DESCRIPTION DOCUMENT FOR Wifi 4-TRIAC WITH POWER MONITORING BOARD

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
AC	Alternating Current
COM	Common pin of Relay
HTTP	Hypertext Transfer Protocol
Hz	Hertz
MQTT	Message Queue Telemetry Transport
NC	Normally Closed
NO	Normally Open
PM	Power Monitoring
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus

2. REFERENCES

Company Weblink	https://www.armtronix.in
Youtube WebLink	https://www.youtube.com/watch?v=lJxl29fOKPc
Intractable's Weblink	
Github's Weblink	

3. PURPOSE

The purpose of this document is to outline the design description for the Wifi Four-Triac with power monitoring Board. It provides a high-level summary of the product.

4. SCOPE

This document describes system architecture which includes Power supply, Triac, WiFi Module and Power monitoring.

5. SAFETY AND WARNING

Note that, this board to be powered with AC 230V with required current. Work and handle carefully with AC power as it is harmful and danger for living beings. Touching live wire or board when it is ON is danger and not advisable, it may cause to death, please avoid it.

Even a 50 V AC supply is sufficient to kill a living being. Please Switch off the mains before you make or change connections, be very careful. If you are not sure of anything related to the AC supply lines, please call an electrician and ask him to help you with it. Do not attempt to interface to mains unless you have adequate training and access to appropriate safety equipment. Never work on high voltages by yourself when you are alone. Always ensure that you have a friend/partner who can see and hear you and who knows how to quickly turn off power in case of an accident. Use a 1A Fuse in series with the input to the board as a safety measure. It is suggested to follow basic safety practices for electrical connections.

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 AC power 100 - 240 V AC 50-60 Hz.
- Power Monitoring (Voltage, Current and Power).
- Product firmware can be updated/reloaded/changed as per user requirement.
- Triac outputs, each output can handle up to 200-watt load.
- Tasmota compatible.
- WiFi with MQTT and/or HTTP protocol.
- The header with GPIOs, to use as DC virtual switches.
- Basic Firmware to enter SSID and password to connect to the router
- Push Button on board Provided to Reset the board.

7. PRODUCT DESCRIPTION

a. PHYSICAL DESCRIPTION

- AC to DC Power supply module
- Triac
- Zero Cross-over detection
- Wifi Module
- Power Monitoring

b. FUNCTIONAL DESCRIPTION

Block Diagram

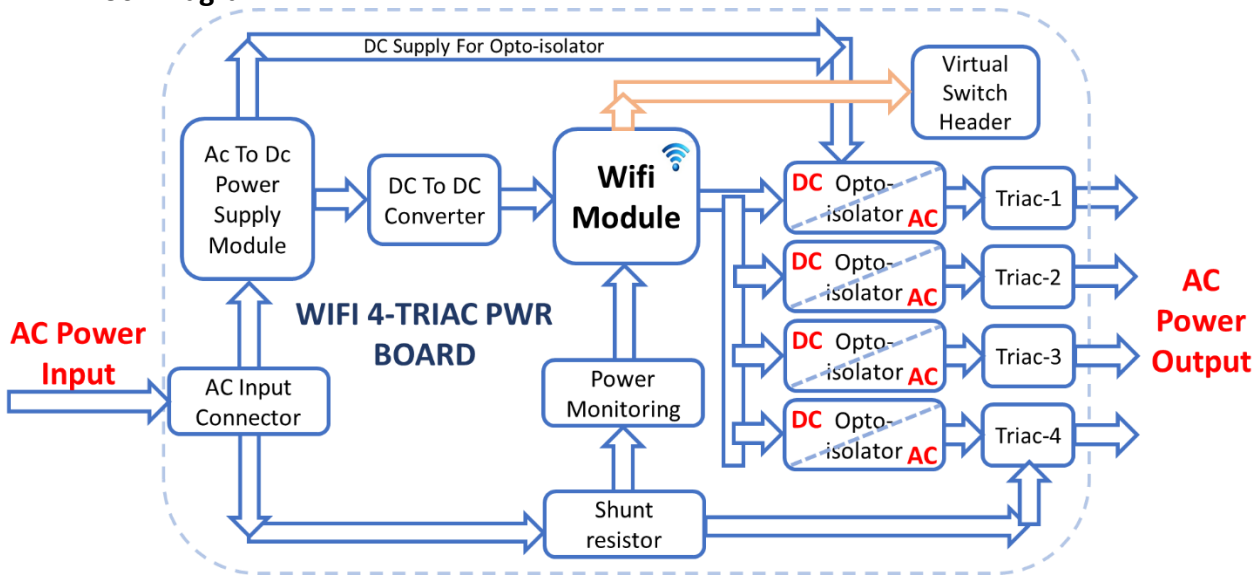


Figure 1: Block Diagram

Four Triacs with power monitoring board is a Wifi based remote control switch product. Specially designed to control (ON/OFF and speed or intensity) household electrical loads like lights, fans… up-to 200 watts each load using smartphone. The board has power monitoring in-built, in it to monitor the consolidated power consumption of the all the loads being controlled by the device. It has provision to connect physical switches to control loads in two-way mode with respect to Smartphone. It has on-board SMPS which takes standard AC power as input. There are 4-traics used on board to control 4 independent external electrical loads from a mobile application using MQTT/HTTP protocol.

