
EMBEDDED SYSTEM

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Introduction

This book introduces Embedded Systems through using the Vaman framework.

Chapter 1

Vaman-ESP32

1.1. Measuring Unknown Resistance Using Vaman-ESP

Through this manual, we learn how to measure an unknown resistance through Vaman-ESP and display it on an LCD.

1.1.1. Components

| Component | Value | Quantity |
|---------------|-----------|----------|
| Resistor | 220 Ohm | 1 |
| | 1K | 1 |
| ESP32 | Devkit V1 | 1 |
| Jumper Wires | | 20 |
| Bread board | | 1 |
| LCD | 16 X 2 | 1 |
| Potentiometer | 10K | 1 |

Table 1.1.1: Components

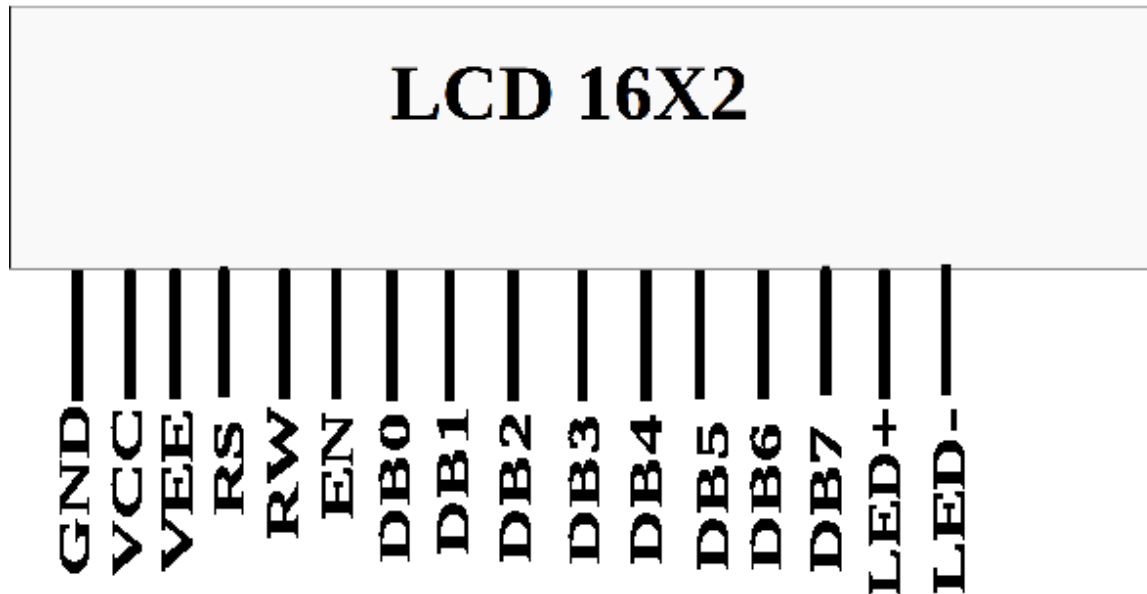


Figure 1.1.1.1: LCD pins

1.1.2. Setting up the Display

1.1.1. Plug the LCD in Fig. 1.1.1.1 to the breadboard.

1.1.2. Connect the Vaman-ESP pins to LCD pins as per Table 1.1.3.1. Make sure that all 5V sources are connected to the LCD through a 220 Ω resistance.

