LAMPIRAN

Lampiran 1. Perhitungan Nilai *Duty Cycle* dan Komponen *Boost Converter*

1. Menentukan nilai *Duty Cycle* dengan input 9,1 volt

   $D = 1 - \frac{V_{in\_min}}{V_{out}}$

   $D = 1 - \frac{9,1}{12}$

   $D = 0,25$

2. Menentukan nilai *Duty Cycle* dengan input 10,1 volt

   $D = 1 - \frac{V_{in\_min}}{V_{out}}$

   $D = 1 - \frac{10,1}{12}$

   $D = 0,16$

3. Menentukan nilai *Duty Cycle* dengan input 11,1 volt

   $D = 1 - \frac{V_{in\_min}}{V_{out}}$

   $D = 1 - \frac{11,1}{12}$

   $D = 0,8$

4. Menentukan nilai induktor

   $L_{min} = \frac{D(1-D)^2}{2f_s} R$

   $L_{min} = \frac{0.25(1-0,25)^2}{2\ x\ 40kHz} 2,4$

   $L_{min} = 421\ \mu H$

5. Menentukan nilai kapasitor

   $C = \frac{V_o\ x\ D}{R\ x\ \Delta V_o\ x\ f_s}$

   $C = \frac{12\ x\ 0,25}{2,4\ x\ 0,012\ x\ 40kHz}$

   $C = 26,04\ \mu F$

Lampiran 2. Kode Program Arduino

```
#define pinModBusTX         4

#include <SoftwareSerial.h>

SoftwareSerial pzem(2, 3); // RX, TX

byte perintah[] = {0x01, 0x04, 0x00, 0x00, 0x00, 0x08};//readInputRegisters
byte bufferDataModbus[100];
byte *ptr;

int PWM = 11;
int pwm = 0; // nilai awal lebar pwm
int range1 = 11.1;
int range2 = 10.1;
int range3 = 9.1;

void setup() {
  pinMode(pinModBusTX, OUTPUT);
  pinMode (PWM, OUTPUT);
  TCCR2B = TCCR2B & B11111000 | B00000001;

  Serial.begin(9600);
  Serial.println(F("Baca Sensor Tegangan"));
  Serial.println();

  pzem.begin(9600);
  ptr = bufferDataModbus;
}

void loop()
{
  uint16_t crc = calcCRC(perintah, sizeof(perintah));
  float voltage = digitalRead(pinModBusTX);
  float range1 = 11.1;
  float range2 = 10.1;
  float range3 = 9.1;

  digitalWrite(pinModBusTX, HIGH);
```

```
  delay(1);
  pzem.write(perintah, sizeof(perintah));
  pzem.write(lowByte(crc));
  pzem.write(highByte(crc));
  delay(10);
  digitalWrite(pinModBusTX, LOW);

  long millisResponModbus = millis() + 1000;
  while (!pzem.available())
  {
   if (millisResponModbus < millis())
   {
    break;//timeout
   }
  }

  while (pzem.available())
  {
   byte b = pzem.read();
   *ptr++ = b;
   delay(2);
  }

  if (memcmp(bufferDataModbus, perintah, 2) == 0)
  {
   ptr = bufferDataModbus;

   float tegangan     = ((ptr[0 + 3] << 8) + ptr[1 + 3]) * 0.01;
   float arus         = ((ptr[2 + 3] << 8) + ptr[3 + 3]) * 0.01;
   float daya         = (((uint32_t)ptr[6 + 3] << 24) + ((uint32_t)ptr[7 + 3] << 16) + (ptr[4 + 3] << 8) + ptr[5 + 3])
* 0.1;
   float energi       = (((uint32_t)ptr[10 + 3] << 24) + ((uint32_t)ptr[11 + 3] << 16) + (ptr[8 + 3] << 8) + ptr[9 +
3]);
   uint16_t alarmHigh  = ((ptr[12 + 3] << 8) + ptr[13 + 3]);
   uint16_t alarmLow   = ((ptr[14 + 3] << 8) + ptr[15 + 3]);

   memset(bufferDataModbus, 0x00, sizeof(bufferDataModbus));

   Serial.println("==========");
   Serial.print("tegangan      = ");
```

```
  Serial.println(tegangan);
  Serial.print("arus          = ");
  Serial.println(arus);
  Serial.print("daya          = ");
  Serial.println(daya);
  Serial.print("energi        = ");
  Serial.println(energi);
  Serial.print("alarmHigh     = ");
  Serial.println(alarmHigh);
  Serial.print("alarmLow      = ");
  Serial.println(alarmLow);
 }

 Serial.println();
 delay(100);

 if (voltage == range1){
  digitalWrite(pwm, 20);
  Serial.println(range1);
  Serial.print("range1        = ");
  delay(1000);
 }

 else if (voltage == range2){
  digitalWrite(pwm, 40);
  Serial.println(range2);
  Serial.print("range2        = ");
  delay(1000);
 }

  else if (voltage == range3){
  digitalWrite(pwm, 63);
  Serial.println(range3);
  Serial.print("range3        = ");
  delay(1000);
 }
  digitalWrite(PWM,pwm);
}

uint16_t calcCRC(byte *data, byte panjang)
```

```
{
  int i;
  uint16_t crc = 0xFFFF;
  for (byte p = 0; p < panjang; p++)
  {
    crc ^= data[p];
    for (i = 0; i < 8; ++i)
    {
      if (crc & 1)
        crc = (crc >> 1) ^ 0xA001;
      else
        crc = (crc >> 1);
    }
  }
  return crc;
}
```