8. SYSTEM OVERVIEW

1. AC to DC Power supply module

AC to DC converter is power supply module manufactured from Hi-Link part number HLK-PM01. This power supply module rectifies and regulates voltage from 230 V AC to 5 V DC with output current capacity of 0.6A DC. The power of HLK-PM01 is at maximum of 3W.
There is a DC-DC converter on board to regulate voltage from 5 V DC to 3.3 V DC to supply power to Wifi module.

2. Wifi Module

Wifi module used on the board is ESP12 with all its required GPIOs are easily accessible to user for their own application. Wifi module is powered on through 3.3 V DC. It works on both MQTT / HTTP protocol.

3. Zero Crossover Detection

Zero cross over detection is used to detect the zero crossing of AC phase to fire the Triac synchronously to get the smooth output. ZCD circuit is optically isolated to avoid device being affected from unwanted signals due to AC lines.

4. Triac

TRIAC is driven through optically isolated TRIAC drivers with reference to zero crossover detection. Synchronous switching method is used to regulate the power to loads. PWM signal will drive the TRIACs, and switches AC mains power from 0% to 100% of its total cycle. The PWM signal pulses can be configured in code with respect to AC mains frequency and voltage level. BT136 Triac is used in this board to act as dimmer or switch.

5. Power Monitoring

Power monitoring block is implemented in the hardware to monitor the consolidated power consumption by the loads. The circuit is based on single phase energy metering IC HLW8012. Which has ability to monitor voltage, current and active power and give the output in the form of pulses. User need to convert these pulse output to appropriate parameters. With these parameters, user can be able to calculate the energy consumption by the loads.

9. TECHNICAL SPECIFICATION

a. ELECTRICAL SPECIFICATION

Input Specifications				
Description	**Min**	**Typ**	**Max**	**Unit**
Voltage AC	100	220	240	Volts
Current AC	-	0.1	-	Amps
Power AC	-	3	-	Watts
Frequency	50	-	60	Hz

Triac-1 to Triac-4 Output Specifications (Maximum)				
Description	**Min**	**Typ**	**Max**	**Unit**
Voltage AC	Same as input			Volts
Power AC	-	-	200	Watts

b. MECHANICAL SPECIFICATION

- Mechanical Dimensions of PCB are 100x 50 x 20 mm (Length x Width x Height)
- Mounting Holes (M3), board dimension is shown below.

