```
// Adam Karas - Zariadenie pre automaticke meranie charakteristik akumulatorov - Bakalarska praca
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
#include <SPI.h>
#include <SD.h>
#include <math.h>

const float referenceVolts = 5.0;
const int batteryPin1 = A2;       // batéria 1
const int batteryPin2 = A3;       // batéria 2
const int TB1 = A6;               // senzor teploty batérie 1
const int TB2 = A8;               // senzor teploty batérie 2
const int TR1 = A9;               // senzor teploty rezistoru 1
const int TR2 = A10;              // senzor teploty rezistoru 2
const int prud1 = A11;             // senzor prúdu okruh 1
const int prud2 = A13;             // senzor prúdu okruh 2

int V_T1, V_T2, V_T3, V_T4;
float C1, C1s, C2, C2s;
float R1 = 2700;
float logR21, logR22, logR23, logR24, R21, R22, R23, R24, T1, T2, T3, T4;
float c1 = 21.41354374e-03, c2 = -32.13095470e-04, c3 = 125.4710222e-07;
int PWM1, PWM2;                   // Hodnoty duty cycle pre PWM <0-255>

void setup()
{
  Serial.begin(9600);                             // začiatok seriovej komunikacie
  Serial.println("Initializing SD card...");     //ukazuje na obrazovke, že prebieha inicializacia SD karty
    if (!SD.begin(8)) {                           //Initialize Card
      Serial.println("initialization failed!");  //Ak sa vyskytuje porucha spojení SD karty, ukazuje
    return;                                       // se chyba a začína sa tento cyklus znovu
                        }
  Serial.println("SD Card Ready");               //SD karta je pripravená.
                                                  //Vytvorenie suboru LOG.csv na SD karte
  File logFile = SD.open("LOG.csv", FILE_WRITE);
    if (logFile) {
      logFile.println(", ,");
      String header = "PWM_1, Current_1 [mA], Voltage_1 [V], Capacity_1 [mAh], PWM_2, Current_2 [mA], Voltage_2 [V], Capacity_2 [mAh]"; //pomenovanie stlpcov
      logFile.println(header);
      logFile.close();
      Serial.println(header);
                  }
    else {
      Serial.println("Error opening LOG file");  //Ak sa subor nepodari otvoriť, vyskytuje sa chyba
         }
```

```
  pinMode(51, OUTPUT);    // Pin 51 - output - rele
  pinMode(5, OUTPUT);     // Pin 5  - output - ventilator
  pinMode(13, OUTPUT);    // Pin 13 - output - PWM generator
  pinMode(4, OUTPUT);     // Pin 4  - output - PWM generator
  pinMode(47, OUTPUT);    // Pin 47 - output - LED
  pinMode(A2, INPUT);     // Pin A2 - input - V1
  pinMode(A3, INPUT);     // Pin A3 - input - V2
  pinMode(A6, INPUT);     // Pin A6 - input - T1
  pinMode(A8, INPUT);     // Pin A8 - input - T2
  pinMode(A9, INPUT);     // Pin A9 - input - T3
  pinMode(A10, INPUT);    // Pin A10 - input - T4
  pinMode(A11, INPUT);    // Pin A11 - input - I1
  pinMode(A13, INPUT);    // Pin A13 - input - I2

  TCCR0B = TCCR0B & B11111000 | B00000001; // PWM frekvencia  62500 Hz

  lcd.init();                              // inicializácia LCD
  lcd.setCursor ( 3, 1);
  lcd.print(" Test LCD ");                 // Nápis "Test LCD"
  delay(64000);
  lcd.clear();                             // Vyčisti obrazovku
  delay(64000);

}

void loop() {
