Parameter analysis of single phase loads using IoT

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Abstract:
This paper presents an approach for determining and analysing the parameters of single-phase loads. Here, three different single-phase units are designed and constructed for simultaneous measuring of parameters which includes voltage, current, and power factor for various loads. The system is designed using Arduino UNO, ESP8266, potential transformer, current transformer, and LCD. The analysis of parameters is considered in three different ways. For first consideration, variable inputs are provided using potentiometers for three similar loads. In second consideration, variable inputs are provided for three different loads. In third consideration, constant input is provided for three different loads. The data can also be analysed in "think speak" local webpage using IoT.

Keywords--- Arduino uno, ESP8266, Thinkspeak, LCD display.

I INTRODUCTION:

The technology is been developing rapidly now-a-days. The wide range of data collected from IoT devices is assessed by the Internet of Things(IoT). Huge quantities of data is assessed and the useful information regarding it is produced. The proposed meter simultaneously measures voltage, current, power factor for the three single phase loads connected to the system. . The power factor is defined as the ratio of working power in kilowatts to apparent power in kilovolt-amperes. The amount of power needed to run machinery and equipment over a certain period is measured by apparent power, also termed as demand. It can be calculated by multiplying (KVA= V*A). The result is expressed as KVA units. A power factor of 96 percent is more efficient than a power factor of 75 percent. Many regions consider power factors below 95 percent to be inefficient.Demand would be equal to the power available if the circuit is 100 percent efficient. The implemented system is classified into two sections: the sensing unit and the data transfer unit.

II SYSTEM ARCHITECTURE:

This section deals with the architecture of the designed system. Current sensor, voltage sensor, LCD module, and ESP8266 are the components of this meter. All the sensor values are given to the ESP8266 to determine the consumed power. The determined values are directed to the local webpage using ESP8266. The calculated values are displayed on LCD screen that adds up the affability to read the values and esthetics of the constructed device.Here, an LCD screen is used to present all the data constraints. The LCD screen is associated with the ESP8266 to display the smart meter parameters. It is of a 16*2 matrix and displays 2 lines with 16 characters per line. Every character is displayed in a 5*7pixel matrix and the supply voltage will be 4.7V - 5.3V. Here, three single phase voltages, three single phase currents, and the power factor are displayed.ESP8266 is a Wi-Fi microchip with a full TCP/IP stack and can be connected to the Wi-Fi through the router TP-Link WR841N. It is a low-cost Wi-Fi-based system on a chip.

ESP8266 is associated with the IoT application and the microcontroller, it acts as the medium to transfer the data from the microcontroller to the IoT page. It has a boot ROM of 64KB, instruction RAM of 32KB, and user data RAM of 80KB. The operating voltage is up to 3.6 V, if it exceeds this operating value then an external voltage convertor is required and the current is of the order 10mA – 12mA.

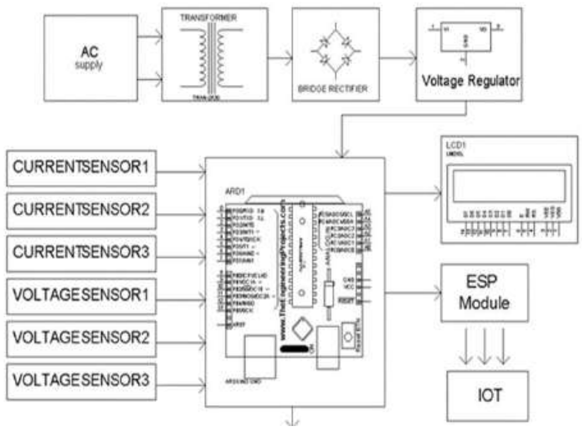

Fig .1. Blockdigram Showing the connection of the Load analysis

In the future, this design can be implemented in such a way that it gives an SMS alert when data crosses some threshold value (that is set either by the customer or the provider) and automatically turns off electronic devices that are consuming more power.

