LAMPIRAN

https://drive.google.com/drive/folders/1ZyCGoYKvJf1ksaxGcUA6ab-sGjWOa40T?usp=drive_link

Name: **Relay Module 2-Channel**
Code: **MR009-004.1**

This *Relay Module 2-Channel* is a module designed to allow you to control two relays in a very simple and intuitive manner. Being compatible with Arduino, the most immediate way to use it is to connect it to an Arduino board using flexible jumpers.

Exploiting the characteristics of the relays mounted on the module and through the use of two Arduino digital I/O pins, it is possible to control motors, inductive loads and other devices; this product is therefore fundamental in domotics projects or, more in general, in robotics projects.

The module is equipped with optocouplers on *IN1* and *IN2* lines in such a way that it ensures the galvanic insulation between the relay load and the control board which drives this module.

CONNECTIONS

Pin	*Function*
IN1	TTL digital input
IN2	TTL digital input
GND	Ground
+5V	Power (+5V)
NO1	Normally open contact
COM1	Common contact
NC1	Normally closed contact

NO2	Normally open contact
COM2	Common contact
NC2	Normally closed contact

Tab.1 – Connections

CHARACTERISTICS

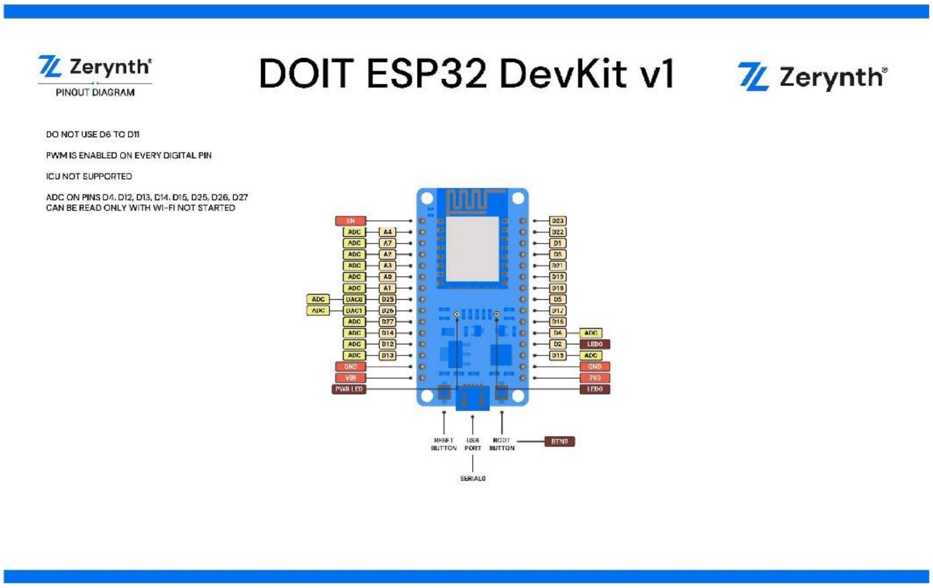
Pin	***Function***
Supply voltage	+5V
Supply current	144mA typ. (150mA max.)
Current on pin IN	14mA typ.
Rated load	7A 250VAC
Operating temperature	-30°C / +70°C
Operate time max.	10ms Max.
Release time max.	5ms Max.
Insulation resistance	100Mohm Min.
Mechanical Life Expectancy	10,000,000 operations
Electrical Life Expectancy	10,000 operations
Dimensions	1.7” x 1.3” (43.2 x 33.0 mm)
Weight	0.92oz (26.2g)

Tab.2 - Characteristics

DOIT Esp32 DevKit v1

The DOIT Esp32 DevKit v1 is one of the development board created by DOIT to evaluate the ESP-WROOM-32 module. It is based on the ESP32 microcontroller that boasts Wifi, Bluetooth, Ethernet and Low Power support all in a single chip.

Pin Mapping



More info about DOIT Esp32 DevKit v1 can be found here.

Flash Layout

The internal flash of the ESP32 module is organized in a single flash area with pages of 4096 bytes each. The flash starts at address 0x00000, but many areas are reserved for Esp32 IDF SDK and Zerynth VM. There exist two different layouts based on the presence of BLE support.

