breadboard -> Click here

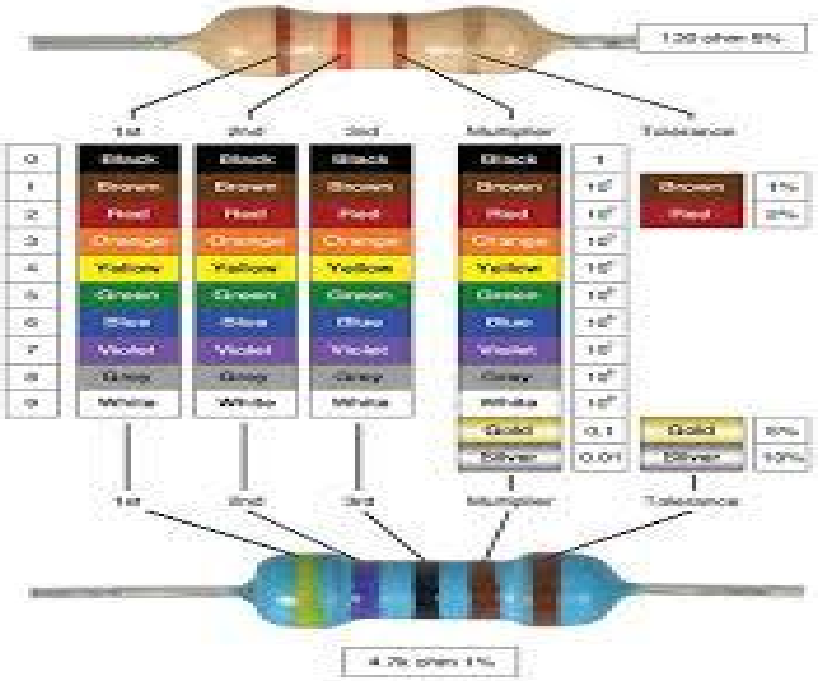


7. Resistors(220, 1k, 5k, 10k)

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component.





Resistor wikipedia page -> Click here
Reading resistors color codes -> Click here

8. Capacitors(0.22UF, 0.1UF, 0.15UF, 0.33UF)

In electrical engineering, a **capacitor** is a device that stores electrical energy by accumulating electric charges on two closely spaced surfaces that are insulated from each other. It is a passive electronic component with two terminals.

Capacitors wikipedia page -> Click here
Functions of capacitors in electronic circuit -> Click here

9. Push Buttons

Feature momentary contact, 4 pins, round black push button, through hole mounting, 6 x 6 x 5mm size, etc.

Used in the fields of electronic products, household appliances and more.
High precision mechanism design offers acute operation and long service life.

10. IN4001 Schottky Diode

The schottky diode is a type of metal – semiconductor junction diode, which is also known as hot-carrier diode, low voltage diode or schottky barrier diode. The schottky diode is formed by the junction of a semiconductor with a metal. Schottky diode offers fast switching action and has a low forward voltage drop. As we are aware that in a PN junction diode, p-type and n-type are joined together to form a PN junction. Whereas, in a Schottky diode metals like platinum or aluminum are used instead of P type semiconductors.

11. LEDS(Red, Blue, Yellow)

3 mm LED Diodes Red Yellow Blue Green round LED Light Emitting Diode.

