LAMPIRAN

Lampiran 1: Listing Program

```
#include <Keypad.h>
#include <Keypad.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#define BACKLIGHT_PIN 3
LiquidCrystal_I2C lcd(0x3F ,2,1,0,4,5,6,7,3, POSITIVE);
const int sensorIn1 = A1;
const int sensorIn2 = A2;
const int sensorIn3 = A3;
double voltage1 = 0;
double voltage2 = 0;
double voltage3 = 0;
int r1 = 22;
int r2 = 24;
int r3 = 26;
int r4 = 28;
int r5 = 32;
int r6 = 34;
int r7 = 37;
int r8 = 39;
int r9 = 40;
int r10 = 42;
int r11 = 44;
int r12 = 46;
int r13 = 48;
int r14 = 50;
const byte numRows= 4;
const byte numCols= 4;
char keymap[numRows][numCols]=
{
{'1', '2', '3', 'A'},
{'4', '5', '6', 'B'},
{'7', '8', '9', 'C'},
```

```
{'*', '0', '#', 'D'}
};
byte rowPins[numRows] = {9,8,7,6};
byte colPins[numCols]= {5,4,3,2};
Keypad myKeypad= Keypad(makeKeymap(keymap), rowPins, colPins, numRows, numCols);
void setup()
{
Serial.begin(9600);
pinMode(r1, OUTPUT);
pinMode(r2, OUTPUT);
pinMode(r3, OUTPUT);
pinMode(r4, OUTPUT);
pinMode(r5, OUTPUT);
pinMode(r6, OUTPUT);
pinMode(r7, OUTPUT);
pinMode(r8, OUTPUT);
pinMode(r9, OUTPUT);
pinMode(r10, OUTPUT);
pinMode(r11, OUTPUT);
pinMode(r12, OUTPUT);
pinMode(r13, OUTPUT);
pinMode(r14, OUTPUT);

digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
```

```
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
lcd.begin(16,2);
lcd.setCursor(0,0);
lcd.print("   REGULATOR");
lcd.setCursor(0,1);
lcd.print("   TIGA FASA");
delay(2000);
lcd.setCursor(0,0);
lcd.print(" LABORATORIUM");
lcd.setCursor(0,1);
lcd.print("MESIN ELEKTRIK");
delay(2000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("     PILIH");
lcd.setCursor(0,1);
lcd.print(" BESAR TEGANGAN");
}
float getVPP()
{
  float result;
  int readValue;
  int maxValue = 0;
  int minValue = 1024;

   uint32_t start_time = millis();
   while((millis()-start_time) < 50)
   {
      readValue = analogRead(sensorIn1);
      if (readValue > maxValue)
      {
```

```
            maxValue = readValue;
        }
        if (readValue < minValue)
        {
            minValue = readValue;
        }
    }
    result = (maxValue - minValue);
    return result;
}
float getVPP2()
{
    float result2;
    int readValue2;
    int maxValue2 = 0;
    int minValue2 = 1024;

    uint32_t start_time = millis();
    while((millis()-start_time) < 50)
    {
        readValue2 = analogRead(sensorIn2);
        if (readValue2 > maxValue2)
        {
            maxValue2 = readValue2;
        }
        if (readValue2 < minValue2)
        {
            minValue2 = readValue2;
        }
    }
    result2 = (maxValue2 - minValue2);
    return result2;
}
float getVPP3()
```

```
{
  float result3;
  int readValue3;
  int maxValue3 = 0;
  int minValue3 = 1024;

   uint32_t start_time = millis();
   while((millis()-start_time) < 50)
   {
      readValue3 = analogRead(sensorIn2);
      if (readValue3 > maxValue3)
      {
         maxValue3 = readValue3;
      }
      if (readValue3 < minValue3)
      {
         minValue3 = readValue3;
      }
   }
   result3 = (maxValue3 - minValue3);
   return result3;
   }
void tegangan()
{
  voltage1=((getVPP()-2.391)/1.0974);
  voltage2=((getVPP2()-0.3511)/1.1821);
  voltage3=((getVPP3()+0.2394)/1.0626);
}
void trip()
{
 digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
```

```
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
}
void loop()
{
char keypressed = myKeypad.getKey();
if (keypressed != NO_KEY)
{
if (keypressed == '1')
{
digitalWrite(r1, LOW);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
```

```
getVPP3();
tegangan();
delay(500);
if(voltage1>15 && voltage1<25 && voltage2>15 && voltage2<25 && voltage3>15 &&
voltage3<25)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("35 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 35 V");
}
}
if (keypressed == '2')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, LOW);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
```

```
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>40 && voltage1<51 && voltage2>40 && voltage2<51 && voltage3>40 &&
voltage3<51)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("80 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 80 V");
}
}
if (keypressed == '3')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, LOW);
digitalWrite(r4, HIGH);
```

```
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>66 && voltage1<76 && voltage2>66 && voltage2<76 && voltage3>66 &&
voltage3<76)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("123 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 123 V");
}
}
```

```
if (keypressed == 'A')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, LOW);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>69 && voltage1<79 && voltage2>69 && voltage2<79 && voltage3>69 &&
voltage3<79)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("127 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
```

```
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 127 V");
}
}
if (keypressed == '4')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, LOW);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>99 && voltage1<109 && voltage2>99 && voltage2<109 && voltage3>99 &&
voltage3<109)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
```

```
lcd.print("180 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 180 V");
}
}
if (keypressed == '5')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, LOW);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
```

```
if(voltage1>122 && voltage1<132 && voltage2>122 && voltage2<132 && voltage3>122
&& voltage3<132)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("220 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 220 V");
}
}
if (keypressed == '6')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, LOW);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
```

```
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>128 && voltage1<138 && voltage2>128 && voltage2<138 && voltage3>128
&& voltage3<138)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("230 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 230 V");
}
}
if (keypressed == 'B')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
```

```
digitalWrite(r8, LOW);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>157 && voltage1<167 && voltage2>157 && voltage2<167 && voltage3>157
&& voltage3<167)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("280 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 280 V");
}
}
if (keypressed == '7')
{
digitalWrite(r1, HIGH);
```

```
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, LOW);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>163 && voltage1<173 && voltage2>163 && voltage2<173 && voltage3>163
&& voltage3<173)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("290 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
```

```
lcd.print("PADA RELAY 290 V");
}
}
if (keypressed == '8')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, LOW);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>174 && voltage1<184 && voltage2>174 && voltage2<184 && voltage3>174
&& voltage3<184)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("310 V (AMAN)");
}
else
```

```
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 310 V");
}
}
if (keypressed == '9')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, LOW);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>186 && voltage1<196 && voltage2>186 && voltage2<196 && voltage3>186
&& voltage3<196)
{
lcd.begin (16,2);
```

```
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("330 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 330 V");
}
}
if (keypressed == 'C')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, LOW);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
```

```
tegangan();
delay(500);
if(voltage1>197 && voltage1<207 && voltage2>197 && voltage2<207 && voltage3>197
&& voltage3<207)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("350 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 350 V");
}
}
if (keypressed == '*')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
```

```
digitalWrite(r12, HIGH);
digitalWrite(r13, LOW);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>209 && voltage1<219 && voltage2>209 && voltage2<219 && voltage3>209
&& voltage3<219)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("370 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 370 V");
}
}
if (keypressed == '0')
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
```

```
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, LOW);
getVPP();
getVPP2();
getVPP3();
tegangan();
delay(500);
if(voltage1>215 && voltage1<225 && voltage2>215 && voltage2<225 && voltage3>215
&& voltage3<225)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("Besar Tegangan");
lcd.setCursor(0,1);
lcd.print("380 V (AMAN)");
}
else
{
trip();
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
lcd.print("PADA RELAY 380 V");
}
}
if (keypressed == 'D')
```

```
{
digitalWrite(r1, HIGH);
digitalWrite(r2, HIGH);
digitalWrite(r3, HIGH);
digitalWrite(r4, HIGH);
digitalWrite(r5, HIGH);
digitalWrite(r6, HIGH);
digitalWrite(r7, HIGH);
digitalWrite(r8, HIGH);
digitalWrite(r9, HIGH);
digitalWrite(r10, HIGH);
digitalWrite(r11, HIGH);
digitalWrite(r12, HIGH);
digitalWrite(r13, HIGH);
digitalWrite(r14, HIGH);
getVPP();
getVPP2();
getVPP3();
tegangan();
if(voltage1>-5 && voltage1<5 && voltage2>-5 && voltage2<5 && voltage3>-5 &&
voltage3<5)
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("RELAY");
lcd.setCursor(0,1);
lcd.print("SEMUA AMAN");
}
else
{
lcd.begin (16,2);
lcd.setCursor(0,0);
lcd.print("TERJADI GANGGUAN");
lcd.setCursor(0,1);
```

```
lcd.print("PADA RELAY");
}
}
}
}
```