In particular, for non-BLE VMs:

Start address	Size	Content
0x00009000	16Kb	Esp32 NVS area
0x0000D000	8Kb	Esp32 OTA data
0x0000F000	4Kb	Esp32 PHY data
0x00010000	1Mb	Zerynth VM
0x00110000	1Mb	Zerynth VM (FOTA)
0x00210000	512Kb	Zerynth Bytecode
0x00290000	512Kb	Zerynth Bytecode (FOTA)
0x00310000	512Kb	Free for user storage
0x00390000	448Kb	Reserved

For BLE VMs:

Start address	Size	Content
0x00009000	16Kb	Esp32 NVS area
0x0000D000	8Kb	Esp32 OTA data
0x0000F000	4Kb	Esp32 PHY data
0x00010000	1216Kb	Zerynth VM
0x00140000	1216Kb	Zerynth VM (FOTA)
0x00270000	320Kb	Zerynth Bytecode
0x002C0000	320Kb	Zerynth Bytecode (FOTA)
0x00310000	512Kb	Free for user storage
0x00390000	448Kb	Reserved

Device Summary

- Microcontroller: Tensilica 32-bit Single-/Dual-core CPU Xtensa LX6
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 25
- Analog Input Pins (ADC): 6
- Analog Outputs Pins (DAC): 2
- UARTs: 3
- SPIs: 2
- I2Cs: 3
- Flash Memory: 4 MB
- SRAM: 520 KB
- Clock Speed: 240 Mhz
- Wi-Fi: IEEE 802.11 b/g/n/e/i:
    - Integrated TR switch, balun, LNA, power amplifier and matching network
    - WEP or WPA/WPA2 authentication, or open networks

Power

Power to the DOIT Esp32 DevKit v1 is supplied via the on-board USB Micro B connector or directly via the "VIN" pin. The power source is selected automatically.

The device can operate on an external supply of 6 to 20 volts. If using more than 12V, the voltage regulator may overheat and damage the device. The recommended range is 7 to 12 volts.

Connect, Register, Virtualize and Program

The DOIT Esp32 DevKit v1 comes with a serial-to-usb chip on board that allows programming and opening the UART of the ESP32 module. Drivers may be needed depending on your system (Mac or Windows) and can be download from the official Espressif documentation page. In Linux systems, the DevKit v1 should work out of the box.

Note

For Linux Platform: to allow the access to serial ports the user needs read/write access to the serial device file. Adding the user to the group, that owns this file, gives the required read/write access:

- **Ubuntu** distribution –> dialout group
- **Arch Linux** distribution –> uucp group

Once connected on a USB port, if drivers have been correctly installed, the DevKit v1 device is recognized by Zerynth Studio. The next steps are:

- **Select** the DevKit v1 on the **Device Management Toolbar** (disambiguate if necessary);
- **Register** the device by clicking the "Z" button from the Zerynth Studio;
- **Create** a Virtual Machine for the device by clicking the "Z" button for the second time;
- **Virtualize** the device by clicking the "Z" button for the third time.

Note

No user intervention on the device is required for registration and virtualization process

After virtualization, the DevKit v1 is ready to be programmed and the Zerynth scripts **uploaded**. Just **Select** the virtualized device from the "Device Management Toolbar" and **click** the dedicated "upload" button of Zerynth Studio.

Note

No user intervention on the device is required for the uplink process.

Firmware Over the Air update (FOTA)

The Firmware Over the Air feature allows to update the device firmware at runtime. Zerynth FOTA in the DevKitC device is available for bytecode and VM.

Flash Layout is shown in table below:

Start address	Size	Content
0x00010000	1Mb	Zerynth VM (slot 0)
0x00110000	1Mb	Zerynth VM (slot 1)
0x00210000	512Kb	Zerynth Bytecode (slot 0)
0x00290000	512Kb	Zerynth Bytecode (slot 1)

For BLE VMs:

Start address	Size	Content
0x00010000	1216Kb	Zerynth VM (slot 0)
0x00140000	1216Kb	Zerynth VM (slot 1)

Start address	Size	Content
0x00270000	320Kb	Zerynth Bytecode (slot 0)
0x002C0000	320Kb	Zerynth Bytecode (slot 1)

For Esp32 based devices, the FOTA process is implemented mostly by using the provided system calls in the IDF framework. The selection of the next VM to be run is therefore a duty of the Espressif bootloader; the bootloader however, does not provide a failsafe mechanism to revert to the previous VM in case the currently selected one fails to start. At the moment this lack of a safety feature can not be circumvented, unless by changing the bootloader. As soon as Espressif relases a new IDF with such feature, we will release updated VMs.

Secure Firmware

Secure Firmware feature allows to detect and recover from malfunctions and, when supported, to protect the running firmware (e.g. disabling the external access to flash or assigning protected RAM memory to critical parts of the system).

This feature is strongly platform dependent; more information at Secure Firmware - ESP32 section.

Zerynth Secure Socket

To be able to use Zerynth Secure Socket on esp32 boards `NATIVE_MBEDTLS: true` must be used instead of `ZERYNTH_SSL: true` in the `project.yml` file.

