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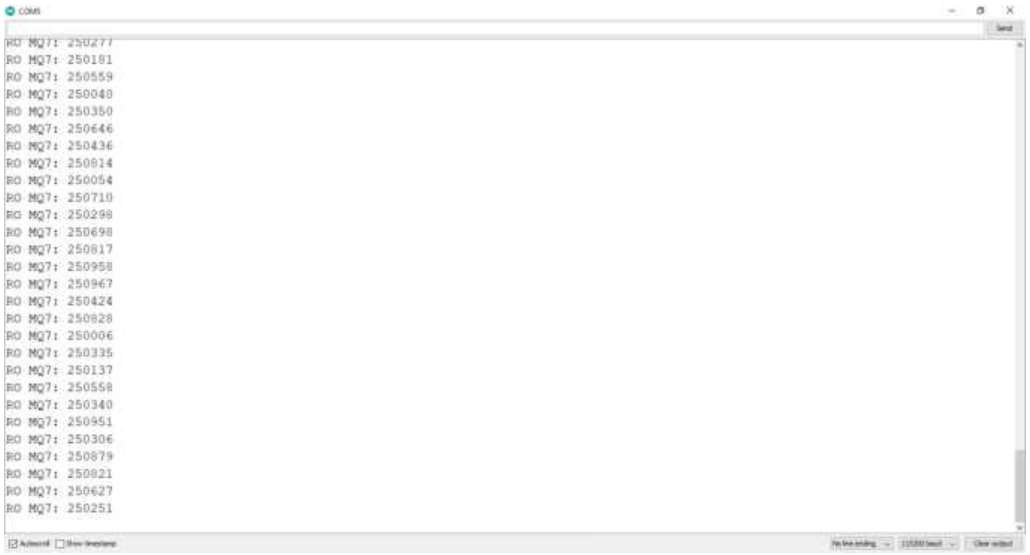
# LAMPIRAN

Lampiran 1 Kode program untuk mendapatkan nilai $R_O$ sensor MQ-7

Program dibawah ini merupakan program yang di*upload* ke Mappi32 untuk mendapatkan nilai $R_O$ sensor MQ-7.

```
#define RL_CO 10 // Nilai RL sensor = 10K
int adcMQ7 = 0;
float VRL_CO = 0;
float Rs_CO = 0;
int R0_CO = 0;

void setup() {
  Serial.begin(115200);
}

void loop() {
  for (int test_cycle = 1; test_cycle <= 500; test_cycle++) {
    adcMQ7 = adcMQ7 + analogRead(33);
  }
  adcMQ7 = adcMQ7 / 500.0;
  VRL_CO = adcMQ7 * (3.3 / 1023.0);
  Rs_CO = ((3.3 / VRL_CO) - 1) * RL_CO;
  R0_CO = static_cast<int>(Rs_CO / 25.63 * 100); // Multiply by 100 for two decimal places
  Serial.print("RO MQ7:  ");
  Serial.println(R0_CO / 100.0); // Divide by 100.0 to display the original value with two decimal places
  delay(1000);
```

Lampiran 2 Hasil nilai $R_O$ sensor MQ-7




Penentuan nilai $R_O$ adalah dengan melihat nilai yang stabil atau nilai yang paling sering muncul. Pada gambar diatas dapat dilihat bahwa nilai $R_O$ yang diperoleh pada sensor MQ-7 adalah 250000 Ω.

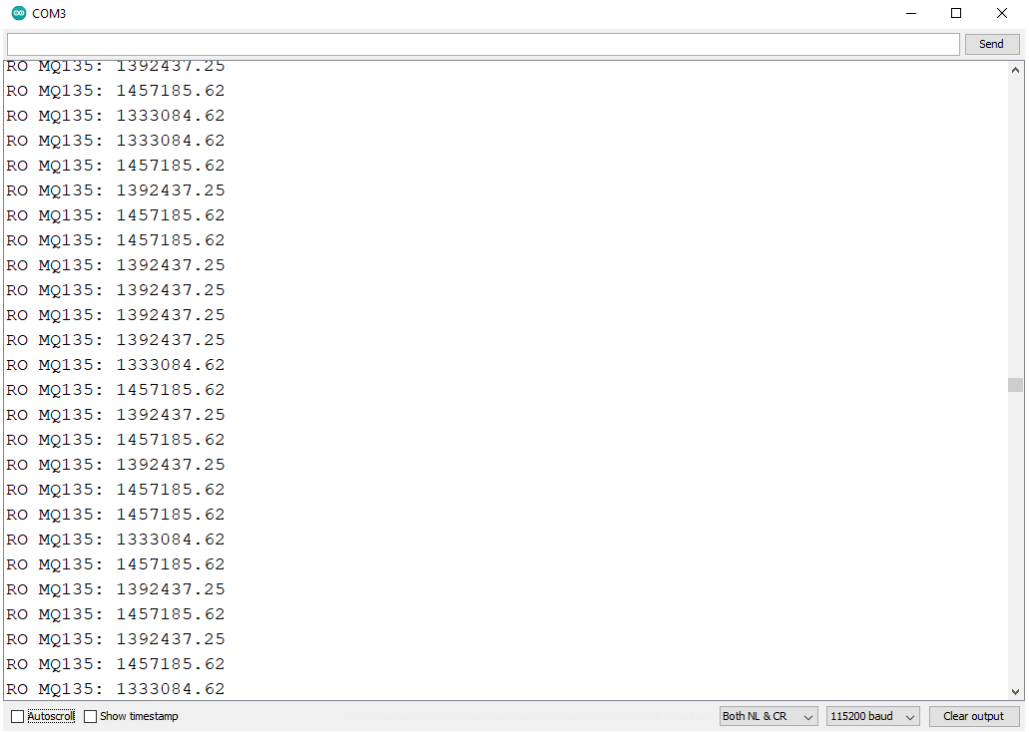
Lampiran 3 Kode program untuk mendapatkan nilai $R_O$ sensor MQ-135

Program dibawah ini merupakan program yang di*upload* ke Mappi32 untuk mendapatkan nilai $R_O$ sensor MQ-135.

```
#include <Wire.h>
#include <AverageValue.h>
int MQ135Pin=34;
int Rload = 20000; // Nilai RL sensor = 20K
double ppmMQ135=499.00; // Nilai CO2 terkalibrasi pada alat referensi
float a_2 = 112.8562882;
float b_2 = -2.870595918;
const long MAX_VALUES_NUM = 10;
AverageValue<long> averageValue(MAX_VALUES_NUM);
void setup() {
        gin(115200);
```

```
void loop() {
float adcMQ135 = analogRead(MQ135Pin);
float rs = ((1023.0 * Rload) / adcMQ135) - Rload;
float R0_CO2 = rs * exp(log(a_2/ppmMQ135) / b_2 );
averageValue.push(R0_CO2);
Serial.print("RO MQ135: ");
Serial.println(averageValue.average());
delay(1000);
}
```

Lampiran 4 Hasil nilai $R_O$ sensor MQ-135




Penentuan nilai $R_O$ adalah dengan melihat nilai yang stabil atau nilai yang paling sering muncul. Pada gambar diatas dapat dilihat bahwa nilai $R_O$ yang diperoleh pada sensor adalah 1300000 Ω.

