Remote controlled power strip to make standby power consumption zero

Daichi Koide^a, Mayu Yamanaka^a, Daisuke Tanaka^a
Takuya Itahashi^b, and Akira Yamawaki^{a,*}

^aKyushu Institute of Technology, 1-1 Sensui-cho, Tobata-ku, Kitakyushu-shi, Fukuoka, 804-8550, Japan

^bTokyo Electron Kyushu Limited, 1-1 Fukuhara, Koushi-shi, Kumamoto, 861-1116, Japan

*yama@ecs.kyutech.ac.jp

Abstract

The standby power consumption of the home appliances occupies 5-10% of the total annual power consumption in Japan. Thus, it is important to eliminate the standby power for the earth environment. However, turning off the standby power consumption of the home appliances is very bothersome job because the power plug of each appliance must be disconnected from the power strip. This paper proposes a remote controlled power strip that can completely eliminate the standby power consumption by the infrared remote controller. By using our proposal, we can handle the operations of the electronic equipment and the plugging and unplugging of the power strip uniformly by the single remote controller. We demonstrate that our proposal can actually plug and unplug the power strip by using the electromotive force from the photodiode remotely.

Keywords: standby power requirement, Remote power switch, Power LED.

1. Introduction

The standby power consumption of the home appliances occupies 5-10% of the total annual power consumption in Japan. It is equivalent to approximately 3.6 of the nuclear power plants. The reduction of standby power is very important for the earth environment.

To eliminate the standby power, we must disconnect the plug from the power strip or switch off the main switch of the electronic product. However, this job is very bothersome. For example, we must approach each electronic product, look for the power strip behind the furniture and find the correct plug.

To achieve such bothersome job automatically, there is the proposal which employs a super condenser attached to an electronic product (?). This technology previously charges

the electric power to the condenser while the product is running. When the product moves to the standby mode, the electric power previously charged in the condenser is used instead of the commercial AC supply. However, this only borrows the power in advance which will be consumed in the standby mode. That is, the standby power is not eliminated.

This paper proposes a remote controlled power strip that can completely eliminate the standby power consumption by the infrared remote controller. By using our proposal, we can handle the operations of the electronic equipment and the plugging and unplugging of the power strip uniformly by the single remote controller.

The rest of the paper is organized as follows. Section 2 describes our proposal. Section 3 develops a prototype system to verify the operation of our proposal and demonstrates that our proposal can actually plug and unplug the power strip by using the electromotive force from the photodiode remotely. Finally, Section 4 concludes our paper.

2. Remote controlled power strip

Fig. 1. Remote control.

Fig. 2. Circuit diagram transceiver.

2.1 Proposed Power Strip

Fig.1 shows a block diagram of the proposed remote controlled power strip. Photodiode generates an electromotive force when irradiated strong infrared. Power transistor to perform the connection and disconnection of GND. Latching relay 1 performs the connection and disconnection of the AC line. Latching relay 2 to record the state of the AC line. Microcomputer controls the cutting and GND connections.

2.2 Remote Controller

Fig. 2 shows a block diagram of the infrared remote controller. The infrared remote controller uses an infrared LED for transmitting infrared normal operation code. The power LED that emits a strong infrared is used to turn on and turn off the proposed power strip.

2.3 Description of Operation

Latching relay 1 performs connection or disconnection of the AC line. Latching relay 2 is used to record the on-off state of the latching relay 1. When latching relay 2 of the AC line is turned off, and outputs a '0' in the conducting state. Latching relay 1 is OFF, that is, indicates that the electronic device is in standby mode. Latching relay 2 when the AC line ON, the outputs '1' in an insulated state. Latching relay 1 is ON, that is, indicates that the electronic device is operational.

Remote Controller is for turning on and off the power to the remote control receiver device. When the button of the power-on is pressed, a pulse is emitted from the power LED. Then, infrared rays modulated by a pulse of 38[kHz] is irradiated from the infrared LED. This is the same frequency as the normal remote control. When the button of the power-off is pressed, a pulse is emitted from the power LED. This is also the same as when the power is turned on.

AC line and the state of OFF→ON, is considered the

state of the ON→OFF as the operation. We show the AC line is the state of OFF→ON in Fig.3. We indicate the state AC line is ON→ OFF in Fig.4.

Introduction to the AC line is described from the state of OFF→ON.

