Design and Study of DC Micro Grid

A Project report submitted in partial fulfilment
of the requirements for the degree of B. Tech in Electrical Engineering

By

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PREFACE

This report comprises the summary of work we namely RUKMINI SANYAL, KUMAR RAHUL, ARKA GHOSH and NISHAT FAEQUE achieved during our final year project the task we have chosen to carry out during this year is DESIGN and STUDY of DC SMART MICRO GRID. The effort is conducted under the supervision of Prof. (Dr.) ASHOKE MONDAL, Department of Electrical Engineering, RCC Institute of Information Technology.

This project is based on DC energy sources which can be generated from the renewable non-conventional energy sources. The micro grid covers small geographic area to distribute power from a utility in case of emergency.

As the conventional energy sources are reducing, the power industry is leaning towards non-conventional renewable energy resources to fulfil the demand of 21st century. Till date there is a system mostly for domestic purpose that consumers have to buy electricity from the responsible power suppliers from the respective areas. Soon there will be a day when the renewable energy resources will be installed to the consumers themselves and the generated power will be synchronized with the grid and then it will be supplied. The consumers will be taking part in the production of power, forming a new concept of Prosumers.

In case of AC power it is not easy to export without proper synchronization. From the power quality point of view it is highly recommended to maintain Phase, Frequency and Amplitude, also the THD and wave shape.

ACKNOWLEDGEMENT

It is my great fortune that I have got the opportunity to carry out the project work under the supervision of Prof. (Dr.) Ashoke Mondal in the department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT) Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India. I express my sincere thanks and deepest sense of gratitude to my guide for his constant support, unparalleled guidance and limitless encouragement.

I wish to convey my gratitude to Prof. (Dr.) Debasish Mondal, HOD, Department of Electrical Engineering, RCCIIT and to the authority of RCCIIT for providing al kind of infrastructural facility towards the research work.

I would also like to convey my gratitude to all the faculty members and the staffs of the Department of Electrical Engineering, RCCIIT for their wholehearted cooperation to make this work turn into reality.

Thanks to fellow members of our group for working as a team.

Name and Signature of the Student

Place:

Date:

Department of Electrical Engineering
RCC INSTITUTE OF INFORMATION TECHNOLOGY
GROUND FLOOR, NEW BUILDING,
CANAL SOUTH ROAD, BELIAGHATA, KOLKATA – 700015, WEST BENGAL

CERTIFICATE

To whom it may concern

This is to certify that the project work entitled **DESIGN AND STUDY OF DC MICRO GRID** is the bona fide work carried out by **RUKMINI SANYAL (11701616039)** a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year **2016-20**, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not been submitted previously for the award of any other degree, diploma or fellowship.

_____ _____

Signature of the Guide **Signature of the HOD**

Name: **Name:**

Designation **Designation**

_____

Signature of the External Examiner

Name:

Designation:

ABSTRACT

This project is designed as a micro grid system which is operated in DC. It acquires the energy from the battery sources. The main objective of the project is to maintain a constant bus voltage 12V in the bus to maintain the load demand [1]. There are two power supply one is primary power supply and another is secondary power supply. At first the primary power supply will start to supply power to the bus, if it is unable to satisfy the load demand then the secondary power supply will be connected and satisfy the load demand. Again, if the load demand decreases then at first the secondary power supply will be disconnected and if the bus voltage remains high still, then to adjust it the primary power supply will also be disconnected for time being. Again, when the power supply and load demand will be balanced it will be connected automatically. There are smart meters connected to the system which can detect any problem and also can measure the health of the equipment other than measuring the parameters required. The smart meters also give an opportunity to check the parameters of the consumers themselves as the data are being stored in cloud. From anywhere the consumers can check their consumption, tariff rate, and also can check the equipment connected to it, which will leave a trace of transparency to the system.

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1. Introduction:

In the fast life of this 21st century power is almost one of the most valuable things in human life. Now to connect the most remote parts of the world with the power will be one of a great achievement to the human-life. Here in this case micro-grid is an essential concept undoubtedly.

"A **microgrid** is a localized group of electricity sources and loads that normally operates connected to and synchronous with the traditional wide area synchronous grid (macro grid), but can also disconnect to "island mode" — and function autonomously as physical or economic conditions dictate"[1]

"The United States Department of Energy Microgrid Exchange Group defines a microgrid as a group of interconnected loads and distributed energy resources (DERs) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both connected or island-mode."

"The EU research project describes a microgrid as comprising Low-Voltage (LV) distribution systems with distributed energy resources (DERs) (microturbines, fuel cells, photovoltaics (PV), etc.), storage devices (batteries, flywheels) energy storage system and flexible loads. Such systems can operate either connected or disconnected from the main grid. The operation of micro sources in the network can provide benefits to the overall system performance, if managed and coordinated efficiently."

In this project we have taken count for DC micro grid which definitely can run small system. A DC microgrid maintains a DC bus, which feeds DC loads connected to it. Normally, DC loads are like lighting load like LED Lamps, Traffic Signal or DC Fan / Pump, low-power rating electronic devices such as laptops, cell phone, wireless phones, DVD players, battery-powered vacuum cleaner, and Internet routers etc.

The main reason the use DC sources is because most of the renewable energy sources generates DC power. Also, the power storing units like battery stores DC power. The DC to AC conversion process through inverter causes a huge inversion loss. And the last but one a very important fact about AC source is that AC generated from different sources cannot be mixed up without proper phase and frequency synchronisation.

A Smart Grid is an electrical grid that uses information and communication technology to gather and act on information such as information about the behaviour of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity

This Smart Grid technology is an essential to provide easy integration and reliable service to the consumers, integration of renewable resources. It is fully automated

control for distribution of power accordingly the load demand, which reduces costs and also increases the transparency.

Now-a-days most of the power that serves the mankind are build up from fossil fuels and almost 80% of the total power consumption comes from the burning of fossil fuels. The ultimate limit of the fossil fuels is to be achieved soon. The renewable energy sources will be taking the lead of power industry soon. So, this DC micro grid system will be equally efficient if connected to a renewable energy source for power generation.

This DC Smart Micro-Grid has some basic functions:

1. Irrespective of load demand the bus voltage must maintained to a previously determined constant level
2. The data from the cloud can be obtained easily and the smart meters helps to monitor the Bus Health and its Parameters in Real-Time using IoT.
3. This system increases reliability and also the power quality.

In the conventional grid method, the consumers can only buy electricity to fulfil their need and the responsibility of generation, transmission and distribution of electricity are bound to respective authorities. With the implementation of renewable energy sources, production of energy may not be bound to respective authorities, which means the consumers can also participate in the production of power and can also supply power to grid. This new group is termed as PROSUMER.

2. Theory:

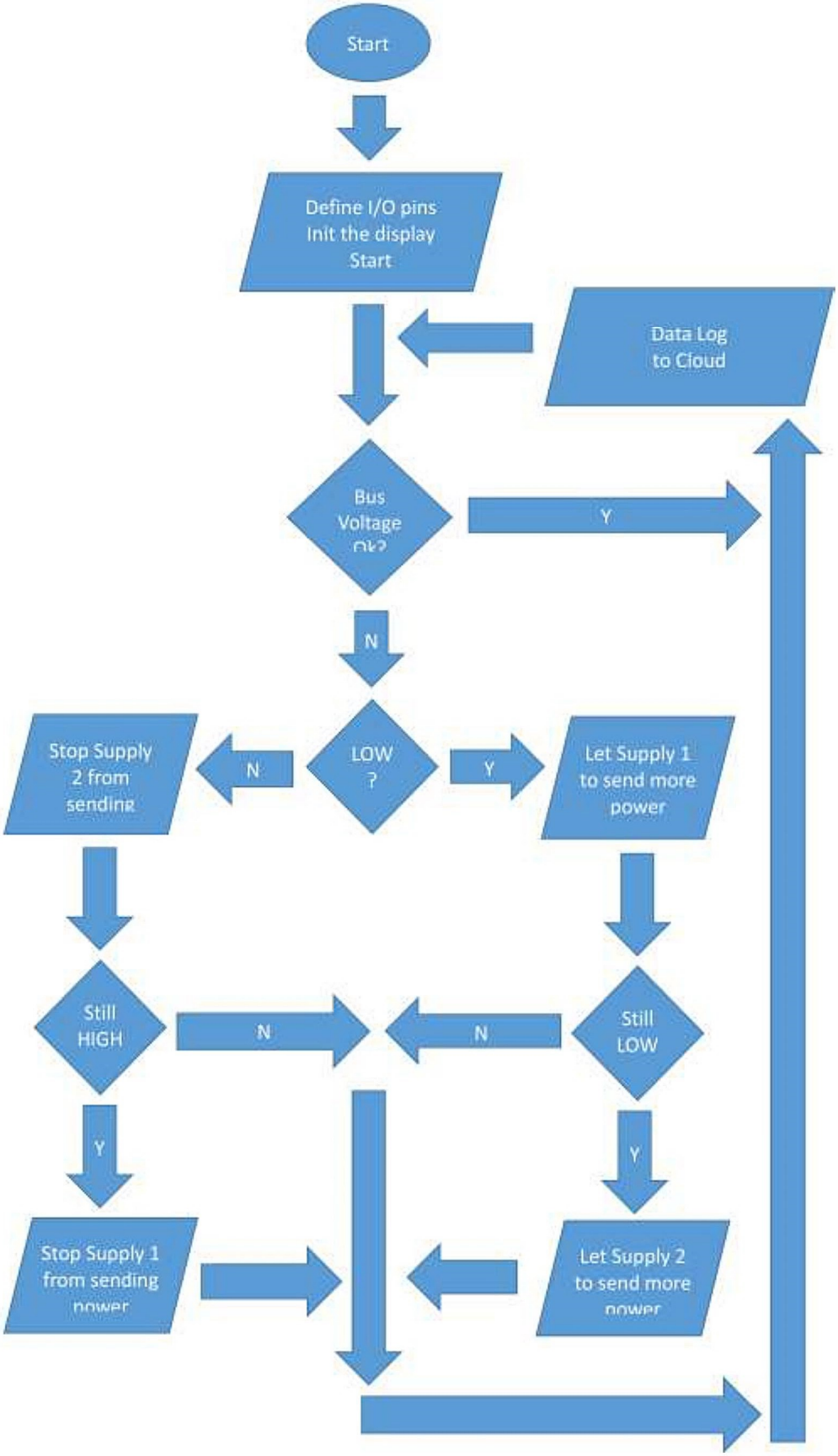
2.1. Working Principle

The DC Micro Grid Controls the power flow to a DC bus by measuring the voltage. It mainly keeps the bus voltage constant in this case 12V. If the voltage falls below controller first allows the supply 1 to send more power to make the voltage high, if it fails then it allows supply 2 to send more power. In other hand it the voltage of the bus increases the controller cuts power from supply 2 if the voltage stays still high it cuts power from the supply 1 also. By this way the controller keeps the voltage of the bus constant irrespective of load.