ı 5 Kode program untuk *end-device*

<SimpleKalmanFilter.h>

ılmanFilter Kalman_s1(4, 2, 0.1);

```
SimpleKalmanFilter Kalman_s2(10, 4, 0.1);

#include "Wire.h"
#include <SPI.h>
#include <LoRa.h>
#include "DHT.h"

// untuk pengetesan kalman filter lewat serial plotter----------------------------------
const long SERIAL_REFRESH_TIME = 100;
long refresh_time;
//-------------------------------------------------------------------------------------------
unsigned long waktu_sebelumnya = 0;

/* Inisialisasi Sensor MQ-7 */
#define RL_1 10000     //Nilai RL 10K
#define m -0.57846  //Nilai Slope dari datasheet
#define b 1.07298   //Nilai intercept dari datasheet
#define r0_1 250000
//nilai Ro = Nilai Rs pada CO kadar 100ppm,
int MQ7Pin = 33;

/* Inisialisasi Sensor MQ-135 */
int MQ135Pin = 34;
int RL_2 = 20000;  // Nilai RL 20K
float rO_2 = 1300000;  //Nilai RO untuk sensor (dengan RL 20K) (pakai resistor divider), semakin besar nilai RO maka ppm juga semakin besar
double ppmMQ135 = 436.00; // Nilai CO2 Terkalibrasi

//MQ135 Coefficient Value
                = 112.8562882;
                = -2.870595918;
```

```
//sensor suhu DHT
#define DHTPIN 17
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);

//define the pins used by the transceiver module
#define ss 15
#define rst 0
#define dio0 27


void setup()
{
  Serial.begin(115200);
  dht.begin();

  Serial.println("1");
  while (!Serial);
  //Serial.println("LoRa Sender");

  //setup LoRa transceiver module
  SPI.begin(14, 12, 13, 15);
  LoRa.setPins(ss, rst, dio0);

  Serial.println("==========================================");
  Serial.println("End-Device Sistem Monitoring Kualitas Udara");
  Serial.println("==========================================");
  delay(3000);
```


```
      LoRa.begin(921E6)) {
      println("LoRa Initializing Failed!");
      println("");
```

```
    delay(1000);
  }
  // Change sync word (0xF3) to match the receiver
  // The sync word assures you don't get LoRa messages from other LoRa
transceivers
  // ranges from 0-0xFF
  LoRa.setSyncWord(0xF3);
  Serial.println("LoRa Initializing OK!");
  Serial.println("");
  analogReadResolution(10); //resolution 10bit
  delay(1000);
}

void loop()
{

  //mq7 sensor----------------------------------------------------------------------------
  int adcMQ7Pin = analogRead(MQ7Pin);
  float VRL = adcMQ7Pin * (3.3 / 1023.0); // measure the voltage drop and convert
to 0 - 3.3V
  float rs_1 = ((3.3 * RL_1) / VRL) - RL_1;  // rumus mencari nilai Rs
  float ratio = rs_1 / r0_1;                  // mencari ratio Rs/Ro
  float ppmMQ7 = pow(10, ((log10(ratio) - b) / m));  // rumus perhitungan dalam
satuan ppm
  float ppmMQ7_filtered = Kalman_s1.updateEstimate(ppmMQ7);
  if (ppmMQ7_filtered > 700) {
    ppmMQ7_filtered = 700;
  }
  if (ppmMQ7_filtered < 0.01) {
    )7_filtered = 0.01;
```

```
  //mq135 sensor----------------------------------------------------------------------------
  int adcMQ135 = analogRead(MQ135Pin);
  double rs_2 = ((1023.0 * RL_2) / adcMQ135) - RL_2; // rumus mencari nilai Rs
  float rSrO = rs_2 / rO_2;                          // mencari ratio RS/RO
  float ppmMQ135 = a_2 * pow((float)rs_2 / (float)rO_2, b_2); //disable ketika
mencari nilai RO
  float ppmMQ135_filtered = Kalman_s2.updateEstimate(ppmMQ135);
  if (ppmMQ135_filtered > 4000) {
    ppmMQ135_filtered = 4000;
  }

  //*
  if (millis() > refresh_time) {
    /*
      Serial.print(ppmMQ7, 4);  //ganti variable dengan yg akan di test
      Serial.print(",");
      Serial.print(ppmMQ7_filtered, 4);  //ganti variable dengan yg akan di test
      Serial.println();
    */
    /*
      Serial.print(ppmMQ135, 4);  //ganti variable dengan yg akan di test
      Serial.print(",");
      Serial.print(ppmMQ135_filtered, 4);  //ganti variable dengan yg akan di test
      Serial.println();
    */
    refresh_time = millis() + SERIAL_REFRESH_TIME;
  }
  //*/
  //gunakan Serial Ploter untuk visualization-----------------------------------------
```

```
ısor----------------------------------------------------------------------------
lht.readHumidity();
```

```
  // Read temperature as Celsius (the default)
  int t = dht.readTemperature();
  // Read temperature as Fahrenheit (isFahrenheit = true)
  int f = dht.readTemperature(true);

  // Check if any reads failed and exit early (to try again).
  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println(F("Failed to read from DHT sensor!"));
    return;
  }
  //dht sensor-----------------------------------------------------------------------------

  LoRa.beginPacket();
  if (millis() - waktu_sebelumnya > 1000) {
    waktu_sebelumnya = millis();
    //send to node---------------------------------------------------------------------------
    String sendData = (String() + h + "/" + t + "/" + ppmMQ7_filtered + "/" +
ppmMQ135_filtered);
    //Serial.println(sendData);
    LoRa.print(sendData);
    //send to node---------------------------------------------------------------------------

    //serial print---------------------------------------------------------------------------
    //*
    Serial.println(String() + "CO: " + ppmMQ7_filtered + " ppm || " + "CO2: " +
ppmMQ135_filtered + " ppm || " + "Suhu: " + t + " °C || " + "Kelembaban: " + h +
" % ");
    //*/
    //serial print---------------------------------------------------------------------------
```



ıdPacket();

```
  //delay(1000);
}
```

Lampiran 6 Kode program untuk *gateway*

```
#include <WiFi.h>
#include "secrets.h"
#include "ThingSpeak.h"
char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int keyIndex = 0;
WiFiClient client;
unsigned long myChannelNumber = SECRET_CH_ID;
const char* myWriteAPIKey = SECRET_WRITE_APIKEY;

#include <SPI.h>
#include <LoRa.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);  //0x3f.0x27
byte derajat[8] = {
  B00000,
  B10000,
  B01110,
  B10001,
  B10000,
  B10000,
  B10001,
  B01110
```