Missing features

Not all IDF features have been included in the Esp32 based VMs. In particular the following are missing but will be added in the near future:

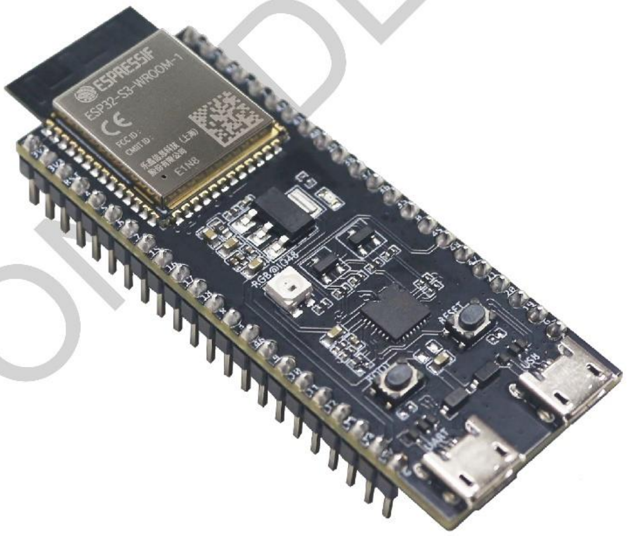
- Touch detection support

ESP32-S3-DevKitC-1

This user guide will help you get started with ESP32-S3-DevKitC-1 and will also provide more in-depth information.

The ESP32-S3-DevKitC-1 is an entry-level development board equipped with either ESP32-S3-WROOM-1 or ESP32-S3-WROOM-1U, a general-purpose Wi-Fi + Bluetooth LE MCU module that integrates complete Wi-Fi and Bluetooth LE functions.

Most of the I/O pins on the module are broken out to the pin headers on both sides of this board for easy interfacing. Developers can either connect peripherals with jumper wires or mount ESP32-S3-DevKitC-1 on a breadboard.



ESP32-S3-DevKitC-1

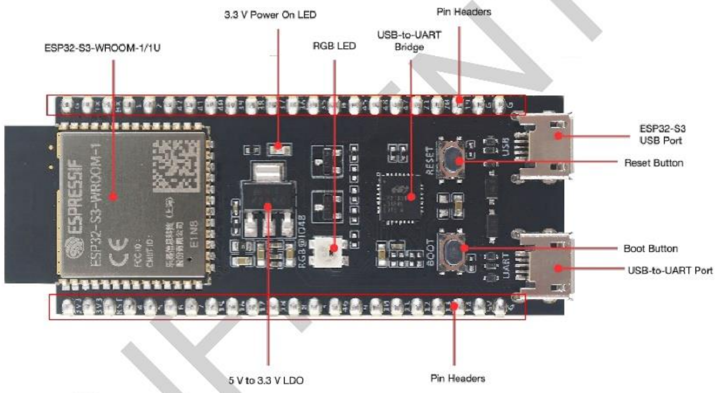
The document consists of the following major sections:

- Getting started: Overview of the board and hardware/software setup instructions to get started.
- Hardware Reference: More detailed information about the board's hardware.
- Hardware Revision Details: Revision history, known issues, and links to user guides for previous versions (if any) of the board.

Getting Started

This section provides a brief introduction of ESP32-S3-DevKitC-1, instructions on how to do the initial hardware setup and how to flash firmware onto it.

Description of Components



ESP32-S3-DevKitC-1 - front

The key components of the board are described in a counter-clockwise direction.

Key Component	Description
ESP32-S3-WROOM-1/1U	ESP32-S3-WROOM-1 and ESP32-S3-WROOM-1U are two powerful, generic Wi-Fi + Bluetooth LE MCU modules that have a rich set of peripherals. They provide acceleration for neural network computing and signal processing workloads.
5 V to 3.3 V LDO	Power regulator that converts a 5 V supply into a 3.3 V output.
Pin Headers	All available GPIO pins (except for the SPI bus for flash) are broken out to the pin headers on the board for easy interfacing and programming. For details, please see Header Block.

Key Component	Description
USB-to-UART Port	A Micro-USB port used for power supply to the board, as well as the communication with the ESP32-S3 chip via the on-board USB-to-UART bridge.
Boot Button	Download button. Holding down **Boot** and then pressing **Reset** initiates Firmware Download mode for downloading firmware through the serial port.
Reset Button	Press this button to restart the system.
ESP32-S3 USB Port	ESP32-S3 full-speed USB OTG interface, compliant with the USB 1.1 specification.
USB-to-UART Bridge	Single USB-to-UART bridge chip provides transfer rates up to 3 Mbps.
RGB LED	Addressable RGB LED, driven by GPIO48.
3.3 V Power On LED	Turns on when the USB power is connected to the board.

