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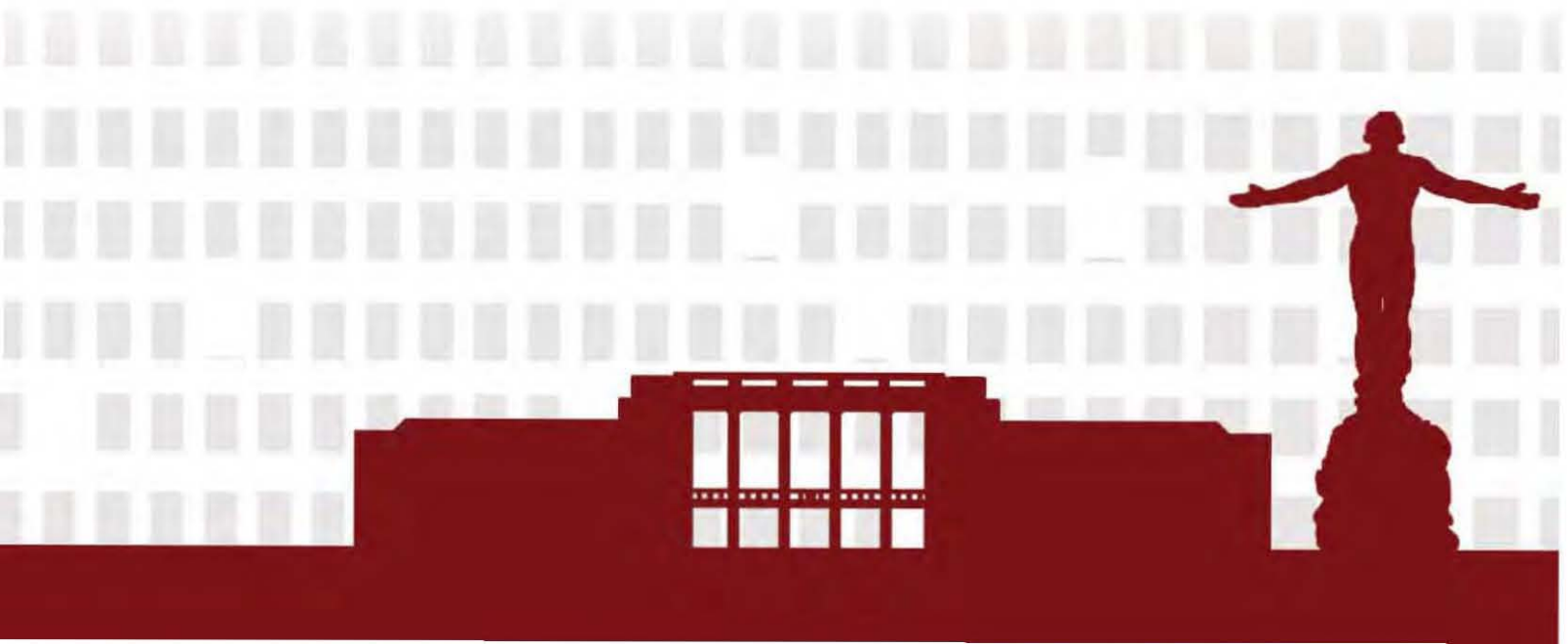
11th ERDT Conference
on Semiconductor and Electronics, Information and Communications Technology and Energy

16-17 November 2015
Metro Manila, Philippines



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MODIFIED PROGRAMMABLE TOGGLE SWITCH USING A LOW POWER 433 MHZ ISM BAND WIRELESS MODULE

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ABSTRACT
The programmable toggle switch (PTS) is a system of switches for controlling electrical loads by means of interconnecting the switches, main controller, and electrical loads through a wired connection. The PTS is a patented technology that aims to provide a low-cost home automation system for the Filipinos. One drawback of the PTS was the use of twisted pairs for wiring between the remote switch and the main controller, which is cumbersome if rewiring is needed and in situations where physical wiring is not possible. Hence, the need for a low cost wireless remote switch suitable to replace the physical wiring of the PTS was realized. Many wireless technologies for home automation like ZigBee, Z-Wave, Insteon, Wavenis, and Bluetooth exist, but either with high price or unavailability in the Philippine market limits their adoption and popularity for use by the masses. The 433MHz ISM band wireless module was chosen for modifying the PTS due to low cost and its performance. The fabricated prototype was tested for functionality and reliability through simulated and actual testing procedures. It was found that it is functional and reliable due to its high success rate considering all the imposed limitations like the assumption of full battery power at the transmitter and within the acceptable distance between the transmitter and receiver.

