HOMELAB PROJECT

A 3-Dollar Tiny Wi-Fi Switch That Works

Creative dealings with the ESP8266

Bera Somnath

Out of curiosity I ordered a tiny ESP8266 relay switch board from aliexpress.com, for next to nothing. Blissfully unaware, then, of the struggle ahead to make the thing work as advertised. |I survived and conquered — here's the story.

The little gizmo pictured in **Figure 1** was stated by the vendor(s) to contain an inbuilt switching program, so all I had to do is "use some Android phone to control it". Sadly, despite several attempts using various Chinese and English-language Android apps, nothing ever hap-

pened! Sure, the device gets connected with the Wi-Fi of my PC or laptop as a server and it also allocates the dynamic IP address — but nothing happens after that. No server page etc. opens anywhere! Utterly frustrated, one day I decided to develop and install my own program into its dumb head!

Starting out

I reprogrammed the switch to connect to my Wi-Fi router with a fixed IP address and a fixed port like these: 192.168.1.99 and port 8083. Once connected the board behaved as a webserver at http://192.168.1.99:8083 and the 'switch' was visible in the browser. Pressing the On or Off button made it act accordingly. For simplicity, I added a refresh counter and a relay status to have a readout for the state of the relay (that being, on or off).

Strategy

Next, in my DSL router I set up 'port forwarding' of the 8083 port to the 8083 port of the "192.168.1.99" computer (i.e. the relay board) which gets connected to it. Once you know the external IP address of your router, you can connect to it from the other side of the universe! So easy! But the question is, how to know the external IP address of your router? Simple, you ask your son, daughter or your spouse to open the router's admin page, go to the Status tab and locate the IP address of the router — it's a common feature of most DSL router modems out there. When your laptop, desktop, or mobile phone gets network, it gets an IP address as the identity of that device on the Wi-Fi network. Likewise, your DSL router gets an IP address when it gets connected to Internet, and that's the address you have to know.

But there is no dearth of problems in Bera's world of electronics! The external IP address of any router changes quite often — up to 10 times per is not uncommon. So really, you'd need a permanent valet near the modem to shout numbers 10 times a day ... you'd wish you could train your pet to do this work there and then!

But where there is a problem there is solution! At least in the world of electronics this is so true. When you can formulate and then simplify a problem, you are actually pushing towards the solution. Fortunately, most run of the mill DSL modem haves an



Figure 1: Wi-Fi controller relay switch board as purchased from aliexpress. Hardware: Pass; cost: Pass; software: div-by-0.



27300		SETUP	ADV	ANCED	MANAGEN	IENT	STATUS		HELP
nced Wireless	POR	T FORWARD	ING						
Forwarding	Port	Forwarding al	llows you to dire	ct incoming traffic	from the WAI	N side (identified t	v protocol and ex	dernal port)te	o the inte
	serv	er with a priva	te IP address or	n the LAN side. Th	e internal por	t is required only i	if the external por	t needs to be	e convert
ntal Control	toa	different port r	number used by	the server on the	LAN SIDE. A I	naximum or 32 en	itnes can be conn	gurea.	
ina Onliner	Sele	ct the service ified server. N	name, and ente lote: Modifying t	r the server IP add he Internal Port S	tart or Intern	al Port End is no	t recommended.	this service t If the Extern	al Port S
ing Options	or th	e External Po	ort End changes	s, the Internal Por	t Start or Inte	ernal Port End au	tomatically chang	ges according	gly.
Configuration	note	: If it's configu	ared for FTP virt	ual server, the exte	ernal port mus	st be the FTP prot	ocol default port :	21.	
Configuration vall Settings	note	: If it's configu	ared for FTP virt	ual server, the exte	ernal port mu:	st be the FTP prot	ocol default port :	21.	
Configuration vall Settings	POR	: If it's configu	ING SETUP	ual server, the exte	ernal port mu	st be the FTP prot	ocol default port :	21.	_
Configuration rall Settings mic DNS	POR	: If it's configu T FORWARD Server	ING SETUP	External Port	Protocol	Internal Port	Server IP	Schedule	Remot
Configuration rall Settings mic DNS ork Tools	POR	: If it's configu T FORWARD Server Name webcam	ING SETUP Wan Connection PVC:0/35	External Port Start/End 5678/5678	Protocol	Internal Port Start/End 5678/5678	Server IP Address 192 168 1 37	Schedule Rule Always	Remot IP
Configuration all Settings mic DNS ork Tools ng	POR	T FORWARD	ING SETUP Wan Connection PVC:0/35 PVC:0/35	External Port Start/End 5678/5678 22/22	Protocol tcp tcp	Internal Port Start/End 5678/5678 22/22	Server IP Address 192.168.1.37 192.168.1.37	Schedule Rule Always Always	Remot
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Configuration all Settings mic DNS ork Tools ng dulies		: If it's configu TFORWARD Server Name webcam berashel bera-web raspberr	ING SETUP Wan Connection PVC:0/35 PVC:0/35 PVC:0/35 PVC:0/35	External Port Start/End 5678/5678 22/22 8082/8082 8081/8081	Protocol tcp tcp tcp tcp	Internal Port Start/End 5678/5678 22/22 8082/8082 8081/8081	Server IP Address 192.168.1.37 192.168.1.37 192.168.1.37 192.168.1.37	Schedule Rule Always Always Always Always	Remot IP
Configuration all Settings mic DNS ork Tools ng dules ut		: If it's configu TFORWARD Server Name webcam berashel bera-web raspberr	ING SETUP Wan Connection PVC:0/35 PVC:0/35 PVC:0/35 PVC:0/35 PVC:0/35	External Port Start/End 5678/5678 22/22 8082/8082 8081/8081 3306/3306	Protocol tcp tcp tcp tcp tcp tcp	Internal Port Start/End 5678/5678 22/22 8082/8082 8081/8081 3306/3306	Server IP Address 192.168.1.37 192.168.1.37 192.168.1.37 192.168.1.37 192.168.1.37 192.168.1.37	Schedule Rule Always Always Always Always Always	Remol
Configuration all Settings mic DNS ork Tools ng dules ut		: If it's configu TFORWARD Server Name webcam berashel bera-web raspberr esp32_ca	ING SETUP Wan Connection PVC:0/35 PVC:0/35 PVC:0/35 PVC:0/35 PVC:0/35 PVC:0/35	External Port Start/End 5678/5678 22/22 8082/8082 8081/8081 3306/3306 5679/5679	Protocol tcp tcp tcp tcp tcp tcp tcp tcp	Internal Port Start/End 5678/5678 22/22 8082/8082 8081/8081 3306/3306 5679/5679	Server IP Address 192.168.137 192.168.137 192.168.137 192.168.137 192.168.137	Schedule Rule Always Always Always Always Always Always	Remot