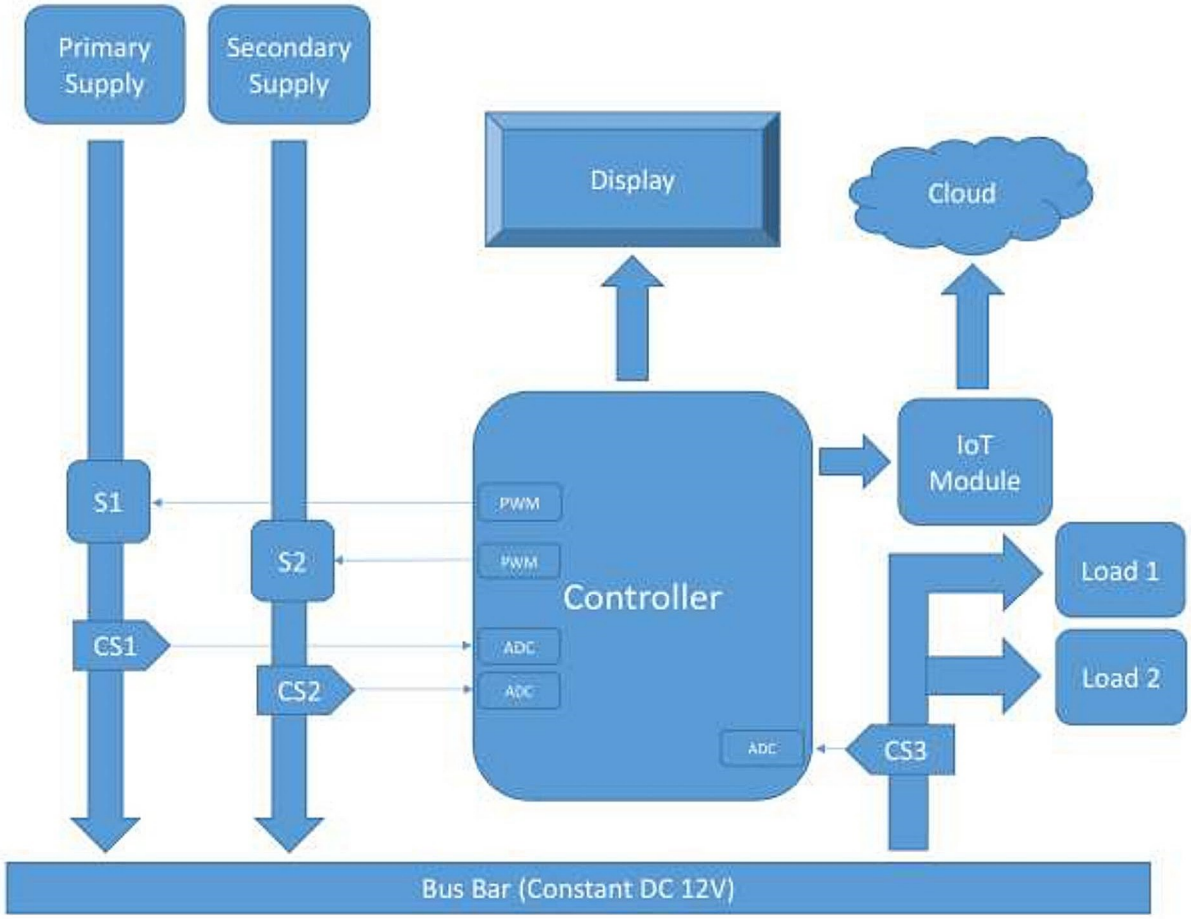
An integrator capacitor is used to smoothen the switched voltage waveform. Too big capacitor introduces delay in system response and a very small one neither able to smooth the waveform nor it can keep necessary energy reserves for momentary peaks.

The data (voltage, load current, supply current 1, supply current 2) measured and calculated has been stored in Thinkspeak cloud through NodeMcu at an interval of 16 seconds for monitoring & measurement purpose. This Cloud data may be used for further Analysis, Characterization and Prediction purpose.

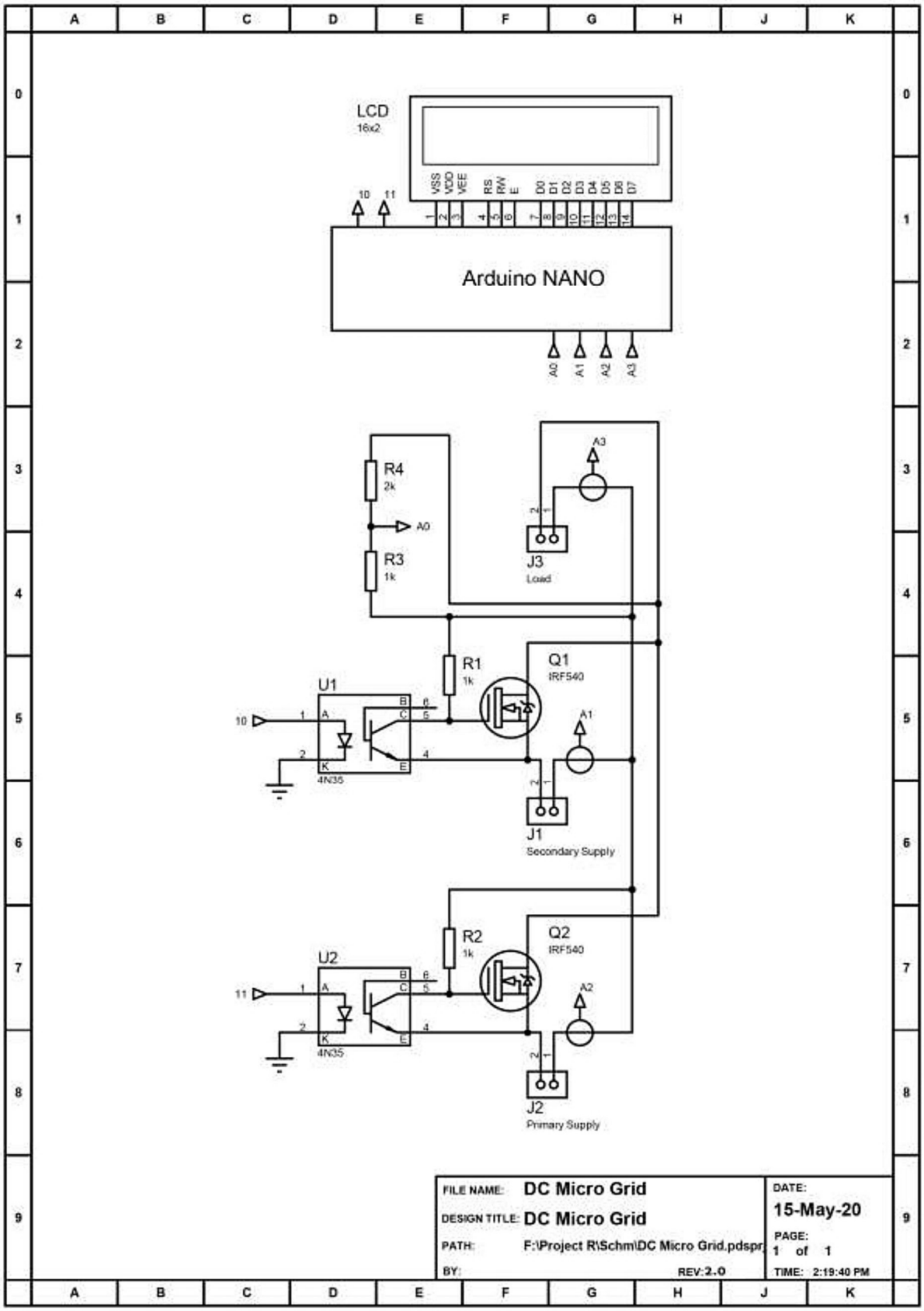
2.2. Flow Chart



2.3. Block Diagram



2.4. Circuit Diagram



2.5. Components List

Sl. No.	Item
1.	Arduino Nano
2.	IRF 540 n-MOSFET
3.	ACS712 Current Sensor
4.	ESP8266
5.	LCD Module
6.	Opto-Isolator

2.6. Component Descriptions

2.6.1. Arduino Nano

Arduino Nano is a small, compatible, flexible and breadboard friendly microcontroller board based on ATMEGA328P. It comes with an operating voltage of 5V, however, the power input pin (Vin) voltage can vary from 7 to 12V.

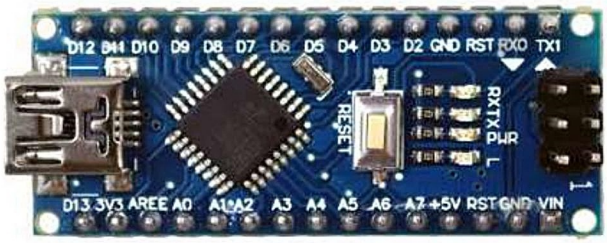
Arduino Nano Pinout contains 14 digital pins,

- D0-D13

8 analog Pins

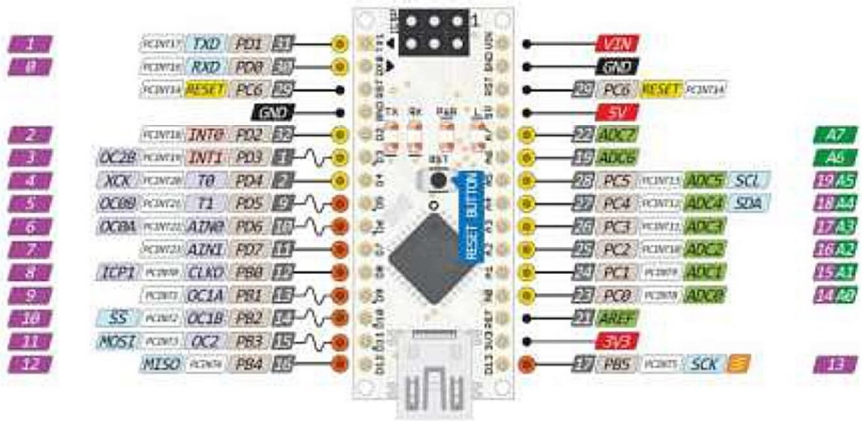
- A0-A7

2 Reset Pins & 6 Power Pins.



It has built in 8channel, 10-bit ADC that can measure approx. 5mV minimum. Pin A0-A5 can be used as digital pin if required.

It has DAC of 8-bit that can give output from 0 to 5 V. PWM Pins 3, 5, 6, 9, 10, & 11 does this operation.



Default Serial Communication pins are D0/RXD and D1/TXD.

Software Serial is also available with any two digital pins by including software serial library.

Programmable Flash Memory is 32 KB.

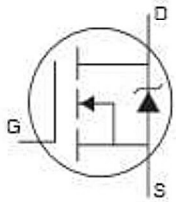
SRAM is 2 KB

EEPROM is 1 KB

CLK Speed is 16 MHz

2.6.2. IRF 540 n-MOSFET

Number: IRF540
Drain-Source Voltage VDS = 100 Volts
Gate-Source Voltage VGS = ± 20 Volts
Continuous Drain Current =
28A @ VGS = 10V, Temp = 25 °C
20A @ VGS = 10V, Temp = 100 °C
RDS (Ω) = 0.077 Ohm
Fast Switching
175 °C Operating Temperature
Package TO-220AB



2.6.3. ACS712 Current Sensor

- IC Number ACS712ELCTR-05B-T
- Range ±5A
- Low-noise analog signal path
- 5.0 V, single supply operation
- 1.2mΩ internal conductor resistance
- Output voltage proportional to AC or DC currents
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Factory-trimmed for accuracy
- Ratiometric output from supply voltage
- 66 to 185 mV/A output sensitivity
- Total output error 1.5% at TA = 25°C
- Small footprint, low-profile SOIC8 package
- 80 kHz bandwidth
- Device bandwidth is set via the new FILTER pin
- 5 µs output rise time in response to step input current

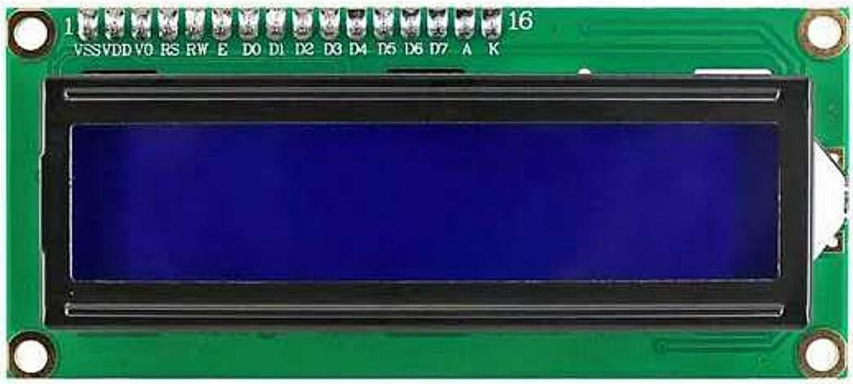
2.6.4. ESP8266

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

- 802.11 b/g/n
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- +19.5dBm output power in 802.11b mode
- Power down leakage current of <10uA
- 1MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

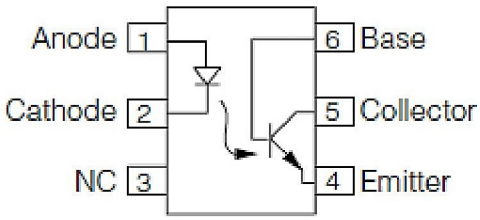
2.6.5. LCD Module

Liquid Crystal Display is a type of flat panel display which uses liquid crystals in its primary form of operation.