Keywords: 433MHz Wireless Module, Home Automation, Programmable Toggle Switch, Wireless Switch

Introduction

The current patented PTS (patent no. PH/1/2009/272) is a system of switches for controlling electrical loads by means of interconnecting the switches, main controller, and electrical loads through a wired connection [1]. Wireless technologies for remote switching is not new. One research focused on Bluetooth wireless technology for home automation where it is useful to keep home comfort and support to the elderly and disabled persons [2]. The researchers used Bluetooth home network to control lighting, heater and air-conditioning. Another research entitled "A ZigBee-Based Home Automation System" [3] (Gill et al., 2009) utilized the ZigBee(IEEE 802.15.4) and Wi-Fi(IEEE 802.11b and IEEE 802.11g) wireless network to design and implement a flexible home automation architecture. The researchers used the ZigBee standard to interconnect switches and actuators; and Wi-Fi for remote access through the internet. Other wireless home automation products available in the market today uses propriety wireless technologies [4] which limit the author to gather specifications and other relevant information. The wireless technologies presented above are all suitable for integration to the PTS, however, they all have things in common which are high price and unavailability in the Philippine market which led to limited adoption and popularity of use by the masses.

With high cost and low in availability of home automation products in the Philippine market, the need for a low cost home automation system was realized. Hence, the PTS was developed. One drawback of the PTS was the use of twisted pairs for wiring between the remote switch and the main controller, which is cumbersome if rewiring is needed and in situations where physical wiring is not possible. This led the author to research on a low cost wireless remote switch suitable to replace the physical wiring between the remote switch and the main controller of the PTS as shown in Figure 1.

The objectives of this study are to (1) develop the suitable transmitter and receiver circuits for the PTS; (2) test the prototype for functionality in a simulated and actual setup; and (3) determine the success rate of the system from the actual testing procedure.

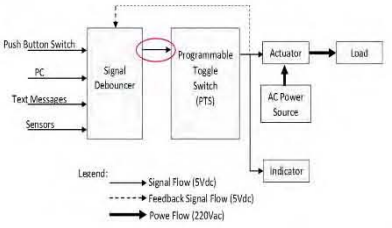

Figure 1. Block diagram of the PTS

Methodology

Six wireless remote switches will be developed to replace the wired remote switches of the PTS. The design and fabrication of the wireless remote switches observes the R&D methodology as shown in Figure 2.

Two testing procedures were observed on the study. These are simulated testing and actual testing. The testing procedures were done to ensure that specification of the system were met and in compliance with the existing Philippine Electrical Code. Floor plan and test points in the actual testing is shown in Figure 3.

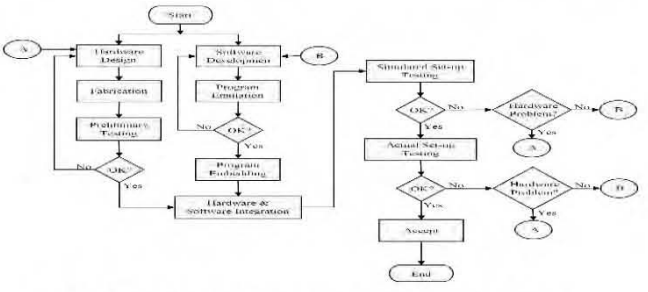

Figure 2. Design and fabrication methodology

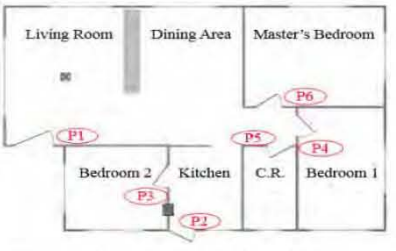

Figure 3. Test points in the floor plan for actual testing

Results

The six fabricated wireless remote swhitch is shown in Figure 4 while the summary on simulated and actual testing is shown in Table 1 and Table 2 respectively.

