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FABRICTION OF A DOMESTIC SOLAR MOBILE PHONE CHARGER

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ABSTRACT

The need for constant means of communication has arouse the quest for alternative electricity supply for the charging of our mobile phones which was replaced with the landlines which is the solar energy charging system. This is the renewable energy source the radiant energy from the sun. A solar panel comprising of the following compositions was purchased; Output tolerance + 5%, Current Pmax (1mp) 1.05A, Short circuit current (Isc) 1.12A, Open circuit voltage (Voc) 23.04V, Maximum system voltage DC 1500v, Maximum series fuse rating 20A and the other component for the construction of the circuit such as DC-DC Boost converter (which uses C1 (0.1μF capacitor) and R (100kΩ ×2 resistors) to filter noise and control current), charge controller, three USB ports, connecting wires and vero boards were used for the fabrication of the domestic solar mobile charger and carefully tested. Results shows that the iphone 11 has a battery of 3,110mah and operate at the voltage of 3.7v. *battery energy (wh) is 15wh*, the redmi 10c feature has a battery capacity of 5000 wh and operates at a voltage of 3.7v, *battery energy (wh) is18.5wh*, the infinix note 30 feature has a battery capacity of 5000mah and operate at a voltage of 4.2v,*battery energy (wh) is 21wh*,the total energy for the iphone 11, redmi 10c and infinix note 30 *energy is 54.5wh*, the efficiency of the solar mobile phone charger was 88%. Having tested the domestic solar mobile charger, the highest voltage was observed between the hours of 11 -12 noon with 10 hours charging duration.

Key words: USB Ports, domestic, mobile, phone, charger, circuit

INTRODUCTION

Solar energy has become a sustainable energy in this our world. Over the years it has been harnessed from the sun to be put into application like in calculator, clock, lighting system and electricity in homes, offices and other firms. In the 7th FOSIC a portable solar mobile phone was presented and after intensive review was published in the proceedings [1] which was with only one USB port (Andiod). This was followed by our student work fabricating two USB port (type C and Andriod) [2]. Communication has become a very essential ingredient in our society. The mobile phone has replaced the land lines. It is disheartening that the epileptic supply of electricity to consumers in developing countries has put industries into obliteration thereby repudiating economic growth [3-5]. When faced with an emergency or important discussion that has to be done with other groups of persons with low battery on your phone due to inconsistency in NEPA supply of electricity it will hinder progress. This solar energy phone charger system is the solution most especially during the day and at summer. Those in the rural settings will appreciate this most. It's cost effective and saves you from the purchase of power-bank. Although there is limitation to this thing, there isn't inbuilt battery that can sustain charge during the night, thus it is still for rural.

The solar mobile phone charger operates with DC. The sun charging the panel and the phone slightly at the same time. The energy of the sun is directly proportional to the charging capacity.

The use of mobile phone systems for easy communication in both developed and developing nations is on the increase when compared with landline telephone that has gradually fizzled out.

The mobile phone charged with solar energy can eliminate the problem of regular battery drain for both residents in villages and cites which encouraged the fabrication of a portable one port solar charger.[1]. In which it was revealed that the solar panel recorded the highest voltage between the hours of 11:00 and 12:00 noon and could charge for 6 hours. By 2022 the global number of

mobile users was projected to surpass 8.58 million, with this figure continuing to rise as technology advances and production costs decrease. A solar energy charging system proffers a solution. A compact charger panel was developed to ensure the proper voltage and power output using a DC-DC step down buck converter. The finalized prototype is designed to charge commonly used mobile phones within 10 – 12 hours of direct sunlight exposure [2]. Design of mobile phone battery helmet charger for online driver based on simple solar panel was also archived [6-7]. This research work intends to fabricate a three USB port port (iphone, type C and Andriod) solar domestic mobile phone charger.

