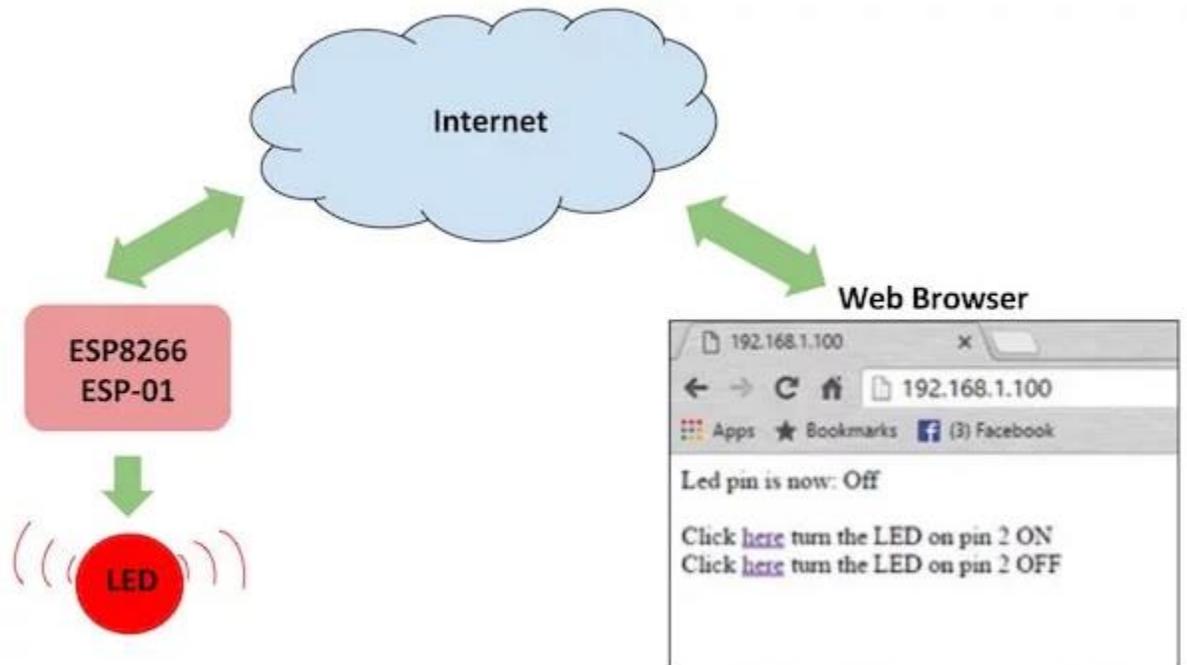


How to use an ESP-01S module

How Does It Work?

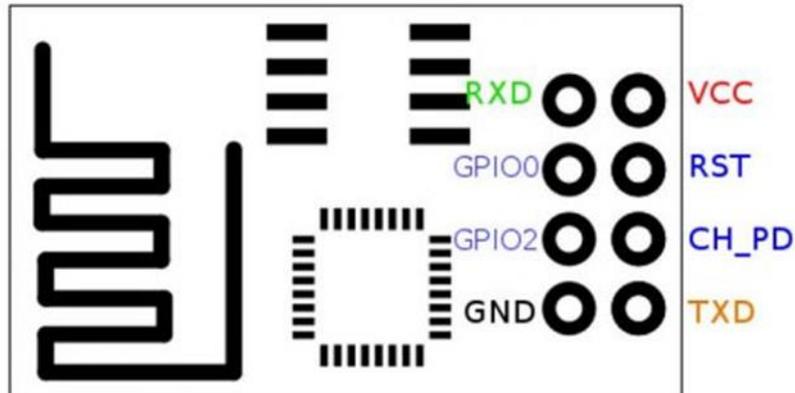
The ESP8266 can be controlled from your local Wi-Fi network or from the internet (after port forwarding). The ESP-01 module has GPIO pins that can be programmed to turn an LED or a relay ON/OFF through the internet. The module can be programmed using an Arduino/USB-to-TTL converter through the serial pins (RX, TX).



Connecting the Hardware to Your ESP8266

We can either use a USB-to-TTL converter or use an Arduino to program the ESP8266. Here are three methods you can follow to upload the code to ESP8266 — select the one that suits you best. Refer to the following diagrams for each and set up the hardware accordingly.

