

A REVIEW: FPGA IMPLEMENTATION OF DALI CONTROLLER

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Abstract— DALI (Digital Addressable Lighting Interface) is serial data protocol which describes digital communication between controller and one or more lighting device. The controller can control each light by means of Manchester coding that is nothing but bi – directional data exchange. But malls, hospitals have large number of lightning devices at that time it is difficult to handle all lighting devices because as number of lighting devices increase, the time required for bi – directional data exchange also increases as well as cost of system which is used to handle such a large no. of lighting devices also increases. So, it is essential to have cost effective solution to handle large no. of devices with increasing speed. Therefore, FPGA implementation of DALI controller with Manchester coding and DALI TOOL (V0.1) software is proposed for DALI commissioning between controller and one or more lighting device.

Keywords—DALI Protocol, Manchester coding, Physical Layer, Data Transfer Layer, FPGA, HDL.

I. INTRODUCTION

Today's world is full of computerized and of automotive systems so now days, electricity becomes need of human beings. During the year 2014-15, the per capita electricity generation in India was about 1,010 kWh and total electricity consumption is of 938.823 billion or 746 kWh with respect to total electricity generation but the most dangerous fact is about 10 percentage of world's total generated electricity energy is consumed in IT industries for lighting purpose. Similarly, in malls, theatres and hospitals large amount of electricity is used for lighting system. Therefore it is necessary to reduce energy consumption using different digital protocols.

Energy is the one of the major inputs for an economical development of any country. In case of developing countries the energy sector assumes critical importance in view of increasing energy needs widening of supply-demand gaps and also huge investment required to meet them. Energy efficiency is achieved when usage of energy in a specific application or in a specific product is reduced without affecting output of

application or user comfort levels. Commercial buildings of Indian Industries are especially poor at managing energy efficiently as compared to other countries therefore, designing lighting systems is the only solution to solve this critical issue. Lighting control systems provide the right amount of light where and when it is needed means lighting control systems are mainly used to maximize the energy savings. So, lighting control system is referred as, "Smart Lighting". Lighting improvements usually offer the easiest and most visible efficiency gains and these are cost-effective also. A lighting control system is a network based lighting control solution which describes communication between various system inputs and outputs. These input and output are controlled with the use of one or more central computing devices. Lighting control systems are widely used for both indoor and outdoor lighting of commercial, industrial, and residential spaces.

There two types of lighting control systems which are:

1. Analog lighting control
2. Digital lighting control

A. Analog lighting control system further classified as:

i) 0-10V based system:

0-10V Analog Lighting Control System is one of the earliest and simplest electronic lighting control system. This system in which input signal is a DC voltage that varies between zero and ten volts. When input voltage of 10V at that time this analogue lighting control system gives output of controlled light is of 100% of its potential output, and at 0 V it is 0% output (i.e. "Off").

To overcome these problems 0-10 V lighting system was replaced by analogue multiplexed systems such as D54 and AMX192 which is basically used for stage lighting.

ii) D54 based systems and AMX192 based systems:

These system requires one wire per control channel and a sophisticated system consist of hundreds of wire so that this system requires expensive Multicore cables and connectors. But, in case of long cable, the voltage drop per channel is greater, so that voltage losses also increases. But digital lighting control system is simple, portable and easy to implement than analog lighting control system.

So, now-a-days, DMX-512 and DALI are popular standards for Lighting Control System because of their digital nature, while DMX-512 is originally targeted to fulfill need of entertainment lighting control, similarly DALI which is digital data protocol is targeted to fulfill need of simpler, commercial and architectural lighting application.

B. Digital lighting control systems further classified as:

- i) **DSI based system :**
DSI means Digital Serial Interface is the foundation Of all digital lighting control system.
- ii) **DALI based systems:**
DALI that is Digital Addressable Lighting Interface Protocol is widely used lighting control solution.
- iii) **KNX based systems:**
- iv) **DMX or DMX-512 based systems:**
KNX based system is basis of DMX-512(Digital Multiplex) protocol which is basically used for stage lighting.