Lampiran 3. Datasheet

1. Datasheet Arduino UNO

Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-9V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) (0.5 KB used by bootloader)
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

2. Datasheet MOSFET IRFP150N

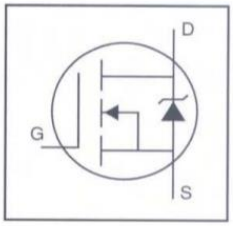
International
IOR Rectifier

PD - 95002

IRFP150NPbF

HEXFET® Power MOSFET

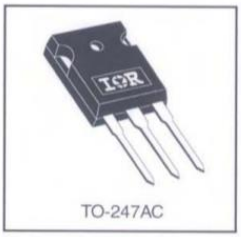
- Advanced Process Technology
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Lead-Free



V_{DSS} = 100V

$R_{DS(on)}$ = 0.036Ω

I_D = 42A



TO-247AC

Description

Fifth Generation HEXFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET Power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-247 package is preferred for commercial-industrial applications where higher power levels preclude the use of TO-220 devices. The TO-247 is similar but superior to the earlier TO-218 package because of its isolated mounting hole.

Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	42	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	30	
I_{DM}	Pulsed Drain Current ①⑤	140	
P_D @T_C = 25°C	Power Dissipation	160	W
	Linear Derating Factor	1.1	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy②⑤	420	mJ
I_{AR}	Avalanche Current①⑤	22	A
E_{AR}	Repetitive Avalanche Energy①	16	mJ
dv/dt	Peak Diode Recovery dv/dt ③⑤	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting torque, 6-32 or M3 srew	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	0.95	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient	—	40	

3. Datasheet Optocoupler PC817

HOTCHIP

PC817(D)

4 PIN DPHOTOTRANSISTOR PHOTOCOUPLER

Description

The 817 series of devices each consist of an infrared emitting diodes, optically coupled to a phototransistor detector encapsulated with green compound.The devices are in a 4-pin DIP package and available in wide-lead spacing and SMD option.

Features

- Current transfer ratio(CTR: 50~600% at IF =5mA, VCE =5V)
- High isolation voltage between inputand output (Viso=5000 V rms)
- Creepage distance >7.62 mm.
- Operating temperature up to +110℃
- Compact small outline package
- Pb free and RoHS compliant.

