Wireless Load Self-Disconnection Module For Automatic Power Supply System

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Abstract— Nowadays, the use of Auxiliary power supply (APS) systems to energize low power rating appliances (e.g. televisions, water dispensers, etc.) and lighting (e.g. CFL lamps) has become pervasive in countries where long power rationing schemes are applied. Although the existing APS systems offer overload protection, it cannot be directly connected to the existing electric circuit unless heavy loads such as refrigerators, microwaves, washing machines, electric water heaters, etc. are disconnected in the absence of the grid. This is usually overcome by separating the wiring circuits feeding these loads from those devoted for lighting and other low power loads like TV and stereo sets, food processors, etc. However, such a separation is very costly and sometimes infeasible in places with narrow wires tubing circuit if a new by side wiring circuit is to be installed. This paper details a module developed from on-shelf cheap components to wirelessly make heavy loads disconnect themselves as soon as the grid is off. The core idea behind our load self-disconnection module is inspired by the low price remote power plugs which use the 434MHz Radio Frequency (RF) technology to remotely on/off as many as 256 electric appliances up to a 30M distance away. Thus, no transmission obstacle, wide coverage and no nearby products interference are achieved as results.

Index Terms— Remote control system, load self-disconnection.

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1 INTRODUCTION

AUXIliary power supply systems are increasingly used to energize low power rating home appliances and lighting in countries where long power rationing schemes are applied. Although the existing APS systems offer overload protection, it cannot be directly connected to the electric circuit of the house unless heavy loads such as refrigerators, microwaves, washing machines, electric water heaters, etc. are disconnected in the absence of the grid. This problem is usually overcome by installing a by side electric wiring circuit dedicated only to loads that cannot be afforded by the APS i.e. the type of loads mentioned above. However, such a solution is very costly and sometimes infeasible in places where the tubing circuit is too narrow and does not allow the drawing of additional wires. Moreover, the installation of apparent cables is strictly forbidden as it might countermeasures electrical safety precautions and more importantly exposes people to electric shocks. In this paper we show how an APS can be directly connected to the existing electrical circuit using an on-shelf low price RF Remote Power Plugs (RPP). Generally speaking, a remote control is an electronic component usually devised to remotely control a TV and Stereo sets, DVD player, etc. from a short line-of-sight distance. Remote control technology have evolved over years to include Bluetooth connectivity, motion sensor enabled capabilities and voice control [1][2]. Although the remote control technology was considered secret and only used with military applications e.g. the German motorboats during the WWI, the world witnessed its first non-military uses e.g., with automatic garage door openers, in the late 1940s. The very first television remote control was wire remote control and created by The Zenith Radio Corporation in 1950.

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Later in 1955 Zenith introduced the first wireless TV remote control that called "Flash-matic" and used four photocells to turn the picture and sound on and off and change TV channels up and down. The fact that Flash-matic had problems working well on sunny days, the sunlight sometimes change channels at random, pushed Zenith's engineer Robert Adler to create the "Zenith Space Command" remote control based on ultrasound waves which remained dominant till 1977. Infrared (IR) devices replaced ultrasonic remote controls in the early 1980s [3]. Transmission through RF is better than IR as signals through RF can travel longer distances, and thus making it more suitable for a variety of applications. In addition, RF signals do not need line-of-sight and can penetrate obstructions between transmitter & receiver. Moreover, RF transmission is more strong and reliable than IR transmission as it uses a specific frequency and does not get affected by other emitting sources like IR signals, and thus the reasons why they cannot be used in our application to disconnect away heavy loads in the absence of the grid. Alternatively, RF remote control uses a variety of radio signals to control various types of distant mechanical or electronic devices such as closing circuit, move handle, start motor like those which are widely used in garage doors, electric gate, automatic barrier, burglar alarm, and wireless home and car alarm systems.

