

LAMPIRAN A
DATA PENGUJIAN

Hasil Pengujian Sensor Tegangan

No	Voltmeter (V)	Sensor Tegangan 1 (V)	Sensor Tegangan 2 (V)	%Error Sensor Tegangan 1	%Error Sensor Tegangan 1
1	15	15.05	14.95	0.33	0.33
2	15,5	15.55	15.52	0.32	0.12
3	16	16.07	16.12	0.43	0.74
4	16,5	16.58	16.68	0.48	1
5	17	17.1	17.14	0.58	0.81
6	17,5	17.45	17.68	0.51	1.02
7	18	17.8	17.9	1.1	0.55
8	18,5	18.62	18.45	0.64	0.27
9	19	19.07	19.13	0.52	0.67
10	19,5	19.6	19.39	0.51	0.56
11	20	20.18	20.12	0.89	0.59
Rata-rata				0.63	0.66

Hasil Pengujian Sensor Arus

No	Amperemeter (A)	Sensor Arus 1 (A)	Sensor Arus 2 (A)	%Error Sensor Arus 1	%Error Sensor Arus 2
1	5.5	5.56	5.54	1.09	0.72
2	6	6.04	6.06	0.66	1
3	6.5	6.54	6.56	0.61	0.92
4	7	7.05	7.06	0.71	0.85
5	7.5	7.59	7.58	1.2	1
6	8	8.09	8.12	1.12	1.5
7	8.5	8.58	8.58	0.94	0.94
8	9	9.08	9.08	0.88	0.88
9	9.5	9.6	9.6	1	1
10	10	10.11	10.13	1.1	1.3
Rata-rata				0.931	1.01

Hasil Pengujian Sensor Suhu

No	Termometer (°C)	Sensor Suhu 1 (°C)	Sensor Suhu 2 (°C)	%Error Sensor Suhu 1	%Error Sensor Suhu 2
1	6	6	6	0	0

2	7	7	7	0	0
3	8	8	8	0	0
4	9	9	9	0	0
5	10	10.01	10.03	0.1	0.3
6	61	62	63	1.66	3.22
7	65	66.8	67.25	2.76	3.64
8	71	73	72.8	2.81	2.53
9	75	76.5	77.56	2	3.41
10	78	80.15	80.87	2.75	3.67
Rata-rata				1.208	1.67

Keterangan :

PV1 : Panel Surya Lama

PV2 : Panel Surya Baru

Hasil Pengukuran Daya Output Cuaca Cerah Berawan

Tanggal	Waktu	Radiasi Matahari (W/m ²)	Arus PV1 (A)	Arus PV2 (A)	Suhu PV1 (°C)	Suhu PV2 (°C)	Tegangan PV1 (V)	Tegangan PV2 (V)	Daya PV1 (W)	Daya PV2 (W)
28-10-2022	08:00:00	363.8	2.675	4.301	38.9	39.5	37.247	38.123	80.46	132.4
28-10-2022	09:00:00	527.9	3.899	6.558	41.3	42.8	37.096	38.026	116.79	201.37
28-10-2022	10:00:00	611.6	4.708	7.648	44.1	46.2	37.294	38.285	141.78	236.44
28-10-2022	11:00:00	851.6	6.69	9.134	47.1	51.6	37.182	38.003	200.86	280.3
28-10-2022	12:00:00	1081.5	7.426	10.01	51.6	54.6	37.29	38.939	223.61	311.43
28-10-2022	13:00:00	911.8	6.707	9.754	51.2	52.1	37.329	38.229	202.17	301.11
28-10-2022	14:00:00	648.4	5.162	8.312	45.2	46.9	37.135	37.963	154.79	254.81
28-10-2022	15:00:00	541.3	4.55	7.231	45.1	44.5	37.256	38.64	136.88	225.62
28-10-2022	16:00:00	131.7	1.108	1.692	39.2	38.7	36.695	37.638	32.83	51.42
28-10-2022	17:00:00	117.1	0.604	0.917	34.9	33.1	36.626	37.588	17.86	27.83

Hasil Pengukuran Daya Output Cuaca Berawan

Tanggal	Waktu	Radiasi Matahari (W/m ²)	Arus PV1 (A)	Arus PV2 (A)	Suhu PV1 (°C)	Suhu PV2 (°C)	Tegangan PV1 (V)	Tegangan PV2 (V)	Daya PV1 (W)	Daya PV2 (W)
24-10-2022	08:00:00	237.8	1.831	2.623	34.4	34.1	36.277	37.131	53.64	78.65