Figure 2: Mechanical dimension

10. ELECTRICAL CONNECTIONS

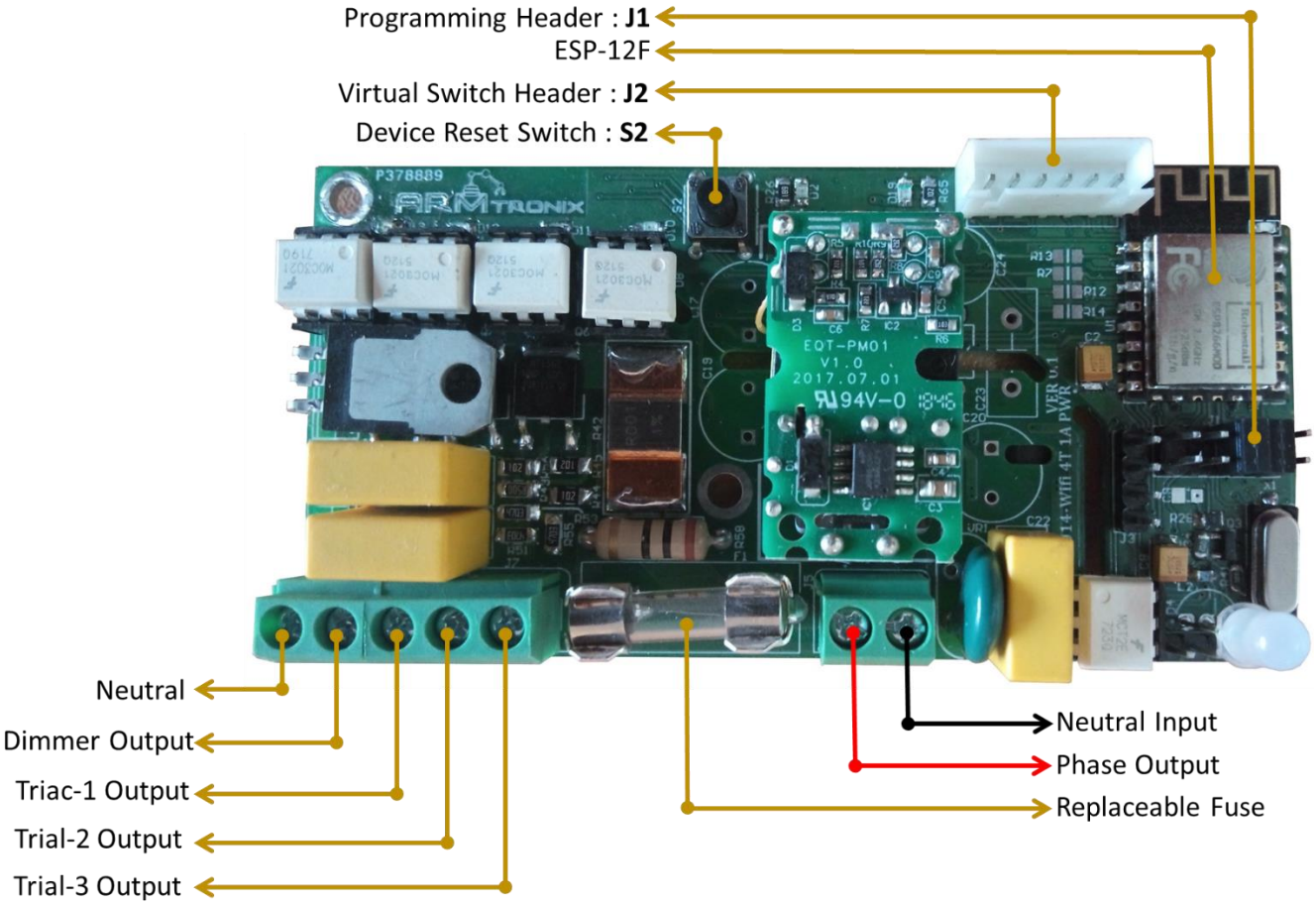


Figure 3: Header and Switch Details

Description of Header and Switches shown in Figure 1:

1. S1 Switch to reset the device
2. J1 Header is for programming purpose.
3. J2 Headers for the connection of virtual switch.
4. J5 Input Power supply.
5. J7 & j8 Output from the board.

a. MCU PIN CONFIGURATION:

MCU Pin No.	MCU Port Name	Description	Arduino Port No.
1	PD3	LED_GREEN	3
2	PD4	LED_RED	4
10	PD6	Dimmer-1	6
12	PB0	TRIAC-1	8
13	PB1	TRIAC-2	9
14	PB2	TRIAC-3	10
15	PB3	MOSI	11
16	PB4	MISO	12
17	PB5	SCK	13
23	PC0	V_SWITCH_1	A0
24	PC1	V_SWITCH_2	A1
25	PC2	V_SWITCH_3	A2
26	PC3	V_SWITCH_4	A3
28	PC4	SDA	A4
29	PC5	SCL	A5
30	PD0/RXD	RXDA	0
31	PD1/TXD	TXDA	1
32	PD2	ZCD	2

Table 1: MCU Pin Configuration

b. ESP PIN CONFIGURATION:

ESP Pin No.	ESP Port Name	Description	Arduino Port No.
20	GPIO5	HLW8012_SEL	D1
7	GPIO13	HLW8012_CF1	D7
5	GPIO14	HLW8012_CF	D5

Table 2: ESP Pin Configuration

c. HEADER PIN CONFIGURATION

i. PROGRAMMING HEADER J1 PIN NUMBERS

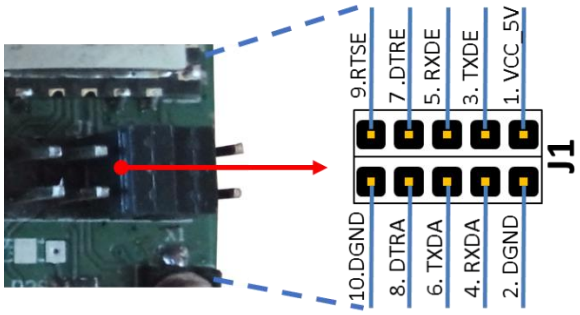


Figure 4: Programing Header PIN numbers

ii. VIRTUAL SWITCH HEADER J2 PIN NUMBERS

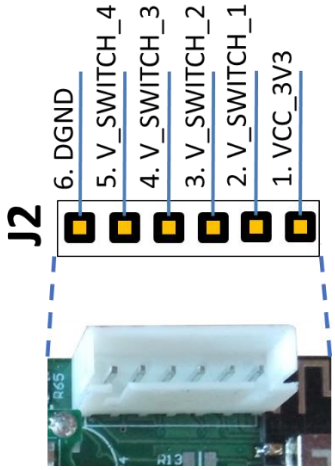


Figure 5: Virtual switch header pin numbers

iii. MCU I2C HEADER

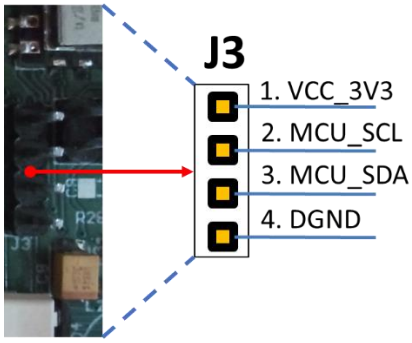


Figure 6: MCU I2C Header

d. EXAMPLE CONNECTION DIAGRAM:

