

## **7. Problem Solving**

### **1. Problem statement**

Many people forget to turn off their computer when they leave the house, which would waste a lot of energy. I will design and make a Bluetooth switch for a computer that connects the ON OFF switch of the computer to their phone. This allows a user who is in the range of the Bluetooth connection to control the ON OFF switch through their phone. If the user is outside of the range of the Bluetooth connection, then the switch will turn off the computer automatically. This will reduce the energy consumption.

## 2. Diagrams

**Figure 1.1**

The diagram below shows the function of each pin on the TPM header.

### 12) TPM (Trusted Platform Module Header)

You may connect a TPM (Trusted Platform Module) to this header.



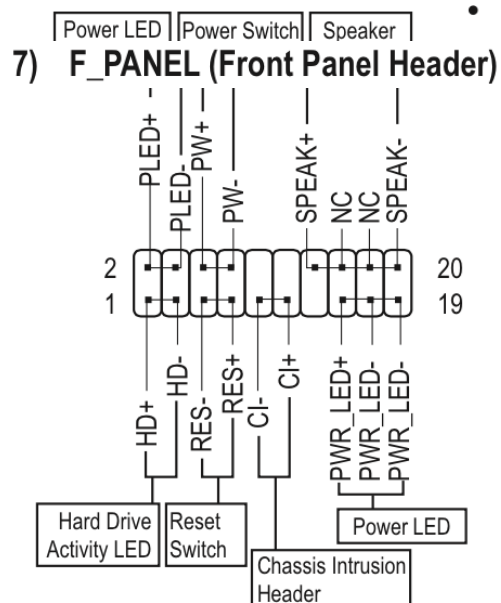
Pin No.	Definition	Pin No.	Definition
1	LCLK	11	LAD0
2	GND	12	GND
3	LFRAME	13	NC
4	No Pin	14	NC
5	LRESET	15	SB3V
6	NC	16	SERIRQ
7	LAD3	17	GND
8	LAD2	18	NC
9	VCC3	19	NC
10	LAD1	20	NC

The TPM header on a motherboard.

From: <https://www.gigabyte.com/Motherboard/GA-A320M-HD2-rev-10#support-manual>

**Figure 1.2**

The diagram below shows the function of each pin on the front panel header.



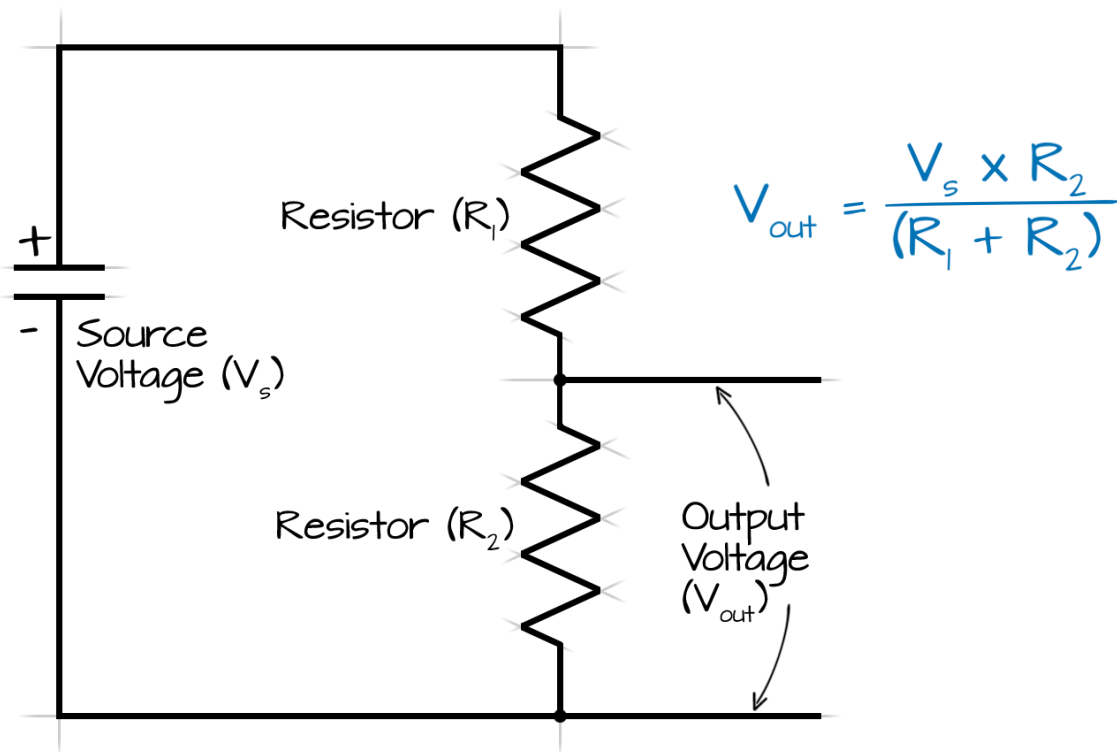
The front panel header on a mother board.