C. DALI Protocol

DALI is an acronym of Digital Addressable Lighting Interface. DALI is Digital Serial Communication Protocol dedicated for Lighting Control Solution. In a typical application, DALI Protocol consist of one controller known as Master and multiple slaves that have DALI interface. It can control up to 64 different slaves (ballasts) as shown in Fig. 1, but at the same time it can control more than 64 devices using multiple separate DALI network which are linked together with gateways such as RS232. It's possible to transmit commands to single device and it also incorporates Grouping and Scene broadcast message to address multiple devices at same time. DALI bus consist of two wire for communication and Data is transmitted in frames through bus. There are two types of frames: "Forward Frame" which is used to control lighting devices or lighting dimming ballasts and a "Backward Frame" which gives current operating status information of lighting devices. These frames started with start bit and ends with two high level stop bits.

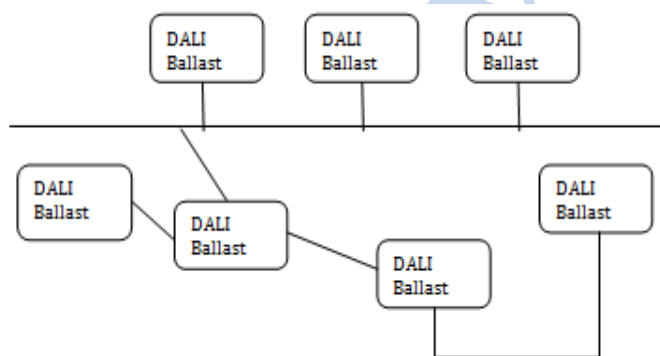


Fig. 1: DALI Topology

DALI Forward Frame:

DALI Forward Frame consist of one S bit where S= Start bit which is a logical 1, eight bit Address byte denoted as "YAAA AAAS" then eight bit Data byte expressed in Fig.2 as

"XXXX XXXX" and at last two stop bits indicated as "I" (Idle line).

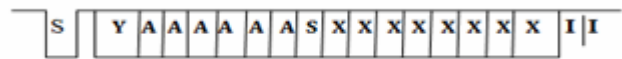


Fig. 2: DALI Forward Frame

DALI Backward Frame

DALI Backward Frame as shown in Fig.3 consist of one S(Start) bit which is a logical 1, eight bit Data byte expressed in fig as "XXXX XXXX" and two stop bits where I = Stop bit (Idle line).

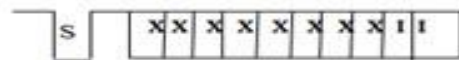


Fig.3: DALI Backward Frame

DALI uses Manchester Coding technique for serial communication. Manchester coding is a digital coding technique in which all the bits of the binary data are arranged in a specific sequence. When transmitting '0' bit, Manchester coder gives "10" while this result occupy half cycles respectively, similarly when transmitting '1' bit, Manchester coder gives "01" means every bit takes two periods denoted by TE. DALI has about 1200 bps bit rate. Therefore, 1 bit period (2TE) is 834µs. During transmission of data between DALI controller and DALI dimming devices, MSB bit of data is first transmitted.

D. Comparison between Latest Digital Lighting Control Communication Protocols

Table 1: Comparison of Protocols

Sr. No.	Control Protocols	DMX -512	DALI
1]	Speed	Fast	Slow
2]	Transmission Of Data	Unidirectional	Bidirectional
3]	Automatic Addressing	No	Yes
4]	Transmission Of Address Code	No	Yes
5]	Types of Addressing	Unique	Unique, Grouping, Broadcasting
6]	Reception of Operating Status message	No	Yes
7]	Centralised Control	Yes	No
8]	Cable Length	300 m	300m

Table1. Shows that the DALI Protocol is the best and cost

effective solution for Lighting Control in any application as compared with other Digital Serial Communication Protocols. DALI Protocol is slow but because of multi-addressing nature, it can be widely used in malls, hospitals.

The review is organized as follows: the system of DALI communication controller is presented; related problems, design challenges are discussed in Section I. Related work is presented in section II. In section III proposed methodology is presented. In section IV, conclusion and set of remarks presented at the end of the brief.

