

**ARTICLE****Safe Power Outlet****Mohammad. Taghipour<sup>1\*</sup> Mohammad. Vaezi<sup>2</sup>**

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**ARTICLE INFO***Article history*

Received: 14 October 2019

Accepted: 26 October 2020

Published Online: 31 October 2020

*Keywords:*

Application

Safe outlet

Power outlet

Wiring

Smartizing

Module

**ABSTRACT**

The main goal of the safe power outlet project is to make power outlets smart and integrate it to all old and new electrical wiring of homes and offices to eliminate the costs. Using the designed socket, home and office electrical appliances can be smarten and controlled remotely through wireless technology. The device designed in this project, is a smart power outlet that supports Wi-Fi connection and the user can connect directly to it and control it by the specific mobile application. There is no need for any other interfaces such as a modem or router, and the user can connect directly to the device. This is the innovative part of the project making it different from the conventional power outlets on the market. All home and office appliances running on AC power can be connected to a safe outlet directly and without an interface; they can be controlled via wireless network by mobiles. This device smartens all old and conventional outlets without making any changes in wiring. It also enables the control via Wi-Fi on the outlets.

**1. Introduction**

**L**ighting system is an integral part of all buildings with different uses <sup>[1]</sup>. Power outlets provide energy for all electrical devices in buildings and workshops <sup>[2]</sup>. In today's world of construction, lighting system is a special subject and is defined differently. In the past, the purpose of the lighting system was only to provide optimal lighting in each part of the building in accordance with the intended use of that part. But today, in addition to its previous definition, the lighting system has various uses such as combining different

types of interior lighting with various interior designs and spaces, volumetric and decorative lighting, changing and dynamic lighting style of an environment for use in different times and situations, multifunctional uses of the environment, etc.

With these new applications, the lighting system is now part of engineering field and has led to special professions. Certainly, with the increasing advances in the lighting industry, new management and control styles have been formed along with it to make the operation of the lighting system easier than before, and it has formed the so-called "intelligent lighting system" topic, which can be used to

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manage energy consumption as well as remote control of the building<sup>[3]</sup>.

In this section, we express some of the disadvantages of the conventional lighting systems and also discuss the advantages of intelligent lighting to highlight the choice of intelligent lighting in the current market of building construction over its conventional counterpart from all aspects.

## 2. Disadvantages of Conventional Lighting Systems

(1) Impossibility to change the type of control: if the control of a conventional lighting system is through one of the switches of single pole, double pole, conversion and cross, it will be the same all the way up and you can only control the lighting line using the switches.

(2) Frequent blackouts during changes and repairs: in the case of a dead bulb or changes and repairs in the path of a lighting system, you have to cut off the power of the fuse controlling that headline. Obviously, that fuse is not only controlling the headline, but also the electric curtain, video doorbell, and socket in the path of the fuse may be off which will make repairs impossible during the dark hours.

(3) High energy consumption without saving: in the conventional lighting design, as your control over the lighting sections is only through the conventional switches mounted on the walls, you cannot manage to reduce energy consumption and the only way to reduce energy consumption is to manually turn off the switch for that headlight.

(4) Frequent bulb burn-outs: with the passage of time and aging of the building, wearing of conventional switches on the path of headlights cause a delay in the time of voltage changing or oscillations from 0 to 220 volts, which reduces the shelf life and eventually burns the bulbs. This is more evident on energy saving bulbs.

(5) Numerous conventional wall switches: undoubtedly, this is the most important defect. In new buildings, and especially the large ones, a lot of lighting sources are used. If the lighting system is implemented in a conventional way, the number of conventional switches on the interior walls of the building will be high. This issue is not considered until the building is ready to settle in. The main disadvantages include: difficult infrastructure wiring, difficult installation of switches next to each other, high volume of wires behind the switches, high insecurity and possibility of high downtime, high cost of buying switches, lots of

switches on the walls, inappropriate and inconsistent appearance with modern decoration of the building, and most importantly difficult selection of the switch which controls the desired headline.

(6) Impossibility of using new lighting systems: in the conventional design, it is not possible to use a variety of new lighting technologies, and many new lighting products cannot be added to our conventional system and used properly.

## 3. Advantages of Intelligent Lighting System

(1) Flexibility: in the intelligent lighting system, you can easily enter the headlight of a new lighting into your smart home system and take control of it through all communication and intelligent control ports.

(2) Implementing a variety of energy saving plans: you can easily reduce your power consumption for lighting by creating various intelligent scenarios and have integrated control over each of the lighting headers or full control over all of them.

