

# Vajravolt AI IoT 4G LTE Industrial Gateway Board - VVM701

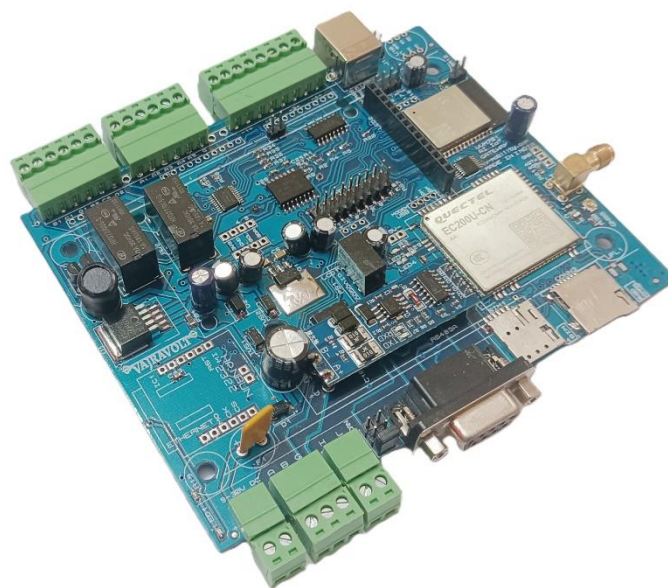
Vajravegha Mobility Pvt Ltd

Product ID: VVM701

Version: v1.1

## On-board Features:

- ESP32-S3 WROOM-1-N16R8 : Wi-Fi, Bluetooth 5, 240MHz with 16MB Flash and 8MB PS-RAM, 36 programmable GPIOs, AI acceleration support, full speed USB 2.0
- Quectel EC200U-CN 4G LTE Cat 1 module with 10Mbps downlink
- Built-in GNSS/GPS
- Isolated RS485 / RS232 ( jumper selector)
- Micro SD Card and Nano SIM slot
- Single USB Type-B connector for programming and monitoring
- DS3231 RTC based on I2C protocol
- MS51FB9AE for Data acquisition
- 5 ch. 12-bit Analog Inputs 4-20mA / 0-5v
- 4 ch. Digital Isolated Inputs (upto 24v)
- 2 Relay Output 30v DC / 2A
- Protocols: MQTT(s), HTTP(s), DHCP, FTP, Modbus, SPI, I2C, etc, FOTA supported
- 9 - 30v DC Power Supply, PCB size 130x105, separate enclosure available