From: <https://www.gigabyte.com/Motherboard/GA-A320M-HD2-rev-10#support-manual>

**Figure 2**

The diagram below explains the voltage divider Law.

This is very important to make a 5V microcontroller and a 3.3V Bluetooth module work together.

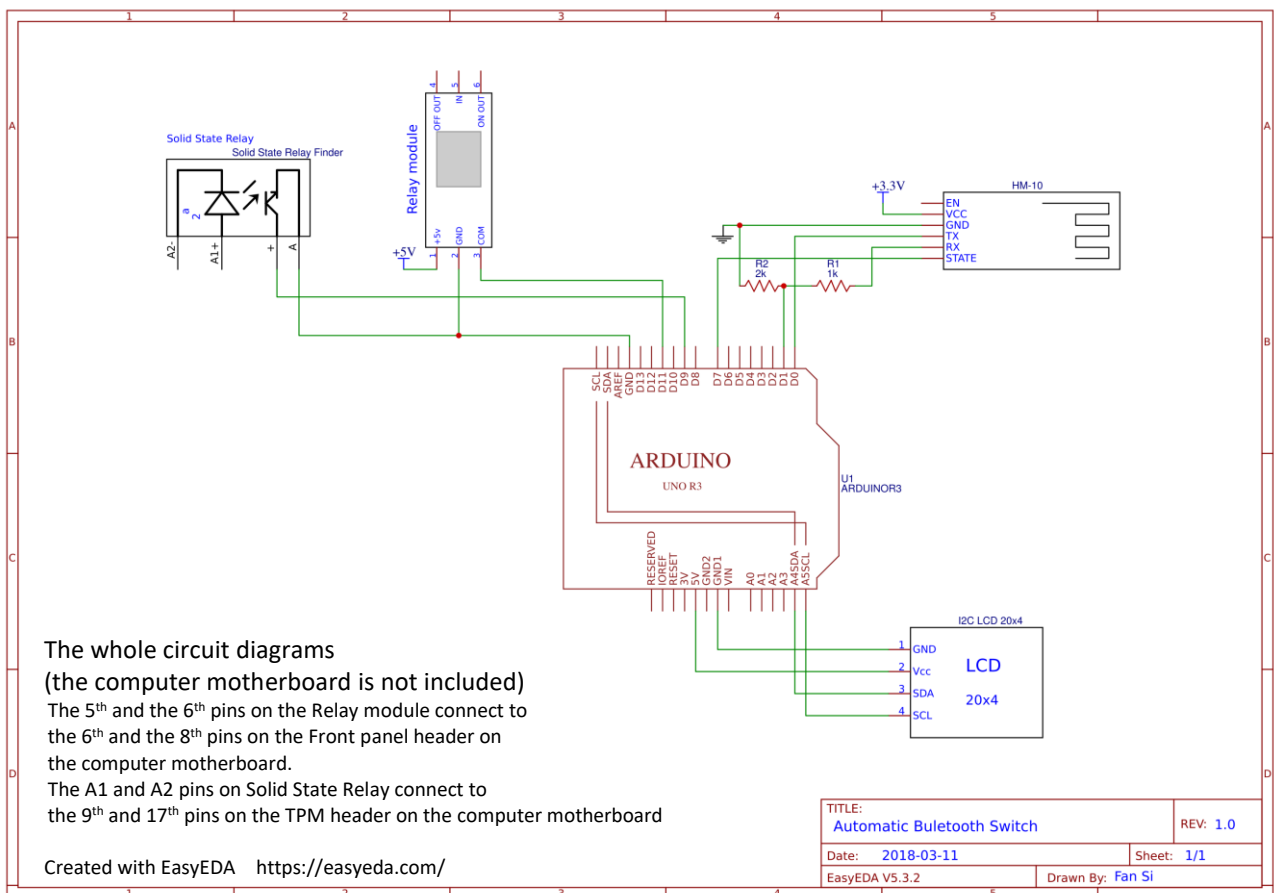


A voltage divider circuit and the formula based on Ohms Law

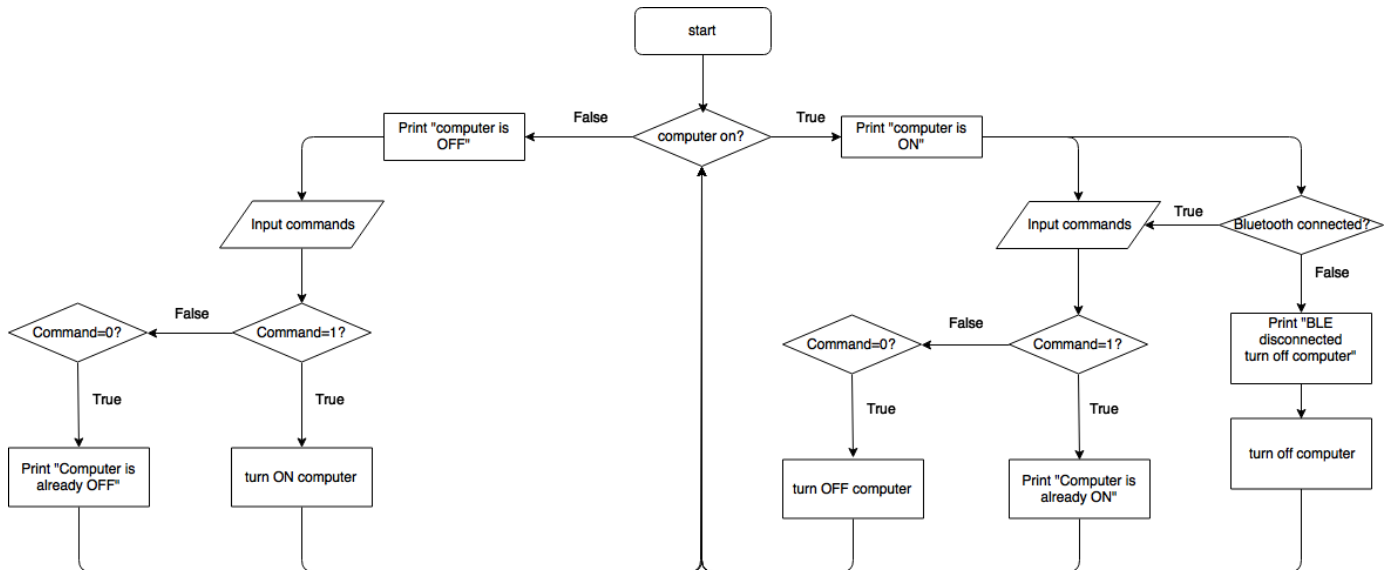
From: <http://www.ohmslawcalculator.com/voltage-divider-calculator>

**Figure 3**

The whole circuit diagrams of my device.



The program will determine the computer power status and then take certain action by checking the Bluetooth connection status or the commands it get.



Created with draw.io

### 3. Theories

a. To turn on and off computer

Short the 6<sup>th</sup> and the 8<sup>th</sup> pins on the Front panel header on the motherboard in figure 1.2 can turn on and off the computer.

b. Determining if the computer is on or off

The 9<sup>th</sup> pin on the TMP header on the motherboard in figure 1.2 will output 3.3V DC when the computer is on. This voltage can trigger a low voltage Solid State Relay with very low current.

c. Determining if the Bluetooth device is still connecting

The status LED on the HM-10 Bluetooth module can set to be turn on or off continuously when the Bluetooth is connected or Unconnected so that I can read it.

From HM-10 Datasheet

[ftp://imall.iteadstudio.com/Modules/IM130614001\\_Serial\\_Port\\_BLE\\_Module\\_Master\\_Slave\\_HM-10/DS\\_IM130614001\\_Serial\\_Port\\_BLE\\_Module\\_Master\\_Slave\\_HM-10.pdf](ftp://imall.iteadstudio.com/Modules/IM130614001_Serial_Port_BLE_Module_Master_Slave_HM-10/DS_IM130614001_Serial_Port_BLE_Module_Master_Slave_HM-10.pdf)

d. To power my devices

There is an option in the BIOS that the USB ports can still output 5V DC even if the computer has been turned off.

e. To turn off the computer safely

There is an option in the Windows power setting that the computer can be turn off normally when the power button pushed.

#### **4. Assumptions**

- a. Must be a desktop computer with a motherboard that I can access.
- b. The phone must support BLE 4.0.
- c. The phone won't turn off itself when you are using the computer. If the phone turns off the computer will turn off.
- d. The computer must be able to power my device when it's off.

