DESCRIPTION DOCUMENT FOR *MODBUS to IIoT*

HARDWARE REVISION 0.1

Department	Name	Signature	Date
Author			
Reviewer			
Approver			

Revision History

Rev	Description of Change	Effective Date
A	Initial Release	

ABSTRACT:

This document is a detailed product description that describes the effective features of the product. It includes a functional hardware description of the product with its internal block diagram and product images.

Table of Contents

Table of figures

1. ABBREVIATIONS

Term	Description
DMA	Direct Memory Access
HTTP	Hypertext Transfer Protocol
MQTT	Message Queue Telemetry Transport
PLC	Programmable Logic Control
DC	Direct Current
GND	Ground (DC)
PLC	Programmable Logic controller
IIoT	Industrial Internet of Things
DO	Digital Output
TCP	Transmission Control Protocol

2. REFERENCES

Company Weblink	https://www.armtronix.in
Youtube Weblink	https://www.youtube.com/channel/UCr3QNs65jDSxKDX4QPc03oQ
Blog	http://armtronix.net/2020/02/18/ultrasonic-level-indicator-and-energy-monitoring-via-modbus-using-armtronix-wifi-rs485-to-iiotia010/
Intractable's Weblink	https://www.instructables.com/member/Armtronix/
Github's Weblink	https://github.com/armtronix

3. PURPOSE

The purpose of this document is to outline the design description for the Modbus to IIoT. It provides a high-level summary of the product.

4. SCOPE

This document describes system architecture which includes Modbus/RS485, Digital Outputs, Ethernet, WiFi Module and Power Supply.

5. SAFETY AND WARNING

If you are working with DC power, please take necessary precautions. Do not short the positive and negative terminals of the power supply, as it may damage the Hardware and may create hazardous to your health. Do not bring AC power in contact with this board, which will damage the hardware and may create hazardous to your health. Please consider disconnecting power supply from the board if you would like to make any changes in connections. Working without safety towards hardware is not advisable. Electronic devices are static sensitive and suggest you to take necessary steps towards antistatic measures.

Fire Hazard: Making wrong connections, drawing more than rated power, contact with water or other conducting material, and other types of misuse/overuse/malfunction can all cause overheating and risk starting a fire. Test your circuit and the environment in which it is deployed thoroughly before leaving it switched on and unsupervised. Always follow all fire safety precautions.

6. PRODUCT FEATURES

- Works directly with Industrial standard DC power 12-24V.
- One isolated digital output, one Modbus, one ethernet port and one Wi-Fi is available to user.
- Both input and output are 12-24 DC voltage level compatible.
- WiFi with MQTT protocol compatible.
- The MQTT commands are given in this document to control and monitor inputs and outputs.
- Basic Firmware to enter SSID and password to connect to the router and testing. (*NOT FOR ANY SPECIFIC APPLICATION*)

7. APPLICATION:

- Energy monitor in any manufacturing industries/plants.
- Container level monitoring using ultra-sonic level sensor in food or chemical industry.
- Temperature monitoring using PID controller.

8. PRODUCT DESCRIPTION

a. PHYSICAL DESCRIPTION

- Wifi Module
- Ethernet
- RS485 / Modbus
- Isolated Digital Outputs – 1 number
- DC to DC Power supply module

b. FUNCTIONAL DESCRIPTION

Block Diagram

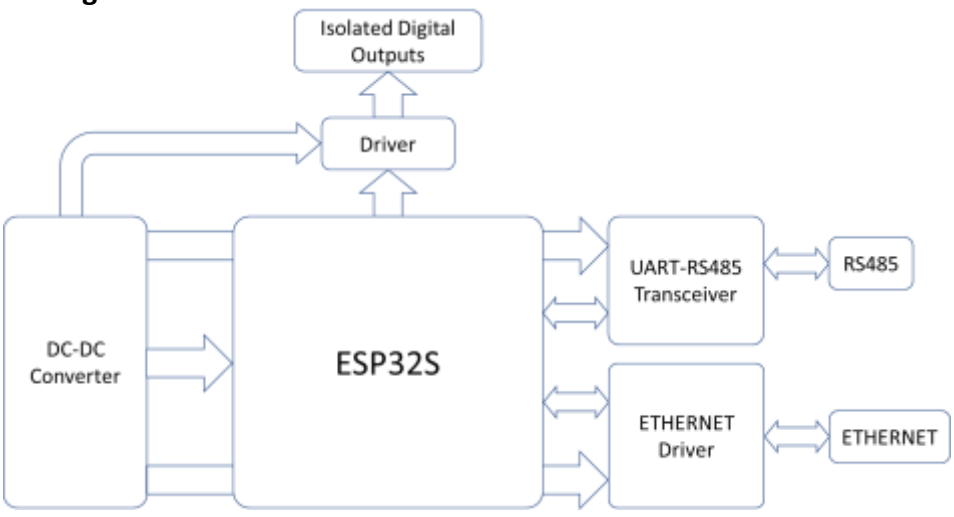


Figure 1: Block Diagram

Modbus to IIoT is designed and developed for industrial automation application to solve the problem of laying cables for remote monitoring and control. The device will be operated with industry standard 24V DC power input. The device has features like, Wifi, Ethernet, RS485, and Digital output. The digital output is an optically isolated to control (ON/OFF) external electrical DC loads like Lamps, relays respectively via available mode of communications like RS485 or ethernet or Wifi or Modbus TCP. The device can be interfaced with PLC and/or MQTT broker or Wifi Access point. User can program the device, based on their requirement like data exchange between RS485 to Ethernet to Wifi.

Ex: Reading energy meter from RS485 and sending data to ethernet or Wifi using MQTT or vice versa to update dash board of software or taking required action at the load.

9. SYSTEM OVERVIEW

1. DC to DC Power supply module

The DC-DC converter on board is used to regulate voltage from 24 V DC to 3.3 V DC to supply power to complete digital part including Wifi module.