he pins used by the transceiver module

s 15

```
#define rst 0
#define dio0 27

int Humidity;
int Temperature;
int ppmMQ7_display; // Integer value for LCD display
int ppmMQ135_display; // Integer value for LCD display
float ppmMQ7;
float ppmMQ135;
int rssi;

unsigned long waktu_sebelumnya = 0;
unsigned long timer = 0;

void setup() {
  //initialize Serial Monitor
  Serial.begin(115200);

  while (!Serial) {
    ;
  }
  WiFi.mode(WIFI_STA);
  ThingSpeak.begin(client);

  lcd.init();
  // lcd.begin();
  lcd.backlight();
  lcd.createChar(1, derajat);
```



```
  Serial)

  println("LoRa Receiver");
```

```
//setup LoRa transceiver module
SPI.begin(14, 12, 13, 15);
LoRa.setPins(ss, rst, dio0);

lcd.setCursor(0, 0);
lcd.print("====================");
lcd.setCursor(0, 1);
lcd.print(" SISTEM  MONITORING");
lcd.setCursor(0, 2);
lcd.print("   KUALITAS UDARA");
lcd.setCursor(0, 3);
lcd.print("====================");
Serial.println("========================================");
Serial.println("Gateway Sistem Monitoring Kualitas Udara");
Serial.println("========================================");
delay(3000);
lcd.clear();

lcd.setCursor(0, 0);
lcd.print("====================");
lcd.setCursor(0, 1);
lcd.print(" M. INDRA KURNIAWAN");
lcd.setCursor(0, 2);
lcd.print("     D041201126");
lcd.setCursor(0, 3);
lcd.print("====================");
delay(2000);
lcd.clear();
```




```
LoRa.begin(921E6)) {
Cursor(0, 0);
```

```
    lcd.print("====================");
    lcd.setCursor(0, 1);
    lcd.print(" LoRa  Initializing");
    lcd.setCursor(0, 2);
    lcd.print("       FAILED");
    lcd.setCursor(0, 3);
    lcd.print("====================");
    delay(1000);
    lcd.clear();
  }
  LoRa.setSyncWord(0xF3);

  lcd.setCursor(0, 0);
  lcd.print("====================");
  lcd.setCursor(0, 1);
  lcd.print(" LoRa  Initializing");
  lcd.setCursor(0, 2);
  lcd.print("        OK");
  lcd.setCursor(0, 3);
  lcd.print("====================");
  Serial.println("LoRa Initializing OK!");
  Serial.println();
  delay(1000);
  lcd.clear();
}

void loop() {
  // try to parse packet
  int packetSize = LoRa.parsePacket();
                   etSize) {
                   ved a packet
                   LoRa.available()) {
```

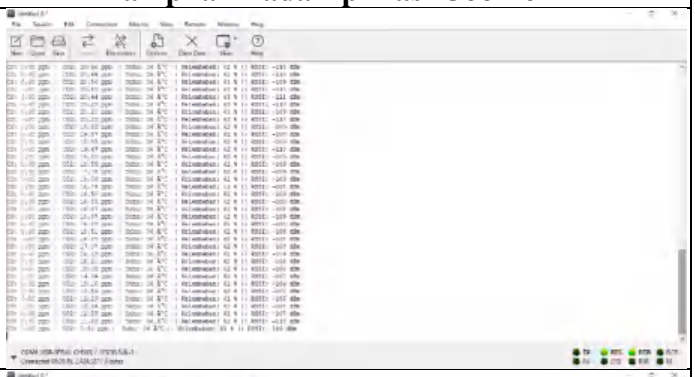
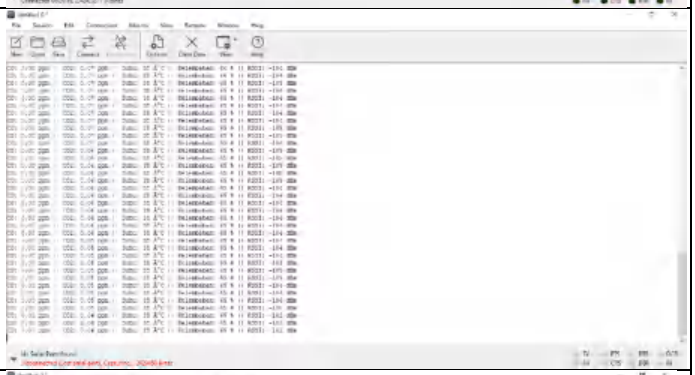
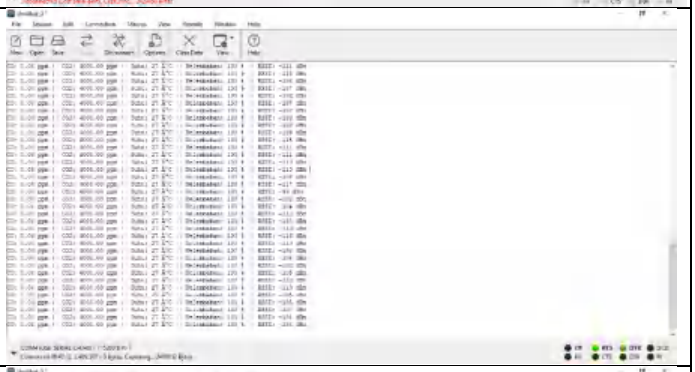
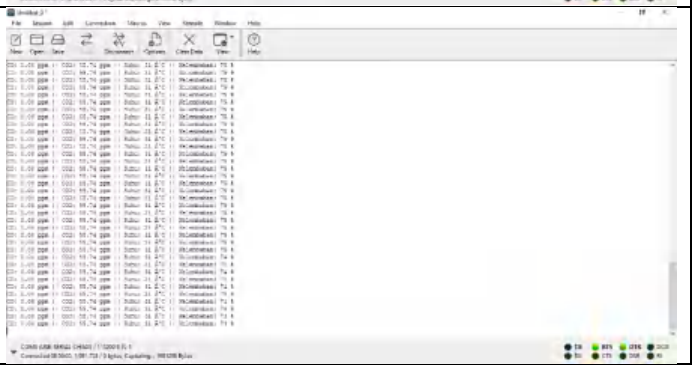
```
// Ukur QoS
unsigned long start = micros();
LoRa.beginPacket();

//start = micros();
rssi = LoRa.packetRssi();
//end = micros();

String receivingData = LoRa.readString();
//Serial.println(receivingData);
String substring1 = getValue(receivingData, '/', 0);
String substring2 = getValue(receivingData, '/', 1);
String substring3 = getValue(receivingData, '/', 2);
String substring4 = getValue(receivingData, '/', 3);

Humidity = substring1.toInt();
Temperature = substring2.toInt();
ppmMQ7 = substring3.toFloat();
ppmMQ135 = substring4.toFloat();
ppmMQ7_display = static_cast<int>(ppmMQ7);
ppmMQ135_display = static_cast<int>(ppmMQ135);

if (millis() - waktu_sebelumnya > 1000) {
  waktu_sebelumnya = millis();
  //serial print----------------------------------------------------------------------
  Serial.println(String() + "CO: " + ppmMQ7 + " ppm || " + "CO2: " +
ppmMQ135 + " ppm || " + "Suhu: " + Temperature + " °C || " + "Kelembaban: " +
Humidity + " % || " + "RSSI: " + rssi + " dBm ");
```

