

Documentation of Electronics Components

1. ESP32

Detailed Description

The ESP32 is a powerful and versatile microcontroller developed by Espressif Systems. It features a dual-core 32-bit Tensilica Xtensa LX6 processor, capable of running at up to 240 MHz.

Equipped with built-in Wi-Fi and Bluetooth (classic and BLE), it's ideal for IoT and wireless applications.

The ESP32 includes a rich set of peripherals such as ADC, DAC, UART, SPI, I2C, PWM, and touch sensors.

It offers 520 KB SRAM and typically 4 MB flash memory, expandable via SPI.

Designed for efficiency, it supports deep sleep modes consuming as little as 10 μ A.

Security is built-in, with features like secure boot and flash encryption.

The chip supports real-time operations via FreeRTOS and other development frameworks.

It is compatible with Arduino IDE, ESP-IDF, MicroPython, and Lua.

Compact, cost-effective, and powerful, the ESP32 is widely used in automation, wearables, and smart devices.



Fig. Esp-32

ESP32 Specifications

Processor

- **Model:** Tensilica Xtensa LX6 Dual-Core
- **Architecture:** 32-bit
 - Dual-core processor (can be individually controlled)
 - Clock speed: up to 240MHz

Memory

- **RAM:**
 - 520KB SRAM
 - 8KB SRAM in RTC
- **Flash:** Typically 4MB (varies depending on the module and manufacturer)
 - External flash memory support via SPI

Networking

- **Wi-Fi:** 802.11 b/g/n
 - Supports 2.4 GHz Wi-Fi
 - WPA/WPA2 security
- **Bluetooth:**
 - Bluetooth v4.2 BR/EDR and BLE (Bluetooth Low Energy)

Peripheral Interfaces

- **GPIO:**
 - 34 programmable GPIO pins
- **ADC:**
 - 18 channels of 12-bit SAR ADC
- **DAC:**
 - 2 channels of 8-bit DAC
- **UART:**
 - 3 UART interfaces
- **SPI:**
 - 4 SPI interfaces
- **I2C:**
 - 2 I2C interfaces

Power Management

- **Power Supply:**

- Operating voltage: 2.2V to 3.6V
- Deep sleep current: $\sim 10\mu\text{A}$
- Light sleep current: $\sim 0.8\text{mA}$
- Active mode: $\sim 160\text{mA}$

Clock

- **RTC:**

- Real-time clock for deep sleep wake-up
- Timer and wake-up interrupts

Security

- **Security Features:**

- Secure boot
- Flash encryption
- Cryptographic hardware acceleration (AES, SHA-2, RSA, ECC, RNG)

Physical Dimensions

- **Dimensions:**

- Varies by module (common modules like ESP-WROOM-32 are approximately 25.5mm x 18mm)

Operating System Support

- **Supported OS:**

- Compatible with FreeRTOS (built-in)
- Supports Arduino IDE
- Other development frameworks: ESP-IDF, MicroPython, Lua

2. JSN-SR04T Ultrasonic Sensor Detailed Description

The JSN-SR04T Ultrasonic Sensor is a distance-measuring sensor based on ultrasonic technology. It uses ultrasonic waves to detect objects and measure distances accurately. This sensor is widely used in robotics, industrial automation, security systems, and various other applications requiring non-contact distance measurement.

1. Operation

The JSN-SR04T sensor operates by emitting ultrasonic pulses and measuring the time taken for the pulses to reflect off an object and return to the sensor. It consists of a transducer that generates ultrasonic waves and a receiver that detects the reflected waves. By measuring the time delay between the emission and reception of ultrasonic pulses, the sensor calculates the distance to the target object using the speed of sound in air as a reference.



Fig. Ultrasonic Sensor

2. Applications

The JSN-SR04T Ultrasonic Sensor has a wide range of applications, including:

- **Obstacle Detection:** Detecting obstacles and avoiding collisions in robotics and autonomous vehicles.
- **Distance Measurement:** Measuring distances between objects or surfaces accurately in industrial automation and control systems.
- **Liquid Level Sensing:** Monitoring liquid levels in tanks or containers for process control and inventory management.
- **Proximity Sensing:** Sensing the presence or absence of objects in security systems, access control, and proximity detection applications.
- **Flow Measurement:** Measuring fluid flow rates by monitoring the transit time of ultrasonic pulses in flow meters.