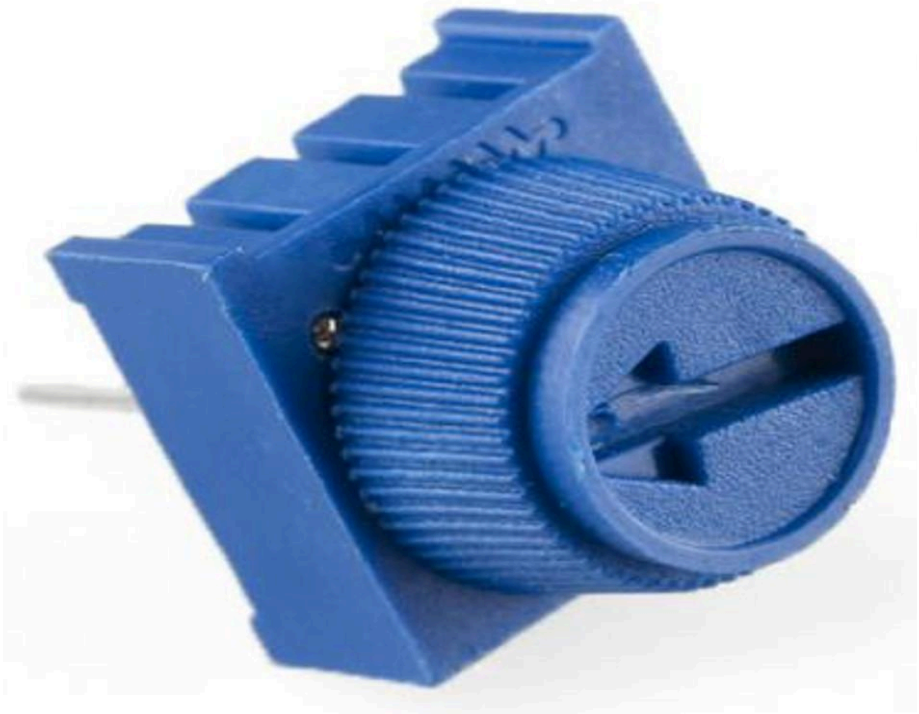
LED specifications -> Click here

12. Jumper Cables(M-M, M-F, F-F)

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed.

13. Potentiometer(10k)

An adjustable potentiometer can open up many interesting user interfaces. Turn the pot and the resistance changes. Connect VCC to an outer pin, GND to the other, and the center pin will have a voltage that varies from 0 to VCC depending on the rotation of the pot. Hook the center pin to an ADC on a microcontroller and get a variable input from the user

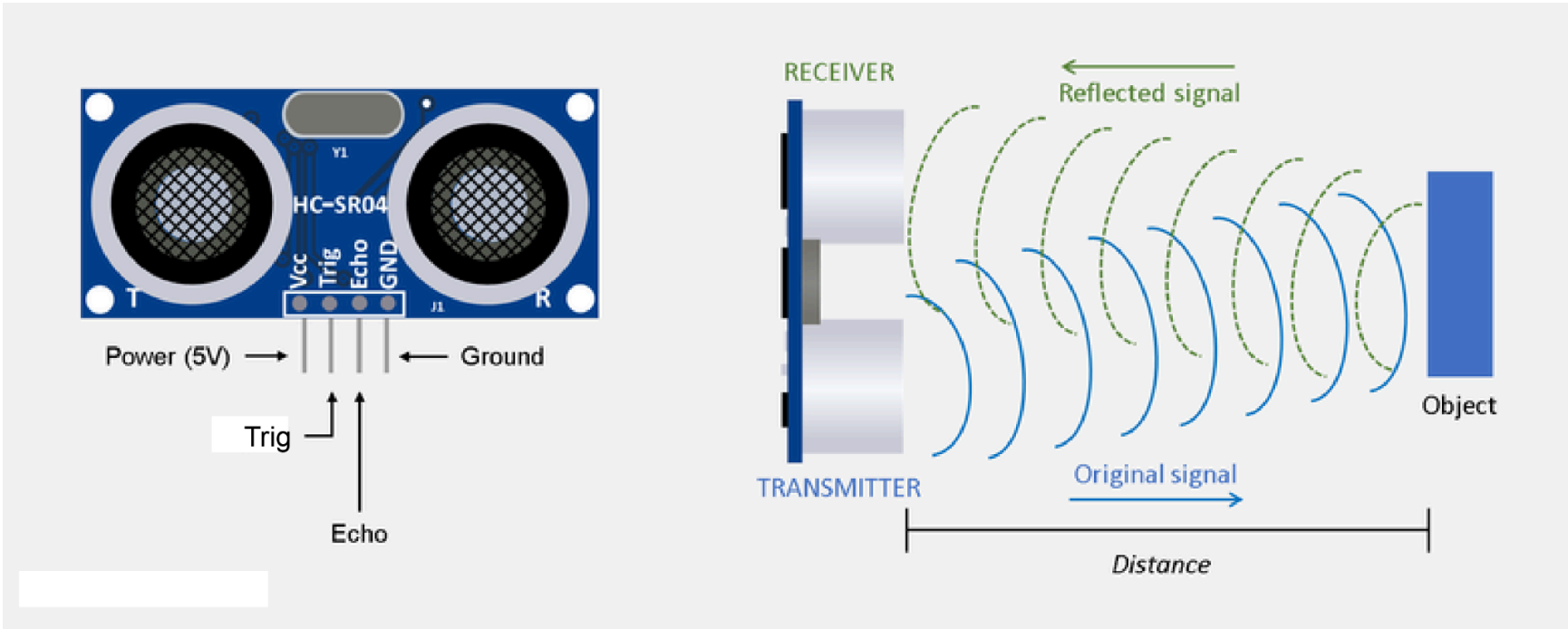


14. HC-SR04 Ultrasonic Distance Sensor

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent range accuracy and stable readings in an easy-to-use package. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit.