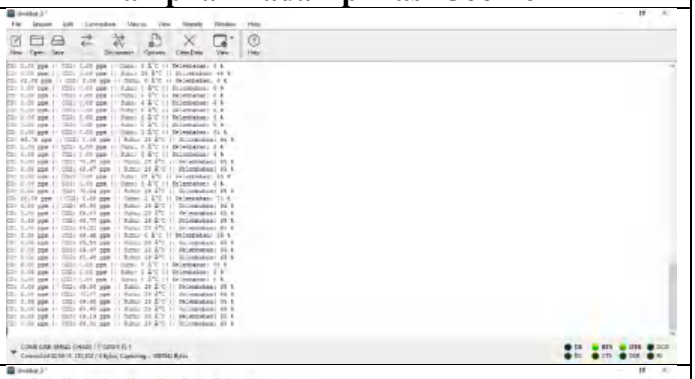
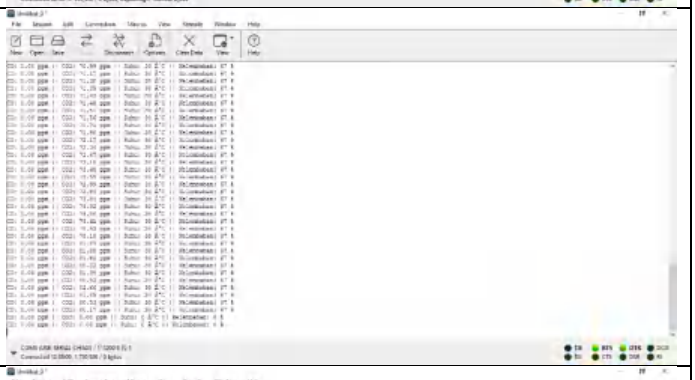
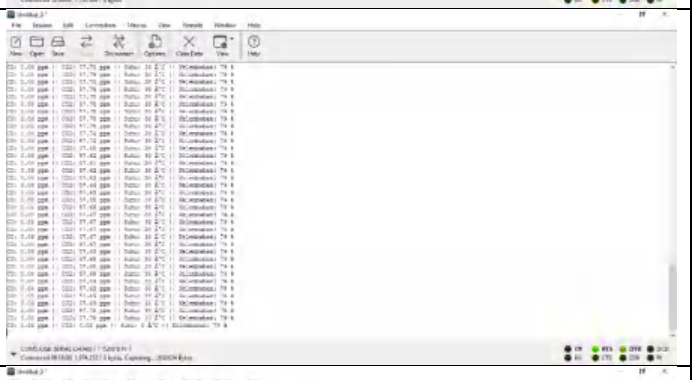
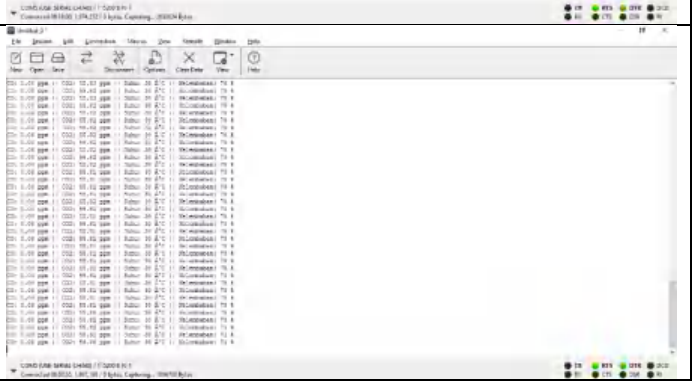
```
lcd.clear();
lcd.setCursor(0, 0);
lcd.print(String() + "CO        : " + ppmMQ7_display + " ppm    ");
lcd.setCursor(0, 1);
lcd.print(String() + "CO2       : " + ppmMQ135_display + " ppm    ");
lcd.setCursor(0, 2);
lcd.print(String() + "Suhu      : " + Temperature + " ");
lcd.write(1);
lcd.print(" ");
lcd.setCursor(0, 3);
lcd.print(String() + "Kelembaban: " + Humidity + " % ");
//lcd print---------------------------------------------------------------------------

timer = timer + 1;
//Serial.println(String() + "Timer: " + timer + " detik");
if (timer >= 30) {

 if (WiFi.status() != WL_CONNECTED) {
  //Serial.print("Attempting to connect to SSID: ");
  //Serial.println(SECRET_SSID);
  while (WiFi.status() != WL_CONNECTED) {
   WiFi.begin(ssid, pass);
   //Serial.print(".");
   delay(5000);
  }
  //Serial.println("\nConnected!");
 }

 //Serial.println("Mengirimkan Data ke Thingspeak");
    ingSpeak.setField(1, ppmMQ7);
    ingSpeak.setField(2, ppmMQ135);
    ingSpeak.setField(3, Temperature);
```

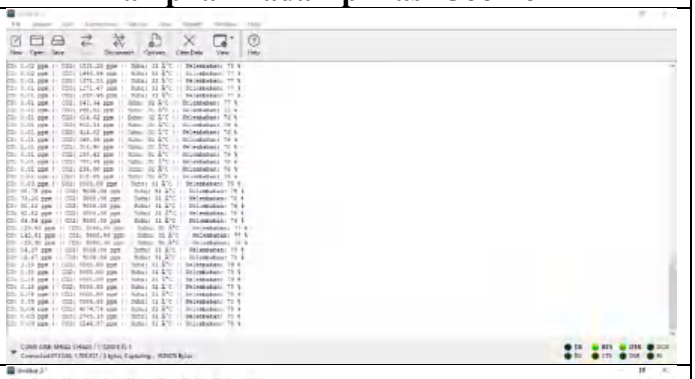
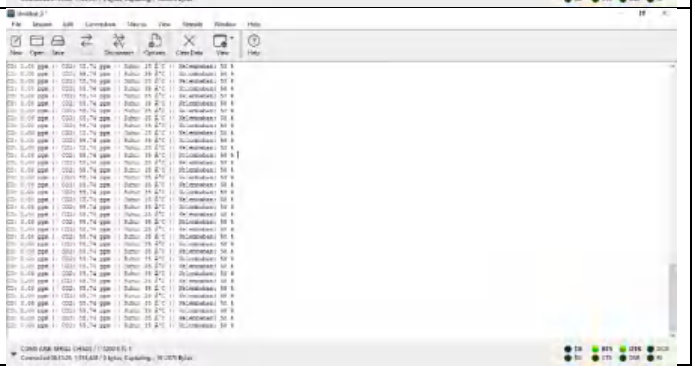
```
        ThingSpeak.setField(4, Humidity);

        int x = ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);
        if (x == 200) {
          //Serial.println("Channel update successful.");
        } else {
          //Serial.println("Problem updating channel. HTTP error code " + String(x));
        }

        timer = 0;
      }
    }

    LoRa.endPacket();
    //unsigned long end = micros();
    //delay_ms = (end - start) / 1000;
  }
 }
}

String getValue(String data, char separator, int index) {
 int found = 0;
 int strIndex[] = { 0, -1 };
 int maxIndex = data.length() - 1;

 for (int i = 0; i <= maxIndex && found <= index; i++) {
  if (data.charAt(i) == separator || i == maxIndex) {
   found++;
   strIndex[0] = strIndex[1] + 1;
        lex[1] = (i == maxIndex) ? i + 1 : i;
```

```
  return found > index ? data.substring(strIndex[0], strIndex[1]) : "";
}
```

