Preface

About Our Company

WayinTop, Your Top Way to Inspiration, is a professional manufacturer over 2,000 open source motherboards, modules, and components. From designing PCBs, printing, soldering, testing, debugging, and offering online tutorials, WayinTop has been committed to explore and demystify the wonderful world of embedded electronics, including but not limited to Arduino and Raspberry Pi. We aim to make the best designed products for makers of all ages and skill levels. No matter your vision or skill level, our products and resources are designed to make electronics more accessible. Founded in 2013, WayinTop has grown to over 100+ employees and a 50,000+ sq ft. factory in China by now. With our unremitting efforts, we also have expanded offerings to include tools, equipments, connector kits and various DIY products that we have carefully selected and tested.

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Real Time Clock Kit
with Arduino_DS3231RTC_SSD1306 OLED

Overview

This tutorial shows how to build a real time clock and timing alarm clock using Arduino DS3231RTC and SSD1306 OLED. The DS3231RTC is used as a real time clock chip which keeps the time running even if the main power supply is off (with the help of a battery), time, date and temperature of nano board are displayed on the SSD1306 OLED.

This digital clock mainly uses the arduino nano board to read the time of the DS3231 clock module, and then controls the OLED display the real time. When the time reaches the set reminder time, the buzzer will automatically sound. The clock can also monitor the real-time temperature of the system, and the time can be adjusted manually.

Parts Required

Arduino Nano Board x 1 (With USB Download Cable)