Lampiran 2: Data Sheet

1. Arduino Mega R2550

Summary

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

Power

The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The Mega2560 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.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode() , digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 0 to 13.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS).** These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Uno, Duemilanove and Diecimila.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH

value, the LED is on, when the pin is LOW, it's off.

- **I2C: 20 (SDA) and 21 (SCL).** Support I2C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I2C pins on the Duemilanove or Diecimila.

The Mega2560 has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and analogReference() function.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).
A SoftwareSerial library allows for serial communication on any of the Mega2560's digital pins.
The ATmega2560 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation on the Wiring website for details. For SPI communication, use the SPI library.

2. *Keypad Membran* 4x4

4x4 Matrix Membrane Keypad (#27899)

This 16-button keypad provides a useful human interface component for microcontroller projects. Convenient adhesive backing provides a simple way to mount the keypad in a variety of applications.

Features

- Ultra-thin design
- Adhesive backing
- Excellent price/performance ratio
- Easy interface to any microcontroller
- Example programs provided for the BASIC Stamp 2 and Propeller P8X32A microcontrollers

Key Specifications

- Maximum Rating: 24 VDC, 30 mA
- Interface: 8-pin access to 4x4 matrix
- Operating temperature: 32 to 122 °F (0 to 50°C)
- Dimensions:
  Keypad, 2.7 x 3.0 in (6.9 x 7.6 cm)
  Cable: 0.78 x 3.5 in (2.0 x 8.8 cm)

Application Ideas

- Security systems
- Menu selection
- Data entry for embedded systems

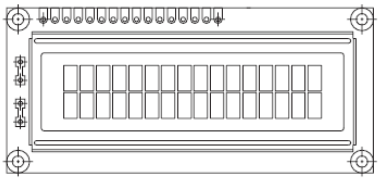
3. LCD 16x2

VISHAY

LCD-016M002B

Vishay

16 x 2 Character LCD



FEATURES

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply

MECHANICAL DATA		
ITEM	STANDARD VALUE	UNIT
Module Dimension	80.0 x 36.0	mm
Viewing Area	66.0 x 16.0	mm
Dot Size	0.56 x 0.66	mm
Character Size	2.96 x 5.56	mm

ABSOLUTE MAXIMUM RATING					
ITEM	SYMBOL	STANDARD VALUE			UNIT
		MIN.	TYP.	MAX.	
Power Supply	VDD-VSS	- 0.3	–	7.0	V
Input Voltage	VI	- 0.3	–	VDD	V