2.6.6. Opto-Isolator

Opto-isolator, consists of an LED that produces infra-red light and a semiconductor photo-sensitive device that is used to detect the emitted infra-red beam. Both the LED and photo-sensitive device are enclosed in a light-tight body or package with metal legs.



4N35

3. Software Program:

```
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>
#include <ArduinoJson.h>
SoftwareSerial s(9,12);
float v,i1,i2,iL;
int Temp,pwmS1=0,pwmS2=0;
float Weight, MeasurementsToAverage, AverageCurrentS1,
PreviousAverageCurrentS1, AverageCurrentS2, PreviousAverageCurrentS2,
AverageCurrentL, PreviousAverageCurrentL;
LiquidCrystal lcd(3, 4, 5, 6, 7, 8);
void setup() {
 analogWrite(11, pwmS1);
 analogWrite(10, pwmS2);
 s.begin(9600);
 lcd.begin(16, 2);
 lcd.print("  DC Micro Grid");
 delay(1500);
 lcd.clear();
 lcd.print("VB=     IL=     ");
 lcd.setCursor(0, 2);
 lcd.print("I1=     I2=     ");
 pinMode(LED_BUILTIN, OUTPUT);
}
void loop() {
v = r_a_d_voltage();
if (v < 12)
 {
   while( v < 12 )
   {
     v = r_a_d_voltage();
     if ( pwmS1 < 255 ) { pwmS1+=1; }
     if ( pwmS1 > 55 )
      {
        if ( pwmS2 < 255 ) { pwmS2+=1; }
      }
   analogWrite(11, 255-pwmS1);
```

```
    analogWrite(10, 255-pwmS2);
    display_i1_i2_iL();
    datatoserver();
    }
  }
else if ( v > 12 )
  {
    if ( pwmS2 > 0 ) { pwmS2-=1; }
    if ( pwmS2 < 200)
     {
       if (  pwmS1 > 0 ) { pwmS1-=1; }
     }
    analogWrite(11, 255-pwmS1);
    analogWrite(10, 255-pwmS2);
    Temp = r_a_d_voltage();
    display_i1_i2_iL();
    datatoserver();
  }
}
void datatoserver(void)
{
  StaticJsonBuffer<1000> jsonBuffer;
  JsonObject& root = jsonBuffer.createObject();
  v = r_a_d_voltage();
  iL = measure_iL();
  i2 = measure_i2();
  i1 = measure_i1();
  root["data1"] = v;
  root["data2"] = iL;
  root["data3"] = i1;
  root["data4"] = i2;
  digitalWrite(LED_BUILTIN, HIGH);
  delay(50);
  digitalWrite(LED_BUILTIN, LOW);
}
float r_a_d_voltage(void) {
  float Weight;
```

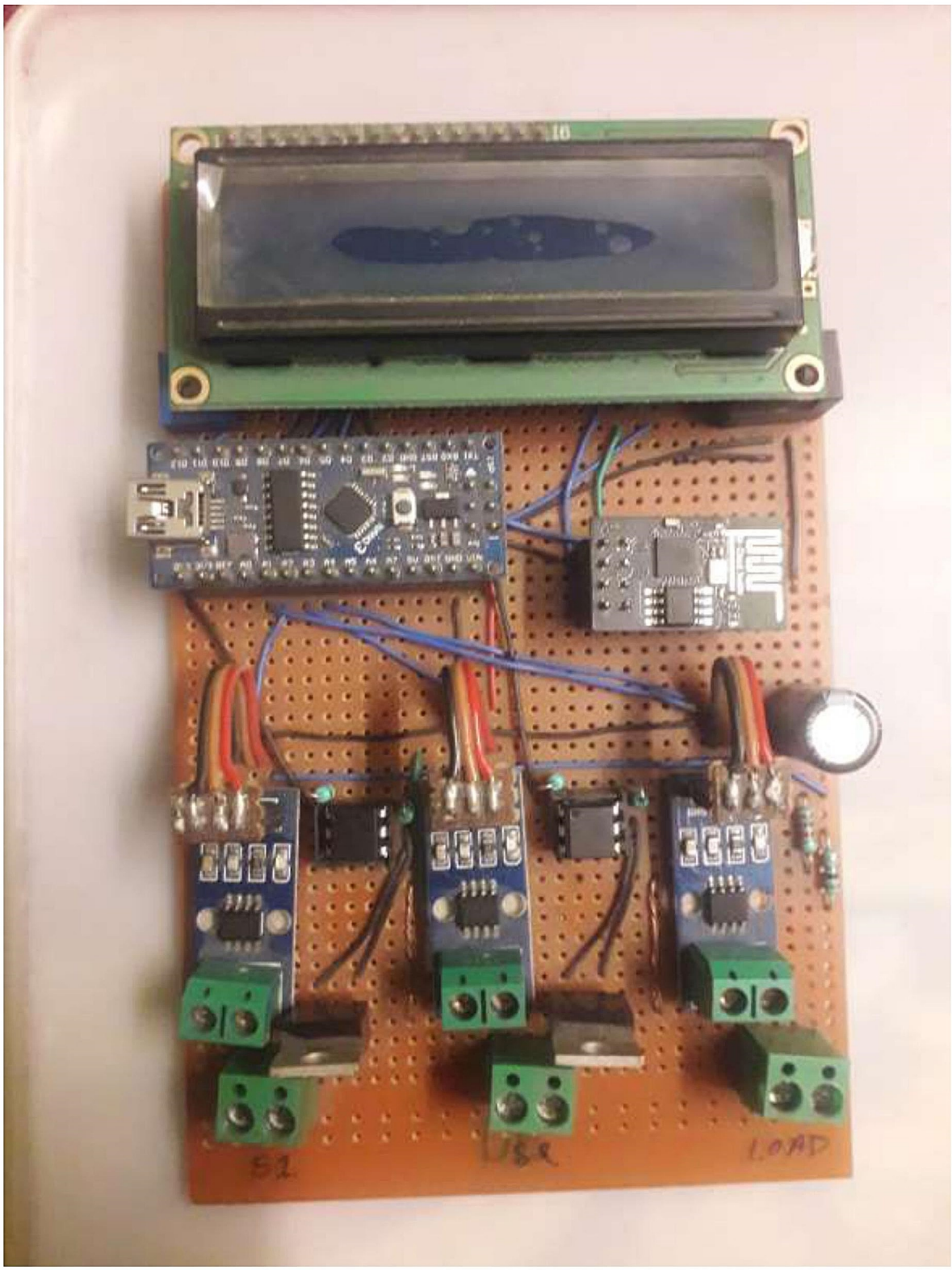
```
 float MeasurementsToAverage = 50;
 float AverageVoltage = 0;
 float PreviousAverageVoltage;
 int i;
 float Temp;
 for(i = 0; i < MeasurementsToAverage; ++i)
 {
  AverageVoltage += (analogRead(A0));
  delay(1);
 }
 AverageVoltage /= MeasurementsToAverage;
 Temp = AverageVoltage;
 AverageVoltage *= 0.026325;//(3.24*(5/1023))*1.66234
 Weight = 0.6;
 AverageVoltage = (Weight*AverageVoltage)+(1-
Weight)*PreviousAverageVoltage;
 PreviousAverageVoltage = AverageVoltage;
 lcd.setCursor(7, 0);
 lcd.print(" ");
 lcd.setCursor(3, 0);
 lcd.print(AverageVoltage);
return AverageVoltage;
}
float measure_i1( void )
{
 float Weight;
 float MeasurementsToAverage = 200;
 float AverageCurrentS1 = 0;
 float PreviousAverageCurrentS1;
 int i;
 for(i = 0; i < MeasurementsToAverage; ++i)
 {
  AverageCurrentS1 += (analogRead(A1)-514.25);//511.05 Needs to be
check
  delay(1);
 }
 AverageCurrentS1 /= MeasurementsToAverage;
```

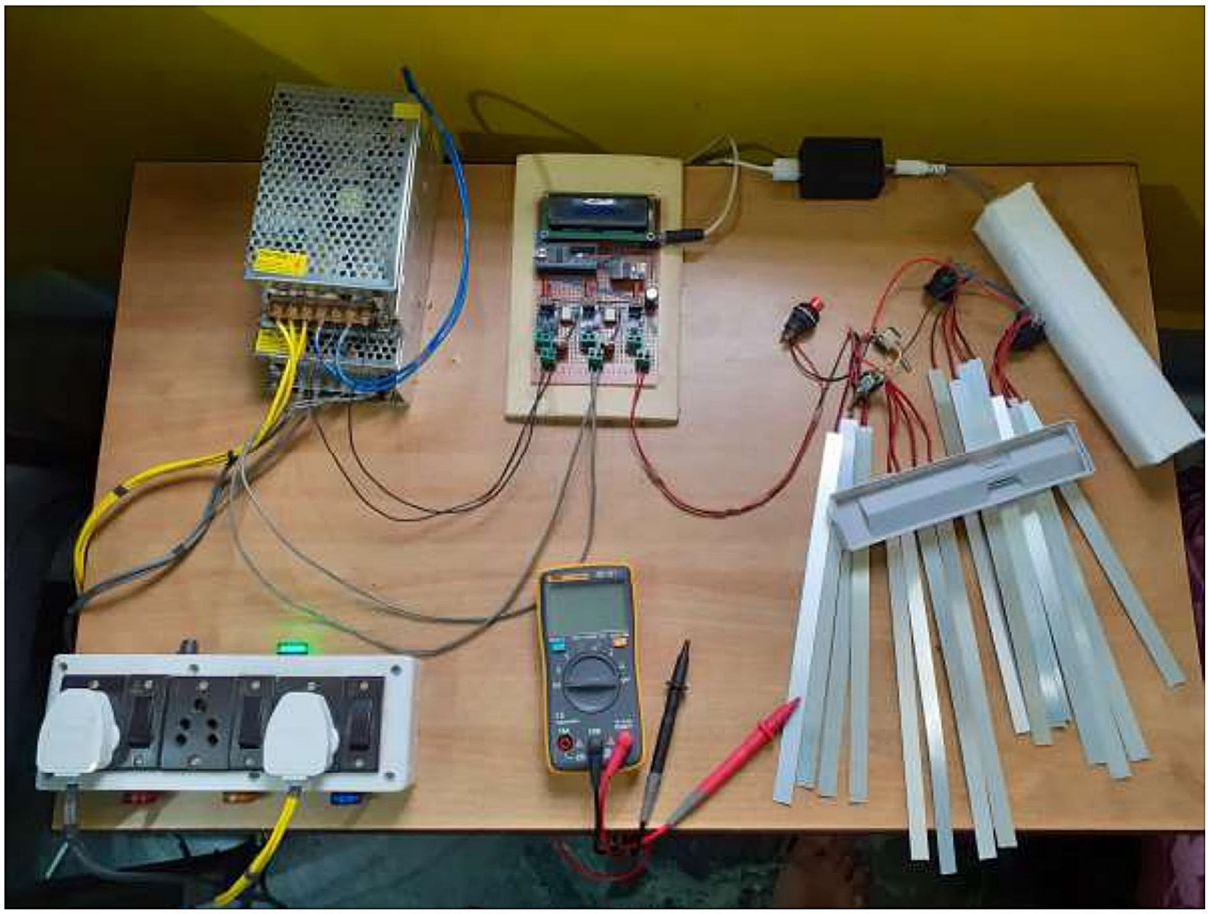
```
  AverageCurrentS1 *= (0.00979*2.65);//Needs to be check
  Weight = 0.6;
  AverageCurrentS1 = (Weight*AverageCurrentS1)+(1-
Weight)*PreviousAverageCurrentS1;
  PreviousAverageCurrentS1 = AverageCurrentS1;
  return AverageCurrentS1*(-1);
}
float measure_i2( void )
{
  float Weight;
  float MeasurementsToAverage = 200;
  float AverageCurrentS2 = 0;
  float PreviousAverageCurrentS2;
  int i;
  for(i = 0; i < MeasurementsToAverage; ++i)
  {
    AverageCurrentS2 += (analogRead(A2)-512.5);//511.05 Needs to be check
    delay(1);
  }
  AverageCurrentS2 /= MeasurementsToAverage;
  AverageCurrentS2 *= (0.00979*2.65);//Needs to be check
  Weight = 0.6;
  AverageCurrentS2 = (Weight*AverageCurrentS2)+(1-
Weight)*PreviousAverageCurrentS2;
  PreviousAverageCurrentS2 = AverageCurrentS2;
  return AverageCurrentS2*(-1);
}
float measure_iL( void )
{
  float Weight;
  float MeasurementsToAverage = 200;
  float AverageCurrentL = 0;
  float PreviousAverageCurrentL;
  int i;

  for(i = 0; i < MeasurementsToAverage; ++i)
  {
```

```
   AverageCurrentL += (analogRead(A3)-511.75);//511.05 Needs to be check
   delay(1);
  }
  AverageCurrentL /= MeasurementsToAverage;
  AverageCurrentL *= (0.00979*2.65);//Needs to be check
  Weight = 0.6;
  AverageCurrentL = (Weight*AverageCurrentL)+(1-
Weight)*PreviousAverageCurrentL;
  PreviousAverageCurrentL = AverageCurrentL;
  return AverageCurrentL;
}
void display_i1_i2_iL( void ) {
  float Weight;
  float MeasurementsToAverage = 200;
  float AverageCurrentL = 0;
  float PreviousAverageCurrentL;
  float AverageCurrentS2 = 0;
  float PreviousAverageCurrentS2;
  float AverageCurrentS1 = 0;
  float PreviousAverageCurrentS1;
  int i;
  for(i = 0; i < MeasurementsToAverage; ++i)
  {
   AverageCurrentL += (analogRead(A3)-511);    AverageCurrentS2 +=
(analogRead(A2)-512);    AverageCurrentS1 += (analogRead(A1)-514);
   delay(1);
  }
  AverageCurrentL /= MeasurementsToAverage;
  AverageCurrentL *= (0.00979*2.65);
  AverageCurrentS2 /= MeasurementsToAverage;
  AverageCurrentS2 *= (0.00979*2.65);//Needs to be check
  AverageCurrentS1 /= MeasurementsToAverage;
  AverageCurrentS1 *= (0.00979*2.65);//Needs to be check
  Weight = 0.2;
  AverageCurrentL = (Weight*AverageCurrentL)+(1-
Weight)*PreviousAverageCurrentL;
  PreviousAverageCurrentL = AverageCurrentL;
```

```
  AverageCurrentS2 = (Weight*AverageCurrentS2)+(1-
Weight)*PreviousAverageCurrentS2;
  PreviousAverageCurrentS2 = AverageCurrentS2;
  AverageCurrentS1 = (Weight*AverageCurrentS1)+(1-
Weight)*PreviousAverageCurrentS1;
  PreviousAverageCurrentS1 = AverageCurrentS1;
  lcd.setCursor(15, 0);
  lcd.print(" ");
  lcd.setCursor(11, 0);
  lcd.print(AverageCurrentL);
  lcd.setCursor(15, 2);
  lcd.print(" ");
  lcd.setCursor(11, 2);
  lcd.print(AverageCurrentS2*(-1));
  lcd.setCursor(7, 2);
  lcd.print(" ");
  lcd.setCursor(3, 2);
  lcd.print(AverageCurrentS1*(-1));
}
```