  int VB1 = analogRead(batteryPin1);            // načitaj hodnotu z pinu
  float V1 = 2*(VB1 / 1024.0) * referenceVolts; // vypočet napätia

  int VB2 = analogRead(batteryPin2);
  float V2 = 2*(VB2 / 1024.0) * referenceVolts;

  V_T1= analogRead(TB1);
  R21 = R1 * (((V_T1/1024.0)* referenceVolts)/(referenceVolts - (V_T1/1024.0)*
referenceVolts));
  logR21 = log(R21);
  T1 = (1.0 / (c1 + c2*logR21 + c3*logR21*logR21*logR21));
  T1 = T1 - 273.15;

  V_T2= analogRead(TB2);
  R22 = R1 * (((V_T2/1024.0)* referenceVolts)/(referenceVolts - (V_T2/1024.0)*
referenceVolts));
  logR22 = log(R22);
  T2 = (1.0 / (c1 + c2*logR22 + c3*logR22*logR22*logR22));
  T2 = T2 - 273.15;

  V_T3= analogRead(TR1);
  R23 = R1 * (((V_T3/1024.0)* referenceVolts)/(referenceVolts - (V_T3/1024.0)*
referenceVolts));
  logR23 = log(R23);
  T3 = (1.0 / (c1 + c2*logR23 + c3*logR23*logR23*logR23));
  T3 = T3 - 273.15;
```

```
  V_T4= analogRead(TR2);
  R24 = R1 * (((V_T4/1024.0)* referenceVolts)/(referenceVolts - (V_T4/1024.0)*
referenceVolts));
  logR24 = log(R24);
  T4 = (1.0 / (c1 + c2*logR24 + c3*logR24*logR24*logR24));
  T4 = T4 - 273.15;

  Serial.print("V1: "); Serial.println(V1);
  Serial.print("V2: "); Serial.println(V2);
  Serial.print("T1: "); Serial.print(T1); Serial.print(", T2: ");
Serial.print(T2); Serial.print(", T3: "); Serial.print(T3); Serial.print(", T4:
"); Serial.println(T4);
  Serial.println();
  delay(64000);

    while (V1 < 4.2 && V2 < 4.2)
   {
        V_T1= analogRead(TB1);
        R21 = R1 * (((V_T1/1024.0)* referenceVolts)/(referenceVolts -
(V_T1/1024.0)* referenceVolts));
        logR21 = log(R21);
        T1 = (1.0 / (c1 + c2*logR21 + c3*logR21*logR21*logR21));
        T1 = T1 - 273.15;

        V_T2= analogRead(TB2);
        R22 = R1 * (((V_T2/1024.0)* referenceVolts)/(referenceVolts -
(V_T2/1024.0)* referenceVolts));
        logR22 = log(R22);
        T2 = (1.0 / (c1 + c2*logR22 + c3*logR22*logR22*logR22));
        T2 = T2 - 273.15;

        V_T3= analogRead(TR1);
        R23 = R1 * (((V_T3/1024.0)* referenceVolts)/(referenceVolts -
(V_T3/1024.0)* referenceVolts));
        logR23 = log(R23);
        T3 = (1.0 / (c1 + c2*logR23 + c3*logR23*logR23*logR23));
        T3 = T3 - 273.15;

        V_T4= analogRead(TR2);
        R24 = R1 * (((V_T4/1024.0)* referenceVolts)/(referenceVolts -
(V_T4/1024.0)* referenceVolts));
        logR24 = log(R24);
        T4 = (1.0 / (c1 + c2*logR24 + c3*logR24*logR24*logR24));
        T4 = T4 - 273.15;

        unsigned int x=0;
        float I1Samples=0.0, V1Samples=0.0, AvgSamplesI1=0.0, AvgSamplesV1=0.0,
I1ValueF=0.0;
        float I2Samples=0.0, V2Samples=0.0, AvgSamplesI2=0.0, AvgSamplesV2=0.0,
I2ValueF=0.0;
        for (int x = 0; x < 100; x++){        // priemer 100 merani
         int I1Value = analogRead(prud1);
         int I2Value = analogRead(prud2);
```

```
         int VB1 = analogRead(batteryPin1);
         float V1 = 2*(VB1 / 1024.0) * referenceVolts;

         int VB2 = analogRead(batteryPin2);
         float V2 = 2*(VB2 / 1024.0) * referenceVolts;

         I1Samples = I1Samples + I1Value;
         I2Samples = I2Samples + I2Value;
         V1Samples = V1Samples + V1;
         V2Samples = V2Samples + V2;