2 Radio Remote Control Concept

A radio remote control system usually has two parts: transmitter and receiver. Both the transmitter and receiver parts are generally divided into two subparts. While the transmitter consists of an encoder and transmission modules, the receiver consists of a decoder and reception modules. Fig. 1 depicts the schematic diagram of four channels RF remote control system [4]. This system could be used to operate a load from a distant place. The RF module exploits radio frequency to send/receive command signals. These signals are transmitted at a particular frequency and a baud rate.
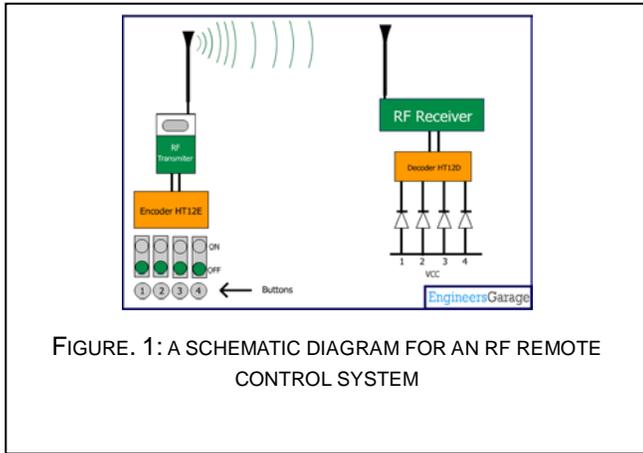
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FIGURE. 1: A SCHEMATIC DIAGRAM FOR AN RF REMOTE CONTROL SYSTEM

The so called Amplitude Shift Keying (ASK) modulation is used in such RF systems to load the digital (on/off) data on the carrier wave as shown in Fig. 2.
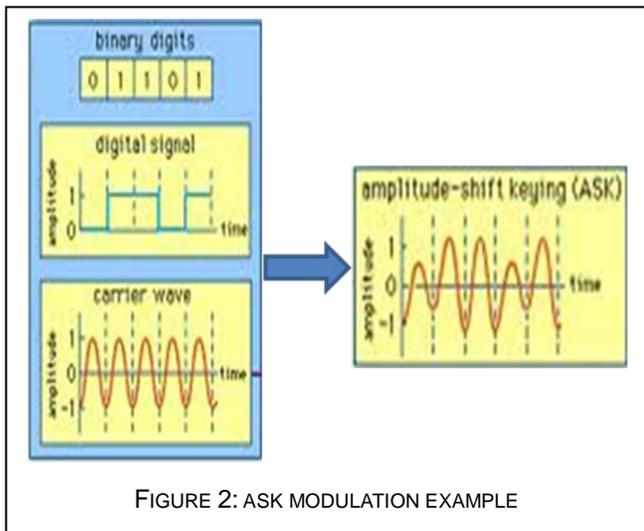

FIGURE 2: ASK MODULATION EXAMPLE

The transmitter/receiver (Tx/Rx) pair (shown in Fig. 3) of this RF system operates at a frequency of 434MHz. The RF transmitter receives serial data and transmits it wirelessly through RF via its antenna. The transmission occurs at the rate of 1Kbps - 10Kbps.
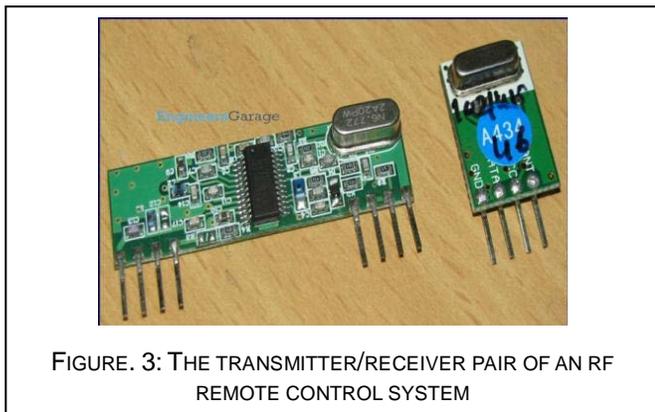

FIGURE. 3: THE TRANSMITTER/RECEIVER PAIR OF AN RF REMOTE CONTROL SYSTEM

The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. Fig. 4 shows the pin diagram of the RF transmitter and receiver and Table 1 details these pins.
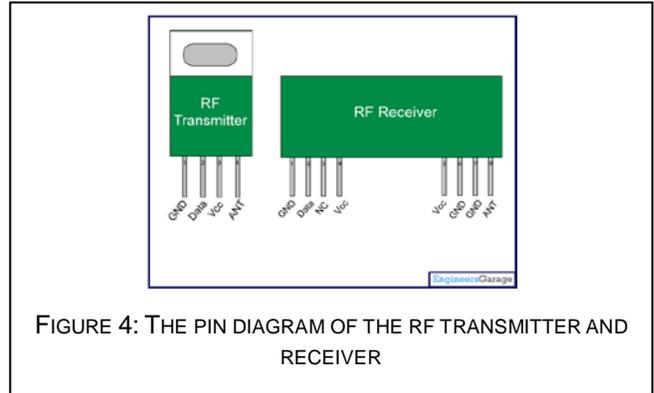