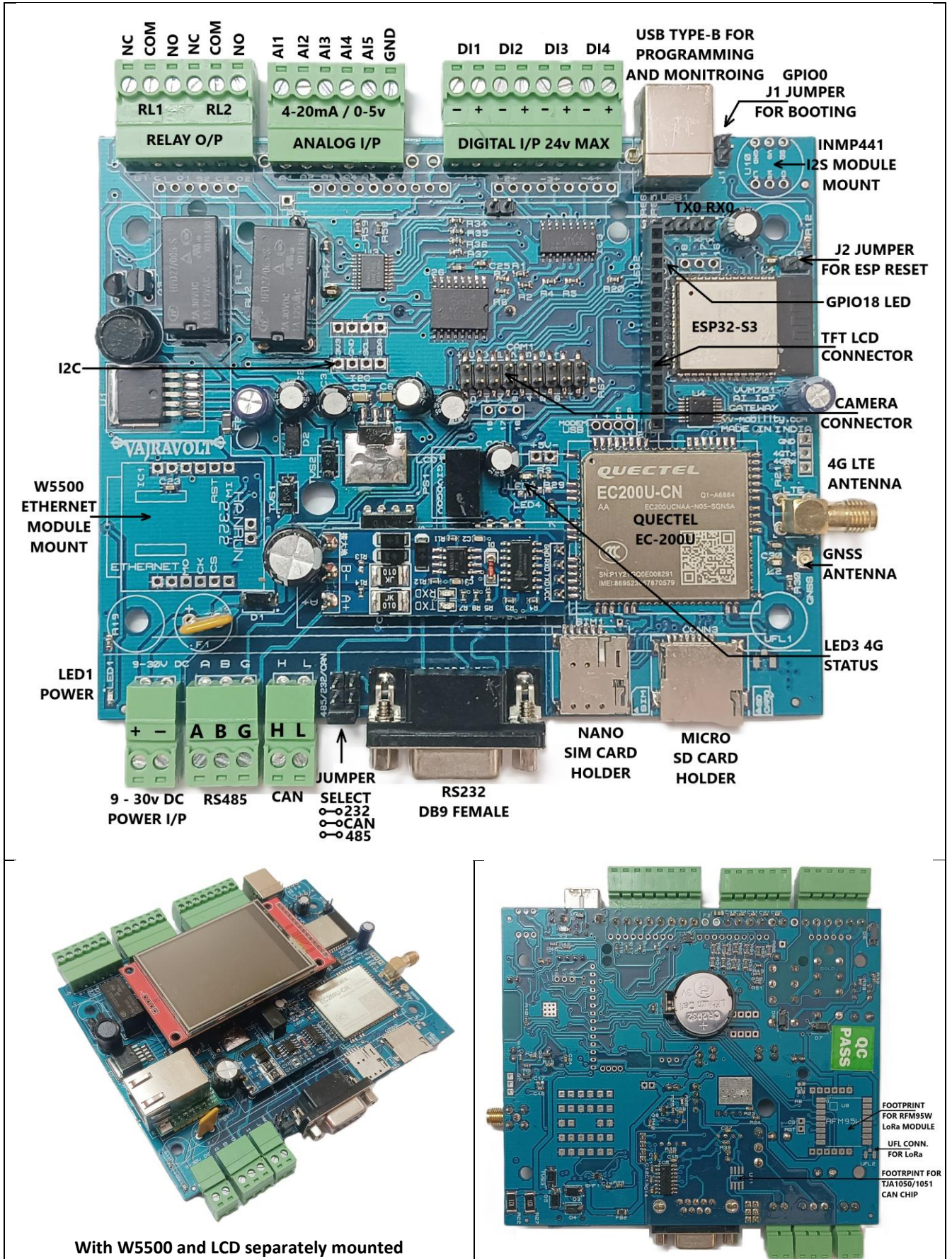
## Additional Peripheral Support (Not Mounted):

- W5500 Ethernet Module for Internet or Modbus TCP/IP
- 2.4 inch SPI Interface 240x320 TFT LCD Display Module with Touch for HMI
- Camera modules like OV2640, OV7670 and other similar modules for AI vision
- INMP441 Digital I2S Microphone Module for Audio / Voice Activation functions
- RFM95W LoRa module
- Header extension for I2C devices like MPU6050 Accelerometer, EEPROM, sensors, etc.
- TJA1050/TJA1051 or similar chip for Isolated CAN support

**Introduction:** Vajravegha Mobility Pvt Ltd, based in Mumbai is a full-scale solution provider in the field of IoT, DC Energy Measurement and Embedded Systems. We take immense pride in introducing **Vajravolt**, an innovative and user-friendly IoT development board designed to simplify the world of embedded Artificial Intelligence (AI) and Internet of Things (IoT). Vajravolt consolidates multiple functionalities into a single module, eliminating the need for additional components. It seamlessly integrates a 32-bit ESP32-S3 controller, a 4G module (EC200U), an Ethernet module (W5500), Wi-Fi and Bluetooth connectivity, RTC, RS485, RS232 for Modbus, Micro SD card slot, Analog inputs, Isolated digital inputs, Relay outputs. Additionally, it supports variety of peripherals like LCD Display, Camera and microphone, LoRa module, etc. This all-in-one design saves time and effort in sourcing and assembling individual components, providing convenience without compromising performance. Our board proudly embodies the "**Make in India**" initiative.