Pinouts:



Pins are arranged in two rows, having 4 on each row. Some models have pin description on the PCB, which make it simple. On the top row you can find following pins from the left to the right:

1. **GND** (Ground from power supply)
2. **GPIO2** (Digital I/O programmable)
3. **GPIO0** (Digital I/O programmable, also used for BOOT modes)
4. **RX** – UART Receiving channel

On the bottom (second row) you can find:

1. **TX** – UART Transmitting channel
2. **CH_PD** (enable/power down, must be pulled to 3.3v directly or via resistor)
3. **REST** – reset, must be pulled to 3.3v)
4. **VCC** -3.3v power supply

Power supply and current consumption

All esp8266 arduino compatible modules must be powered with **DC current** from any kind of source that can deliver **stable 3.3V** and **at least 250mA**. Also **logic signal** is rated at **3.3v** and the RX channel should be protected by a 3.3v divisor step-down. You should be careful when using this module with Arduino or other boards which supplies 5v, because this module usually **do not come with overpower protection** and can be easily destroyed.

Here is the declared power consumption from Espressif:

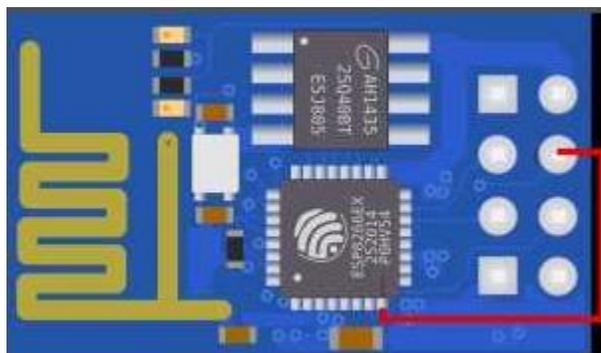
Parameters	Typical	Unit
Tx802.11b, CCK 11Mbps, P OUT=+17dBm	170	mA
Tx 802.11g, OFDM 54Mbps, P OUT =+15dBm	140	mA
Tx 802.11n, MCS7, P OUT =+13dBm	120	mA
Rx 802.11b, 1024 bytes packet length , -80dBm	50	mA
Rx 802.11g, 1024 bytes packet length, -70dBm	56	mA
Rx 802.11n, 1024 bytes packet length, -65dBm	56	mA
Modem-Sleep	15	mA
Light-Sleep	0.9	mA
Deep-Sleep	10	uA
Power Off	0.5	uA

If you are going to use ESP-01 in a project that is powered by batteries or by solar power it is mandatory to know everything about ESP8266 arduino Sleep modes. Current version offers 3 different sleep modes which can be triggered programmatically. ESP8266WiFi library offers specific functions to call sleep modes which can take settings parameters that change the callback jobs after wake-up like waking up with RF module powered off or on.

The most important mode is DEEP_SLEEP because of the very low power consumption rates during sleep. Deep sleep mode is very common in projects that do data-logging at specific intervals and idle between measurements.

In order to take advantage of this mode when using esp8266 arduino compatible module, ESP-01 standard, you need to make a little workaround and connect REST pin with the GPIO16 pin (which is not available in default 6 six pins).

Here is an example how to do it



After doing this connection you can use the following command to trigger the deep sleep mode:

```
ESP.deepSleep(sleepTimeInSeconds * 1000000);
```

Talking with ESP-01 (AT / LUA / Arduino)

ESP8266-01 gives you many methods to communicate with it through the RX/TX pins or over the air (OTA). The differences are not only in hardware but can be also in what kind of firmware is flashed out of the box. No matter what firmware comes default installed, you should be able to flash your preferred firmware by following the firmware flashing instruction from the datasheet. This module can be programmed using LUA code, Arduino code or directly through AT commands and this gives us more freedom when embedding this device in our projects. Also, there are few python firmware modes but i haven't had the chance to test them. I personally choose to work with Arduino because of the past experience and tones of libraries available. As it comes, out of the box, this module is ready to talk via AT commands without any other extra settings or configurations. There are many software applications which you can use to communicate via AT and have tones of readymade tools and functions which will make everything easier. I used ESPlorer and i totally recommend it, you can find it here. After booting, to be able to use AT commands, module should display "ready" on the serial monitor.