1.1.3. The Vaman pin diagram is available in Fig. 1.1.3.1

1.1.4. Execute the following code after editing the wifi credentials

```
vaman/vaman-esp/lcd/codes/setup
```

You should see the following message

```
Hi
This is CSP Lab
```


VAMAN LC-1 PINOUT

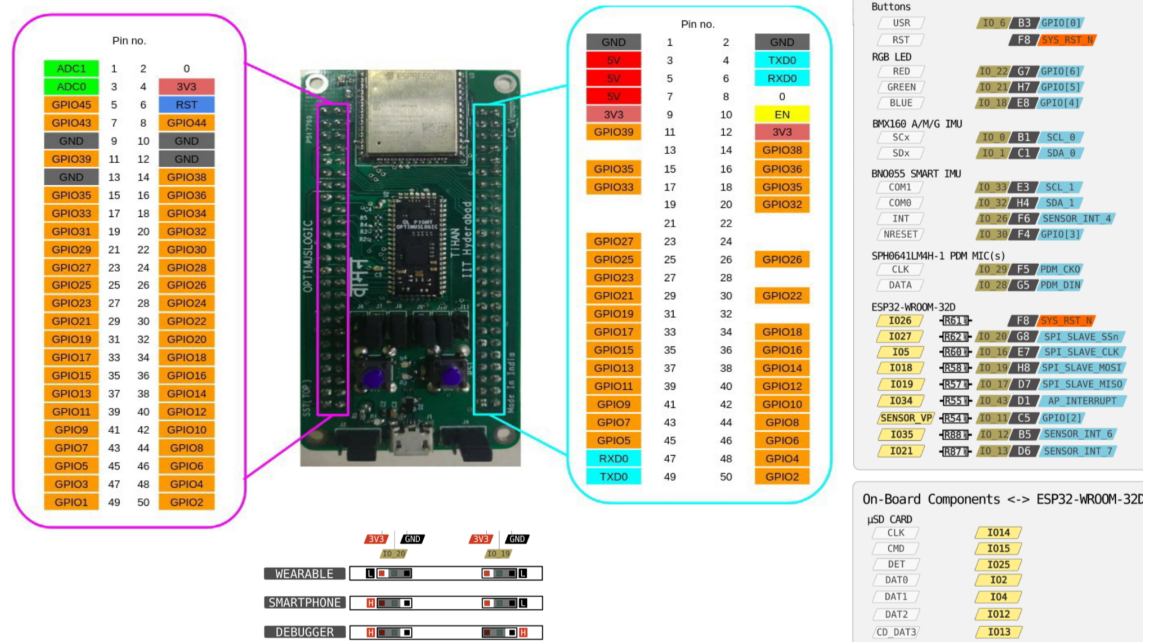


Figure 1.1.3.1: Vaman pins

| ESP32 | LCD Pins | LCD Pin Label | LCD Pin Description |
|---------|----------|-----------------|---------------------|
| GND | 1 | GND | |
| 5V | 2 | V _{cc} | |
| GND | 3 | V _{ee} | Contrast |
| GPIO 19 | 4 | RS | Register Select |
| GND | 5 | R/W | Read/Write |
| GPIO 23 | 6 | EN | Enable |
| GPIO 18 | 11 | DB4 | Serial Connection |
| GPIO 17 | 12 | DB5 | Serial Connection |
| GPIO 16 | 13 | DB6 | Serial Connection |
| GPIO 15 | 14 | DB7 | Serial Connection |
| 5V | 15 | LED+ | Backlight |
| GND | 16 | LED- | Backlight |

Table 1.1.3.1: Make sure that all 5V sources are connected to the LCD through a 220 Ω resistance.

1.1.5. Modify the above code to display your name.

1.1.3. Measuring the resistance

1.1.1. Connect the 5V pin of the Vaman-ESP to an extreme pin of the Breadboard shown in Fig. 1.1.1.1. Let this pin be V_{cc} .