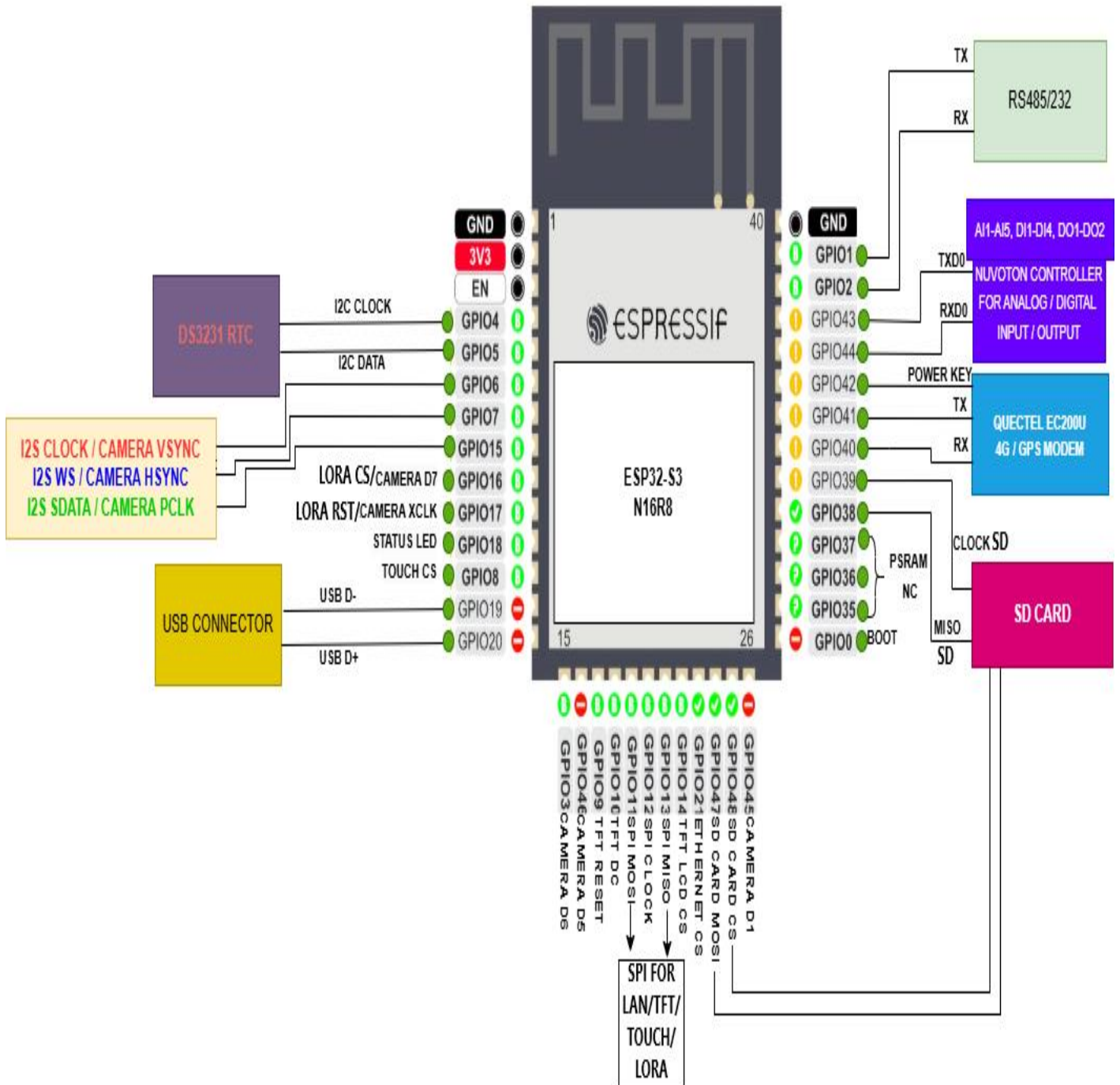
**Applications:** Embedded / Edge AIoT, Industrial Automation, Data Acquisition and Logging, Control, etc. Various protocols such as MQTT(s), HTTP(s), DHCP, FTP, Modbus, SPI, and I2C are supported, enabling easy integration with different systems.

