# Useful ICs

## Analog multiplexer/demultiplexer

1. **74HC4051** – An 8-channel analog multiplexer/demultiplexer that allows switching between one common pin and 8 selectable pins. It works with both digital and analog signals.
2. **CD4051** – Similar to 74HC4051, but operates at a wider voltage range (3V to 15V).
3. **MAX4617** – A low-resistance analog switch with 8 channels.
4. **ADG508** – A precision 8-channel analog multiplexer from Analog Devices.
5. **CD74HCx4067** High-Speed CMOS Logic 16-Channel
6. **PCF8574 (I2c I/O Expander)**

## Shift Registers

### ****Serial-In, Parallel-Out (SIPO) Shift Registers****

Used to **expand output pins**, great for **driving LEDs, 7-segment displays, or relays**.

1. **74HC595** – 8-bit SIPO with a latch (most popular for Arduino, ESP32).
2. **TPIC6B595** – 8-bit power SIPO with open-drain outputs (good for high-current loads).
3. **CD4094** – 8-bit SIPO with buffered outputs, works at a wide voltage range.
4. **M74HC595** – Similar to 74HC595 but optimized for low power.

### ****Parallel-In, Serial-Out (PISO) Shift Registers****

Used to **read multiple input buttons/switches with fewer GPIOs**.

1. **74HC165** – 8-bit PISO, often used for reading buttons efficiently.
2. **CD4021** – 8-bit PISO, similar to 74HC165 but works at wider voltage (3V-15V).
3. **SN74LS166** – 8-bit PISO with synchronous loading.

### ****Universal Shift Registers (Parallel & Serial In/Out)****

Can function as **SIPO, PISO, or shift both ways**.

1. **74HC194** – 4-bit universal shift register.
2. **74HC299** – 8-bit bidirectional universal shift register.

## Timers

### ****1. 555 Timer IC (Most Famous)****

* The **NE555** is the most widely used timer IC ever.
* Works in **Astable (oscillator), Monostable (one-shot), and Bistable** modes.
* Used for **PWM, delays, frequency generation, and tone generation**.
* Variants:
  + **NE555** – Standard version.
  + **LM555** – Low-power version.
  + **TLC555** – CMOS version (low power, wider voltage range).
  + **7555** – Another CMOS version with lower power consumption.
  + **LM556** – Dual 555 timers in one IC.

### ****2. 74HC123 (Dual Retriggerable Monostable Multivibrator)****

* Generates precise **timing pulses** with adjustable duration.
* Useful for **pulse shaping, frequency counting, and delays**.
* Dual timers in one package.

Used for **delays, pulse generation, and oscillators**.

* **NE555** – Most famous timer IC.
* **74HC123** – Dual monostable multivibrator for pulse timing.
* **DS3231** – Real-time clock (RTC) for keeping time.

## ****Logic ICs****

Used for **digital logic operations (AND, OR, NOT, etc.)** in circuits.

* **74HC00 (NAND Gate)** – Fundamental building block of logic circuits.
* **74HC04 (NOT Gate)** – Inverter IC.
* **74HC32 (OR Gate)** – OR logic operation.
* **74HC86 (XOR Gate)** – Used in arithmetic and encryption circuits.

## Sensor ICs

Used for measuring physical parameters like temperature, pressure, and motion.

DHT11/DHT22 – Temperature & humidity sensor IC.

MPU6050 – Gyroscope & accelerometer.

ADS1115 – 16-bit ADC for precise analog readings.

## Audio and VU Meters

LM3915

## Best High-Precision ADCs for ESP32

### ADS1115 (16-bit, I²C, 4 channels) – Easy to Use

✅ 16-bit resolution (compared to ESP32’s 12-bit)

✅ I²C interface (easy to connect)

✅ Adjustable gain (measure small voltages)

✅ Built-in comparator (can trigger interrupts)

✅ 4 channels (can measure multiple inputs)

Best for: Measuring resistance, sensors, voltage dividers

Limitations: 860 SPS max sampling rate (not for fast signals)

### ADS1015 (12-bit, I²C, 4 channels) – Faster but Less Accurate

✅ Faster than ADS1115 (3300 SPS vs 860 SPS)

✅ I²C interface

✅ Same features as ADS1115 but lower resolution

📌 Best for: When you need speed over accuracy

🔻 Limitations: Lower resolution than ADS1115

### MCP3424 (18-bit, I²C, 4 channels) – Higher Precision

✅ 18-bit resolution (better than ADS1115)

✅ Configurable sample rate

✅ I²C interface

✅ Built-in PGA (Programmable Gain Amplifier)

📌 Best for: High-precision measurements, battery monitoring

🔻 Limitations: Slower sampling rate (15 SPS at 18-bit mode)

### HX711 (24-bit, SPI, 2 channels) – Best for Load Cells

✅ 24-bit resolution

✅ Optimized for weight sensors (load cells)

✅ Cheap & easy to use

📌 Best for: Measuring very small voltages (e.g., weight, strain gauges)

🔻 Limitations: Only 2 channels, low sampling rate

### ADS1256 (24-bit, SPI, 8 channels) – Ultra High Precision

✅ 24-bit resolution (extreme precision)

✅ 8 input channels (great for multiple sensors)

✅ Very high sampling rate (30,000 SPS)

✅ SPI interface (faster than I²C)

📌 Best for: Lab-grade measurements, industrial sensors

🔻 Limitations: More expensive, requires SPI