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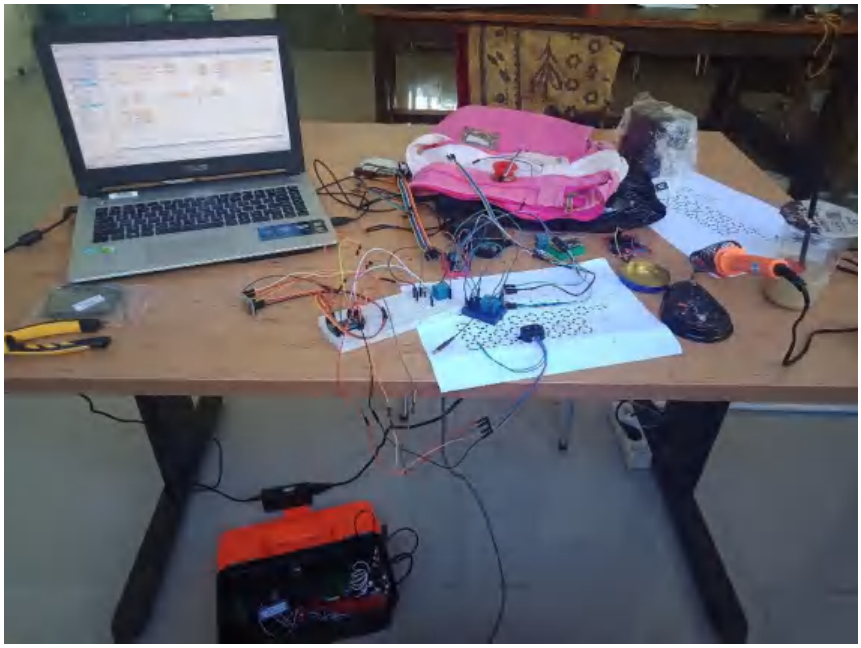
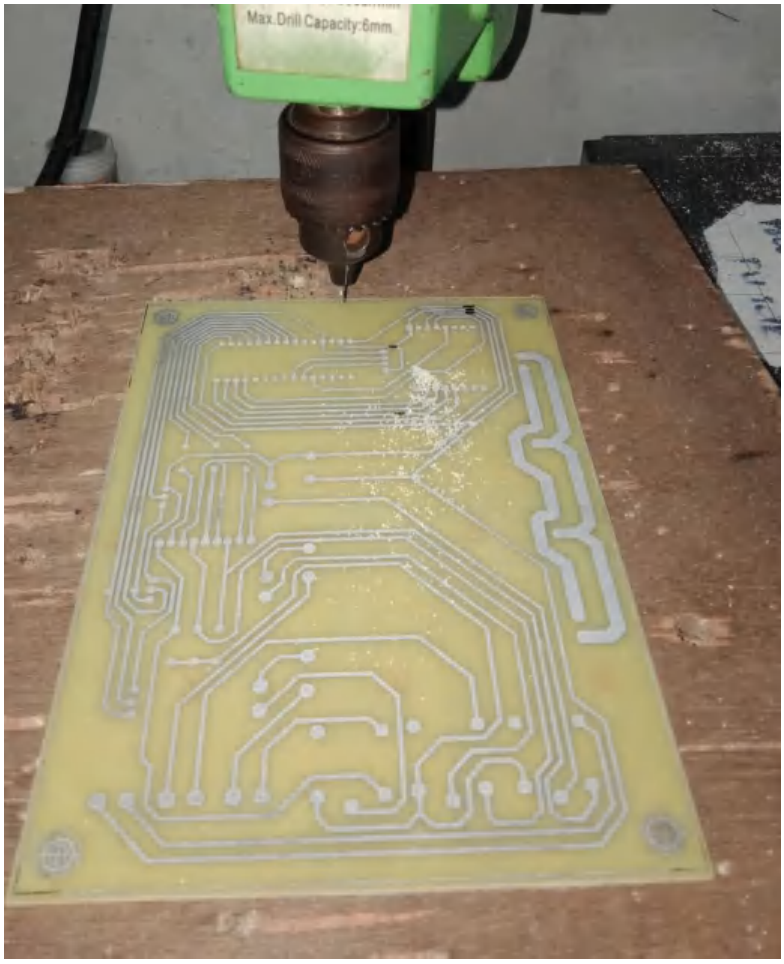
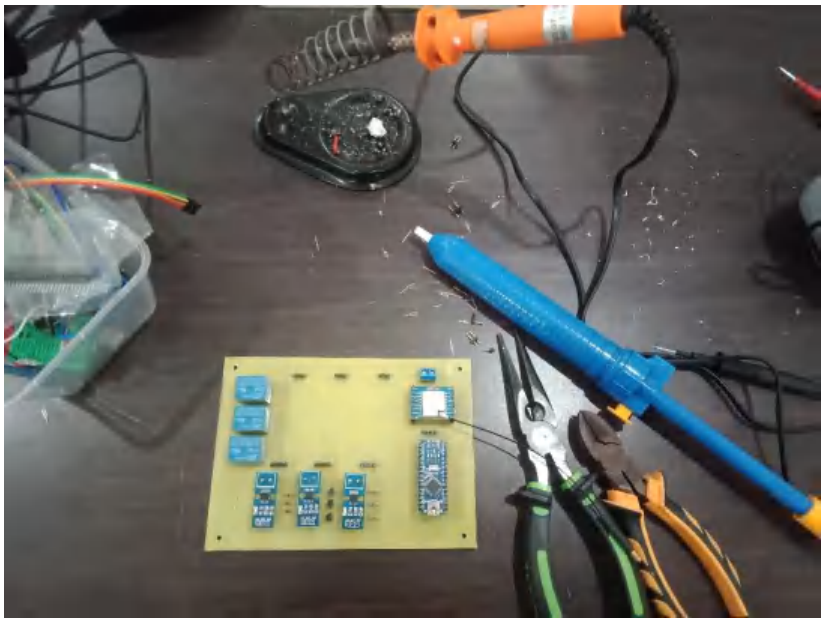
LAMPIRAN