There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground).
Specifications":

- Power Supply :5V DC
- Quiescent Current : <2mA
- Effectual Angle: <15°
- Ranging Distance : 2 cm – 500 cm/1" - 16ft
- Resolution : 0.3 cm



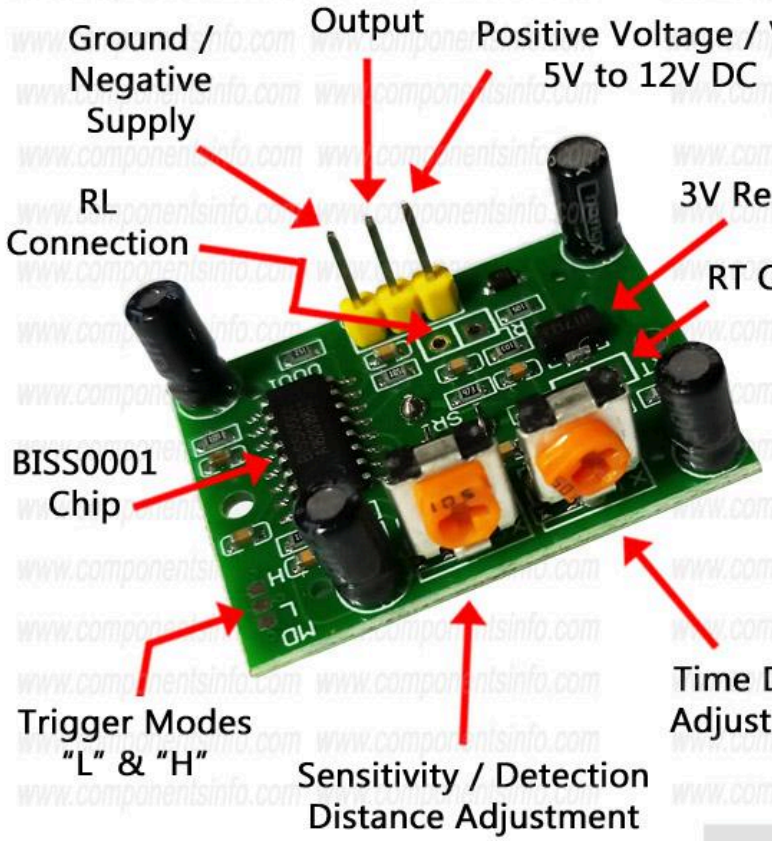
15. HC-SR501

This is an easy, simple to use Passive IR (PIR) sensor – it only needs a single I/O pin on a microcontroller.
or can be easily interfaced with relay or output transistor to control various loads eg: lamps, motors etc
Specifications:

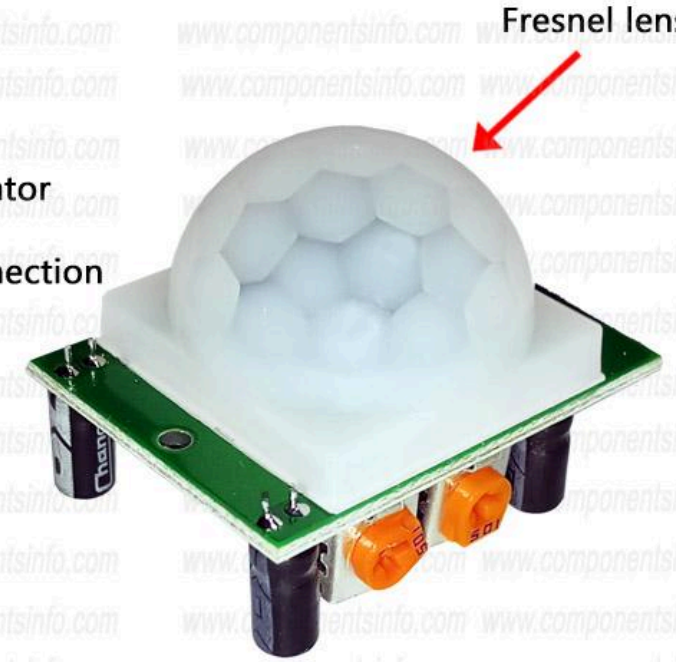
- **Working voltage:** 4.5V to 20V
- **Output:** High: 3.3V, Low: 0V
- **Detection angle:** Approximately 120 degrees
- **Range:** Adjustable, up to 7m
- **Trigger modes:** L unrepeatable trigger / H repeatable trigger (default)
- **Dwell time:** (Stay-ON time) adjustable between 5-300 Seconds. –
  – it can be further increased by increasing the value of the CY1-Timing capacitor on pin 4 of the IC
- **Operating Temperature:** -20 – +80 Degrees C.
- **PCB Dimensions**: 33x25mm, 14mm High not including the Lens; **Lens**: 11mm high, 23mmDiameter.
- **Weight:** 6g