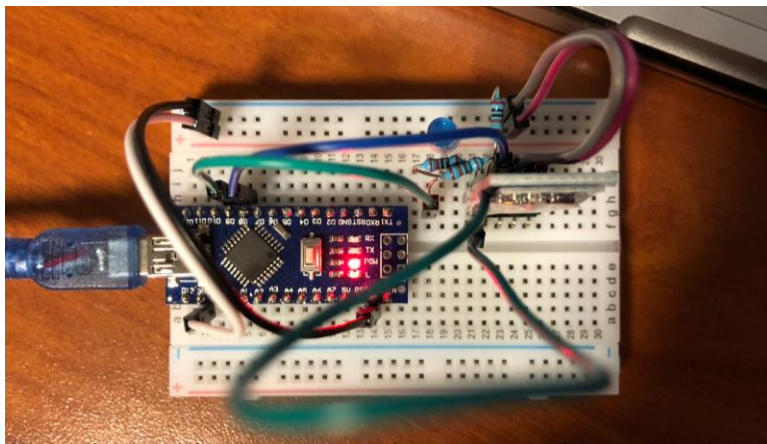
## 5. Solution Steps

### 1. Setup the HM-10 BLE module for working with my project.

The module I got does not have a status pin that connects with the LED VCC on the module, so for determining the Bluetooth connection I have to modify it by soldering a jump wire right on the LED VCC.



Then I used some of the instructions and codes on <http://www.martyncurrey.com/hm-10-bluetooth-4ble-modules/> to setup and test my Bluetooth module.



This is the serial monitor in Arduino IDE. It shows the Bluetooth module works pretty well and responding to my commands.

I changed the Bluetooth NAME to "Project Test" and the status LED setting.

```

/dev/cu.wchusbserial1410
发送

FFfx'55 55 55ff5fx 555 f55' 5555' fSketch: /Users/SiFan/Desktop/Arduino/ENGR Project 01/BT_moudle_setting/BT_moudle_setting.ino
Uploaded: Mar 14 2018

BTserial started at 9600

>AT
OK

>AT+NAME

>AT+NAME?
OK+Name:SH-M08

>AT+NAMEProject Test
OK+Set:Project Test

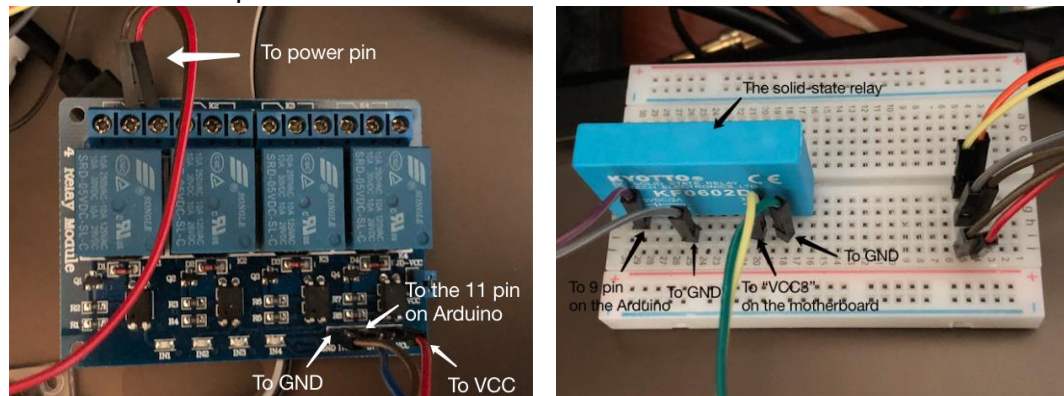
>AT+PIO11

[自动滚屏] NL 和 CR 9600 波特率 Clear output
```

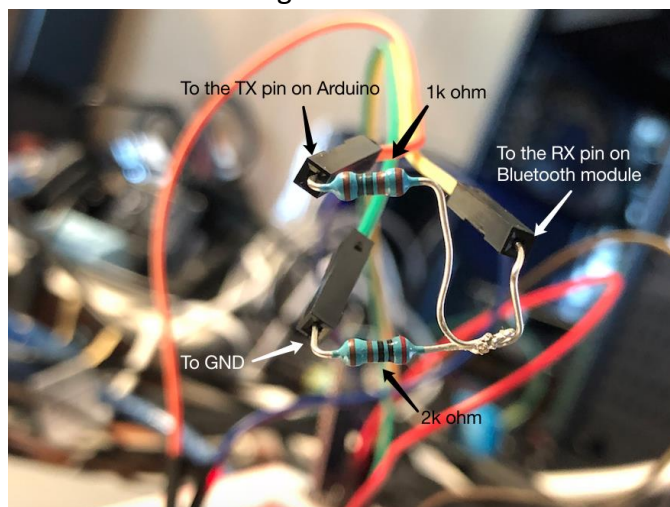


## 2. Hardware design and connections

I use a relay module to short the power pins in figure 1.2 on the motherboards to turn on or off the computer and a solid-state relay connect to the TMP VCC3 and GND pins in figure 1.1 to read if the computer is on or off.