(3) Changing the light intensity or dimming the light: in the smart system, you can dim your lights and change the light intensity or in the form of various scenarios; in this way, your space can have different levels of brightness. You can also easily convert a headline that was previously an ON/OFF headline to DIMMER mode without any infrastructure changes and take advantage of it.

(4) Ability to change scenarios: your lighting system is intelligent and you can have different lighting scenarios in different spaces of your building, such as entry, living room, study, sleep, TV mode, leaving home, travel, security, etc. Most importantly, you can integrate your lighting system with sound systems, heating and cooling, electric curtains, etc. in specialized and efficient scenarios.

(5) Using smart wall switches with a high number of poles (high output): using a variety of smart wall switches to suit your taste and also your space, instead of the large number of conventional switches on the wall, a smart switch is installed in any space of your building. Therefore, in addition to controlling each of the lighting headlines, you can also run various scenarios, and also control other equipment such as smart heating and cooling, smart audio system, smart electric curtain, etc.

(6) Brightness control through intelligent remote and close communication ports: with lighting intelligence, wireless sensor networks (WSN), upgrade of communication protocols, distributed intelligence for smart objects, wireless radio frequency systems, and several other technologies and communicative solutions together have made possible the promising technology of Internet of Things (Manu Elappila, Suchismita Chinara, Dayal Ramakrush-

na Parhi). Wireless energy transmission has received so much attention today <sup>[4]</sup> and you can control the brightness of your space through different interesting communication ports. Intelligent communication ports are smart wall switches, remote control, control via mobile phones and tablets, control outside the home via the Internet and SMS, as well as control and management with a variety of sensors in different logic layers.

(7) Stylish shape and ease of intelligent management and control: wall switches are the first communication port in the smart system, which are certainly more beautiful than conventional single-pole, double-pole, and converter switches. Also, since they come with LCD displays, lights, remote control, built-in thermostat, and scenarios, it is easier to use them in controlling the equipment.

(8) Convenience in repairs and changes: when changing the bulbs of a headline or repairing it, only that headlight is off during the change and repair, and all the fixtures in its vicinity can have their own electricity and normal use, which is a feature to bring comfort, and also provide security and safety.

(9) Reducing the final costs of the building's electrical system: the implementation of the building lighting infrastructure based on the smart design is different from its conventional design. Some costs of consuming equipment such as wires and pipes may be added, but the implementation of this plan is much easier for the electricity infrastructure operator (project electrician), and wiring is standardized, costs of conventional switches and various thermostats are saved. The installation of the equipment is much easier and faster. Moreover, the final costs of the electrical system of the building are reduced.

In addition to the mentioned advantages, working with intelligent systems at all levels and equipment such as intelligent lighting, intelligent heating and cooling system, intelligent electric curtains, intelligent sound system, etc. brings high pleasure and satisfaction for its users. Everyone will realize this important feature once they experience working with a smart home.

The main goal of the safe outlet project is to combine conventional and smart types, because in the conventional type it is not possible to use new lighting systems and in the smart type it is not possible to adapt them to conventional wiring or products of different companies, which leads to the monopoly of intelligent systems and unconventional pricing. For this reason, the innovative design of safe outlet can remove all the limitations of conventional and intelligent systems and is flexible with all conventional and intelligent systems. In this regard, we have used the ESP8266 module in this outlet:

#### 4. Ways to use ESP8266 module

(1) Sending AT commands from computer to module by USB to TTL converter. This method is mostly used to test and set up the module.

(2) Connecting the module to the microcontroller and using ESP8266 as a peripheral device: in this method, AT commands are sent to the module to set up and work with the module through the serial port of the microcontroller.

(3) Direct programming of the processor on the ESP8266 module and using the GPIO pins of the module to communicate with other devices: in this method, there is no need to use a microcontroller and therefore both the circuit volume and the final cost of the project will be less. Due to the innovation in this project, we use the third method to use the module and its planning.

#### 5. Direct Programming of ESP8266 Module Processor

Utilizing the features to have a smart home has always been an interesting issue, and engineers have created several solutions for this purpose during different periods of technology development. Smart home is a home the residents of which can adjust and control their electronic equipment remotely. In order to create smart homes, it is necessary to design, develop, and integrate hardware and software systems. Arduino is one of the hardware platforms that plays an important role in the design and development of smart homes today. The platform is a single-board microcontroller designed to make it easier to produce applications that interact with objects or the environment. One of the most widely used cases in homes is electrical multi-outlet; in this research and with the help of Arduino platform, we tried to make it smart so that we could control, turn on and off plugs through Bluetooth technology and also developed software installed in smartphones with Android operating system <sup>[5]</sup>.