- A cloud server named "Think speak" is used in this project. The data from the ESP8266 is transferred to the think speak page and stored in private channels by default. The data can also be shared through public channels. The data in this is stored in a private channel with four channels. These four channels are for voltage, current, power factor, and meter reading.The interfacing of ESP8266 and thinkspeak is done with the login credentials. The login credentials are coded in the ESP8266. Unless we enter the correct credentials, interfacing will not be done.
- Arduino UNO is a microcontroller board. This board consists of the I/O pins in which there are 14 digital pins and 6 analog pins. To program the Arduino UNO, we use a software called Arduino IDE through a B type USB link. The voltage range will be around 7-20Volts. Arduino UNO plays an important role in this designed system. It acts as the communication medium for all the other parts of the system. Arduino collects the feedback from the current and voltage measurement unit. From here, the calculated values of three different single-phase loads will be sent to the LCD display and ESP8266.

III EXPERIMENTAL SETUP AND WORKING PROTOTYPE MODEL

In the designed system potential transformers, current transformer, Arduino UNO, ESP8266, energy meter are accustomed. In brief, there are two sections in this prototype. The first section includes the potential transformer,current transformer, potentiometer, and the load. The other section includes a stepdown transformer, bridge rectifier, ATMEGA328, ESP8266, and LCD display. The power from the switch is transferred to the step-down transformer through a wire. The step-down transformer reduces the voltage from 240V AC to 12V AC. The AC supply is changed completely to DC by rectifier.

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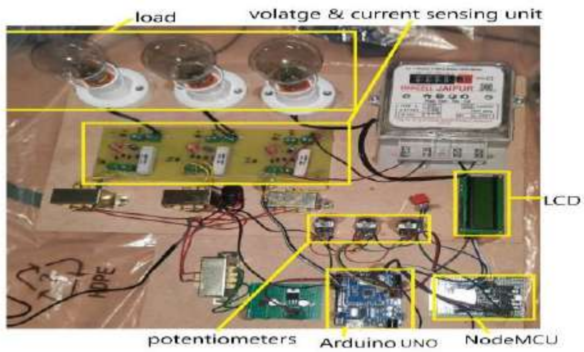

Fig.1. Prototype working model of implemented smart energy meter.

The capacitor is present to change the ripple factor to zero which indicates that the noise is reduced to zero. The 5V output voltage is regulated by a voltage regulator and further filtered to eliminate the noise. The obtained 5V DC is given to the ATMEGA328, ESP8266 and LCD. This sensing units are installed for each load.Since it is difficult to vary the voltage and frequency on live voltage so three potentiometers are used for each load to vary the voltage. If the voltage is varied using a potentiometer, the current and the power factor will also vary proportionately. And the values then are updated on the LCD display and the IoT page. The current and voltage values are sensed by the voltage and current measuring units and the feedback is given to Arduino analog channel and from the Arduino analog channel the voltage, current and power factor are calculated. Arduino sends the data to ESP8266 and the LCD display. All the three single-phase load values are displayed on LCD. Voltage, current and the power factor for every load are displayed separately. The power factor is displayed in the form of a percentage.In the IoT section, the data in the ESP8266 collected from Arduino is transferred to the cloud server named “Think speak”. As the ESP8266 and cloud server are interfaced. The ESP8266 is programmed such that, when it is connected and logged in to the page with the credentials, the data will be transferred to the IoT page.

