**ESP32 Introduction**

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# Big Resource Page

( <http://esp32.net/>)

(https://randomnerdtutorials.com/getting-started-with-esp32/)

# ESP 32 Data sheet ( 65 Pg )

* Single 2.4 GHz Wi-Fi and Bluetooth combo chip.
* Low duty cycle is used to minimize the amount of energy that the chip expends.
* Output of the power amplifier is adjustable
  + Optimal trade off between communication range, data and power consumption
* 20 external components
* **Wi-fi Key Features**
  + **802.11 B/G/N** : IEEE 802.11 is a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.
  + **UP to 150 Mbps**
  + **WMM :** WMM is a subset of the IEEE 802.11e standard
  + **TX/RX A-MPDU, RX A-MSDU**
  + **Immediate Block ACK :**The Block Ack mechanism improves channel efficiency by aggregating several acknowledgments into one frame.
  + **Defragmentation :**  Help for smoother communication
  + **Automatic Beacon Monitoring** : I am assuming something like watch dog
  + **4 x Virtual Wi-Fi interfaces** : Can connect to four separate Wi-Fi interfaces
  + **Simultaneous support for infrastructure station, SoftAP, and Promiscuous modes**
  + **Antenna Diversity**
* **Bluetooth Key features**
  + +9dBm transmitting power
  + Adaptive frequency Hopping
  + Synchronous Connection-Oriented/Extended
* **MCU and advanced Features** 
  + 1 Core at 240 MHz: 504.85 Coremark; 2.10 Coremark/MHz
  + 2 cores at 240 MHz: 994.26 CoreMark; 4.14 CoreMark/Mhz
  + Internal 8 MHz oscillator with calibration
  + External 2 Mhz ~ 60 MHz crystal Oscillator ( 40 MHz only got Wi-Fi/ Bluetooth functionality)
  + Two timer groups , including 2x 64 bit timers and 1 x main watchdog in each group
  + 34 programmable GPIOs
  + 12 bit SAR ADC up to 18 channels
  + 2 X 8 – bit DAC
  + 3 UART
  + LED PWM up to 16 Channels
  + Chart, diagram

    Description automatically generated
  + The operating voltage of ESP32 ranges from 2.3 V to 3.6 V.
    - When using a single power supply , the recommended voltage of the power supply is 3.3V and it’s recommended output current is 500 mA or more
    - If VDD\_SDIO 1.8V is used , add a 2 K ohm grounding resistor .
* **RADIO**
  + 2.4 GHz receiver
  + 2.4 GHz transmitter
  + Bias and regulators
  + Balun and transmit receive switch
  + Clock Generator
* **WI-FI** 
  + TCP/IP and full 802.11 b/g/n Wi-Fi Mac protocol
  + Provides UART HCI interface, up to 4 Mbps
  + Provides SDIO/SPI HCI interface
  + Provides PCM/I2S audio interface
* **RTC and Low Power Management** 
  + Power modes
    - Active – Chip radio is on, the chip can receive, transmit, or listen
    - Modem sleep mode – CPU is operational, and the clock is configurable. Radio and exterior boards are not
    - Light sleep mode – CPU is paused, any wake-up events will wake up the chip
    - Deep sleep mode – Only the RTC memory and RTC peripherals are powered on.
    - Hibernation mode – Only one RTC timer on the slow clock and certain RTC GPIOs are active
  + For the most part the power consumption of the chip depends on the mode, with most of the modes being around 80 mA
  + SAR ADC
    - Successive Approximation Registers
* **Electrical Characteristics** 
  + Voltage applied to power supply pins per power domain
    - Min : -0.3 V
    - Max : 3.6 V
  + Cumulative IO output current
    - Max : 1200 mA
  + LDO = Low dropout regulator
  + High level source current
    - 40 mA
  + Low level sink current
    - 28 mA

# ESP-IDF Programming Guide

(<https://docs.espressif.com/projects/esp-idf/en/latest/esp32/>)

WiFi (2.4 GHz Band)