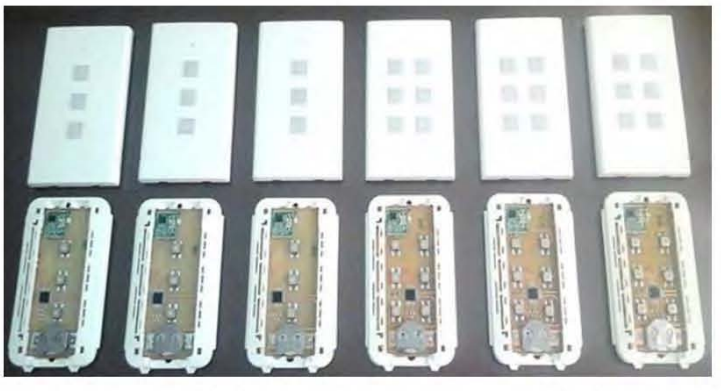

Figure 4. The Fabricated wireless remote switches for the PTS

Table 1. Received signal strength from the transmitter with respect to distance.

Distance (m)	Switch 1	Signal Strength (dBm)	Expected Light Output	Actual Light Output
10	Pressed	-71	ON	ON
10	Pressed	-71	OFF	OFF
20	Pressed	-80	ON	ON
20	Pressed	-79	OFF	OFF
30	Pressed	-85	ON	ON
30	Pressed	-83	OFF	OFF
40	Pressed	-85	ON	ON
40	Pressed	-86	OFF	OFF
50	Pressed	-92	ON	ON
50	Pressed	-91	OFF	OFF
60	Pressed	---	ON	OFF
60	Pressed	---	OFF	OFF
70	Pressed	---	ON	OFF
70	Pressed	---	OFF	OFF
80	Pressed	---	ON	OFF
80	Pressed	---	OFF	OFF
90	Pressed	---	ON	OFF
90	Pressed	---	OFF	OFF
100	Pressed	---	ON	OFF
100	Pressed	---	OFF	OFF

It can be observed from Table 1 that the maximum distance between the transmitter and receiver unit is around 50 meters and the weakest signal strength received was -92 dBm.

Table 2. Summary of the success rate of the system based on the different tests conducted.

Test Conducted	Success Rate
Five location switch controlling 1 light bulb at test point P1 to P5	100%
Four location switch controlling 1 light bulb at test point P1, P2, P3 and P4	100%
Three location switch controlling 1 light bulb at test point P1, P2 and P3	100%
Two location switch controlling 1 light bulb at test point P1 and P2	100%
One location switch controlling 1 light bulb at test point P1	100%
One location switch controlling 1 light bulb at test point P2	100%
One location switch controlling 1 light bulb at test point P3	100%
One location switch controlling 1 light bulb at test point P4	100%
One location switch controlling 1 light bulb at test point P5	100%
One location switch controlling 1 light bulb at test point P6	100%

It can be depicted from Table 2 that the success rate of the system on all tests conducted is 100%. Although in reality, there's no such perfect system, the author believes that the 100% success rate was obtained due to the careful confinement of the system within the limitations of the study. This means that the developed wireless remote switch is functional as designed and can replace the wired switches of the PTS.

Conclusion

The author was able to develop a functional wireless remote switch prototype at an effective range of 50 meters (open space) for the PTS using a low-power 433MHz ISM band wireless module. Its functionality was tested through simulated and actual testing procedures and found out to be effective in controlling connected loads to the PTS. It was also found that the designed prototype is reliable through the computed success rate of the system which is 100%. The author believes that the 100% success rate was obtained due to the careful confinement of the system within the limitations of the study. With all these findings, the study is successful since the objectives were met. However, further studies must still be pursued to achieve a more improved system.

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