STUDY OF CELLPHONE CHARGERS

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ABSTRACT

This report shows charging nature of different cellphone chargers with different cellphones. Here we took into case, chargers from Nokia, Samsung, Apple, Icube and two Local chargers. This report provides an idea how the charging current varies when a cellphone is charged with different chargers. It also gives an idea of USB based charging .

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1 .INTRODUCTION

Most cellphone chargers are not really chargers, they are only a power adaptor that provide a power source for the charging circuitry which is almost always contained within the mobile phone. They are notoriously diverse, having a wide variety of DC connector-styles and voltages, most of which are not compatible with other manufacturers' phones or even different models of phones from a single manufacturer.

Cellphone chargers are nothing but AC to DC converters. They take an input of 220 volt AC and give an output voltage around 5Volt DC. Generally the output voltage of the chargers is in the range of 5 to 5.5 Volts DC. But some local make chargers give an output voltage beyond this level. As a user who is not bothered much about these technical details just connects the phone and checks whether the cellphone is getting charged or not. But in reality a cellphone which is exposed to conditions which are beyond the permissible limits might actually reduce the life of cellphone.

So we performed a an experiment on different cellphone chargers from different brands like Apple ,Nokia, Samsung, Sony , icube and two local make chargers. We also charged a cellphone through the USB port of the Laptop.

2. THEORY

Phones have rechargeable batteries inside which need to be charged with a DC voltage (slightly higher than the battery voltage). Simple phone chargers provide this DC voltage. Most of the chargers work as follows. These accept AC power supply which gets down converted to smaller AC voltage through a transformer and is followed an AC-DC convertor (rectifier). After that there is a filter circuit that cleans the voltage before giving out on the charger pins. This voltage is used for charging the phone.

Depending on mode of operation there are two types of power supply units they are

1. Linear regulated power supply

2. SMPS (switched mode power supply)

2.1 Linear regulated power supply

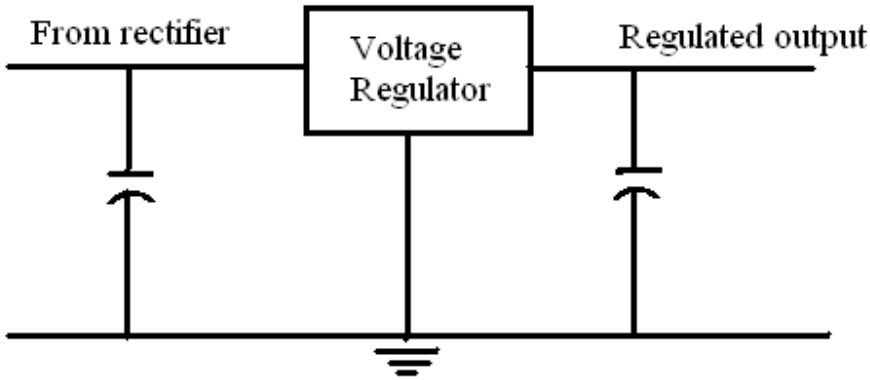

Fig A. Block diagram of Linear Regulated power supply

In case of linear regulated power supply the AC voltage is first stepped down, then this voltage is rectified and then filtered using a capacitor. The output of this capacitor goes to linear type power supply circuit. Linear regulators employ a Voltage regulator which further employs a pass element serving as a variable resistor which forms a voltage divider with the load. The pass element can be a transistor placed in between the unregulated dc voltage and the desired regulated dc output.

2.2 Switched Mode Power Supply (SMPS)

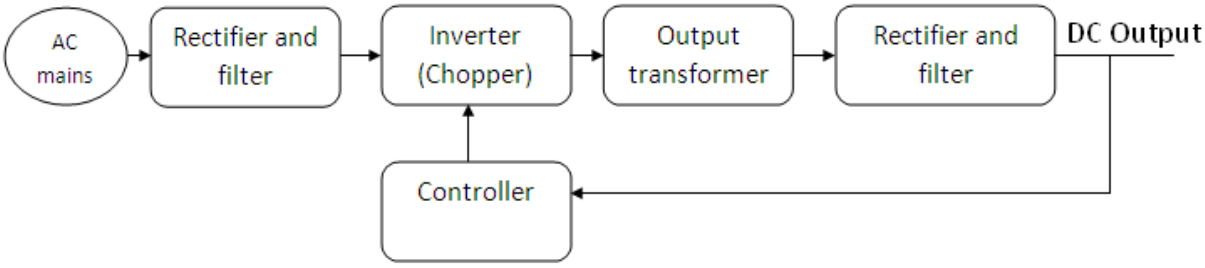

Fig B Switched Mode Power Supply Schematic

Like a linear power supply, the switched mode power supply too converts the available unregulated ac or dc input voltage to a regulated dc output voltage. However in case of SMPS with input supply drawn from the ac mains, the input voltage is first rectified and filtered using a capacitor. Then it is converted into an AC voltage by an inverter. This AC voltage is applied to a high frequency transformer the output of the transformer is again rectified and filtered. A switch is used to control the inverter. A switch can be a MOSFET. The switch is operated for finite ON and OFF time by some control method. The ratio of the ON time to the (ON +OFF)time is called duty cycle. By controlling the ON time we can achieve a required voltage which can be then filtered using Inductor and Capacitors to get the regulated output.