The main power input 24V supply is also used to provide limited power to isolated outputs.

2. Wifi Module

Wifi module used in the device is ESP32 as it is compatible with Arduino IDE for ease of programming. with all its required GPIOs are easily accessible to user for their own application. Wifi module is powered on through on-board regulated 3.3 V DC. User can program this device for their application to work on either on MQTT / HTTP mode of protocol.

3. Ethernet:

Ethernet MAC interface with dedicated DMA and IEEE 1588 Precision Time Protocol support. commonly used in local area networks. This device has dedicated RJ45 jack for ethernet based operations. User can program this ethernet port for required protocols like Ethernet, TCP, Modbus TCP etc.

4. Isolated Digital output – 1 Number

There is an optically isolated output given accessible to user to control low power consumption loads with voltage level between 12V DC – 24V DC. The optical isolation is used to protect the hardware from any electrical hazardous at/from external interfaces to the board like solenoids, relays or any other respective loads.

10. TECHNICAL SPECIFICATION

a. ELECTRICAL SPECIFICATION

Input Specifications				
Description	**Min**	**Typ**	**Max**	**Unit**
Voltage DC	12	24	24	Volts
Current DC	-	1	-	Amps
Power DC	-	24	-	Watts

Isolated Digital Outputs Specifications (Maximum)				
Description	**Min**	**Typ**	**Max**	**Unit**
Voltage DC	-	-	24	Volts
Current DC	-	-	0.3	Amps
Power DC	-	-	0.72	Watts

b. MECHANICAL SPECIFICATION

- Mechanical Dimensions of PCB are 36.5 x 88 x 59 mm (Length x Width x Height)
- For more details on dimension of the board, please refer to Figure 2.
- Mounting type: Standard DIN rail C-type

