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MINIMÁLIS KIMENETI TELJESÍTMÉNY MEGHATÁROZÁSA ENERGY HARVESTING PROTOTÍPUSHOZ: EGY ESETTANULMÁNY MOBILTELEFON SPECIFIKÁCIÓKRA

APPROXIMATING THE MINIMUM OUTPUT POWER FOR ENERGY HARVESTING PROTOTYPE: A CASE STUDY OF CELL PHONE SPECIFICATIONS

Afghan Syeda Adila[1], Almusawi Husam[2], Geza Husi[3]

University of Debrecen, Faculty of Engineering, Department of Electrical Engineering and Mechatronics,4028, Hunagry, Debrecen, Ótemető Street 2-4, Telefon +36-203-938197

[1]*adila@eng.unideb.hu*
[2]*asd_sw@ymail.com*
[3]*husigeza@eng.unideb.hu*

Abstract

Micro-scale energy harvesting solutions are highly demanded globally in almost every field.Specifically, when it comes for a cell phone battery life. The imbalanced situation between battery technology and cell phone evolution is getting worse. However the efficient system is needed which is able to charge a cell phone when we are off from the power source.The researchers put forwards the attention towards the readily available energy sources to be harvested for charging purpose.For making such efforts, number of solutions have been proposed but many hurdles lies in it which includes the design, compatibility and most importantly the different parameters of every cell phone device.This paper demonstrates the specifications of different cell phone models and a datasheet is produced which includes the minimum output power requirement during standby and talk time.

Keywords: *energy harvesting, renewable energy sources, micro-scale energy, energy harvesting modules.*

Összefoglalás

A mikro mértékű "energy harvesting" megoldásokra világszerte, szinte minden területen óriási igény van. Különösen, amikor a mobiltelefon élettartamát illeti, hiszen a használati követelmények nem megfelelően gondoskodnak a képességek szerinti technológiai fejlesztésekről. Ebben a kiegyensúlyozatlan helyzetben az akkumulátor technológia és a mobiltelefon fejlődése között hatalmas különbség van a tudományos kutatásokban is. Azonban egy hatékony rendszerre van szükség, amely képes a mobiltelefon töltésére akkor is, amikor messze vagyunk az áramforrástól. A kutatók figyelmet fordítanak a könnyen elérhető energiaforrásokra, amelyek töltési célokra "beszüretelhetőek". Az ilyen erőfeszítésekkel számos megoldás érhető el, de számos akadály is rejlik bennük, mint például a tervezés, a kompatibilitás és ami a legfontosabb, hogy minden mobiltelefon készülék különböző paraméterekkel rendelkezik. Ez a cikk bemutatja a különböző telefon modellek specifikációit, valamint egy adatlapot állít elő, amely meghatározza a minimális kimeneti teljesítmény követelményeket készenléti és beszélgetési időre vonatkozóan ideális körülmények között.

Kulcsszavak: *energia szüret, megújuló energiaforrások, mikro-méretű energia, energy harvesting modulok.*

1. Introduction

Cell phone battery capacity creates a major challenge in the field of research and industrial domain. Considering the alternative solutions like increasing the battery size and providing power banks are not admired by the users [10].Energy harvesting devices are needed which are able to charge the cell phone any where any time without being bound to the power source.There are number of energy harvesting modules available that are taking power from ambient energy sources like Solar, Wind and Heat energy, but still its a long way to go for providing efficient solutions for cell phone charging [2-4].

2. Energy Harvesting Prototypes

2.1. Solar Energy based Energy Harvesting Prototype

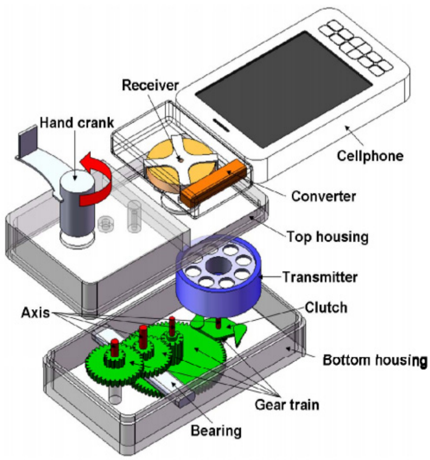
This source is considered as the most powerful of all, as it is available in vast amount to charge the electronic devices.A low cost photovoltaic energy harvesting circuit was introduced which is able to operate constantly on solar panel's MPP in order to grant maximum amount of power[4]. A wireless technique suggested by another researcher by using optical wireless power transfer, consist of an optical antenna built in on a solar cell and a DC-DC conversion circuit. Author claims that the efficiency is 40 times more than the conventional solar charger [8]. Other than that Maximum Power Transfer Tracking ystems are upgraded with dynamic online programming system [9].

2.2. Radio frequency based Energy Harvesting Prototype

We are surrounded by radio frequency every time transmitted by communication systems [1,11]. A model proposed in which power generating circuits are used to extracts the radio frequency, in which a printed dipole antenna extracts the power from GSM900 and GSM1800[1]. As the retrieved power from radio frequency is very low so in order to enhance the power, different techniques are proposed like matching and rectifying circuit and voltage multiplying circuit, in order to charge the cell phone [11].