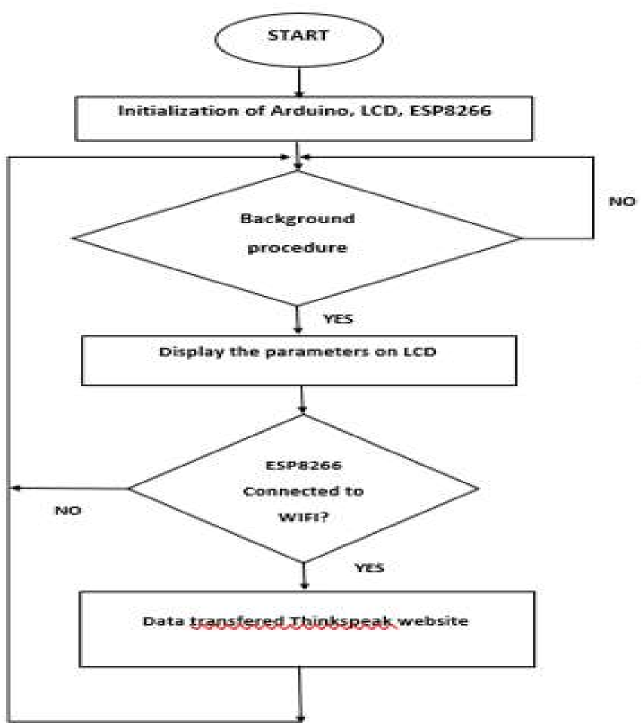

Fig.3. Flow chart for smart energy meter pramteraization of loads

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IV HARDWARE IMPLEMENTATION AND RESULT ANALYSIS:

The below figure shows the experimental setup of 3 single-phase units. The setup consists of an LCD, current transformer, potential transformer, transformers, rectifier, voltage regulator, and ESP8266 module. After connecting the circuit as shown in the circuit diagram the current readings, voltage readings, and power factor readings(outputs) are obtained on the LCD screen.

The voltage, current, and the power factor values are recorded for all the three considerations.In first consideration, all the three loads are of 60W for different input voltages. The power factor and current changes in proportion to the input voltage.

Table : 1 Shows the recorded values of the loads for first Case

	Single phase load-1			Single phase load-2			Single phase load-3		
s.no	V	I	P.F	V	I	P.F	V	I	P.F
1	0	0	0	0	0	0	0	0	0
2	18	0.38	6	16	0.32	6	24	0.5	9
3	30	0.53	12	59	1.18	23	40	0.9	16
4	44	0.78	17	90	1.79	36	64	1.57	25
5	58	1	23	99	1.97	39	68	1.67	27
6	97	1	39	136	2.71	54	84	2.06	33
7	99	1	39	137	2.73	55	94	2.3	37
8	107	2	43	147	2.93	59	135	3.31	54
9	136	2	54	163	3.25	65	141	3.46	56
10	139	2	56	171	3.41	68	160	3.92	64
11	147	2	63	197	3.92	79	204	5	82
12	188	3	75	207	4.12	83	211	5.17	85
13	190	3	76	211	4.2	85	218	5.34	87
14	199	3	80	222	4.42	89	235	5.76	94
15	228	4	91	244	4.86	98	240	5.88	96

From the table various analysis are plotted across each for the future analysis the below figure 4, figure 5,figure 6 shows the graphical analysis at each load point