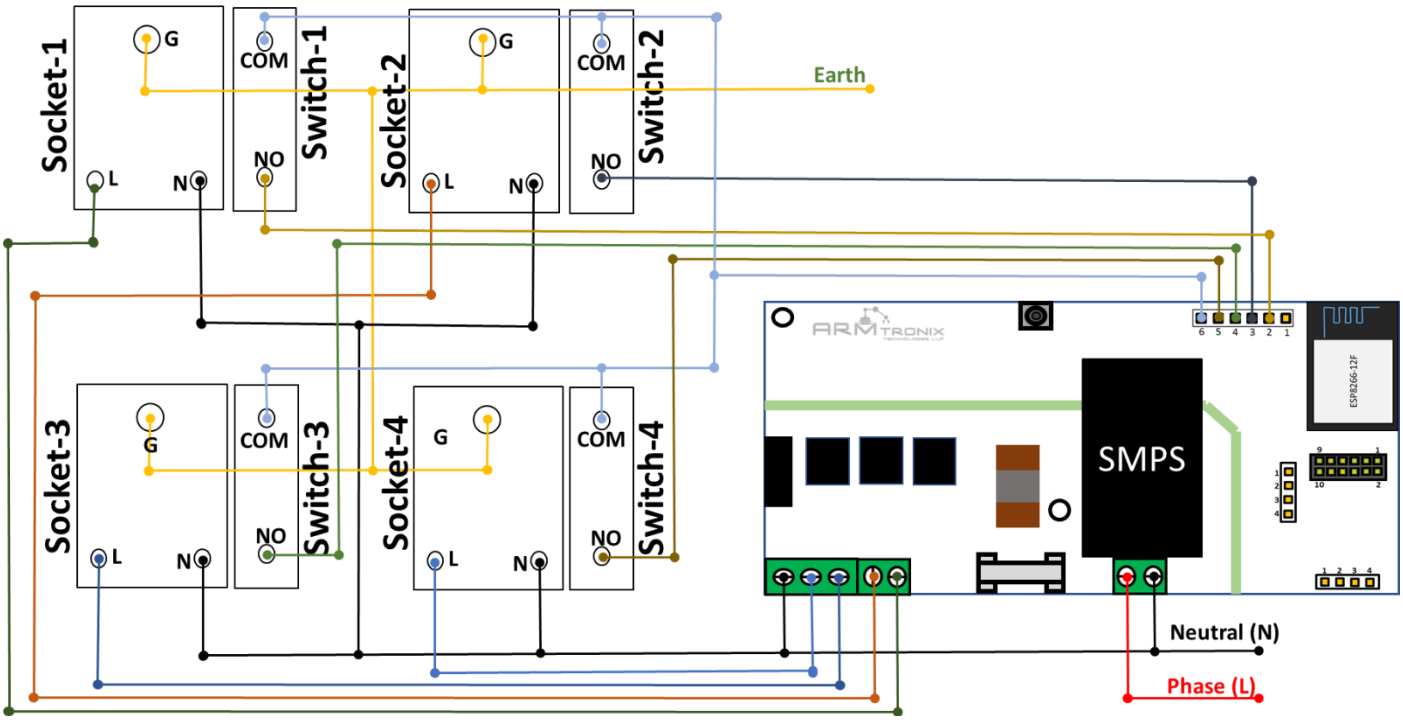


Figure 7: Example wiring diagram

Supply AC phase and neutral to the board at terminal block j5. Figure 4 represents example connection of load and Triacs output (J7 & J8) connector. It is recommended to connect only phase output line from board to loads and Neutral terminal of all the loads directly to common neutral connection of the electrical network outside the board.

By default, the product comes with code as three Triac output 1-3 for switch ON/OFF function and one Triac as Dimmer output to control speed of fan or intensity of incandescent bulb or Triac dimmable LED bulbs.

11. HOW TO USE THE PRODUCT

a. PROCEDURE POWER ON THE DEVICE.

1. Make an input connection AC phase and Neutral connection as shown in Figure 4.
2. Use an electrical fuse in series to input connections for the purpose of safety.
3. Check and make sure that there is no short circuit between phase and neutral.
4. Ensure that, safety precautions are taken care.
5. Power ON the device by turning ON the main input supply.
6. Then observe the LED D3 on the device is in ON condition.
7. If the device has NOT powered ON, then turn OFF the main input supply and recheck for connections by following above steps.

b. PROCEDURE TO CONFIGURE THE DEVICE

Power ON the device, so that, it will host the access point as shown in Figure 7,

Figure 8: Device hosting Access point

Connect your mobile to access point with Armtronix-(MAC ID). EX: Armtronix-1a-65-7 as shown in Figure 8.