3. Features

- **High Accuracy:** Provides accurate distance measurements with resolutions typically in the millimeter range, depending on the sensor's specifications and configuration.
- **Long Range:** Offers long-range detection capabilities, with maximum ranges extending from a few centimeters to several meters, depending on the sensor model and environment.
- **Non-Contact Operation:** Operates without physical contact with the target object, making it suitable for applications requiring non-invasive sensing.
- **Wide Operating Voltage Range:** Compatible with a wide range of supply voltages, typically ranging from 3.3V to 5V, allowing for easy integration with various microcontroller platforms and electronic systems.

4. Considerations

When using the JSN-SR04T Ultrasonic Sensor, consider the following:

- **Operating Environment:** Ensure that the sensor's operating conditions, including temperature, humidity, and ambient noise levels, are within its specified operating range to ensure accurate and reliable performance.
- **Mounting Position:** Install the sensor at an appropriate height and angle relative to the target object to optimize detection range and accuracy.
- **Target Object Properties:** Be aware that the sensor's performance may be affected by the material, shape, and surface texture of the target object, which can impact ultrasonic wave reflection and absorption.

3. Float Sensor

A float sensor is a passive liquid-level detection device used to determine the presence or level of liquid in a tank. It typically consists of a hollow float containing a small magnet, which moves along a non-conductive stem as the liquid level rises or falls. A reed switch embedded in the stem closes or opens the circuit based on the magnet's position.

1. Operation

The float sensor does not require any power to operate — it relies on the movement of the float and magnet.

When the liquid (e.g., water) rises to the float's position, it pushes the float upward.

The magnet inside the float comes close to the reed switch inside the shaft.

This closes the circuit, allowing current to flow.

As the liquid drops, the float moves down and the circuit opens again.

This simple on-off behavior is ideal for liquid level detection using microcontrollers or logic circuits.



Fig. Float Sensor

2. Applications

The float sensor is commonly used in environments that require **liquid level monitoring or control**.

- **Water tanks:** Detect when water reaches a specific level for overflow or pump automation.
- **Industrial containers:** Monitor chemical or fluid levels in process control systems.
- **Aquariums:** Help maintain desired water levels for aquatic life.
- **Sump pumps:** Trigger pump activation or deactivation.
- **Home appliances:** Water level detection in washing machines or RO systems.

3. Features

- **Passive Operation:** Requires no external power for sensing; purely mechanical and magnetic.
- **Simple Integration:** Acts like a switch — easy to interface with digital input pins or relays.
- **Reliable Design:** Waterproof construction with sealed float and stem.
- **Versatile Mounting:** Typically mounted vertically in tanks or containers.
- **Reversible Logic:** Can be configured for normally open (NO) or normally closed (NC) operation depending on installation.

4. Considerations

- **Mounting Orientation:** Must be installed vertically for proper float movement.
- **Liquid Compatibility:** Ensure material compatibility with the liquid to prevent degradation.
- **Magnetic Sensitivity:** Avoid strong external magnetic fields which may cause false triggering.
- **Debounce Logic:** In software, implement debouncing to avoid false readings due to ripples or vibrations.
- **Limitations:** Suitable for non-pressurized, clean liquid environments — avoid use in viscous or high-debris tanks.

4. Relay

A 5V SPDT (Single-Pole Double-Throw) relay is an electromechanical switch designed to handle a variety of high-power electrical applications. It operates with a 5V control signal and offers a Single-Pole Double-Throw configuration, allowing it to switch between two different circuits.

1. Operation

The relay comprises a coil, armature, and contacts. When a 5V control signal is applied across the coil, it generates a magnetic field, which moves the armature, and consequently, changes the state of the relay's switch contacts. In the case of an SPDT relay, there are three terminals: common (COM), normally open (NO), and normally closed (NC). The relay can be configured to connect the common terminal either to the normally open or normally closed terminal based on the state of the coil.



Fig. 5v Relay

2. Applications

This type of relay is commonly used in applications where a single control signal needs to switch between two separate circuits. Some common applications include:

- **Home Automation:** Controlling lights, fans, and appliances with a single switch.
- **Industrial Machinery:** Switching between different operational modes or configurations.
- **Power Distribution:** Routing power from a single source to two different loads based on control inputs.
- **Automotive:** Switching between primary and secondary power sources or activating different electrical systems in vehicles.