NOTE: VSS = 0 Volt, VDD = 5.0 Volt

ELECTRICAL SPECIFICATIONS							
ITEM	SYMBOL	CONDITION		STANDARD VALUE			UNIT
				MIN.	TYP.	MAX.	
Input Voltage	VDD	VDD = + 5V		4.7	5.0	5.3	V
		VDD = + 3V		2.7	3.0	5.3	V
Supply Current	IDD	VDD = 5V		–	1.2	3.0	mA
Recommended LC Driving Voltage for Normal Temp. Version Module	VDD - V0	- 20 °C		–	–	–	V
		0°C		4.2	4.8	5.1	
		25°C		3.8	4.2	4.6	
		50°C		3.6	4.0	4.4	
		70°C		–	–	–	
LED Forward Voltage	VF	25°C		–	4.2	4.6	V
LED Forward Current	IF	25°C	Array	–	130	260	mA
			Edge	–	20	40	
EL Power Supply Current	IEL	Vel = 110VAC:400Hz		–	–	5.0	mA

DISPLAY CHARACTER ADDRESS CODE:

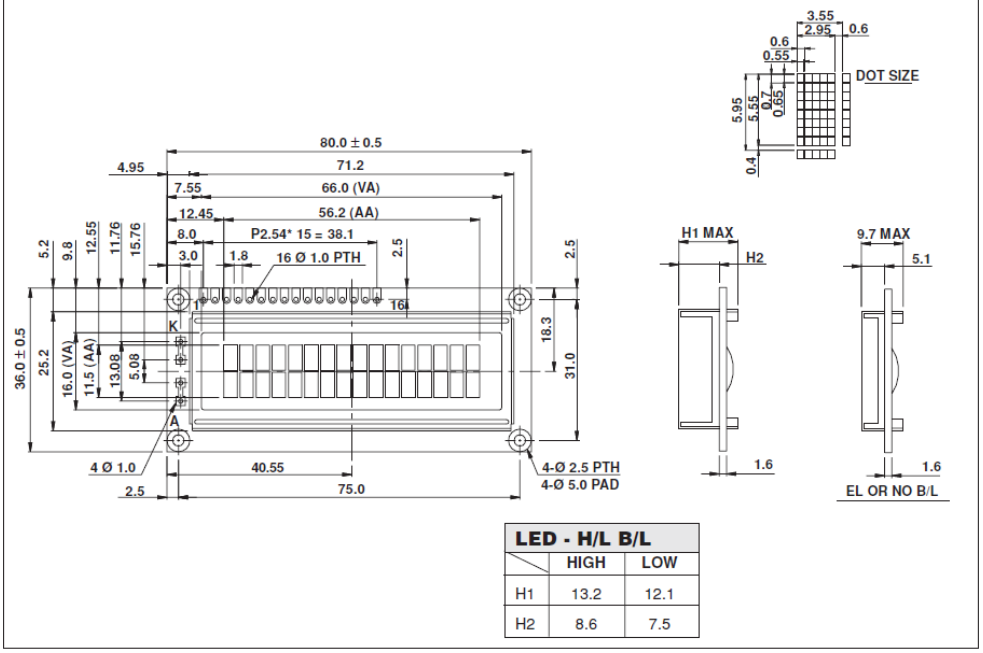
Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	00	01														0F
DD RAM Address	40	41														4F

LCD-016M002B

Vishay 16 x 2 Character LCD

PIN NUMBER	SYMBOL	FUNCTION
1	Vss	GND
2	Vdd	+ 3V or + 5V
3	Vo	Contrast Adjustment
4	RS	H/L Register Select Signal
5	R/$\overline{W}$	H/L Read/Write Signal
6	E	H →L Enable Signal
7	DB0	H/L Data Bus Line
8	DB1	H/L Data Bus Line
9	DB2	H/L Data Bus Line
10	DB3	H/L Data Bus Line
11	DB4	H/L Data Bus Line
12	DB5	H/L Data Bus Line
13	DB6	H/L Data Bus Line
14	DB7	H/L Data Bus Line
15	A/Vee	+ 4.2V for LED/Negative Voltage Output
16	K	Power Supply for B/L (OV)

DIMENSIONS in millimeters



LED - H/L B/L	HIGH	LOW
H1	13.2	12.1
H2	8.6	7.5

4. I2C

Datasheet

I2C 1602 Serial LCD Module

Product features:

The I2C 1602 LCD module is a 2 line by 16 character display interfaced to an I2C daughter board. The I2C interface only requires 2 data connections, +5 VDC and GND to operate

For in depth information on I2C interface and history, visit: http://www.wikipedia/wiki/i2c

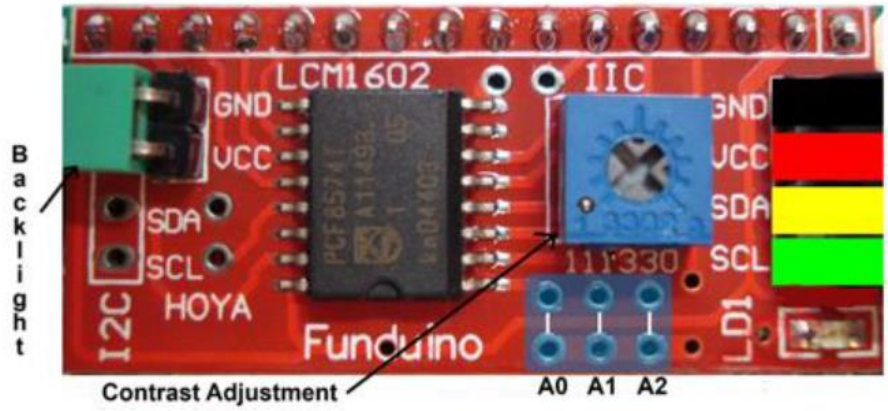
Specifications:

	2 lines by 16 character
I2C Address Range	0x20 to 0x27 (Default=0x27, addressable)
Operating Voltage	5 Vdc
Backlight	White
Contrast	Adjustable by potentiometer on I2c interface
Size	80mm x 36mm x 20 mm
Viewable area	66mm x 16mm

Power:

The device is powered by a single 5Vdc connection.