4. Hardware Model:





During Testing

5. Observations and Results:

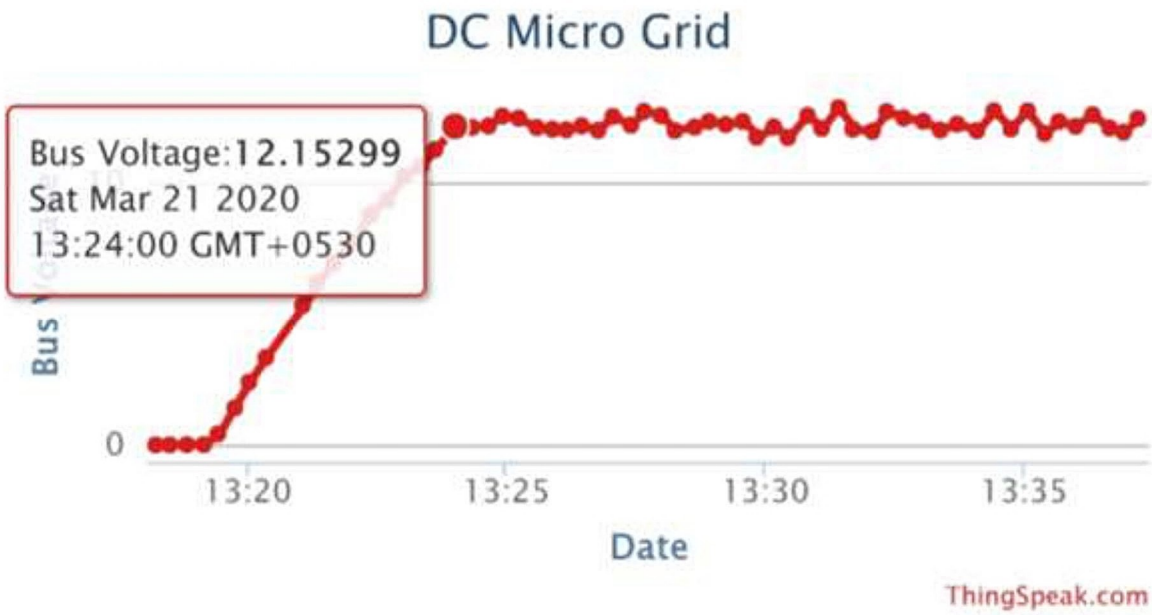
After running the hardware many times for hours with different loads we have observed that **the change in Bus Voltage is very less** and with time it **decreases to zero**. We have four loads and those are switched on and off randomly. According to that the load current also increased or decreased. But the bus voltage successfully managed to come back to its designated voltage of 12V.

The below result is shown of a test performed on 21st March 2020.

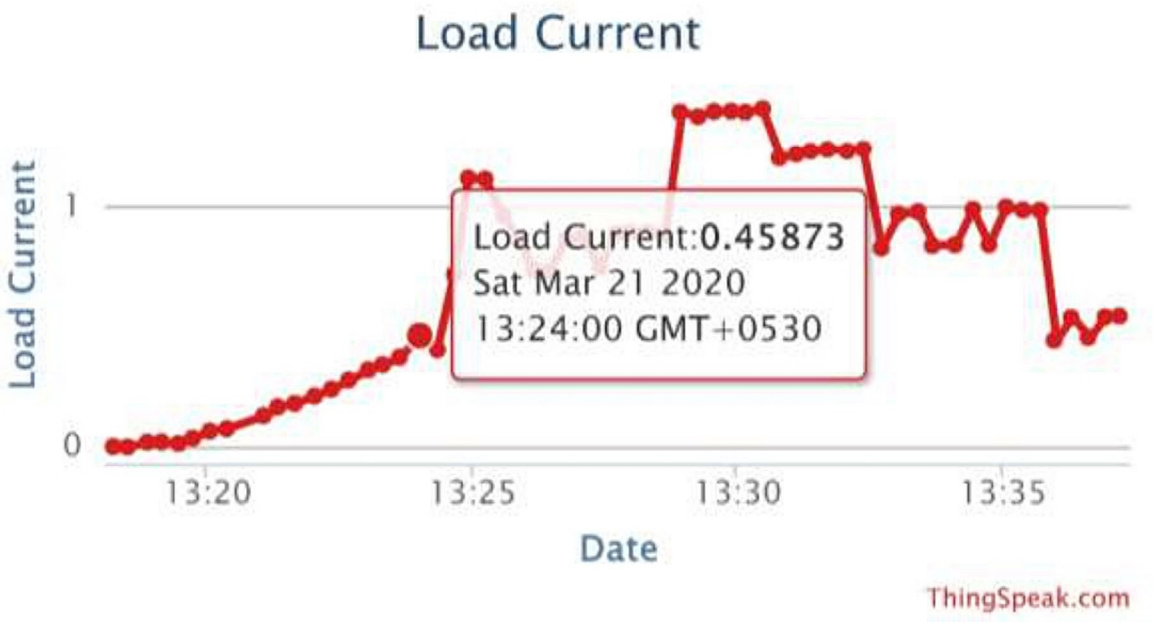
The samples blow were taken from the plot randomly are shown below.

Time		Bus Voltage	Load Current	Secondary Supply Current	Primary Supply Current
2020-03-21 13:24:00 IST	438	12.15299	0.45873	0.02483	0.4364
2020-03-21 13:25:14 IST	442	12.46068	1.11274	0.42589	0.65487
2020-03-21 13:28:38 IST	453	12.12393	0.88143	0.30385	0.54045
2020-03-21 13:30:11 IST	458	12.12898	1.39566	0.63782	0.72779
2020-03-21 13:31:44 IST	463	12.04432	1.23844	0.54069	0.64459
2020-03-21 13:33:24 IST	468	12.00894	0.97654	0.3753	0.56341

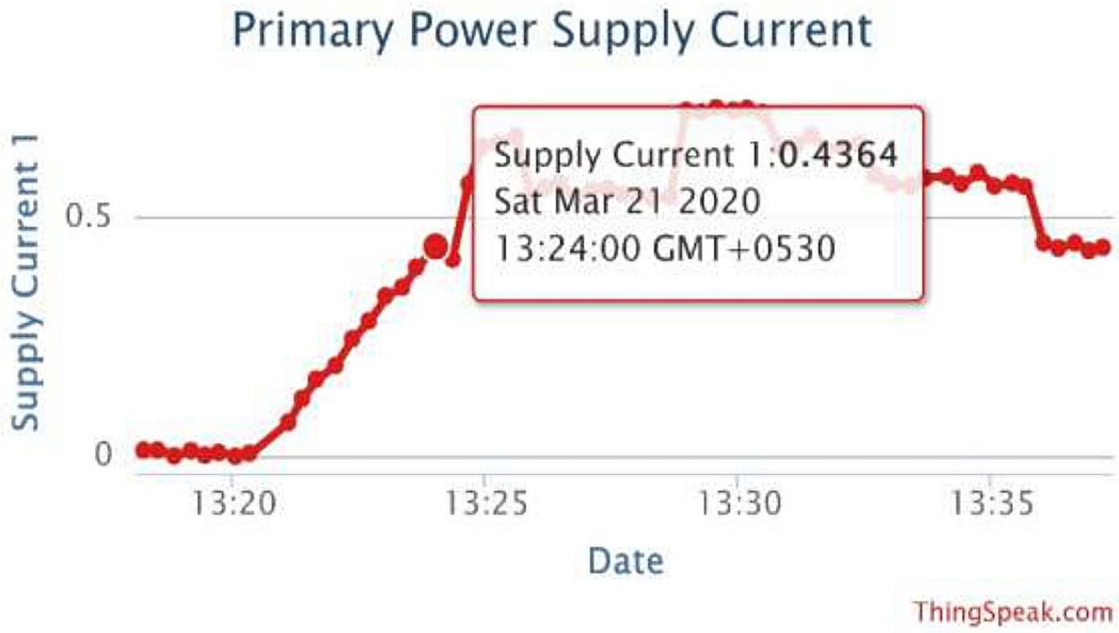
Only Load 1


DC Micro Grid
Bus Voltage:12.15299
Sat Mar 21 2020
13:24:00 GMT+0530
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