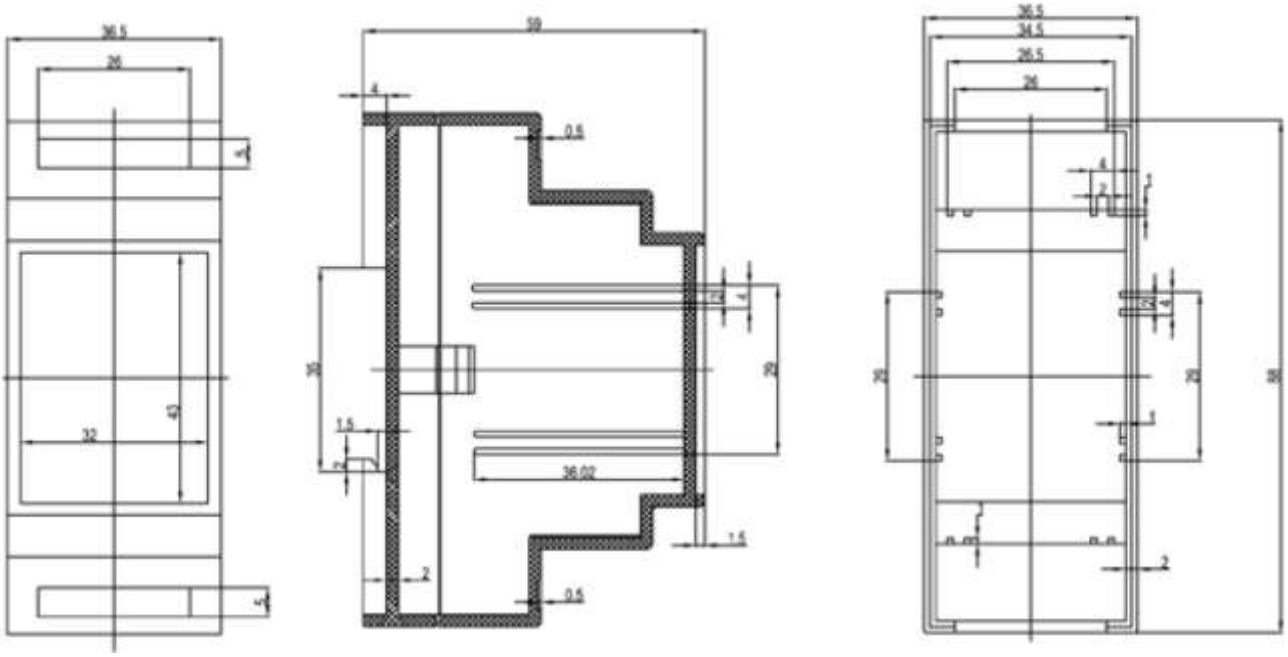


Figure 2: Box Dimensions

11. ELECTRICAL CONNECTIONS

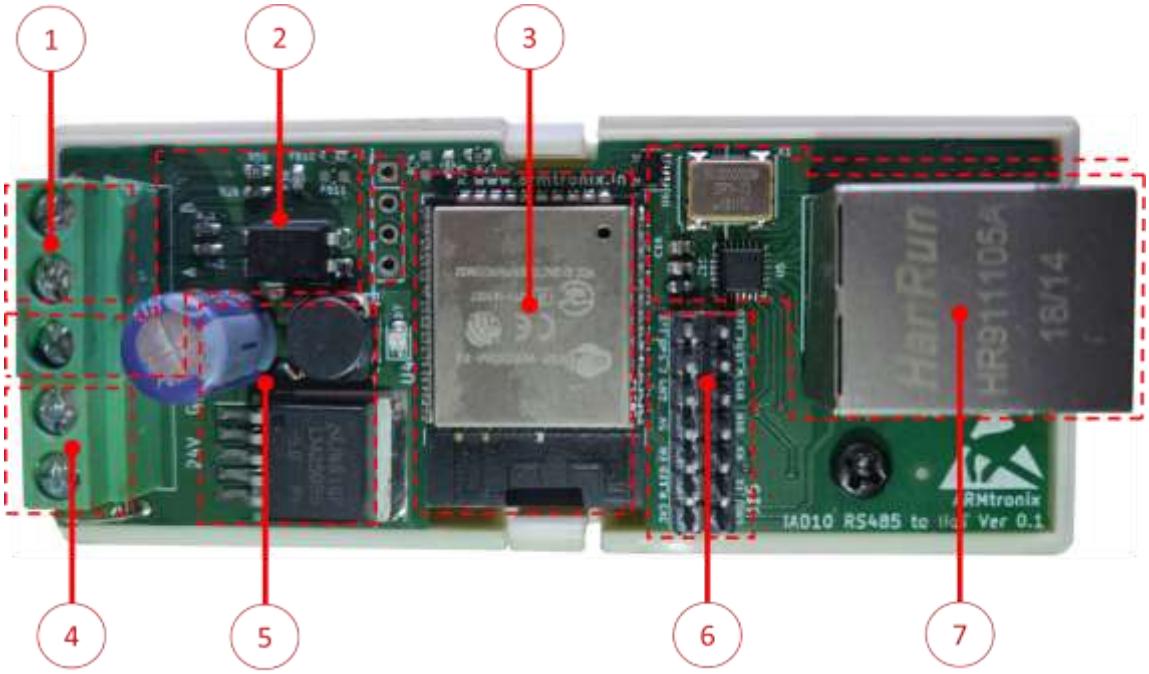


Figure 3: Input / Output Details

Hardware anatomy shown in Figure 3:

	Description
1.	Ethernet Port/RJ45 Jack
2.	Programming header
3.	ESP 32 SIP module
4.	DC-DC converter
5.	24V DC input terminal block
6.	Digital output block and terminal block
7.	RS485 Terminal block.

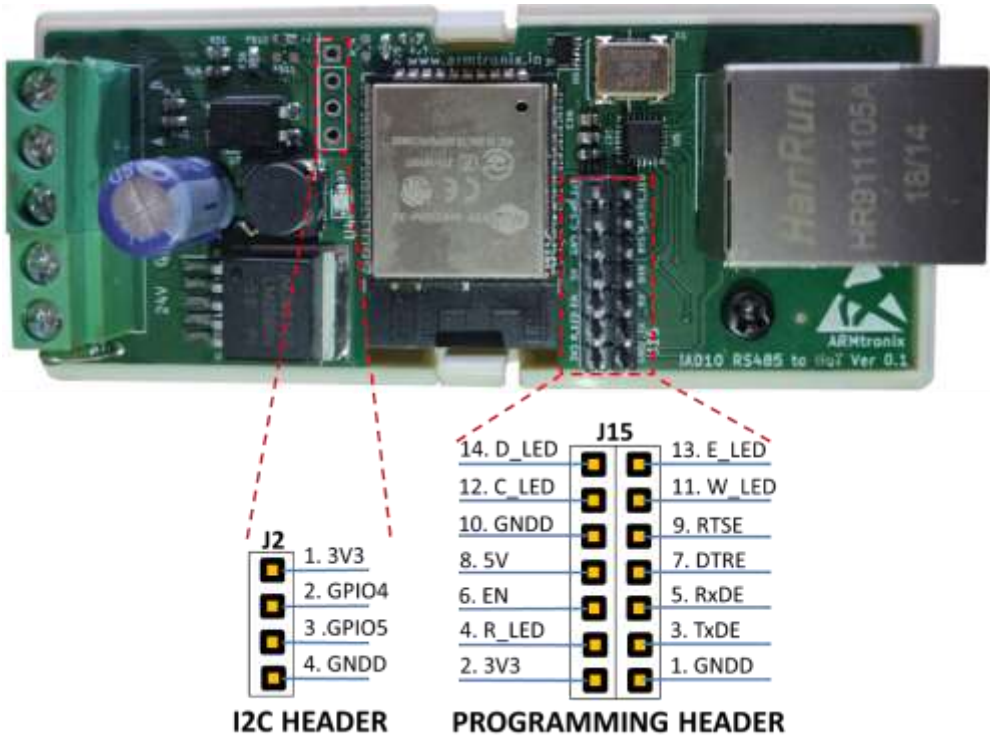


Figure 4: Header Pin number references

a. HEADER PIN CONFIGURATION

i. HEADER J2 (I2C HEADER)

Header Pin Number	Pin Name
1	3V3
2	GPIO4
3	GPIO5
4	GNDD

Table 1: Header J2 Pin Configuration

ii. HEADER J15 (PROGRAMMING HEADER)

Header Pin Number	Pin Name
1	GNDD
2	3V3
3	TXDE
4	RS485 LED
5	RXDE
6	RESET ESP32 / EN
7	DTRE
8	5V
9	RTSE
10	GNDD
11	WIFI LED
12	CONFIGURATION SWTITCH
13	ETHERNET LED
14	DEVICE STATUS LED