3. Features

- **Current and Voltage Ratings:** Capable of handling up to 20A current and 220V AC voltage, making it suitable for a wide range of high-power applications.
- **SPDT Configuration:** Provides flexibility to switch between two circuits, offering versatility in various control scenarios.
- **Reliable Operation:** The electromechanical design ensures reliable switching performance over a long lifespan, making it suitable for industrial and commercial use.
- **5V Control Signal:** Operates with a low-voltage 5V control signal, compatible with common microcontrollers, digital logic circuits, and control systems.

4. Considerations

When using a 5V SPDT relay capable of handling 20A current and 220V AC, it's essential to consider the following:

- **Load Compatibility:** Ensure that the relay's current and voltage ratings match the requirements of the load being switched.
- **Control Circuit:** Use an appropriate control circuit capable of providing a 5V signal to energize the relay coil.
- **Safety:** Implement proper safety measures, including insulation and isolation, to prevent electrical hazards when working with high-power circuits.

5. Buzzer

1. Overview

A 5V buzzer can be of two main types: active and passive. Active buzzers have an internal oscillator that generates the sound automatically when power is applied, while passive buzzers require an external driving signal to produce sound.

2. Key Features

- **Operating Voltage:** 5V DC
- **Current Consumption:** Typically around 10-30mA, depending on the specific model and manufacturer
- **Sound Output:** Usually around 85dB to 100dB at a distance of 10cm, which is sufficient for most small to medium-sized alert systems
- **Frequency:** For active buzzers, the sound frequency is fixed, often around 2-4kHz. Passive buzzers can produce a range of frequencies depending on the input signal.
- **Size and Packaging:** Buzzers come in various sizes and packages, including cylindrical, rectangular, and surface-mount types, making them suitable for different mounting and space requirements.



Fig. Buzzer

3. Construction and Operation

A 5V buzzer typically consists of the following components:

- **Housing:** Encloses the internal components and amplifies the sound. It is usually made of plastic and may include mounting holes for easy installation.
- **Piezoelectric Element or Electromagnetic Coil:** The sound-producing element. Piezoelectric buzzers use a piezoelectric ceramic disc that vibrates when an electrical signal is applied. Electromagnetic buzzers use an electromagnetic coil and a diaphragm to generate sound.
- **Internal Oscillator (for Active Buzzers):** Generates the required frequency to produce sound without the need for an external signal.

4. Applications

5V buzzers are versatile and find use in a wide range of applications:

- **Alarms and Warning Systems:** Used in security systems, smoke detectors, and other alarm systems to provide audible alerts.
- **Timers and Clocks:** Provides sound notifications in kitchen timers, alarm clocks, and other timing devices.
- **Electronic Toys and Gadgets:** Used in toys and various electronic gadgets to produce sounds and music.
- **User Interface Feedback:** Provides audio feedback in appliances and devices, such as button presses on a microwave oven or other home appliances.
- **DIY Electronics Projects:** Popular among hobbyists and makers for use in custom-built projects and prototypes.

5. Considerations

- **Sound Volume:** Ensure the sound volume is appropriate for the application. Some environments may require louder buzzers, while others may need quieter ones.
- **Type of Buzzer:** Choose between active and passive buzzers based on the control requirements. Active buzzers are simpler to use, while passive buzzers offer more flexibility in sound generation.
- **Mounting and Packaging:** Consider the physical size and mounting requirements to ensure proper integration into the final product.
- **Operating Environment:** Ensure the buzzer is suitable for the operating environment, especially if used in outdoor or harsh conditions.

6. LM7805

1. Overview

The LM7805 is a three-terminal positive voltage regulator IC, commonly housed in a TO-220 package, although other packages are available. It is capable of providing up to 1.5A of output current, making it suitable for powering small to medium-sized electronic circuits.