II. RELATED WORK

Different methods that are used to implement DALI Protocol is presented below.

The Real Time Implementation of Digital Addressable Lighting Interface is presented in [1], in which work is carried out using a system consisting of PSoc microcontroller and PIC microcontroller. PSoc microcontroller performs receiving & processing input data and sending the data to PIC microcontroller. PIC microcontroller performs the function of controlling brightness of the bulb. Because of flexibility and two way communication, DALI Protocol is used in real time applications. Similarly this paper concludes that with the use of thyristor circuit that makes DALI system suitable for use in other applications such as speed control, PWM generation and light intensity control as well as in motor control applications.

Implementation of Centralized Building Automation System (BAS) using DALI-WSN network is presented in [2]. Building Automation System (BAS) is basically performs functions of automation such as heating ventilation, air conditioning, lighting control as well as it controls different kinds of alarms. Adapting IEEE 802.15.4 standard based wireless sensor network in this system allows integration of DALI devices (Dimming Ballasts) as a part of WSN. This DALI-WSN integration is done in this paper with powerful simulation modeling capabilities of Matlab / Simulink. Here different subsystem functions are connected through Matlab functional block with coding. This utility of digital addressing capability of DALI makes integration of blocks for the purpose of centralized building automation.

Implementation of DALI Protocol using microcontroller is presented in [3] which is modified Digital Lighting Control System used for lighting control in malls, hospitals instead of Analog Lighting Control System. Due to two way communication, cost effective control of individual fixtures, different types of addressing such as unique, broadcasting, grouping DALI Lighting Control System is best over an Analog Lighting Control System. In this system ballast achieves very low power by controlling communication circuit with communication enable signal and receive drive.

Remote Control System using DALI protocol for efficient street lighting system is implemented with TDA5051A modem IC for power line communication is presented in [4]. This system uses sensor combination to control desired system parameters and information is transferred using power line communication.

Hence the problem definition is, "To implement DALI communication Controller in FPGA using HDL to improve communication speed as well as various terms such as correctness, clock frequency, power, area used in FPGA in order to verify design flow of system."

III. PROPOSED METHODOLOGY

Proposed system requires DALI power supply, soft core controller, power driver, DALI bus, Dimming ballasts and FPGA these are main blocks of Hardware design.

For Software requirement Xilinx HDL Platform used for FPGA implementation. General purpose I/O, UART, Timer, Manchester Encoder/Decoder, on chip ADC/DAC, on chip Program memory, LCD/Keyboard Drivers these are proposed blocks in FPGA design. Proposed System will be design using FPGA as main control unit due to following design issue:

1. FPGA embedded processor system has complete flexibility to select any combination of peripherals and controllers.
2. Some companies have design requirement to ensure that a product lifespan that is much longer than the lifespan of a standard electronics products then FPGA soft core processors are an excellent solution in this case.
3. Due to versatile nature of the FPGA, other systems such as microcontroller, PIC Controller, Wireless Sensor Network in which multiple components required to implement system that can be replaced with a single FPGA. Thus, by reducing the component count in a design, a company can reduce board size which will save design time and cost also.
4. FPGA embedded processor has ability to deal with hardware and software in order to maximize efficiency and performance.

Hence, due to above mentioned points system will have to be implemented by using FPGA.

A. Proposed Block Diagram

1] DALI MASTER CONTROL SECTION

FPGA based DALI controller proposed block diagram is shown in Fig. 4 and Fig. 5. DALI master control section consist of power supply, special DALI power supply, two wire DALI bus and FPGA with soft core DALI controller. Power supply for DALI Protocol is 24V DC with current limiter circuit. DALI controller is Application Specific Controller so it performs one specific application. Therefore it is dedicated towards only for lighting control in Building Automation. With the help of DALI TOOL V (0.1) software, DALI controller can send as well as execute DALI instructions or commands. According to DALI commands, lighting devices are controlled means DALI master control section control DALI dimming devices by transmission of data. This communication between DALI controller and DALI devices is done using Manchester Coding format.