DS3231 Real Time Clock Module x 1

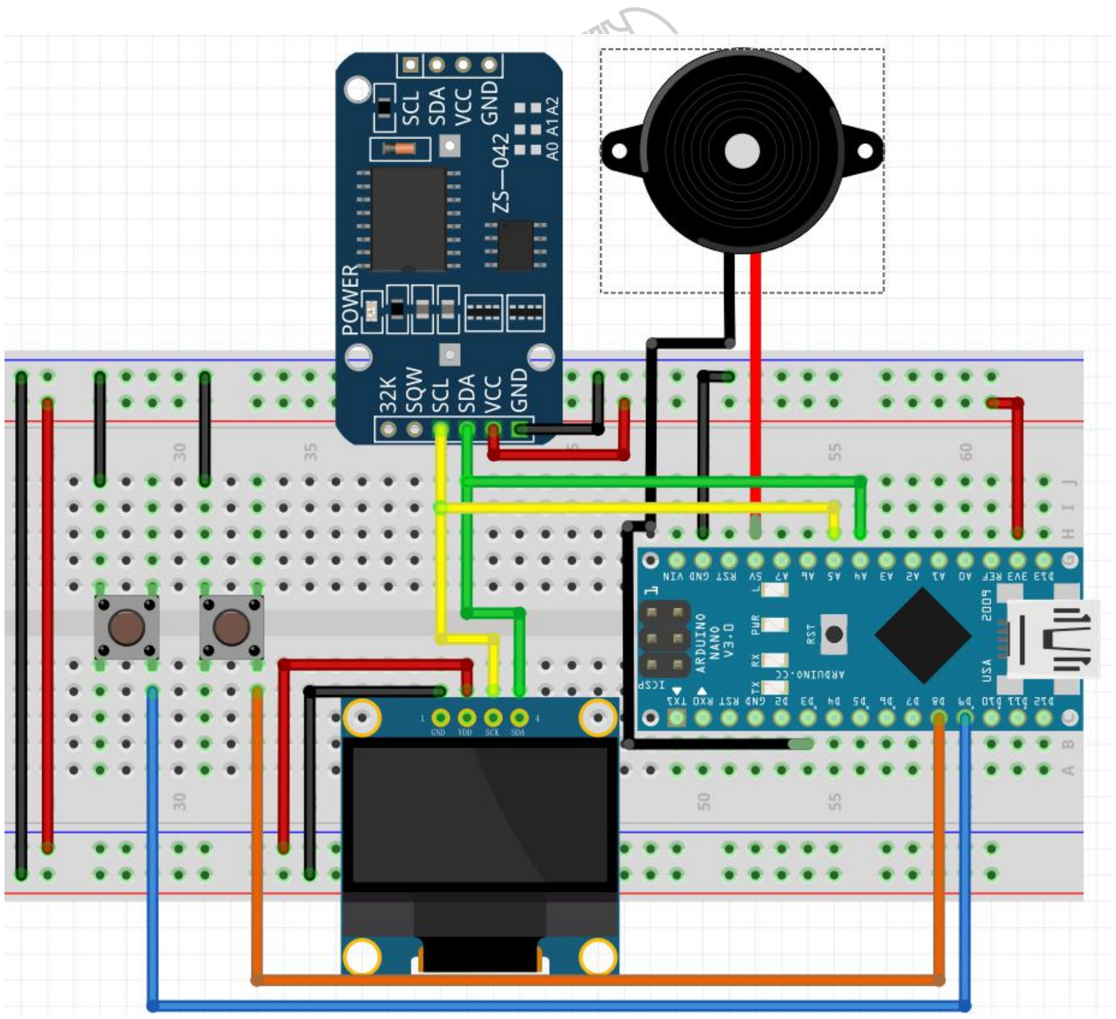
0.96” OLEDDisplay Module x1

5V Active buzzer x 1

Tactile Push Button Switch x 2

Dupont Wires x N

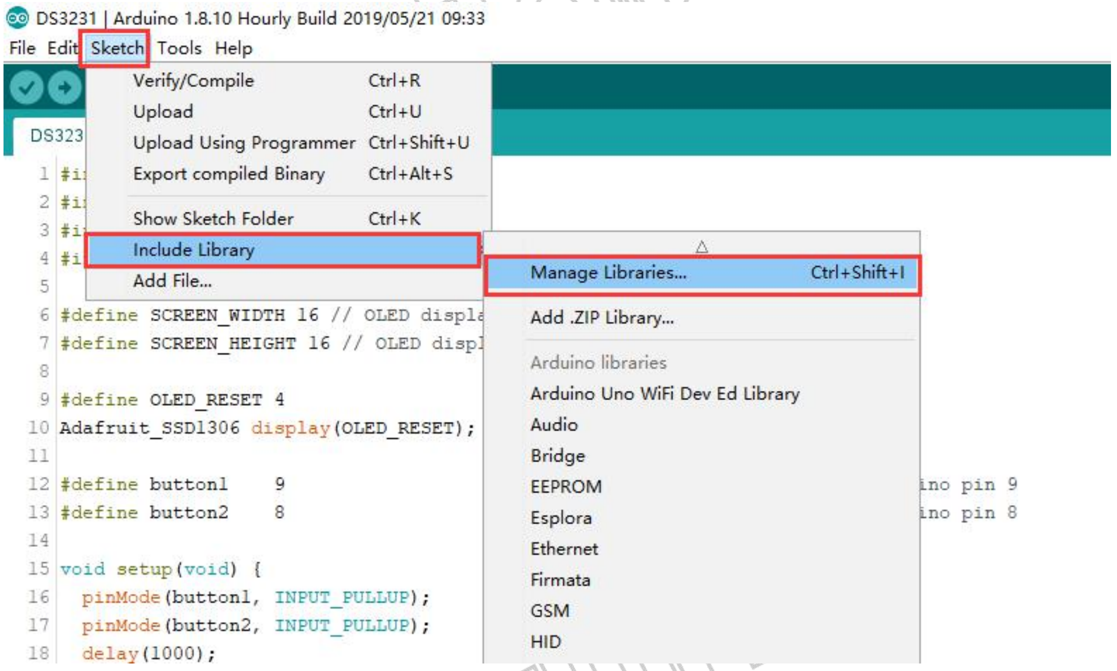
Connection Diagram



Arduino Control Program

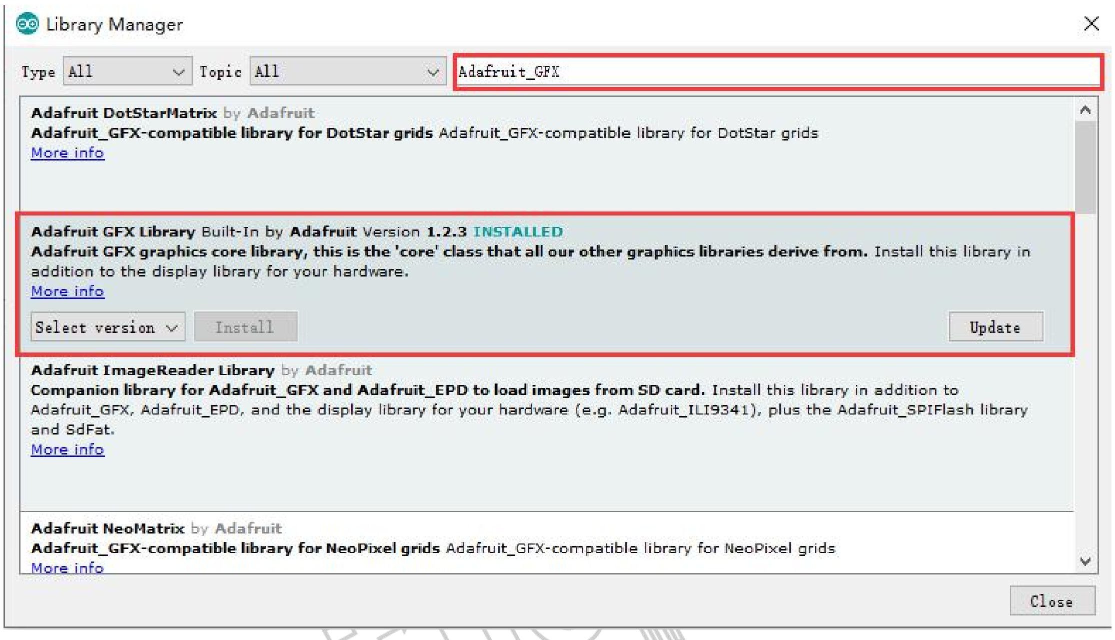
Before using the control program, you need to load the Adafruit_GFX.h and Adafruit_SSD1306 library functions required by the system.

Step 1: Open the arduino IDE, select "Sketch"-> "Include Library"-> "Manage Libraries ...." as shown below.


DS3231 | Arduino 1.8.10 Hourly Build 2019/05/21 09:33
File Edit Sketch Tools Help
Verify/Compile Ctrl+R
Upload Ctrl+U
Upload Using Programmer Ctrl+Shift+U
Export compiled Binary Ctrl+Alt+S
Show Sketch Folder Ctrl+K
Include Library
Add File...
Manage Libraries... Ctrl+Shift+I
Add .ZIP Library...
Arduino libraries
Arduino Uno WiFi Dev Ed Library
Audio
Bridge
EEPROM
Esplora
Ethernet
Firmata
GSM
HID
DS323

```
#i
#i
#i
#i

#define SCREEN_WIDTH 16 // OLED displa
#define SCREEN_HEIGHT 16 // OLED displ

#define OLED_RESET 4
Adafruit_SSD1306 display(OLED_RESET);

#define button1     9                                              ino pin 9
#define button2     8                                              ino pin 8

void setup(void) {
  pinMode(button1, INPUT_PULLUP);
  pinMode(button2, INPUT_PULLUP);
  delay(1000);
```

Step 2: Enter "Adafruit_GFX" in the pop-up window to search for library functions, and then install the Adafruit GFX Library functions, as shown below, which has installed the library functions.。



