A Touch-Dim Network for the Dimming Control of Lighting System

Jyh-Ching Juang, and Hung-Chi Wang
Department of Electrical Engineering
National Cheng Kung University
Tainan, Taiwan
keikey2002@gmail.com

Chun-Lin Lu*, Wen-Ming Chen, and Ching-Wen Hsu
Department of Computer and Communication
Kun Shan University
Tainan, Taiwan
cllu2007@gmail.com

Abstract—DALI is a popular interface of lighting network system with an excellent dimming facility, but it is too complicated when it is applied in family house. Touch-Dim installation of DALI ballast is then developed. The installation and operation are much simplified but the network function is no more valid. This paper proposed an alternative network structure, which is named as “Touch-Dim network”, to offer an operation as simple as Touch-Dim but the network function is valid again. The system architecture and the hardware design are described in the paper. An internet u-Lighting system with three switches and three fluorescent lights is also implemented in this work to demonstrate the proposed Touch-Dim network.

Keywords-DALI; lighting; network; Touch-Dim

I. INTRODUCTION

Properly dimming the lighting will save up to 50% electrical energy [1]. Digital control of lighting system is slowly emerging as a popular means for controlling complete lighting environments. Its purpose is to ensure the monitoring and control functions of lighting for energy-saving. It provides the right light utilization with better efficiency via light dimming. The digital control allows the design of intelligent lighting systems with more complex features, such as the lighting dimming with a dedicated digital power controller [2], or the remote lighting control based on lighting network communication protocols. Numerous interface of lighting network protocol has been proposed. The EIB (European Installation Bus) [3] can be installed in large buildings with Home Server 3 enabling the user to control all lighting from a particular location through the Internet. Each user can manage the lighting in a certain part of the building which was assigned to him. A significant amount of lighting behaviors can be programmed in the server to perform high level control over the KNX systems. An electronic system with controlling and monitoring features for lighting lamps becomes a part of a novel Controller Area Network (CAN) bus lighting network [4]. The proposal shows new possibilities in lighting configurations with different potential applications. The main reason of this development was due to its robust performance. Most of the existing lighting network systems are based on a master-slave scheme such as the proposals in [5] and [6], where the power line is used as transmission media. One of the most commercially available lighting network protocols is the Digital Addressable Lighting Interface (DALI) [7, 8], which also performs with a master-slave scheme. The system known as DALI is developed in Europe, which has been widely adopted by several companies and is in the process of becoming a standard. It is a two-wire system with a defined digital communication protocol for sending and receiving instructions. DALI is very useful for large building. But, due to the complexity of the network, the system becomes expensive for lighting system and no more suitable for family house. Hence a trade-off version known as “Touch-Dim” of dimming control of DALI is developed. It allows two terminals of DALI interface to be connected directly to the mechanical buttons and then to the AC lines. The user can turn on/off the lighting by “touch” the connected button, and can adjust the brightness of lighting by “hold” the button. With “Touch-Dim” interface, the DALI ballast is suitable for family house installation. But there is another problem appearing that it is impossible for the mechanical button to offer network function.

In this paper, a Touch-Dim network is proposed. It can be applied to connect the devices with DALI interface to let the operation like “Touch-Dim” but the network function is valid again.

II. DALI AND TOUCH-DIM

The DALI is an electrical interface and bus protocol mainly used for the control of lighting systems. The interface and the protocol are defined in the standard IEC 60929/EN 60929 Section E.4. Figure 1 shows the DALI-bus segment that one master controller must be installed. A master can control up to 64 individually addressable slaves. This means ballasts on the same circuit can be controlled independently.

The DALI network allows the master to communicate with all of the ballasts at once, groups of ballasts or individual ballasts. The communication functions include on/off, dimming level and fading time. Various operating parameters can be changed and stored dynamically within the ballast memory.
Another feature of DALI is the ability to diagnose problems, such as lamp brightness, or even lamp failure. DALI provides 256 levels of brightness and also includes a logarithmic dimming curve. This gives larger increments in brightness at high dim levels and smaller increments at low dim levels. The result is a dimming curve which appears linear to the human eye.