Few basic AT commands examples:

AT – response OK

AT+CWLAP – list nearby available WiFi networks

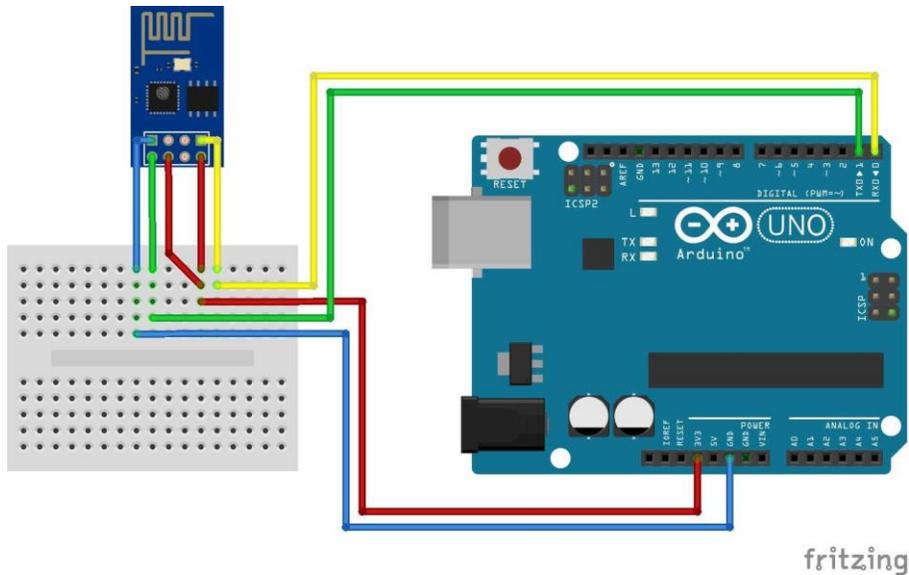
AT+GMR – check the firmware version

AT+CWJAP=" <access_point_name>","<password>" – join WiFi network using credentials

AT+CIFSR – get current allocated IP address

In order to be able to talk with the ESP8266 arduino compatible module, you need to choose a way to connect it with your computer. You can communicate with the module via standard Serial communication RS232 by using an Arduino board as a proxy/bridge

Arduino Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. In order to use Arduino as a bridge, first you need to load an empty program on it. After doing that, you need to make the following connections in order to work:



UNO	ESP-01S
RX	RX
TX	TX
3.3V	3.3V
GND	GND
RST	RST
CH_PD OR EN	3.3V

After that you should be able to see data and send AT commands in Serial Monitor by selecting Arduino's COM port, setting a proper baudrate, default should be 115200, and make the additional settings to read "Both NL & CR

Firmware Over The Air (FOTA) solution in every embedded DIY or commercial project is a highly desirable if not a required feature today, when every project core needs to be scalable. So the possibility to upload your code from a remote computer via Wi-Fi connection rather than Serial is a high advantage in every project. First you need FOTA needs prerequisites. First firmware upload needs to be done via Serial, and if the OTA routines are correctly implemented in the program next uploads can be done over the air.

Because the module needs to be exposed wirelessly, the chance of being hacked and loaded with maleficent code exists. You can improve your security by setting a custom port and password. Check functionalities from the ArduinoOTA library that may help you to boost security. Because of the complexity of these procedures we will cover the full story in a future article, but for now be aware that this option exists and it works pretty good.