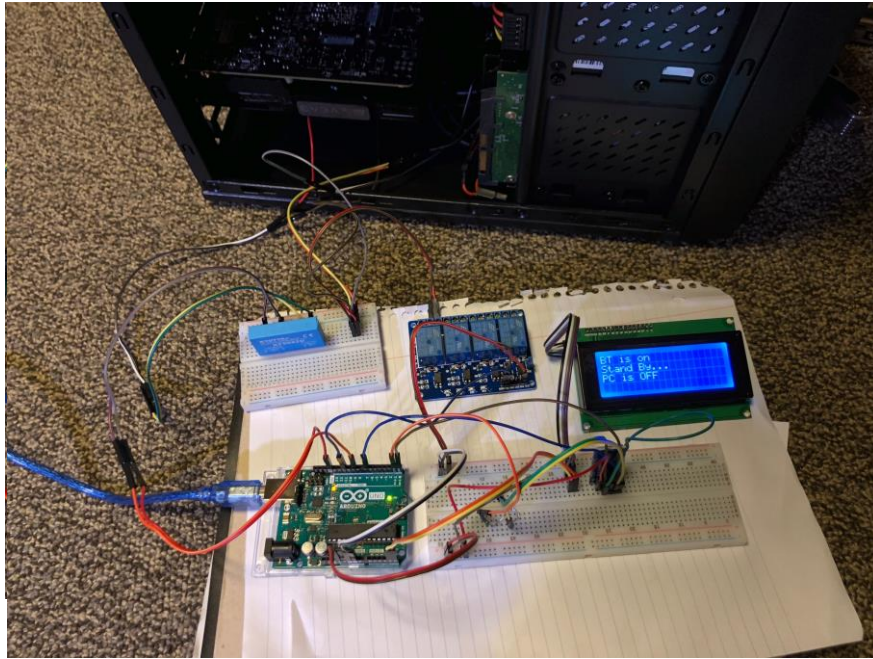


Future more, the Bluetooth module is a 3.3V device but the Arduino is a 5V device. Therefore, I need to reduce the voltage on the Arduino TX pin from 5V to 3.3V. I use a 1k ohm resistor, a 2k ohm resistor, and the voltage divider law in figure 2 to make a voltage divider as shown in figure 3.

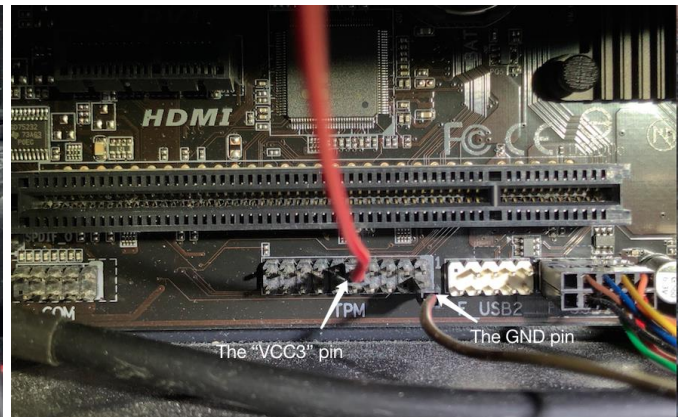
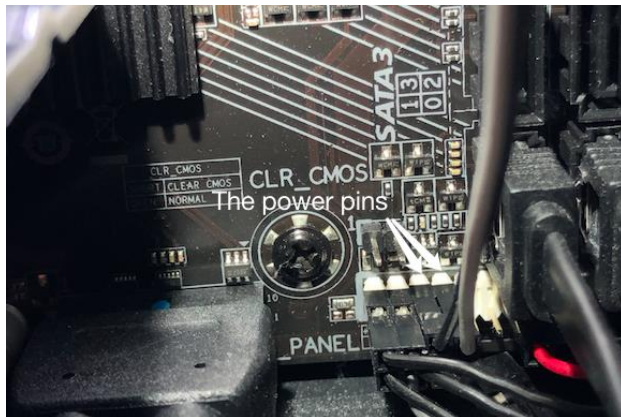


For better user interaction, I use a I2C LCD screen to show the information about Bluetooth state, computer power state, and it will show the “power button” state when it “push” the “power button” These statuses will also send to the phone via Bluetooth.