24-10-2022	09:00:00	357.4	2.945	4.574	35.6	36.8	36.617	37.471	87.08	138.4
24-10-2022	10:00:00	504.5	4.141	6.326	39.6	41.2	37.674	38.442	125.98	196.37
24-10-2022	11:00:00	543.5	4.266	6.584	40.5	44.3	38.148	39.012	131.41	207.41
24-10-2022	12:00:00	370.5	2.418	3.724	35.9	38.8	37.118	37.94	72.47	114.09
24-10-2022	13:00:00	751.1	5.033	7.833	42.8	45.3	37.993	38.728	154.41	244.96
24-10-2022	14:00:00	362.5	2.4	3.696	34.2	38.5	37.044	37.887	71.79	113.07
24-10-2022	15:00:00	250	1.817	2.794	33.7	35.4	36.497	37.354	53.55	84.28
24-10-2022	16:00:00	150	1.154	1.772	31.4	31.9	36.419	37.286	33.94	53.35
24-10-2022	17:00:00	75.9	0.334	0.501	28.3	30	35.255	36.107	9.51	14.61

Hasil Pengukuran Daya Output Cuaca Hujan Berawan

Tanggal	Waktu	Radiasi Matahari (W/m ²)	Arus PV1 (A)	Arus PV2 (A)	Suhu PV1 (°C)	Suhu PV2 (°C)	Tegangan PV1 (V)	Tegangan PV2 (V)	Daya PV1 (W)	Daya PV2 (W)
25-10-2022	08:00:00	107.1	0.566	0.859	25.1	26.1	36.579	37.537	16.72	26.04
25-10-2022	09:00:00	162.2	1.091	1.667	28.8	29.7	36.889	37.975	32.5	51.12
25-10-2022	10:00:00	291.3	2.502	3.678	34.1	36.9	37.006	37.821	74.77	112.33
25-10-2022	11:00:00	338.2	2.708	4.215	37.3	37.9	37.144	38.153	81.22	129.86
25-10-2022	12:00:00	633.9	4.642	7.142	43.7	45.9	36.945	37.691	138.49	217.37
25-10-2022	13:00:00	429.7	3.363	5.124	39.2	41.2	37.023	37.859	100.54	156.65
25-10-2022	14:00:00	180.4	1.517	2.128	29	31.5	36.95	37.735	45.26	64.84
25-10-2022	15:00:00	152.9	1.156	1.935	27.8	28.1	36.385	37.271	33.96	58.24
25-10-2022	16:00:00	109.7	0.607	0.917	25.8	26	36.393	37.255	17.84	27.59
25-10-2022	17:00:00	56.9	0.211	0.314	22.4	23.8	34.064	35.062	5.8	8.89

Efisiensi Panel Surya

Tanggal	Waktu	Efisiensi PV1	Efisiensi PV2
24-10-2022	08:00:00	13.89%	20.18%
24-10-2022	09:00:00	15.01%	23.63%
24-10-2022	10:00:00	15.38%	23.75%
24-10-2022	11:00:00	14.89%	23.29%
24-10-2022	12:00:00	12.05%	18.79%

24-10-2022	13:00:00	12.66%	19.90%
24-10-2022	14:00:00	12.20%	19.03%
24-10-2022	15:00:00	13.19%	20.57%
24-10-2022	16:00:00	13.93%	21.70%
24-10-2022	17:00:00	7.72%	11.74%
Rata-rata		13.09%	20.26%
25-10-2022	08:00:00	9.61%	14.83%
25-10-2022	09:00:00	12.34%	19.23%
25-10-2022	10:00:00	15.81%	23.53%
25-10-2022	11:00:00	14.79%	23.43%
25-10-2022	12:00:00	13.46%	20.92%
25-10-2022	13:00:00	14.41%	22.24%
25-10-2022	14:00:00	15.45%	21.93%
25-10-2022	15:00:00	13.68%	23.24%
25-10-2022	16:00:00	10.02%	15.34%
25-10-2022	17:00:00	6.28%	9.53%
Rata-rata		12.59%	19.42%
28-10-2022	08:00:00	13.62%	22.21%
28-10-2022	09:00:00	13.63%	23.28%
28-10-2022	10:00:00	14.28%	23.59%
28-10-2022	11:00:00	14.53%	20.08%
28-10-2022	12:00:00	12.73%	18.79%
28-10-2022	13:00:00	13.66%	20.15%
28-10-2022	14:00:00	14.70%	23.98%
28-10-2022	15:00:00	15.58%	25.43%
28-10-2022	16:00:00	15.35%	23.82%
28-10-2022	17:00:00	9.40%	14.50%
Rata-rata		13.75%	21.51%