2.3. Mechanical Energy based Energy Harvesting Prototype

Human power is a viable source which can be used to charge cell phone devices, transformation can be extracted by piezo electric material. However, number of significant contributions are done like key pressing on cell phone [1], Hand crank generators [5], to name few. A prototype was also suggested named as Human Powered Contactless Charger for CellPhones (HCCC),the device includes a Human Power Harvester (HPH) and a Receiving Unit (RU) along with gears and clutch as shown in the Figure 1. The authors demonstrates the 1020mAh battery is being efficiently charged by the proposed model [7].



1.Figure. *The Structure of HCCC*

2.4. Hybrid Energy Harvesting Prototype

Hybrid systems can collectively harvest multiple energy sources from the environment. Solutions have been provided in which a model combines the mechanical and piezoelectric techniques on a human shoe for extraction of human power. This system harvest the walking patterns by mechanical energy harvester and at the same time the exerted pressure which is produced by human weight is being harnessed by piezoe lectric system,Hence the converted power is able to charge a cell phone [6].

3. Methodology

3.1. Cell Phone specifications as data requirement

According to the research objective, the required data includes, Battery Capacity (mAh), Battery Potential (V). Battery Life during Stand By (h) and Battery life during Talk time (h).

For the calculation of the output power (mW) during Stand By and output power (mW) during a talk time; following formulae are used.

Current (I):

$$\boldsymbol{I = \frac{Q_{battery}}{t}} \tag{1}$$

Reference of the equation (1) Where I is charging current, $Q_{battery}$ is battery capacity and t denotes battery life.
Power (P):

$$\boldsymbol{P = V \times I} \tag{2}$$

Reference of the equation (2) Where P denotes Power, V is battery potential and I is charging current.

An example has been taken under consideration of a cell phone model of Apple iPhone 7 along with the required input variables for the desired output.

To calculate required power during standby under ideal conditions we have the following specifications:
– Battery voltage = 3.7 V
– $Q_{battery}$ = 1960 mAh
– $t_{standby}$ = 240 h
– $t_{talk\ time}$ = 14 h

To calculate the power (P) value during standby, first we must need to know that how much current (I) is required for charging purpose. These calculations are assumed to be ideal as we are not including the state of charge (SOC) for current (I) level of a battery cell.

1. table. *Output Power (P) during Stand by*

Calculation of Current (I) during Stand by	Calculation of Power (P) during Stand by
$I = \frac{1960}{240} = 8.16\ mA$	$P = 3.7 \times 8.16 = 30.19\ mW$

2. table. *Output Power (P) during Talk time*

Calculation of Current (I) during Stand by	Calculation of Power (P) during Stand by
$I = \frac{1960}{14} = 140\ mA$	$P = 3.7 \times 140 = 518\ mW$

The values are demonstrated in 1.Table and 2. Table for the charging current and output power in order to charge the specific cell phone during standby and talk time.

4. Results and Conclusion

The datasheet is produced as shown in Figure.2 which shows the minimum output power required during standby and talk time for different cell phone models. These calculated values are the optimal ones which can be used for generic approximation in order to understand the power requirement.

S.No	Model	Battery Type	Battery Capacity	Unit	Battery Stand By Time	Unit	Battery Talk Time	Unit	Current for S.B	Unit	Current for T.T	Unit	Voltage	Unit	Power Req: during S.B	Unit	Power Req: duting T.T	Unit
1	iPhone 7	Li ion	1960	mAh	240	h	14	h	8.16667	mA	140	mA	3.7	V	30.2166667	mW	518	mW
2	Blackberry Priv	Li ion	2610	mAh	576	h	17	h	4.53	mA	153.53	mA	3.7	V	16.77	mW	568.06	mW
3	HuaweiAscend 511	Li ion	1730	mAh	300	h	13	h	5.77	mA	133.08	mA	3.7	V	21.34	mW	492.38	mW
4	HTC 10	Li ion	3000	mAh	456	h	27	h	6.58	mA	111.11	mA	3.7	V	24.34	mW	411.11	mW
5	Galaxy Note 3	Li ion	3200	mAh	420	h	21	h	7.62	mA	152.38	mA	3.7	V	28.19	mW	563.81	mW
6	Sony Xperia Z3	Li ion	3100	mAh	890	h	14	h	3.48	mA	221.43	mA	3.7	V	12.89	mW	819.29	mW
7	Lenovo VibeZ2	Li ion	3000	mAh	408	h	30	h	7.35	mA	100.00	mA	3.7	V	27.21	mW	370.00	mW
8	LG K10	Li ion	2300	mAh	100	h	4	h	23.00	mA	575.00	mA	3.7	V	85.10	mW	2127.50	mW
9	Noir E8	Li ion	3520	mAh	437	h	39	h	8.05	mA	90.26	mA	3.7	V	29.80	mW	333.95	mW
10	Infinix Hot 3	Li Poly	3000	mAh	230	h	20	h	13.04	mA	150.00	mA	3.7	V	48.26	mW	555.00	mW

2. Figure. *Power during Standby & Talk time*

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