These are the connections on motherboard.



### 3.Coding

I wrote a program to control the Arduino UNO to do works.

This is the first part of my program.

This part is for define the function of each pin on the microcontroller on the Arduino, initialize the LCD screen and set baud for the Bluetooth module.

I use two libraries called "Wire" and "LiquidCrystal\_I2C" from

<https://www.arduino.cc/en/Reference/Wire>

and [https://github.com/marcoschwartz/LiquidCrystal\\_I2C](https://github.com/marcoschwartz/LiquidCrystal_I2C).

"Wire" allows Arduino to communicate with I2C devices with A4 and A5 ports, that works with LiquidCrystal\_I2C"to control the I2C LCD screen.

```
Project_01_BT_Switch $
1 #include <Wire.h> //communicate with I2C, A4 (SDA), A5 (SCL) https://www.arduino.cc/en/Reference/Wire
2 #include <LiquidCrystal_I2C.h> //control I2C LCD https://www.arduino.cc/en/Reference/LiquidCrystal
3
4 LiquidCrystal_I2C lcd(0x27,20,4); // LCD setup
5
6 char BT = 0; //variable for BT data
7
8 void setup()
9 {
10   lcd.init(); //initialize LCD
11   lcd.backlight(); //turn on LCD backlight
12   lcd.begin(20,4); //set LCD dimensions
13   Serial.begin(9600); //set baud for BT
14
15   pinMode(11, OUTPUT); //really control pin 1
16   digitalWrite(11, HIGH); //low level trigger
17   pinMode(12, OUTPUT); //really control pin 2 for future use
18   digitalWrite(12, HIGH); //low level trigger
19
20   pinMode(9, INPUT); //PC power
21   digitalWrite(9, HIGH); //low level trigger
22
23   pinMode(7, INPUT); //to BT Status LED pin "+" side. The Arduino will see the 3.3v signal from the HM-10 as HIGH
24   digitalWrite(7, LOW); //high level trigger
25
26   lcd.setCursor(0,0);
27   lcd.print("Automatic BT Switch");
28   delay(5000);
29   lcd.clear();
30   lcd.setCursor(0,0);
31   lcd.print("BT is on");
32   delay(500);
33   lcd.setCursor(0,1);
34   lcd.print("Stand By...");
35   delay(5000);
36 }
```



This is the second part of my program. This part is the logic part.

Project\_01\_BT\_Switch §

```
38 void loop()
39 {
40   //if(Serial.available() > 0) //when get data //some problems here
41   //{
42     BT = Serial.read(); //put into BT
43
44     if(digitalRead(9) == LOW) //if the PC is on
45     {
46       Serial.println("PC is ON");
47       lcd.setCursor(0,2);
48       lcd.print("PC is ON ");
49       if(BT == '1')
50       {
51         Serial.println("PC is already ON");
52         lcd.setCursor(0,3);
53         lcd.print("PC is already ON ");
54         delay(1500);
55         lcd.setCursor(0,3);
56         lcd.print("          ");
57       }
58       else if(BT == '0')
59       {
60         digitalWrite(11, LOW);
61         delay(250);
62         digitalWrite(11, HIGH);
63         Serial.println("shutting down...");
64         lcd.setCursor(0,3);
65         lcd.print("shutting down...");
66         delay(1500);
67         lcd.setCursor(0,3);
68         lcd.print("          ");
69       }
70       else if (digitalRead(7) == LOW) //when BT disconnect
71       {
72         digitalWrite(11, LOW);
73         delay(250);
74         digitalWrite(11, HIGH);
75         lcd.setCursor(0,3);
76         lcd.print("Disconnect PC OFF");
77         delay(1500);
78         lcd.setCursor(0,3);
79         lcd.print("          ");
80
81         delay(5000);
82       }
83     }
84
85     else if(digitalRead(9) == HIGH) //if the PC is off
86     {
87       Serial.println("PC is OFF");
88       lcd.setCursor(0,2);
89       lcd.print("PC is OFF");
90       if(BT == '1')
91       {
92         digitalWrite(11, LOW);
93         delay(250);
94         digitalWrite(11, HIGH);
95         Serial.println("turning on...");
96         lcd.setCursor(0,3);
97         lcd.print("turning on...");
98         delay(1500);
99         lcd.setCursor(0,3);
100        lcd.print("          ");
101      }
102      else if(BT == '0')
103      {
104        Serial.println("PC is already OFF");
105        lcd.setCursor(0,3);
106        lcd.print("PC is already OFF");
107        delay(1500);
108        lcd.setCursor(0,3);
109        lcd.print("          ");
110      }
111      //else if()
112    }
113  //}
114 }
```

I wrote all of those codes with my flow chart in figure 4.