Lampiran 1 Proses uji coba komponen sebelum membuat skematik dan PCB layout.

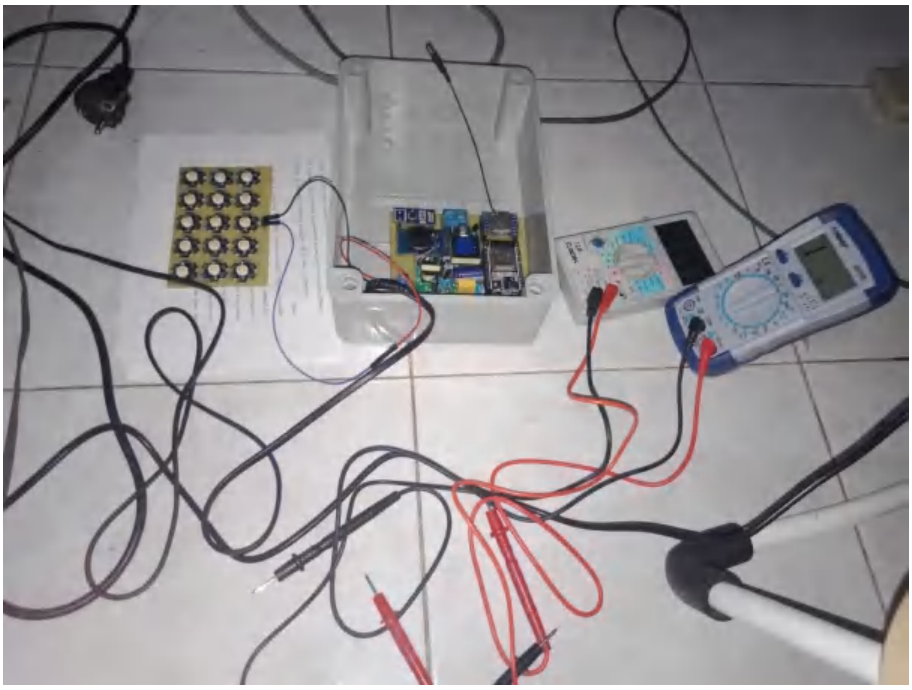


Lampiran 2 Proses fabrikasi layout PCB





Lampiran 3 Uji coba rangkaian



Lampiran 4 Pengujian dan pengambilan data

Lampiran 5 *Listing* program

```
String arusPath = "/ARUS";
String dayaPath = "/DAYA";
String pwmPath = "/PWM";
String ldrPath = "/LDR";
String mode = "a";
String pwmControl = "0|0|0";
String broadcastData = mode+pwmControl;
float ldr1, ldr2, ldr3 = 0;
String saveLogServer = "https://streetlightiot.000webhostapp.com/saveLog.php";
bool forceSaveLog = false;

struct DataArray {
  String val[6];
};

// Inisialisasi WiFi
void initWiFi() {
  Serial.println("Mencari WiFi...");
  WiFi.mode(WIFI_STA);
  int nbVisibleNetworks = WiFi.scanNetworks();
  while (nbVisibleNetworks == 0) {
    Serial.println("Tidak ada WiFi ditemukan, coba ulang setelah 1 detik...");
    delay(1000);
    nbVisibleNetworks = WiFi.scanNetworks();
  }
  boolean wifiFound = false;
  int i, n;
  for (i = 0; i < nbVisibleNetworks; ++i) {
    for (n = 0; n < KNOWN_SSID_COUNT; n++) {
      if (!strcmp(KNOWN_SSID[n], WiFi.SSID(i).c_str())) {
        wifiFound = true;
        break;
      }
    }
    if (wifiFound) break;
  }
  if (!wifiFound) {
```

```
    Serial.println("Tidak ada WiFi yang dikenali");
    while (1);
  }
  Serial.print("Menghubungkan ke " + String(KNOWN_SSID[n]) + "...");
  WiFi.begin(KNOWN_SSID[n], KNOWN_PASSWORD[n]);
  while (WiFi.status() != WL_CONNECTED) {
      delay(500);
      Serial.print(".");
  }
  Serial.println(" BERHASIL");
}

// Inisialisasi Firebase
void initFirebase() {
  Serial.print("Menghubungkan ke Firebase...");
  fconfig.api_key = API_KEY;
  fconfig.database_url = DATABASE_URL;
  fauth.user.email = USER_EMAIL;
  fauth.user.password = USER_PASSWORD;
  Firebase.begin(&fconfig, &fauth);
  Firebase.reconnectWiFi(true);
  if (Firebase.RTDB.setString(&fbdo, "config/mode", mode) &&
Firebase.RTDB.setString(&fbdo, "config/pwm", pwmControl)) {
    Serial.println(" BERHASIL");
  } else {
    Serial.println(" GAGAL");
    while(1);
  }
}

// Sinkronisasi Waktu
void syncTime() {
  struct tm timeinfo;
  int yr = 0;
  int mt = 0;
  int dy = 0;
  int hr = 0;
```

```
  int mi = 0;
  int se = 0;
  Serial.print("Menyinkronkan waktu...");
  configTime(gmtOffset_sec, daylightOffset_sec, ntpServer);
  getLocalTime(&timeinfo);
  Serial.println(&timeinfo, " %A, %B %d %Y %H:%M:%S");
  yr = timeinfo.tm_year + 1900;
  mt = timeinfo.tm_mon + 1;
  dy = timeinfo.tm_mday;
  hr = timeinfo.tm_hour;
  mi = timeinfo.tm_min;
  se = timeinfo.tm_sec;
  rtc.adjust(DateTime(yr, mt, dy, hr, mi, se));
}