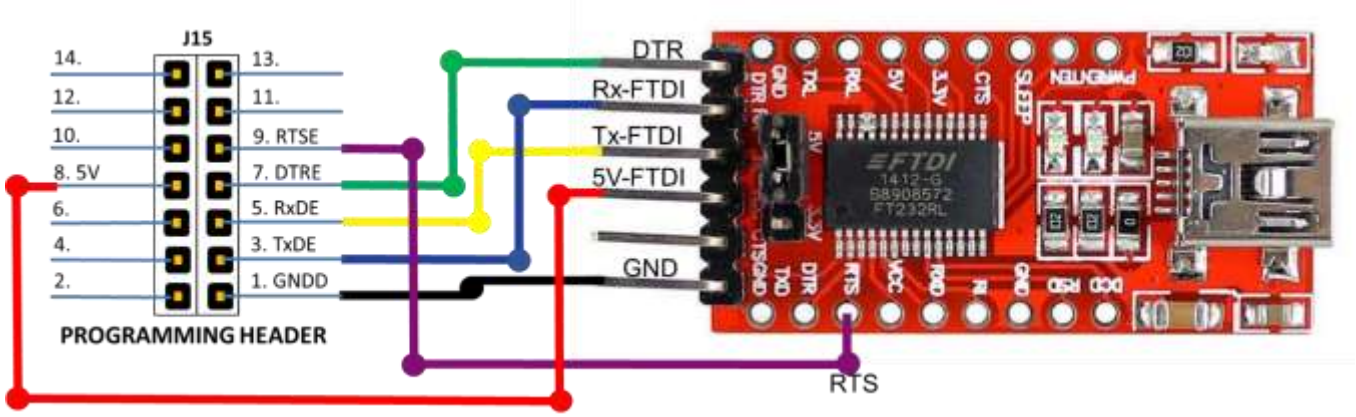
Table 2: Header J2 Pin Configuration

b. ESP32 GPIO'S USED

SERIAL NUMBER	ESP32 GPIO	ARDUINO NO.	PURPOSE
1	GPIO1	1	TXDE
2	GPIO2	2	WIFI LED
3	GPIO3	3	RXDE
4	GPIO12	12	RS485 RE/DE
5	GPIO13	13	RS485 LED
6	GPIO15	15	ETHERNET LED
7	GPIO16	16	RS485_RO
8	GPIO17	17	RS485 DI
9	GPIO32	32	DEVICE STATUS LED
10	GPIO33	33	DIGITAL OUTPUT
11	GPIO34		CONFIGURATION SWTITCH

Table 3: ESP32 GPIO Configuration

c. PROGRAMMER CONNECTION DIAGRAM



Wifi Esp32 I/O Board	USB-UART-FTDI Programmer
TxDE	Rx-FTDI
RxDE	Tx-FTDI
DTRE	DTR
RTSE	RTS
GROUND	GND
5V	5V-FTDI

Figure 5: Programmer Connection Diagram

Note: Main power supply input 12v to 24 VDC has to be given while programming.

12. EXAMPLE CONNECTION ARCHITECTURE

a. Device as Modbus master and can be connected with multiple slaves.

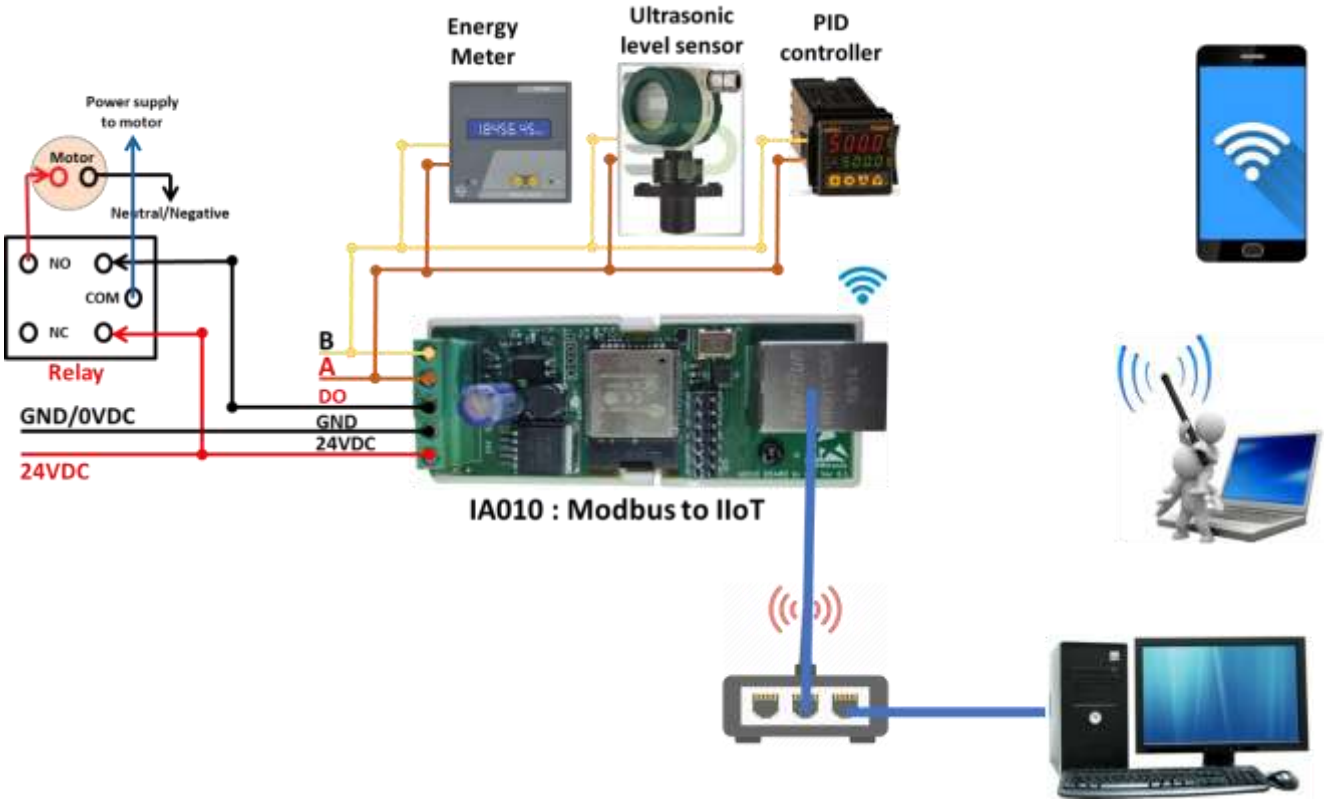


Figure 6:Example-1 device with multiple slave

b. Device as Modbus master and can be connected with single slave as energy meter.