Figure 2a: Port forwarding on the D-Link modem.

inbuilt DDNS (Dynamic DNS) tracking facility. You just supply the DNS host server's name, the DNS name and the remaining authorization details, and the Modem will track the changes of the external address on its own. You just need to remember the DNS name you have registered with the DNS host server's site and the port you are forwarding in the modem — in my case it's berapi.ddns.net:8083 from noip.com. See **Figures 2a and 2b** for my setups.

Architecture

The basic ESP8266 — also called ESP-01 — has 8 pins coming out of the chip board (**Figure 3**). But if you look carefully, the chip has total of 32 pins. That means for simplicity, on this board the other pins are not used by the manufacturer. The 5-volt relay is connected to GPIO0 pin through a switching transistor. When the GPIO0 drops Low, the relay is actuated and conversely, it's deactuated when GPIO0 goes High. The board has a common 3.3-V regulator chip installed and happily accepts 7–9 VDC on its Vcc pin.



Figure 4. Sketch-uploading using the FTDI USB-to-Serial tool.

JSL-2/300	SETUP	ADVANCED	MANAGEMENT	STATUS	HELP
Advanced Wireless	DYNAMIC DNS				
ort Forwarding	The dynamic DNS (DDI	NS) feature enables you	to host a server (such as W	eb, FTP, game server) using	a domain name tha
DMZ.	you have purchased (w provider, Using a DDNS	ww.xxx.com) with the d	ynamic (changing) IP address an enter your host name to c	s assigned by the broadband	Internet service
Parental Control	IP address.				
Filtering Options					
QoS Configuration	DYNAMIC DNS				
Firewall Settings	Hostna	me	Username	Service	Interface
DNS	berapi.ddi	ns.net de	rasomnatn@gmail.com	www.noip.com	PVC:0/35
Dynamic DNS					
Network Tools			Add Edit Delete	1	
Routing	ADD DYNAMIC DNS				
		DDNS provider : W	ww.noip.com *		
Schedules		Hostname : be	eras.ddns.net		
Logout					
Logout		Interface : P	VC:0/35 •		
Logout		Interface : P Username : be	VC:0/35 •		

Figure 2b: Dynamic DNS-ing on the D-Link modem.



Figure 3: The basic ESP8266 (ESP-01) has 8 connections bonded out on pins.

Programmer

This is really the easiest part of the project. You just need a programmer to program this tiny little wonder! The programmer is just another way to transfer the Arduino sketch from the computer's USB port to the ESP8266's 'chip brains'. FTDI's CP2102 board is available at aliexpress for \$1.02 only. In case



Figure 5: As an alternative to Figure 4: using an Arduino UNO board.

you have a working Arduino UNO board available around, you can also use it to upload your sketch to the little wonder. The connections for either type are shown in **Figures 4** and **5**. In fact, when you tie the Arduino's Reset pin to ground you are just making the Arduino UNO board act as an USB-to-serial uploader like the FTDI CP2120!

We have provided a Push-to-On switch in both cases, which needs to be depressed for about 10 seconds while uploading the sketch. After 10 seconds, release it and the sketch will upload in another 60 seconds. All the lights on the FTDI board will blink while the sketch is uploading.

Program output

The program sketch is available as a free download from the Elektor magazine website [1]. Replace the Wi-Fi ID and password with your Wi-Fi ID and password and then upload the sketch by pressing the 'Upload' command within the Arduino IDE (go to Sketch Upload).

Figure 6 shows the output of this little wonder, when the sketch got uploaded and the DDNS & port forwarding was done properly. By calling this url in any browser window be it on an Android or Apple phone, anywhere of the world, the relay will behave as per the button press.

A Bill of Materials, and prices

Prices from aliexpress.com and correct at the time of writing. FTDI USB to Serial, CD2120: \$1.02 (optional) WiFi ESP8266 Relay: \$1.85 **Grand Total: <\$3.00** (excl. 5-V power supply)

Activities 🤘	🕽 Chromium Web Browser 🔻	
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← → C ↔ Apps 🔀	 Not secure berapi.ddns.net:8083 zangout	de@inc
Welcome to Be Press Button Ne	ra's mini WiFi switch ow	
ON	OFF	
page refresh nu	mber: 1	
The relay is: Or	1	

Figure 6. The author's mini relay switcher in action on a homespun web server.

Aftermath

The only thing left to now is to make the connection secure, otherwise anyone aware of the switch URL will be able to operate the relay, with dire consequences. I know you will start to explore that right now. Best of luck.

180724-01

Web Link

[1] Project software: www.elektormagazine.com/180724-01