1.1.2. Connect the GND pin of the Vaman-ESP to the opposite extreme pin of the Breadboard.

1.1.3. Let R_1 be the known resistor and R_2 be the unknown resistor. Connect R_1 and R_2

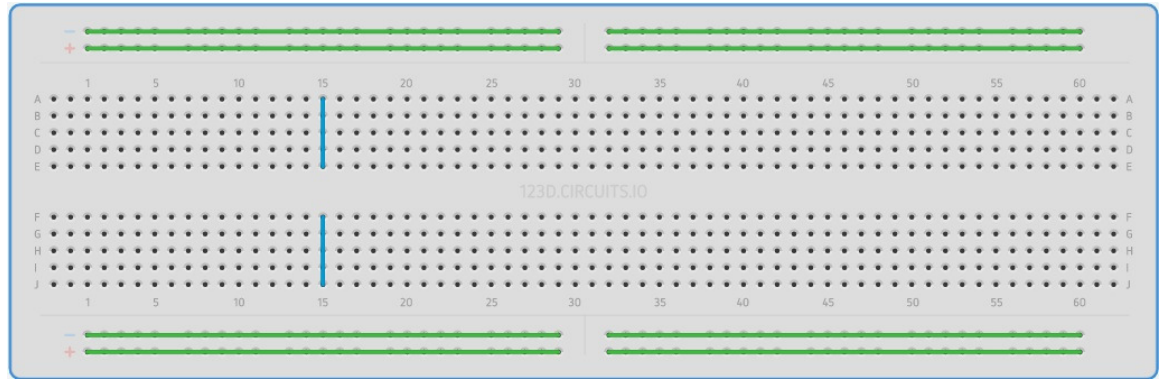


Figure 1.1.1.1: Breadboard

in series such that R_1 is connected to V_{cc} and R_2 is connected to GND. Refer to Fig. 1.1.3.1