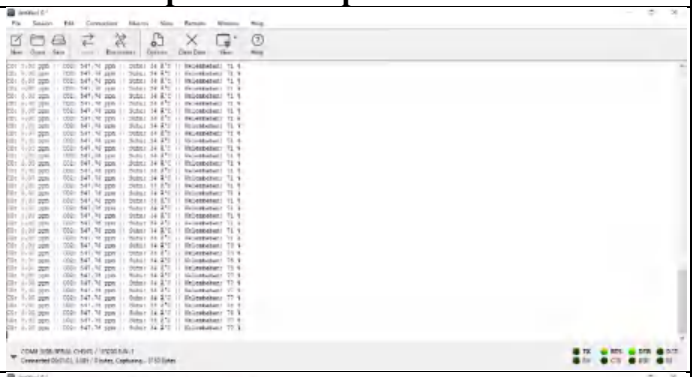
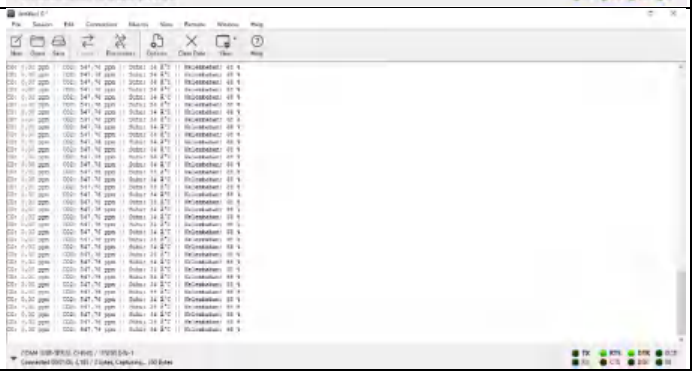
Lampiran 7 Data pengujian alat – kondisi libur semester

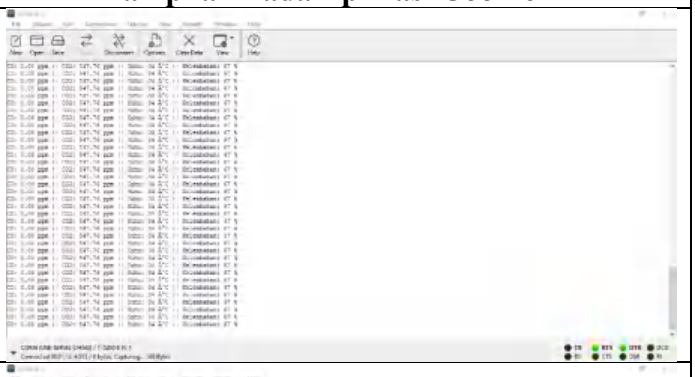
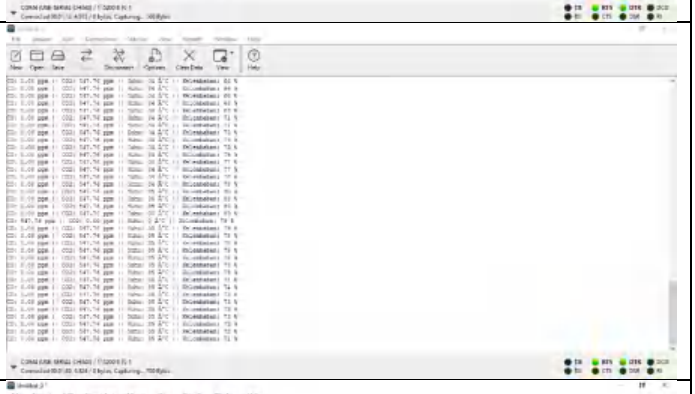
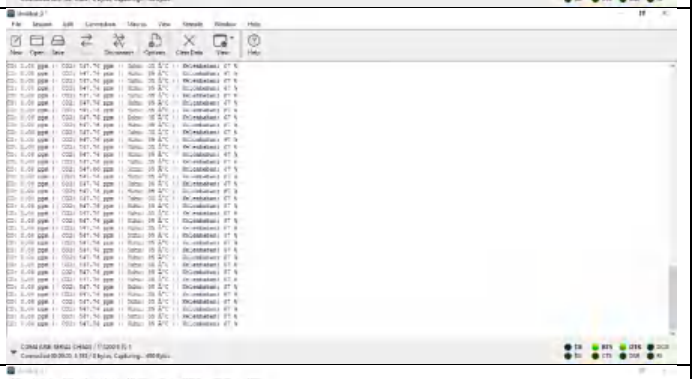
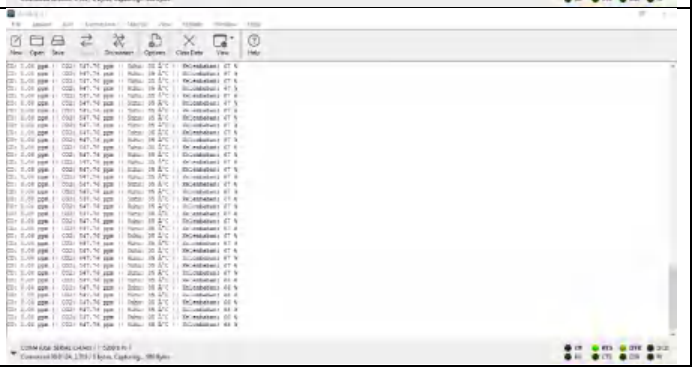
| Lokasi | Tanggal | Tampilan Pada Aplikasi CoolTerm |
|---|---|---|
| Gedung Elektro | Selasa, 9 Januari 2024 |  |
| | Rabu, 10 Januari 2024 |  |
| Gedung Sipil | Kamis, 11 Januari 2024 |  |
| | Jum'at, 12 Januari 2024 |  |