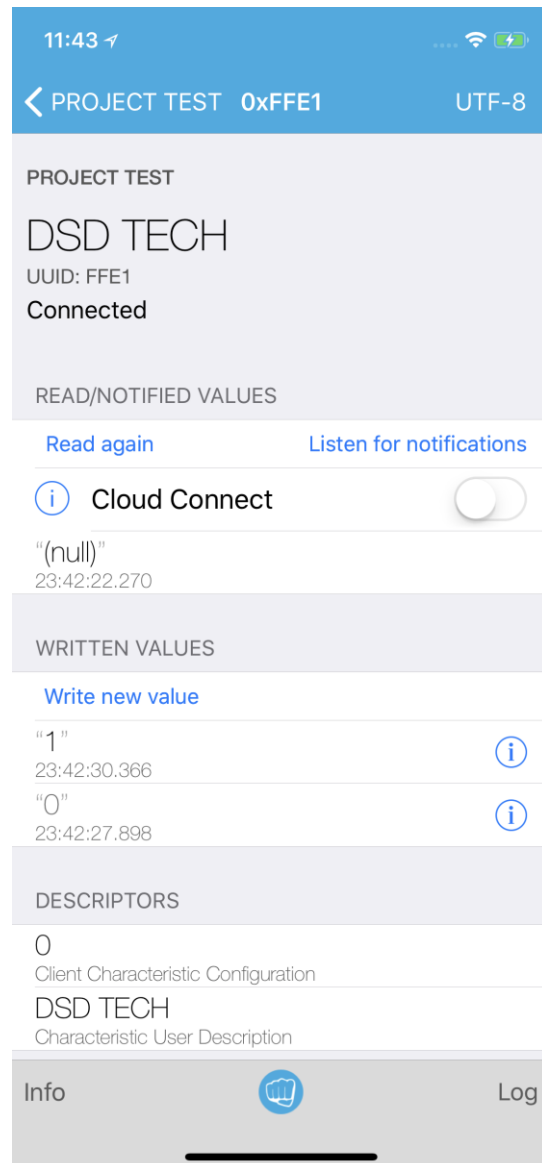
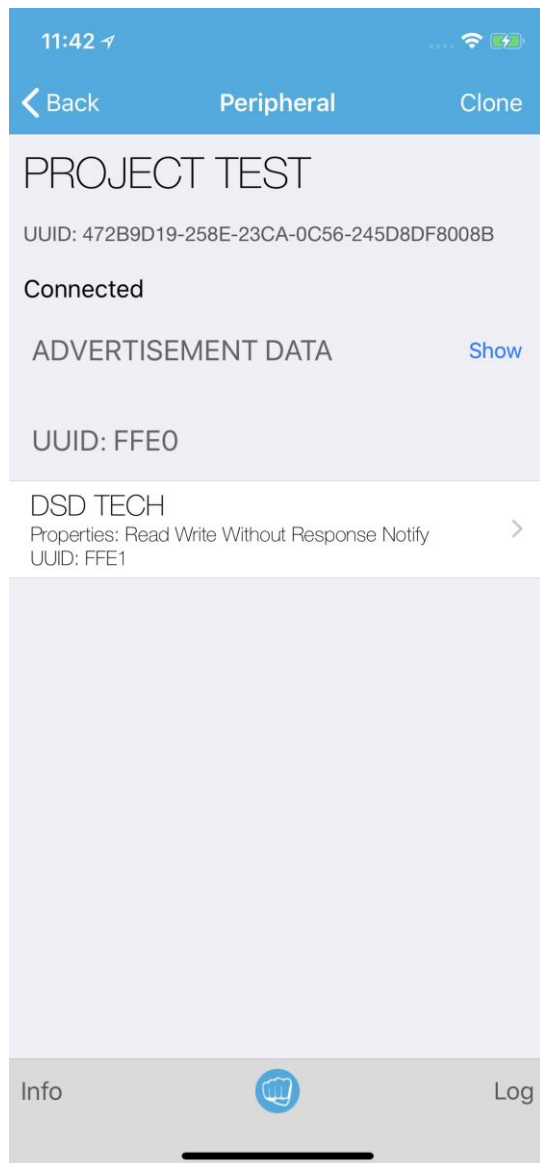
The program will determine if the computer is on or off and turn off the computer when Bluetooth disconnected.