Pinout Diagram:



Pin/Control Descriptions:

Pin #	Name	Type	Description
1	GND	Power	Supply & Logic ground
2	VCC	Power	Digital I/O 0 or RX (serial receive)
3	SDA	I/O	Serial Data line
4	SCL	CLK	Serial Clock line
A0	A0	Jumper	Optional address selection A0 - see below
A1	A1	Jumper	Optional address selection A1 - see below
A2	A2	Jumper	Optional address selection A2 - see below
Backlight		Jumper	Jumpered - enable backlight, Open - disable backlight
Contrast		Pot	Adjust for best viewing

Addressing:

A0	A1	A2	Address
Open	Open	Open	0x27
Jumper	Open	Open	0x26
Open	Jumper	Open	0x25
Jumper	Jumper	Open	0x24
Open	Open	Jumper	0x23
Jumper	Open	Jumper	0x22
Open	Jumper	Jumper	0x21
Jumper	Jumper	Jumper	0x20

5. Relay 5 V (SONGLE RELAY)

SONGLE RELAY

松乐继电器 ® SONGLE RELAY	RELAY ISO9002	SRD

1. MAIN FEATURES

- Switching capacity available by 10A in spite of small size design for highdensity P.C. board mounting technique.
- UL,CUL,TUV recognized.
- Selection of plastic material for high temperature and better chemical solution performance.
- Sealed types available.
- Simple relay magnetic circuit to meet low cost of mass production.

2. APPLICATIONS

- Domestic appliance, office machine, audio, equipment, automobile, etc.
  (Remote control TV receiver, monitor display, audio equipment high rushing current use application.)

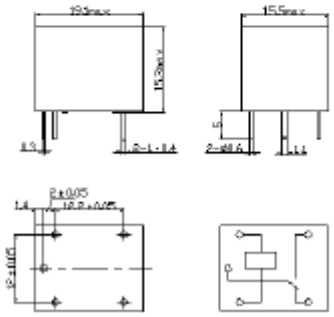
3. ORDERING INFORMATION

SRD	XX VDC	S	L	C
Model of relay	Nominal coil voltage	Structure	Coil sensitivity	Contact form
SRD	03、05、06、09、12、24、48VDC	S:Sealed type	L:0.36W	A:1 form A
				B:1 form B
		F:Flux free type	D:0.45W	C:1 form C

4. RATING

CCC	FILE NUMBER:CH0052885-2000	7A/240VDC
CCC	FILE NUMBER:CH0036746-99	10A/250VDC
UL /CUL	FILE NUMBER: E167996	10A/125VAC 28VDC
TUV	FILE NUMBER: R9933789	10A/240VAC 28VDC

5. DIMENSION(unit:mm) DRILLING(unit:mm) WIRING DIAGRAM



6. COIL DATA CHART (AT20ºC)

Coil Sensitivity	Coil Voltage Code	Nominal Voltage (VDC)	Nominal Current (mA)	Coil Resistance (Ω) ±10%	Power Consumption (W)	Pull-In Voltage (VDC)	Drop-Out Voltage (VDC)	Max-Allowable Voltage (VDC)
SRD (High Sensitivity)	03	03	120	25	abt. 0.36W	75%Max.	10% Min.	120%
	05	05	71.4	70				
	06	06	60	100				
	09	09	40	225				
	12	12	30	400				
	24	24	15	1600				
	48	48	7.5	6400				
SRD (Standard)	03	03	150	20	abt. 0.45W	75% Max.	10% Min.	110%
	05	05	89.3	55				
	06	06	75	80				
	09	09	50	180				
	12	12	37.5	320				
	24	24	18.7	1280				
	48	48	10	4500	abt. 0.51W			

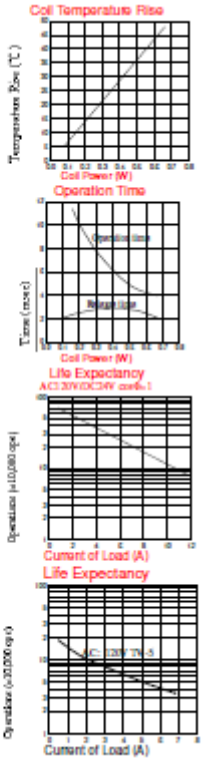
7. CONTACT RATING

Item \ Type	SRD FORM C	SRD FORM A
Contact Capacity Resistive Load (cosΦ=1)	7A 28VDC 10A 125VAC 7A 240VAC	10A 28VDC 10A 240VAC
Inductive Load (cosΦ=0.4 L/R=7msec)	3A 120VAC 3A 28VDC	5A 120VAC 5A 28VDC
Max. Allowable Voltage	250VAC/110VDC	250VAC/110VDC
Max. Allowable Power Force	800VAC/240W	1200VA/300W
Contact Material	AgCdO	AgCdO

8. PERFORMANCE (at initial value)

Item \ Type	SRD
Contact Resistance	100mΩ Max.
Operation Time	10msec Max.
Release Time	5msec Max.
Dielectric Strength Between coil & contact Between contacts	 1500VAC 50/60HZ (1 minute) 1000VAC 50/60HZ (1 minute)
Insulation Resistance	100 MΩ Min. (500VDC)
Max. ON/OFF Switching Mechanically Electrically	 300 operation/min 30 operation/min
Ambient Temperature	-25ºC to +70ºC
Operating Humidity	45 to 85% RH
Vibration Endurance Error Operation	 10 to 55Hz Double Amplitude 1.5mm 10 to 55Hz Double Amplitude 1.5mm
Shock Endurance Error Operation	 100G Min. 10G Min.
Life Expectancy Mechanically Electrically	 10^7 operations. Min. (no load) 10^5 operations. Min. (at rated coil voltage)
Weight	abt. 10grs.

