LIGHTING SYSTEM FOR AUDITORIUM

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Abstract: This paper sums up the implementation of a cost effective lighting system, which cannot be realized directly using DMX512 due to its limited performance. The implementation consists of the network topology and the end device design. The overall design and results of a further analysis will be described.

Keywords: DMX512, RS485, ArtNet, CAN, Fast Ethernet, 100BASE-TX, PWM, LED driver, PIC32, LabWindows, QLC+

1 INTRODUCTION

The protocol DMX512, which is normally used in the lighting systems is designed to work theoretically upto with 512 end lighting fixtures. In practice, no more than 64 fixtures can be connected to the same network, since the underlaying physical layer of DMX512 (called TIA-485/RS485) does not allow it [1]. The challange is to design a topology, which will however make use of this standard protocol and yet allow a greater number of end devices.

2 SOLUTION

After an analysis, which can be found in [2], it was shown, that a suitable solution to the given problem is to avoid a flat network topology - the units need to be separated in groups, which will be consequently interconnected with a backbone network. The task was therefore to find an appropriate backbone network technology.

2.1 BACKBONE NETWORK

The Ethernet was chosen as the best solution for multiple reasons: First, Ethernet interface card is a standard part of every today's PC, which makes it simple to interface with the network. Second, it is an isolated bus (e.g. 100BASE-TX has a 1.5 kV isolation), which makes the system robust against outage of each of its parts. Third, there already exist a standard encapsulation of DMX traffic over the Ethernet, which is called Art-Net. Finally, with a ring network topology redudancy, an Ethernet familly protocol called STP (standing for Spanning Tree Protocol) helps us to make the network more robust. Therefore if the physical medium is broken in one part, the network will still continue to work normally.

2.2 LAST MILE BUS

To facilitate the installation of the whole network having a uniform type of cable, the Cat5 was used also for the last mile bus. This allows to have not only one RS485 bus, but two. The second one can be used for diagnostic bidirectional communication with the end device of the network [4]. Moreover in case of outage of the first RS485 bus, the DMX can be sent alternatively through this bus as a backup.

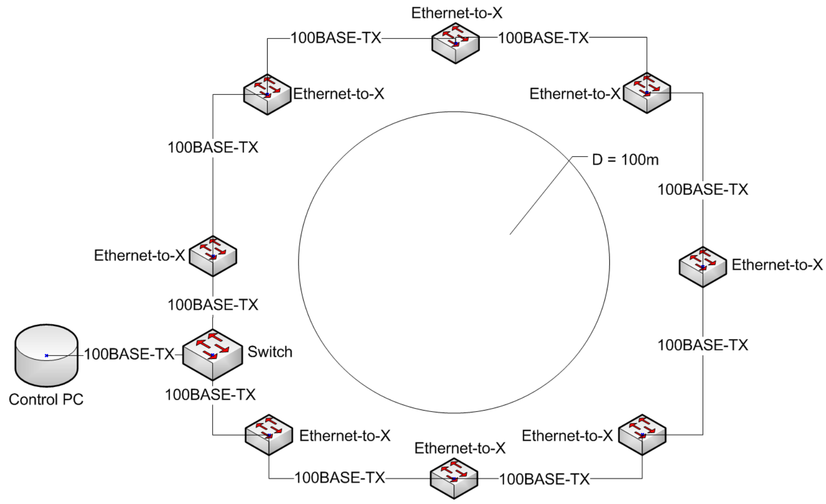

Figure 1: Backbone network

To further improve the robustness of the whole design, the last mile bus was electrically isolated in multiple sections. The divisions are quite natural, since each 8 light fixtures' power section is going to be alimented from one shared 48 V source.