Library Manager

Type All | Topic All | Adafruit_GFX

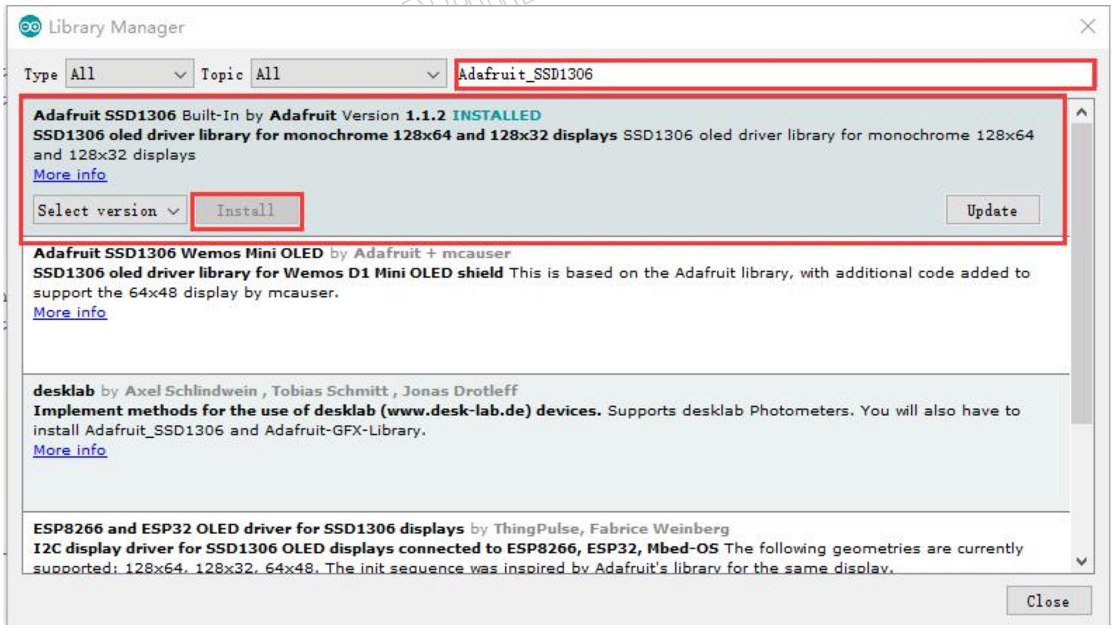
Adafruit DotStarMatrix by Adafruit
Adafruit_GFX-compatible library for DotStar grids Adafruit_GFX-compatible library for DotStar grids
More info

Adafruit GFX Library Built-In by **Adafruit** Version **1.2.3** INSTALLED
Adafruit GFX graphics core library, this is the 'core' class that all our other graphics libraries derive from. Install this library in addition to the display library for your hardware.
More info

Adafruit ImageReader Library by Adafruit
Companion library for Adafruit_GFX and Adafruit_EPD to load images from SD card. Install this library in addition to Adafruit_GFX, Adafruit_EPD, and the display library for your hardware (e.g. Adafruit_ILI9341), plus the Adafruit_SPIFlash library and SdFat.
More info

Adafruit NeoMatrix by Adafruit
Adafruit_GFX-compatible library for NeoPixel grids Adafruit_GFX-compatible library for NeoPixel grids
More info

Step 3: After installating the Adafruit GFX Library library function, enter "Adafruit_SSD1306" in the input text box to search for the SSD1306 library function, and then install Adafruit SSD1306, as shown in the figure below.



Library Manager

Type All | Topic All | Adafruit_SSD1306

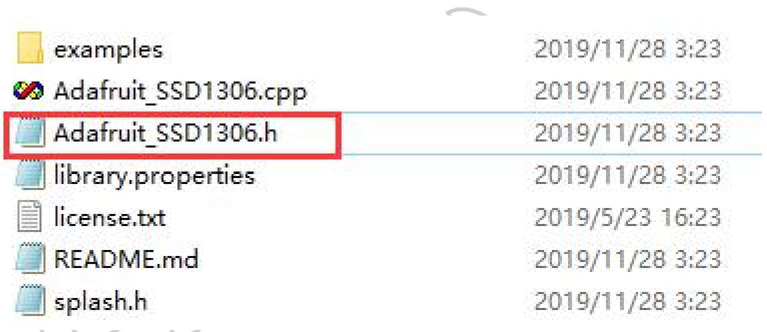
Adafruit SSD1306 Built-In by **Adafruit** Version **1.1.2** INSTALLED
SSD1306 oled driver library for monochrome 128x64 and 128x32 displays SSD1306 oled driver library for monochrome 128x64 and 128x32 displays
More info

Adafruit SSD1306 Wemos Mini OLED by Adafruit + mcauser
SSD1306 oled driver library for Wemos D1 Mini OLED shield This is based on the Adafruit library, with additional code added to support the 64x48 display by mcauser.
More info

desklab by Axel Schlindwein , Tobias Schmitt , Jonas Drotleff
Implement methods for the use of desklab (www.desk-lab.de) devices. Supports desklab Photometers. You will also have to install Adafruit_SSD1306 and Adafruit-GFX-Library.
More info

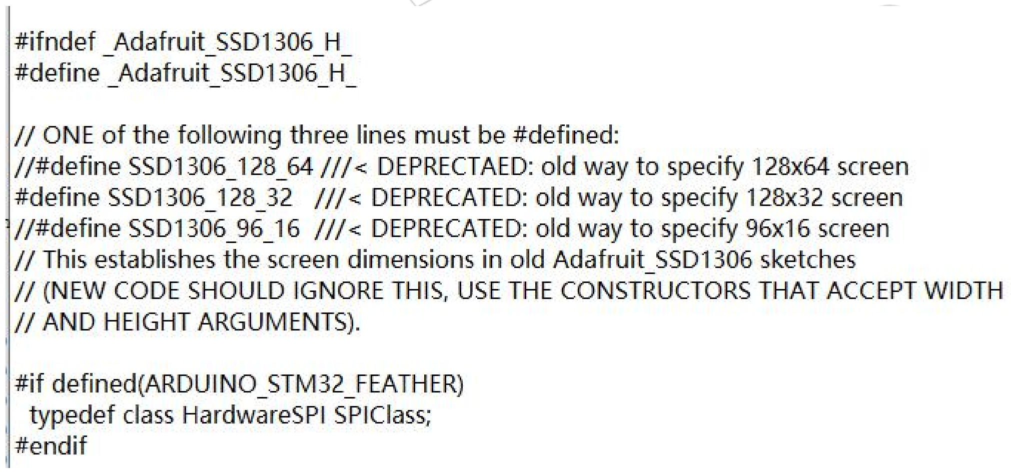
ESP8266 and ESP32 OLED driver for SSD1306 displays by ThingPulse, Fabrice Weinberg
I2C display driver for SSD1306 OLED displays connected to ESP8266, ESP32, Mbed-OS The following geometries are currently supported: 128x64, 128x32, 64x48. The init sequence was inspired by Adafruit's library for the same display.