Figure 9: Access point name

After connecting, open browser and enter 192.168.4.1 IP address, it will open the web server as shown in the Figure 9,

Figure 10: Web server

fill the SSID and password and select HTTP, if user wants to connect to MQTT then he has to select MQTT radio button, enter MQTT broker IP address, enter MQTT publish topic then MQTT subscribe topic and submit.

After submitting configuration, the ESP 8266 will connect to the router and router assigns IP address to the ESP. Open that IP address in the browser to control the switch (Relay).

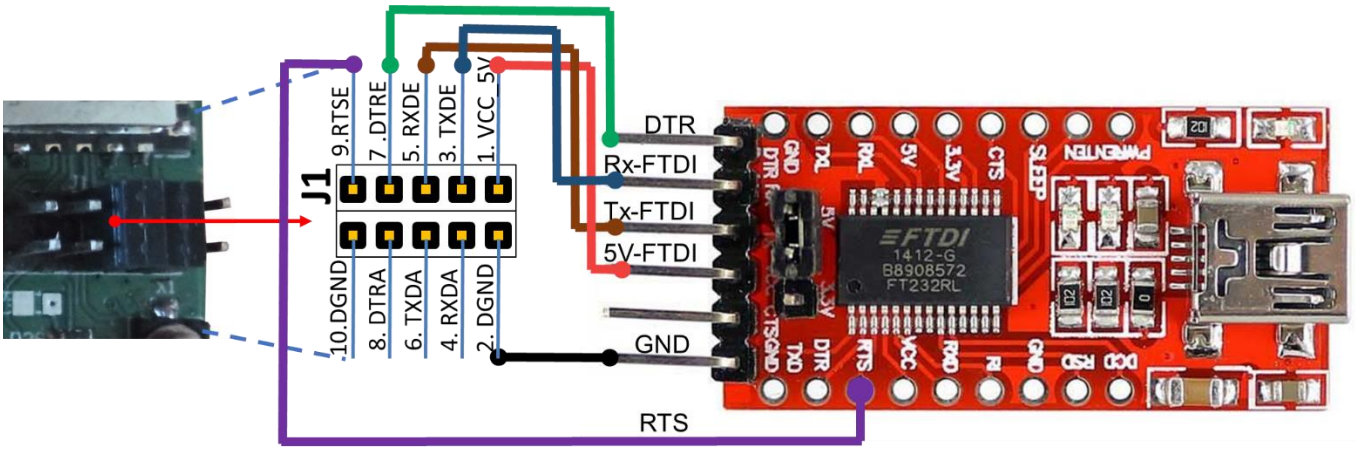
Without configuring the SSID and Password we can control the Wifi Switch by connecting to the access point of the device and open the IP address of device i.e 192.168.4.1 the web server page will show the link with the name Control GPIO as shown in the Figure 8, by clicking this link we can control the Wifi Switch board but the response will be slow.

12. HOW TO CUSTOMISE FIRMWARE

You can program this board using Arduino IDE. Please follow the below steps to program the board by yourself with easy steps as mentioned below:

a. STEPS TO LOAD PROGRAM TO ESP8266:

1. Use external USB-UART converter between computer and this board.
2. Connect Micro USB cable between your computer and "USB-UART converter".
3. Make connections as mentioned in below table:



J1 Header			USB-UART Converter
J1 Pin No.	Pin Description		Pin Description
1	VCC_5V		5V
3	TXDE		RXD
5	RXDE		TXD
7	DTRE		DTR
9	RTSE		RTS
2, 10	DGND		GND

Figure 11: USB-UART converter connection details for ESP programming

4. Open your code in Arduino IDE as shown.
5. Click on Tools Tab, move mouse pointer on “Board: xxxxxxxxxx” and click on “NodeMCU0.9 (ESP-12 Module)” as shown in figure 9.