Performa Rasio Panel Surya

Tanggal	Waktu	Performa Rasio PV1 (%)	Performa Rasio PV2 (%)
24-10-2022	08:00:00	56.11	81.1
24-10-2022	09:00:00	60.61	94.96
24-10-2022	10:00:00	62.12	95.45
24-10-2022	11:00:00	60.15	93.58
24-10-2022	12:00:00	48.66	75.51
24-10-2022	13:00:00	51.14	79.97
24-10-2022	14:00:00	49.27	76.49
24-10-2022	15:00:00	53.29	82.66
24-10-2022	16:00:00	56.28	87.22
24-10-2022	17:00:00	31.16	47.19

Rata-rata		52.879	81.413
25-10-2022	08:00:00	38.83	59.61
25-10-2022	09:00:00	49.84	77.28
25-10-2022	10:00:00	63.85	94.56
25-10-2022	11:00:00	59.75	94.15
25-10-2022	12:00:00	54.35	84.09
25-10-2022	13:00:00	58.21	89.39
25-10-2022	14:00:00	62.42	88.14
25-10-2022	15:00:00	55.26	93.4
25-10-2022	16:00:00	40.45	61.66
25-10-2022	17:00:00	25.37	38.31
Rata-rata		50.833	78.059
28-10-2022	08:00:00	55.02	89.24
28-10-2022	09:00:00	55.04	93.54
28-10-2022	10:00:00	57.67	94.8
28-10-2022	11:00:00	58.68	80.71
28-10-2022	12:00:00	51.44	72.44
28-10-2022	13:00:00	55.16	80.98
28-10-2022	14:00:00	59.39	96.36
28-10-2022	15:00:00	62.91	102.21
28-10-2022	16:00:00	62.02	95.75
28-10-2022	17:00:00	37.95	58.28
Rata-rata		55.528	86.455

LAMPIRAN B PERHITUNGAN

A. Perhitungan Efisiensi Panel Surya

Nilai efisiensi panel surya diperoleh melalui persamaan (2.5), sebagai contoh sempel perhitungan pada pukul 08:00 tanggal 24 Oktober 2022 yaitu sebagai berikut:

1. PV Lama

$$\begin{aligned} A \text{ PV Lama} & : 1,6236 \text{ m}^2 \\ G \text{ PV Lama} & : 237,8 \text{ W/m}^2 \\ P_{act} \text{ PV Lama} & : 53.64 \text{ W} \end{aligned}$$

Maka:

$$\begin{aligned} P_{in} & = G \times A \\ P_{in} & = 607 \times 1,6236 \\ P_{in} & = 386,09 \text{ W} \\ \eta_p & = \frac{P_{act}}{P_{in}} \times 100\% \\ \eta_p & = \frac{53,64}{386,09} \times 100\% \\ \eta_p & = 13,89\% \end{aligned}$$

2. PV Baru

$$\begin{aligned} A \text{ PV Baru} & : 1,6389 \text{ m}^2 \\ G \text{ PV Baru} & : 237,8 \text{ W/m}^2 \\ P_{act} \text{ PV Baru} & : 78,65 \text{ W} \end{aligned}$$

Maka:

$$\begin{aligned} P_{in} & = G \times A \\ P_{in} & = 607 \times 1,6389 \\ P_{in} & = 389,73 \text{ W} \\ \eta_p & = \frac{P_{act}}{P_{in}} \times 100\% \\ \eta_p & = \frac{78,65}{389,73} \times 100\% \\ \eta_p & = 20,18\% \end{aligned}$$

B. Perhitungan Performa Rasio

Nilai performa rasio diperoleh dari persamaan (2.6), berikut contoh perhitungan performa rasio:

1. PV Lama

Pact PV lama : 53,64 W
Pmax PV lama : 401,98 W
G PV lama : 237,8 W/m²

Maka:

$$PR = \left(\frac{Pact}{Pmax}\right) / \left(\frac{G}{1000}\right)$$

$$PR = \left(\frac{53,64}{401,98}\right) / \left(\frac{237,8}{1000}\right)$$

$$PR = \frac{0,133}{0,2378} \times 100\%$$

$$PR = 56,11\%$$

2. PV baru

Pact PV baru : 78,65 W
Pmax PV baru : 407,81 W
G PV baru : 237,8 W/m²

$$PR = \left(\frac{Pact}{Pmax}\right) / \left(\frac{G}{1000}\right)$$

$$PR = \left(\frac{78,65}{407,81}\right) / \left(\frac{237,8}{1000}\right)$$

$$PR = \frac{0,195}{0,2378} \times 100\%$$

$$PR = 81,1\%$$

LAMPIRAN C
LISTING PROGRAM

```
#define THINGER_SERIAL_DEBUG

#define SSID "UNTIRTAKU"
#define SSID_PASSWORD "untirtajawara"

#define USERNAME "trisonngobhe"
#define DEVICE_ID "NodeMCU_DATALOG"
#define DEVICE_CREDENTIAL "oc8AG4yuEpA%N_yp"

#include <Adafruit_ADS1X15.h>
#include <LiquidCrystal_PCF8574.h>
#include <Wire.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <WiFiUdp.h>
#include <NTPClient.h>
#include <TimeLib.h>
#include <SPI.h>
#include <SD.h>
// #include "PCF8574.h"
#include <ThingyESP8266.h>
#include "arduino_secrets.h"

ThingyESP8266 thing(USERNAME, DEVICE_ID, DEVICE_CREDENTIAL);

Adafruit_ADS1115 adsA, adsB;
LiquidCrystal_PCF8574 lcd(0x27);
OneWire oneWire(D4);
DallasTemperature sensors(&oneWire);

#define LOG_INTERVAL 5000
#define SYNC_INTERVAL 1000
uint32_t syncTime = 0;

// Alamat sensor suhu DS18B20
// =====
DeviceAddress sensor1 = { 0x28, 0x52, 0x94, 0x95, 0xF0, 0x01,
    0x3C, 0xC2 };
DeviceAddress sensor2 = { 0x28, 0xFF, 0xA3, 0x01, 0x00, 0x00,
    0x00, 0xBA };

// Konfigurasi Network Time Protocol
// =====
WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "pool.ntp.org", 25200, 60000);
char Time[ ] = "00:00:00";
char Date[ ] = "00-00-2000";
byte last_second, second_, minute_, hour_, day_, month_;
int year_;

// Konfigurasi SDCARD
// =====
```



```

const int chipSelect = D8;
char filename[14];
File dataFile;

// Iterasi 50 kali pengambilan data
// =====
int NUMBR_OF_SAMPLES = 50;

// Variabel sensor arus ACS712 dan Voltage divider
// =====
int16_t adc0, adc1, adc2, adc3, adc4, adc5, results;
double volts0, volts1, volts2, volts3, volts4, volts5;
double Voc1, Voc2, Voc3;
float multiplier = 0.0078125F; //
  ads1115 +/- 0.256 gain
double outpyr, irradiance;
float Vmid1 = 2.5111;
float Vmid2 = 2.5097;

// Variabel sensor Suhu DS18B20
// =====
float KalibrasiSuhu1;
float KalibrasiSuhu2;

// Convert Tipe Data Float ke String
// =====
static char ArusPV1[10];
static char ArusPV2[10];
static char TeganganPV1[10];
static char TeganganPV2[10];
static char Pyranometer[10];
static char SuhuPV1[10];
static char SuhuPV2[10];
char DATA_KESELURUHAN[200];

void setup()
{
  Serial.begin(9600);
  thing.add_wifi(SSID, SSID_PASSWORD);
  LCD_setup();
  ADS1115_setup();
  sensors.begin();
  SDCARD_setup();

  timeClient.begin();

  // Pengiriman data ke platform THINGER.IO
  // =====
  thing["DATAVOC"] >> [](pson& out) {
    out["ArusPV1"] = volts0;
    out["ArusPV2"] = volts1;
    out["TeganganPV1"] = volts3;
    out["TeganganPV2"] = volts4;
    out["SuhuPV1"] = KalibrasiSuhu1;
    out["SuhuPV2"] = KalibrasiSuhu2;
    out["Pyranometer"] = irradiance;
  };
}