         delay (3*64);                          // let ADC settle before next
sample 3ms
                                    }
         AvgSamplesI1= I1Samples/100.0;
         AvgSamplesI2=I2Samples/100.0;
         AvgSamplesV1=V1Samples/100.0;
         AvgSamplesV2=V2Samples/100.0;

         I1ValueF = (-(2.5 - (AvgSamplesI1 * (5.0 / 1024.0))) /0.185 -0.12)*1000
;
         I2ValueF = (-(2.5 - (AvgSamplesI2 * (5.0 / 1024.0))) /0.185
-0.09)*1000;

         C1s=(C1s+I1ValueF)*30;
         C1=(C1+C1s)/3600.0;
         C2s=(C2s+I2ValueF)*30;
         C2=(C2+C2s)/3600.0;

         //Ukladanie dát do SD karty
          String dataString = String(PWM1) + ", " + String(I1ValueF) + ", " +
String(AvgSamplesV1)+ ", " + String(C1)+ ", " + String(PWM2) + ", " +
String(I2ValueF) + ", " + String(AvgSamplesV2)+ ", " + String(C2);
          File logFile = SD.open("LOG.csv", FILE_WRITE);
            if (logFile)
                {
              logFile.println(dataString);
              logFile.close();
              Serial.println(dataString);
                }
            else
                {
              Serial.println("Couldn't open LOG file");
                 }
        Serial.print("PWM1: "); Serial.print(PWM1); Serial.print(", I1 [mA]: ");
Serial.print(I1ValueF); Serial.print(", V1: "); Serial.print(V1),
Serial.print(", C1 [mAh]: "); Serial.println(C1);
        Serial.print("PWM2: "); Serial.print(PWM2); Serial.print(", I2 [mA]: ");
Serial.print(I2ValueF); Serial.print(", V2: "); Serial.print(V2),
Serial.print(", C2 [mAh]: "); Serial.println(C2);
        Serial.print("T1[°C]: "); Serial.print(T1); Serial.print(", T2[°C]: ");
Serial.print(T2); Serial.print(", T3[°C]: "); Serial.print(T3); Serial.print(",
T4[°C]: "); Serial.println(T4);
        Serial.println();
        delay(32000);
```

```
        digitalWrite(51, HIGH); // sets the digital pin 51 on
        digitalWrite(13, LOW); // sets the digital pin 13 off
        digitalWrite(4, LOW); // sets the digital pin 4 off
        digitalWrite(47, HIGH); // sets the digital pin 47 on
        delay(32000);            // waits for a second
        digitalWrite(47, LOW);  // sets the digital pin 47 off
        delay(32000);
        lcd.setCursor(0, 0);
        lcd.print("Charging..");
        lcd.setCursor(0, 1);
        lcd.print((V1 - 2.5)/1.7 *100 );
        lcd.setCursor(6, 1);
        lcd.print((V2 - 2.5)/1.7 *100 );
            if (T1 or T2 or T3 or T4 > 100)
              {
                digitalWrite(5, HIGH);
              }
        delay(28*64000);
   }
    while (2.5 < V2 && 2.5 < V1 )
   {
        V_T1= analogRead(TB1);
        R21 = R1 * (((V_T1/1024.0)* referenceVolts)/(referenceVolts -
(V_T1/1024.0)* referenceVolts));
        logR21 = log(R21);
        T1 = (1.0 / (c1 + c2*logR21 + c3*logR21*logR21*logR21));
        T1 = T1 - 273.15;

        V_T2= analogRead(TB2);
        R22 = R1 * (((V_T2/1024.0)* referenceVolts)/(referenceVolts -
(V_T2/1024.0)* referenceVolts));
        logR22 = log(R22);
        T2 = (1.0 / (c1 + c2*logR22 + c3*logR22*logR22*logR22));
        T2 = T2 - 273.15;

        V_T3= analogRead(TR1);
        R23 = R1 * (((V_T3/1024.0)* referenceVolts)/(referenceVolts -