Start Application Development

Before powering up your board, please make sure that it is in good condition with no obvious signs of damage.

Required Hardware

- ESP32-S3-DevKitC-1
- USB 2.0 cable (Standard-A to Micro-B)
- Computer running Windows, Linux, or macOS

Note

Be sure to use an appropriate USB cable. Some cables are for charging only and do not provide the needed data lines nor work for programming the boards.

Software Setup

Please proceed to Get Started, where Section Installation Step by Step will quickly help you set up the development environment and then flash an application example onto your board.

Contents and Packaging

Retail orders

If you order a few samples, each board comes in an individual package in either antistatic bag or any packaging depending on your retailer.

For retail orders, please go to https://www.espressif.com/en/company/contact/buy-a-sample.

Wholesale Orders

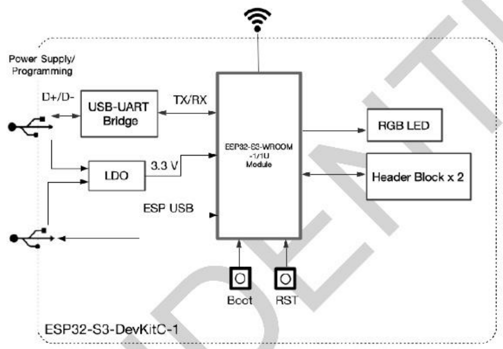
If you order in bulk, the boards come in large cardboard boxes.

For wholesale orders, please go to https://www.espressif.com/en/contact-us/sales-questions.

Hardware Reference

Block Diagram

The block diagram below shows the components of ESP32-S3-DevKitC-1 and their interconnections.



ESP32-S3-DevKitC-1 (click to enlarge)

Power Supply Options

There are three mutually exclusive ways to provide power to the board:

- USB-to-UART Port, default power supply (recommended)
- 5 V and GND pins
- 3V3 and GND pins

Header Block

The two tables below provide the **Name** and **Function** of the pins on both sides of the board (J1 and J3). The pin names are shown in ESP32-S3-DevKitC-1 - front. The numbering is the same as in the Board Schematic (PDF).

J1

No.	Name	Type [1]	Function

No.	Name	Type	Function
1	3V3	P	3.3 V power supply
2	3V3	P	3.3 V power supply
3	RST	I	EN
4	4	I/O/T	RTC_GPIO4, GPIO4, TOUCH4, ADC1_CH3
5	5	I/O/T	RTC_GPIO5, GPIO5, TOUCH5, ADC1_CH4
6	6	I/O/T	RTC_GPIO6, GPIO6, TOUCH6, ADC1_CH5
7	7	I/O/T	RTC_GPIO7, GPIO7, TOUCH7, ADC1_CH6
8	15	I/O/T	RTC_GPIO15, GPIO15, U0RTS, ADC2_CH4, XTAL_32K_P
9	16	I/O/T	RTC_GPIO16, GPIO16, U0CTS, ADC2_CH5, XTAL_32K_N
10	17	I/O/T	RTC_GPIO17, GPIO17, U1TXD, ADC2_CH6
11	18	I/O/T	RTC_GPIO18, GPIO18, U1RXD, ADC2_CH7, CLK_OUT3
12	8	I/O/T	RTC_GPIO8, GPIO8, TOUCH8, ADC1_CH7, SUBSPICS1
13	3	I/O/T	RTC_GPIO3, GPIO3, TOUCH3, ADC1_CH2
14	46	I/O/T	GPIO46
15	9	I/O/T	RTC_GPIO9, GPIO9, TOUCH9, ADC1_CH8, FSPIHD, SUBSPIHD
16	10	I/O/T	RTC_GPIO10, GPIO10, TOUCH10, ADC1_CH9, FSPICS0, FSPIIO4, SUBSPICS0
17	11	I/O/T	RTC_GPIO11, GPIO11, TOUCH11, ADC2_CH0, FSPID, FSPIIO5, SUBSPID
18	12	I/O/T	RTC_GPIO12, GPIO12, TOUCH12, ADC2_CH1, FSPICLK, FSPIIO6, SUBSPICLK
19	13	I/O/T	RTC_GPIO13, GPIO13, TOUCH13, ADC2_CH2, FSPIQ, FSPIIO7, SUBSPIQ
20	14	I/O/T	RTC_GPIO14, GPIO14, TOUCH14, ADC2_CH3, FSPIWP, FSPIDQS, SUBSPIWP
21	5V	P	5 V power supply
22	G	G	Ground