FIGURE 4: THE PIN DIAGRAM OF THE RF TRANSMITTER AND RECEIVER

TABLE 1: RF TRANSMITTER AND RECEIVER PINS

RF Transmitter		
PIN No.	Function	Name
1	Ground (0V)	GND
2	Serial data input pin	Data
3	Supply voltage; 5V	Vcc
4	Antenna output pin	ANT
RF Receiver		
1	Ground (0V)	GND
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	Vcc
5	Supply voltage; 5V	Vcc
6	Ground (0V)	GND
7	Ground (0V)	GND
8	Antenna output pin	ANT

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs. Fig. 5 illustrates their connection diagrams in an RF remote control system.
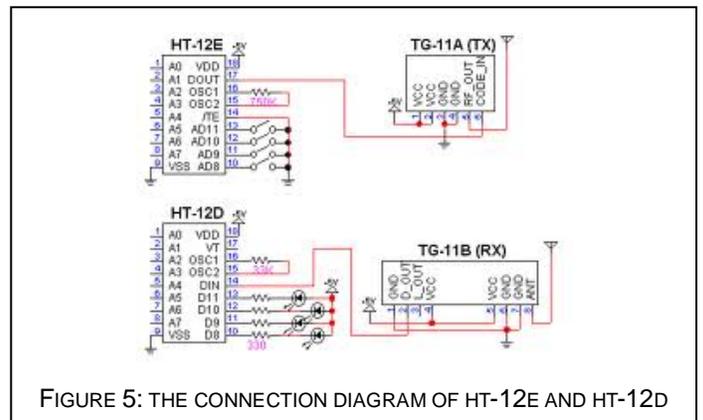

FIGURE 5: THE CONNECTION DIAGRAM OF HT-12E AND HT-12D

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3 WIRELESS LOAD SELF-DISCONNECTION MODULE

In general, the capacity of APS systems used to power low current loads (light loads) such as CFL bulbs, TV sets, water dispenser, electric fans, etc. is small (<1.5 KW) and cannot be used to energize loads with higher current loads (heavy loads) like washing machines, air conditioners, refrigerators, microwaves, toasters, etc. Therefore, such heavy loads must be disconnected from the power line as soon as the grid is off or the overload protection feature of the APS will be activated, and thus all loads will be deactivated otherwise. The easiest and most applied means to overcome this problem is to install a second electric wiring circuit dedicated only to loads that cannot be afforded by the APS. However, such a solution is very costly and sometimes infeasible in places where the tubing circuit is too narrow and does not allow the drawing of additional wires. Moreover, the installation of apparent cables is strictly forbidden as it might countermeasures electrical safety precautions and more importantly exposes people to electric shocks. FIG. 6 depicts how an APS system can be directly connected to the existing electrical circuit (power line) and heavy loads can be automatically and wirelessly disconnected at the same time the APS intervenes through the Automatic Transfer Switch (ATS) to power light loads using on-shelf low price RF RPPs such as those of Super Star [5].