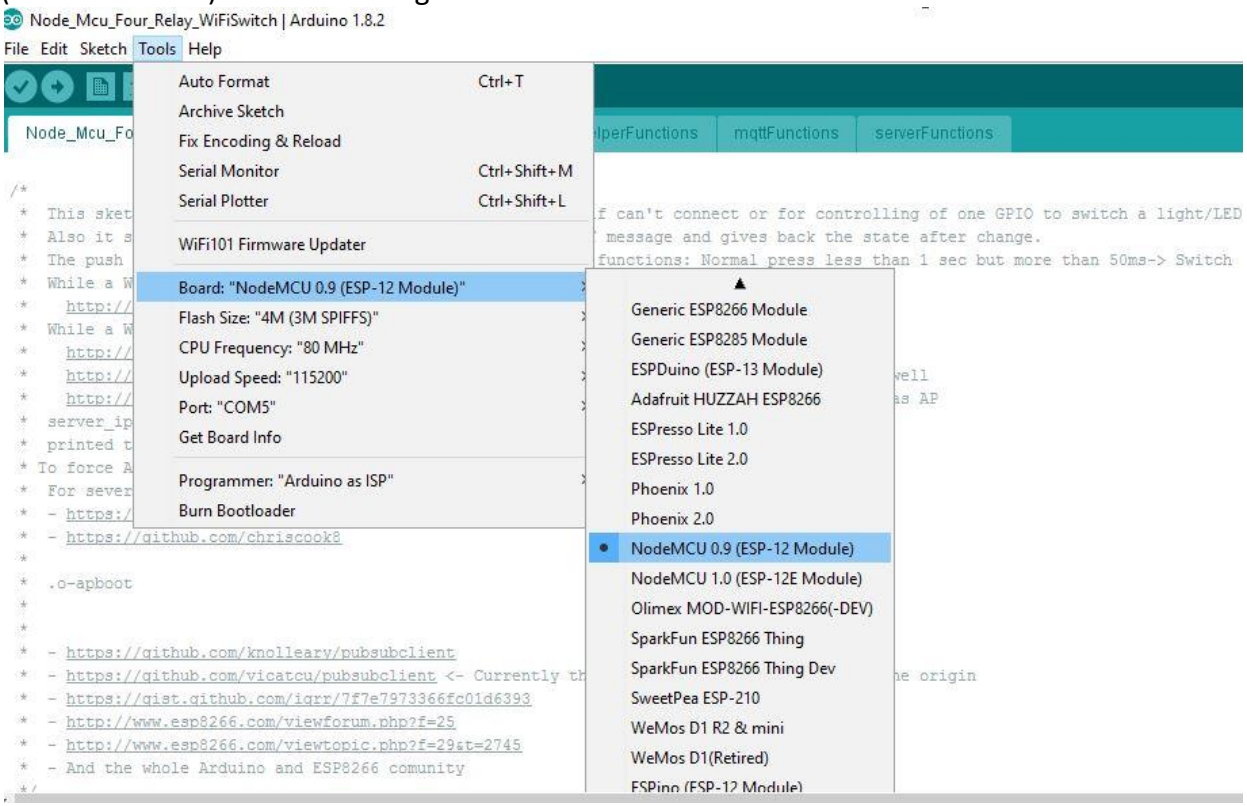


Figure 12: Board Selection

6. Click on tools tab, move mouse pointer to “Programmer: “Arduino as ISP’”, under this click on “Arduino as ISP” to select. Refer to figure 10.