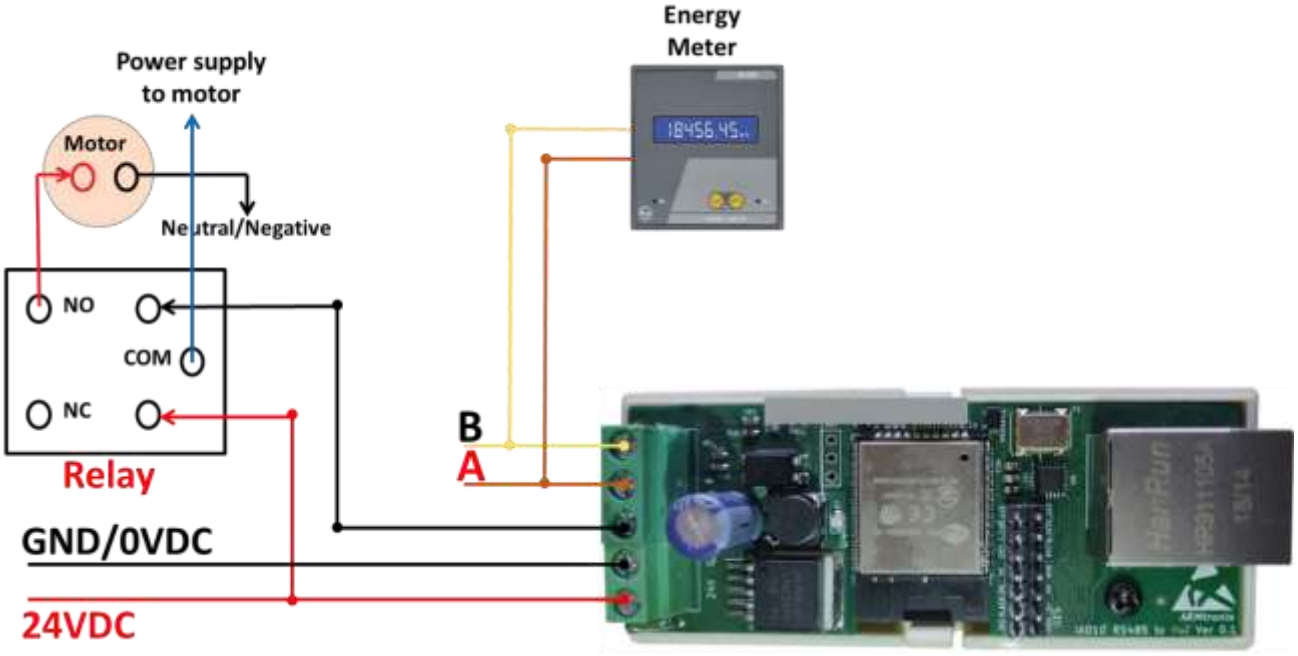


Figure 7: Example-2 slave as energy meter

13. HOW TO USE THE DEVICE

a. STEPS TO CONFIGURE THE DEVICE TO NETWORK HOSTED BY YOU:

i. Switch ON the device.

ii. Press the **config** button, wait till blinking of dual color LED to turns OFF. This indicate that the device is healthy and not previously configured to any network.

iii. To configure the device, Press and hold the **Reset** button and then press and hold the **Config** Button.

iv. Now release only the **Reset** button, wait for 30 seconds, then release the **Config** button. Now the device will host its own network (Access point/Hotspot) to allow users to configure it.

v. Take any Smartphone.

vi. Switch ON Wifi in it. (make sure that, its Mobile Data connection is turned OFF).

vii. Search for available Wifi networks in the range

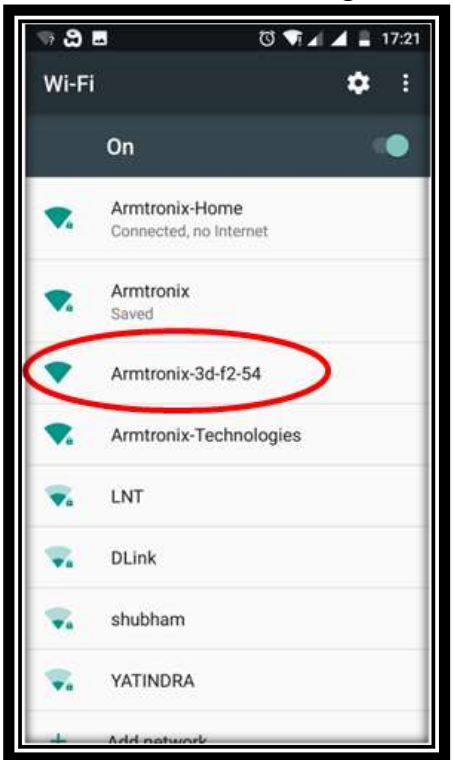


Figure 8: Available Wifi networks searched

viii. You will observe one of the available Wifi network as “Armtronix-xx-xx-xx”. Where xx: is last 6 digits of MAC address of the particular device. Click on that particular available network connect your smart phone to it. So, in this scenario, the device is ‘Wifi Host’ and Smartphone is ‘Wifi Client’.

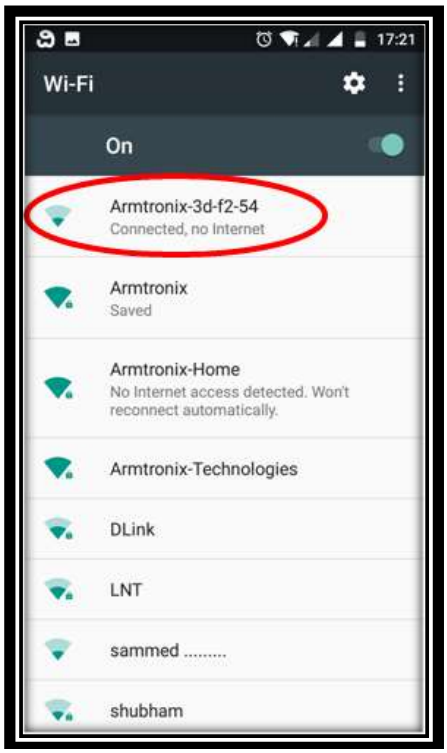


Figure 9: Smartphone Connected to Wifi hosted by DIO board

ix. Open any web browser, enter default IP address 192.168.4.1 of the device when it is hosting its own Wifi network and click enter.