HC SR501 Pir Motion Sensor Module Pinout & Details

Back Side of Module

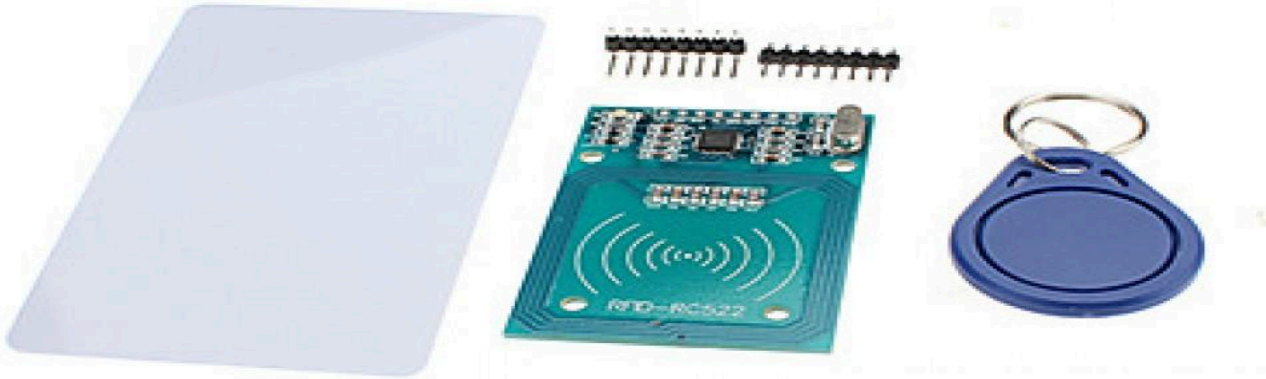


Front Side of Module

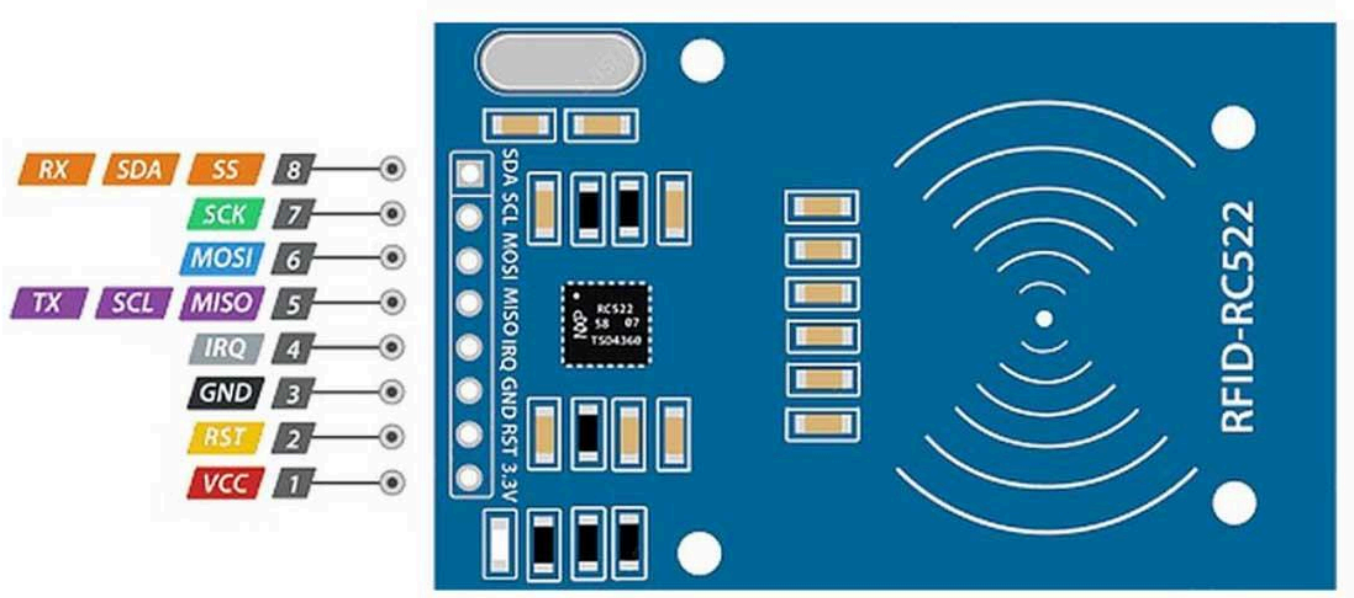


16. RFID Card Reader/ Detector Module Kit

Radio Frequency Identification (RFID) refers to a wireless system comprising two components: tags and readers. The reader is a device that has one or more antennas that emit radio waves and receive signals back from the RFID tag.



MFRC522 Pinout



Pinout Diagram:

- **SDA SCL**: I2C Communication pins. DATA and CLOCK.
- **SS SCK MOSI MISO**: SPI communication pins. Slave Select, Clock, MOSI, and MISO.
- **RX TX**: UART Communication pins.
- **IRQ**: Interrupt signal from the module to indicate RFID tag detection.