// Simpan Data ke Firebase
void saveDataFirebase() {
  DataArray data1 = parseData(dataNode1);
  DataArray data2 = parseData(dataNode2);
  DataArray data3 = parseData(dataNode3);
  keyPath = "NODE_1";
  fjson.set(keyPath+teganganPath.c_str(), data1.val[0].toFloat());
  fjson.set(keyPath+arusPath.c_str(), data1.val[1].toFloat());
  fjson.set(keyPath+dayaPath.c_str(), data1.val[2].toFloat());
  fjson.set(keyPath+pwmPath.c_str(), data1.val[3].toFloat());
  fjson.set(keyPath+ldrPath.c_str(), data1.val[4].toFloat());
  ldr1 = data1.val[4].toFloat();
  keyPath = "NODE_2";
  fjson.set(keyPath+teganganPath.c_str(), data2.val[0].toFloat());
  fjson.set(keyPath+arusPath.c_str(), data2.val[1].toFloat());
  fjson.set(keyPath+dayaPath.c_str(), data2.val[2].toFloat());
  fjson.set(keyPath+pwmPath.c_str(), data2.val[3].toFloat());
  fjson.set(keyPath+ldrPath.c_str(), data2.val[4].toFloat());
  ldr2 = data2.val[4].toFloat();
  keyPath = "NODE_3";
  fjson.set(keyPath+teganganPath.c_str(), data3.val[0].toFloat());
  fjson.set(keyPath+arusPath.c_str(), data3.val[1].toFloat());
```

```
  fjson.set(keyPath+dayaPath.c_str(), data3.val[2].toFloat());
  fjson.set(keyPath+pwmPath.c_str(), data3.val[3].toFloat());
  fjson.set(keyPath+ldrPath.c_str(), data3.val[4].toFloat());
  ldr3 = data3.val[4].toFloat();
  Firebase.RTDB.setJSON(&fbdo, "/data/", &fjson);
  if (data1.val[5]=="save" || data2.val[5]=="save" || data3.val[5]=="save") {
    forceSaveLog = true;
  }
}

// Baca Data dari Firebase
void readDataFirebase() {
  if (Firebase.RTDB.getJSON(&fbdo, "/config")) {
    FirebaseJson json = fbdo.to<FirebaseJson>();
    FirebaseJsonData result;
    mode = (json.get(result, "mode")) ? result.to<String>() : mode;
    if (mode == "a") {
      if (now.hour() >= 18 && now.hour() <= 23) {       // Jam >= 18 DAN <= 23
(Kondisi yang memenuhi: 18.00 - 23.59)
        pwmControl = "1|1|1";
      } else if (now.hour() >= 0 && now.hour() <= 5) {  // Jam >= 0 DAN <=
5   (Kondisi yang memenuhi: 00.00 - 05.59)
        pwmControl = "0.5|0.5|0.5";
        if (now.hour() == 5 && now.minute() > 30) {     // Jam lewat 05.30, lampu
mati
          pwmControl = "0|0|0";
        }
      } else {                                          // Selain
itu          (Kondisi yang memenuhi: 06.00 - 17.59)
        pwmControl = "0|0|0";
      }
    } else {
      pwmControl = (json.get(result, "pwm")) ? result.to<String>() : pwmControl;
    }
    broadcastData = mode+pwmControl;
  }
}
```

```
void saveLog() {
  HTTPClient http;
  http.begin(saveLogServer.c_str());
  int httpResponseCode = http.GET();
  if (httpResponseCode == 200) {
    Serial.println(" BERHASIL");
  } else {