Step 4: After the installation is completed, close arduinoIDE, and then find the "Adafruit_SSD1306.h" file in the "Adafruit_SSD1306" library function file that was just loaded (the path of this file is different, it will usually be under the "libraries" file in the arduino installation directory, or in arduino The "libraries" file under the code file storage path. Mine is under the "C: \ Users \ Admin \ Documents \ Arduino \ libraries \ Adafruit_SSD1306" path), as shown below.



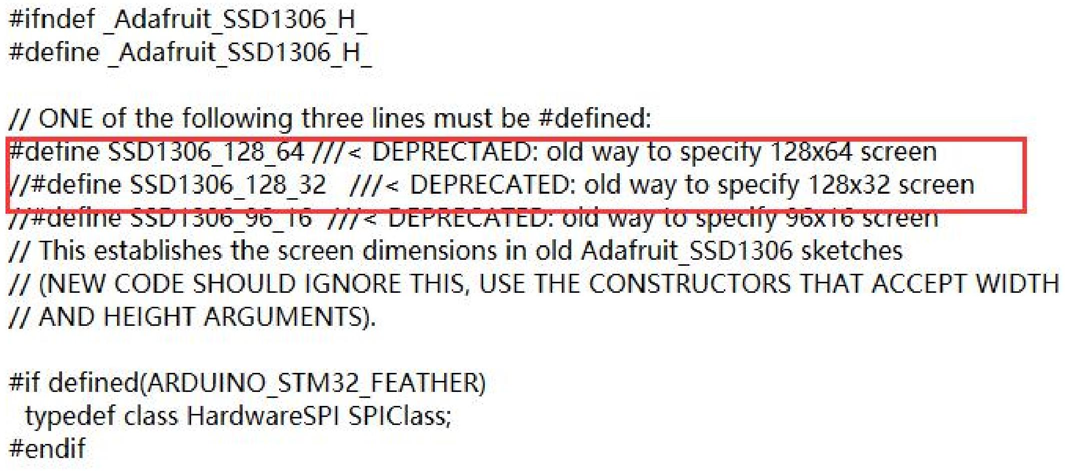
```
examples                2019/11/28 3:23
Adafruit_SSD1306.cpp    2019/11/28 3:23
Adafruit_SSD1306.h      2019/11/28 3:23
library.properties      2019/11/28 3:23
license.txt             2019/5/23 16:23
README.md               2019/11/28 3:23
splash.h                2019/11/28 3:23
```

Step 5: Open the file in Notepad and find the location shown below.



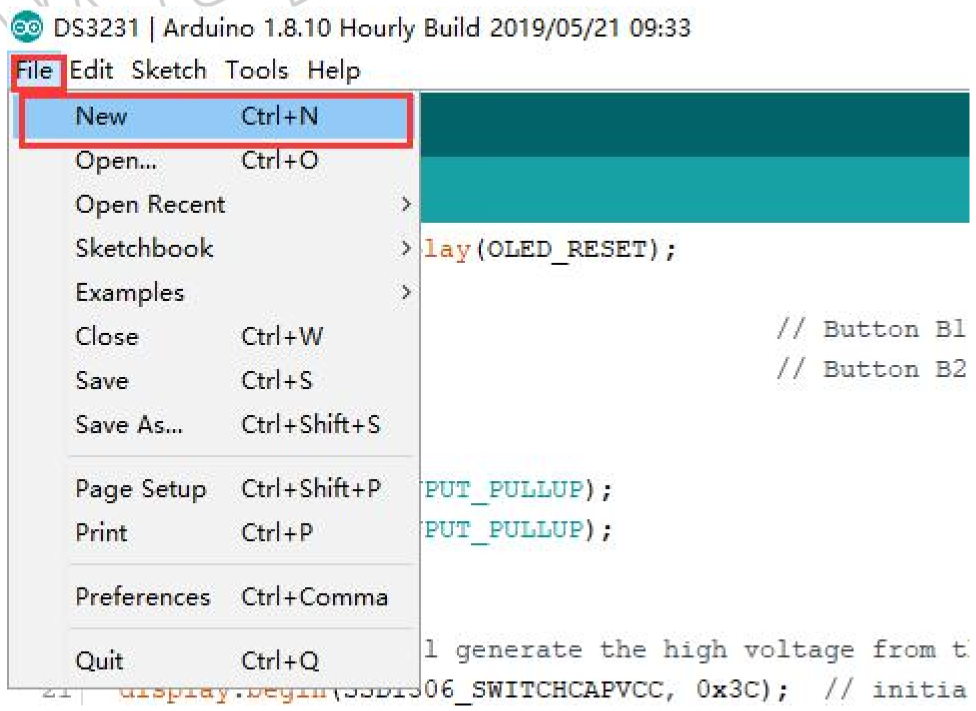
```
#ifndef _Adafruit_SSD1306_H_
#define _Adafruit_SSD1306_H_

// ONE of the following three lines must be #defined:
//#define SSD1306_128_64 ///< DEPRECTAED: old way to specify 128x64 screen
#define SSD1306_128_32   ///< DEPRECATED: old way to specify 128x32 screen
//#define SSD1306_96_16  ///< DEPRECATED: old way to specify 96x16 screen
// This establishes the screen dimensions in old Adafruit_SSD1306 sketches
// (NEW CODE SHOULD IGNORE THIS, USE THE CONSTRUCTORS THAT ACCEPT WIDTH
// AND HEIGHT ARGUMENTS).

#if defined(ARDUINO_STM32_FEATHER)
  typedef class HardwareSPI SPIClass;
#endif
```

