

DOCUMENT REV: A

**DOCUMENT NAME:** DESIGN DESCRIPTION, Wifi 4T 1A PWR.

## 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
А	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.



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### 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=IJxI29fOKPc
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.



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## 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



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.



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### 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	Тур	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	Тур	Max	Unit
Voltage AC	S	ame as input		Volts
Power AC	-	-	200	Watts





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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	PBO	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	PCO	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** 



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### c. HEADER PIN CONFIGURATION

i. PROGRAMMING HEADER J1 PIN NUMBERS



**Figure 4: Programing Header PIN numbers** 

### ii. VIRTUAL SWITCH HEADER J2 PIN NUMBERS





iii. MCU I2C HEADER





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.



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### **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,

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	Configuration of Armtron	nix-1a:65:7 at 192.168.4,1
	Control GPIO	
	<ul> <li>1: Armtronix-Home</li> <li>2: DLink (-93)*</li> <li>3: Armtronix (-53)*</li> <li>4: LNT (-84)*</li> </ul>	(-35)*
	SSID: Amitronia The following is not read	Pass. were here and h
	IOT mode: O HTTP N	AQTT
	MQTT Broker IP/DNS:	
	MQTT Publish topic:	
	MQTT Subscribe topic:	
	Submit	

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.



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### **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	VCC_5V		
2	TXDE	RXD		
3	RXDE	TXD		
4	RTSE	RTSE		
5	DTRE	DTRE		
6	GND	GND		

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

	Auto Format Archive Sketch	Ctrl+T						
Node_Mcu_Fo	Fix Encoding & Reload		IperFunctions	mqttFunctions	serverFunctions			
	Serial Monitor	Ctrl+Shift+M						
This sket	Serial Plotter	Ctrl+Shift+L	f can't conne	ect or for cont	rolling of one GPIO to switch a light/LF			
Also it s The push	lso it s WiFi101 Firmware Updater			message and gives back the state after change. functions: Normal press less than 1 sec but more than 50ms-> Switch				
While a W	Board: "NodeMCU 0.9 (ESP-12 Mo	odule)"		*				
http://	Flash Size: "4M (3M SPIFFS)"	3	Generic ESP8266 Module					
http://	CPU Frequency: "80 MHz"		Generic ESP8285 Module					
http://	Upload Speed: "115200"		ESPDuino (E	ESP-13 Module)	vell			
* <u>http://</u>	Port: "COM5"		Adafruit HU	ZZAH ESP8266	as AP			
* server_ip	Get Board Info		ESPresso Lit	e 1.0				
To force A			ESPresso Lit	e 2.0				
For sever	Programmer: "Arduino as ISP"	3	Phoenix 1.0					
* - <u>https:/</u>	Burn Bootloader		Phoenix 2.0					
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*			Olimex MO	D-WIFI-ESP8266(-DE	EV)			
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* /			FOPINO (FSP	- 17 WINGUIË)				

Figure 11: Board Selection



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 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.

Node\_Mcu\_Four\_Relay\_WiFiSwitch | Arduino 1.8.2

o 🖬	Auto Format Archive Sketch	Ctrl+T					
lode_Mcu_Fo	Fix Encoding & Reload		IperFunctions	mqttFunctions	serverFunctions		
	Serial Monitor	Ctrl+Shift+M					
This sket	Serial Plotter	Ctrl+Shift+L	f can't conne	ot or for cost	colling of one GPTO to swit		
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While a W							
http://	Flash Size: "4M (3M SPIFFS)"	1	>				
http://	CPU Frequency: "80 MHz" >		d a switch form for it rectly and display the above aswell				
http://							
http://	Parts "COM5"		ing and rest	to configure m	ode as AP		
server_ip			1				
printed t	Get Board Info		y it will be	192.168.4.1)			
To force A	Programmer: "Arduino as ISP"		AVR ISP				
- https:/	Burn Bootloader		AVRISP mkll				
- https://	github.com/chriscook8	2	LISP				
.o-apboot		AndrianICD					
		Ardumoise					
			ArdunoISP.	org			
			USBasp				
- https://github.com/knolleary/pubsubclient			Parallel Programmer				
<ul> <li>https://github.com/vicatcu/pubsubcifent &lt;- currently th</li> <li>https://github.com/igrr/257878386560146393</li> </ul>		Arduino as ISP					
- http://www.esp8266.com/viewforum.php?f=25		Arduino Gemma					
- http://www.esp8266.com/viewtopic.php?f=29at=2745		Pur Dirate as ISD					
Total selection of	thele laduine and EGD0266 service	Long to the second s	busi nuce as	1.51			

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.





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### 8. Run the program. Refer to Figure 12.

💿 Node\_Mcu\_Four\_Relay\_WiFiSwitch | Arduino 1.8.2

File Edit Sketch Tools Help

📀 📀 🛅 🖬 🔛 Upload					
Node_Mcu_Four_Relay_WiFiSwitch	ConfigFunctions	Network	helperFunctions	mattFunctions	serverFunctions
//select GPIO's					
<pre>#define OUTPIN_04 4 //output pin</pre>					
#define OUTPIN_12 12 //output pin	n				
#define OUTPIN_13 13//output pin					
#define OUTPIN_14 14 //output pin	n				
#define INPIN 0 // input pin (p	ush button)				
#define OUTLED 5					
<pre>#define RESTARTDELAY 3 //minimal</pre>	time in sec for	button pr	ess to reset		
#define HUMANPRESSDELAY 50 // the	e delay in ms un	till the p	ress should be ha	undled as a norm	nal push by human.
<pre>#define RESETDELAY 20 //Minimal</pre>	time in sec for	button pre	ss to reset all s	settings and boo	ot to config mode
//##### Object instances #####					
MDNSResponder mdns;					
ESP8266WebServer server(80);					
WiFiClient wifiClient;					
PubSubClient mqttClient;					
Ticker btn_timer;					
Ticker otaTickLoop;					
//##### Flags ##### They are nee	ded because the	loop needs	to continue and	cant wait for 1	long tasks!
<pre>int rstNeed=0; // Restart need</pre>	ed to apply new	settings			
<pre>int toPub=0; // determine if sta</pre>	te should be pub	lished.			
<pre>int configToClear=0; // determine</pre>	e if config shou	ild be clea	red.		
<pre>int otaFlag=0;</pre>					
boolean inApMode=0;					
//##### Global vars #####					
int webtypeGlob;					
<pre>int otaCount=300; //imeout in se</pre>	c for OTA mode				
<pre>int current; //Current state of</pre>	the button				
	<b>F</b> : 4 /	A. E	State and a		

#### Figure 14: Executing code



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