(a) During standby, the power-on transistor and latching relay 1 is turned OFF. Since the GND is disconnected, the microcomputer does not require standby power. In addition, since the AC line is disconnected, an electronic product connected to the power strip does not require standby power. (b) When receiving a strong infrared pulse indicating power ON from the remote controller, the photodiode generates an electromotive force. Whereby the power-on transistor is ON. (c) Then, the microcomputer continues to turn ON the power transistor. The output of the latching relay 2 is '0'. This means that the AC line is disconnected by the latching relay 1.

(d) The microcomputer turns ON the latching relay 1. As a result, the electronic product connected to the power strip goes to the normal operation. To record that the electronic device is a normal operating state, the microcontroller turns off the latching relay 2 and make its output 1. The microcomputer continue to ON the power transistor.

(e) The microcomputer makes some delay to ensure that the latching relay 1 and 2 stay at the stable state. Then, the microcomputer turns off the power transistor.

(f) AC line is turned ON, electronic equipment comes into play as usual. Microcomputer, because you have OFF the power transistor, a non-power state.

Next, let us explain the operations turning off the power strip shown in Fig. 4.

(a) During an electronic product connected to the power strip is running, the power-on transistor is turned OFF. Since the GND is disconnected, the microcomputer, i.e. the proposed power strip, does not require any standby power.

(b) When receiving a strong infrared pulse from the remote control, the photodiode generates an electromotive force. Whereby the power-on transistor is ON.

(c) Then, the microcomputer continues to turn ON the power transistor. Since the output of the latching relay 2 is '1', the microcomputer recognizes that the electronic equipment is in the normal operation.

(d) The microcomputer turns off the latching relay 1 to turn off the electronic product. To record that the electronic equipment is again in standby state, the microcomputer turns ON latching relay 2. As a result the output of the latching relay 2 becomes 0.

(e) The microcomputer waits for the latching relay 1 and 2 going to the stable state. Then, the microcomputer stops to

continue to turn ON the power transistor.

(f) As a result, the power-on transistor and latching relay 1 are both turned OFF. That is, the whole system does not consume any power.

Fig. 4. ON→OFF.

3. Operation verification

3.1 Prototype

In this paper, we have developed a prototype hardware to verify the switching operation about our proposal. We used photodiode (6775-01), P-type MOSFET (IRFR9024NPbF) and N-type MOSFET (IRLRU3410PbF) as the elements. We also used power relay (G6CK-2117P-US). We used the CYPRESS company's PSoC

(CY8C24423-24PXI) as a microcomputer. We used the 9[V] battery of as the power of the PSoC. We stepped down to 5[V] form 9[V] by three-terminal regulator and used it because the operating voltage of PSoC is 5[V]. We used a three-terminal regulator (7805A) for the voltage conversion.

3.2 Validation result

Fig.5 shows the signal of the remote control transmission unit and AC line of the waveform. The upper waveform shows a signal of the remote control transmission unit and the lower waveform shows the AC line waveform

operation of the waveform. We found that the pulse width of the on-off signal is approximately 135[ms] and the switching operation is completed in approximately 20[ms] since the on-off signal is sent from the transmission unit. This is a very short time. The big difference is not observed even actually use. It was confirmed that to be disconnect or connect the AC line on-off signal of the remote control transmission unit. Since this duration is a very short time, the user does not feel a time lag when using the electronic product employing our proposal. We also demonstrate that our proposal can actually plug and unplug the power strip by using an electromotive force from the photodiode remotely.

4. Conclusion

We have proposed a remote controlled power strip making the standby power consumption of an electronic product zero. Also the plugging and unplugging of the power strip connected to an electronic product can be achieved by the unified manner using the remote controller.

On a prototype hardware we have developed, it has also been confirmed that our proposal can actually plug and unplug the power strip by using an electromotive force from the photodiode remotely.

As future work, we will evaluate the power consumption of the actual home appliances employing our proposal. Through this evaluation, we expect to show the efficiency of our proposal to reduce the total standby power consumption.

Acknowledgment

This research is partially supported by the JSPS KAKENHI Grant Number 26330106.

References

- (1) National Institute of Advanced Nuclear Energy Safety Organization Planning Department : “2013 edition nuclear facility operation management annual report”, Nuclear facility operation management annual report, Vol. 1, No. 1, pp. 1-526, 2013
- (2) Hijikata KeiJiro : “Standby power zero watts of television by eco chip™”, ITE Journal, Vol. 1, No. 1, pp. 729-731, 2012

(a) ON.

(b) OFF.

Fig. 5. Signal waveform.