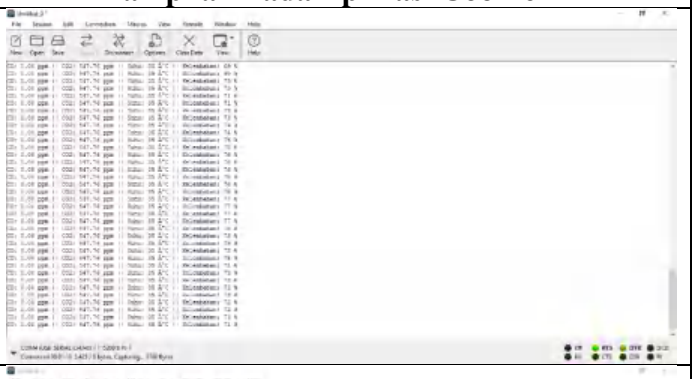
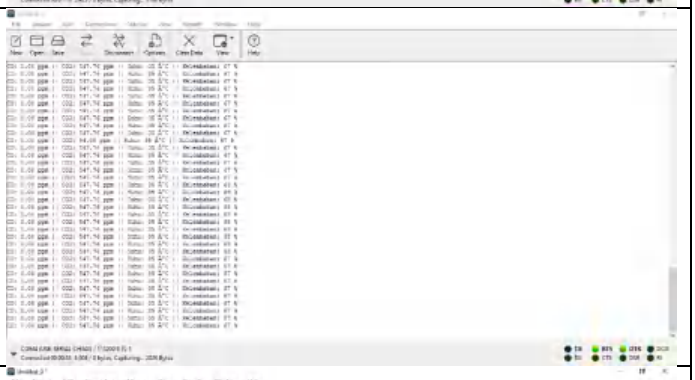
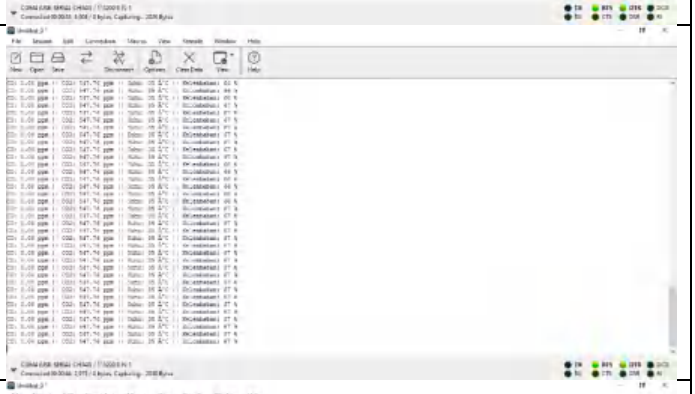
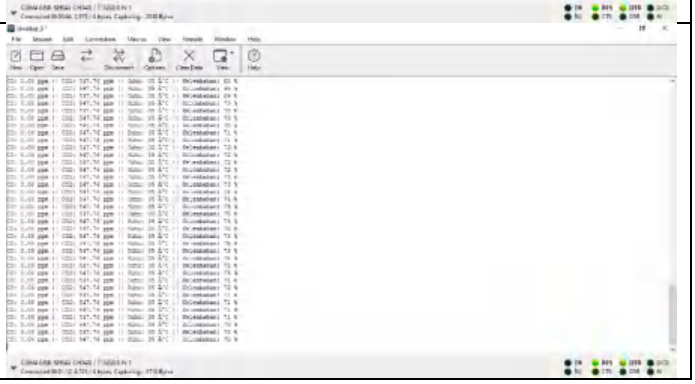
| Lokasi | Tanggal | Tampilan Pada Aplikasi CoolTerm |
|---|---|---|
| Gedung Geologi | Rabu, 17 Januari 2024 |  |
| | Kamis, 18 Januari 2024 |  |
| Gedung Mesin | Jum'at, 19 Januari 2024 |  |
| | Selasa, 23 Januari 2024 |  |

| Lokasi | Tanggal | Tampilan Pada Aplikasi CoolTerm |
|---|---|---|
| Gedung Perkapalan | Rabu, 24 Januari 2024 |  |
| | Kamis, 25 Januari 2024 |  |

Lampiran 8 Data pengujian alat – kondisi perkuliahan

| Lokasi | Tanggal | Tampilan Pada Aplikasi CoolTerm |
|---|---|---|
| Gedung Elektro | Kamis, 22 Februari 2024 |  |
| | Jum'at, 23 Februari 2024 |  |

| Lokasi | Tanggal | Tampilan Pada Aplikasi CoolTerm |
|---|---|---|
| Gedung Sipil | Senin, 25 Februari 2024 |  |
| | Selasa, 26 Februari 2024 |  |
| Gedung Geologi | Rabu, 27 Februari 2024 |  |
| | Kamis, 28 Februari 2024 |  |

| Lokasi | Tanggal | Tampilan Pada Aplikasi CoolTerm |
|---|---|---|
| Gedung Mesin | Jum'at, 29 Februari 2024 |  |
| | Senin, 1 Maret 2024 |  |
| Gedung Perkapalan | Selasa, 2 Maret 2024 |  |
| | Rabu, 3 Maret 2024 |  |

Lampiran 9 Perhitungan *delay* LoRa

| Lokasi | Perhitungan *Delay* | |
|---|---|---|
| Elektro | Waktu Kirim | 11:00:52.027 |
| | Waktu Terima | 11:00:52.142 |
| | ***Delay* (ms)** | **115** |

| Lokasi | Perhitungan *Delay* | |
|---|---|---|
| Mesin | Waktu Kirim | 14:47:49.354 |
| | Waktu Terima | 14:47:49.674 |
| | ***Delay* (ms)** | **320** |
| Sipil | Waktu Kirim | 11:15:10.532 |
| | Waktu Terima | 11:15:10.672 |
| | ***Delay* (ms)** | **140** |
| Geologi | Waktu Kirim | 14:11:00.890 |
| | Waktu Terima | 14:11:01.148 |
| | ***Delay* (ms)** | **258** |
| Perkapalan | Waktu Kirim | 14:27:35.770 |
| | Waktu Terima | 14:27:36.094 |
| | ***Delay* (ms)** | **324** |
| Classroom 1 | Waktu Kirim | 15:12:52.087 |
| | Waktu Terima | Tidak Terukur |
| | ***Delay* (ms)** | **Tidak Terukur** |
| Classroom 2 | Waktu Kirim | 12:40:58.402 |
| | Waktu Terima | Tidak Terukur |
| | ***Delay* (ms)** | **Tidak Terukur** |
| Parkiran Utama | Waktu Kirim | 14:02:26.000 |
| | Waktu Terima | Tidak Terukur |
| | ***Delay* (ms)** | **Tidak Terukur** |

Lampiran 10 Perhitungan *throughput* dan *packet loss*

| Parameter | Parkiran Gedung | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Elektro | Mesin | Sipil | Geologi | Perkapalan | Classroom | | Parkiran Utama |
| | | | | | | Parkiran Mobil | Parkiran Motor | |
| Mulai Pengamatan | 11:00:52 | 14:47:49 | 11:15:10 | 14:11:00 | 14:27:35 | 15:12:52 | 12:40:58 | 14:02:26 |
| Selesai Pengamatan | 11:05:58 | 14:52:59 | 11:20:21 | 14:16:06 | 14:32:48 | 15:18:07 | 12:46:08 | 14:07:43 |
| Lama Pengamatan (s) | 306 | 310 | 311 | 306 | 313 | 315 | 310 | 317 |
| Total Length (bits) | 175256 | 177304 | 176328 | 178040 | 179712 | 179336 | 180192 | 182328 |
| **Throughput (bps)** | **572.73** | **571.95** | **566.97** | **581.83** | **574.16** | **569.32** | **581.26** | **575.17** |
| Paket Terkirim | 305 | 309 | 310 | 303 | 310 | 314 | 307 | 314 |
| Paket Diterima | 289 | 300 | 296 | 292 | 286 | 0 | 0 | 0 |
| **Packet Loss (%)** | **5** | **3** | **5** | **4** | **8** | **100** | **100** | **100** |