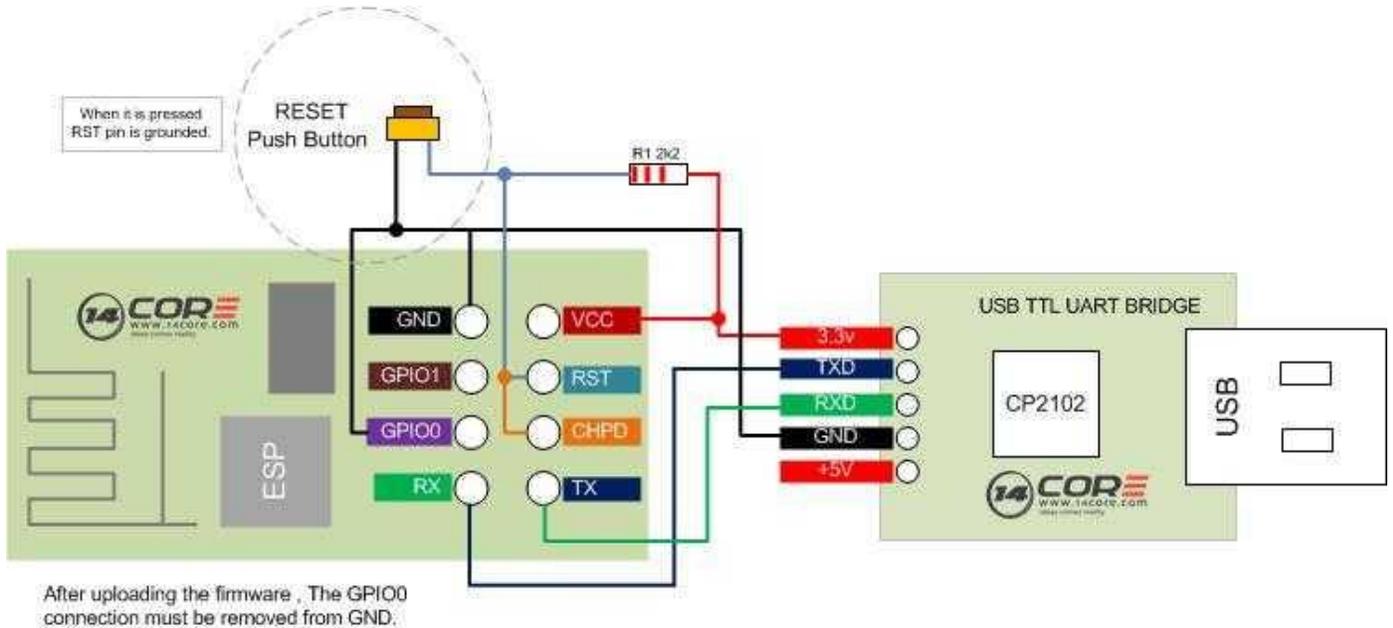
Another way to connect the esp8266 arduino module to a computer is to use a TTL or FTDI USB-to-serial dedicated module. There are plenty of them on the market and they are quite cheap, but make no mistake, here quality does matter. You may encounter problems when working with it if you end up with a cheap one because of the differences in connections and also driver compatibility.

Most used TTL / FTDI converters chips are CH340G, CP2102 and FT232RL. I personally used the first two ones and i have no problem when loading programs. Following connections need to be done:

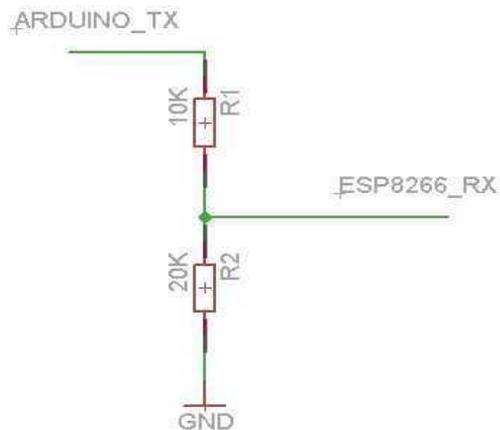
ESP-01S	TTL/FTDI
RX	TX
TX	RX
VCC	3.3V
GND	GND
RST	3.3V/Float
CH_PD OR EN	3.3V

I highly recommend you not to use the TTL 3.3v power supply because most of them are not able to provide enough power to handle the esp8266 arduino compatible device. The embedded voltage regulator used on this module are not the happiest choice and you may get in trouble if it cannot support ESP peaks. If you choose to use an external power supply don't forget to setup a common ground in order to have a working circuit.

You can find TTL modules that have TX rated at 3.3v, if not, you should step-down the TX channel to protect your ESP-01 module. You can see below a wiring scheme between ESP-01 and CP2102 which includes a reset button connected to ground, and also GPIO0 for boot switch.



Here is a simple 3.3v divisor sketch using resistors:



In order to setup your Arduino IDE to work with your esp8266 arduino compatible module you need to make the following steps:

1. Connect your ESP8266-01 Module to PC
2. Open your Arduino IDE
3. Go to File -> Preferences
4. Add this link to Additional Board Manager
5. Go to Tools -> Board Manager
6. Find ESP8266 board set and activate it
7. Select Generic ESP8266 board from Tools->Boards
8. Choose your programmer COM port
9. You are ready to go!