Step 6: Uncomment "#define SSD1306_128_64", and then comment "#define SSD1306_128_32". as the picture shows. Save and exit after making changes.



```
#ifndef _Adafruit_SSD1306_H_
#define _Adafruit_SSD1306_H_

// ONE of the following three lines must be #defined:
#define SSD1306_128_64 ///< DEPRECTAED: old way to specify 128x64 screen
//#define SSD1306_128_32   ///< DEPRECATED: old way to specify 128x32 screen
//#define SSD1306_96_16  ///< DEPRECATED: old way to specify 96x16 screen
// This establishes the screen dimensions in old Adafruit_SSD1306 sketches
// (NEW CODE SHOULD IGNORE THIS, USE THE CONSTRUCTORS THAT ACCEPT WIDTH
// AND HEIGHT ARGUMENTS).

#if defined(ARDUINO_STM32_FEATHER)
  typedef class HardwareSPI SPIClass;
#endif
```

Step 7: Open arduinoIDE and select "File"-> "New" and create a new project file, as shown in the figure below.



```
lay(OLED_RESET);
                          // Button B1
                          // Button B2
PUT_PULLUP);
PUT_PULLUP);
l generate the high voltage from t
display.begin(SSD1306_SWITCHCAPVCC, 0x3C);  // initia
```

Step 8: Copy the following program into the newly created project.

```
#include <SPI.h>
#include <Wire.h>
#include <Adafruit_GFX.h>
```

```
#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 16 // OLED display width, in pixels
#define SCREEN_HEIGHT 16 // OLED display height, in pixels

#define OLED_RESET 4
Adafruit_SSD1306 display(OLED_RESET);

#define button1     9                       // Button B1 is connected to Arduino pin 9
#define button2     8                       // Button B2 is connected to Arduino pin 8
#define buzzer      3

void setup(void) {
  pinMode(button1, INPUT_PULLUP);
  pinMode(button2, INPUT_PULLUP);
  pinMode(buzzer, OUTPUT);
  digitalWrite(buzzer, HIGH);
  delay(1000);
  Serial.begin(115200);

  // by default, we'll generate the high voltage from the 3.3v line internally! (neat!)
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);   // initialize with the I2C addr
  // init done

  // Clear the display buffer.
  display.clearDisplay();
  display.display();

  display.setTextColor(WHITE,BLACK);
  display.drawRect(117, 55, 3, 3, WHITE);      // Put degree symbol ( ° )
  draw_text(0, 55, "TEMPERATURE =", 1);
  draw_text(122, 55, "C", 1);
}

char Time[]      = "   :   :   ";
char Calendar[] = "   /   /20    ";
char temperature[] = " 00.00";
char temperature_msb;
byte i, second, minute, hour, day, date, month, year, temperature_lsb;

void display_day(){
  switch(day){
    case 1:   draw_text(0, 0, " SUNDAY    ", 1); break;
```

