Remote power strip with zero standby power controllable from every direction

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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. So we have developed a remote control power strip that standby power is zero by infrared remote control to eliminate that bothersome job. Since the proposed power strip contains the light receiving part, the installation location is strictly limited to the space where the user can irradiate the power strip from the remote controller. This paper attempts to separate the light-receiving part from the proposed power strip. As a result, the proposed power strip can be installed to any location. To allow the user to irradiate the light receiving part from every direction, we introduce a hemispherical mirror that reflect the light from any direction to the receiving part. The preliminary experiment shows that the switching operation can be accomplished actually in all directions.

Keywords: standby power requirement, half-spherical mirrors, 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 ⁽²⁾. 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 avoid such bothersome job automatically, there is the proposal which employs a super condenser attached to an electronic product ⁽³⁾. 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.

We have developed a remote control power strip that standby power is zero by infrared remote control ⁽¹⁾. We have verified switching operation. We did a calculation of power consumption and battery life.

Since the proposed power strip contains the light receiving part, the installation location is strictly limited to the space where the user can irradiate the power strip from the remote controller. This paper attempts to separate the light-receiving part from the proposed power strip. As a result, the proposed power strip can be installed to any location. To allow the user to irradiate the light receiving part from every direction, we introduce a hemispherical mirror that reflect the light from any direction to the receiving part. Finally, we confirm whether the switching operation is performed actually in all directions.

2. Remote controlled power strip

2.1 System overview

Fig. 1 shows a diagram of the overall system. When the remote controller irradiates a strong infrared light to the light receiving part, the electromotive force is generated from the photodiode. The latching relay connects or disconnects the AC line by utilizing the electromotive force. When AC line is disconnected, the standby power of the electronic devices connected to the power strip becomes zero.

Fig. 1. System summary.

Fig. 2. Light receiving part.

2.2 Light receiving part

Fig. 2 shows a diagram of the Light receiving part. A cylindrical transparent box has a half spherical mirrors. On top of the half spherical mirrors there is a photodiode. The θ_1 is the angle of the X and Z. The θ_2 is the angle of the X and Y. Half Spherical mirrors can be display the range of $\theta_1=360^\circ$, $\theta_2=180^\circ$. If the light source is higher than the half spherical mirrors. The light reflected by the half spherical mirrors photodiode is received.

2.3 Power Strip

Fig.3 (a) shows a detailed block diagram of the proposed remote controlled power strip. Photodiode generates an electromotive force when irradiated strong infrared. Power transistor performs the connection and disconnection of GND line. Latching relay 1 performs the connection and disconnection of the AC line. Latching relay 2 records the state of the AC line indicating whether it is disconnected or connected. A microcomputer manages the relays.

2.4 Remote Controller

Fig. 3 (b) 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.

2.5 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 is turn off, outputs '0' in the conduction state. When latching relay 1 is turn off, the electronic device is a standby state. When the latching relay 2 is turn on, outputs '1' of the insulating state. When latching relay 1 is turn on, the electronic equipment 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 light pulse is emitted from the power LED. When the button of the power-off is pressed, a light pulse is emitted from the power LED. This is also the same as when the power is turned on. When other buttons to control the electronic product are pushed, the infrared light modulated by a pulse of 38[kHz] is irradiated from the infrared LED. This is the same frequency as the normal remote control.

When receiving a strong infrared pulse indicating power on from the remote controller, the photodiode generates an electromotive force. Whereby the power transistor is on. 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. 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. Microcomputer is turned on the power transistor. 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. AC line is turned on. Electronic devices operates as usual. When the power transistor is turned off, the microcomputer is a non-powered state.

(a) Remote Controller.

Fig. 3. Circuit diagram transceiver.

3.1 Experimental Setup

3.2 Distance Effect from Light Emitter to Receiver

We measure the electromotive force when changing the distance between the light-receiving part and the infrared light emitter. We set at an angle between the light-receiving part and the infrared light emitter of the $\theta_1 = \theta_2 = 0$ [°]. We changed by 5 [cm] the range from 0 ~35[cm].

3.3 Switching from any direction

We set the distance 15 [cm] from the infrared emitter to the light receiving part. We have varied a range of $\theta_1=0\sim360$ [$^\circ$] of the half spherical mirror by 45 [$^\circ$]. We have changed by 15 [$^\circ$] for the range of $\theta_2=0\sim90$ [$^\circ$]. Every angle, we have recorded the electromotive force of the photodiode at the time of switching operation.

3.4 Validation result

Fig. 4 shows the verification result of distance effect from light emitter to receiver. We were able to confirm the on-off of the AC line of the distance between the light-receiving part and the infrared light emitter to 25[cm]. We have found that the AC line cannot be turned on-off in the threshold voltage of the power transistor 2[V].

Fig. 5 shows the verification result of switching from any direction. Fig. 5 (a) is the electromotive force when changing the θ_1 . Fig. 5 (b) is the electromotive force when changing the θ_2 . We have confirmed of the AC line on-off at all angles. We found that can be received from any direction light receiving part. Electromotive force at all angles was higher than 2[V] threshold voltage.

Fig. 4. Electromotive force.

(a) Horizontal direction.

(b) Vertical direction.

Fig. 5. Electromotive force.

4. Conclusions

We used a half spherical mirrors. We developed a remote power strip of standby power zero by an infrared remote control. We confirmed the on-off of the AC line although the infrared light from the remote controller is reflected by the half spherical mirror. We have found that the AC line is not turned on-off in the threshold voltage of the power transistor 2V when distance between the light-receiving part and the infrared light emitter is far. It has become possible to install only the light receiving part in a location that is easily illuminated by releasing the proposed strip and the light receiving part. We were able to widen considerably the range of light receiving ($\theta_1=0\sim360$ [$^\circ$], $\theta_2=0\sim90$ [$^\circ$]). Future, the remote control transmitter part to be able to store the signal of equipment. We will extend the communication distance of the proposed strip. We want to be able to operate the electronic equipment and power strip by a remote control.

References

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