(V_T3/1024.0)* referenceVolts));
        logR23 = log(R23);
        T3 = (1.0 / (c1 + c2*logR23 + c3*logR23*logR23*logR23));
        T3 = T3 - 273.15;

        V_T4= analogRead(TR2);
        R24 = R1 * (((V_T4/1024.0)* referenceVolts)/(referenceVolts -
(V_T4/1024.0)* referenceVolts));
        logR24 = log(R24);
        T4 = (1.0 / (c1 + c2*logR24 + c3*logR24*logR24*logR24));
        T4 = T4 - 273.15;

        unsigned int x=0;
        float I1Samples=0.0, V1Samples=0.0, AvgSamplesI1=0.0, AvgSamplesV1=0.0,
I1ValueF=0.0;
        float I2Samples=0.0, V2Samples=0.0, AvgSamplesI2=0.0, AvgSamplesV2=0.0,
```

```
I2ValueF=0.0;
        for (int x = 0; x < 100; x++){        // priemer 100 merani
         int I1Value = analogRead(prud1);
         int I2Value = analogRead(prud2);

         int VB1 = analogRead(batteryPin1);
         float V1 = 2*(VB1 / 1024.0) * referenceVolts;

         int VB2 = analogRead(batteryPin2);
         float V2 = 2*(VB2 / 1024.0) * referenceVolts;

         I1Samples = I1Samples + I1Value;
         I2Samples = I2Samples + I2Value;
         V1Samples = V1Samples + V1;
         V2Samples = V2Samples + V2;
         delay (3*64);                        // let ADC settle before next
sample 3ms
                                    }
         AvgSamplesI1= I1Samples/100.0;
         AvgSamplesI2=I2Samples/100.0;
         AvgSamplesV1=V1Samples/100.0;
         AvgSamplesV2=V2Samples/100.0;

         I1ValueF = (-(2.5 - (AvgSamplesI1 * (5.0 / 1024.0))) /0.185 -0.12)*1000
;
         I2ValueF = (-(2.5 - (AvgSamplesI2 * (5.0 / 1024.0))) /0.185
-0.09)*1000;

         C1s=(C1s+I1ValueF)*30;
         C1=(C1+C1s)/3600.0;
         C2s=(C2s+I2ValueF)*30;
         C2=(C2+C2s)/3600.0;

         //Ukladanie dát do SD karty
          String dataString = String(PWM1) + ", " + String(I1ValueF) + ", " +
String(AvgSamplesV1)+ ", " + String(C1)+ ", " + String(PWM2) + ", " +
String(I2ValueF) + ", " + String(AvgSamplesV2)+ ", " + String(C2);
          File logFile = SD.open("LOG.csv", FILE_WRITE);
            if (logFile)
                {
              logFile.println(dataString);
              logFile.close();
              Serial.println(dataString);
                }
            else
                {
              Serial.println("Couldn't open LOG file");
                 }
        Serial.print("PWM1: "); Serial.print(PWM1); Serial.print(", I1 [mA]: ");
Serial.print(I1ValueF); Serial.print(", V1: "); Serial.print(V1),
Serial.print(", C1 [mAh]: "); Serial.println(C1);
        Serial.print("PWM2: "); Serial.print(PWM2); Serial.print(", I2 [mA]: ");
Serial.print(I2ValueF); Serial.print(", V2: "); Serial.print(V2),
Serial.print(", C2 [mAh]: "); Serial.println(C2);
```

```
        Serial.print("T1[°C]: "); Serial.print(T1); Serial.print(", T2[°C]: ");
Serial.print(T2); Serial.print(", T3[°C]: "); Serial.print(T3); Serial.print(",
T4[°C]: "); Serial.println(T4);
        Serial.println();
        delay(32000);

        analogWrite(13,PWM1);
        analogWrite(4, PWM2); //PWM pin D4, duty cycle 15/255
        digitalWrite(51, LOW);
        digitalWrite(47, HIGH);
        lcd.setCursor(0, 0);
        lcd.print("Discharging..");