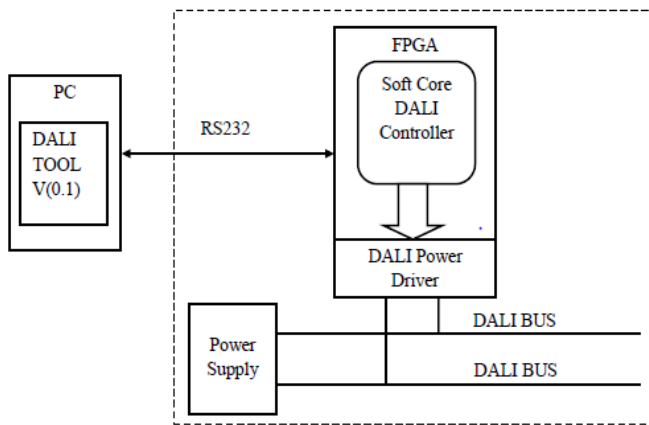


Fig. 4: DALI master control section

2] DALI SLAVE SECTION

As shown in the Fig. 5, the DALI slave section consist of no. of DALI dimming ballast (Lighting Devices). The control of DALI devices are done according to digital address being send from DALI master control section. If correct digital address of device is being received, the particular DALI dimming ballast is then activated. DALI has special feature of grouping of devices and Scene broadcast messages to address multiple devices at a time. As well as change grouping of DALI devices with software is easily possible. Due to these properties DALI cost effective as well as time saving protocol.

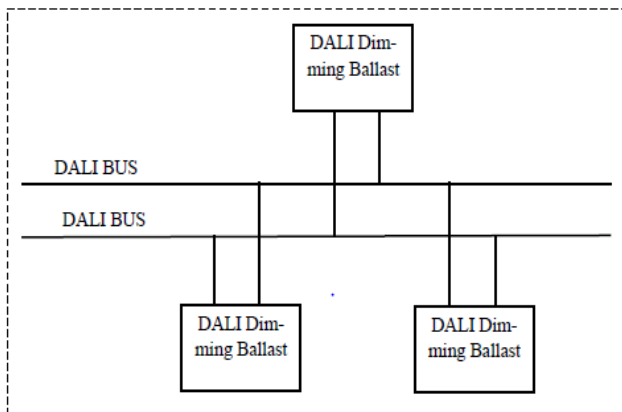


Fig. 5: DALI slave section

B. Logical Flow Chart of Proposed System

Logical Flow of proposed system shown in Fig. 6, in which it starts with DALI TOOL V (0.1) software and ends at automatic controlling of lighting devices means lighting devices can turn ON, OFF or it changes to certain intensity level, as per command sent by DALI Master section. With this DALI TOOL V (0.1) software, broadcasting, multicasting and individual addressing is also possible. As well as, greatest advantage of this proposed system is according to requirement automatic grouping of lighting devices is also possible. Malls, Hospital which have large no. of lighting devices so now a

days, it needs this benefit of proposed system in order to control large no. of lighting devices within a second with help of this system.