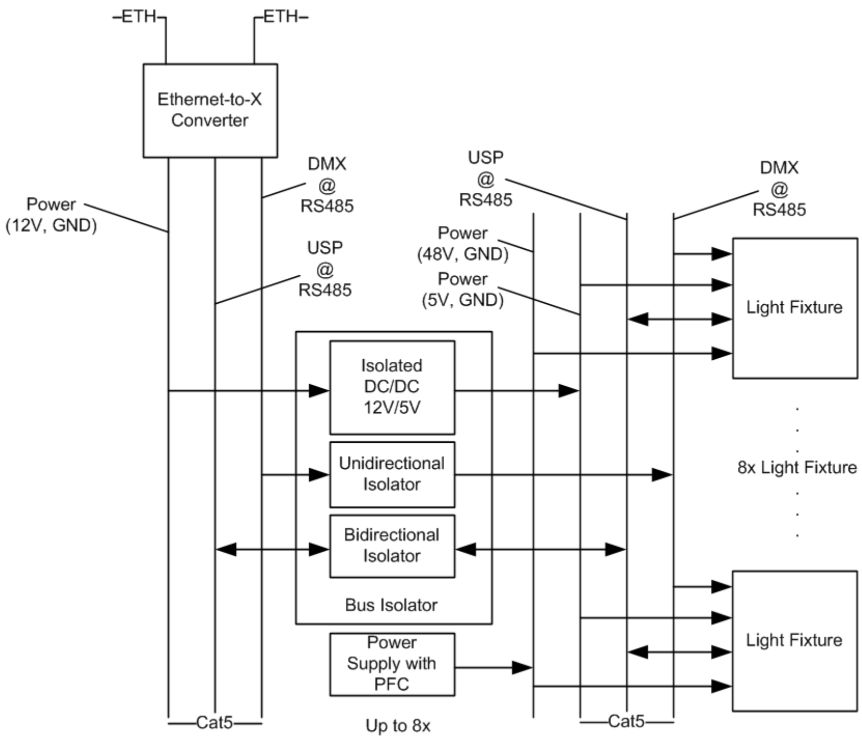

Figure 2: Last mile bus

2.3 END DEVICE

The end device or light fixture consists of two parts: The control board, and the power board. The first one is used to receive DMX512 frames, take the intesity data and apply the linearization looking up the appropriate value in an on board EEPROM and to produce a bias voltage for the switching LED source, which is situated on the power board along with the LEDs. Furthermore the device monitors the power board temperature and source voltage. In case of failure, the device can send a diagnostic data via the second, diagnostic RS485 bus.

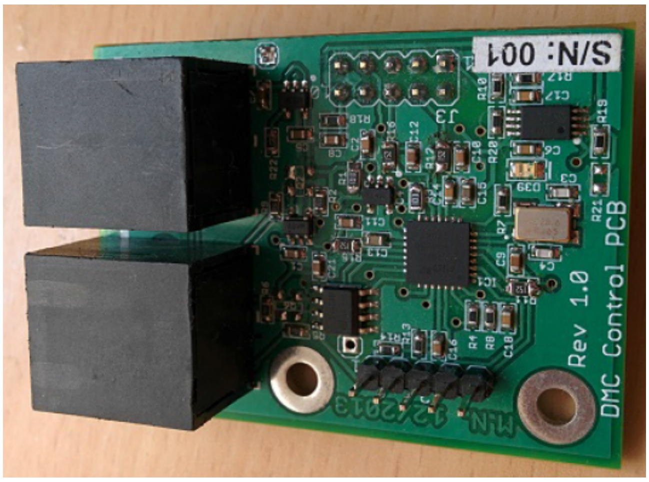

Figure 3: Control board

3 CONCLUSION

The implementation, which was briefly described in this article was realized and tested with a particular power board or lighting front end. However the control board, of which picture is included, can be used with different power boards. To make the control interface of the intensity linear, the transfer function of the lighting front end can be measured and loaded into the onboard EEPROM. This makes the control board partially universal. A software for such measurements was also created in the associated bachelor project along with the interface to upload the measured data to the device. This way, the concept I have developed can be reused in many other situations, where the capabilities of DMX512 itself are not sufficient. As an example can serve lighting networks where the robustness needs to be improved (compared to simple DMX512) or where the units are physically distant one from another.

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