        lcd.setCursor(0, 1);
        lcd.print((V1 - 2.5)/1.7 *100 );
        lcd.setCursor(6, 1);
        lcd.print((V2 - 2.5)/1.7 *100 );
            if (T1 or T2 or T3 or T4 > 100)
                    {
                      digitalWrite(5, HIGH);
                    }
        delay(29*64000);
            while (2.52 < V1 && V2 < 2.52 )
              {
              V_T1= analogRead(TB1);
              R21 = R1 * (((V_T1/1024.0)* referenceVolts)/(referenceVolts -
(V_T1/1024.0)* referenceVolts));
              logR21 = log(R21);
              T1 = (1.0 / (c1 + c2*logR21 + c3*logR21*logR21*logR21));
              T1 = T1 - 273.15;

              V_T2= analogRead(TB2);
              R22 = R1 * (((V_T2/1024.0)* referenceVolts)/(referenceVolts -
(V_T2/1024.0)* referenceVolts));
              logR22 = log(R22);
              T2 = (1.0 / (c1 + c2*logR22 + c3*logR22*logR22*logR22));
              T2 = T2 - 273.15;

              V_T3= analogRead(TR1);
              R23 = R1 * (((V_T3/1024.0)* referenceVolts)/(referenceVolts -
(V_T3/1024.0)* referenceVolts));
              logR23 = log(R23);
              T3 = (1.0 / (c1 + c2*logR23 + c3*logR23*logR23*logR23));
              T3 = T3 - 273.15;

              V_T4= analogRead(TR2);
              R24 = R1 * (((V_T4/1024.0)* referenceVolts)/(referenceVolts -
(V_T4/1024.0)* referenceVolts));
              logR24 = log(R24);
              T4 = (1.0 / (c1 + c2*logR24 + c3*logR24*logR24*logR24));
              T4 = T4 - 273.15;

              unsigned int x=0;
              float I1Samples=0.0, V1Samples=0.0, AvgSamplesI1=0.0,
AvgSamplesV1=0.0, I1ValueF=0.0;
```

```
              float I2Samples=0.0, V2Samples=0.0, AvgSamplesI2=0.0,
AvgSamplesV2=0.0, I2ValueF=0.0;
              for (int x = 0; x < 100; x++){        // priemer 100 merani
              int I1Value = analogRead(prud1);
              int I2Value = analogRead(prud2);

              int VB1 = analogRead(batteryPin1);
              float V1 = 2*(VB1 / 1024.0) * referenceVolts;

              int VB2 = analogRead(batteryPin2);
              float V2 = 2*(VB2 / 1024.0) * referenceVolts;

              I1Samples = I1Samples + I1Value;
              I2Samples = I2Samples + I2Value;
              V1Samples = V1Samples + V1;
              V2Samples = V2Samples + V2;
               delay (3*64);                        // let ADC settle before
next sample 3ms
                                          }
              AvgSamplesI1= I1Samples/100.0;
              AvgSamplesI2=I2Samples/100.0;
              AvgSamplesV1=V1Samples/100.0;
              AvgSamplesV2=V2Samples/100.0;

              I1ValueF = (-(2.5 - (AvgSamplesI1 * (5.0 / 1024.0))) /0.185
-0.12)*1000 ;
              I2ValueF = (-(2.5 - (AvgSamplesI2 * (5.0 / 1024.0))) /0.185
-0.09)*1000;

              C1s=(C1s+I1ValueF)*30;
              C1=(C1+C1s)/3600.0;
              C2s=(C2s+I2ValueF)*30;
              C2=(C2+C2s)/3600.0;

              //Ukladanie dát do SD karty
              String dataString = String(PWM1) + ", " + String(I1ValueF) + ", "
+ String(AvgSamplesV1)+ ", " + String(C1)+ ", " + String(PWM2) + ", " +
String(I2ValueF) + ", " + String(AvgSamplesV2)+ ", " + String(C2);