    Serial.println(" GAGAL");
  }
  http.end();
}

void setup() {
  Serial.begin(115200);
  while(!Serial);

  initWiFi();
  initFirebase();

  if (!rtc.begin()) {
    Serial.println("Tidak ada RTC terpasang");
    while (1);
  }

  syncTime();

  LoRa.setPins(csPin, resetPin, irqPin);
  if (!LoRa.begin(frequency)) {
    Serial.println("Inisialisasi LoRa gagal");
    while (1);
  }
  LoRa.onReceive(onReceive);
  LoRa.onTxDone(onTxDone);
  LoRa_rxMode();

  Serial.println("READY");
```

```
}

void loop() {
  now = rtc.now();
  if (runEvery(10000)) {
    char formatRTC[] = "YYYYMMDD-hh:mm:ss";

    saveDataFirebase();
    readDataFirebase();

    Serial.println("=======================================");
    Serial.println(now.toString(formatRTC));

    Serial.println("Node #1: " + dataNode1);
    Serial.println("Node #2: " + dataNode2);
    Serial.println("Node #3: " + dataNode3);

    Serial.println("CONFIG: " + mode + " " + pwmControl);
    Serial.println("=======================================");
    Serial.println("");

    LoRa_sendMessage(broadcastData);
  }

  if (now.minute() != lastSaveLog.minute() || forceSaveLog) {
    forceSaveLog = false;
    lastSaveLog = now;
    Serial.println("--------------------");
    Serial.print("Saving LOG...");
    saveLog();
    Serial.println("--------------------");
    Serial.println("");
  }
}

void LoRa_rxMode(){
  LoRa.disableInvertIQ();
```

```
  LoRa.receive();
}

void LoRa_txMode(){
  LoRa.idle();
  LoRa.enableInvertIQ();
}

void LoRa_sendMessage(String message) {
  LoRa_txMode();
  LoRa.beginPacket();
  LoRa.print(message);
  LoRa.endPacket(true);
}

void onReceive(int packetSize) {
  String message = "";

  while (LoRa.available()) {
    message += (char)LoRa.read();
  }

  String idNode = message.substring(0, 1);
  String data = message.substring(1);
  if (idNode == "1") {
    dataNode1 = data;
  } else if (idNode == "2") {
    dataNode2 = data;
  } else if (idNode == "3") {
    dataNode3 = data;
  }
}

void onTxDone() {
  LoRa_rxMode();
}
```

```
boolean runEvery(unsigned long interval){
  static unsigned long previousMillis = 0;
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= interval)
  {
    previousMillis = currentMillis;
    return true;
  }
  return false;
}

DataArray parseData(String data) {
  DataArray dataArray;
  int indexArray = 0;
  while (data.length() > 0) {
    int separator = data.indexOf("|");
    if (separator == -1) {
      dataArray.val[indexArray++] = data;
      break;
    } else {
      dataArray.val[indexArray++] = data.substring(0, separator);
      data = data.substring(separator+1);
    }
  }
  return dataArray;
}
```