- **GND**: Ground pin that needs to be connected to the GND pin on the Arduino.

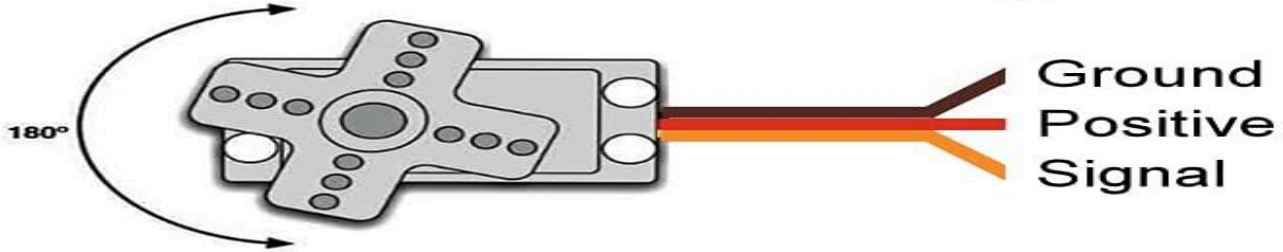
- **RST**: Reset pin for the module.
- **VCC**: Supply pin for the module (2.5V to 3.3V).

17. Micro Servo 9g TS180 Degree

Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos.

A wide range of applications for SG90 servo motors exists, including cameras, telescopes, antennas, industrial automation, and robots. A motor rotates from 0 to 180 degrees at each position of 90 degrees so that is called SG90.

Operating speed: 0.12second/ 60degree (4.8V no load) ;
0.10 seconds / 60 degrees (6.0 V)
Stall Torque (4.8V): 17.5oz /in (1kg/cm)
Operating voltage: 3.0V~ 6V
Temperature range: -30 to +60
Dead band width: 7usec
No Load Running Speed: 0.09±0.01 sec/60° at 4.8V