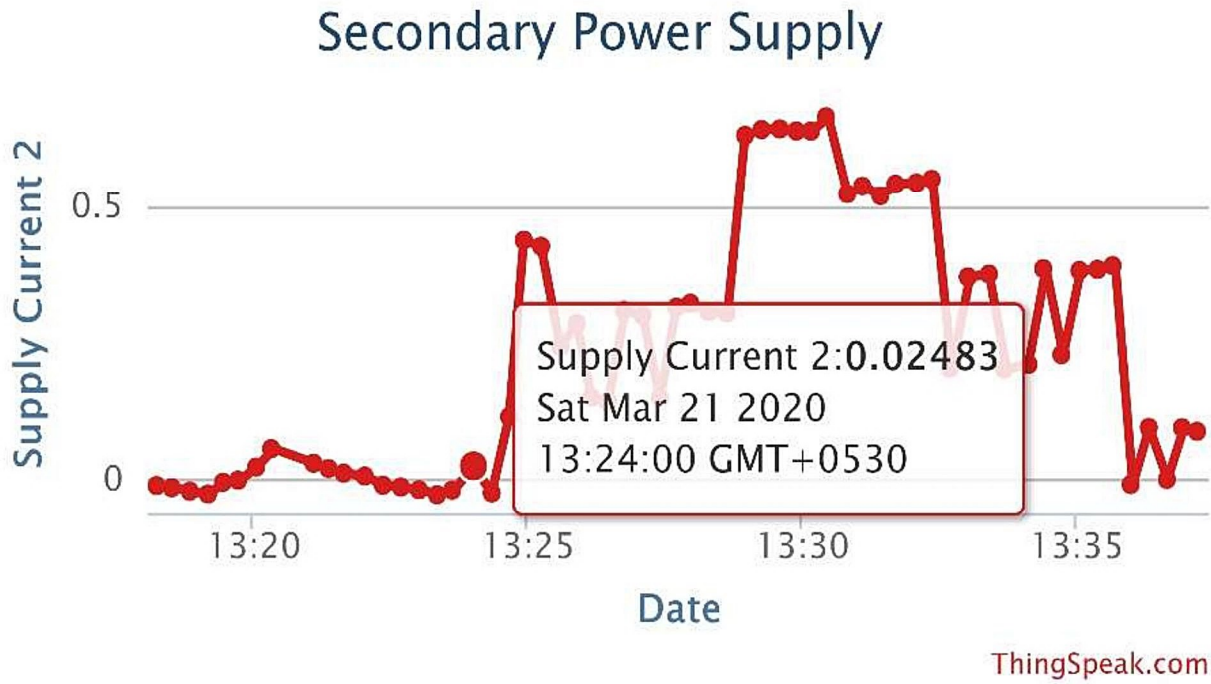
Only Load 1


Load Current
Load Current
1
0
Load Current:0.45873
Sat Mar 21 2020
13:24:00 GMT+0530
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

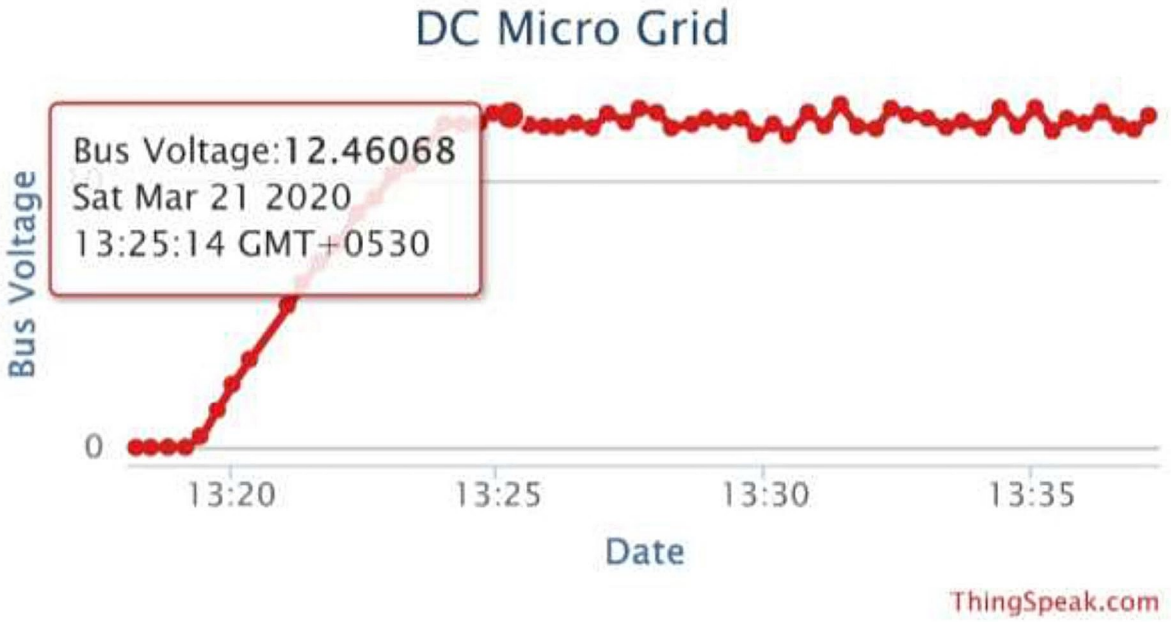
Only Load 1


Primary Power Supply Current
Supply Current 1
0.5
0
Supply Current 1:0.4364
Sat Mar 21 2020
13:24:00 GMT+0530
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

Only Load 1


Secondary Power Supply
Supply Current 2
0.5
0
Supply Current 2:0.02483
Sat Mar 21 2020
13:24:00 GMT+0530
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

Load 1, 2 & 3


DC Micro Grid
Bus Voltage:12.46068
Sat Mar 21 2020
13:25:14 GMT+0530
Bus Voltage
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

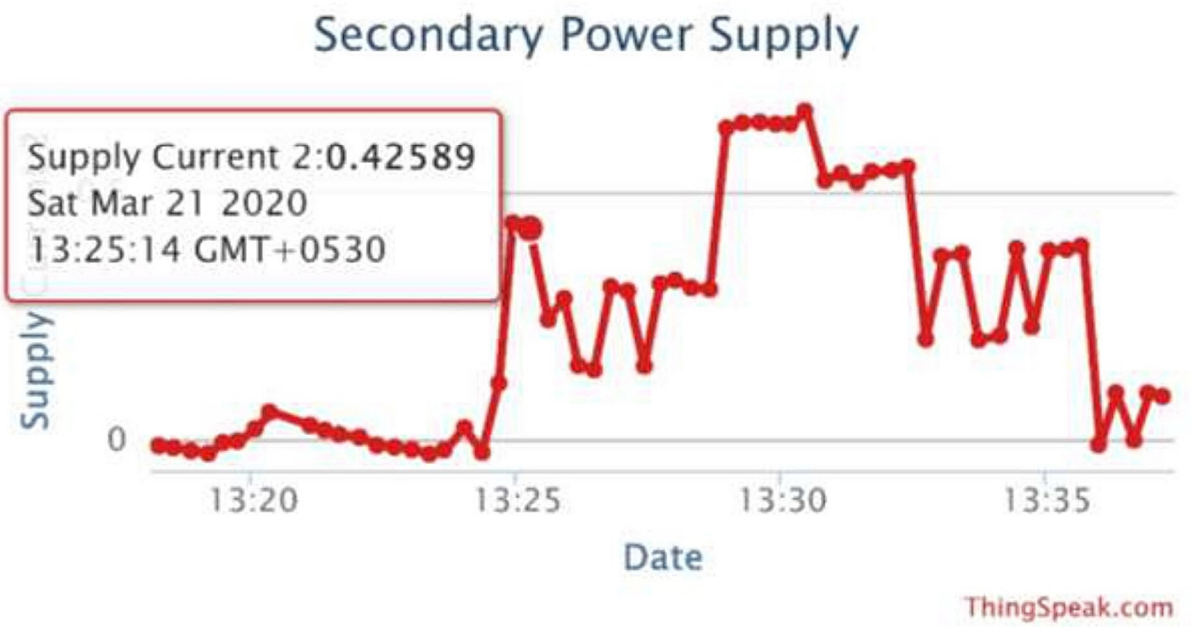
Load 1, 2 & 3


Load Current
Load Current:1.11274
Sat Mar 21 2020
13:25:14 GMT+0530
Load Current
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

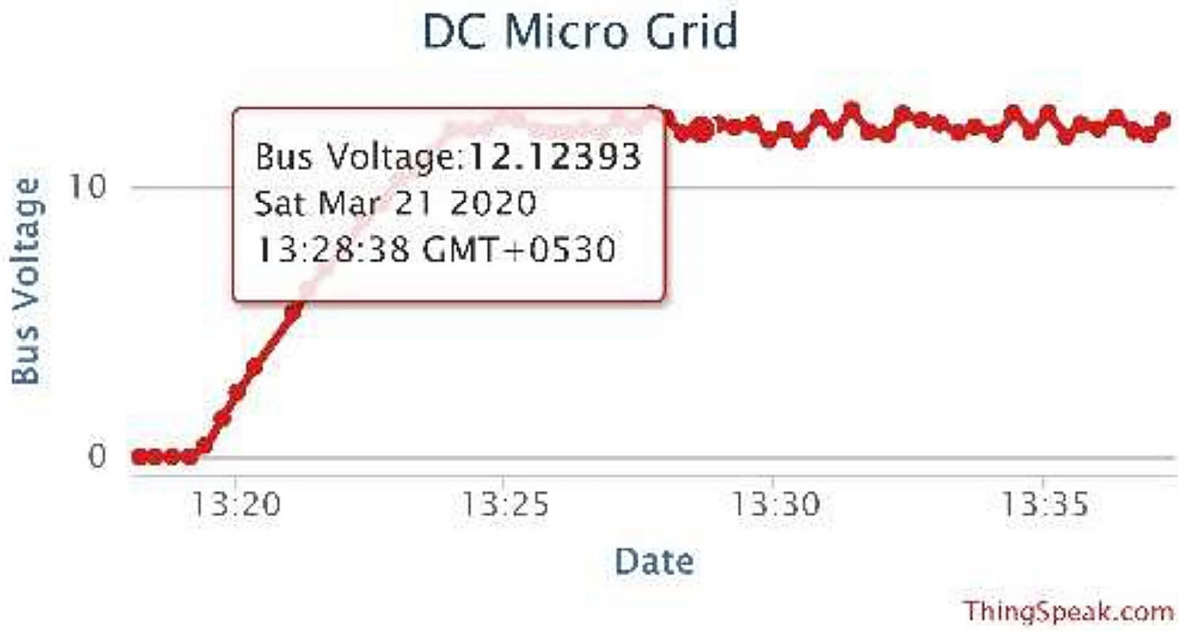
Load 1, 2 & 3


Primary Power Supply Current
Supply Current 1:0.65487
Sat Mar 21 2020
13:25:14 GMT+0530
Supply
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

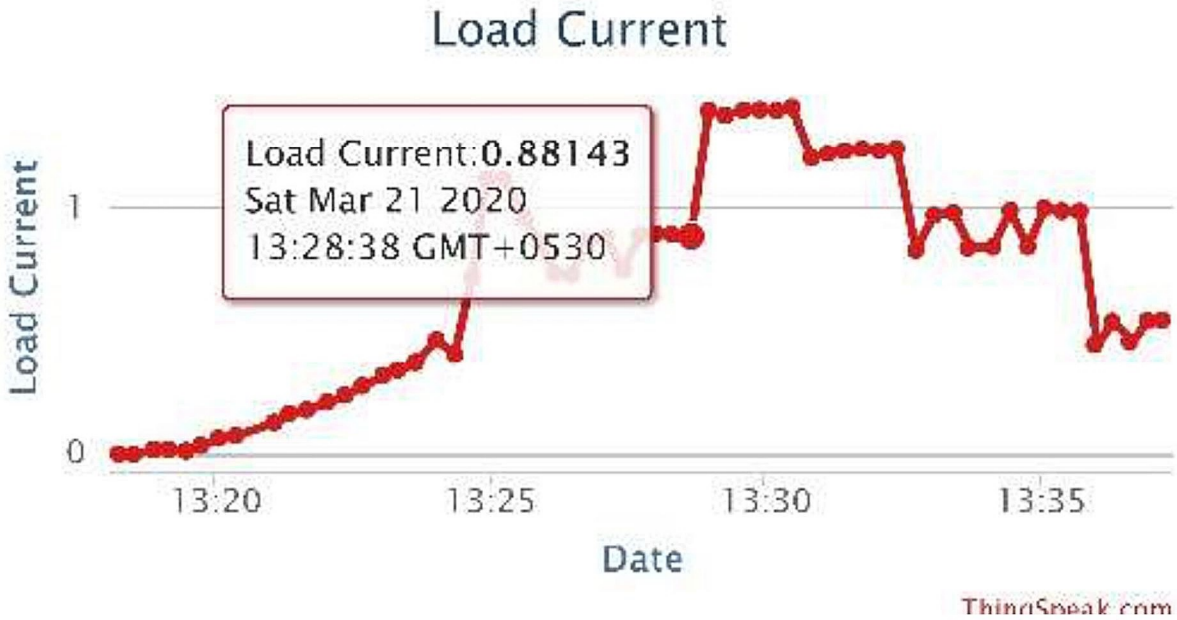
Load 1, 2 & 3


Secondary Power Supply
Supply Current 2:0.42589
Sat Mar 21 2020
13:25:14 GMT+0530
Supply
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