“Touch-Dim” is an alternative installation of DALI. As shown in figure 2, it allows simple dimming via standard pushbutton without an extra dimming or control device. Here “Touch” means a short push of the button. It will actuate the DALI ballast to turn on/off alternatively. “Dim” means a long push of the button. The brightness of the ballast will be changed gradually while the button is pushed, and will be memorized at the moment of the button being released. Touch-Dim simplifies the configuration and the installation of DALI, but the network function is no more valid. Touch-Dim installation connects the DALI terminals to AC 220 V via pushbutton, while the DALI network uses 16 Vdc as the high state and 2400 bps of the Manchester code as the communication protocol. Hence Touch-Dim and DALI must never be used at the same time.

III. THE PROPOSED TOUCH-DIM NETWORK

This paper proposes a new interface for the DALI ballast. The user can use the DALI ballast as simple as Touch-Dim installation via the interface, but the network function is still valid. This is why the interface is named as “Touch-Dim Network”. The system architecture of the proposed network and the hardware design are described as the follows.

A. System Architecture

Figure 3 shows the system architecture of the proposed Touch-Dim network. There are interface circuits, such as light driver and switch interface, connected with the DALI/Touch Dim modules, the switch modules, and even the personal computer.

For the switch modules, the pushing activity is transferred to be a data stream and broadcasted in the network. All the devices connected with the network will be notified. The corresponding ballast will execute a proper action when a complete data stream is received. After the action, the ballast will send a response data stream including the status of the light onto the bus of the network. All the connected switches will update the indicating light status according to the data stream.

The output of the light driver can be designed either to be DALI interface or to be Touch-Dim interface. In DALI interface, a 16-bits Manchester code of 2400 bps with 16 Vdc of high state is implemented.

The personal computer in Figure 3 is optional for the application of the network. If it is connected, the network becomes accessible from the internet. This will much expand the range of the network and let ubiquitous control of the lighting system (u-Lighting) come true.

B. Hardware design

Refer to Figure 4, the Touch-Dim network consists of twisted-pair wires which consists of a data line and a ground line. There is at least one terminator connected with the wires. The output stage of the circuit is designed to be an open collector configuration to let all circuits be connected together in parallel. This design eliminates not only the tri-states buffers but also the master controller. The input comparator is always connected to the network to immediately reflect the data on the bus of the network. It is useful for detecting data collision on the bus. The reference “DC” level of the input data comparator is designed to be automatically adjustable. It will trace to the level of 0.6 V lower than the highest state of the bus. This design is useful for improving the received data quality.
IV. IMPLEMENTATION RESULTS

As shown in Figure 5, three switches and three fluorescent lights with DALI ballasts are implemented to be a Touch-Dim network lighting system. Three switch modules are all designed to have three pushbuttons and three LEDs. Each light can be controlled by any one of the above switches. All the switches can display all the statuses of the lights. It is the basic requirement for energy saving and Carbon reduction. Based on the network lighting system, people will easily see the light statuses, and also will turn off them very conveniently.

The communication protocol of the proposed Touch-Dim network is similar to UART (universal asynchronous receiver and transmitter). Data communication is conducted via the format of 9600 bps, 8 data bits with non-parity, and 1 stop bit (9600n81).

The implemented Touch-Dim network is also connected with the PC interface circuit. Then the network is able to communicate with the remote computers or even the remote PDA to let it be accessible at any place. It becomes ubiquitous lighting system (u-Lighting). Figure 6 shows the demonstration panel of u-Lighting. It is proved to work that all the lights in the demonstration house located in the remote end can be turned on or off on the panel of PDA.

V. CONCLUSION

A Touch-Dim network for dimming lighting control is proposed. It can be connected with the DALI ballasts to compose a u-Lighting system to let the lighting control be accessible at any place. Due to the separation of the DALI ballasts and the network bus, the ballasts can be installed either in standard DALI of 16 Vdc with Manchester coding, or in simple connection with AC 220 V via switches as the Touch-Dim installation. The proposed network lets the lights on the net to be operated as simple as Touch-Dim and they still have networking. The output stage of the interface circuit which is designed in this work is selected to be open collector configuration to eliminate not only the tri-states buffers but also the master controller of the network. An internet u-Lighting system with three switches and three T5 fluorescent lights is also implemented in this work to demonstrate the proposed Touch-Dim network.

ACKNOWLEDGMENT

This work is partly supported by the National Science Council in Taiwan under Grant of NSC 98-2218-E-168-001.

REFERENCES