Using the Arduino to program ESP8266 Modules: there are several ways to program the module processor directly. Some of these methods have special software programming language. Because programming in the Arduino IDE environment is in C programming language and most people are familiar with this language and also the environment of this program is user friendly, we chose this software to program our module. To do this, the following steps are taken:

First, we download and install the latest version of Arduino IDE from the website ([www.arduino.cc](http://www.arduino.cc)). Then we enter the Arduino IDE environment and click on the File tab to enter the Preferences section. Next, we Copy-paste

the following link in the Additional Board Manager URLs box and click OK.

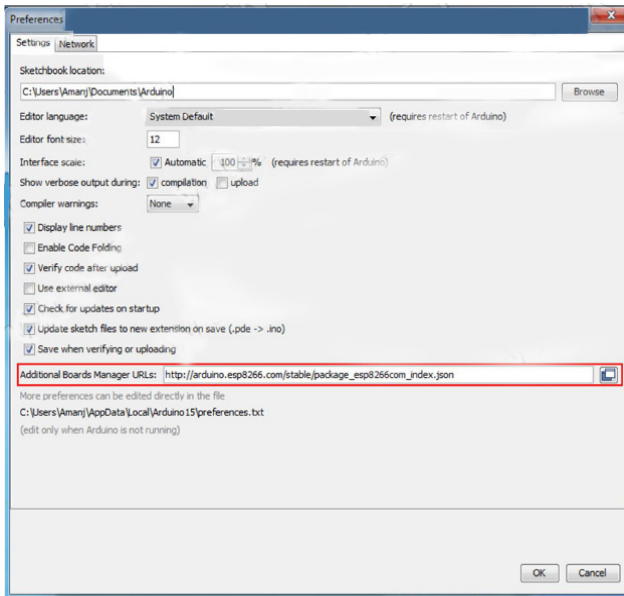


Figure 1. Arduino IDE environment

From Tools tab, we enter the Board submenu, then enter the Board manager and find the ESP8266 package, and then install it. This package is about 150 MB in size. Then we wait for the package to be fully installed.

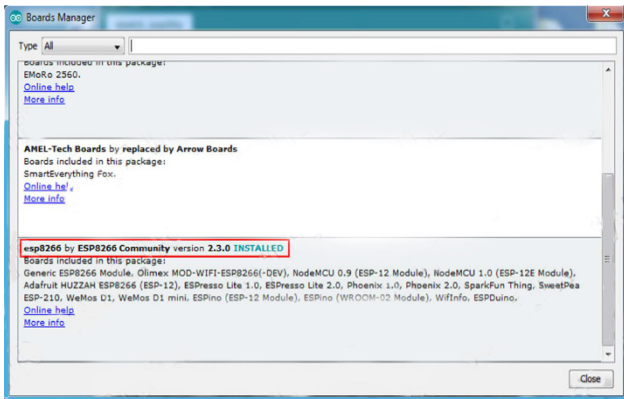


Figure 2. Activation of ESP8266 package in Board manager environment

## 6. Changing the settings to program the ESP8266 module

After the installation of the package, whenever we want to upload the code on the module, we must make the settings in the Arduino IDE according to the images below. These settings include:

- (1) Select the board on which the program is to be uploaded.
- (2) The volume of the baud rate of the board.
- (3) The COM port number of the converter.

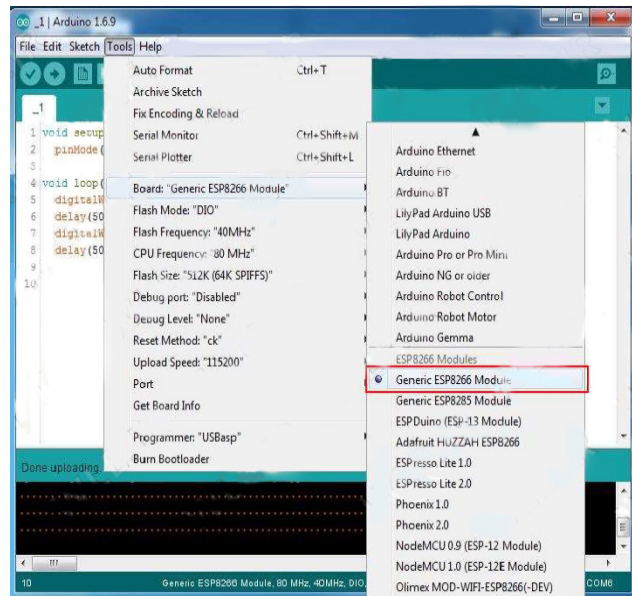


Figure 3. The settings for programming ESP8266 module

Change other settings in the Tools section according to the image below (we use the default settings without change).