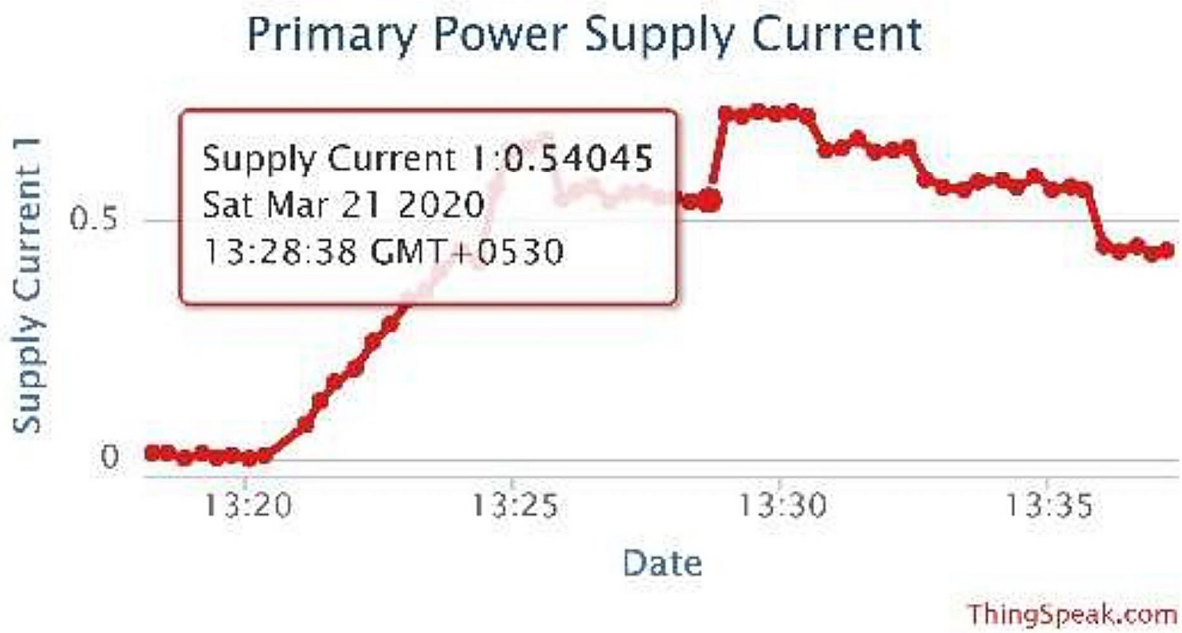
Load 1 & 2


DC Micro Grid
Bus Voltage:12.12393
Sat Mar 21 2020
13:28:38 GMT+0530
Bus Voltage
10
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

Load 1 & 2


Load Current
Load Current:0.88143
Sat Mar 21 2020
13:28:38 GMT+0530
Load Current
1
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

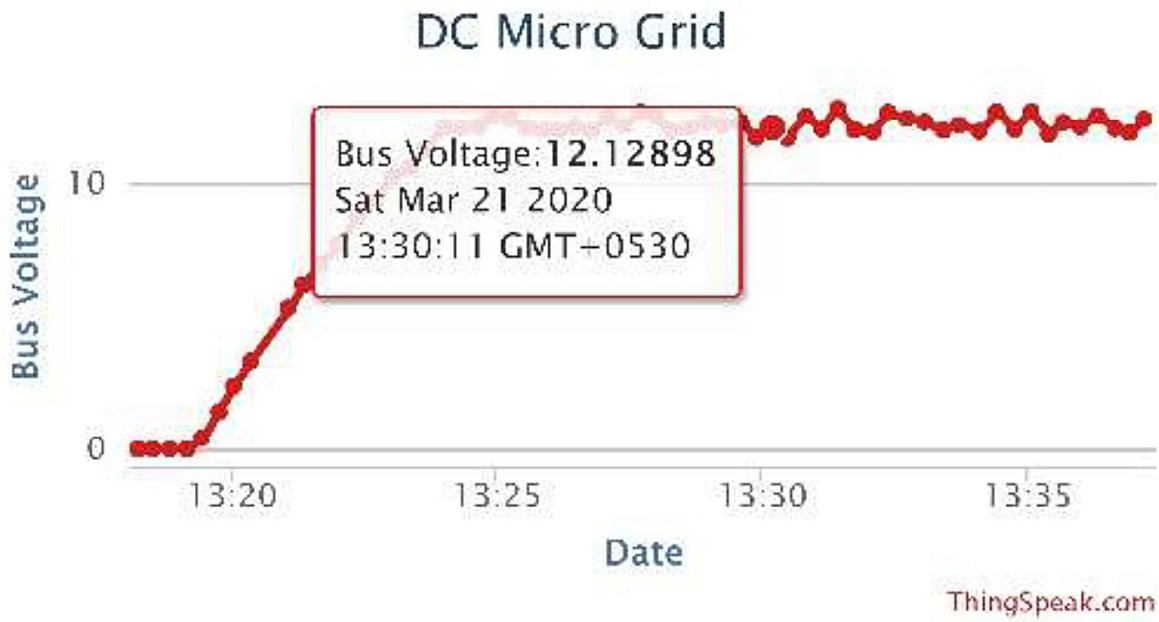
Load 1 & 2


Primary Power Supply Current
Supply Current 1:0.54045
Sat Mar 21 2020
13:28:38 GMT+0530
Supply Current 1
0.5
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

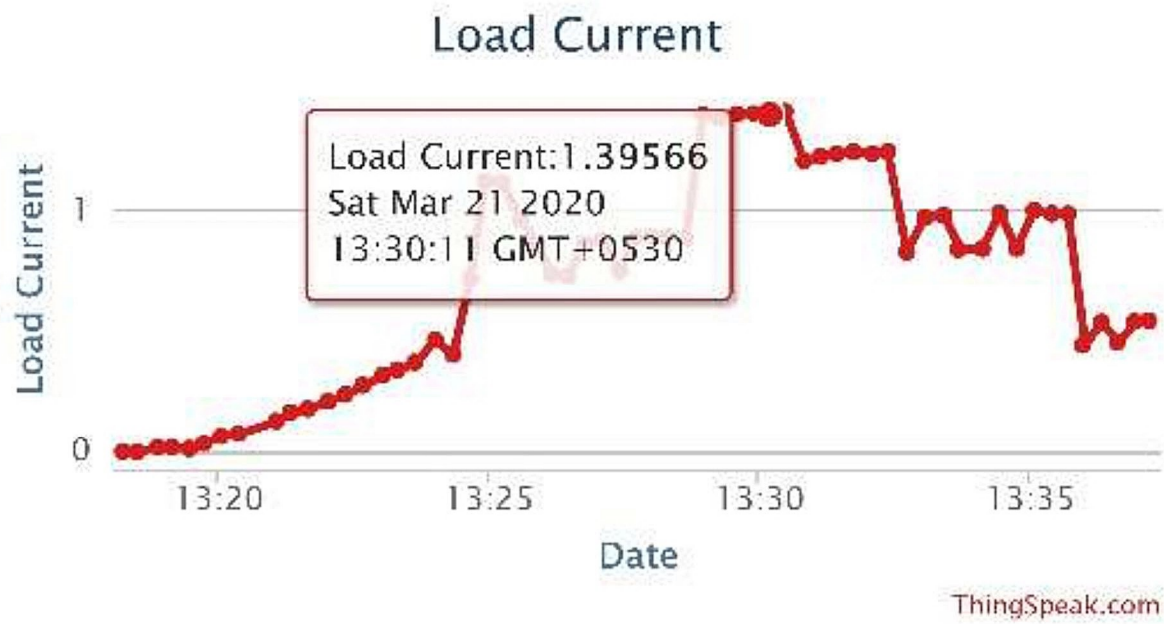
Load 1 & 2


Secondary Power Supply
Supply Current 2
0.5
0
Supply Current 2:0.30385
Sat Mar 21 2020
13:28:38 GMT+0530
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

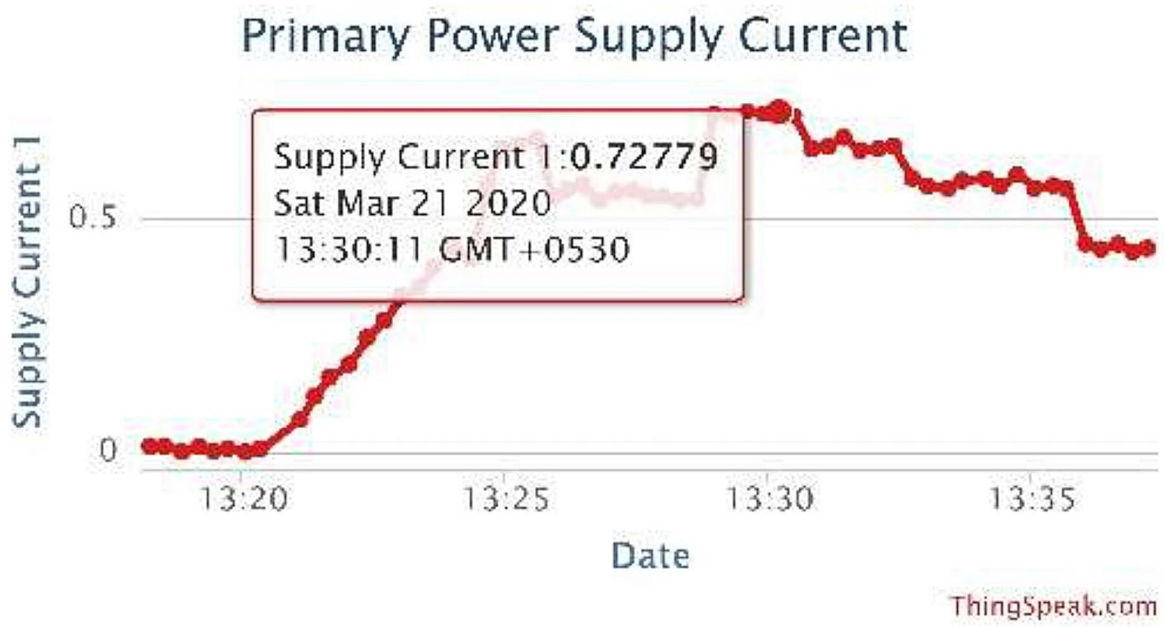
Load 1, 2, 3 & 4


DC Micro Grid
Bus Voltage:12.12898
Sat Mar 21 2020
13:30:11 GMT+0530
Bus Voltage
10
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