EXPERIMENTAL PROCEDURE

A vero board was constructed. The solar panel's positive terminal is linked to the 2N3055 transistor (Q1) through a capacitor (C1, 0.1µF) and a resistor (100kΩ). The capacitor removes noise, while the resistor helps control current. The base of the transistor is connected through a diode and a Zener diode, which keeps the voltage stable. A capacitor (C3, 10µF) to ground helps smooth the voltage, while another capacitor (C2, 0.1µF) provides extra filtering. In simple terms, the circuit takes the unstable solar power, filters it, and regulates it to provide a steady voltage for safe mobile phone charging. The circuit makes the solar panel's power clean and steady so it can safely charge a phone at about 5V. The 2N3055 transistor controls the output: its emitter is connected to the USB output through C3 (10µF), which smooth the voltage. A Zener diode keeps the voltage stable, while the transistor adjusts whenever the solar panel voltage changes. C1(0.1µF) removes noise from the panel while C2 (0.1µF) keeps the transistor's base voltage steady and C3 (10µF) smooth the final output. Together, these parts provide a reliable 5V USB output for charging, as shown in the circuit diagram figure 1.

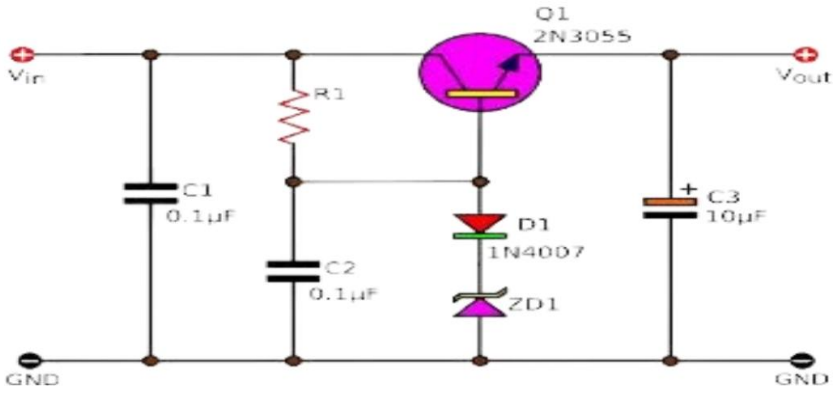

Figure 1: The circuit diagram

Figure 2: Experimental block diagram

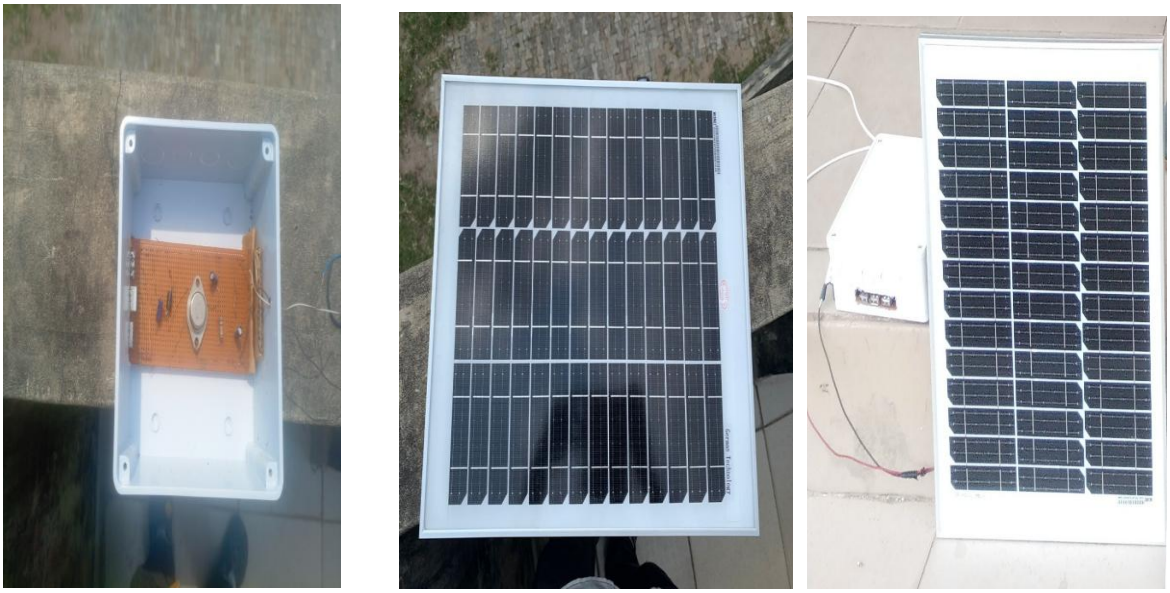

Figure 3: The vero board, the 18V solar panel and complete set up

Determination of Component Sizes

The Zener diode sets the reference voltage. For USB output, typically 5V, you might use a Zener diode with a breakdown voltage slightly below 5V to account for the base-emitter voltage drop (approximately 0.7V for silicon transistors)