It can also be a remote switch of the computer with a phone in the Bluetooth connection range. You can send commands to it with the phone.

"1" means turn on the computer  
"0" means turn off the computer

#### 4. Interact with the phone

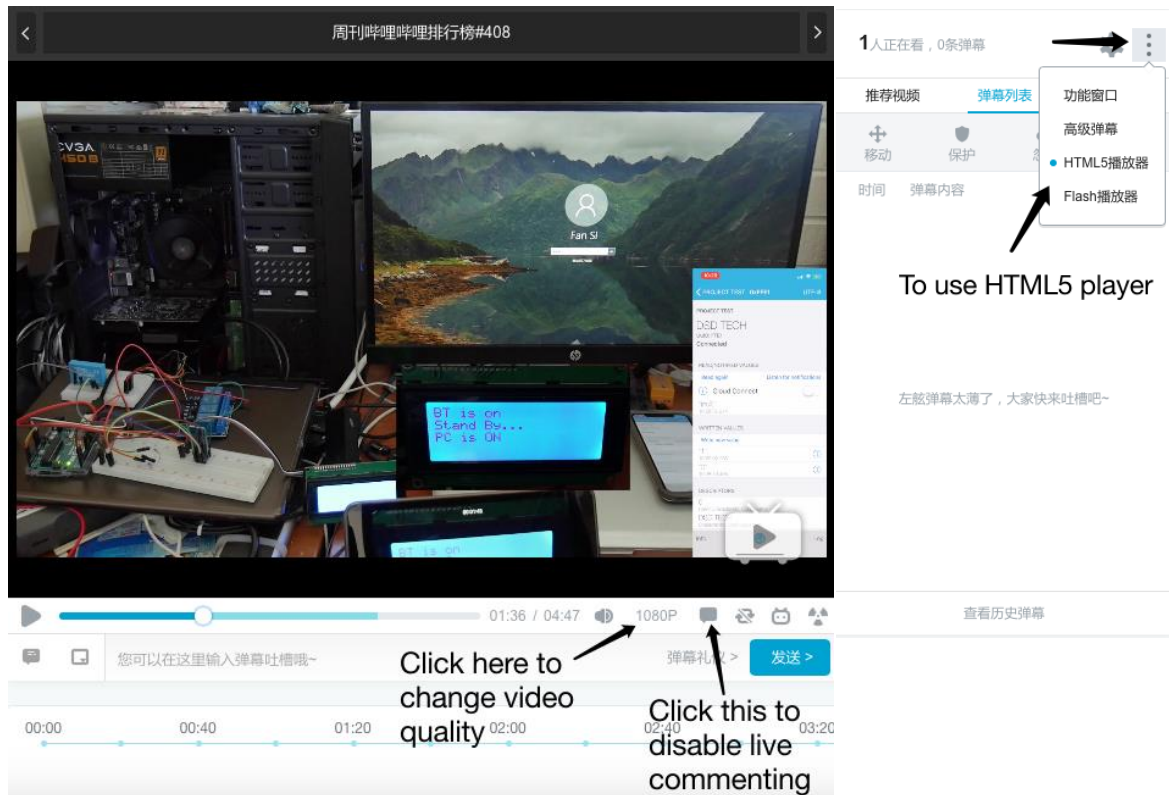
I use a software called LightBlue Explorer. It's a software that let you to talk with the Bluetooth module so that you can test your Bluetooth project easily.



## 6. Result

This link below is a video I made. It shows how my device works.

<https://www.bilibili.com/video/av22277399/>



There should not be any live comment in this video. However, if there are live comments bothers you, you can turn it off.

## **7. Conclusion & discussion**

I tested it by leave the building when my computer is on. After I get back my computer had been turned off. I also tested it by use my phone to send control commands to the device. It works pretty well.

To make it better, I will make a PCB to put everything of my device on a signal board instead of bread boards and jump wires. Then I will make a case for it, so that I can put everything into the computer.

Next, I will try to make it to do more things. This device can be a smart home device by simply change the program. It can be an automatic switch for the lights in your room or a controller of some household appliances. I will also try to make a device that connects to the internet, so that you can remote everything in your home no matter where you are as long as you get internet connection. This will reduce energy consumption and bring convenience to people.