J3

No.	Name	Type	Function
1	G	G	Ground
2	TX	I/O/T	U0TXD, GPIO43, CLK_OUT1

No.	Name	Type	Function
3	RX	I/O/T	U0RXD, GPIO44, CLK_OUT2
4	1	I/O/T	RTC_GPIO1, GPIO1, TOUCH1, ADC1_CH0
5	2	I/O/T	RTC_GPIO2, GPIO2, TOUCH2, ADC1_CH1
6	42	I/O/T	MTMS, GPIO42
7	41	I/O/T	MTDI, GPIO41, CLK_OUT1
8	40	I/O/T	MTDO, GPIO40, CLK_OUT2
9	39	I/O/T	MTCK, GPIO39, CLK_OUT3, SUBSPICS1
10	38	I/O/T	GPIO38, FSPIWP, SUBSPIWP
11	37	I/O/T	SPIDQS, GPIO37, FSPIQ, SUBSPIQ
12	36	I/O/T	SPIIO7, GPIO36, FSPICLK, SUBSPICLK
13	35	I/O/T	SPIIO6, GPIO35, FSPID, SUBSPID
14	0	I/O/T	RTC_GPIO0, GPIO0
15	45	I/O/T	GPIO45
16	48	I/O/T	GPIO48 [2], SPICLK_N, SUBSPICLK_N_DIFF
17	47	I/O/T	GPIO47, SPICLK_P, SUBSPICLK_P_DIFF
18	21	I/O/T	RTC_GPIO21, GPIO21
19	20	I/O/T	RTC_GPIO20, GPIO20, U1CTS, ADC2_CH9, CLK_OUT1, USB_D+
20	19	I/O/T	RTC_GPIO19, GPIO19, U1RTS, ADC2_CH8, CLK_OUT2, USB_D-
21	G	G	Ground
22	G	G	Ground

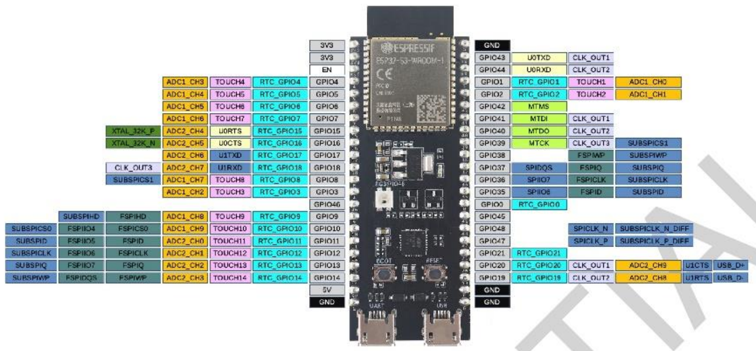
1

P: Power supply; I: Input; O: Output; T: High impedance.

2

Used to drive the RGB LED.

Pin Layout


3V3
3V3
EN
ADC1_CH3 TOUCH4 RTC_GPIO4 GPIO4
ADC1_CH4 TOUCH5 RTC_GPIO5 GPIO5
ADC1_CH5 TOUCH6 RTC_GPIO6 GPIO6
ADC1_CH6 TOUCH7 RTC_GPIO7 GPIO7
XTAL_32K_P ADC2_CH4 U0RTS RTC_GPIO15 GPIO15
XTAL_32K_N ADC2_CH5 U0CTS RTC_GPIO16 GPIO16
ADC2_CH6 U1TXD RTC_GPIO17 GPIO17
CLK_OUT3 ADC2_CH7 U1RXD RTC_GPIO18 GPIO18
SUBSPICS1 ADC1_CH7 TOUCH8 RTC_GPIO8 GPIO8
ADC1_CH2 TOUCH3 RTC_GPIO3 GPIO3
GPIO46
SUBSPIHD FSPIHD ADC1_CH8 TOUCH9 RTC_GPIO9 GPIO9
SUBSPICS0 FSPIIO4 FSPICS0 ADC1_CH9 TOUCH10 RTC_GPIO10 GPIO10
SUBSPID FSPIIO5 FSPID ADC2_CH0 TOUCH11 RTC_GPIO11 GPIO11
SUBSPICLK FSPIIO6 FSPICLK ADC2_CH1 TOUCH12 RTC_GPIO12 GPIO12
SUBSPIQ FSPIIO7 FSPIQ ADC2_CH2 TOUCH13 RTC_GPIO13 GPIO13
SUBSPIWP FSPIDQS FSPIWP ADC2_CH3 TOUCH14 RTC_GPIO14 GPIO14
5V
GND
GND
GPIO43 U0TXD CLK_OUT1
GPIO44 U0RXD CLK_OUT2
GPIO1 RTC_GPIO1 TOUCH1 ADC1_CH0
GPIO2 RTC_GPIO2 TOUCH2 ADC1_CH1
GPIO42 MTMS
GPIO41 MTDI CLK_OUT1
GPIO40 MTDO CLK_OUT2
GPIO39 MTCK CLK_OUT3 SUBSPICS1
GPIO38 FSPIWP SUBSPIWP
GPIO37 SPIDQS FSPIQ SUBSPIQ
GPIO36 SPIIO7 FSPICLK SUBSPICLK
GPIO35 SPIIO6 FSPID SUBSPID
GPIO0 RTC_GPIO0
GPIO45
GPIO48 SPICLK_N SUBSPICLK_N_DIFF
GPIO47 SPICLK_P SUBSPICLK_P_DIFF
GPIO21 RTC_GPIO21
GPIO20 RTC_GPIO20 CLK_OUT1 ADC2_CH9 U1CTS USB_D+
GPIO19 RTC_GPIO19 CLK_OUT2 ADC2_CH8 U1RTS USB_D-
GND
GND
ESPRESSIF
ESP32-S3-WROOM-1
BOOT
RESET
UART
USB