FIGURE 6: THE SCHEMATIC DIAGRAM OF THE WIRELESS LOAD SELF-DISCONNECTION MODULE

RPPs are usually designed to operate distant loads by manually pressing the on/off button(s) of the remote control unit. Of course, such manual operation of the loads is not suitable for our application in which heavy loads must disconnect themselves automatically. To do so, we connect the on/off buttons of the RF remote control unit to the contacts of a low consumption 220V-AC relay which connects contacts A and B, and thus pushes the RF transmitter to send an *on* signal in the existence of the grid and an *off* signal in the grid absence as shown in FIG. 7.
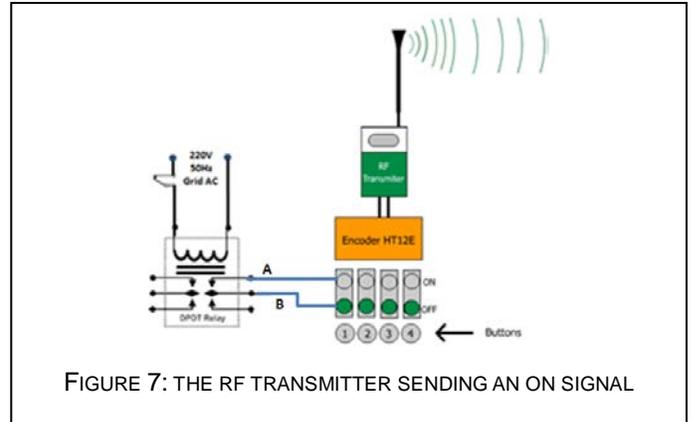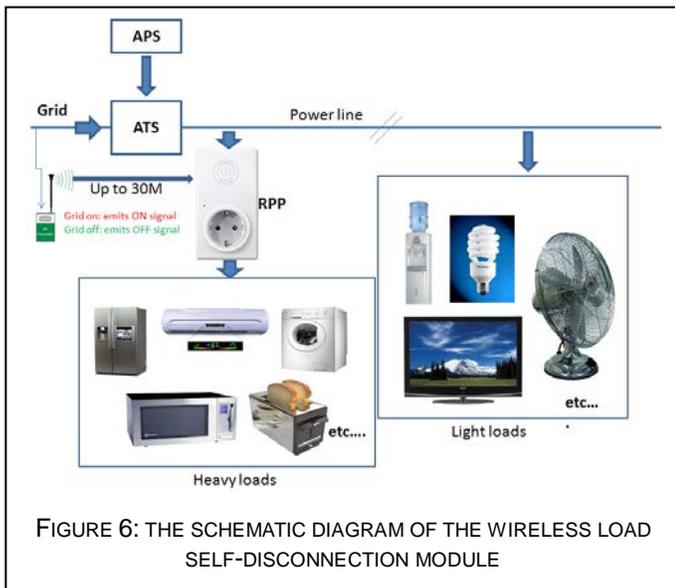

FIGURE 7: THE RF TRANSMITTER SENDING AN ON SIGNAL

It is worthy to note that the RF transmitter in the connection introduced in FIG. 6 will be on all the time, and thus the small size 12Volts battery that usually provided with the remote control unit of the RPP will get empty in few days after installation. Therefore, the battery bank of the APS system is used as an alternative energy source to supply the RF transmitter.

4   APPLICATION RESULTS

We have installed our wireless load self-disconnection modules in more than hundred houses having three bed rooms, one sitting room, one dining room, two bathrooms, and kitchen. The average area of these houses ranges from 150 to 170 square meters. Their average length and width range from 15 to 20 meters and 10 to 15 meters respectively. The location where the APS systems are already installed and where the remote control unit is best located was always almost found to be only 7 to 10 meters away from heavy loads i.e. less than 30 meters – RF remote control coverage. FIG. 8 shows a top view example for such houses together with the distribution of heavy loads (blue boxes) in it.
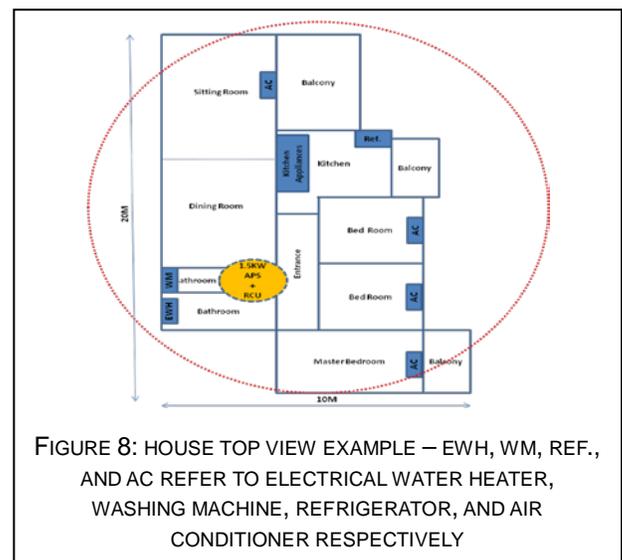

FIGURE 8: HOUSE TOP VIEW EXAMPLE – EWH, WM, REF., AND AC REFER TO ELECTRICAL WATER HEATER, WASHING MACHINE, REFRIGERATOR, AND AIR CONDITIONER RESPECTIVELY

5 CONCLUSION

This paper discusses a module that uses on shelf wireless plugs to make specific heavy loads e.g. refrigerators, air conditioners, etc. disconnect themselves automatically as soon as the utility grid is off and a stand by small size APS/generator intervenes to energize only low power rating appliances. The obtained results show that no interference occurs even when this module is installed in houses existing in the proximity of each other e.g. buildings. Financially speaking, our wireless load self-disconnection module was found to cost much less than the third of installing a by side electric circuit to separate heavy loads from the power line in the absence of the grid. Finally, none of the modules installed so far has needed any kind of maintenance although many of them have been applied since two years.

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