Kontrol lampu jalan

```
#include <SPI.h>
#include <LoRa.h>
#include <Wire.h>
#include <Adafruit_INA219.h>

Adafruit_INA219 inaSensor;

const int mosfetPin = 6;
int mosfetPWM = 0;
float mosfetPercent = mosfetPWM/255;

const int ldrPin = A1;
float ldrValue = 0;
float ldrThreshold = 0.3;

float voltage = 0;
float current = 0;
float power = 0;

const long frequency = 433E6;
const int csPin = 10;
const int resetPin = 9;
const int irqPin = 2;

String mode = "a";
String loraNode = "1";

bool forceSaveLog = false;
unsigned long currentTime = 0;
unsigned long previousOutputTime = 0;

void setup() {
  Serial.begin(115200);
  while (!Serial);
```

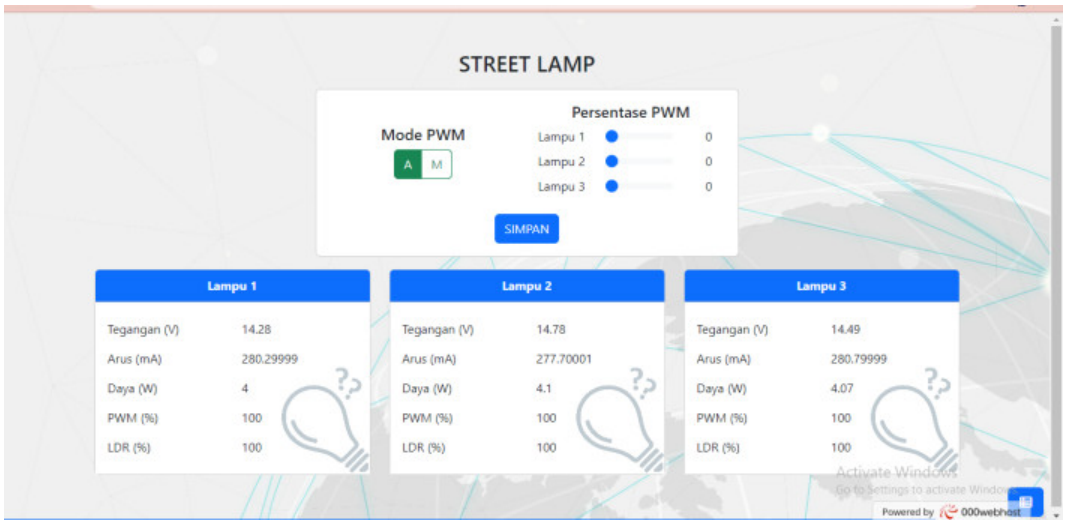
```
  pinMode(mosfetPin, OUTPUT);
  analogWrite(mosfetPin, mosfetPWM);

  if (!inaSensor.begin()) {
    Serial.println("Sensor INA219 tidak ditemukan");
    while(1);
  }

  LoRa.setPins(csPin, resetPin, irqPin);
  if (!LoRa.begin(frequency)) {
    Serial.println("Inisialisasi LoRa gagal");
    while (1);
  }
  LoRa.onReceive(onReceive);
  LoRa.onTxDone(onTxDone);
  LoRa_rxMode();

  Serial.println("READY");
}

void loop() {
  voltage = inaSensor.getBusVoltage_V();
  voltage = (voltage < 0) ? 0 : voltage;
  current = inaSensor.getCurrent_mA();
  current = (current < 0) ? 0 : current;
  power = voltage * (current/1000);
  power = (power < 0) ? 0 : power;
  mosfetPercent = (float)mosfetPWM / 255;
  ldrValue = (float)analogRead(ldrPin) / 1023;

  if (runEvery(3000)) {
    String message = loraNode;
    message += String(voltage, 2) + "|";
    message += String(current, 2) + "|";
    message += String(power, 2) + "|";
    message += String(mosfetPercent, 2) + "|";
    if (forceSaveLog) {
```

