Deliverable 1: Basic Project Design: hardware design, back-end and front-end architecture.

Work Package 1.1: Hardware Schematic and Hardware specification: micro-controller, fingerprint sensor, real time clock (RTC), etc.

1. **Micro-controller: ESP32 DevKit V1**

Characteristics:

- Processor: Dual-core Tensilica LX6 microprocessor, up to 240 MHz
- Memory:
    - RAM: 520 KB SRAM
    - Flash: Varies (commonly 4MB)
- Connectivity:
    - Wi-Fi: 802.11 b/g/n (STA, AP and dual mode)
    - Bluetooth: Bluetooth v4.2 BR/EDR and BLE
- GPIO Pins:
    - Digital I/O: 34 GPIO pins (various multifunction)
    - Analog Inputs: 18 (ADC1: GPIO32-39, ADC2: GPIO0, 2, 4, 12-15, 25-27, 34-39)
- Communication Interfaces:
    - UART: 3 (UART0, UART1, UART2)
    - SPI: 4
    - I2C: 2 (HSI and HSI2)
    - PWM: Multiple channels
- Power Supply:
    - Input Voltage: 5V via USB or VIN pin
    - Operating Voltage: 3.3V (logic level)

Functionality in Project:

- Acts as the central controller managing data acquisition from the fingerprint sensor, LCD display, RTC module, and communication with the remote server via Wi-Fi.
- Handles user authentication and data storage operations.

1.6 Block Diagram

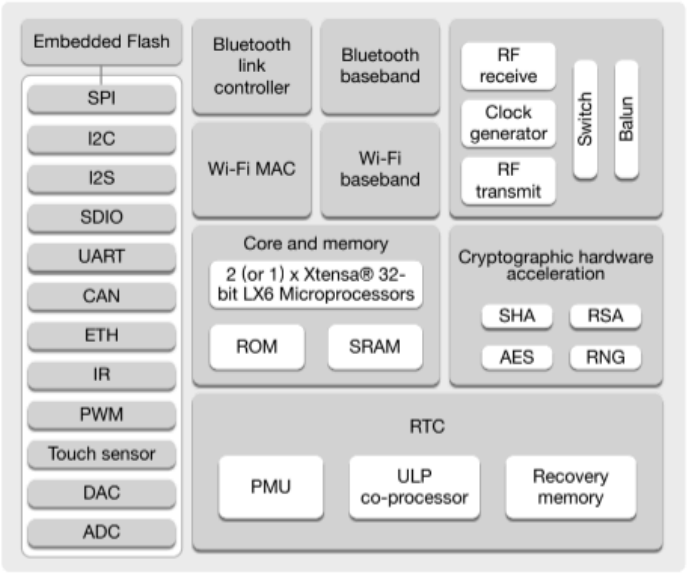


Figure 1: Functional Block Diagram

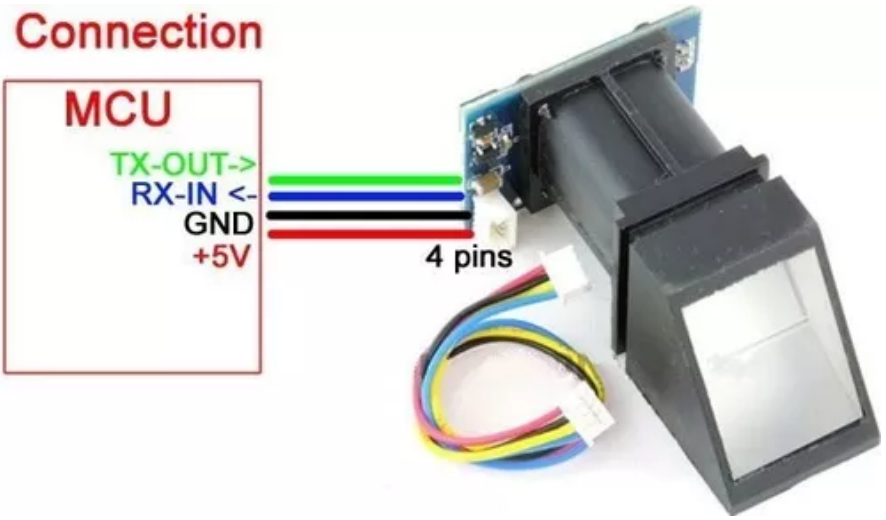
2. **Fingerprint Sensor: R305**

Key Specifications:

- Interface: UART (Serial Communication)
- Operating Voltage: 3.3V to 6V (compatible with ESP32's 3.3V logic)
- Resolution: 500 DPI (dots per inch)
- Precision :
    - FAR (False Acceptance Rate): < 0.001%.
    - FRR (False Rejection Rate): < 0.1%.
- Fingerprint Capacity: Up to 1000 fingerprints
- Capture Time: ~0.3 seconds
- Storage: Onboard memory for fingerprint templates
- LED Indicators: Status LEDs for operations (enrollment, verification)

Functionality in Project:

- Captures and reads users' fingerprint data for authentication.
- Sends fingerprint data to the ESP32 for processing and verification against stored templates.