ESP32-S3-DevKitC-1 Pin Layout (click to enlarge)

Hardware Revision Details

No previous versions available.

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Previous

Next

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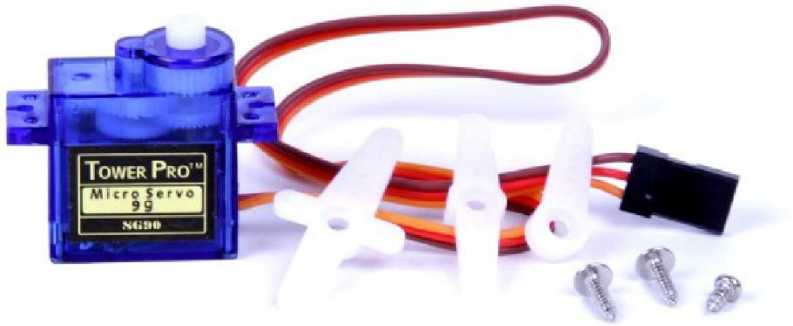
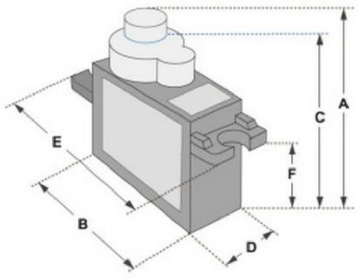
SERVO MOTOR SG90 DATA SHEET

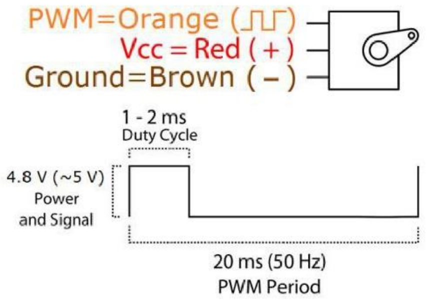


Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.



Dimensions & Specifications
A (mm) : 32
B (mm) : 23
C (mm) : 28.5
D (mm) : 12
E (mm) : 32
F (mm) : 19.5
Speed (sec) : 0.1
Torque (kg-cm) : 2.5
Weight (g) : 14.7
Voltage : 4.8 - 6

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, is all the way to the right, "-90" (~1ms pulse) is all the way to the left.



HC-SR04 Ultrasonic Sensor

Elijah J. Morgan

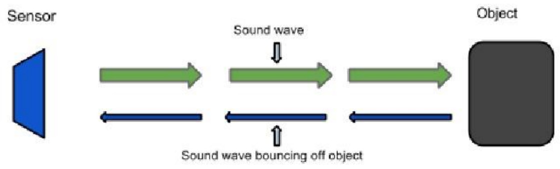
Nov. 16 2014

The purpose of this file is to explain how the HC-SR04 works. It will give a brief explanation of how ultrasonic sensors work in general. It will also explain how to wire the sensor up to a microcontroller and how to take/interpret readings. It will also discuss some sources of errors and bad readings.

1. **How Ultrasonic Sensors Work**
2. **HC-SR04 Specifications**
3. **Timing chart, Pin explanations and Taking Distance Measurements**
4. **Wiring HC-SR04 with a microcontroller**
5. **Errors and Bad Readings**

1. How Ultrasonic Sensors Work

Ultrasonic sensors use sound to determine the distance between the sensor and the closest object in its path. How do ultrasonic sensors do this? Ultrasonic sensors are essentially sound sensors, but they operate at a frequency above human hearing.