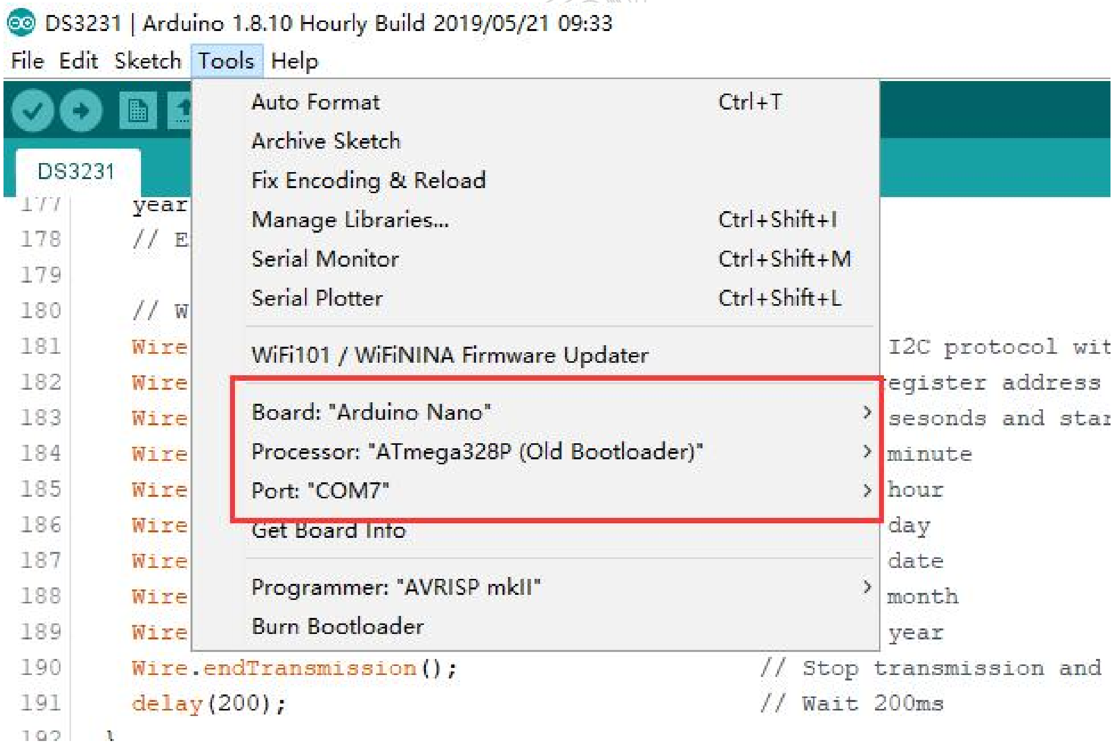
```
        case 2:   draw_text(0, 0, " MONDAY    ", 1); break;
        case 3:   draw_text(0, 0, " TUESDAY ", 1); break;
        case 4:   draw_text(0, 0, "WEDNESDAY", 1); break;
        case 5:   draw_text(0, 0, "THURSDAY ", 1); break;
        case 6:   draw_text(0, 0, " FRIDAY    ", 1); break;
        default: draw_text(0, 0, "SATURDAY ", 1);
    }
}

void DS3231_display(){
    // Convert BCD to decimal
    second = (second >> 4) * 10 + (second & 0x0F);
    minute = (minute >> 4) * 10 + (minute & 0x0F);
    hour     = (hour >> 4)     * 10 + (hour & 0x0F);
    date     = (date >> 4)     * 10 + (date & 0x0F);
    month   = (month >> 4)   * 10 + (month & 0x0F);
    year     = (year >> 4)     * 10 + (year & 0x0F);
    // End conversion

    Time[7]         = second % 10 + 48;
    Time[6]         = second / 10 + 48;
    Time[4]         = minute % 10 + 48;
    Time[3]         = minute / 10 + 48;
    Time[1]         = hour     % 10 + 48;
    Time[0]         = hour     / 10 + 48;
    Calendar[9] = year     % 10 + 48;
    Calendar[8] = year     / 10 + 48;
    Calendar[4] = month   % 10 + 48;
    Calendar[3] = month   / 10 + 48;
    Calendar[1] = date     % 10 + 48;
    Calendar[0] = date     / 10 + 48;
    if(temperature_msb < 0){
        temperature_msb = abs(temperature_msb);
        temperature[0] = '-';
    }
    else
        temperature[0] = ' ';
    temperature_lsb >>= 6;
    temperature[2] = temperature_msb % 10    + 48;
    temperature[1] = temperature_msb / 10    + 48;
    if(temperature_lsb == 0 || temperature_lsb == 2){
        temperature[5] = '0';
        if(temperature_lsb == 0) temperature[4] = '0';
```

```
      else                              temperature[4] = '5';
    }
    if(temperature_lsb == 1 || temperature_lsb == 3){
      temperature[5] = '5';
      if(temperature_lsb == 1) temperature[4] = '2';
      else                              temperature[4] = '7';
    }

    draw_text(60,   0, Calendar, 1);                        // Display the date (format: dd/mm/yyyy)
    draw_text(10, 24, Time, 2);                             // Display the time
    draw_text(75, 55, temperature, 1);                      // Display the temperature
    if(Time[0]=='2' && Time[1]=='0' && Time[3]== '3' && Time[4]=='0')
    {
      digitalWrite(buzzer, LOW);
     }
    else
     {
       digitalWrite(buzzer, HIGH);
     }
}

void blink_parameter(){
    byte j = 0;
    while(j < 10 && digitalRead(button1) && digitalRead(button2)){
      j++;
      delay(25);
    }
}

byte edit(byte x_pos, byte y_pos, byte parameter){
    char text[3];
    sprintf(text,"%02u", parameter);
    while(!digitalRead(button1));                           // Wait until button B1 released
    while(true){
      while(!digitalRead(button2)){                         // If button B2 is pressed
        parameter++;
        if(i == 0 && parameter > 31)                          // If date > 31 ==> date = 1
          parameter = 1;
        if(i == 1 && parameter > 12)                          // If month > 12 ==> month = 1
          parameter = 1;
        if(i == 2 && parameter > 99)                          // If year > 99 ==> year = 0
          parameter = 0;
        if(i == 3 && parameter > 23)                          // If hours > 23 ==> hours = 0
```

```
          parameter = 0;
        if(i == 4 && parameter > 59)                       // If minutes > 59 ==> minutes = 0
          parameter = 0;
        sprintf(text,"%02u", parameter);
        draw_text(x_pos, y_pos, text, 1);
        delay(200);                                       // Wait 200ms
      }
      draw_text(x_pos, y_pos, "    ", 1);
      blink_parameter();
      draw_text(x_pos, y_pos, text, 1);
      blink_parameter();
      if(!digitalRead(button1)){                         // If button B1 is pressed
        i++;                                               // Increament 'i' for the next parameter
        return parameter;                                  // Return parameter value and exit
      }
    }
  }

void draw_text(byte x_pos, byte y_pos, char *text, byte text_size) {
  display.setCursor(x_pos, y_pos);
  display.setTextSize(text_size);
  display.print(text);
  display.display();
}

void loop() {

  if(!digitalRead(button1)){                             // If button B1 is pressed
    i = 0;
    while(!digitalRead(button1));                        // Wait for button B1 release
    while(true){
      while(!digitalRead(button2)){                      // While button B2 pressed
        day++;                                             // Increment day
        if(day > 7) day = 1;
        display_day();                                    // Call display_day function
        delay(200);                                       // Wait 200 ms
      }
      draw_text(0, 0, "            ", 1);
      blink_parameter();                                  // Call blink_parameter function
      display_day();                                      // Call display_day function
      blink_parameter();                                  // Call blink_parameter function
      if(!digitalRead(button1))                          // If button B1 is pressed
        break;
    }
    //set position of text when editing on button press
    date     = edit(60, 0, date);                        // Edit date
    month    = edit(80, 0, month);                       // Edit month
    year     = edit(110,0, year);                        // Edit year
    hour     = edit(14, 9, hour);                        // Edit hours
    minute = edit(50, 9, minute);                        // Edit minutes

    // Convert decimal to BCD
    minute = ((minute / 10) << 4) + (minute % 10);
    hour = ((hour / 10)   << 4) + (hour % 10);
    date = ((date / 10) <<   4) + (date % 10);
    month = ((month / 10)   << 4) + (month % 10);
    year = ((year / 10)   << 4) + (year % 10);
    // End conversion

    // Write data to DS3231 RTC
    Wire.beginTransmission(0x68);                    // Start I2C protocol with DS3231 address
    Wire.write(0);                                   // Send register address
    Wire.write(0);                                   // Reset sesonds and start oscillator
    Wire.write(minute);                              // Write minute
    Wire.write(hour);                                // Write hour
    Wire.write(day);                                 // Write day
    Wire.write(date);                                // Write date
    Wire.write(month);                               // Write month
    Wire.write(year);                                // Write year
    Wire.endTransmission();                          // Stop transmission and release the I2C bus
    delay(200);                                      // Wait 200ms
  }

  Wire.beginTransmission(0x68);                      // Start I2C protocol with DS3231 address
  Wire.write(0);                                     // Send register address
  Wire.endTransmission(false);                       // I2C restart
  Wire.requestFrom(0x68, 7);                         // Request 7 bytes from DS3231 and release I2C
//bus at end of reading
  second = Wire.read();                              // Read seconds from register 0
  minute = Wire.read();                              // Read minuts from register 1
  hour     = Wire.read();                            // Read hour from register 2
  day      = Wire.read();                            // Read day from register 3
  date     = Wire.read();                            // Read date from register 4
  month    = Wire.read();                            // Read month from register 5
  year     = Wire.read();                            // Read year from register 6
  Wire.beginTransmission(0x68);                      // Start I2C protocol with DS3231 address
```

```
   Wire.write(0x11);                              // Send register address
   Wire.endTransmission(false);                   // I2C restart
   Wire.requestFrom(0x68, 2);                       // Request 2 bytes from DS3231 and release I2C
//bus at end of reading
   temperature_msb = Wire.read();                  // Read temperature MSB
   temperature_lsb = Wire.read();                 // Read temperature LSB

   display_day();
   DS3231_display();                               // Diaplay time & calendar

   delay(50);                                     // Wait 50ms
}
```