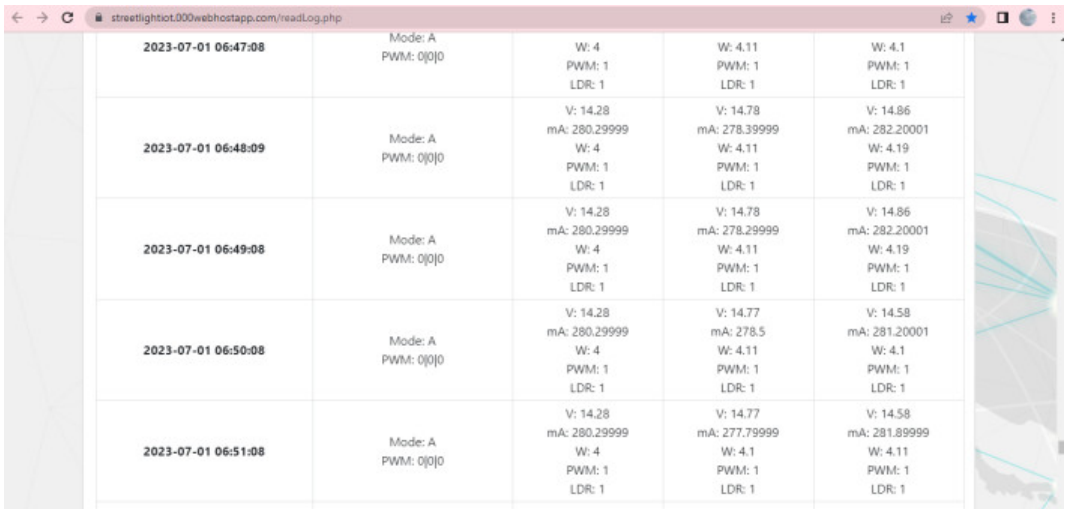
```
      message += String(ldrValue, 2) + "|";
      message += "save";
    } else {
      message += String(ldrValue, 2);
    }
    Serial.print("#"+loraNode+" ");
    Serial.println(message.substring(1));

    LoRa_sendMessage(message);
  }

  if (mode == "a" && ldrValue <= ldrThreshold) {
    mosfetPWM = ldrValue * 255;
    forceSaveLog = true;
    currentTime = millis();
    if (currentTime - previousOutputTime >= 1000) {
      previousOutputTime = millis();
      Serial.print("Mode LDR Aktif... ");
      Serial.println(String(voltage, 2) + "V|" + String(current, 2) + "ma|" +
String(power, 2) + "W|" + String(mosfetPercent*100, 2) + "%(PWM)|" +
String(ldrValue*100, 2) + "%(LDR)");
    }
  } else {
    forceSaveLog = false;
  }

  if (mosfetPWM > 255) {
    mosfetPWM = 255;
  } else if (mosfetPWM < 0) {
    mosfetPWM = 0;
  }

  analogWrite(mosfetPin, mosfetPWM);
}

void LoRa_rxMode(){
  LoRa.enableInvertIQ();
```

```
  LoRa.receive();
}

void LoRa_txMode(){
  LoRa.idle();
  LoRa.disableInvertIQ();
}

void LoRa_sendMessage(String message) {
  LoRa_txMode();
  LoRa.beginPacket();
  LoRa.print(message);
  LoRa.endPacket(true);
}

void onReceive(int packetSize) {
  String message = "";

  while (LoRa.available()) {
    message += (char)LoRa.read();
  }

  mode = message.substring(0, 1);
  String pwmControl = message.substring(1);
  Serial.println("CONFIG: " + mode + " " + pwmControl);
  int separator = pwmControl.indexOf("|");
  if (loraNode == "1") {
    pwmControl = pwmControl.substring(0, separator);
  } else if (loraNode == "2") {
    pwmControl = pwmControl.substring(separator+1);
    separator = pwmControl.indexOf("|");
    pwmControl = pwmControl.substring(0, separator);
  } else if (loraNode == "3") {
    pwmControl = pwmControl.substring(separator+1);
    separator = pwmControl.indexOf("|");
    pwmControl = pwmControl.substring(separator+1);
    separator = pwmControl.indexOf("|");
```