9.REFERENCE DATA



6.Sensor Tegangan ZMPT101B

1、Wiring diagram

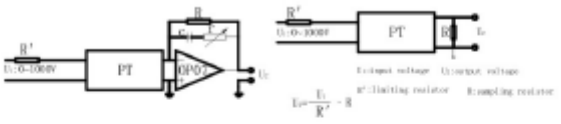


Figure Ⅰ **Figure Ⅱ**

2、Determination of maximum output rms voltage Umax:

Umax is decided by the AD peak voltage in the sampling loop in principle.

As for Bipolar AD, Umax= $\frac{Peakvoltag\ e}{\sqrt{2}}$

As for unipolar AD, Umax= $\frac{peak\ voltage}{2\sqrt{2}}$

for example:

As for ±5V AD, the maximum rms voltage of the transformer: Umax = $5V/\sqrt{2}$ **=3.53V**

As for 0~3.3V AD, the maximum rms voltage of

the transformer: $V_{max}=3.3V/2\sqrt{2}$ **=1.16V**

3、Determination of input current-limiting resistor R'

Current-limiting resistor $R'=\frac{V}{I}$

V：Rated input voltage

I ： Rated operating current （ when Coil resistance is compared with current-limiting resistor R' , it can be ignored.）

ZMPT101B/ZMPT107 usually working at rated current:1~2mA. When Rated input voltage≤100V，Usually choosing the operating current I=2mA; When Rated input voltage≥220V，To reducing the resistor power，Usually choosing the operating current 1 mA ≤I≤2 mA.

for example: V=100V，I=2 mA，

$R'=\frac{V}{I}$**=50K**Ω

for example: V=220V，I=1.1mA，

$R'=\frac{V}{I}$**=200**kΩ

To improve reliability, the current-limiting resistor selected usually is greater than its 4times the rated power, and generally use a high

temperature coefficient metal film resistor.

4、Determination of the sampling resistor R

$$R=\frac{V_{outputmax}}{I}=\frac{V_{outputmax}}{V_{inputmax}}\bullet R$$

for example: $V_{outputmax}$=3.53V, $V_{inputmax}$=120V, R=50kΩ

$$R=\frac{3.53}{120}\times 50k\Omega=1.471k\Omega$$

Directions:

(1) Above formula is also suitable for the two ways of active and passive output .

(2)when selecting the sampling resistor, Resistor should not exceed :$V_{outputmax}\bullet R/V_{inputmax}$

5、The advantages and disadvantages of the two wiring

(1)、Active output

Advantage: high precise, small phase error, high output voltage, strong load capacity。

As for unipolar AD, the positive input terminal of the op amp can plus a fixed benchmark reference voltage to solve.

Meanwhile, in order to simplify the line, Generally do not access the c and r which are for the phase compensation. If you need to compensate, Usually use the software way.

Disadvantage: Line is a little more complicated.

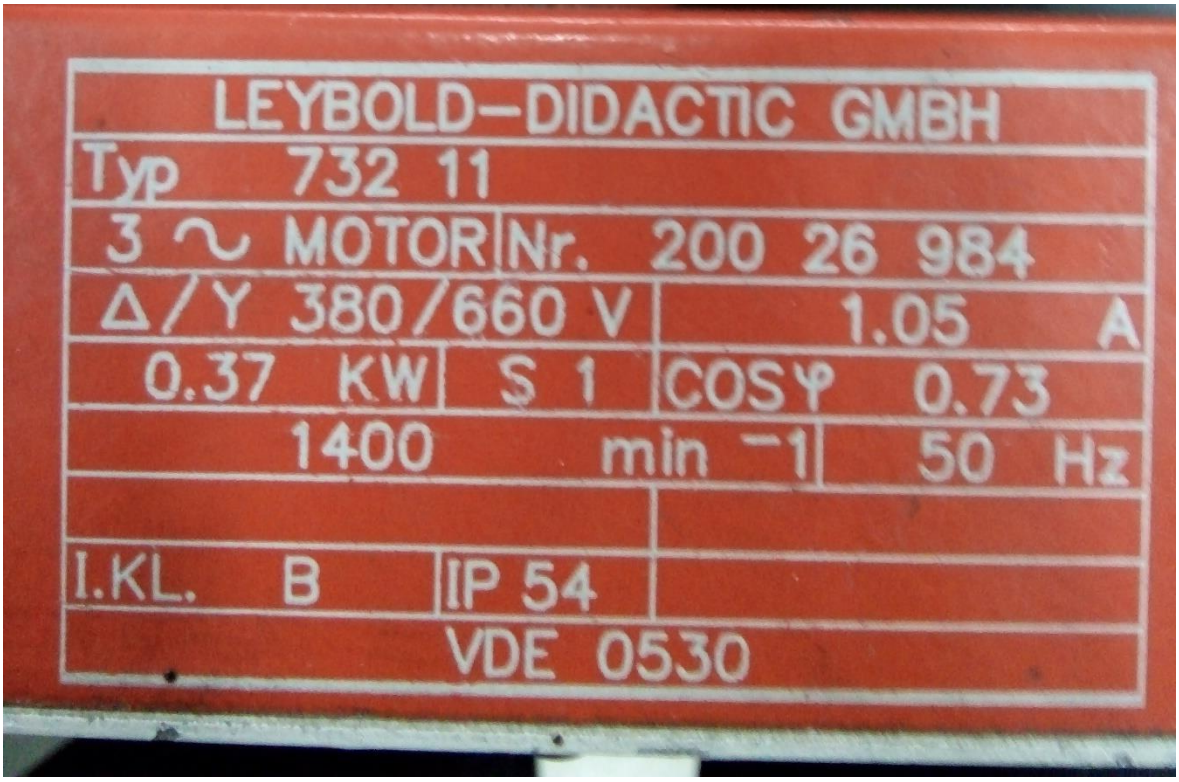
(2)、Passive output

Advantage: Simple circuit, High precision.