Zener Voltage Vz

Vz = VUSB - VBE

Vz = 5v - 0.7v

Vz = 4.3v

Choose a Zener diode with a breakdown voltage around 4.3v

Base Resistor (R) Calculation to provided sufficient base current (IB) to the transistor, ensuring it operates in the active region:

$$IB = \frac{Ic}{\beta}$$

Where:

Ic Is the collector current (depends on the load current).

β is the current gain of the transistor (varies but typically around 20-70 for 2N3055).

Assume β = 50 for calculation

For a load current (1 load) of 1A

$$IB = \frac{1A}{50} = 20mA$$

The base resistor R2 should limit the current from the Zener diode to this value:

$$R\,\frac{Vz - V_{BE}}{IB}$$

$$R\,\frac{4.3v - 0.7v}{20mA}$$

$$R\,\frac{3.6v}{20mA}$$

$R = 180\ \Omega$

Determination of duration of hour's rechargeable battery will last

The hour for the mobile phone to charger fully. For iPhone 11, Redmi 10C and infinix note 30

The iPhone 11 has a battery of 3,110mAh and operate at the voltage of 3.7V. *Battery energy (wh) = 3110 *3.7/1000=15wh*

The Redmi 10c feature has a battery capacity of 5000mAh and operates at a voltage of 3.7V.

*Battery energy (wh) = 5000 * 3.7/1000=18.5wh*

The infinix note 30 features has a battery capacity of 5000mAh and operate at a voltage of 4.2V

*Battery energy (wh) = 5000*4.2/1000=21wh*

The total Energy for the iPhone 11 + Redmi 10c + infinix note 30

Energy= 15wh +18.5wh+21wh = 54.5wh

The efficiency of the solar mobile phone charger

*(Input power/output power) * (100% / 1)*

*(16 x 0.25/15 x 0.30) * (100%/1)*

Effective battery capacity
*Power (W) = Voltage (V) * Current (A)*
*Power = 15V * 1.33A = 19.95 = 20W*
*Energy (Wh) = Power (W) * Sunlight Hours (h)*

Testing and Results

Initial Setup and Voltage Measurement: Connect the solar panel to the circuit and ensure all components are properly connected as described (capacitors, resistors, diodes, and the 2N3055 transistor). Measure the voltage output of the solar panel using a millimeter, especially under different sunlight conditions (direct sunlight, cloudy conditions, etc.). Monitor the input voltage at the collector of the 2N3055 transistor, filtered through C1 and the 100kΩ resistor.
Base Voltage Stabilization: Measure the voltage at the base of the 2N3055 transistor, making sure that the filtering capacitor (C2) is properly stabilizing the base voltage. Test the voltage regulation effect provided by the Zener diode. Ensure that the Zener diode maintains a constant reference voltage as expected.
Output Voltage Monitoring: Measure the voltage at the emitter of the 2N3055 transistor, where the output voltage is expected to be stable around 5V (USB standard voltage). Ensure that C3 is effectively smoothing the output voltage, minimizing ripple and providing steady power to the USB output terminal.
Charging Performance Test: Connect a mobile phone or another USB-powered device to the charger. Measure the current and voltage during charging to ensure the current is adequate for charging, typically within the range of 500mA to 2A. Test under different lighting conditions to observe how well the circuit adjusts to varying solar input. The readings are recorded in tables 1 – 3 and figures 4 – 5.