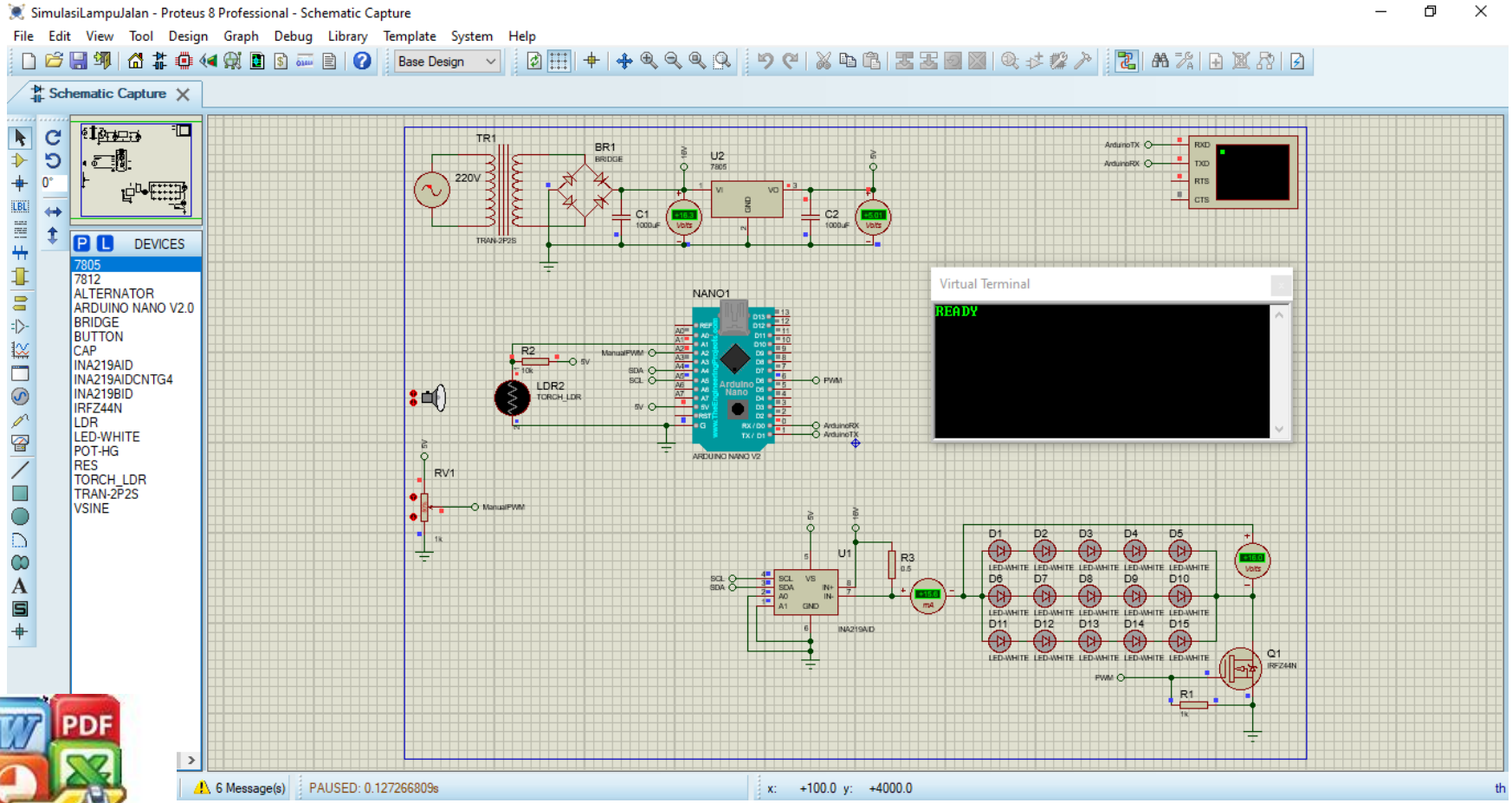
```
    pwmControl = pwmControl.substring(0, separator);
  }
  mosfetPWM = pwmControl.toFloat() * 255;
}

void onTxDone() {
  LoRa_rxMode();
}

boolean runEvery(unsigned long interval){
  static unsigned long previousMillis = 0;
  unsigned long currentMillis = millis();
  if (currentMillis - previousMillis >= interval)
  {
    previousMillis = currentMillis;
    return true;
  }
  return false;
}
```