# Block Diagram and Basic Schematic



With W5500 and LCD separately mounted

# VAJRAVOLT SCHEMATIC



**Note:** Isolated sections on the board are only for RS485/RS232/CAN section, 4 Digital Inputs and 2 Relay Output.

| <b>ESP32-S3 GPIO Pin Mapping (All peripherals not mounted on board. Few pins may be shared among peripherals)</b> |  |
|---|--|
| EC200U-CN 4G LTE / GPS Module (Serial Communication)  | 41(Tx) to Rx , 40(Rx) to Tx, 42 to Power Key respectively of 4G Module   |
| SPI Communication for Ethernet/LCD/LoRa   | 11(MOSI), 13(MISO), 12(CLK) - Regular SPI for W5500 Ethernet, 2.4 inch Touchscreen LCD, RFM95W LoRa                            |
| SD Card (HSPI Communication)  | 38(MISO), 47(MOSI), 39(CLK), 48(CS) Alternate HSPI   |
| RS485 / RS 232 / CAN (Serial Comm.)   | 1(Tx), 2(Rx). Select either RS485 or RS232 or CAN by the Jumper Selector   |
| RTC (DS3231 based – I2C Comm.)  | 4(SCL), 5(SDA)   |
| Data Acquisition (Serial Comm.)   | TXD0 and RXD0 for communication with Nuvoton MS51FB9AE for 5 Analog Channel, 4 Isolated Digital Channel and 2 Relay Channel    |
| W5500 Ethernet (SPI Comm.)  | 21 for Chip Select, plus regular SPI pins  |
| 2.4" TFT Touchscreen LCD (SPI)  | 9(LCD Reset), 10(LCD DC), 14(LCD CS), 8(Touch CS), plus regular SPI pins   |
| LoRa RFM95W (SPI)   | 16(LoRa CS), 17(LoRa RST), plus regular SPI pins   |
| Camera (SCCB Communication) OV2640, OV7670 or similar cameras.  | 4(SCL/SIOC), 5(SDA/SIOD), 6(VSYNC), 7(HREF), 15(PCLK), 16(D7), 17(XCLK), 3(D6), 46(D5), 10(D4), 11(D0), 12(D2), 13(D3), 45(D1) |
| INMP441 I2S Microphone  | 6(I2S CLK), 7(I2S WS), 15(I2S SDATA)   |
| Green Status LED  | 18, Used for Diagnosis to indicate network, data transmission, health, etc.  |

**Note:** ESP32-S3 strapping pins are **GPIO 0, 3, 45, 46**. Also this module uses 8MB PSRAM internally , which is connected to **GPIO 35, 36, 37**. Use these pins with caution.

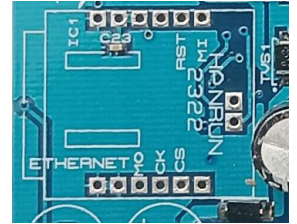
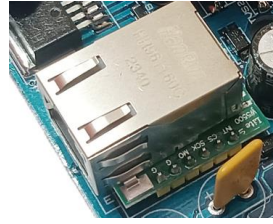
**Setup:** Connect the 4G Antenna and gently insert a Nano SIM card having valid 4G subscription service in the SIM Card holder. Insert a micro SD Card (16GB max) in the SD card holder. SD Card is optional and required only if Data Logging or Data Storage is required. Create a Mobile / Wireless Router Hotspot with the following credentials: **SSID: iotgateway Password: iot@1234** .Connect a good quality regulated SMPS (9v to 30v range, 2A) to the Power Input Connector of the board, ensuring proper polarity. Set the communication for either RS485 or RS232 using the jumper selector. Power LED LED1 turns on and within 5-10 seconds the Network LED3 turns on and starts blinking. Following is the status of this LED:

Flicker slowly (200 ms high/1800 ms low) : Searching for network; Flicker quickly (234 ms high/266 ms low) : Connected to network (idle) ; Flicker rapidly (62 ms high/63 ms low) : Data transfer ongoing.