              File logFile = SD.open("LOG.csv", FILE_WRITE);
               if (logFile)
                {
                   logFile.println(dataString);
                   logFile.close();
                   Serial.println(dataString);
                }
               else
                {
                   Serial.println("Couldn't open LOG file");
                }
              Serial.print("PWM1: "); Serial.print(PWM1); Serial.print(", I1
[mA]: "); Serial.print(I1ValueF); Serial.print(", V1: "); Serial.print(V1),
Serial.print(", C1 [mAh]: "); Serial.println(C1);
              Serial.print("PWM2: "); Serial.print(PWM2); Serial.print(", I2
[mA]: "); Serial.print(I2ValueF); Serial.print(", V2: "); Serial.print(V2),
```

```
Serial.print(", C2 [mAh]: "); Serial.println(C2);
              Serial.print("T1[°C]: "); Serial.print(T1); Serial.print(",
T2[°C]: "); Serial.print(T2); Serial.print(", T3[°C]: "); Serial.print(T3);
Serial.print(", T4[°C]: "); Serial.println(T4);
              Serial.println();
              delay(32000);


              analogWrite(13, PWM1); //PWM pin D13, duty cycle 15/255
              digitalWrite(4, LOW);
              digitalWrite(51, LOW);
              digitalWrite(47, HIGH);
              lcd.setCursor(0, 0);
              lcd.print("Discharging B1..");
              lcd.setCursor(0, 1);
              lcd.print((V1 - 2.5)/1.7 *100 );
              lcd.setCursor(6, 1);
              lcd.print((V2 - 2.5)/1.7 *100 );
                if (T1 or T2 or T3 or T4 > 100) // tepelna poistka pri prekoceni
teploty 100°C zapne pin pre ventilator
                  {
                    digitalWrite(5, HIGH);
                  }
              delay(29*64000);
             }
           while (2.52 < V2 && V1 < 2.52 )
             {
              V_T1= analogRead(TB1);
              R21 = R1 * (((V_T1/1024.0)* referenceVolts)/(referenceVolts -
(V_T1/1024.0)* referenceVolts));
              logR21 = log(R21);
              T1 = (1.0 / (c1 + c2*logR21 + c3*logR21*logR21*logR21));
              T1 = T1 - 273.15;

              V_T2= analogRead(TB2);
              R22 = R1 * (((V_T2/1024.0)* referenceVolts)/(referenceVolts -
(V_T2/1024.0)* referenceVolts));
              logR22 = log(R22);
              T2 = (1.0 / (c1 + c2*logR22 + c3*logR22*logR22*logR22));
              T2 = T2 - 273.15;

              V_T3= analogRead(TR1);
              R23 = R1 * (((V_T3/1024.0)* referenceVolts)/(referenceVolts -
(V_T3/1024.0)* referenceVolts));
              logR23 = log(R23);
              T3 = (1.0 / (c1 + c2*logR23 + c3*logR23*logR23*logR23));
              T3 = T3 - 273.15;

              V_T4= analogRead(TR2);
              R24 = R1 * (((V_T4/1024.0)* referenceVolts)/(referenceVolts -
(V_T4/1024.0)* referenceVolts));
              logR24 = log(R24);
              T4 = (1.0 / (c1 + c2*logR24 + c3*logR24*logR24*logR24));
              T4 = T4 - 273.15;
```

```
              unsigned int x=0;
              float I1Samples=0.0, V1Samples=0.0, AvgSamplesI1=0.0,
AvgSamplesV1=0.0, I1ValueF=0.0;
              float I2Samples=0.0, V2Samples=0.0, AvgSamplesI2=0.0,
AvgSamplesV2=0.0, I2ValueF=0.0;