Lampiran 6 *Monitoring* dan *database*

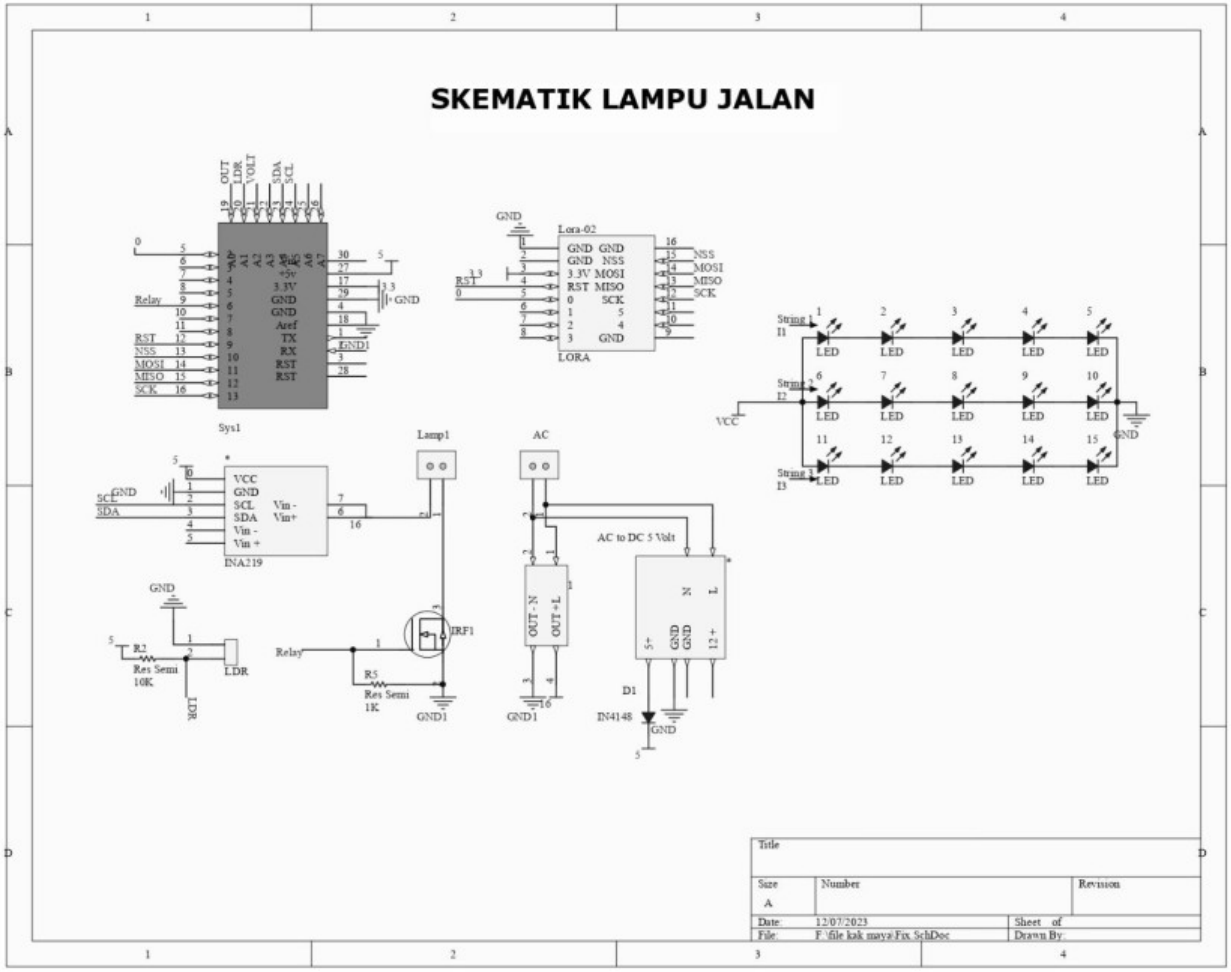




Lampiran 7 Rangkaian simulasi proteus 8 professional



Lampiran 8 Skematik lampu jalan



Lampiran 9 Skematik kontrol utama lampu jalan