Schematic

Pin Configuration
1. Anode
2. Cathode
3. Emitter
4. Collector

Applications

- Programmable controllers.
- System appliances, measuring instruments.
- Telecommunication equipments.
- Home appliances, such as fan heaters, etc.
- Signal transmission between circuits of different potentials and impedances.

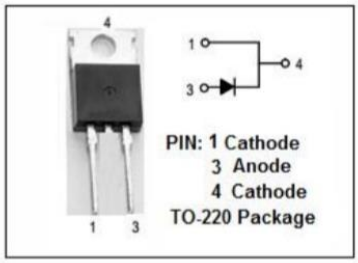
Absolute maximum ratings (Ta=25℃)

Parameter	Symbol	Rating	Unit	
Input	Forward current	IF	50	mA
	Reverse voltage	VR	6	V
	Power dissipation	PD	70	mW
	Derating factor (above Ta = 100℃)		2.9	mW/℃
Output	Power dissipation 150 mW	PC	150	mW
	Derating factor (above Ta = 100℃)		5.8	mW/℃
	Collector current	IC	50	mA
	Collector-Emitter voltage	VCEO	35	V
	Emitter-Collector voltage	VECO	6	V
Total power dissipation	PTOT	200	mW	
Isolation voltage *1	VISO	5000	V rms	
Operating temperature	Topr	-40~+110	℃	
Storage temperature	Tstg	-55~+125	℃	
Soldering temperature *2	Tsol	260	℃	

4. Datasheet Dioda MUR1560G

FEATURES

- Ultrafast 35 and 60 nanosecond recovery time
- Popular TO-220 package
- Low forward drop
- Avalanche energy rated
- 100% avalanche tested
- Minimum Lot-to-Lot variations for robust device performance and reliable operation

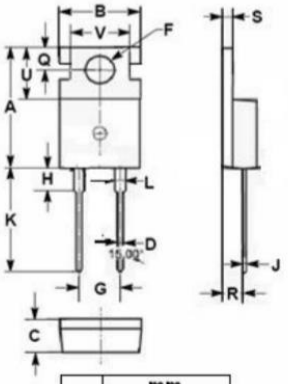


APPLICATIONS

- The MUR1560 is designed for use in switching power Supplies,inverters and as free wheeling diodes.

ABSOLUTE MAXIMUM RATINGS(T_a=25℃)

SYMBOL	PARAMETER	VALUE	UNIT
V_{RRM} V_{RWM} V_R	Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	600	V
$I_{F(AV)}$	Average Rectified Forward Current @Tc=145℃	15	A
I_{FRM}	Peak Rectified forward current @Tc=145℃	30	A
I_{FSM}	Nonrepetitive Peak Surge Current (Surge applied at rated load conditions half-wave, single phase, 60Hz)	150	A
T_J	Junction Temperature	-65~175	℃
T_{stg}	Storage Temperature Range	-65~175	℃



DIM	mm MIN	MAX
A	15.50	15.90
B	9.80	10.20
C	4.20	4.50
D	0.70	0.90
F	3.40	3.70
G	4.98	5.18
H	2.68	2.90
J	0.44	0.60
K	12.80	13.40
L	1.20	1.45
Q	2.70	2.90
R	2.30	2.70
S	1.29	1.35
U	6.45	6.65
V	8.66	8.86

5. Datasheet PZEM-003

PZEM-003/017 DC communication module

Overview

This document describes the specification of the PZEM-003/017 DC communication module, the module is mainly used for measuring DC voltage, current, active power, frequency and energy consumption, the module is without display function, the data is read through the RS485 interface.