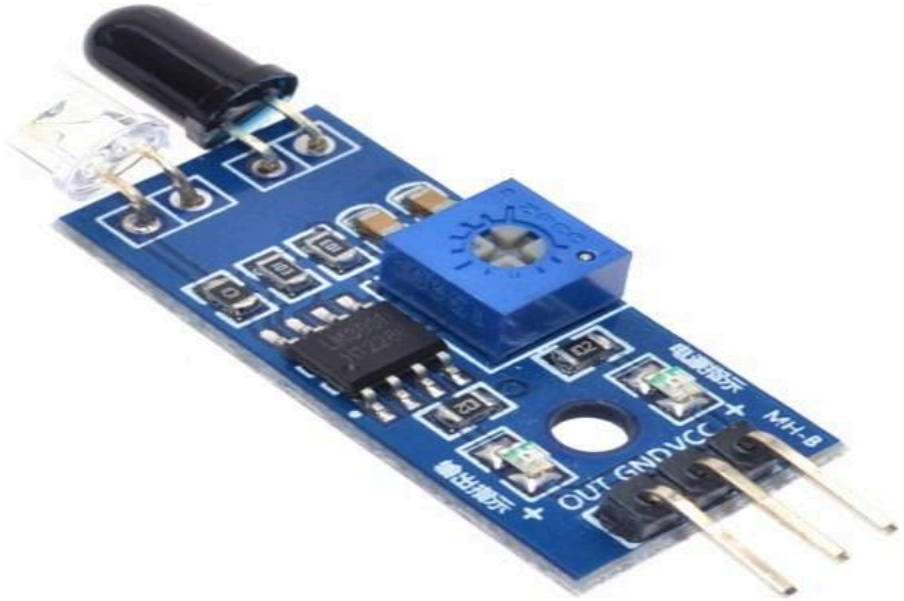


Microservo 9g datasheet -> Click here

18. IR Infrared sensor module

The sensor module light is adaptable to the environment, it has a pair of infrared transmitting and receiving tube, tube infrared emitting a certain frequency, when detecting

direction meet with obstacles (reflecting surface), reflected infrared receiving tube, after the comparator circuit processing, green indicator will light up, at the same time signal output interface and output digital signal (a low level 0V) signal, can be adjusted through the potentiometer knob detection distance, effective distance range 2 ~ 30 cm, the working voltage of 3.3 V to 5 V.The detection range of the sensor can through the potentiometer to adjust and have small interference, easy to assemble, easy to use, etc, can be widely used in robot obstacle avoidance, obstacle avoidance car, line count and black and white line tracking and so on many occasions.



Performance:

- when the signal module without obstacles ahead, the OUT port (5V) output level Continuously.
- When the module detects obstacles ahead signal, circuit board on the green light is lit, the OUT port at the same time Continuous output low level (0 v) signal, the detection module from 2-30 cm, 35 ° Angle detection, detection Distance can be adjusted through the potentiometer, clockwise adjust potentiometer, detection distance increases;Counter-clockwise tuning Potentiometer, reduce the detection distance.
- Active infrared reflection detecting sensor, therefore the reflectivity and shape of the target is the key of the detection range.
- One black minimum detection range, white biggest;Small area of the object distance, large distance.
- The sensor module output port OUT can be directly connected to the microcontroller IO port, can also direct drive a 5V relay,Connection mode: the VCC - VCC;GND - GND The OUT - IO
- The comparator USES the LM393, work stability.
- You can use 3.3 V to 5 V dc power to power supply module.When power on, the red power indicator Lights up

19. IR Remote Control Module Kit

Latest infrared wireless remote control kit consists of Mini Slim 38KHz IR remote control and infrared receiver modules, Mini Slim infrared remote control with 17 function keys, firing distances of up to 8 meters, ideal for a variety of devices in the control room. IR receiver

modules can receive standard 38 KHz modulation remote control signal, through programming, you can achieve remote control signal decoding operation, which can produce a variety of remote control robots and interactive works.