Figure 10: Default IP address entered in the Web browser

x. Clinking on Enter button after entering default IP address, you will be able to access its webpage as shown in Figure 9.

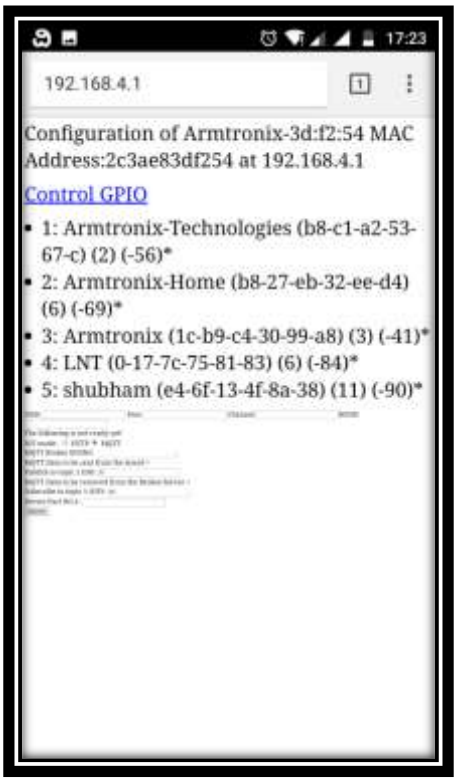


Figure 11: Accessed webpage of DIO module

xi. In the accessed webpage, fill-in all the required details like:

- **SSID** : SSID of Access Point
- **Pass** : Password of Access point
- **Channel** : Channel of Access point
- **BSSID** : BSSID (MAC Add) of Access Point
- **IOT Mode** : MQTT
- **MQTT Broker IP/DNS** : xxx.xxx.xxx.xxx (Ex. 192.168.0.1)
- **Publish to Topic 1 (IN)** : /I/xxx (Ex. /I/001)
- **Subscribe to topic 1 (OP)** : /O/xxx(Ex. /O/001)
- **Device Part NO.1** : xxx (Ex. 001)

Figure 12: Entered all the required details

xii. After entering all the required details, click on Submit button. It will save the parameters you entered and reboot the device and acknowledge the user in the webpage.
Do not turn OFF the device, it will automatically reboot.

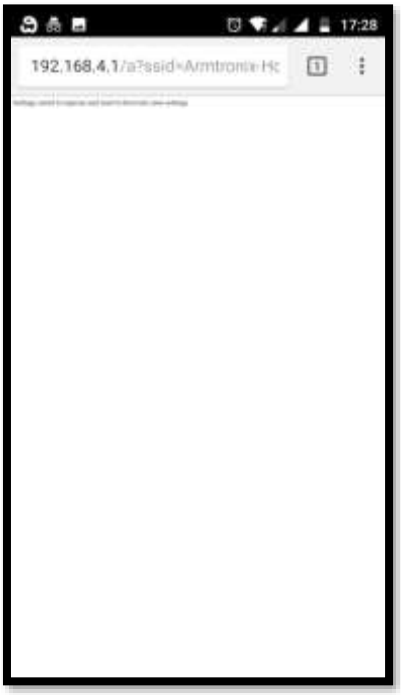


Figure 13: Submitted the updates

b. STEPS TO CONNECT SMARTPHONE TO MQTT BROKER:

i. Disconnect Smartphone from any other Wifi network if connected.

ii. Search for available Wifi network where the MQTT broker is running.
In our case it is “Armtronix-Home” is the Wi-Fi network where our MQTT broker is running.

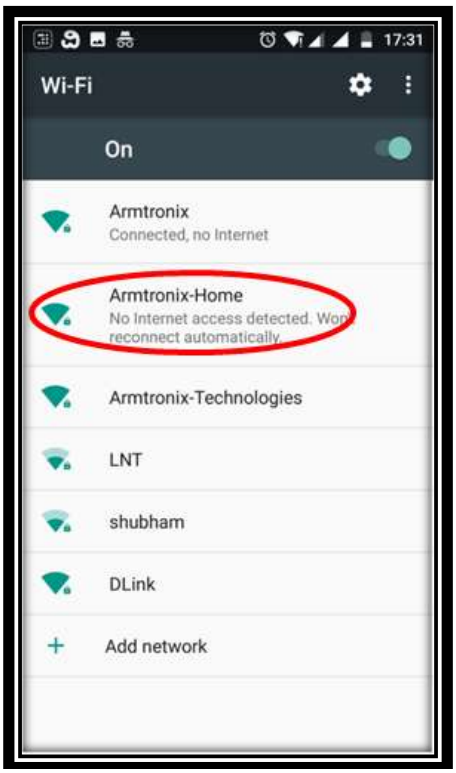


Figure 14: Smartphone searched for available Wifi networks

iii. Click on that particular available network to connect your smart phone to it.