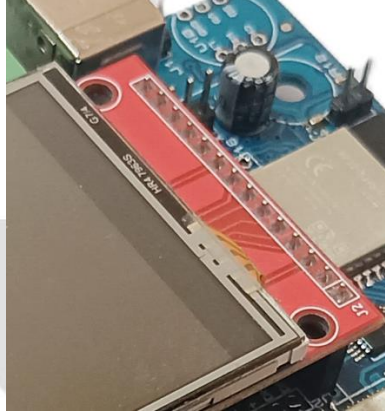
Default code **“BasicTest”** is already present in ESP32-S3. Refer our git-hub page <http://www.github.com/vajravegha/vajravolt> . If the board is connected to the router hotspot, its home webpage can be accessed via any web browser on the following address: **“iotgateway.local”** and **“iotgateway.local/update”** for OTA. For programming ESP32 and serial monitor, connect a USB Type A to B cable from the board to a laptop. Open Arduino Serial Monitor or any Serial Port Software like PuTTY, etc., set Baud Rate to 115200 and observe the data log. To upload new code via Arduino, change board settings to ESP32S3 Dev Module, ensure **“USB CDC on Boot” is set to Enabled** under Tools, install the relevant libraries and upload the code. Jumpers J1 and J2 are provided for boot and reset functionality respectively in-case new code becomes unresponsive.

**Additional Peripheral Support for other modules that can be mounted**

**Ethernet:** W5500 module can be easily soldered to the Ethernet module mount. It uses SPI protocol and can be used for Internet connectivity over TCP/IP. It can also be used for Modbus TCP/IP applications. Refer GPIO Mapping Table for pin allocation and git-hub link for sample codes.



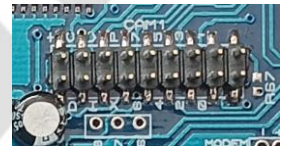
**Touch Screen TFT LCD:** A 2.4 inch SPI based TFT LCD with or without touchscreen facility can be inserted into the connector provided. These are based on ILI9341 or similar drivers and uses SPI protocol. Mounting holes are provided on the PCB. It is recommended to remove the SD card holder behind the display for proper fitting. Refer GPIO Mapping Table for pin allocation and git-hub link for sample codes.



|         |          |
|---------|----------|
| • T_IRQ | N.C.     |
| • T_DO  | 13(MISO) |
| • T_DIN | 11(MOSI) |
| • T_CS  | 8        |
| • T_CLK | 12(CLK)  |
| • SDO   | 13(MISO) |
| • LED   | 3.3v     |
| • SCK   | 12(CLK)  |
| • SDI   | 11(MOSI) |
| • DC    | 10       |
| • RST   | 9        |
| • CS    | 14       |
| • GND   | -        |
| • VCC   | 3.3v     |

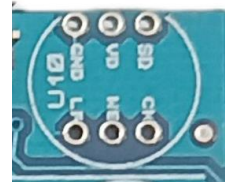
**Camera Module for AI vision:**

Camera modules like OV2640, OC5640, OV7670, etc. with 18-pin header can be connected to the board with 18 pin FRC cables as shown in the right image. Before connection ensure that pin names are matched on both Vajravolt and the camera module. Refer GPIO Mapping Table for pin allocation and git-hub link for sample codes. Such cameras are from Omnivision Technologies and run on SCCB protocol. They are seen in ESP32 Cam Module, ESP32S3 EYE module, etc



|     |        |
|-----|--------|
| • • | +(3v3) |
| • • | C(4)   |
| • • | D(5)   |
| • • | HR(7)  |
| • • | VS(6)  |
| • • | XC(17) |
| • • | PC(15) |
| • • | D6(3)  |
| • • | D7(16) |
| • • | D4(10) |
| • • | D5(46) |
| • • | D2(12) |
| • • | D3(13) |
| • • | D0(11) |
| • • | D1(45) |
| • • | N.C.   |

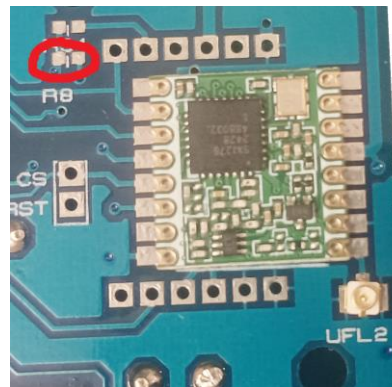
**INMP441 I2S Microphone for audio / voice activation:** This I2S module can be directly soldered to the slot on the PCB. It can be used for audio pattern recognition, voice activation, acoustic analysis, etc. Refer GPIO Mapping Table for pin allocation and git-hub link for sample codes.