Step 9: Use the hardware connected with the data cable to connect to the computer, and then set the hardware parameters in arduinoIDE. The specific settings are shown in the figure below.



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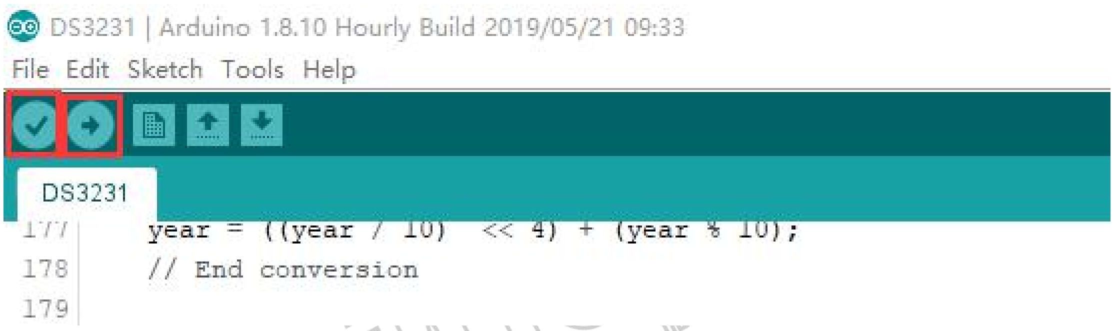
File Edit Sketch Tools Help
DS3231
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Get Board Info
Burn Bootloader

Board: "Arduino Nano"
Processor: "ATmega328P (Old Bootloader)"
Port: "COM7"
Programmer: "AVRISP mkII"

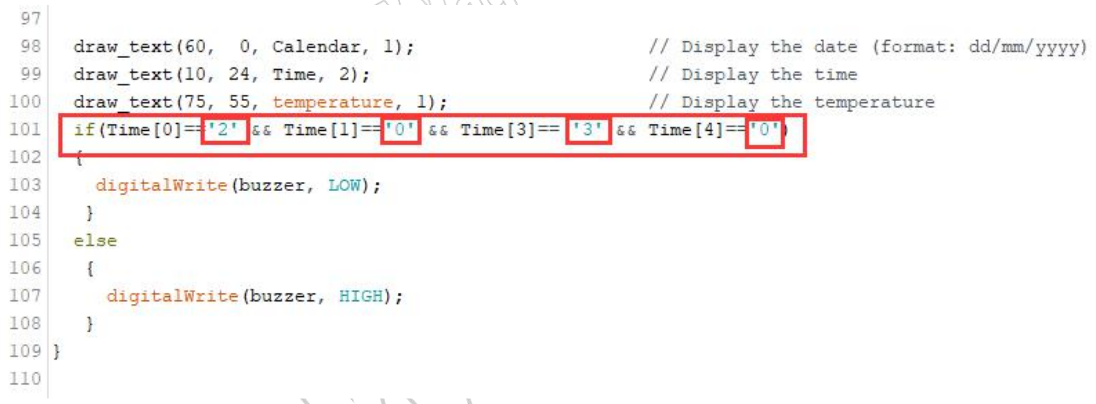
```
    year
    // E
    
    // W
    Wire                         I2C protocol wit
    Wire                        egister address
    Wire                        sesonds and star
    Wire                        minute
    Wire                        hour
    Wire                        day
    Wire                        date
    Wire                        month
    Wire                        year
    Wire.endTransmission();                         // Stop transmission and
    delay(200);                                     // Wait 200ms
  }
```

Step 10: After the setting is completed, select the first button to compile the program. If there are no errors, select the second button to upload the program to the arduino nano board. As shown below.


DS3231 | Arduino 1.8.10 Hourly Build 2019/05/21 09:33
File Edit Sketch Tools Help
DS3231

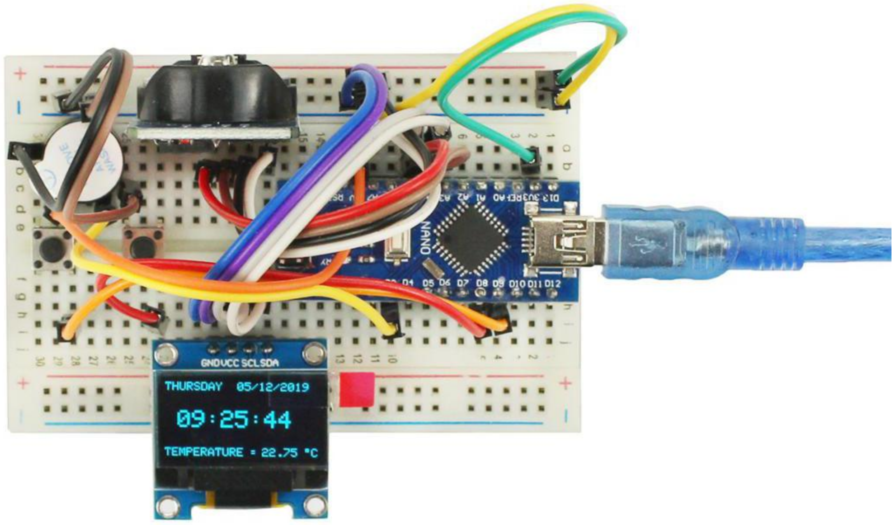
```
    year = ((year / 10)  << 4) + (year % 10);
    // End conversion