3. **Display LCD: 16x2 I2C**

Characteristics:

- Type: Character LCD, 16 columns x 2 rows
- Interface: I2C via PCF8574 I/O expander
- Operating Voltage: 5V (logic levels are typically 5V compatible, but can work with 3.3V with proper configuration)
- Backlight: LED backlight (typically controlled via I2C)
- Contrast Control: Potentiometer or via I2C commands
- PINS:
    - SDA Pin: Data line
    - SCL Pin: Clock line
- Address: Common default is 0x27 or 0x3F

Functionality in Project:

- Displays system status, prompts, and other information.
- Provides real-time feedback to users during the authentication process.

4. **RTC Module: DS3231**

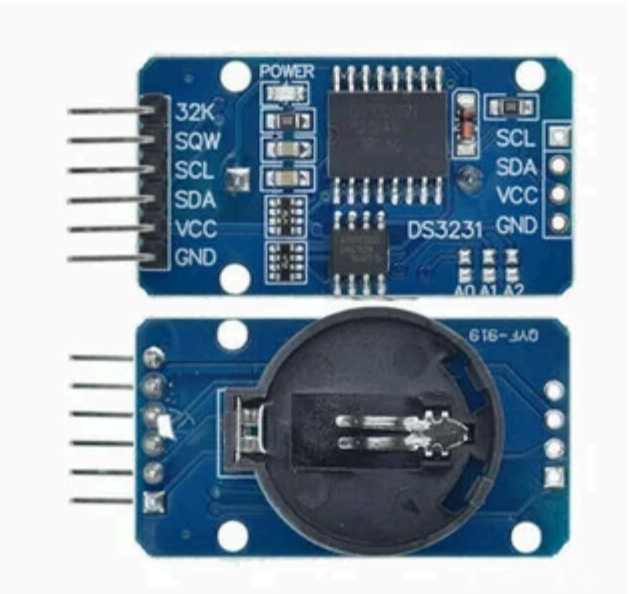
Although the ESP32 microcontroller already has an integrated RTC, it may experience synchronization problems due to the lack of an internal battery as a power source. This is the main reason why we decided to use the **DS3231** module. It is a low-cost, highly accurate I2C real-time clock with an integrated temperature-compensated crystal oscillator (TCXO) and crystal. The device incorporates a **battery input** and maintains accurate timekeeping even when the main power to the device is interrupted.

Characteristics:

- Interface: I2C
- Operating Voltage: 3.3V to 5V
- Accuracy: ±2 minutes per year
- Battery backup (for timekeeping when power is off)
- Timekeeping: Supports seconds, minutes, hours, day, date, month, and year.
- PINS:
    - SDA Pin: Data line
    - SCL Pin: Clock line
- Address: Typically 0x68

Functionality in Project:

- Keeps accurate real-time data for logging entry and exit times.
- Ensures time stamps are maintained even during power outages via the backup battery.



Power Supply: USB Current Adaptor

Characteristics:

- Output Voltage: 5V DC
- Current Rating: Minimum 2A
- Connector: USB Type-A or Micro/USB

Functionality in Project:

- Provides stable power to the ESP32 and connected peripherals.
- Ensures reliable operation of the system by maintaining adequate power supply.

Hardware Schematics

The system will have the following connections as shown in the figure:

1. **ESP32:**
    - Power from USB.
    - I2C bus for LCD and RTC:
        - SDA (GPIO21), SCL (GPIO22).
    - UART for fingerprint sensor:
        - TX (GPIO1), RX (GPIO3).
2. **Fingerprint Sensor (R305):**
    - VCC → ESP32 3.3V or 5V.
    - GND → ESP32 GND.
    - TX → ESP32 RX (GPIO16).
    - RX → ESP32 TX (GPIO17).
3. **LCD 16x2:**
    - VCC → ESP32 5V.
    - GND → ESP32 GND.
    - SDA → ESP32 GPIO21.
    - SCL → ESP32 GPIO22.
4. **RTC DS3231:**
    - VCC → ESP32 3.3V or 5V.
    - GND → ESP32 GND.
    - SDA → ESP32 GPIO21.
    - SCL → ESP32 GPIO22.