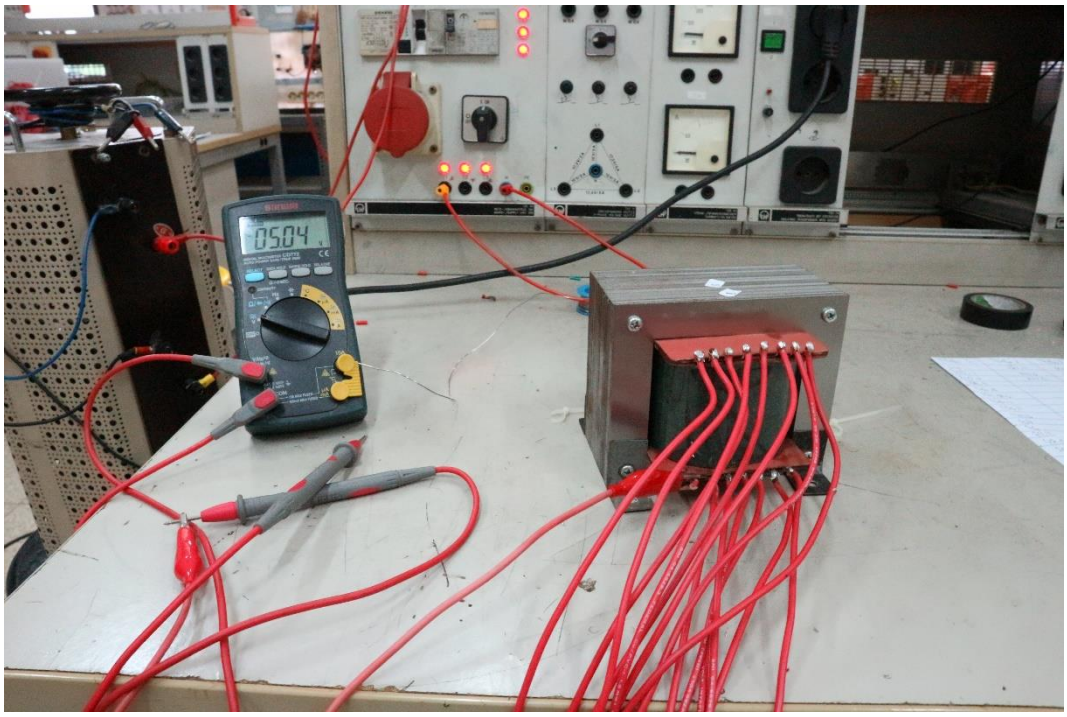
Disadvantage : The output voltage has certain limitations , The greater the load resistance, the greater the phase difference

Typical testing data are as follows:

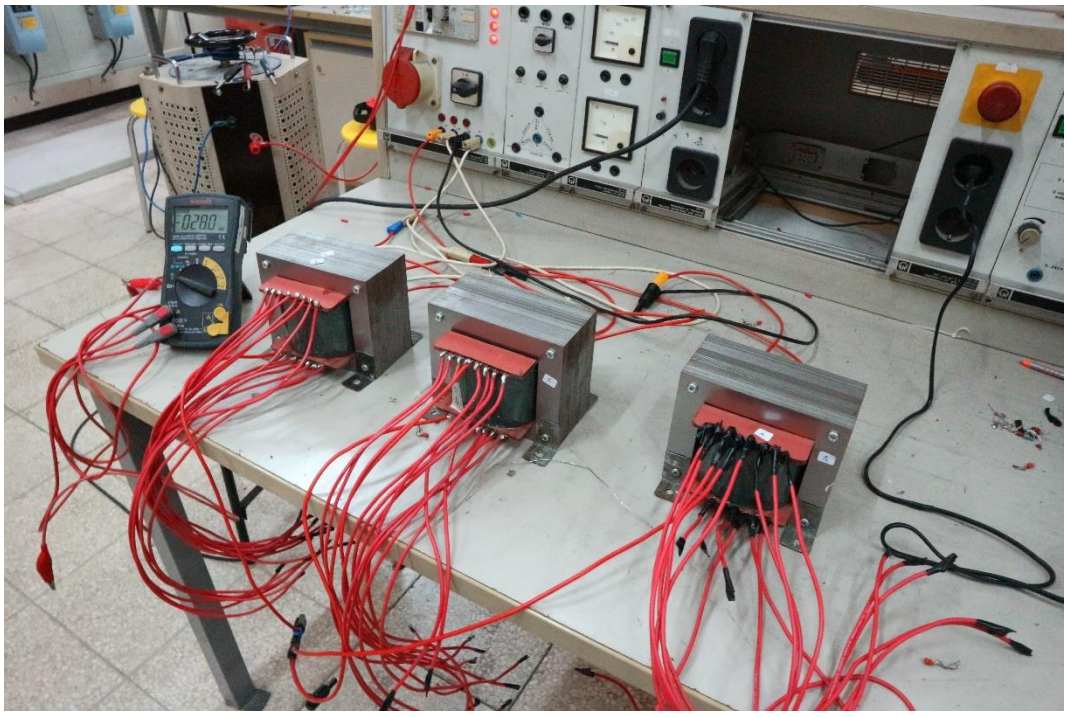
7. Motor Induksi 370 W



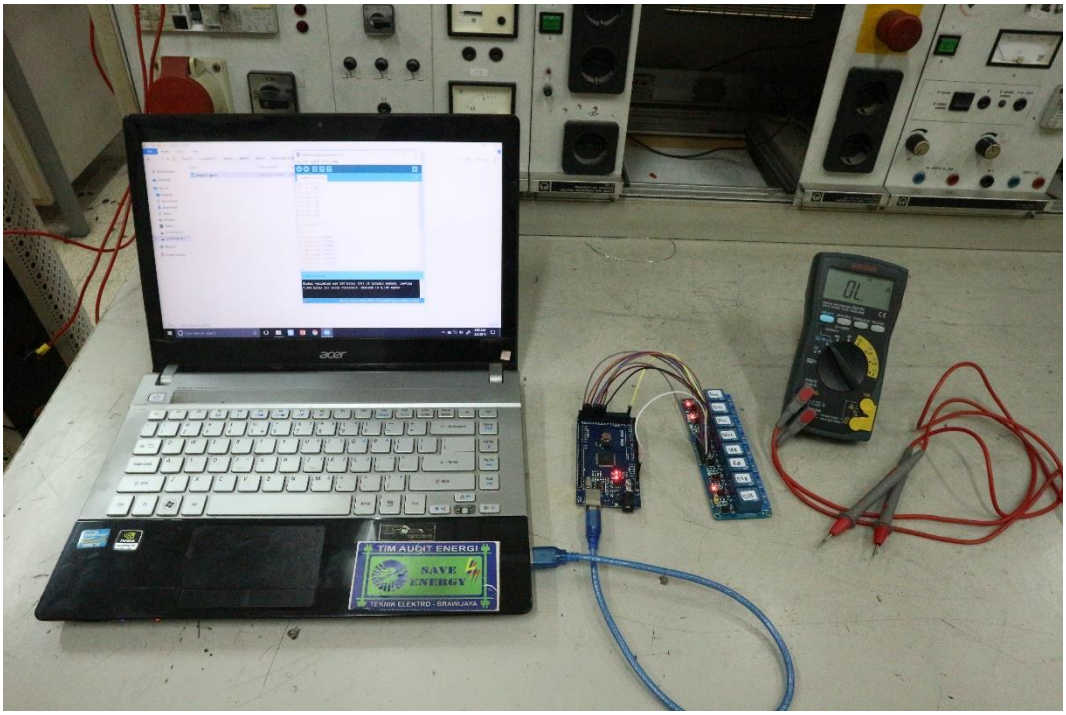
Lampiran 3: Dokumentasi



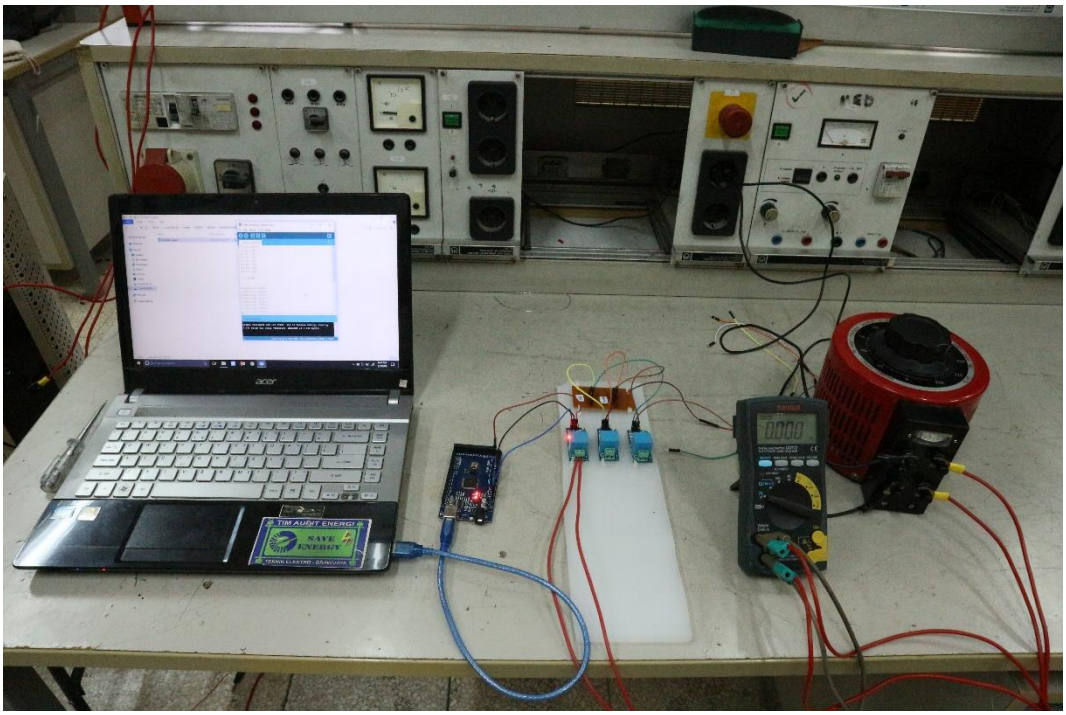
Gambar 1 Pengujian transformator 1 fasa



Gambar 2 Pengujian transformator 3 fasa hub Y-Y

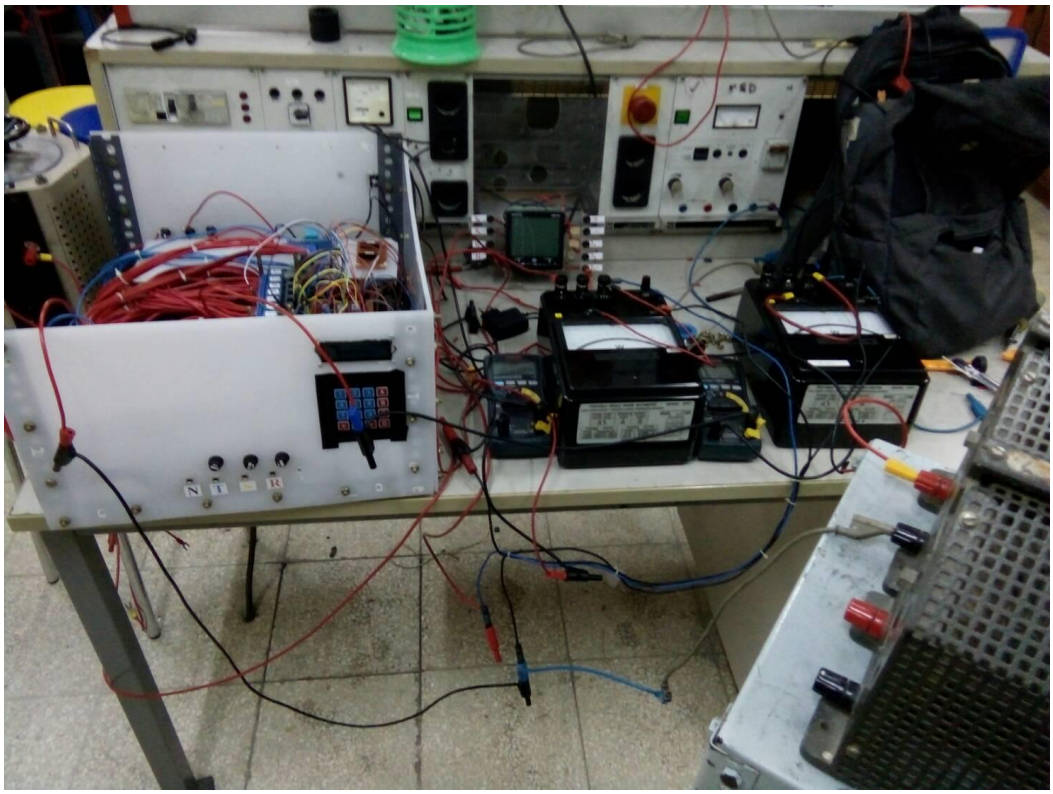


Gambar 3 Pengujian *driver relay*



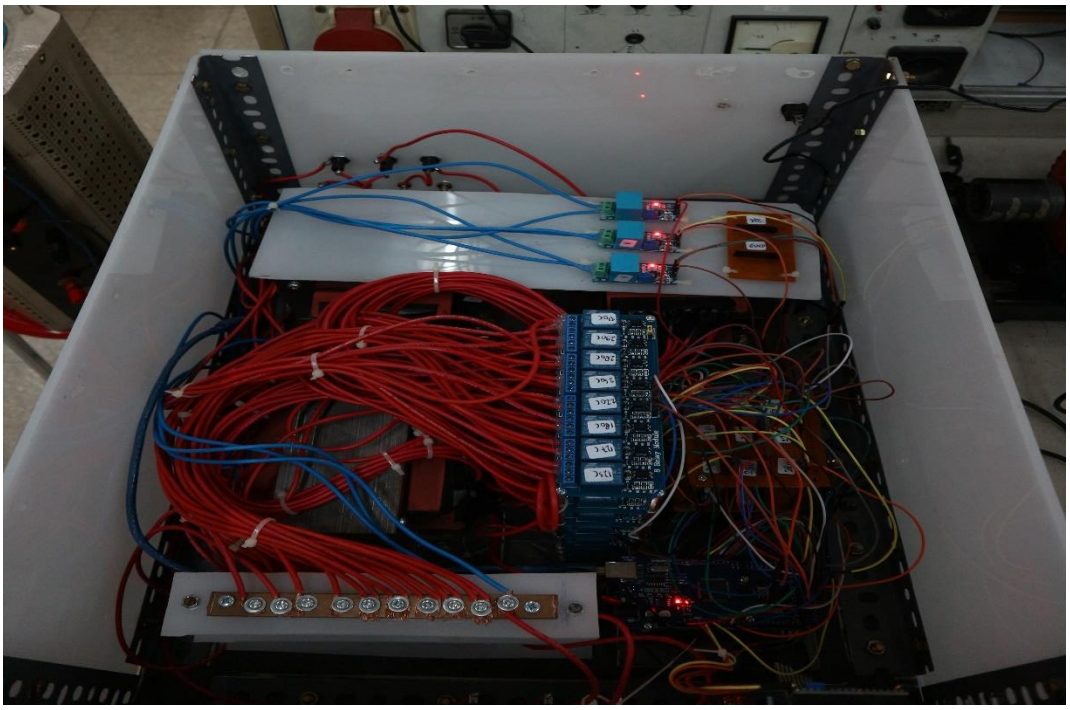
Gambar 4 Pengujian sensor tegangan ZMPT101B

Gambar 5 Pengujian tegangan keluaran alat penurun tegangan tiga fasa setelah diberi beban



Gambar 6 Pengujian untuk penentuan efisiensi transformator

Gambar 6 Alat penurun tegangan tiga fasa yang dibuat tampak depan



Gambar 7 Alat penurun tegangan tiga fasa yang dibuat tampak atas

Gambar 8 Alat penurun tegangan tiga fasa yang dibuat tampak belakang