2.3 Comparison between SMPS and Linear supply

In case of linear regulator circuit the excess voltage from the unregulated dc input supply drops across a series element (and hence there is power loss in proportion to this voltage drop) whereas in switched mode circuit the unregulated portion of the voltage is removed by modulating the switch duty ratio. The switching losses in modern switches (like: MOSFETs) are much less compared to the loss in the linear element.

Linear power supplies though they are bulky they provide a much clean DC compared to SMPS circuits. SMPS circuits are subjected to EMI since they operate on high frequencies so proper care must be taken while designing them on PCB. Linear supplies are used in the system with tight constraints on power supply.

For more information refer

http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Power%20Electronics/PDF/L-21%28DP%29%28PE%29%20%28%28EE%29NPTEL%29.pdf

http://www.power-supply-manufacturers.com/en/knowledge-base/306-smps-and-linear-power-supply-comparison.html

http://www.engineersgarage.com/insight/how-mobile-phone-charger-works

http://dmohankumar.wordpress.com/2011/08/31/smps/

2.4 USB

Universal Serial Bus (USB) is a hardware interface for connecting peripherals such as keyboards, mouse, joystick, storage device etc.

USB Power

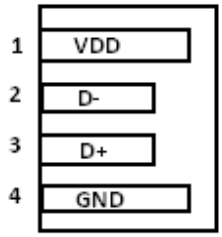

Fig. C

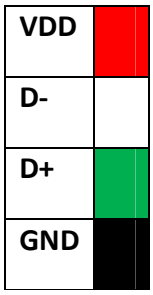

Fig. D

Before using USB as a power source we must be aware of the color coding. The Fig.C and Fig. D shows the color coding of a typical USB A type connector. If you cut open a USB cable you will see 5 different wires.There is a shielding wire which sheilds the USB data from interfrence.Then there Red and Black wires which form the VDD and Ground respectively.Then there are White and Green wires which form D- and D+ which are used for data communication.

The USB bus can supply 5V DC regulated power (maximum 500mA) to each port on pins 1 and 4 (Refer Fig C). The pins 1 and 4 are longer than the data pins to ensure that the power pins mate first and next the Data pins. Low power devices can then therefore be powered from USB there by eliminating the need of separate power supply such as Adaptors.

.3.Experimental Setup

Aim: To study the amount of charging current drawn for charging a cellphone by using chargers of different manufacturers

Components used:

1) Chargers from different companies i.e. Nokia, Samsung, I cube, Apple and two local make chargers.

2) Cell phones i.e Samsung Duos ,Sony Xperia S ,Nokia N73 ,I cube.

3) Multimeters and clips.

Description:

Most of the cell phone chargers are based on the SMPS because of the advantage of the reduced size of the components. The schematic for the experiment is as shown in the figure. Ammeter is connected in series with the cell phone to measure the charging current and voltmeter in parallel to observe the potential drop. The experiment is repeated for each cellphone and the values of voltage and current are recorded each time.

To start with we first take a cellphone and note its current and voltage with all chargers. Then we perform the same for remaining cell phones. Next we perform the same experiment using USB as the power source and finally with USB Hub.The voltage and the current are measured with load.

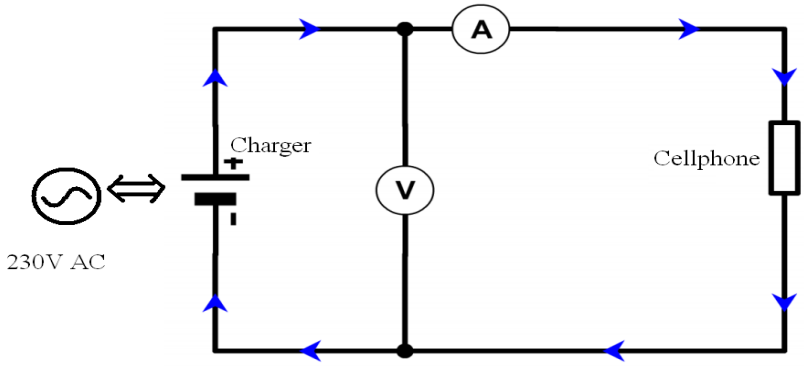

Fig E Schematic used to perform the experiment

Rating of different chargers

Charger name	Output current	Output Voltage	Interface
Nokia	350mA	5V	2mm DC connector
Samsung	700mA	5V	Micro USB
Sony	800mA	5V	USB Type A
Apple Iphone	1.5A	5V	USB Type A
Apple Ipad	2A	5V	USB Type A
Icube	500mA	5V	2mm DC connector
Local charger-1	350mA	5V	2mm DC connector
Local charger-2	500mA	5V	USB Type A

4 Results

4.1 Charging **Sony Xperia S** by various mobile chargers

Above are the pictures of the experimental setup of Sony Xperia S with different chargers.