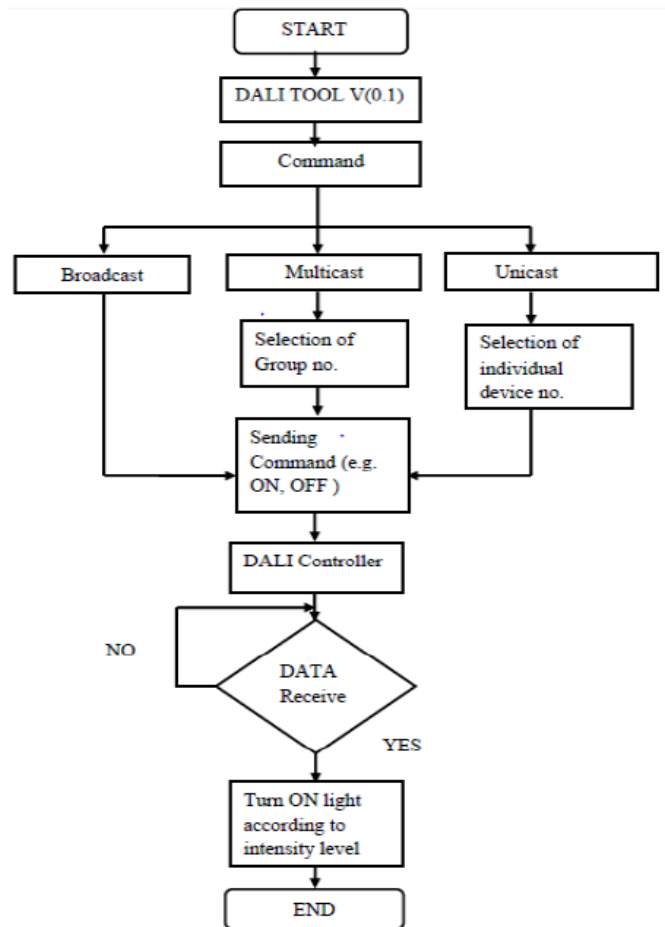


Fig. 6: Logical Flow Chart of Proposed system

IV. CONCLUSIONS

DALI is digital, serial communication protocol which describes the new interface standard for lighting control solutions defined by the lighting industry. DALI can also use for automation but with limited speed so, lot of research work done in this regard and still is in progress. There is need to propose a new technique which will satisfy the requirement of energy saving by using different Digital Communication Protocols such as DALI. It is possible to enhance speed and controllability of controller by using HDL communication controller which will be useful in big malls, hospitals and industries etc. Thus, FPGA implementation of DALI Protocol is useful for performance improvement of DALI controller. It gives cost effective relation between speed and efficiency and different application.

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REFERENCES

- [1] Anand M S, George Kurian, Manu G, Vineeth Narayanan, "Real Time Implementation of Digitally Addressable Lighting Interface (D.A.L.I)", International Journal of Electrical and Electronics Research, Volume 3, Issue 2, pp: 128-133, Month: April - June 2015.
- [2] K.Durgaprasad, P. Harika et.al, "Building Automation System with WSN and DALI," International Journal of Advance Foundation And Research In Science & Engineering, vol.1, Issue 8, pp. 1- 10, January 2015.
- [3] Suchitra Suresh, "VHDL Implementation of Manchester Encoder and Decoder," International Journal of Electrical, Electronics and Data Communication, vol.1, Issue-2, pp. 43-47, April-2013.
- [4] Anuja.P, T.Murugeswari, "A novel approach towards Building Automation through DALI-WSN integration", International Journal of Scientific and Research Publications, Volume 3, Issue 4, pp: 1-5, April 2013.
- [5] Jaymala C. Patil, A. B. DIGGIKAR, "The Digital Addressable Lighting Interface (DALI): An Emerging Energy Conserving Lighting Solution," Journal of Information, Knowledge and Research in Electronics and Communication, Volume 02, Issue 02, pp: 871-873, Nov 12 to Oct 13.
- [6] Inken Wohlers, Rumen Andonov, and Gunnar W. Klau, "DALIX: Optimal DALI Protein Structure Alignment", IEEE/ACM Transactions on Computational Biology and Bioinformatics, Vol. 10, No. 1, pp: 26-36, January/February 2013.
- [7] "Digital Addressable Lighting Interface (DALI) Implementation Using MSP430 Value Line Microcontrollers," Application note of TEXAS Instrument. pp: 1-12, Oct2012.
- [8] Yufang Zhong, Huadong Li, Mingguang Wu State Key, "Research of Feedback Control of Lighting System Based on DALI", 7th IEEE International Conference on Industrial Informatics (INDIN 2009), pp: 396-401, 2009.
- [9] Wei Wu, Mingguang Wu, and Yanpeng Liu, "A Design of Embedded DALI Controller", Department of Control Science and Engineering Zhejiang University Hangzhou, Zhejiang, China, pp: 1237-1240, 2006.
- [10] Paolo Oteri, Ulrich Kirchenberger, Francesco Girardi, "Energy Saving With Dali:Implementation In A High Frequency Fluorescent Lamp Ballast Using A Dedicated 8-Bit Microcontroller", Right light 6 Conference, Shanghai, China, pp: 1-10, 9-11 May 2005.