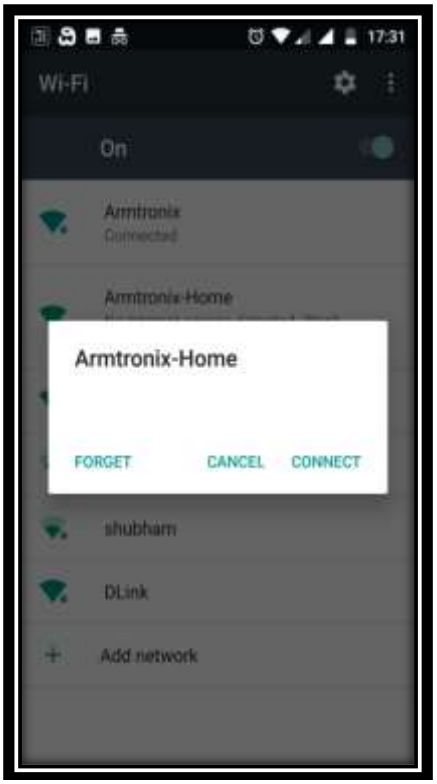


Figure 15: Trying to connect to pre-configured MQTT broker

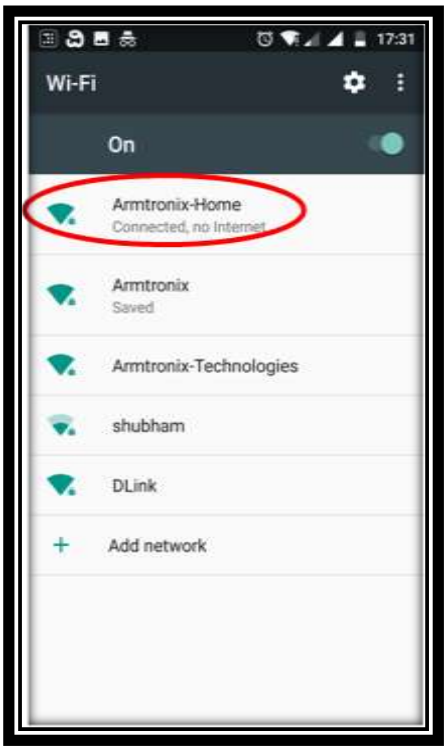


Figure 16: Smartphone connected to MQTT broker

c. STEPS TO TEST OUR *Modbus to IIoT* MODULE USING SMARTPHONE AND MQTT BROKER:

i. Install 'MyMQTT' Android app in to a Smartphone you would use for testing.

ii. Open an app 'MyMQTT' app Smartphone.

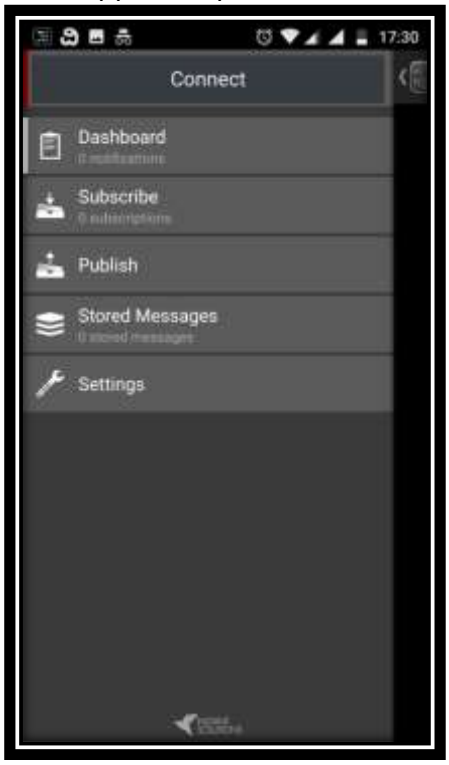


Figure 17: MyMQTT app menu page

iii. Click on settings option.

iv. Enter MQTT broker IP address and default Port number as 1883 (if not changed)
Our MQTT broker IP address is 192.168.0.1

Figure 18: MQTT broker IP address and port number entered

v. On the completion of your IP address and port number entry, Save the settings by clicking on **Save** button. Popup will indicate once the settings saved.

Figure 19: Saved the settings

d. CONTROL OUTPUTS VIA SMARTPHONE:

i. Connect Smartphone to network hosted having MQTT broker as said in section 12.b.
ii. Open MyMQTT app in Smartphone.
iii. Tap on the screen, it will open menu window.
iv. Click on the Publish option.
v. Enter topic as "/O/00y" where 'y' is client device number entered while configuring.
vi. Ex. Message "/O/00y_1" (Device will turn output as ON.)

Figure 20 Entered topic and message to control outputs

vii. Click on Publish button to publish the topic.
viii. On publishing the topic, popup will arrive as '*Message Published*' the device will take action on the outputs.

e. READ STATUS OF DIGITAL OUPUT RANDOMLY VIA SMARTPHONE.

i. Follow steps from 13.b.i to 13.b.viii

ii. Click on the publish option.

Figure 21: Opened Publish option

iii. Enter topic as /O/001?? (To read status of outputs)

Figure 22: Entered topic and message to be published to read the current status of Digital Outputs

iv. Click on publish button to publish the topic, you will get popup as *'Message Published'*
v. Click on back button located at left-top-corner of the screen.
vi. Tap on the screen. It will open the menu.
vii. Open the dashboard by clicking on Dashboard option in the menu.
viii. You will receive the current status of Outputs.

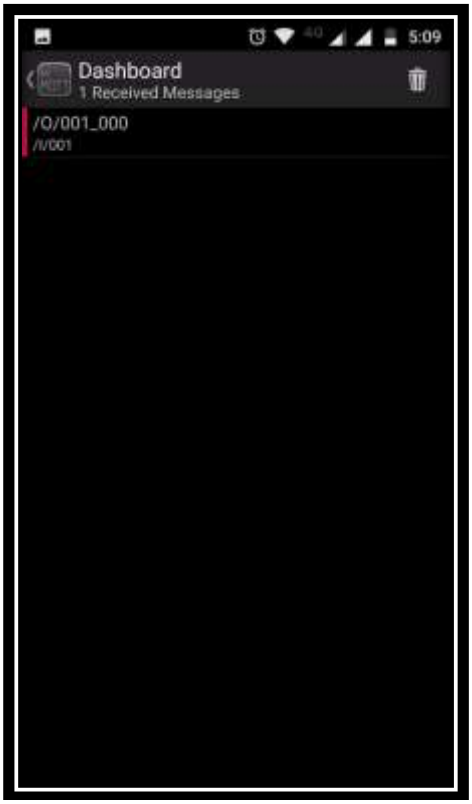


Figure 23: Reading status of Outputs on Dashboard screen

f. READ MAC ADDRESS OF CLIENT DEVICE VIA SMARTPHONE.

i. Follow steps from 12.b.i to 12.b.viii

ii. Click on the publish option.