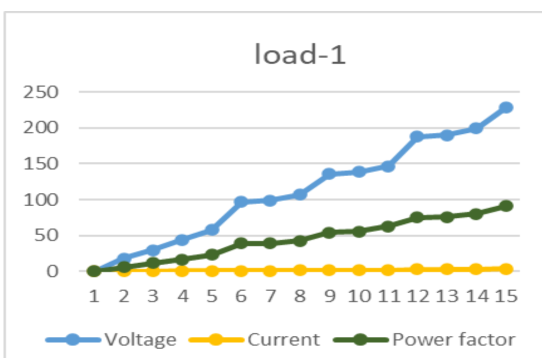

Fig.4. Graphical representation various parameters at of load Point 1

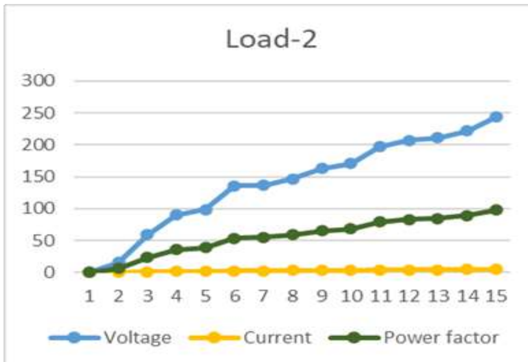

Fig.5. Graphical representation various parameters at of load Point 2

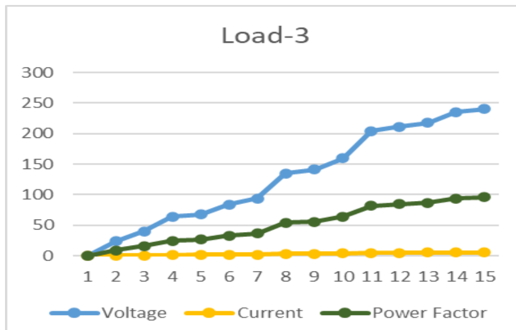

Fig.6. Graphical representation various parameters at of load Point 3

In second consideration, the variable loads considered are 60W, 10W, and 200W bulbs. For the variable input voltages, the currents as well as the power factors are recorded and observed.

Table : 2 Shows the recorded values of the loads for Second Case

Single Phase Load-1				Single Phase Load-2			Single Phase Load-3		
S.No	V	I	PF	V	I	PF	V	I	PF
1	5	0.12	2	8	0.16	3	5	0.12	2
2	32	0.6	12	48	1.55	31	28	0.69	11
3	46	0.82	18	74	1.47	29	52	1.27	20
4	66	1	26	77	1.53	31	55	1.35	22
5	67	1.03	27	103	2.05	41	64	1.57	25
6	78	1.05	31	119	2.37	47	94	2.3	37
7	112	2	45	122	2.43	49	107	2.62	43
8	113	2.02	45	124	2.47	50	113	2.77	45
9	114	2	45	129	2.57	52	116	2.84	46
10	116	2	46	152	3.03	61	156	3.82	62
11	144	2.06	58	153	3.05	62	166	4.07	66
12	163	3	65	154	3.07	62	204	5	82
13	174	3	70	160	3.19	64	211	5.17	85
14	215	4	86	175	3.49	70	223	5.47	89
15	224	4.02	90	195	3.88	78	231	5.66	93
16	240	4.05	96	236	4.7	95	239	5.86	96

From the table various analysis are plotted across each for the future analysis the below figure 7, figure 8,figure 9 shows the graphical analysis at each load point