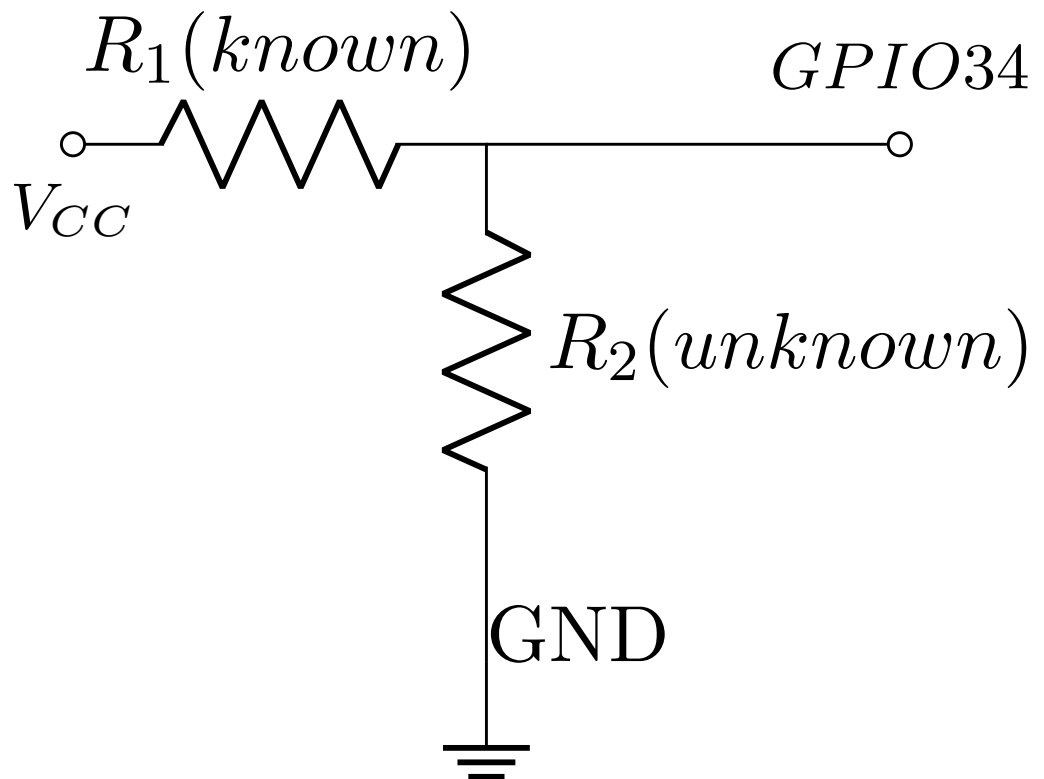


Figure 1.1.3.1: Voltage Divider

1.1.4. Connect the junction between the two resistors to the GPIO34 pin on the Vaman-ESP.

1.1.5. Connect the Vaman-ESP to the computer so that it is powered.

1.1.6. Execute the following code after editing the wifi credentials

```
vaman/vaman-esp/lcd/codes/resistance
```

1.1.4. Displaying the Measured resistance on LCD and website

1.1.1. The unknown resistance is measured and displayed the measured resistance on the LCD display and also on the Vaman-ESP webserver.

1.1.2. Connect the Vaman-ESP pins to LCD pins as per Table 1.1.3.1.

1.1.3. Execute the following code after editing the wifi credentials

```
vaman/vaman-esp/lcd/webserver/codes
```

1.1.4. After flashing the code to vaman-ESP, the board will be connected to the wifi credentials provided.

1.1.5. Now connect the same WiFi credentials to the mobile phone for accessing the IP address, which can be accessed by

```
ifconfig  
nmap -sn 192.168.x.x/24
```

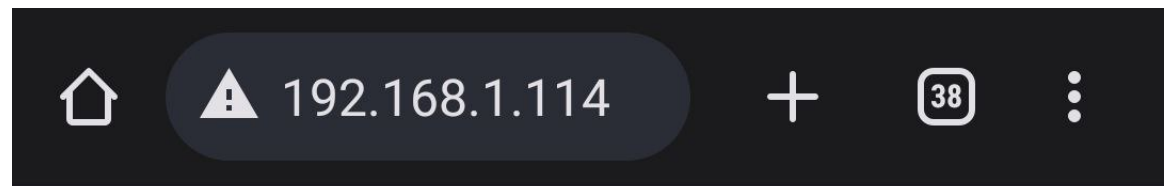
1.1.6. Change the IP address in the second command accordingly with the IP address provided by first command.

1.1.7. By the above commands the IP address of vaman-ESP will be displayed.

1.1.8. Now the vaman-ESP will be hosting a webserver

1.1.9. In order to access the webserver type the IP address of the vaman-ESP in the web browser.

1.1.10. In the website loaded by the IP address of vaman-ESP the Unknown resistance is displayed as shown in Fig. 1.1.10.1



Resistance Monitor

Measured Resistance: 190.75 Ohms

Figure 1.1.10.1: Website

1.1.5. Explanation

1.1.1. We create a variable called analogPin and assign it to 0. This is because the voltage value we are going to read is connected to analogPin GPIO34.

1.1.2. The 12-bit ADC can differentiate 4096 discrete voltage levels, 5 volt is applied to 2 resistors and the voltage sample is taken in between the resistors. The value which we get from analogPin can be between 0 and 4095. 0 would represent 0 volts falls across the unknown resistor. A value of 4095 would mean that practically all 5 volts falls across the unknown resistor.

1.1.3. V_{out} represents the divided voltage that falls across the unknown resistor.

1.1.4. The Ohm meter in this manual works on the principle of the voltage divider shown in Fig. 1.1.3.1.

$$V_{out} = \frac{R_1}{R_1 + R_2} V_{in} \quad (1.1.4.1)$$

$$\Rightarrow R_2 = R_1 \left(\frac{V_{in}}{V_{out}} - 1 \right) \quad (1.1.4.2)$$

In the above, $V_{in} = 5V$, $R_1 = 220\Omega$.