PZEM-003: Measuring Range 10A (Built-in Shunt)

PZEM-017: Measuring Range 50A、100A、200A、300A (the current range is depend on the external shunt specification)

1. Function description

1.1 **Voltage**

1.1.1 Measuring range:0.05-300V. (when the test voltage is ＜7V, please use the independent power supply mode)

1.1.2 Resolution:0.01V.

1.1.3 Measurement accuracy:1%.

1.2 **Current**

1.2.1 Measuring range:0.01-10A(PZEM-003);0.02-300A(PZEM-017;can be matched with 50、100、200、300A four kinds of shunt).

1.2.2 Resolution:0.01A

1.2.3 Measurement accuracy:1%

1.3 **Power**

1.3.1 Measuring range:0.1-3kW(PZEM-003);0.2-90kW(PZEM-017)

1.3.2 Resolution: 0.1W

1.3.3 Measurement accuracy:1%

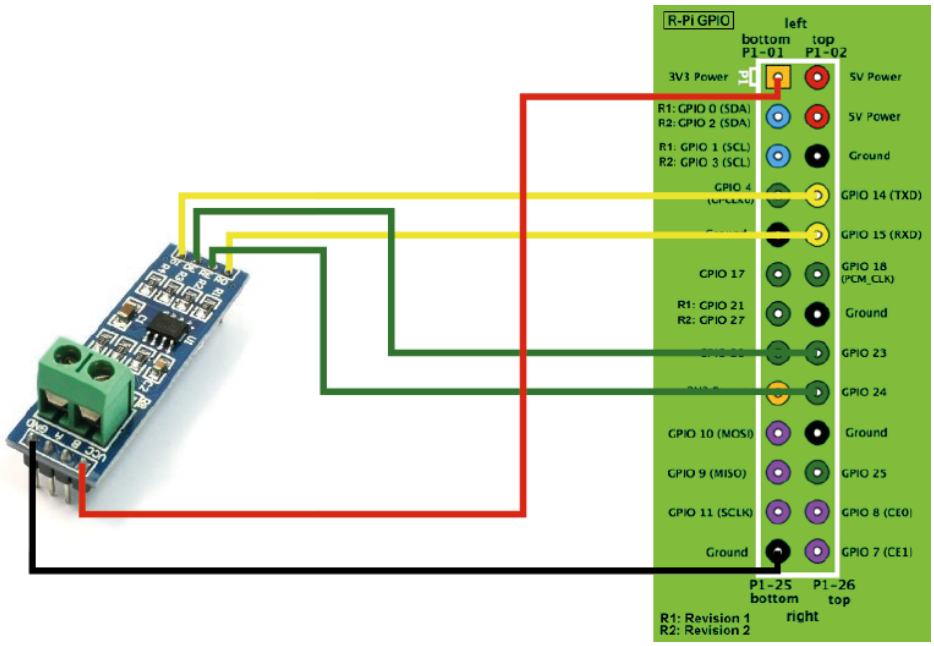
1.4 **Energy Consumption**

1.4.1 Measuring range: 0-9999kWh

1.4.2 Resolution: 1Wh

1.4.3 Measurement accuracy:1%

6. Datasheet Modul RS458



BIOGRAFI

Ahmad Rizky Darmawan lahir di Klaten, Jawa Tengah, Indonesia. Mendapatkan Pendidikan pertama SDN Domas, kemudian melanjutkan mekolah menengah pertama di SMP Sunan Giri Menganti, kemudian melanjutkan sekolah menengah atas di SMKN 1 Driyorejo. Setelah itu melanjutkan Pendidikan di perguruan tinggi Universitas 17 Agustus 1945 Surabaya di Fakultas Vokasi jurusan Teknologi Listrik. Pada semester 1 mengikuti Himpunan Mahasiswa Teknologi Listrik (HIMATEKLISTA), kemudian pada semester 5 mengikuti Badan Eksekutif Mahasiswa (BEM) Fakultas Vokasi. Akhir kata penulis mengucapkan rasa syukur yang sebesar-besarnya atas terselesaikannya Proyek Akhir yang berjudul "Pemanfaatan *Boost Converter* Untuk Memperpanjang Durasi Menyala Lampu *Emergency*".

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- Badan Eksekutif Mahasiswa Fakultas Vokasi