

Realization of Wireless Control of the Dimmable Electronics Ballast for Electrodeless Fluorescent Lamps

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Abstract - A new scheme of dimmable ballast system for the electrodeless fluorescent lamp is proposed. The proposed scheme is composed of the conventional ballast system and the wireless communication part using an EPLD. As a result, the proposed system has a dimming control capability by wireless communication technology. In this paper, wireless dimming control system for electrodeless fluorescent lamp was introduced.

1. INTRODUCTION

The goal of power management for lighting is to ensure the dimming and control capability on the electronic ballasts of the lamps. In addition to this capability of the ballast, the wireless control method is recently required for convenience and larger size of power management system for lighting.

Recently, the electrodeless fluorescent lamp which is expected as the next generation lighting has feature of the extremely long life, due to it has no electrodes in discharge bulbs. For the electrodeless fluorescent lamp, the use of dimmable electronics ballasts can further reduce power consumption in building areas where continuous full-power operation of the electrodeless fluorescent lamp is not necessary.

In this paper, a wireless control of the dimmable electronic ballast for electrodeless fluorescent lamp was realized. An EPLD was used to realize the wireless control system. The EPLD has three main parts which are communication with RF module, gate driver for the ballast, and indication of the current status of the lamp.

2. THE WIRELESS CONTROL OF DIMMABLE ELECTRONICS BALLAST

Fig.1 shows the total system of wireless control of the ballast for the electrodeless fluorescent lamp. In the figure, the RF component of the system adopted the Zigbee 2.4 GHz wireless networking technology, which is based on 802.15.4 standard. L stands for the distance between RF transmitter and ballast, while N is the number of ballasts in the figure.

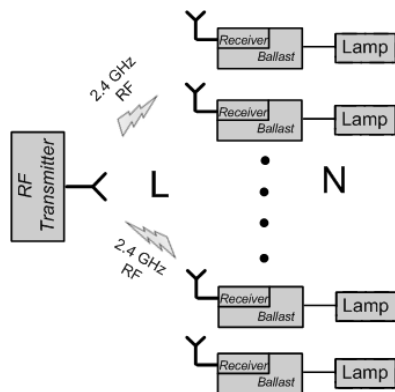


Fig.1 Scheme for wireless control of a group of ballasts

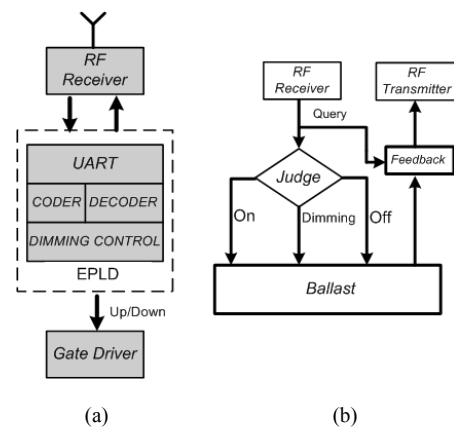


Fig.2 Block diagram and command flowchart of the EPLD

Fig.2 shows EPLD inside the ballast as a communication block and command flowchart of the EPLD. In the figure, UART was employed to communicate the serial data with the RF module. The serial data are composed of a low star bite, 8 data bits, and 1 stop bit. The Baud Rate is 38400 Baud/s.

The operational principle of the EPLD is as follows:

Once the RF module sends the control commands to EPLD, the UART receives the commands and Decoder interprets them into the dimming control information. On the other hand, to read out the current status of the lamp, the dimming control sends the information on the current status to the Coder. Then, the Coder codes them and sends the coded data to UART. Finally, the RF module gets the information required through UART. The command flowchart shown in Fig.2.(b), summarizes the principles above. Table 1 and Table 2 show the single-control and group-control commands to control the lamp.

Table 1 Single-control commands of ballast

| Commands | Functions |
|---------------------|---------------------------------------|
| Increment Intensity | Increase 1% dimming level by one step |
| Decrement Intensity | Decrease 1% dimming level by one step |
| Power On | Turn on the lamp |
| Power Off | Turn off the lamp |
| Set Dimming Level | Set the dimming level |
| Query | Read the status and dimming level |

Table 2 Group-control commands of ballast

| Commands | Functions |
|-------------------|---|
| Power On | Turn on all the lamp |
| Power Off | Turn off all the lamp |
| Set dimming level | Set all the dimming level synchronously |

Fig.3 shows block diagram of the electronic ballast for the electrodeless fluorescent lamp. The electronic ballast requires EMI filter and power factor correction (PFC) circuitry in order to meet the requirements of EMI standards and DC link voltage is also be boosted to a constant value nearly 400V. The resonant inverter is adopted for a half-bridge circuit, whose resonant tank circuit is formed by inductor and capacitor, as same as conventional ballasts. [2-3].

