Study Plan

Embedded Development Basics

Hardware Introduction

Basic concepts of voltage, current, resistance and capacitance

Resistors, capacitors, inductors, diodes, transistors functions

Input Threshold Voltage (V_IL, V_IH) and Output Threshold Voltage (V_OL, V_OH)

Operating a Multimeter

Software Introduction

C Language

Data Types

Functions, pointers, and memory management

Project compilation, linking and execution process

Code and documentation standards

Peripherals

GPIO, TIMER, UART, SPI, I2C

Network Protocol

TCP, UDP

Upper-layer application protocols, such as HTTP, MQTT

Embedded Development Introduction

Git Project Management

FreeRTOS Operating System

Linux Instructions

Getting Started with ESP32

Differences between chips, modules and development boards

Understand chip technical reference manuals and hardware design guidelines

When the chip is powered on, it enters two modes according to the strapping pin.

Run Mode (Run Firmware Normally)

Download mode (used when flashing firmware)

Features and functions of each chip series

ESP Product Selector

Selection and construction of development environment

Zero-code development project: UIFlow

Developing entry-level projects: Arduino

Developing complex projects: ESP-IDF

ESP Build System

IDF project structure and construction specifications

- Partition Table
- CMakeLists
- sdkconfig
- Kconfig

Component Manager, Component Configuration

Start Flow

Compile and flash example code

get-started\hello_world：Simple output code

get-started\blink：Simple lighting control code

wifi\getting_started\station：Basic code for connecting Wi-Fi

Read and write basic peripherals

Refer to peripheral examples in IDF：examples/peripherals

- I2C, SPI, ADC, USB

Using Components

ESP Component Registry

Espressif Component Library Documentation

Project Integration

ESP Solution

Zero-configuration Cloud Connectivity

ESP-RAINMAKER

AI Solutions

- Deep Learning Development Library ESP-DL
- Voice Recognition ESP-SR
- Computer Vision Development Library ESP-WHO

Wi-Fi Networking Solution

ESP-MESH-LITE

Camera Solution

DVP, USB, MIPI

LCD Solution

SPI (QSPI), I80, RGB, MIPI

USB Solution

Host & Device

Low Power Consumption Solution

Light-sleep, Deep-sleep, ULP

Wireless Communication Protocol

ESP-NOW

BLE Solution

Bluetooth Mesh Network

Matter Solution

Zigbee Solution

OpenThread

Thread Border Router Gateway Solution

Smart Presence Detection Solution

ESP-CSI

Gateway Solution

ESP-IoT-Bridge

Advanced Embedded Hardware Development

Theoretical Knowledge

Electronics Basics

Ohm's Law and Kirchhoff's Laws

Analog and digital signals

- Signal type and characteristics
- Threshold voltage

Circuit Theory

Basic circuit diagram reading knowledge

Common electronic component functions

- Resistors, capacitors, inductors
- diode
- triode
- MOSFET

Analog Circuit

Amplifier

- Fundamentals of Operational Amplifiers
- Differential amplifier, common emitter amplifier, etc.

Filter

- Low-pass filter, high-pass filter, band-pass filter, band-stop filter

Oscillator

- RC oscillator、LC oscillator、crystal oscillator

Power Supply Circuit

- Voltage regulator circuit, switching power supply
- Signal Processing
- Modulation and demodulation of analog signals

Digital Circuit

Basic Logic Gates

- AND, OR, NOT, NAND, NOR, XOR, XNOR
- Truth Table and Logic Symbols of Logic Gates

Combinational Logic Circuit

- Adder , Subtractor, Encoder, Decoder, Multiplexer, Demultiplexer

Sequential Logic Circuit

- Flip-flop (SR, D, JK, T)
- Registers, counters, timing circuits

Logic Gate Working Principles

- CMOS and TTL Technology
- Logic Level

Threshold Voltage

- Definition and Calculation
- Input Threshold Voltage (VIL, VIH), Output Threshold Voltage (VOL, VOH)

Noise Margin

- Definition and Calculation

Transmission Characteristics

- Propagation Delay, Rise Time, and Fall Time

Logic Gate Electrical Characteristics

- Input Capacitance and Output Capacitance
- Driving Capability

Practical Knowledge

Usage of Common Instruments

Multimeter

- Measurement of Voltage, Current, and Resistance

Oscilloscope

- Waveform Observation and Analysis
- Measurement of Signal Frequency and Amplitude

Logic Analyzer

- Capture and Analysis of Digital Signals

常见电路设计Common Circuit Design

Microcontroller Minimal System

- Basic Composition and Working Principle of Microcontroller
- Minimal System Circuit Design

Power Supply Circuit

- Linear Power Supply, Switching Power Supply

Common Driver Circuit

- Relay Driver, MOSFET Driver, Motor Driver Circuit, Constant Current Driver Circuit

Common Sensor Interfaces and Circuit Design

Analog Voltage and Current Sampling

I2C, SPI, UART Hardware Interface Design, Level Shifting

Common Simulation Software and EDA Software for Circuit Design

EasyEDA, Altium Designer, Proteus, Multisim, KiCAD

PCB Prototyping and SMT

Component Soldering and Debugging

3D Modeling and Printing

Advanced Embedded Software Development

Data Types

Basic Data Types

- Integer, character, floating point

Standard Library Data Types

- Boolean, string

Pointer Types

Composite Data Types

- Array, structure, union, enumeration

Custom Data Types

Data type modifiers

- constant modifier, static modifier, volatile modifier

GPIO (General Purpose Input/Output)

GPIO initialisation, mode, read, write

GPIO Configuration Options

- Determine the function of each pin based on the data sheet and pinout diagram

GPIO Interrupts

Strapping Pins

Memory Management

Dynamic memory allocation and deallocation, such as malloc, calloc and free

Memory layout and stack management

Interrupt Handling

Understanding and handling hardware interrupts

Implementing an Interrupt Service Routine (ISR) to respond to external events

Clocks and timers

Use timers and clock sources to implement time control and scheduled tasks

Handling delays and timed operations

Error Handling

Handling hardware and software errors

Low Power Mode Design

Implement power optimization strategies to extend battery life or reduce energy consumption

- Deep Sleep
- Light Sleep

FreeRTOS Task Management

Creating and terminating tasks

Task management and scheduling

Resource allocation and use of tasks

Communication between tasks

- Message Queue, Signal, Shared Memory, Semaphore, Socket, Mutex, Condition Variable, Barrier, Spin Lock

Driver Development

Drivers can be written , including but not limited to sensors, actuators, storage devices (such as flash and SD cards), communication interfaces (such as UART, SPI, I2C), displays, network interface cards (NICs), etc.

OTA Updates

ESP HTTPS OTA Updates