Table 1: voltage measure at output of the solar panel

Number	Time	No load voltage(V)	Load voltage (V)
1	9:00am	27.13	25.07
2	10:00am	25.16	24.13
3	11:00am	20.11	19.05
4	12:00pm	23.15	22.21
5	1:00pm	25.25	23.41
6	2:00pm	17.25	15.67
7	3:00pm	16.75	14.95
8	4:00pm	17.05	14.91

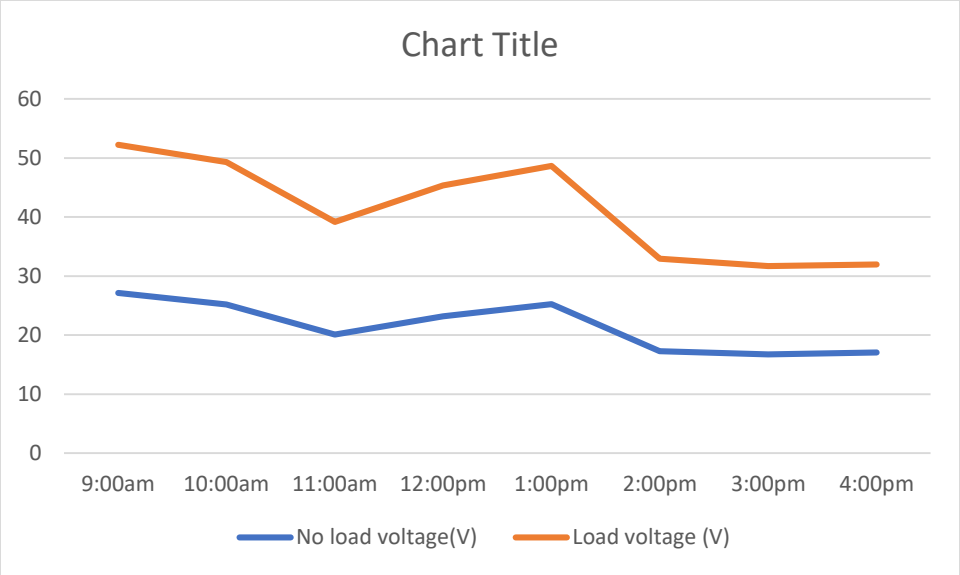

Figure 4: A graph of LOAD/NO LOAD Versus period of day on the solar panel

Table 2: voltage measures charging board

Number	Time	No load voltage (V)	Load voltage (V)
1	9:00am	6.07	4.98
2	10:00am	5.85	4.72
3	11:00am	5.29	5.01
4	12:00pm	5.37	5.00
5	1:00pm	5.35	4.86
6	2:00pm	5.38	4.78
7	3:00pm	5.09	4.76
8	4:00pm	5.71	4.55

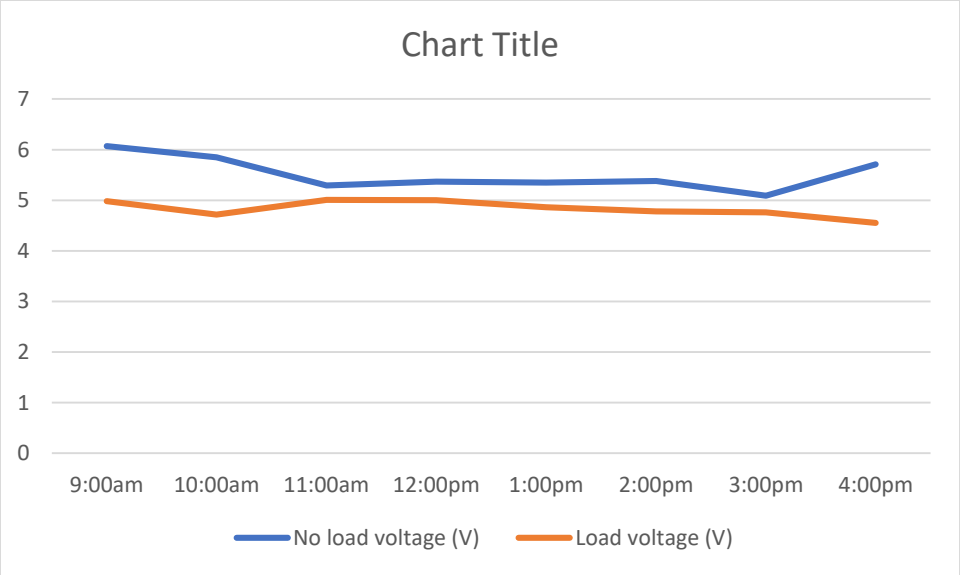

Figure 5: A graph of load/no load versus period of day on the vero or charging board