Key Features

- **Output Voltage:** Fixed at 5V
- **Input Voltage Range:** Typically requires an input voltage of 7V to 35V to maintain a stable 5V output
- **Output Current:** Can provide up to 1.5A of continuous current
- **Thermal Overload Protection:** Automatically shuts down if the IC overheats, preventing damage from excessive heat
- **Short-Circuit Protection:** Limits output current to protect the IC and connected components in case of a short circuit
- **Safe Operating Area (SOA) Protection:** Ensures the IC operates safely under various load conditions

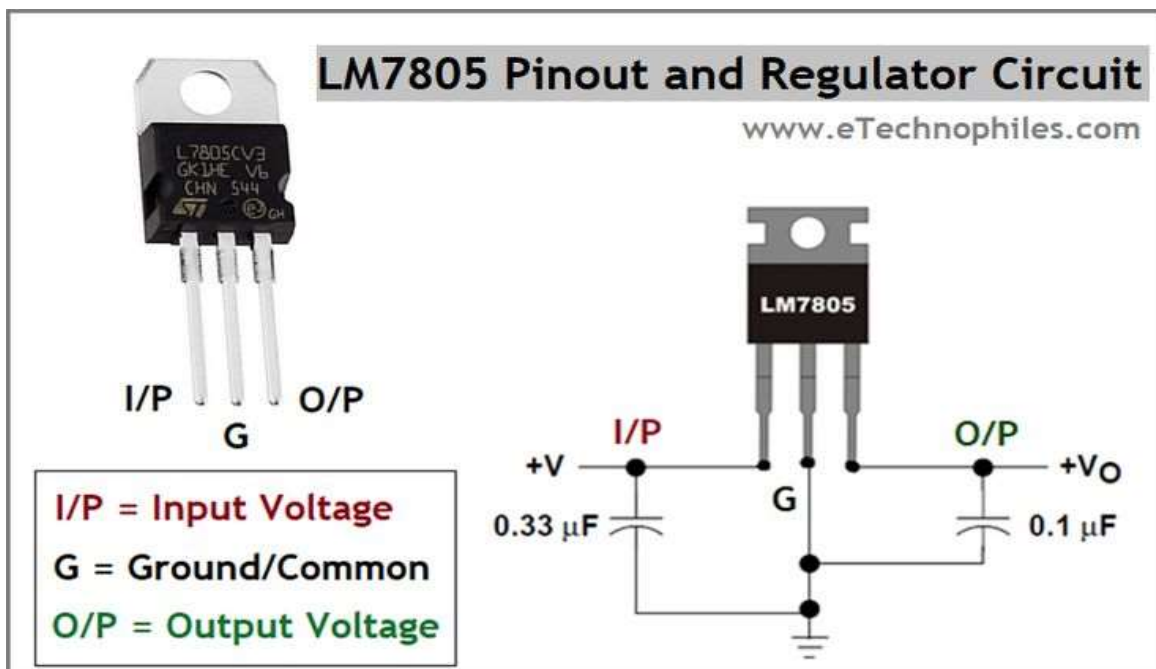


Fig. LM7805

2. Construction and Operation

The LM7805 consists of a series of internal components, including an error amplifier, a reference voltage source, and a pass transistor. The error amplifier compares the output voltage to a precise reference voltage and adjusts the pass transistor to maintain a stable 5V output. This closed-loop feedback system ensures that the output remains constant even with varying input voltage and load conditions.

3. Applications

The LM7805 is versatile and can be used in a wide range of applications:

- **Power Supplies:** Provides a stable 5V output for powering microcontrollers, sensors, and other low-power devices.
- **Battery Chargers:** Regulates the voltage supplied to rechargeable batteries, ensuring they are charged safely and efficiently.
- **Embedded Systems:** Supplies a reliable 5V to embedded systems, ensuring stable operation of the processor and peripherals.
- **Consumer Electronics:** Used in various consumer electronics to maintain consistent voltage levels for proper operation.

4. Considerations

- **Heat Dissipation:** The LM7805 can generate significant heat, especially when there is a large difference between input and output voltage. Adequate heat sinking or cooling measures are necessary to maintain safe operating temperatures.
- **Efficiency:** As a linear regulator, the LM7805 is less efficient than switching regulators, particularly when the input voltage is much higher than the output voltage. This can lead to power loss in the form of heat.
- **Capacitors:** While the LM7805 requires minimal external components, using appropriate input and output capacitors can improve stability and transient response. Typically, a 0.33 μ F capacitor on the input and a 0.1 μ F capacitor on the output are recommended.