Lampiran 11 Perhitungan RSSI

| | RSSI (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Elektro | Sipil | Geologi | Perkapalan | Mesin | Classroom | | Parkiran Utama |
| | | | | | | 1 | 2 | |
| | -107 | -97 | -105 | -118 | -111 | - | - | - |
| | -104 | -98 | -100 | -118 | -111 | - | - | - |

| No. | RSSI (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Elektro | Sipil | Geologi | Perkapalan | Mesin | Classroom | | Parkiran Utama |
| | | | | | | 1 | 2 | |
| 3 | -101 | -100 | -104 | -118 | -110 | - | - | - |
| 4 | -107 | -98 | -101 | -118 | -107 | - | - | - |
| 5 | -104 | -100 | -108 | -119 | -108 | - | - | - |
| 6 | -103 | -100 | -101 | -119 | -110 | - | - | - |
| 7 | -107 | -99 | -100 | -119 | -112 | - | - | - |
| 8 | -107 | -97 | -109 | -118 | -109 | - | - | - |
| 9 | -106 | -96 | -114 | -118 | -110 | - | - | - |
| 10 | -104 | -96 | -116 | -120 | -110 | - | - | - |
| 11 | -106 | -101 | -102 | -119 | -112 | - | - | - |
| 12 | -102 | -98 | -101 | -119 | -110 | - | - | - |
| 13 | -107 | -91 | -104 | -118 | -109 | - | - | - |
| 14 | -105 | -95 | -103 | -118 | -109 | - | - | - |
| 15 | -108 | -95 | -101 | -118 | -110 | - | - | - |
| 16 | -107 | -93 | -99 | -119 | -111 | - | - | - |
| 17 | -108 | -94 | -101 | -120 | -111 | - | - | - |
| 18 | -109 | -93 | -104 | -119 | -113 | - | - | - |
| 19 | -108 | -92 | -103 | -119 | -115 | - | - | - |
| 20 | -109 | -93 | -108 | -119 | -113 | - | - | - |
| 21 | -109 | -93 | -111 | -119 | -110 | - | - | - |
| 22 | -109 | -92 | -107 | -119 | -110 | - | - | - |
| 23 | -109 | -95 | -108 | -119 | -110 | - | - | - |
| 24 | -113 | -92 | -105 | -118 | -109 | - | - | - |
| 25 | -108 | -93 | -105 | -119 | -108 | - | - | - |
| 26 | -107 | -94 | -104 | -118 | -109 | - | - | - |
| 27 | -106 | -93 | -104 | -119 | -109 | - | - | - |
| 28 | -106 | -93 | -106 | -118 | -109 | - | - | - |
| 29 | -115 | -95 | -103 | -117 | -110 | - | - | - |
| 30 | -101 | -95 | -103 | -118 | -112 | - | - | - |
| 31 | -105 | -93 | -105 | -118 | -110 | - | - | - |
| 32 | -104 | -93 | -104 | -118 | -110 | - | - | - |
| 33 | -104 | -94 | -107 | -118 | -111 | - | - | - |
| 34 | -103 | -92 | -101 | -117 | -110 | - | - | - |
| 35 | -104 | -92 | -103 | -117 | -110 | - | - | - |
| 36 | -106 | -93 | -104 | -118 | -111 | - | - | - |
| | -108 | -92 | -96 | -118 | -111 | - | - | - |
| | -110 | -92 | -95 | -118 | -111 | - | - | - |
| | -110 | -92 | -97 | -118 | -111 | - | - | - |
| | -110 | -92 | -97 | -118 | -111 | - | - | - |

| No. | RSSI (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Elektro | Sipil | Geologi | Perkapalan | Mesin | Classroom | | Parkiran Utama |
| | | | | | | 1 | 2 | |
| 41 | -101 | -92 | -95 | -118 | -111 | - | - | - |
| 42 | -101 | -92 | -98 | -119 | -110 | - | - | - |
| 43 | -101 | -93 | -101 | -119 | -110 | - | - | - |
| 44 | -102 | -93 | -102 | -117 | -110 | - | - | - |
| 45 | -103 | -92 | -100 | -118 | -111 | - | - | - |
| 46 | -101 | -92 | -101 | -118 | -111 | - | - | - |
| 47 | -100 | -92 | -102 | -118 | -110 | - | - | - |
| 48 | -102 | -93 | -102 | -117 | -110 | - | - | - |
| 49 | -109 | -92 | -100 | -118 | -111 | - | - | - |
| 50 | -107 | -92 | -98 | -117 | -111 | - | - | - |
| 51 | -106 | -91 | -100 | -117 | -110 | - | - | - |
| 52 | -101 | -92 | -96 | -117 | -111 | - | - | - |
| 53 | -100 | -91 | -95 | -117 | -111 | - | - | - |
| 54 | -107 | -92 | -95 | -117 | -111 | - | - | - |
| 55 | -100 | -93 | -96 | -118 | -110 | - | - | - |
| 56 | -105 | -93 | -97 | -119 | -110 | - | - | - |
| 57 | -108 | -93 | -96 | -117 | -110 | - | - | - |
| 58 | -111 | -94 | -98 | -117 | -110 | - | - | - |
| 59 | -110 | -92 | -99 | -118 | -110 | - | - | - |
| 60 | -106 | -91 | -97 | -119 | -110 | - | - | - |
| 61 | -113 | -93 | -98 | -120 | -110 | - | - | - |
| 62 | -103 | -93 | -102 | -118 | -110 | - | - | - |
| 63 | -100 | -93 | -99 | -118 | -110 | - | - | - |
| 64 | -101 | -92 | -103 | -119 | -110 | - | - | - |
| 65 | -101 | -92 | -103 | -119 | -111 | - | - | - |
| 66 | -102 | -92 | -98 | -118 | -110 | - | - | - |
| 67 | -102 | -92 | -99 | -118 | -109 | - | - | - |
| 68 | -101 | -92 | -98 | -117 | -110 | - | - | - |
| 69 | -103 | -92 | -95 | -118 | -109 | - | - | - |
| 70 | -102 | -92 | -96 | -119 | -110 | - | - | - |
| 71 | -102 | -91 | -97 | -118 | -110 | - | - | - |
| 72 | -103 | -92 | -96 | -118 | -110 | - | - | - |
| 73 | -104 | -92 | -96 | -118 | -110 | - | - | - |
| 74 | -104 | -93 | -97 | -118 | -109 | - | - | - |
| | -106 | -91 | -98 | -116 | -110 | - | - | - |
| | -107 | -92 | -101 | -118 | -110 | - | - | - |
| | -103 | -91 | -101 | -118 | -110 | - | - | - |
| | -105 | -91 | -99 | -118 | -110 | - | - | - |