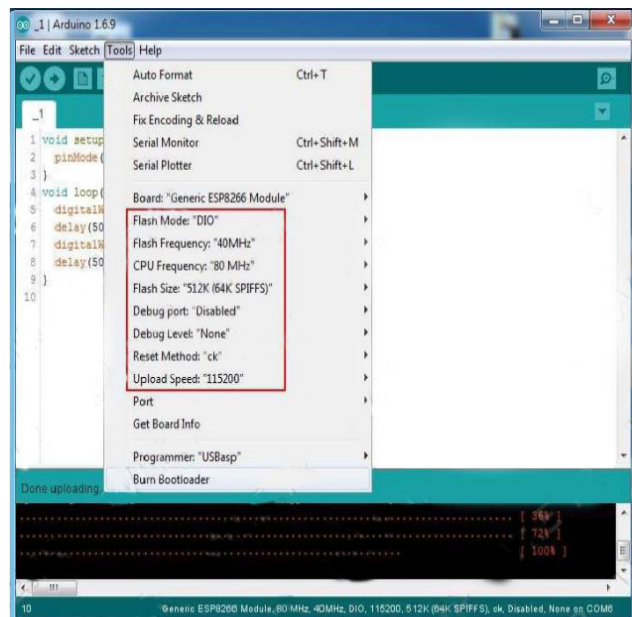
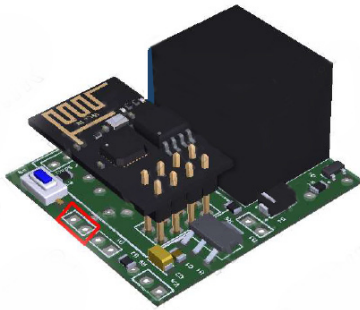


Figure 4. The settings for programming ESP8266 module

The module is now ready to be programmed by our software.

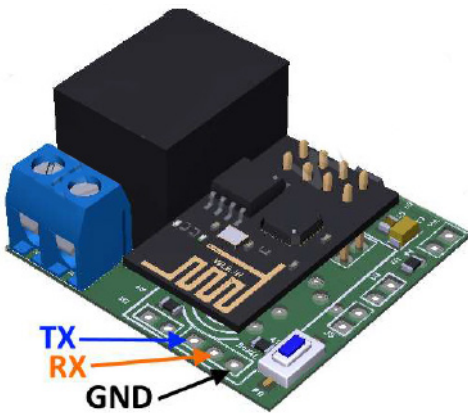
### 6.1 Programming

To program the module, we must first put it in Flash mode. To do this, when the board is off, we need to short-circuit the Flash section on the board with the jumper specified below, i.e. connect the two pins together.



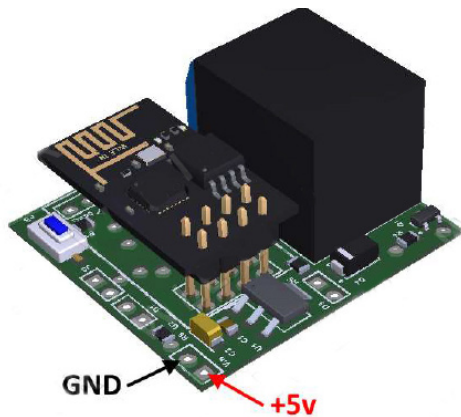
**Figure 5.** Technical schematic of the location of the settings related to Flash mode

Then we need to connect the USB to TTL converter to the board. To do this, we need 3 pins TX, RX, and GND from the converter. We connect these 3 pins of the converter to the pins of the program board section as shown below.



**Figure 6.** Technical schematic of the settings for the USB to TTL converter

Now we have to apply the board power supply. We use 5V DC voltage for power supply and connect the positive and negative power supply pins to the board as shown below.