Now, to be able to download the program to your ESP-01 module, you first need to put your device in the proper BOOT mode (Download code from UART). ESP8266-01 have the following boot modes:

MTDO / GPIO15	GPIO0	GPIO2	Mode	Description
L	L	H	UART	Download code from UART
L	H	H	Flash	Boot from SPI Flash
H	X	X	SDIO	Boot from SD-card

After resetting the module in Download code from UART you should see a message containing “boot mode: [1,6]” in the serial monitor, if you are on the correct baudrate. A wrong baudrate setting will display garbage text / characters or nothing at all. After that you should be able to upload your sketch to ESP8266. When upload is done, module should reset itself. Don’t forget to pull HIGH the GPIO0 or the module will get in Download mode again and you will not be able to see it working. The module can be rebooted at any time by pulling REST pin to LOW. After each reset it will follow the boot sequence and program loading.

Once the ESP8266 board is installed and activated in Arduino IDE, you will be able to include all ESP WiFi libraries and examples that comes with the package. The most used library is ESP8266WiFi which offers many implementation examples like WiFiClient, WiFiServer, WiFiAccessPoint etc. You can find allot of projects examples over the internet, I for example, found great ideas on arduino.cc projecthub. Here is a simple Arduino blink example which you can use to test the esp module with the built in LED:

```
/*
```

ESP8266 Arduino Blink by Simon Peter

Blink the blue LED on the ESP-01 module

This example code is in the public domain

The blue LED on the ESP-01 module is connected to GPIO1

(which is also the TXD pin; so we cannot use Serial.print() at the same time)

Note that this sketch uses LED_BUILTIN to find the pin with the internal LED

```
*/
```

```
void setup() {
```

```
  pinMode(LED_BUILTIN, OUTPUT); // Initialize the LED_BUILTIN pin as an output
```

```
}
```

```
// the loop function runs over and over again forever

void loop() {

    digitalWrite(LED_BUILTIN, LOW); // Turn the LED on (Note that LOW is the voltage level

        // but actually the LED is on; this is because

        // it is active low on the ESP-01)

    delay(1000); // Wait for a second

    digitalWrite(LED_BUILTIN, HIGH); // Turn the LED off by making the voltage HIGH

    delay(2000); // Wait for two seconds (to demonstrate the active low LED)

}
```

Off course, after that you can try a more complex example by loading a ESP8266 Arduino WiFi Client example program that sends data via WiFi to the data.sparkfun.com iot platform:

```
/*  
  
* This sketch sends data via HTTP GET requests to data.sparkfun.com service.  
  
*  
  
* You need to get streamId and privateKey at data.sparkfun.com and paste them  
  
* below. Or just customize this script to talk to other HTTP servers.  
  
* ESP8266 Arduino example  
  
*/
```

```
#include <ESP8266WiFi.h>
```

```
const char* ssid = "your-ssid";
```

```
const char* password = "your-password";
```

```
const char* host = "data.sparkfun.com";
```

```
const char* streamId = ".....";
```

```
const char* privateKey = ".....";
```

```
void setup() {  
  
  Serial.begin(115200);  
  
  delay(10);  
  
  // We start by connecting to a WiFi network  
  
  Serial.println();  
  
  Serial.println();  
  
  Serial.print("Connecting to ");  
  
  Serial.println(ssid);  
  
  WiFi.begin(ssid, password);  
  
  while (WiFi.status() != WL_CONNECTED) {  
  
    delay(500);  
  
    Serial.print(".");  
  
  }  
  
  Serial.println("");
```

```
Serial.println("WiFi connected");

Serial.println("IP address: ");

Serial.println(WiFi.localIP());

}

int value = 0;

void loop() {

  delay(5000);

  ++value;

  Serial.print("connecting to ");

  Serial.println(host);

  // Use WiFiClient class to create TCP connections

  WiFiClient client;

  const int httpPort = 80;

  if (!client.connect(host, httpPort)) {

    Serial.println("connection failed");
```

```
        return;
    }

    // We now create a URI for the request

    String url = "/input/";

    url += streamId;

    url += "?private_key=";

    url += privateKey;

    url += "&value=";

    url += value;

    Serial.print("Requesting URL: ");

    Serial.println(url);

    // This will send the request to the server

    client.print(String("GET ") + url + " HTTP/1.1\r\n" +

        "Host: " + host + "\r\n" +

        "Connection: close\r\n\r\n");

    unsigned long timeout = millis();
```