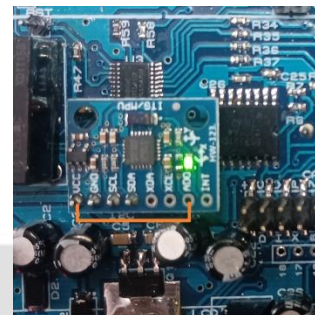
**GPS Antenna:** UFL connector is provided for connecting active GPS antenna. Most active GPS antennas come with SMA connector, so use UFL to SMA cable. Refer git-hub for sample code.



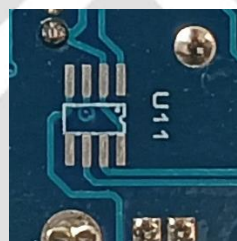
**LoRa Module RFM95W:** This module by HopeRF can be used as long range LoRa transmitter / receiver. RFM95W can be soldered on the back side of Vajravolt PCB. Standard SPI is used for communication and GPIO 16 and 17 is used for Chip Select and Reset respectively. Solder a 0 ohm 0603 size SMD resistor for R8 or short both tabs on R8 using solder to enable Reset pin. Also solder UFL connector on UFL2 for the antenna. In India, 868MHz module and antenna can be used. Refer GPIO Mapping Table for pin allocation and git-hub link for sample codes. **Please note that this module cannot be used as a LoRaWAN gateway as the hardware doesn't support it.**



**I2C Devices like MPU6050:** I2C header is provided on the PCB. Accelerometer module like MPU6050 can be directly soldered in this space as shown in the image. GPIO 4 is SCL and GPIO 5 is SDA. Please note that Default I2C address for MPU6050 is 0x68, which is also the same as that of DS3231 RTC. To prevent address conflict, AD0 pin on the sensor module must be connected to Vcc(3.3v) using a short wire soldered to both the tabs. Also I2C address for MPU6050 must be changed to 0x69 in the code. Refer GPIO Mapping Table for pin allocation and git-hub link for sample codes.



**TJA1050 CAN Chip:** ESP32 has a built-in CAN bus-compatible controller, but it doesn't have a built-in CAN transceiver. Chips like TJA1050/ TJA1051 can be soldered to U11 on the back side of the PCB for isolated connection to CAN bus. Please note that only one out of RS485 / RS232 / CAN communication can be used at a time, depending on jumper setting.



**NOTES AND PRECAUTIONS:**

- Before reprogramming the ESP32, understand the AT Commands of the 4G module properly. Incorrect AT commands sent to the 4G module can corrupt the module memory or change the default configuration settings.
- THIS MODULE IS NOT USED TO MAKE DIRECT MOBILE CALLS AS SPEAKER AND MICROPHONE IS NOT PRESENT ON THE BOARD. CONTACT US DIRECTLY IN CASE OF CUSTOMISED SOLUTIONS
- For programming under Arduino IDE, ensure **“USB CDC on Boot” is set to Enabled** under Tools
- ESP32-S3 strapping pins are **GPIO 0, 3, 45, 46**. Also this module uses 8MB PSRAM internally, which is connected to **GPIO 35, 36, 37**. Use these pins with caution. Refer to ESP32-S3 datasheet on Espressif website and Quectel EC200U datasheet for further details
- Enclosure model MB130-2PT can be purchased separately from <http://www.oceanenclosures.com> or from us.

Scan this QR Code for source codes and images in github link

<http://www.github.com/vajravegha/vajravolt>



**Technical Support:** If encountering any issues or difficulties, consult the manufacturer's technical support ([info@vv-mobility.com](mailto:info@vv-mobility.com) Ph: +918850627350) for assistance.