**Figure 7.** Technical schematic of the location of power supply settings

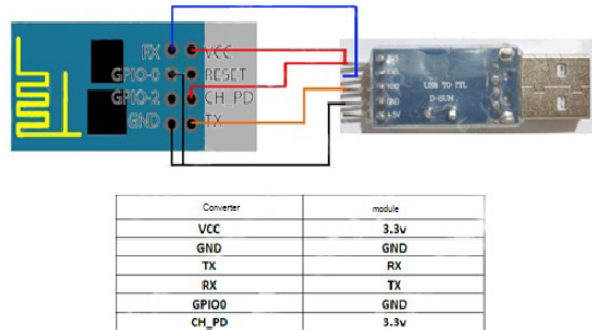
Now, we reset it using the reset key on the board to enable the Flash mode. Then we open the program and make the settings inside the Arduino IDE according to the above description. Next, we select the COM port number assigned to the converter from the Port section and click on Upload to program the software on the board.

The important point here is that in order to execute the code uploaded on the board, the jumper used to go to Flash mode must be removed and then the board must be reset to remove the module from the program mode.

### 6.2 Steps to Install or Update the Module Firmware

If we fail to upload the program to the ESP8266 module, we must reinstall the firmware. To do this, the following steps are taken:

(1) The module we purchased may not have a firmware installed on it at all, or the firmware may be outdated. According to the following steps, we can install or update the firmware:



**Figure 8.** Steps to install or update the module firmware

Another point is to connect the GPIO base of the module to GND. The grounding of this base causes the module to go into program mode.

Note that the converter used is the PL2303 model and the module used is ESP8266-01, the first version of this module.

Note that all versions of the module can be used. The only difference is that some modules have different wiring. For example, in modules where more GPIOs are available, the GPIO15 pin must also be grounded.

(2) We connect the converter to the computer and after the converter is detected by the computer, we assign a COM address to it and run the file esp8266\_flasher.exe and then enter the Com Port of the converter in the software and also Click on BIN to open the v0.9.5.2 AT Firmware.bin file to load the software.

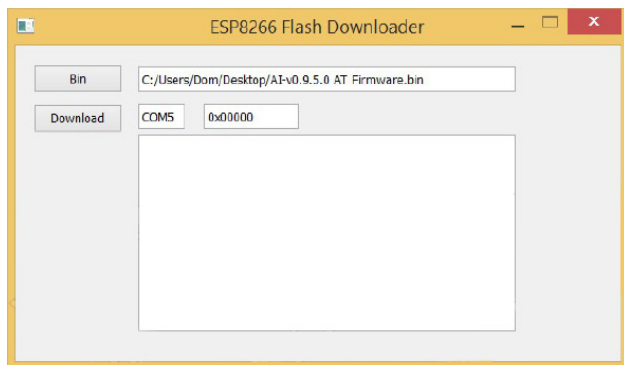


Figure 9. Installing the firmware

(3) We click on Download to install the firmware on the module and wait until the end of the installation.

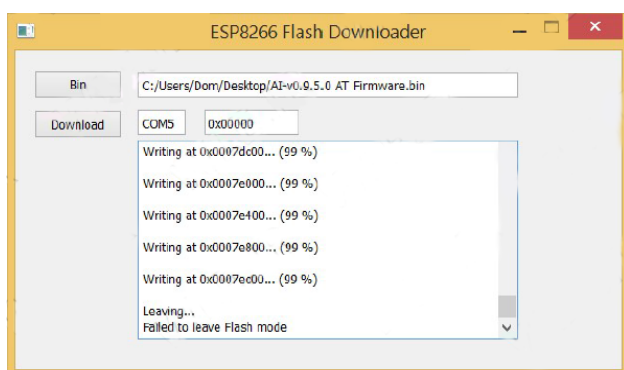


Figure 10. Installing firmware on the module

We must pay attention to 3 points:

(1) Failed to leave Flash mode message has no effect on the proper installation of the firmware on the module. After completing these steps, by removing the GPIO pin from the ground and resetting the module, we can exit Flash mode.

(2) Failed to connect message means that we have not selected the converter COM port correctly.

(3) After completing the installation, the module settings such as baud rate may change, which can be found by testing the module (usually between 9600-115200).

## 7. Conclusion

Regarding the disadvantages and limitations of conventional and smart outlets, we attempted to introduce the innovative safe outlet design in the market. The features

that can be listed for this design are as follows:

(1) Control of all devices that work with AC power directly and without any interfaces and converters

(2) No need for modems, internet or routers for remote control

(3) Ability to control the devices through the Android application or the web page

(4) Ability to convert old electrical outlets to smart sockets without changing the wiring and eliminating the exorbitant costs of smartizing

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