```

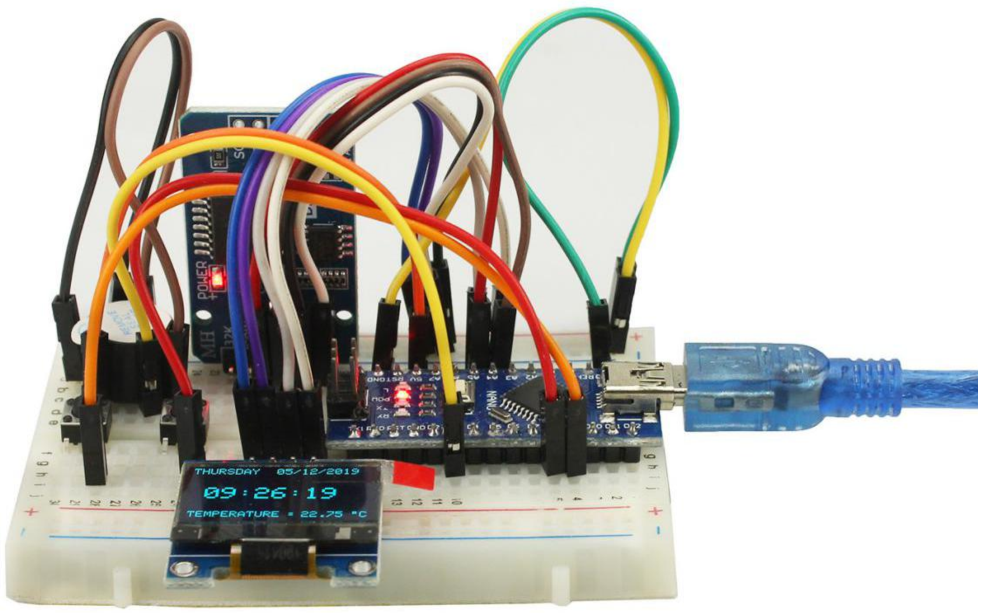
Step 11: The alarm clock of this tutorial is set at "20:30". If you need to change it, please modify the code shown in the figure below.

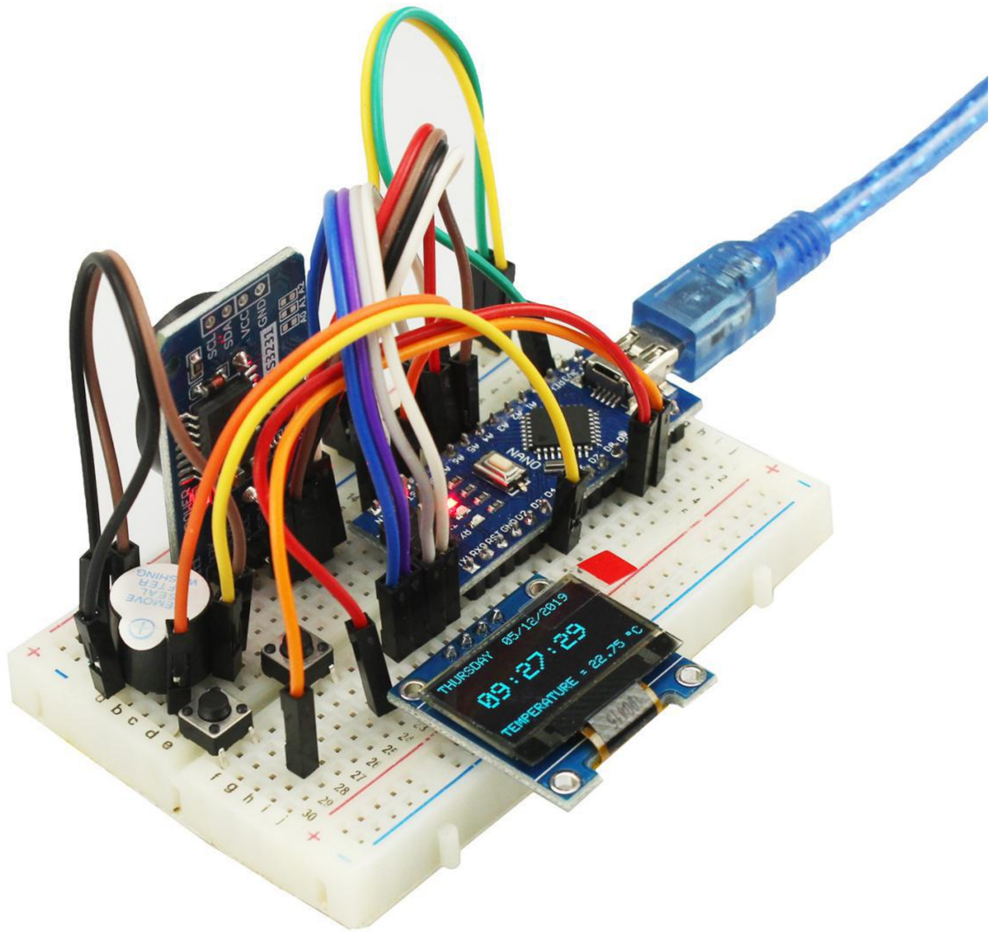


```

  draw_text(60,  0, Calendar, 1);                     // Display the date (format: dd/mm/yyyy)
  draw_text(10, 24, Time, 2);                         // Display the time
  draw_text(75, 55, temperature, 1);                  // Display the temperature
  if(Time[0]=='2' && Time[1]=='0' && Time[3]=='3' && Time[4]=='0')
  {
    digitalWrite(buzzer, LOW);
   }
  else
   {
     digitalWrite(buzzer, HIGH);
   }
}

```

Step 12: The final Experiment map is shown below. Press and hold the button connected to the D9 pin of the Arduino nano board for about 3 seconds to enter the time setting function. After entering, just short press to select the next data. After selecting the data to be set, press the key connected to the D8 pin of the Arduino nano board to change the data.






THURSDAY 05/12/2019
09:27:29
TEMPERATURE = 22.75 °C