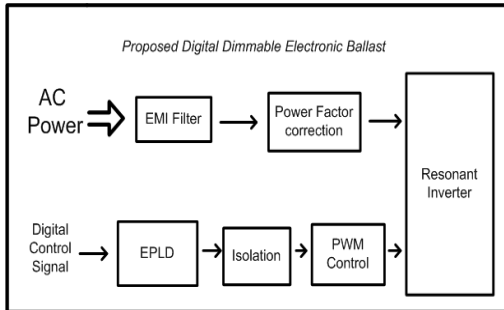


Fig.3 Block diagram of the electronics ballast

The dimming method is based on the burst dimming method that controls the duty ratio for the two switches of the electronics ballast by intermittently modulated pulse signal. As it is almost impossible to synchronize the burst frequency and the switching frequency with an analog control circuit, we use the digital control circuit to realize the dimming method, as discussed in [4]. The digital control block diagram is shown in Fig.4 [4].

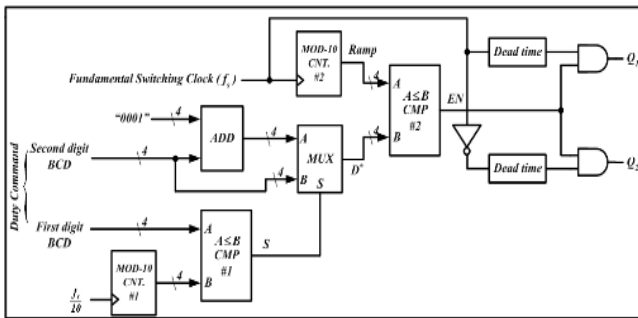


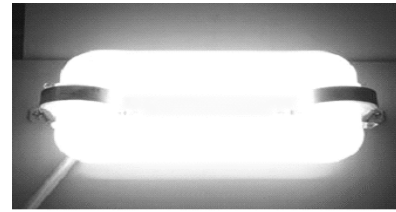
Fig.4 Block diagram of the dimming method [4]

3. EXPERIMENT RESULTS

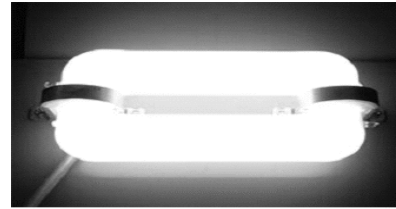
For the experiment of wireless control of the electrodeless fluorescent lamps, the following parameters are used:

- .DC link voltage V_{DC} : 400 [V]
- .switching frequency f_s : 250 [KHz]
- .switching device (MOSFET) : IRF840
- .resonant inductor L : 158 μ H
- .resonant capacitor C : 3.2 nF
- .lamp : Endura 150 W (Osram)
- .distance between RF transmitter and ballast L : 10m
- .number of lamps N : 10

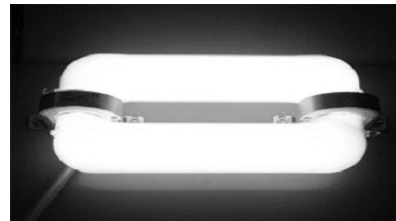
The dimming level realized in this test is in the range of 30 to 100, with 30 corresponding to 30% brightness and 100 corresponding to full brightness. Once full brightness has been reached, however, additional Increment Intensity Command will be ignored until the brightness reduced below full brightness. And the Decrement Intensity Command cannot decrease the intensity below 30%. Figure.5 shows the dimming controlled results of the lamp. From the results, it can be seen that the luminescences is well controlled.



(a) D=100%



(b) D=50%



(c) D=30%

Fig.5 Luminescences according to the duty ratio

4. CONCLUSION

In this paper, the wireless dimming control system for the electrodeless fluorescent lamp was realized. Through the experiment, it is confirmed that the dimming range of 30% to 100% could be achieved by the wireless control. In addition to dimming control, individual control and group control of the lamps also attained.

As a future task, extension of wireless distance and number of lamps should be considered.

5. REFERENCES

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