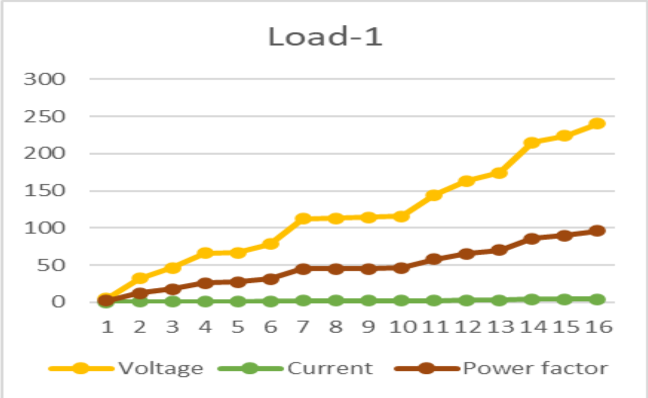

Fig.7. Graphical representation various parameters at of load Point 1

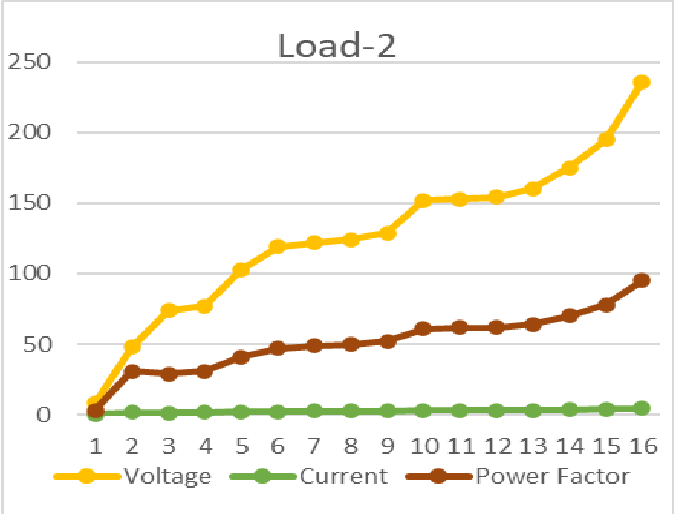

Fig.8. Graphical representation various parameters at of load Point 2

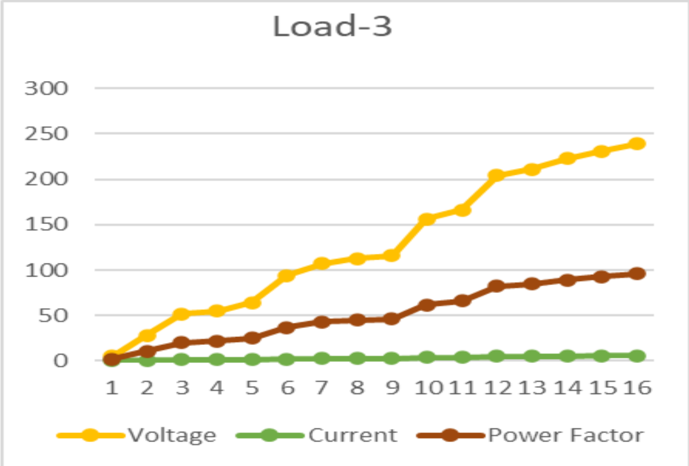

Fig.9. Graphical representation various parameters at of load Point 3

In third consideration, similar input voltage is given for three different loads and the corresponding current and power factor values are recorded.

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Table : 2 Shows the recorded values of the loads for Third case

	V	I	P.F
load-1	89	1	35
load-2	88	1.75	35
load-3	88	2.16	35

The data is stored in thinkspeak local webpage also. From the above analysis, it is clearly shown that the high voltage input, the high the power factor which leads to power conservation.