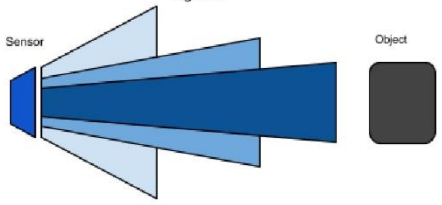
The sensor sends out a sound wave at a specific frequency. It then listens for that specific sound wave to bounce off of an object and come back (Figure 1). The sensor keeps track of the time between sending the sound wave and the sound wave returning. If you know how fast something is going and how long it is traveling you can find the distance traveled with equation 1.

Equation 1. $d = v \times t$

The speed of sound can be calculated based on the a variety of atmospheric conditions, including temperature, humidity and pressure. Actually calculating the distance will be shown later on in this document.

It should be noted that ultrasonic sensors have a cone of detection, the angle of this cone varies with distance, Figure 2 show this relation. The ability of a sensor to detect an object also depends on the objects orientation to the sensor. If an object doesn't present a flat surface to the sensor then it is possible the sound wave will bounce off the object in a way that it does not return to the sensor.

Figure 2



2. HC-SR04 Specifications

The sensor chosen for the Firefighting Drone Project was the HC-SR04. This section contains the specifications and why they are important to the sensor module. The sensor modules requirements are as follows.

- Cost
- Weight
- Community of hobbyists and support
- Accuracy of object detection
- Probability of working in a smoky environment
- Ease of use

The HC-SR04 Specifications are listed below. These specifications are from the Cytron Technologies HC-SR04 User's Manual (source 1).

- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working current: 15mA
- Effectual Angle: <15º
- Ranging Distance: 2-400 cm
- Resolution: 0.3 cm
- Measuring Angle: 30º
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm
- Weight: approx. 10 g

The HC-SR04's best selling point is its price; it can be purchased at around $2 per unit.

3. Timing Chart and Pin Explanations

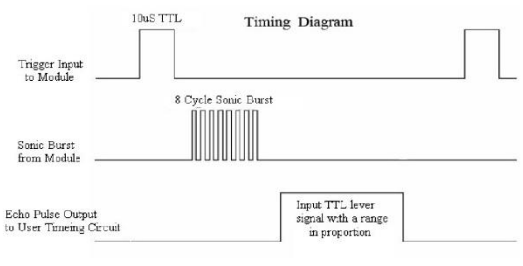
The HC-SR04 has four pins, VCC, GND, TRIG and ECHO; these pins all have different functions. The VCC and GND pins are the simplest -- they power the HC-SR04. These pins need to be attached to a +5 volt source and ground respectively. There is a single control pin: the TRIG pin. The TRIG pin is responsible for sending the ultrasonic burst. This pin should be set to HIGH for 10 μs, at which point the HC-SR04 will send out an eight cycle sonic burst at 40 kHZ. After a sonic burst has been sent the ECHO pin will go HIGH. The ECHO pin is the data pin -- it is used in taking distance measurements. After an ultrasonic burst is sent the pin will go HIGH, it will stay high until an ultrasonic burst is detected back, at which point it will go LOW.

Taking Distance Measurements

The HC-SR04 can be triggered to send out an ultrasonic burst by setting the TRIG pin to HIGH. Once the burst is sent the ECHO pin will automatically go HIGH. This pin will remain HIGH until the the burst hits the sensor again. You can calculate the distance to the object by keeping track of how long the ECHO pin stays HIGH. The time ECHO stays HIGH is the time the burst spent traveling. Using this measurement in equation 1 along with the speed of sound will yield the distance travelled. A summary of this is listed below, along with a visual representation in Figure 2.

1. Set TRIG to HIGH
2. Set a timer when ECHO goes to HIGH
3. Keep the timer running until ECHO goes to LOW
4. Save that time
5. Use equation 1 to determine the distance travelled

Figure 3
Source 2


10uS TTL
Timing Diagram
Trigger Input to Module
8 Cycle Sonic Burst
Sonic Burst from Module
Echo Pulse Output to User Timeing Circuit
Input TTL lever signal with a range in proportion

Source 2

To interpret the time reading into a distance you need to change equation 1. The clock on the device you are using will probably count in microseconds or smaller. To use equation 1 the speed of sound needs to determined,which is 343 meters per second at standard temperature and pressure. To convert this into more useful form use equation 2 to change from meters per second to microseconds per centimeter. Then equation 3 can be used to easily compute the distance in centimeters.

Equation 2. $Distance = \frac{Speed}{170.15\ m} \times \frac{Meters}{100\ cm} \times \frac{1e6\ \mu S}{170.15\ m} \times \frac{58.772\ \mu S}{cm}$

Equation 3. $Distance = \frac{time}{58} = \frac{\mu s}{\mu s/cm} = cm$

4. Wiring the HC-SR04 to a Microcontroller

This section only covers the hardware side. For information on how to integrate the software side, look at one of the links below or look into the specific microcontroller you are using.