Table 3: Comparison of no- load current from solar panel and load correct from output of the charger

Number	Time	No load current from solar	Load current from charge output
1	9:00am	0.07	0.30
2	10:00am	0.08	0.29
3	11:00am	0.09	0.30
4	12:00pm	0.10	0.25
5	1:00pm	0.07	0.26
6	2:00pm	0.11	0.27
7	3:00pm	0.08	0.27
8	4:00pm	0.09	0.25

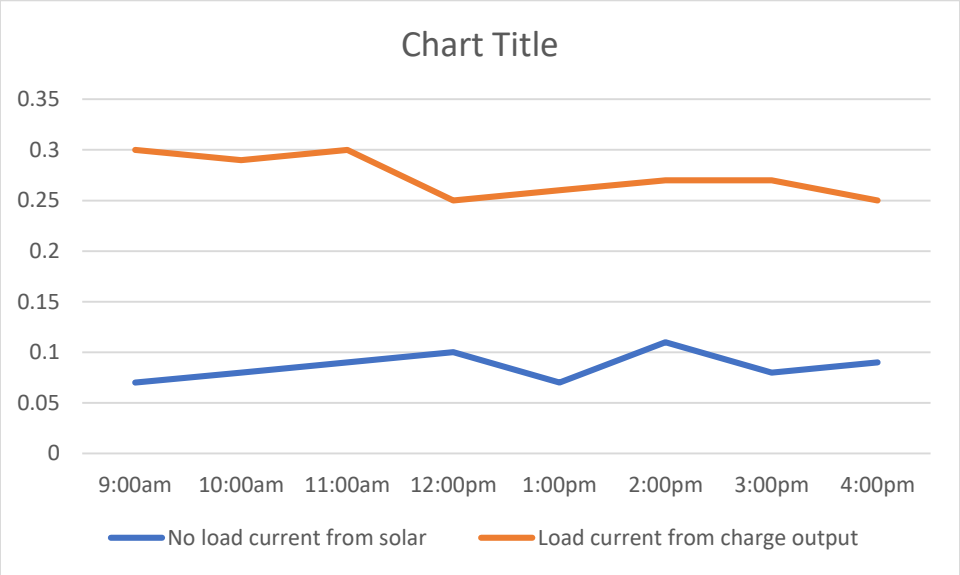

Figure 6: A graph of comparison between no load current from panel and load current from output

DISCUSSION OF RESULTS

The solar panel provided an input of approximately (20V), the voltage of the power transistor 2N3055 was (5.56V) then it was filter by the 100kilohms. The Zener diode was approximately (5V) and the diode successfully maintained a steady reference of current coming in as the solar panel output fluctuated. The Emitter of the 2N3055 transistor provides a constant output voltage of (5V) under direct sunlight, which was suitable for the USB charging. The voltage remained stable around 5V throughout the test.

CONCLUSION AND RECOMMENDATION

Having successfully constructed a solar mobile phone charger, the duration of charging an iPhone 11, infinix Note 30 and Redmi 10C was approximately 10 hrs. with a very high solar energy output during the day. Previous work done by Ezeh *et al* 2023, and that of Ezeh and Igho 2024, shows a 9v panel with one USB port and a domestic solar mobile phone charger with 15v panel and two USB port. In comparison with this work there was an improvement in the fact that a panel of 18v with three USB port was archived. Although there is limitation of no inbuilt battery that can sustain charge during the night, thus it's still useful during the day. The solar mobile phone charger operates with DC since the sun charges the panel and the phone at the same time. The energy of the sun is directly proportional to the charging capacity. The constructed solar mobile phone charger has no inbuilt battery, it is recommended that further research be done with inbuilt battery to enable charging during the night

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