A Robust Wireless Power Transmission for Charging Low Power Consumption Appliances

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***Abstract*—A novel method for transferring electrical power wirelessly in order to charge various low power consumption appliances is presented. In practice, a variable power and wideband Agilent N5182A transmitter and an RF electronic receiver were configured in such manner to examine and to demonstrate the constructed WPT system. The RF-circuit part of the receiver consisted of the antenna system, RF-signal processing and converter, DC-operational amplifier and the electronic load. The distance separation between the transmitter and the receiver was varied to measure the transmission performance. Several critical factors influence the performance of WPT design such as the strength of transmitter power, moving objects surrounding the receiver, the absorbed obstacle existed, and the pointing angle of the energy illumination were also investigated.**

I. INTRODUCTION

Some studies related to methods of transmitting electricity through a wireless medium has been done over the last two decades [1-4]. Techniques for wireless transferring of electrical energy is one alternative solution for charging any low power consumption electronic devices. Until recently, most of the WPT system that has been studied and constructed using the coil elements. This resonator part which acted as the critical component of WPT system is vitally important on the energy transfer purpose via the electromagnetic field induction mechanism. In principle, the WPT technology adopts this technique by exploiting the emf voltage induced in a receiver resonator coil element. The corresponding electric wave can be further processed and converted to a DC signal. The generated DC-voltage is useful for triggering the operation of electronic devices connected.

The energy transfer technology that will be presented in this manuscript offers very different technique as applied previously [1-4]. The proposed WPT system is no longer being developed using the resonator elements on the receiver. The wireless electronic charging prototype was built using an antenna, RF detector, signal conditioning circuits and DC operational amplifier. The circuit layout of the RF-signal processing and converter unit applied in the research activity was actually adopted and developed from techniques that have been published earlier [5-6]. The tested WPT configuration has exhibited the potential wireless transmission of electrical power that varies to larger than 2.2 meter distance depending on the strength of the transmitted power. The developed WPT method is capable for providing the voltage supply about 3 Volts.

II. WIRELESS POWER TRANSMISSION CONFIGURATION

As shown in Figure 1, the proposed WPT system was built using a variable power transmitter, antenna systems, a converter and RF signal processing unit and the low power consumption appliances. The transmitter unit deployed in the transmitting part is in fact the Agilent N5182A RF generator. It has a very wide frequency band (UWB) operation and variable power for transmission purpose. The power output of the transmitter could be manually altered from less than -110 dBm up to +23 dBm. It operates from 100 kHz to 6 GHz. The transmitter can be set-up on two modulation modes, whether analog or digital format.

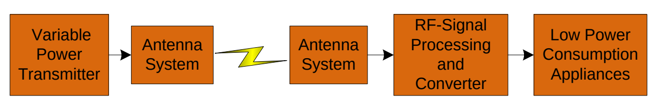

Figure 1. The configuration for WPT system.

The antenna system deployed on both sides, transmitter and receiver, are two identical patch antennas of the butterfly model. The designed 2.4 GHz patch antennas were part of the research outcomes presented in [7]. The RF-signal processing and converter unit was built from RF-detector Wiltron71850, LM358 DC-Op amplifier and a 9 Volts battery unit. The next development, the battery unit will be replaced with a tiny solar cell power. In order to obtain the better electronic circuit performance an LNA chip could be inserted after the antenna system on the receiver part. This will boost the received RF-signal transmitted from another side (transmitter). The current study consistently undertaken is intended to create the more compact, light and low cost production of a plug and play WPT charging prototype suitable for the low power consumption appliances for instance mobile phone, moving toys, and so on.

In general, a certain amount of modulated electrical power energy is generated at the N5182A UWB and variable power transmitter part (seen Fig.1). The RF-electromagnetic waves then fed-up into the antenna system. After traveling along the air propagation medium the transmitted waves will arrive at the antenna receiver. The wideband signal processing and converter unit performs the signal modification to alter RF-waves into DC-signals of slightly less than 3 Volts magnitude. The generated DC-voltage is used to supply the electrical power to various low power electric loads.

(a)

(b)

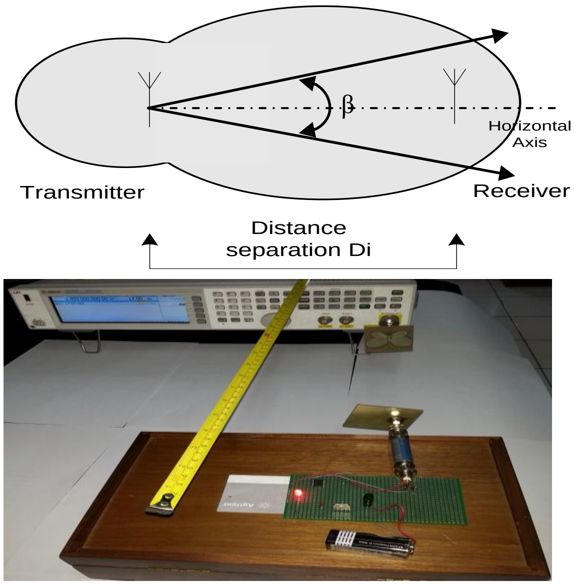

Figure 2. WPT system testing set-up: (a) schematic configuration; (b) experimental WPT evaluation.

TABLE I. WPT PERFORMANCE INDICATOR.

Tx-Power (dBm)	Performance Indicator	
	Maximum Communication Range Di (meter)	*Effective Beam Power Illumination β (^{0})*
+ 17	2.2	44
+ 10	1.2	78
+ 3	0.4	102

III. WPT TESTING AND EVALUATION

The performance of the proposed WPT system was experimentally confirmed through various transmissions testing as depicted in Fig.2. Several different numbers of WPT performance have been intensively studied including the maximum communication distance (*Di*) between the transmitter and the receiver as the function of the transmitted power radiated from the transmitter station, the effective beam power illumination (*β*), and the critical factors influenced the quality of the communication link in WPT network such as the effects of moving objects and the absorbed obstacles existed between the transmitter and the receiver.

The whole experimental evaluations of WPT performance were performed by moving the receiver along the horizontal axis to alter the distance *Di*. As the maximum distance *Di* was identified the receiver then moved to the right or left direction to test the beam power reception. The tabulated experimental evaluation is presented in Table 1. As clearly seen in the table that the maximum communication distance between the transmitter (the source of electrical power radiation) and the receiver (resembles the appliances to be charging using 3 Volts electrical voltage) correlates to the amount of electrical power transmitted. The more the power illuminated from the transmitter the longer the communication distance existed. The effective beam power illumination existed has the different value at any different distance values *Di*. The closer the receiver to the source of RF-power emission the wider the effective beam to allow good signal reception. The WPT operation is significantly influenced by the present of absorbed objects and other close moving objects.

IV. CONCLUDING REMARKS

A typical WPT method has been discussed. The constructed WPT was designed to charge various low power consumption appliances. The WPT configuration consisted of a variable power and wideband Agilent N5182A transmitter and an RF electronic receiver. The WPT was configured in such manner that the distance separation between the transmitter and the receiver was varied to examine and to demonstrate the WPT system operation. This is done to measure its transmission performance capability.

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