```

```

void loop() {
  thing.handle();
  NTP_loop();
  sprintf(filename, "%s.txt", Date);
  dataFile = SD.open(filename, FILE_WRITE);

  delay((LOG_INTERVAL -1) - (millis() % LOG_INTERVAL));

  // Pembacaan Tegangan
  //=====
  adc3 = adsA.readADC_SingleEnded(3);
  adc4 = adsB.readADC_SingleEnded(0);
  volts3 = abs(adsA.computeVolts(adc3)*230000)/10000;
  volts4 = abs((adsB.computeVolts(adc4)*220680)/680;
  Voc1 = abs((volts3/45.2)*100);
  Voc2 = abs((volts4/40.7)*100);
  delay(10);

  dtostrf(volts3, 7, 3, TeganganPV1);
  dtostrf(volts4, 7, 3, TeganganPV2);
  //=====

  // Pembacaan arus
  //=====

  double avg0 = 0, avg1 = 0;
  volts0 = 0;
  volts1 = 0;

  for (int i = 0; i < NUMBR_OF_SAMPLES; i++){
    avg0 += adsA.computeVolts(adsA.readADC_SingleEnded(0));
    avg1 += adsA.computeVolts(adsA.readADC_SingleEnded(1));
  }
  volts0 = abs((Vmid1 - (avg0/NUMBR_OF_SAMPLES))/0.1);
  volts1 = abs((Vmid2 - (avg1/NUMBR_OF_SAMPLES))/0.1);
  delay(10);
  dtostrf(volts0, 7, 3, ArusPV1);
  dtostrf(volts1, 7, 3, ArusPV2);
  yield();

  //Pembacaan PYRANOMETER
  //=====
  results = adsB.readADC_Differential_2_3();
  outpyr = results*multiplier;
  irradiance = abs((outpyr/7)*1000);
  dtostrf(irradiance, 7, 3, Pyranometer);

  // Pembacaan Sensor Suhu DS18B20
  //=====
  sensors.requestTemperatures();
  float temp1 = sensors.getTempC(sensor1);
  float temp2 = sensors.getTempC(sensor2);
  KalibrasiSuhu1 = (((temp1-4.688)*68)/72.750)+6;
  KalibrasiSuhu2 = (((temp2-4.500)*68)/72.688)+6;
  delay(10);
  dtostrf(KalibrasiSuhu1, 7, 1, SuhuPV1);
  dtostrf(KalibrasiSuhu2, 7, 1, SuhuPV2);
  //=====

```

```

sprintf(DATA_KESELURUHAN, "| %s | %s | %s | %s | %s | %s | %s | %s |
    %s | %s | %s | %s | %s |", Date, Time, TeganganPV1,
    TeganganPV2, ArusPV1, ArusPV2, Pyaranomter, SuhuPV1,
    SuhuPV2);

if (dataFile) {
    lcd.setCursor(13,3);
    lcd.print("SD OK");
    dataFile.println(DATA_KESELURUHAN);
}
else {
    lcd.setCursor(13,3);
    lcd.print("SD NOT");
}

    lcd.setCursor(0,0);
    lcd.print("V1:");
    lcd.print(TeganganPV1);
    lcd.print("V");
    lcd.setCursor(0,1);
    lcd.print("V2:");
    lcd.print(TeganganPV2);
    lcd.print("V");
    lcd.setCursor(12,0);
    lcd.print("T1:");
    lcd.print(KalibrasiSuhu1);
    lcd.setCursor(12,1);
    lcd.print("T2:");
    lcd.print(KalibrasiSuhu2);
    lcd.print("Rad: ");
    lcd.print(Pyranometer);
    lcd.setCursor(15,2);
    lcd.print(" W/m2 ");

    if ((millis() - syncTime) < SYNC_INTERVAL) return;
    syncTime = millis();

}
void ADS1115_setup(){
    adsA.begin(0x4A);
    adsB.begin(0x4B);
    adsB.setGain(GAIN_SIXTEEN);
}
void LCD_setup(){
    Wire.begin();
    Wire.beginTransmission(0x27);
    lcd.begin(20, 4);
    lcd.setBacklight(255);
}
void NTP_loop(){
    timeClient.update();
    unsigned long unix_epoch = timeClient.getEpochTime(); // Get
    Unix epoch time from the NTP server

    second_ = second(unix_epoch);
    if (last_second != second_) {

        minute_ = minute(unix_epoch);

```

```

hour_   = hour(unix_epoch);
day_    = day(unix_epoch);
month_  = month(unix_epoch);
year_   = year(unix_epoch);

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;

Date[0] = day_    / 10 + 48;
Date[1] = day_    % 10 + 48;
Date[3] = month_  / 10 + 48;
Date[4] = month_  % 10 + 48;
Date[8] = (year_  / 10) % 10 + 48;
Date[9] = year_  % 10 % 10 + 48;
last_second = second_;
}
}
void SDCARD_setup(){
  if (!SD.begin(chipSelect)) {
    Serial.println("Card failed, or not present");
    // don't do anything more:
    return;
  }
  Serial.println("card initialized.");
}
}

```