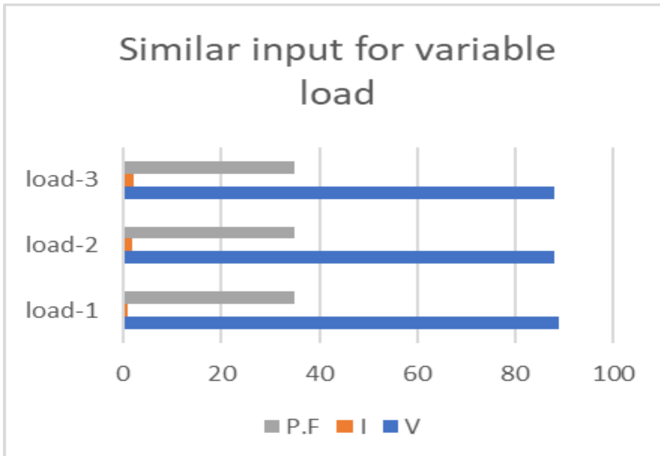

Fig.10. Similar inputs for various load points

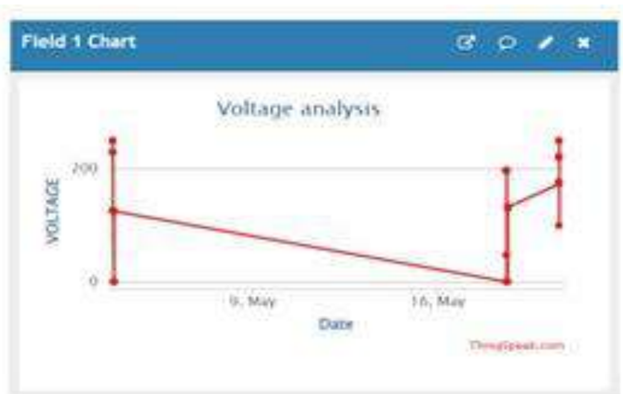

Fig.11. Voltage profile on cloud

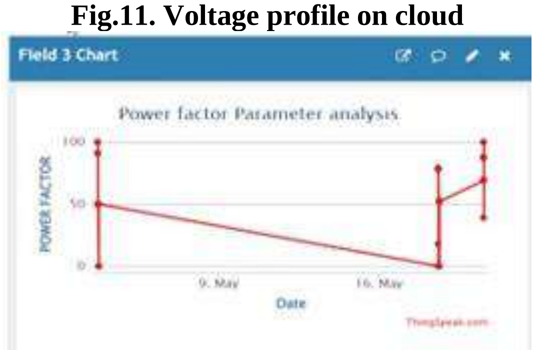

Fig.10. Power factor Profile on cloud

From all the above considerations it is shown that power factor is above 85 percentage only when the voltage is higher. Therefore the loads have to be selected such that the powerfactor should be greater than 85 percentage which makes effective power usage.Effective power usage leads to conservation of power.

CONCLUSION:

Arduino UNO, ESP8266 and IoT are used to construct the system. The designed system is primarily intended to increase power conservation by analysing the data obtained. A voltage and current sensing unit, Arduino, and a ESP8266 make up this system. Arduino UNO will receive the data from the sensor's reading and transfer them to ESP8266. The load's electrical parameters will be calculated by Arduino UNO. ESP8266 will transfer the data to the customer's webpage named "Thingspeak" when connected to Wi-Fi. This website can keep track all of this information.

REFERENCES:

[1] W.Hlaing, S.Thepphaeng, V.Nontaboot, N.Tangsunantham, T.Sangsuwan, and C.Pira, "Implementation of WiFi-based single-phase smart meter for Internet of Things (IoT)," 2017 International Electrical Engineering Congress (iEECON), Pattaya, 2017, pp. 1-4, doi: 10.1109/IEECON.2017.8075793.

[2] S.Saha, S.Mondal, A.Saha and P.Purkait, "Design and Implementation of IoT Based Smart Energy Meter," 2018 IEEE Applied Signal Processing Conference (ASPCON), Kolkata, India, 2018, pp. 19- 23, doi: 10.1109/ASPCON.2018.8748696.

[3] J.K. Mishra, S.Goyal, V. A.Tikkiwal and A.Kumar, "An IoT Based Smart Energy Management System," 2018 4th International Conference on Computing Communication and Automation (ICCCA), Greater Noida, India, 2018, pp. 1-3, doi: 10.1109/CCAA.2018.8777547.

[4] M.Aboelmaged, Y.Abdelghani and M.A. Abd El Ghany, "Wireless IoT based metering system for energy efficient smart cites," 2017 29th International Conference on Microelectronics (ICM), Beirut, 2017, pp. 1-4, doi: 10.1109/ICM.2017.8268836.

[5] B.K.Barman, S. N. Yadav, S.Kumar and S.Gope, "IOT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid," 2018 2nd International Conference on Power, Energy and Environment: Towards Smart Technology (ICEPE), Shillong, India, 2018, pp. 1-5, doi: 10.1109/EPETSG.2018.8658501.

[6] Terry Chandler "The Technology Development of Automatic Metering and Monitoring Systems", The 7th International Power Engineering Conference, pp. 147-150, Nov. 2005.

[7] Bharath P, Ananth N, Vijetha S, Jyothi Prakash K.V ,"Wireless automated digital Energy Meter", ICSET 2008.

[8] Vinu V Das, "Wireless Communication System for Energy Meter Reading" International Conference on Advances in Recent Technologies in Communication and Computing 2009.