| No. | RSSI (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Elektro | Sipil | Geologi | Perkapalan | Mesin | Classroom | | Parkiran Utama |
| | | | | | | 1 | 2 | |
| 79 | -103 | -91 | -97 | -118 | -110 | - | - | - |
| 80 | -103 | -91 | -97 | -117 | -111 | - | - | - |
| 81 | -104 | -91 | -96 | -118 | -110 | - | - | - |
| 82 | -104 | -92 | -96 | -117 | -110 | - | - | - |
| 83 | -103 | -93 | -96 | -117 | -110 | - | - | - |
| 84 | -104 | -92 | -96 | -118 | -111 | - | - | - |
| 85 | -104 | -94 | -95 | -117 | -111 | - | - | - |
| 86 | -104 | -93 | -96 | -118 | -110 | - | - | - |
| 87 | -104 | -93 | -96 | -118 | -110 | - | - | - |
| 88 | -104 | -93 | -98 | -119 | -111 | - | - | - |
| 89 | -104 | -94 | -101 | -118 | -110 | - | - | - |
| 90 | -110 | -95 | -101 | -119 | -111 | - | - | - |
| 91 | -104 | -94 | -100 | -118 | -112 | - | - | - |
| 92 | -103 | -92 | -100 | -117 | -111 | - | - | - |
| 93 | -105 | -93 | -98 | -116 | -111 | - | - | - |
| 94 | -102 | -91 | -100 | -117 | -111 | - | - | - |
| 95 | -104 | -94 | -99 | -118 | -110 | - | - | - |
| 96 | -103 | -93 | -101 | -117 | -111 | - | - | - |
| 97 | -102 | -93 | -100 | -118 | -111 | - | - | - |
| 98 | -101 | -93 | -101 | -118 | -111 | - | - | - |
| 99 | -104 | -94 | -100 | -118 | -111 | - | - | - |
| 100 | -101 | -93 | -96 | -118 | -112 | - | - | - |
| 101 | -109 | -93 | -96 | -118 | -111 | - | - | - |
| 102 | -113 | -91 | -95 | -118 | -110 | - | - | - |
| 103 | -110 | -94 | -96 | -118 | -111 | - | - | - |
| 104 | -105 | -93 | -95 | -117 | -110 | - | - | - |
| 105 | -106 | -93 | -95 | -117 | -111 | - | - | - |
| 106 | -106 | -93 | -95 | -118 | -110 | - | - | - |
| 107 | -106 | -94 | -94 | -118 | -111 | - | - | - |
| 108 | -109 | -92 | -95 | -118 | -111 | - | - | - |
| 109 | -107 | -92 | -95 | -119 | -110 | - | - | - |
| 110 | -109 | -92 | -97 | -120 | -109 | - | - | - |
| 111 | -109 | -93 | -97 | -118 | -109 | - | - | - |
| 112 | -111 | -92 | -96 | -118 | -111 | - | - | - |
| | -111 | -93 | -99 | -119 | -110 | - | - | - |
| | -114 | -92 | -98 | -119 | -110 | - | - | - |
| | -101 | -92 | -100 | -119 | -109 | - | - | - |
| | -102 | -92 | -98 | -118 | -110 | - | - | - |

| No. | RSSI (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Elektro | Sipil | Geologi | Perkapalan | Mesin | Classroom | | Parkiran Utama |
| | | | | | | 1 | 2 | |
| 117 | -105 | -92 | -99 | -118 | -111 | - | - | - |
| 118 | -105 | -92 | -97 | -119 | -110 | - | - | - |
| 119 | -104 | -93 | -97 | -119 | -110 | - | - | - |
| 120 | -106 | -91 | -98 | -119 | -110 | - | - | - |
| 121 | -105 | -91 | -97 | -119 | -110 | - | - | - |
| 122 | -103 | -93 | -97 | -119 | -110 | - | - | - |
| 123 | -103 | -90 | -98 | -118 | -110 | - | - | - |
| 124 | -107 | -93 | -98 | -118 | -110 | - | - | - |
| 125 | -111 | -91 | -101 | -118 | -110 | - | - | - |
| 126 | -105 | -91 | -98 | -119 | -110 | - | - | - |
| 127 | -101 | -91 | -96 | -119 | -110 | - | - | - |
| 128 | -102 | -92 | -96 | -119 | -111 | - | - | - |
| 129 | -101 | -91 | -97 | -119 | -110 | - | - | - |
| 130 | -103 | -92 | -96 | -118 | -111 | - | - | - |
| 131 | -103 | -92 | -98 | -118 | -111 | - | - | - |
| 132 | -103 | -91 | -98 | -118 | -111 | - | - | - |
| 133 | -103 | -91 | -100 | -118 | -111 | - | - | - |
| 134 | -103 | -91 | -100 | -118 | -110 | - | - | - |
| 135 | -104 | -92 | -99 | -119 | -111 | - | - | - |
| 136 | -105 | -92 | -98 | -119 | -110 | - | - | - |
| 137 | -104 | -92 | -98 | -118 | -110 | - | - | - |
| 138 | -104 | -91 | -98 | -116 | -109 | - | - | - |
| 139 | -104 | -92 | -98 | -118 | -109 | - | - | - |
| 140 | -102 | -92 | -98 | -119 | -110 | - | - | - |
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| 233 | -102 | -92 | | -118 | -112 | - | - | - |
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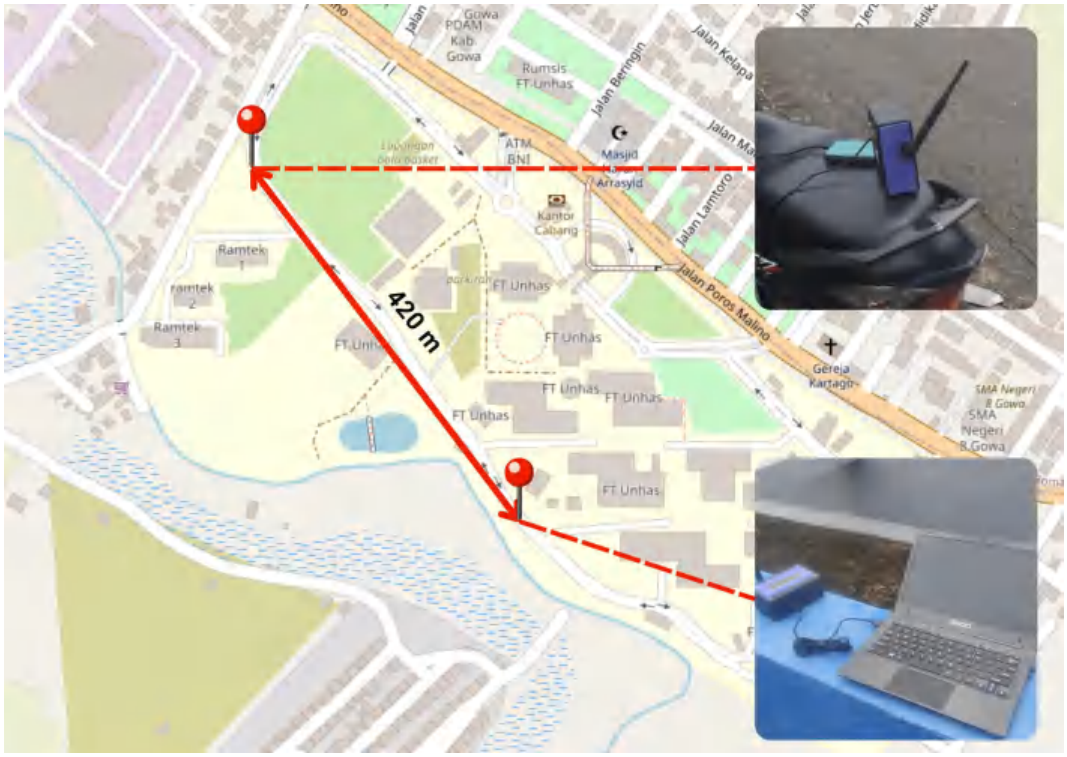
| **Rata-Rata** | **-105** | **-93** | **-100** | **-118** | **-110** | **Tidak Terukur** | **Tidak Terukur** | **Tidak Terukur** |

Lampiran 12 Pengujian untuk daerah *line of sight*




| Jenis Pengujian | Kategori | |
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| **Percobaan** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | **Rata-Rata** |
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| **RSSI (dBm)** | -225 | -225 | -225 | -225 | -225 | -225 | -225 | -225 | -225 | -224 | -224 | -224 | -223 | -223 | -223 | **-224.4** |