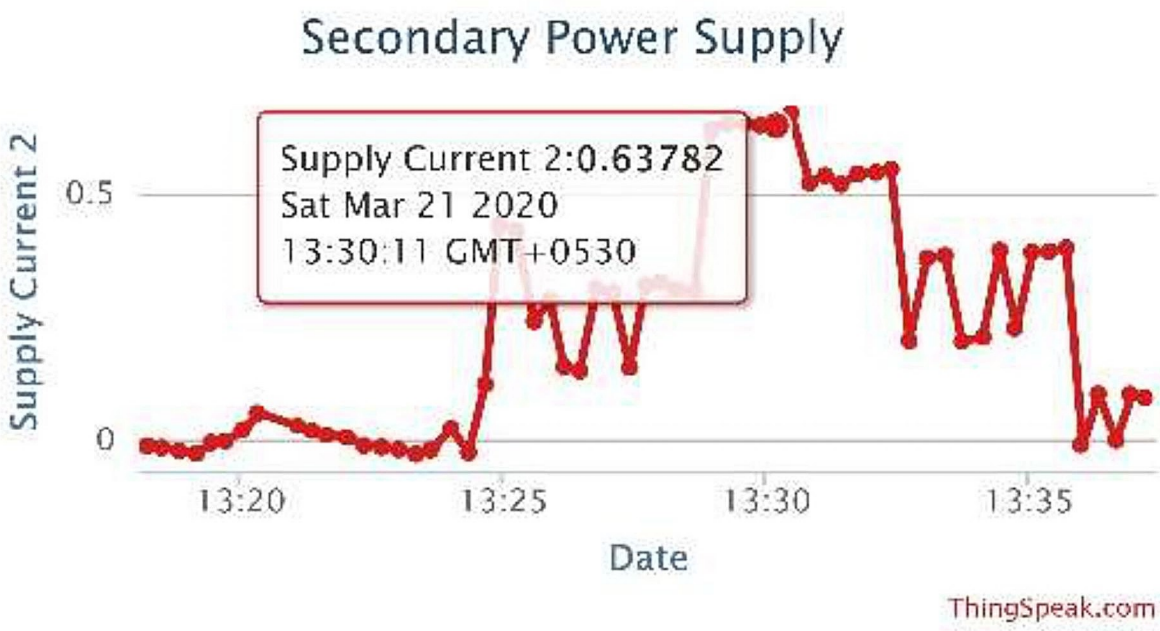
Load 1, 2, 3 & 4


Load Current
Load Current:1.39566
Sat Mar 21 2020
13:30:11 GMT+0530
Load Current
1
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

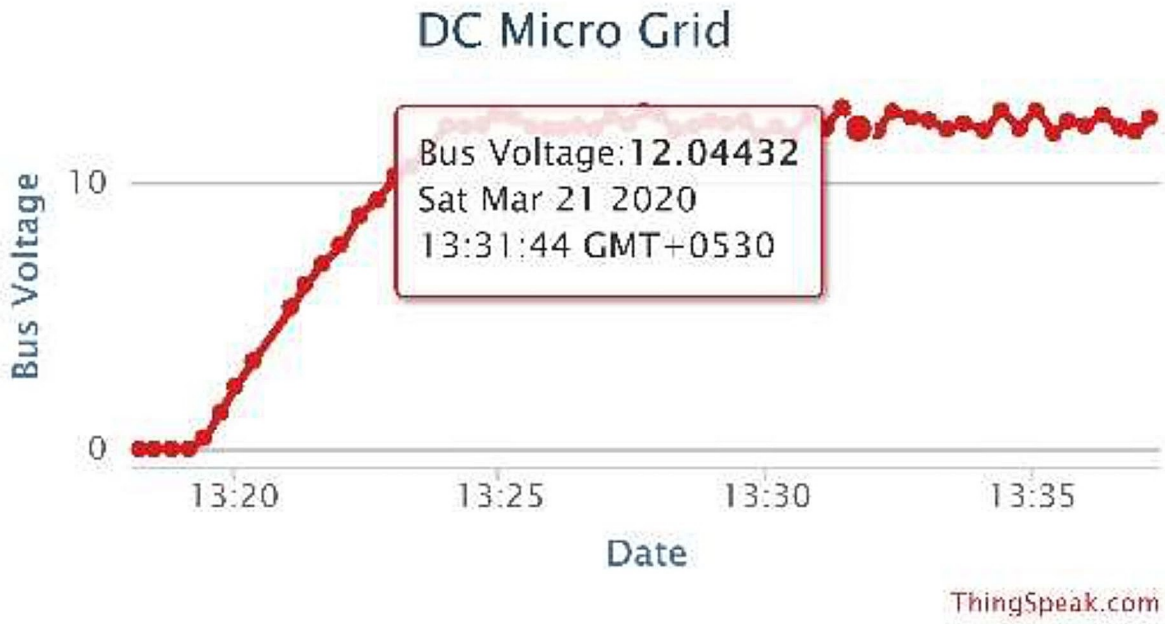
Load 1, 2, 3 & 4


Primary Power Supply Current
Supply Current 1:0.72779
Sat Mar 21 2020
13:30:11 GMT+0530
Supply Current 1
0.5
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

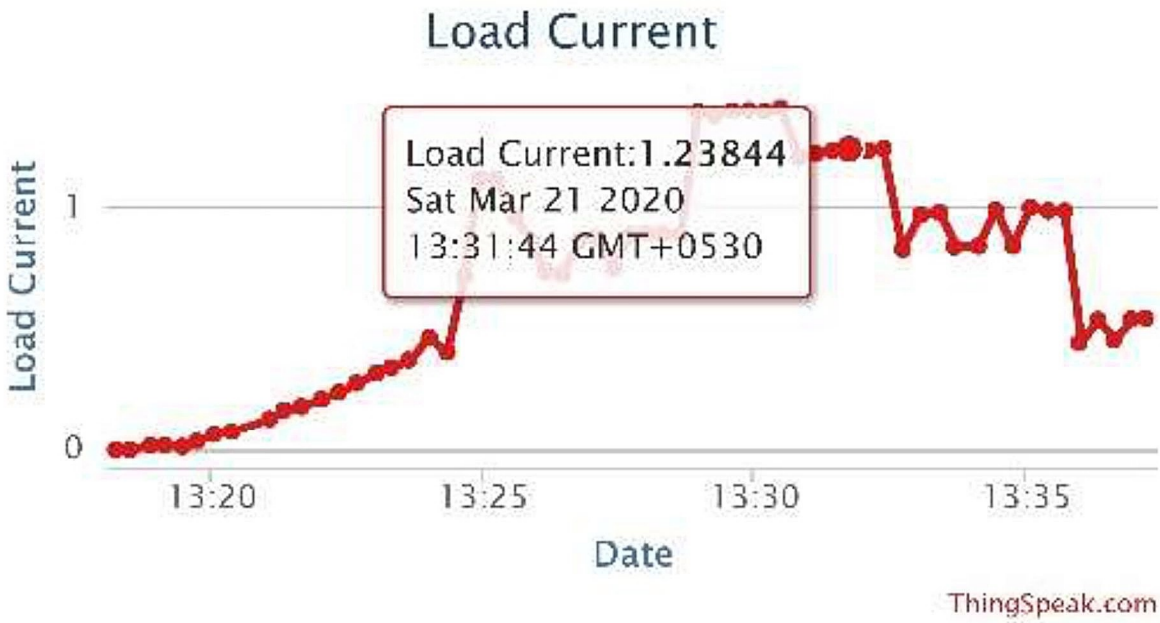
Load 1, 2, 3 & 4


Secondary Power Supply
Supply Current 2:0.63782
Sat Mar 21 2020
13:30:11 GMT+0530
Supply Current 2
0.5
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

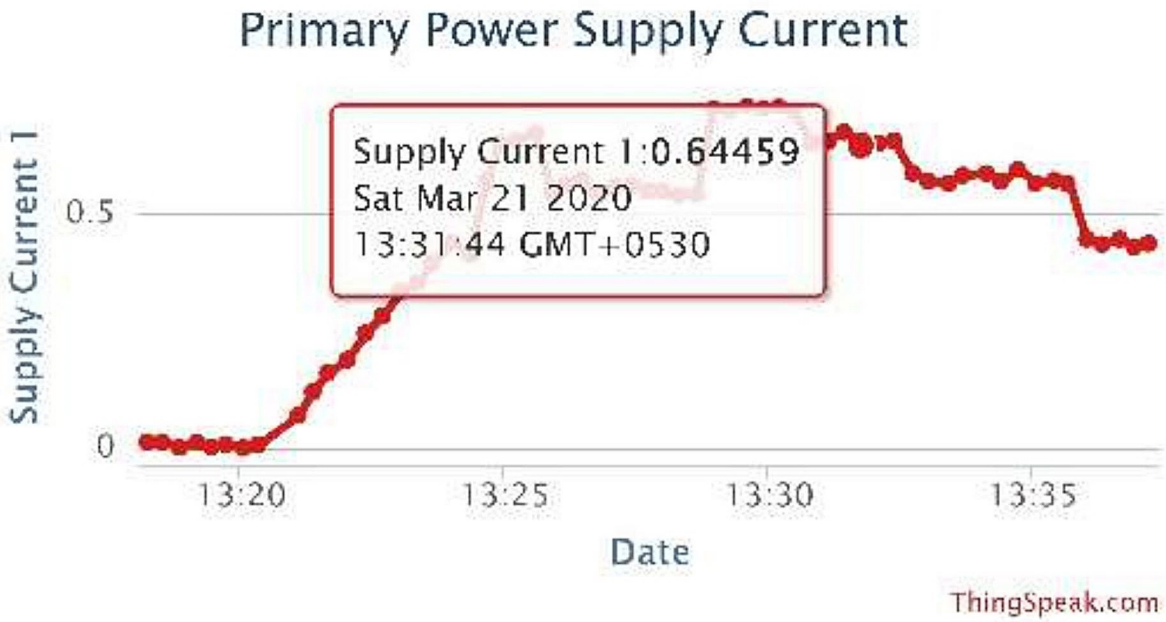
Load 1, 2 & 3


DC Micro Grid
Bus Voltage:12.04432
Sat Mar 21 2020
13:31:44 GMT+0530
Bus Voltage
10
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

Load 1, 2 & 3


Load Current
Load Current:1.23844
Sat Mar 21 2020
13:31:44 GMT+0530
Load Current
1
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

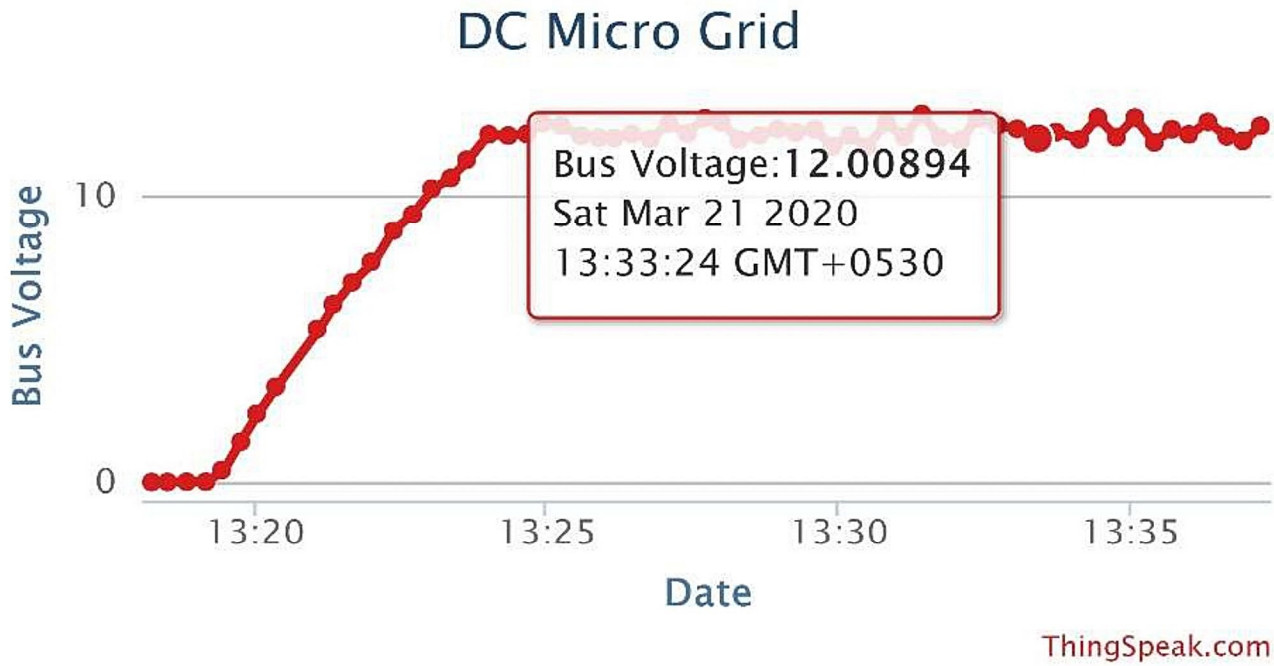
Load 1, 2 & 3


Primary Power Supply Current
Supply Current 1:0.64459
Sat Mar 21 2020
13:31:44 GMT+0530
Supply Current 1
0.5
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