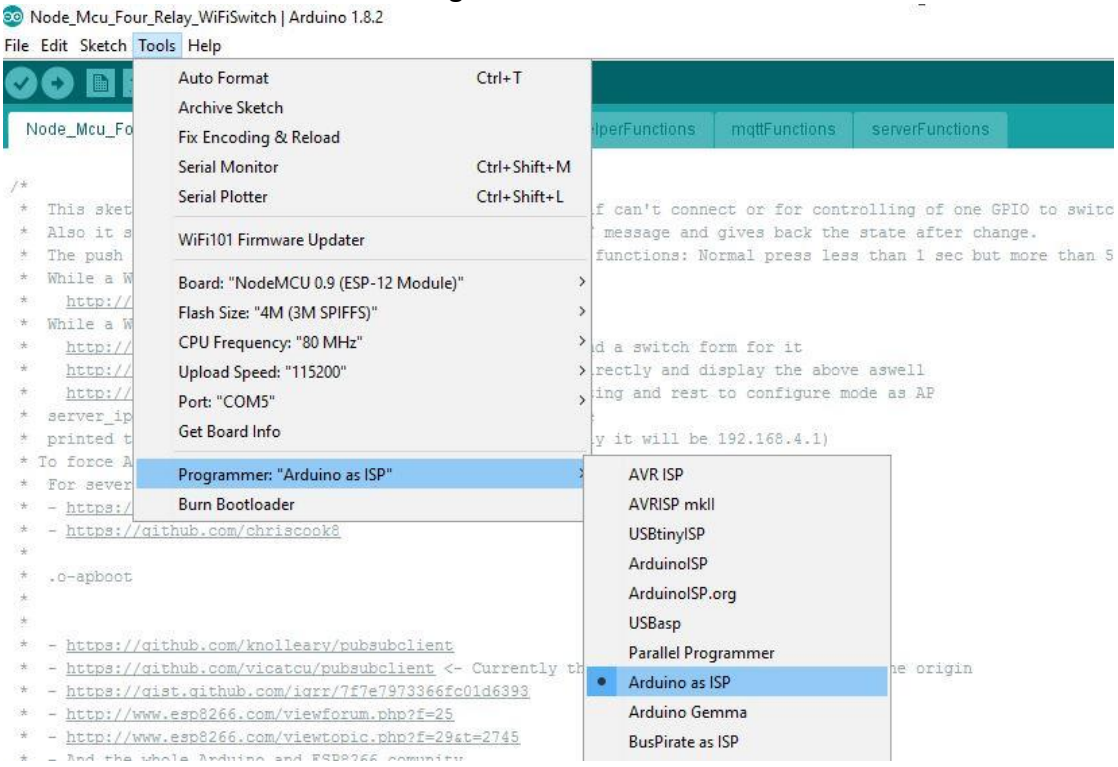


Figure 13: IDE Selection

7. Click on tools tab, move mouse pointer to “Port: “COMx”, under this click on “COMx” to select. (“x” refers to port number available in your computer) Refer to figure 11.

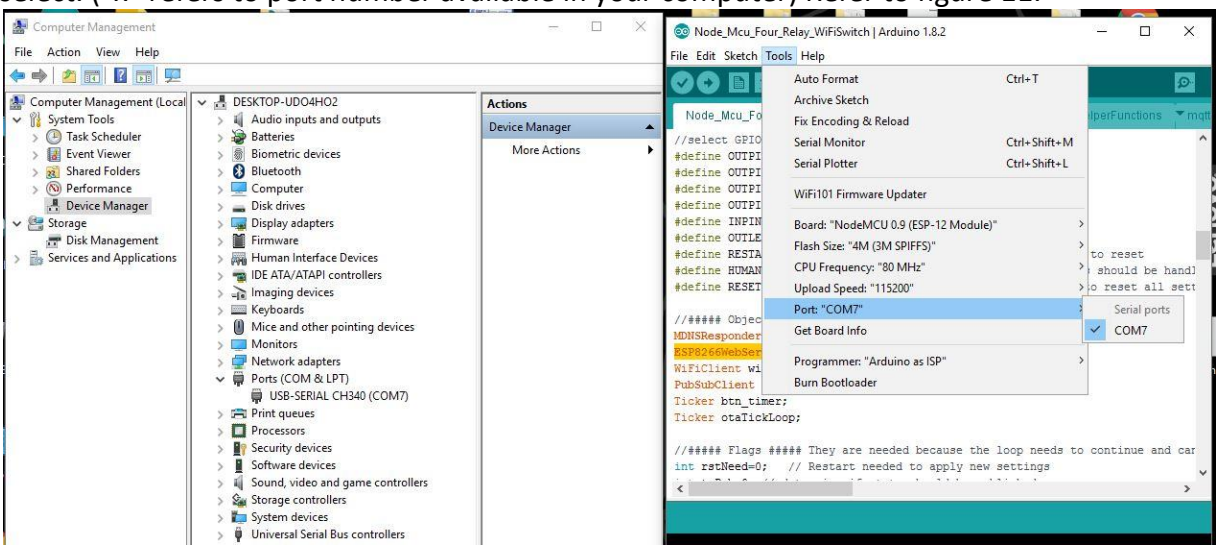


Figure 14: COM port selection.