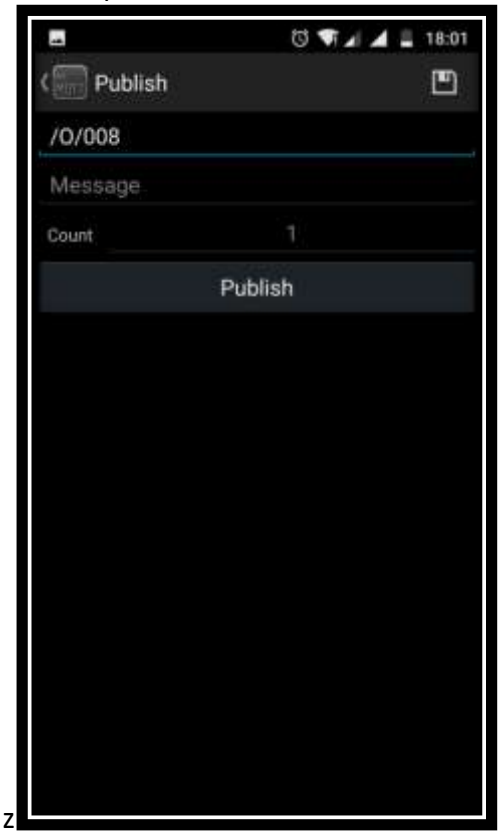


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Figure 24: Opened Publish option

iii. Enter topic as /O/00xMAC? (To read MAC address)

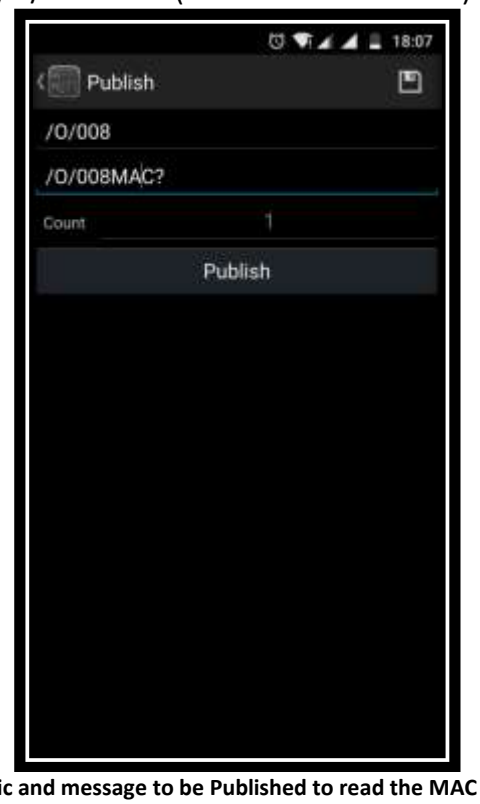

Figure 25: Entered topic and message to be Published to read the MAC address of the device

iv. Click on publish button to publish the topic, you will get popup as *'Message Published'*

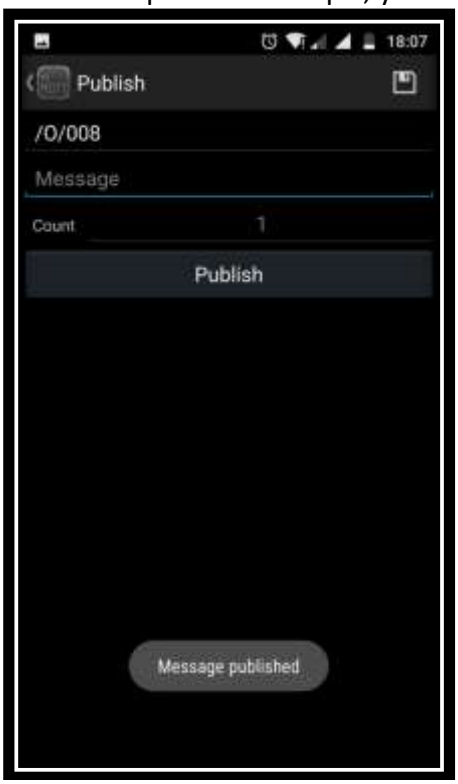

Figure 26: Message Published

v. Click on back button located at left-top-corner of the screen.
vi. Tap on the screen. It will open the menu.
vii. Open the dashboard by clicking on Dashboard option in the menu.
viii. You will receive the MAC address of the client without ":" or "-".

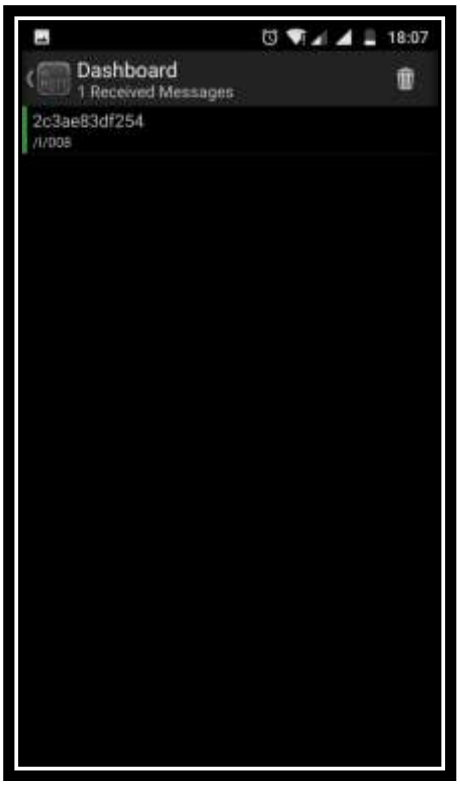

Figure 27: Reading MAC address on Dashboard screen

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