The HC-SR04 has 4 pins: VCC, GND, TRIG and ECHO.

1. VCC is a 5v power supply. This should come from the microcontroller
2. GND is a ground pin. Attach to ground on the microcontroller.
3. TRIG should be attached to a GPIO pin that can be set to HIGH
4. ECHO is a little more difficult. The HC-SR04 outputs 5v, which could destroy many microcontroller GPIO pins (the maximum allowed voltage varies). In order to step down the voltage use a single resistor or a voltage divider circuit. Once again this depends on the specific microcontroller you are using, you will need to find out its GPIO maximum voltage and make sure you are below that.

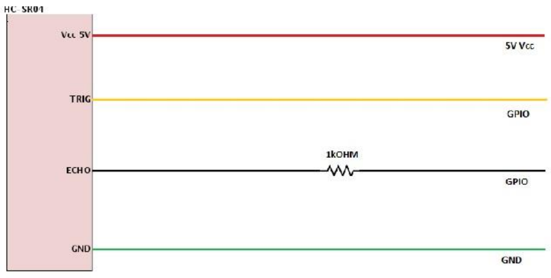
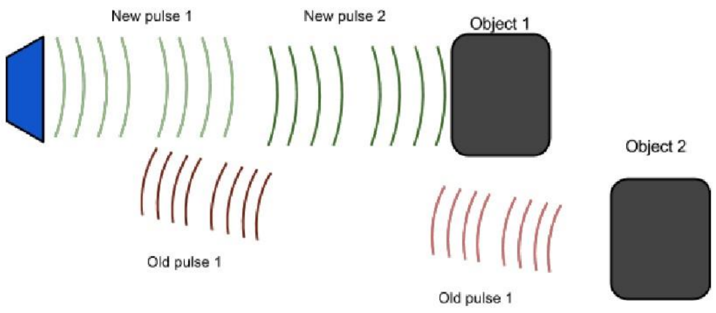


Figure 4

5. Errors and Bad Readings

Ultrasonic sensors are great sensors -- they work well for many applications where other types of sensors fall short. Unfortunately, they do have weaknesses. These weaknesses can be mitigated and worked around, but first they must be understood. The first weakness is that they use sound. There is a limit to how fast ultrasonic sensors can get distance measurements. The longer the distance, the slower they are at reporting the distance. The second weakness comes from the way sound bounces off of objects. In enclosed spaces it is possible, if not probable that there will be unintended echos. The echos can very easily cause false short readings. In Figure 2 a pulse was sent out. It bounced off of object 1 and returned to the sensor. The distance was recorded and then a new pulse was sent. There was another object farther away, so that when the new pulse reaches object 1, the first signal will reach the sensor. This will cause the sensor to think that there is an object closer than is actually true. The old pulse is smaller than the new pulse because it has grown weaker. The longer the pulse exists the weaker it grows until it is negligible. If multiple sensors are being used, the number of echos will increase along with the number of errors. There are two main ways to reduce the number of errors. The first is to provide shielding around the sensor. This prevents echos coming in from angle outside what the sensor should actually pick up. The second is to reduce the frequency at which pulses are sent out. This gives more time for the echos to dissipate.



Works Cited

Source 1.
"HC-SR04 User's_Manual." *docs.google.* Cytron Technologies, May 2013 Web. 5 Dec. 2009.
<https://docs.google.com/document/d/1Y-yZnNhMYy7rwhAgyL_pfa39RsB-x2qR4vP8saG73rE/edit>

Source 2.
"Attiny2313 Ultrasonic distance (HR-SR04) example." *CircuitDB.* n.a. 7 Sept. 2014 Web. 5 Dec. 2014. <http://www.circuitdb.com/?p=1162>

Links

These are not formatted; you will need to copy and paste them into your web browser.

Want to learn about Ultrasonic Sensors in general?
http://www.sensorsmag.com/sensors/acoustic-ultrasound/choosing-ultrasonic-sensor-proximity-or-distance-measurement-825

All about the HC-SR04

- http://www.circuitdb.com/?p=1162
- http://www.micropik.com/PDF/HCSR04.pdf
- http://randomnerdtutorials.com/complete-guide-for-ultrasonic-sensor-hc-sr04/
- http://www.ezdenki.com/ultrasonic.php
  (^fantastic tutorial, explains a lot of stuff)
- http://www.elecrow.com/hcsr04-ultrasonic-ranging-sensor-p-316.html
  (^ this one has some cool charts)