8. Run the program. Refer to Figure 12.

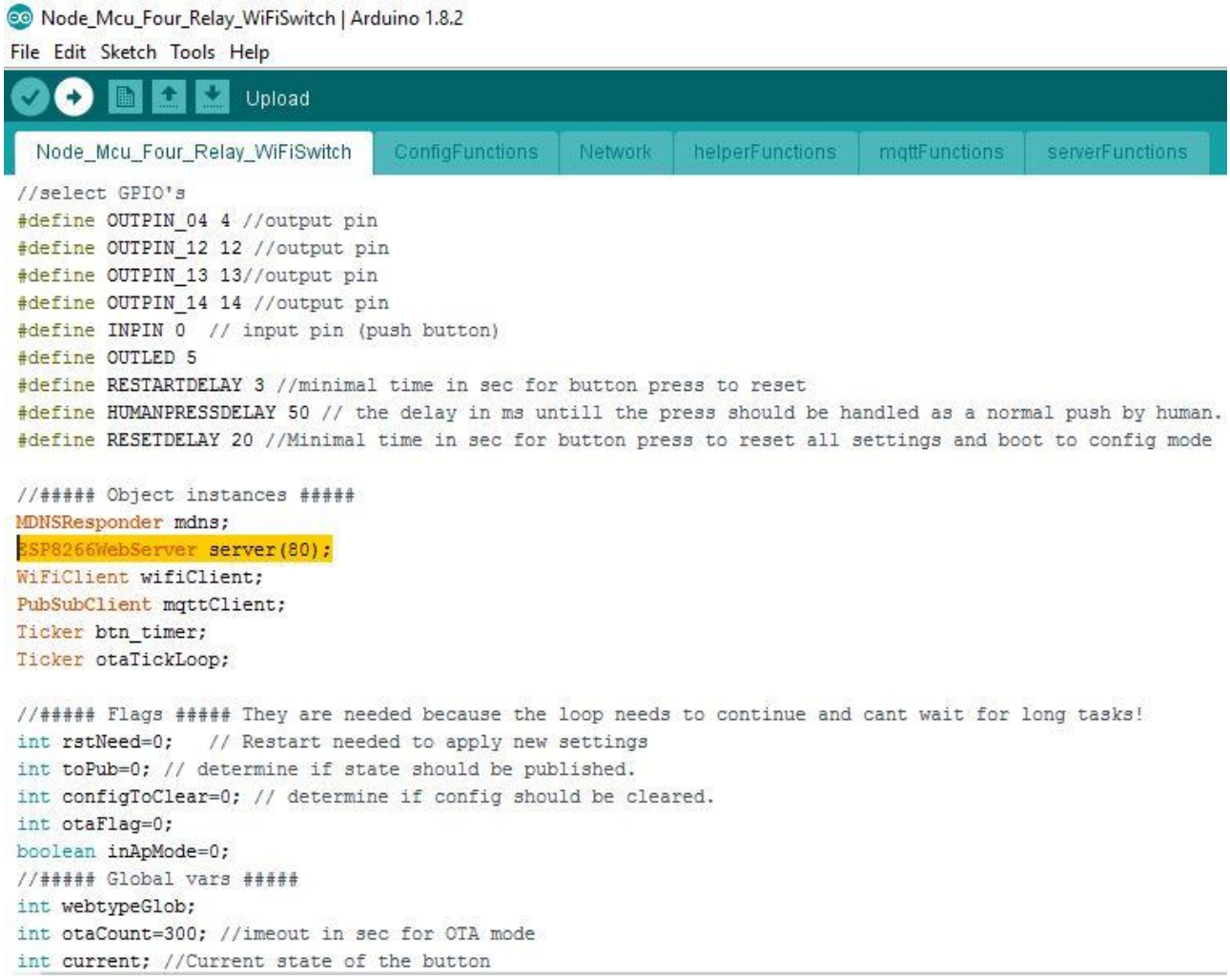
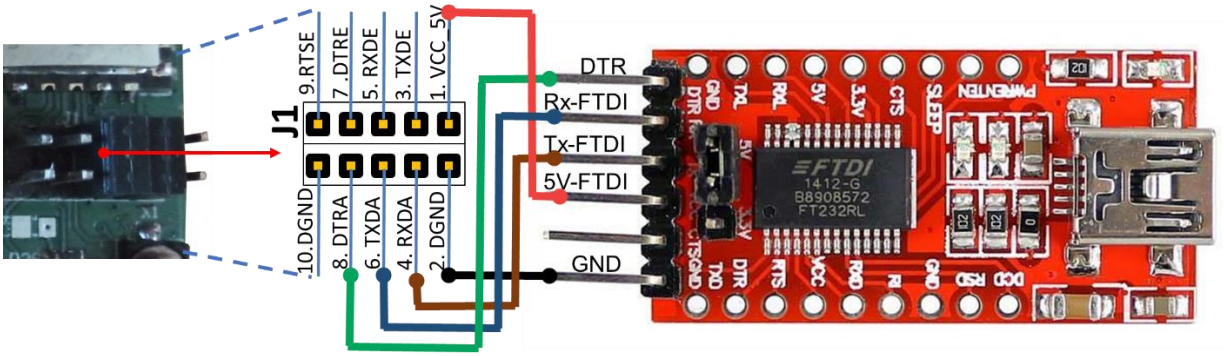


Figure 15: Executing code

b. STEPS TO LOAD PROGRAM TO ESP8266:

1. Use external USB-UART converter between computer and this board.
2. Connect USB-UART converter to header J1 of this board as shown in below figure:



J1 Header			USB-UART Converter
J1 Pin No.	Pin Description		Pin Description
1	VCC_5V		5V
4	RXDA		TXD
6	TXDA		RXD
7	DTRA		DTR
2, 10	DGND		GND

3. Connect Micro USB cable between your computer and U5 of "BA014 – Wifi 4T PWR Board".
4. Open your code in Arduino IDE as shown.
5. Click on Tools Tab, move mouse pointer on "Board: xxxxxxxxxx" and click on "Arduino Uno" as shown in figure 12.
6. Select Upload Speed as "115200"
7. Click on tools tab, move mouse pointer to "Programmer: "Arduino as ISP'", under this click on "Arduino as ISP", as shown in figure 13.
8. Click on tools tab, move mouse pointer to "Port: "COMx", under this click on "COMx" to select. ("x" refers to port number available in your computer) as shown in figure 14.
9. Run the program.

Once your loading of program is completed, switch OFF the board and disconnect converter from it and short Pin-3. TXDE to Pin-4.RXDA, short Pin-5.RXDE to Pin-6.TXDA, to check the board functionality and use. If the board is working as per your code, then you can install it for your application.

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