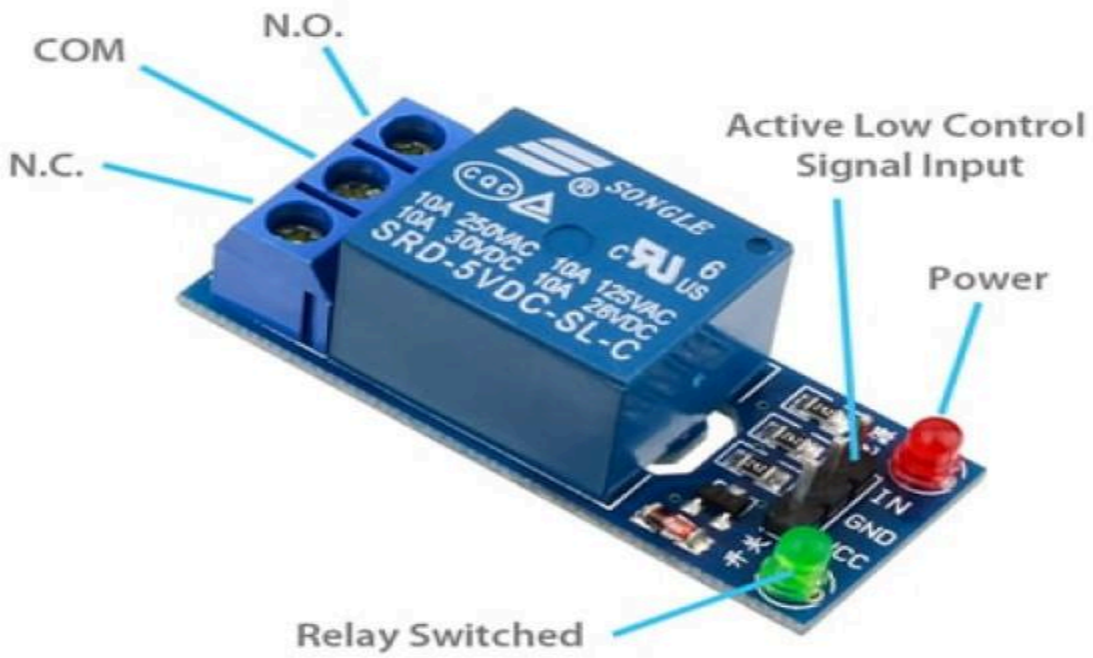
This IR Remote Control Kit is ideal for implementing an IR remote control for many projects including controlling robotics since the remote includes direction keys and basic number keys without all the unnecessary key clutter found on remotes used for TV style control.

Specifications:

- Transmission distance: up to 8m(depending on the surrounding environment-sensitivity of receiver etc)
- Battery: CR2025 button battery
- Battery capacity: 160mAh
- Effective angle: 60°
- Sticking material: 0.125mmPET
- Effective life: 20-000 times
- Static current: 3uA - 5uA
- Dynamic current: 3mA - 5mA

20. 5V Relay 1 Channel Relay Module

The Single Channel Relay Module is a convenient board which can be used to control high voltage, high current load such as motor, solenoid valves, lamps and AC load. It is designed to interface with microcontrollers such as Pico, ESP32 etc.



21. AHT10 Temperature and Humidity Sensor

The AHT10, a new generation of temperature and humidity sensors, sets a new standard in size and intelligence. The sensor outputs a calibrated digital signal in standard I2C format.

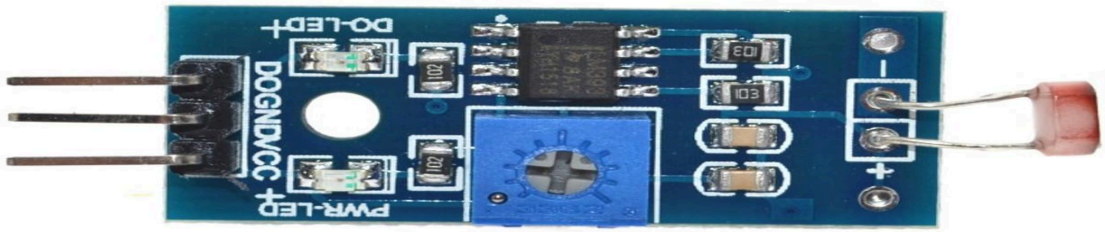
Specifications:

- **Module size:** 16*11 mm

- **Interface type:** I2C
- **Working voltage:** 1.8 - 6.0 V
- **Interface size:** 4*2.54mm pitch
- **Humidity accuracy:** typical ± 2%
- **Humidity resolution:** 0.024%
- **Temperature accuracy:** typical ± 0.3 ° C
- **Temperature resolution:** Typical 0.01 °C
- **Working temperature:** -40°C--85°C

22. Photoresistor Light Detection Sensor

A photocell or photoresistor is a sensor that changes its resistance when light shines on it. The resistance generated varies depending on the light striking at his surface. A high intensity of light incident on the surface will cause a lower resistance, whereas a lower intensity of light will cause higher resistance.



23. FT232 FTDI Breakout Board

FT232R chip is a single-chip solution, the general use of basic do not need peripherals, and even crystal, USB matching resistor, place the product information EEPROM has been integrated in the internal. FT232R there are some more useful features, the specific details can refer to the FT232R data sheet.

Performance:

- Standard interface, compatible with a variety official controller
- Original FT232 chip, stable performance

- With power, send, receive indicator, work status at a glance
- With 3.3V and 5V power supply options
- Can do ordinary USB to serial TTL module to use, download the STC microcontroller