Sony Xperia S		
Charger Name	**Voltage(V)**	**Current(mA)**
Sony	4.661	375.3
Apple Iphone	4.702	426
Apple Ipad	4.690	410.7
Samsung	4.994	858.8
Laptop	4.694	420.5
Icube	-	652.4

4.2 Charging **Samsung DUOS GT B5512 ,Nokia N73 and Icube** by various mobile chargers

Samsung DUOS GT B5512		
Charger Name	**Voltage(V)**	**Current(mA)**
Samsung	5.27	496.3
Local Charger-1	4.28	307.7
Local Charger-2	4.29	318.0
Icube	5.59	496.0
Laptop	4.69	460
Apple Iphone	-	477.5
Apple Ipad	-	471.8
SONY	-	446.6

Nokia N73		
Charger Name	**Voltage(V)**	**Current(mA)**
Samsung	5.27	222.1
Apple Iphone	4.85	228.6
Icube	5.6	361.3
Sony	4.75	245.8
Nokia	4.95	360.9
Laptop	4.82	270.9
Local charger-1	4.69	206.2
Local charger-2	5.27	247.2

ICube		
Charger Name	**Voltage(V)**	**Current(mA)**
Samsung	-	235.3
Local Charger-1	-	252.5
Local Charger-2	-	153.6
Icube	-	332.7
Laptop	-	141.3
Apple Iphone	-	185.5
Apple Ipad	-	175.5
SONY	-	121.5

4.3 Voltages at the USB pins of different chargers


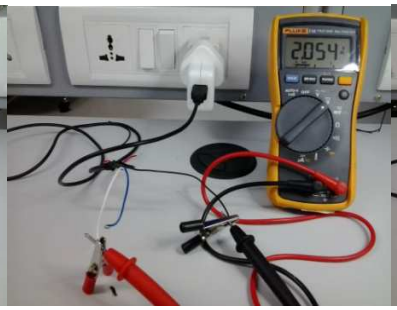
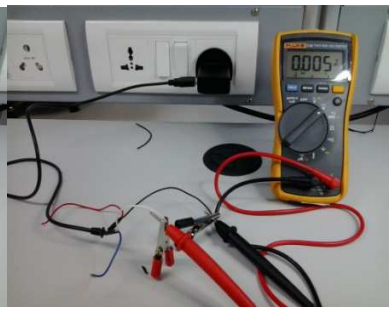

Fig. F Fig. G Fig. H

Pins	Apple Iphone charger	Apple ipad charger	Sony
Vcc	5.12 V	5.15 V	4.94 V
D-	2.73 V	2.05 V	floating
D+	2.03 V	2.76 V	floating
GND	0	0	0

The pictures shown above are the voltages at the D- pin of the Apple Iphone charger, Apple Ipad charger, Sony charger respectively.

From the above experiment we can see that there is a finite voltage in case of Apple chargers on data lines. Whereas there is no voltage on the data lines in case of Sony chargers that means data lines are floating.

It can be observed that both in case of Apple Iphone(Fig .F) and Ipad (Fig. G) chargers voltages at D- in both cases are different . Apple uses this combination of voltages to detect whether a valid device is connected to the charger.

4.4 Charging Cellphone using a Hub

	Voltage	Current(mA)
Hub port	4.69	453.3

From the above activity we can infer that even with the presence of Hub there is no considerable drop and we can use even hub for charging cellphones.

5 Summary

The below chart explains the voltage and current from different cellphone chargers taken into account

Cellphones →	Sony Xperia		Nokia N73		Samsung Duos		Icube	
Charger ↓	V	I(mA)	V	I(mA)	V	I(mA)	V	I(mA)
Sony	4.66	375.3	4.75	245.8	-	446.6	-	121.5
Samsung	4.994	858.8	5.27	222.1	5.27	496.3	-	235.3
Nokia	-	-	4.95	360.9	-	-	-	225.6
Icube	-	652.4	5.6	361.3	5.59	496.0	-	332.7
Laptop	4.69	420.5	4.82	270.9	4.694	460	-	141.3
Apple Iphone	4.70	426	4.84	228.6	-	477.5	-	185.5
Apple Ipad	4.69	410.7	-	-	-	471.8	-	175.5
Local charger1	-	-	4.69	206.2	4.28	307.7	-	252.5
Local charger2	-	-	5.27	247.2	4.29	318.0	-	153.6

When cellphones are connected to USB ports of Laptops, the USB port can support a charging current of nearly 450mA without enumeration. Even with the hub case remains the same.

We observed that maximum charging current with Windows Xp and Windows 7 operating system is 500mA without enumeration.