Or if you need to make a server in your network, you can try ESP8266 Arduino Wifi Server example program:

```
/*  
  
* This sketch demonstrates how to set up a simple HTTP-like server.  
  
* The server will set a GPIO pin depending on the request  
  
* http://server_ip/gpio/0 will set the GPIO2 low,  
  
* http://server_ip/gpio/1 will set the GPIO2 high  
  
* server_ip is the IP address of the ESP8266 Arduino module, will be  
  
* printed to Serial when the module is connected.  
  
*/  
  
#include <ESP8266WiFi.h>  
  
const char* ssid = "your-ssid";  
  
const char* password = "your-password";  
  
// Create an instance of the server  
  
// specify the port to listen on as an argument  
  
WiFiServer server(80);
```

```
void setup() {  
  
  Serial.begin(115200);  
  
  delay(10);  
  
  // prepare GPIO2  
  
  pinMode(2, OUTPUT);  
  
  digitalWrite(2, 0);  
  
  // Connect to WiFi network  
  
  Serial.println();  
  
  Serial.println();  
  
  Serial.print("Connecting to ");  
  
  Serial.println(ssid);  
  
  WiFi.begin(ssid, password);  
  
  while (WiFi.status() != WL_CONNECTED) {  
  
    delay(500);  
  
  }  
  
}
```

```
        Serial.print(".");
    }

    Serial.println("");

    Serial.println("WiFi connected");

    // Start the server
    server.begin();

    Serial.println("Server started");

    // Print the IP address
    Serial.println(WiFi.localIP());
}

void loop() {

    // Check if a client has connected
    WiFiClient client = server.available();

    if (!client) {

        return;

    }
}
```

```
// Wait until the client sends some data
```

```
Serial.println("new client");
```

```
while(!client.available()){
```

```
    delay(1);
```

```
}
```

```
// Read the first line of the request
```

```
String req = client.readStringUntil('\r');
```

```
Serial.println(req);
```

```
client.flush();
```

```
// Match the request
```

```
int val;
```

```
if (req.indexOf("/gpio/0") != -1)
```

```
    val = 0;
```

```
else if (req.indexOf("/gpio/1") != -1)
```

```
    val = 1;
```

```
else {
```

```
Serial.println("invalid request");

client.stop();

return;
}

// Set GPIO2 according to the request

digitalWrite(2, val);

client.flush();

// Prepare the response

String s = "HTTP/1.1 200 OK\r\nContent-Type: text/html\r\n\r\n<!DOCTYPE
HTML>\r\n<html>\r\nGPIO is now ";

s += (val)?"high":"low";

s += "</html>\n";

// Send the response to the client

client.print(s);

delay(1);
```

```
Serial.println("Client disconnected");
```

```
// The client will actually be disconnected
```

```
// when the function returns and 'client' object is destroyed
```

```
}
```

And in the last example an ESP8266 Arduino WiFi Access Point which hosts a web server is created:

```
/* Create a WiFi access point and provide a web server on it.
```

```
ESP8266 Arduino example
```

```
*/
```

```
#include <ESP8266WiFi.h>
```

```
#include <WiFiClient.h>
```

```
#include <ESP8266WebServer.h>
```

```
/* Set these to your desired credentials. */
```

```
const char *ssid = "ESPap";
```

```
const char *password = "thereisnospoon";
```

```
ESP8266WebServer server(80);
```

```
/* Just a little test message. Go to http://192.168.4.1 in a web browser
```

```
* connected to this access point to see it.
```

```
*/  
  
void handleRoot() {  
  
    server.send(200, "text/html", "<h1>You are connected</h1>");  
  
}  
  
void setup() {  
  
    delay(1000);  
  
    Serial.begin(115200);  
  
    Serial.println();  
  
    Serial.print("Configuring access point...");  
  
    /* You can remove the password parameter if you want the AP to be open. */  
  
    WiFi.softAP(ssid, password);  
  
  
    IPAddress myIP = WiFi.softAPIP();  
  
    Serial.print("AP IP address: ");  
  
    Serial.println(myIP);  
  
    server.on("/", handleRoot);  
  
    server.begin();  
  
    Serial.println("HTTP server started");  
  
}
```

```
}
```

```
void loop() {
```

```
    server.handleClient();
```

```
}
```