Bluetooth

Dual high performance xtensa cpu cores

Ultra low power co processor

Multiple peripherals

Review this once you have the ESP32 IC

<https://github.com/espressif/vscode-esp-idf-extension/blob/master/docs/tutorial/basic_use.md>

# Getting Started with the ESP32 development Board

(Random Tutorials link)

* It combines WIFI and Bluetooth wireless capabilities
* Recommend to buy the DOIT ESP32 DEVKIT V1 Board ( WiFi and Bluetooth)
* Theres a possible course that we can buy but will attempt to do on own first
* Clock can go up to 240MHz and it has a 512 kB RAM
* With the ESP32 you can decide which pins are UART,I2C, or SPi – can be set in code
* Multiplexing feature that allows to assign multiple functions to the same pin
* Graphical user interface

  Description automatically generated
* Graphical user interface

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* Red = not recommended to use as inputs or outputs
* Green = are ok to use
* Yellow = ok to use but you need to pay attention because they may have an unexpected behavior mainly at boot
* Input only pins = 34 – 39; they don’t have internal pull up or pull down resistors
* Do not use GPIO 6 to GPIO 11 as they are reserved to be connected to the integrated SPI Flash
* 10 Internal capacitive touch sensors = can sense variations in anything that holds an electrical charge like the human skin; include T0,T1,T2,T3,T4,T5,T6,T7,T8,T9 (can learn how to use the touch pads with Arduino IDE)
* 18 x 12 bits ADC Input channels
  + ADC1\_CH0 (GPIO 36)
  + ADC1\_CH1 (GPIO 37)
  + ADC1\_CH2 (GPIO 38)
  + ADC1\_CH3 (GPIO 39)
  + ADC1\_CH4 (GPIO 32)
  + ADC1\_CH5 (GPIO 33)
  + ADC1\_CH6 (GPIO 34)
  + ADC1\_CH7 (GPIO 35)
  + ADC2\_CH0 (GPIO 4)
  + ADC2\_CH1 (GPIO 0)
  + ADC2\_CH2 (GPIO 2)
  + ADC2\_CH3 (GPIO 15)
  + ADC2\_CH4 (GPIO 13)
  + ADC2\_CH5 (GPIO 12)
  + ADC2\_CH6 (GPIO 14)
  + ADC2\_CH7 (GPIO 27)
  + ADC2\_CH8 (GPIO 25)
  + ADC2\_CH9 (GPIO 26)
* Note that ADC2 cannot be used while WiFi is used , should use ADC1
* Working ranges for ADC are 0 – 3.3 Volts
* 12 bit resolution , 0 – 4095
* Chart, line chart

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* Note that the lower limits of the ADC are difficult to capture as well as the upper limit.
* Digital to analog converter ; 2 x 8
  + DAC1 (GPIO25)
  + DAC2 (GPIO26)
* RTC GPIO support on the ESP32 ( Low Power subsystem for when the ESP32 is in deep sleep and needs to wake)
  + RTC\_GPIO0 (GPIO36)
  + RTC\_GPIO3 (GPIO39)
  + RTC\_GPIO4 (GPIO34)
  + RTC\_GPIO5 (GPIO35)
  + RTC\_GPIO6 (GPIO25)
  + RTC\_GPIO7 (GPIO26)
  + RTC\_GPIO8 (GPIO33)
  + RTC\_GPIO9 (GPIO32)
  + RTC\_GPIO10 (GPIO4)
  + RTC\_GPIO11 (GPIO0)
  + RTC\_GPIO12 (GPIO2)
  + RTC\_GPIO13 (GPIO15)
  + RTC\_GPIO14 (GPIO13)
  + RTC\_GPIO15 (GPIO12)
  + RTC\_GPIO16 (GPIO14)
  + RTC\_GPIO17 (GPIO27)
* All pins that can act as outputs can be used as PWM Pins except pins 34 -39
  + Set the following parameters:
    - Signals frequency
    - Duty cycle
    - Pwm channel
    - GPIO where you want to output the signal
* ESP32 has two I2C channels and any pin can be set as SDA or SCL
  + GPIO 21 (SDA)
  + GPIO 22 (SCL)
* SPI Pins
* Absolute maximum current drawn from GPIO is 40mA