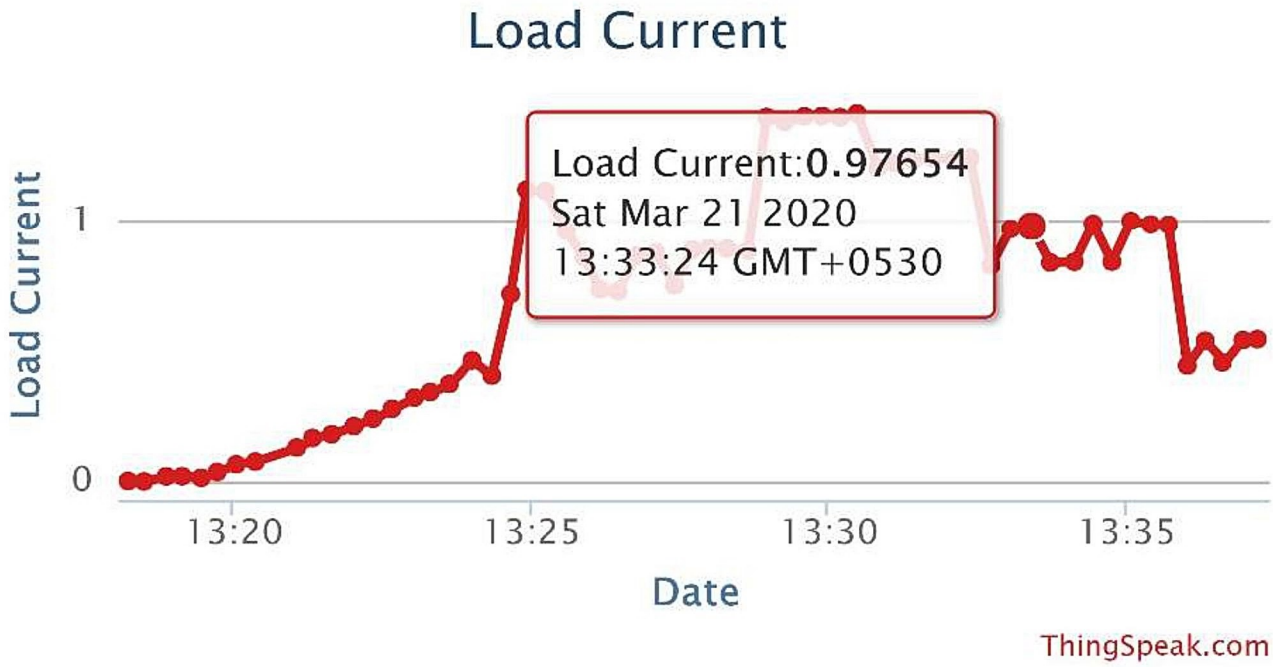
Load 1, 2 & 3


Secondary Power Supply
Supply Current 2:0.54069
Sat Mar 21 2020
13:31:44 GMT+0530
Supply Current 2
0.5
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

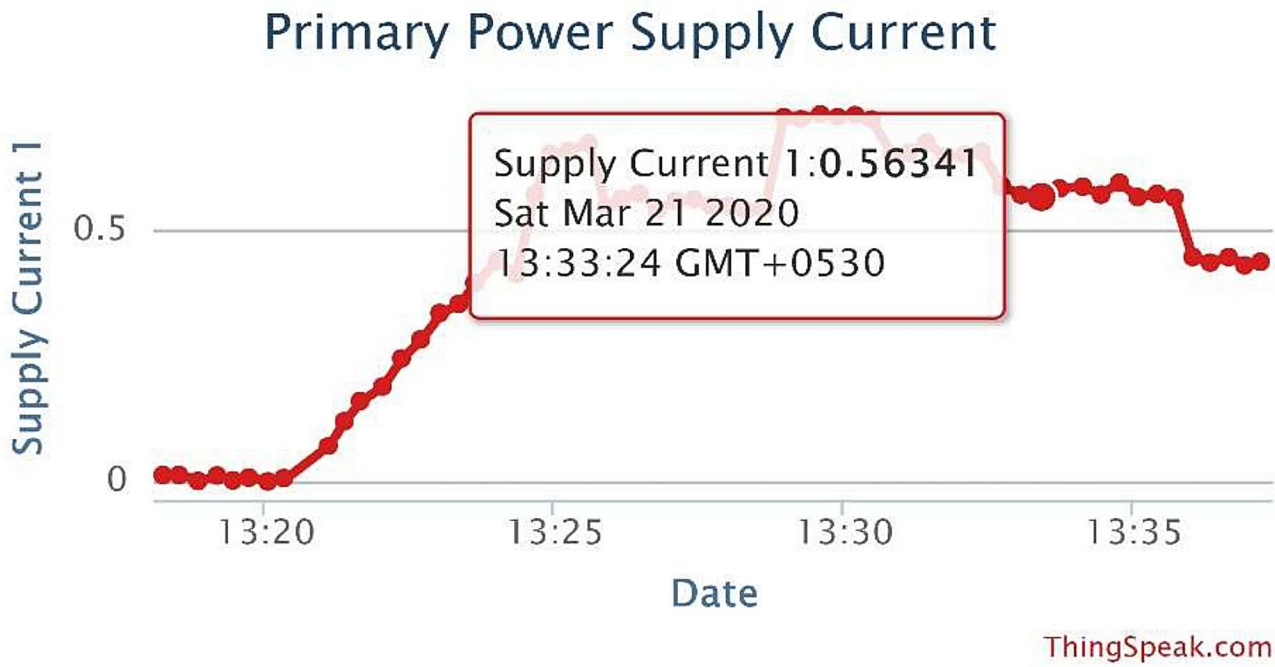
Only Load 1 & 2


DC Micro Grid
Bus Voltage:12.00894
Sat Mar 21 2020
13:33:24 GMT+0530
Bus Voltage
10
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

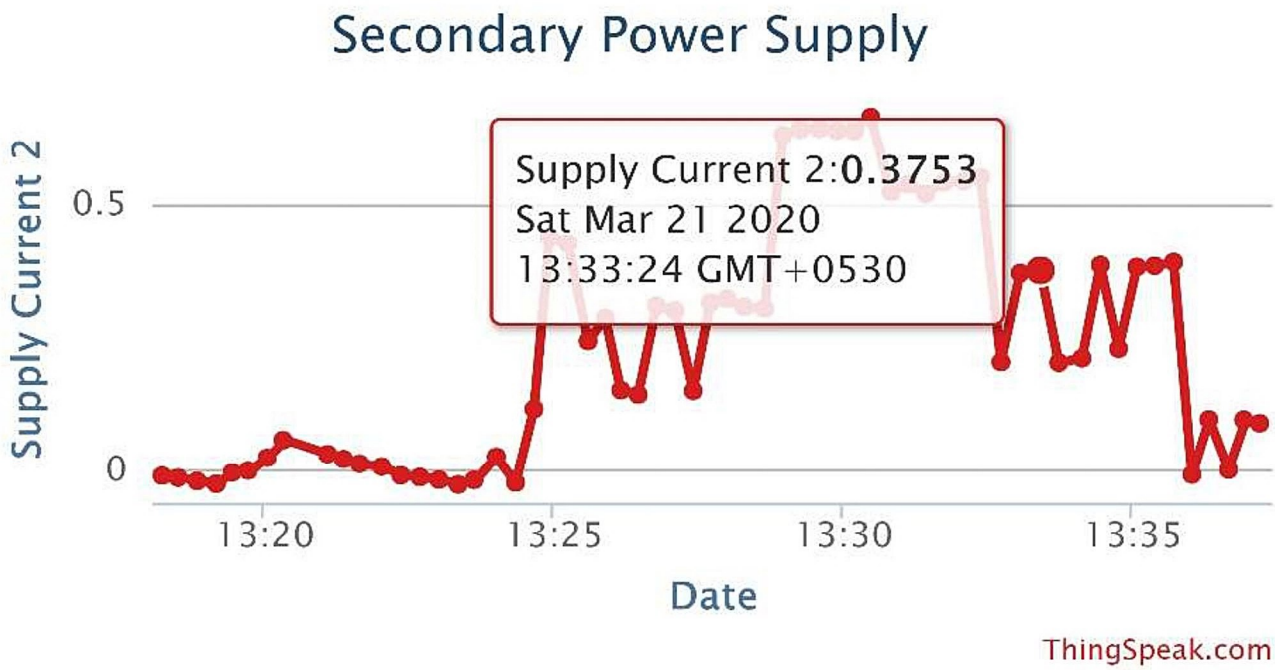
Only Load 1 & 2


Load Current
Load Current:0.97654
Sat Mar 21 2020
13:33:24 GMT+0530
Load Current
1
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

Only Load 1 & 2


Primary Power Supply Current
Supply Current 1:0.56341
Sat Mar 21 2020
13:33:24 GMT+0530
Supply Current 1
0.5
0
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

Only Load 1 & 2


Secondary Power Supply
Supply Current 2
0.5
0
Supply Current 2:0.3753
Sat Mar 21 2020
13:33:24 GMT+0530
13:20
13:25
13:30
13:35
Date
ThingSpeak.com

6. Discussion

In this project we have used current sensors to measure the current coming in or going out from the DC bus and ADC to measure the voltage of the bus. Using these two data we have developed such a logic that the voltage of the bus is not allowed to go beyond a certain level. We have used MOSFET to control the incoming current. Which were used to control the bus voltage using PWM signal.

An integrator capacitor is used to smoothen the switched voltage waveform. Too big capacitor introduces delay in system response and a very small one neither able to smooth the waveform nor it can keep necessary energy reserves for momentary peaks.

After the process to monitor and log the health of the DC bus we have included IoT technology by which we send different parameter of the bus to cloud to record the data. This data could be monitored real time as well as after some time when needed.

It has future scope for connecting more input Power Supply channel according to their priority.

Individual loads can be connected and monitored if needed.

7. Conclusion:

As of the results above what we have seen, from that we can conclude that the Bus Voltage remains almost constant at any load as long as the load is less then-than the total capacity of both the supply.

If the bus voltage fluctuates during switching load on and off the system is capable enough to go back to its designated voltage automatically.

The bus voltage and other parameters like Load current, and the current coming from the Primary and Secondary Supply can be monitored from the Inbuilt display and as well as Using IoT.

So it can be said that we have achieved all the objective given to us hence the project undertaken inferred to be successful.

8. References:

[1] Grid interfaced Urban Domestic Power Pack - H. Saha , A. Mondal , A.Mahato and K. Mukhopadhayay - IEEE Photovoltaic Specialist Conference , New Orleans , 2002

[2] Rajesh, M.P.; Pindoriya, N.M.; Rajendran, S. Simulation of DC/DC converter for DC nano-grid integrated with solar PV generation. In Proceedings of the IEEE Innovative Smart Grid Technologies-Asia (ISGT ASIA),Bangkok, Thailand, 3–6 November 2015.

[3] Panguloori, R.B.; Mishra, P.R.; Boeke, U. Economic viability improvement of solar powered Indian rural banks through DC grids. In Proceedings of the Annual IEEE India Conference (INDICON), Hyderabad, India, 16–18 December 2011.

[4] Kaur, P.; Jain, S.; Jhunjhunwala, A. Solar-DC deployment experience in off-grid and near off-grid homes: Economics, technology and policy analysis. In Proceedings of the IEEE First International Conference on DC Microgrids (ICDCM), Atlanta, GA, USA, 7–10 June 2015; pp. 26–31.

[5] Global Buildings Performance Network. Residential Buildings in India: Energy Use Projections and Savings Potentials; Global Buildings Performance Network: Ahmedabad, India, 2014.

[6] Rodriguez-Diaz, E.; Vasquez, J.C.; Guerrero, J.M. Intelligent DC homes in future sustainable energy systems: When efficiency and intelligence work together. IEEE Consum. Electron. Mag. 2016,5, 74–80. [CrossRef]

[7] Nilsson, D.; Sannino, A. Efficiency analysis of low and medium-voltage DC distribution systems. In Proceedings of the Power Engineering Society General Meeting, Denver, CO, USA, 6–10 June 2004; pp. 2315–2321