              for (int x = 0; x < 100; x++){        // priemer 100 merani
                int I1Value = analogRead(prud1);
                int I2Value = analogRead(prud2);

                int VB1 = analogRead(batteryPin1);
                float V1 = 2*(VB1 / 1024.0) * referenceVolts;

                int VB2 = analogRead(batteryPin2);
                float V2 = 2*(VB2 / 1024.0) * referenceVolts;

                I1Samples = I1Samples + I1Value;
                I2Samples = I2Samples + I2Value;
                V1Samples = V1Samples + V1;
                V2Samples = V2Samples + V2;
                delay (3*64);                         // let ADC settle before
next sample 3ms
                                                }
              AvgSamplesI1= I1Samples/100.0;
              AvgSamplesI2=I2Samples/100.0;
              AvgSamplesV1=V1Samples/100.0;
              AvgSamplesV2=V2Samples/100.0;

              I1ValueF = (-(2.5 - (AvgSamplesI1 * (5.0 / 1024.0))) /0.185
-0.12)*1000 ;
              I2ValueF = (-(2.5 - (AvgSamplesI2 * (5.0 / 1024.0))) /0.185
-0.09)*1000;

              C1s=(C1s+I1ValueF)*30;
              C1=(C1+C1s)/3600.0;
              C2s=(C2s+I2ValueF)*30;
              C2=(C2+C2s)/3600.0;

              //Ukladanie dát do SD karty
                String dataString = String(PWM1) + ", " + String(I1ValueF) + ",
" + String(AvgSamplesV1)+ ", " + String(C1)+ ", " + String(PWM2) + ", " +
String(I2ValueF) + ", " + String(AvgSamplesV2)+ ", " + String(C2);
                File logFile = SD.open("LOG.csv", FILE_WRITE);
                  if (logFile)
                    {
                    logFile.println(dataString);
                    logFile.close();
                    Serial.println(dataString);
                    }
                  else
                    {
                    Serial.println("Couldn't open LOG file");
                    }
              Serial.print("PWM1: "); Serial.print(PWM1); Serial.print(", I1
```

```
[mA]: "); Serial.print(I1ValueF); Serial.print(", V1: "); Serial.print(V1),
Serial.print(", C1 [mAh]: "); Serial.println(C1);
              Serial.print("PWM2: "); Serial.print(PWM2); Serial.print(", I2
[mA]: "); Serial.print(I2ValueF); Serial.print(", V2: "); Serial.print(V2),
Serial.print(", C2 [mAh]: "); Serial.println(C2);
              Serial.print("T1[°C]: "); Serial.print(T1); Serial.print(",
T2[°C]: "); Serial.print(T2); Serial.print(", T3[°C]: "); Serial.print(T3);
Serial.print(", T4[°C]: "); Serial.println(T4);
              Serial.println();
              delay(32000);

              analogWrite(4, PWM2); //PWM pin D4, duty cycle 15/255
              digitalWrite(13,LOW);
              digitalWrite(51, LOW);
              digitalWrite(47, HIGH);
              lcd.setCursor(0, 0);
              lcd.print("Discharging B2..");
              lcd.setCursor(0, 1);
              lcd.print((V1 - 2.5)/1.7 *100 );
              lcd.setCursor(6, 1);
              lcd.print((V2 - 2.5)/1.7 *100 );
                  if (T1 or T2 or T3 or T4 > 100)
                    {
                      digitalWrite(5, HIGH);
                    }
               delay(29*64000);
               }
      }
  }
```