1.1.5. Repeat the exercise with another unknown resistance.

1.2. I2C Communication Between Vaman-ESP and Arduino

Through this manual, we will learn how to setting up the vaman-ESP as a Master and Arduino as a Slave using I2C protocol.

| Component | Value | Quantity |
|------------------|-----------|----------|
| ESP32 | Devkit V1 | 1 |
| Arduino | UNO | 1 |
| Connecting Wires | | 30 |
| LCD | 16 X 2 | 1 |

Table 1.2.1: Components

1.2.1. Components

1.2.2. Setting up the Master and Slave

1.2.1. Connect the vaman-ESP pins to Arduino pins as per Table 1.2.1.1.

| I2C | ESP32 | Arduino |
|-----|---------|---------|
| SDA | GPIO 21 | A4 |
| SDC | GPIO 22 | A5 |
| | VCC | VCC |
| | GND | GND |

Table 1.2.1.1:

1.2.2. Connect the vaman-ESP pins to LCD pins as per 1.1.3.1..

1.2.3. The Vaman pin diagram is available in Fig. 1.1.3.1

1.2.4. Configure Arduino Uno as a Slave using the following code.

```
vaman/vaman-esp/I2C/codes/I2C_Sender_Arduino/src/main.cpp
```

1.2.5. Now configure vaman-ESP as a Master using the following code.

```
vaman/vaman-esp/I2C/codes/I2C_Reciever_ESP32/src/main.cpp
```

1.3. UART Communication between Vaman-ESP and Arduino

Through this manual, we learn how to communicate between Vaman-ESP32 and Arduino UNO through UART Protocol. The Unknown resistance is measured using Arduino and sending the value to Vaman through UART and displaying the unknown Resistance on ESP-Webserver.

1.3.1. Components

| Component | Value | Quantity |
|--------------|---------|----------|
| Resistor | 220 Ohm | 1 |
| | 1K | 1 |
| Vaman | LC | 1 |
| Arduino | UNO | 1 |
| Jumper Wires | | 10 |
| Bread board | | 1 |

Table 1.3.2: Components

1.3.2. Connections

1.3.1. Connect the Vaman and Arduino as shown Table. 1.3.1.2.

| Arduino UNO | Vaman-ESP |
|--------------|-----------|
| Rx(Pin-0) | 17 (Tx) |
| Tx (Pin-1) | 16 (Rx) |

Table 1.3.1.2: Connections

1.3.2. The Vaman pin diagram is available in Fig. 1.1.3.1

1.3.3. Upload the following code to Arduino UNO

```
vaman/vaman-esp/UART/codes/UNO
```

1.3.3. Measuring the resistance

1.3.1. Connect the 5V pin of the Vaman-ESP to an extreme pin of the Breadboard shown in Fig. 1.1.1.1. Let this pin be V_{cc} .

1.3.2. Connect the GND pin of the Vaman-ESP to the opposite extreme pin of the Breadboard.

1.3.3. Let R_1 be the known resistor and R_2 be the unknown resistor. Connect R_1 and R_2 in series such that R_1 is connected to V_{cc} and R_2 is connected to GND. Refer to Fig. 1.1.3.1

1.3.4. Connect the junction between the two resistors to the A0 pin on the Arduino board.

1.3.5. Now Power the Vaman board

1.3.6. Execute the following code after editing the wifi credentials

```
vaman/vaman-esp/UART/codes/VAMAN
```

1.3.4. Displaying the Measured resistance on website

1.3.1. The unknown resistance is measured and displayed the measured resistance on the Vaman-ESP webserver.

1.3.2. After flashing the code to vaman-ESP, the board will be connected to the wifi credentials provided.

1.3.3. Now connect the same WiFi credentials to the mobile phone for accessing the IP address, which can be accessed by

```
ifconfig  
nmap -sn 192.168.x.x/24
```

1.3.4. Change the IP address in the second command accordingly with the IP address provided by first command.

1.3.5. By the above commands the IP address of vaman-ESP will be displayed.

1.3.6. Now the vaman-ESP will be hosting a webserver

1.3.7. Inorder to access the webserver type the IP address of the vaman-ESP in the web browser.

1.3.8. In the website loaded by the IP address of vaman-ESP the Unknown resistance is displayed as shown in Fig. 1.1.10.1