Using LIN over Powerline Communication to Control Truck and Trailer Backlights

Yair Maryanka, Yuval Koren and Yaniv Seri

***Abstract*—The Truck-Trailer harness consists of many wires for activating simple backlights functions. These wires are bulky and expensive. In the EU SPARC program, a new concept of using the powerline to control the backlights of both Truck and its Trailer saved significant amount of wires. Adding LED lights, reduced further more the power consumption from the Truck's generator, saving 200W that was desperately required for other electronics modules.**

This paper describes how the DC-LIN powerline communication was used in the SPARC project to control the backlight modules simplifying the harness of both the Truck and Trailer.

The LIN network aspects of communication for backlight control are described in details.

***Index Terms*—Powerline communication, LIN, DC-BUS, Backlight, Truck Trailer. Network,**

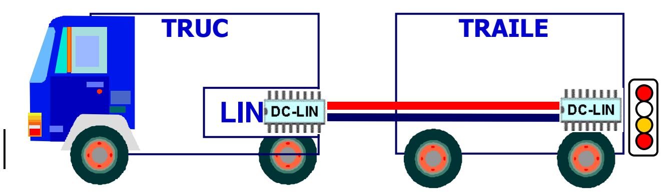

Figure 1 - Trailer Backlight communication

I. Introduction

This paper describes the implementation of a backlight system operating over the powerline between the Truck and the Trailer, eliminating the heavy and expensive Trailer harness used for backlights operation.

This paper explains the protocol used for controlling Backlight modules of towing (truck) and towed (trailer) vehicles over the vehicle's power line.

The Backlight control system consists of a truck and optional trailers. A Master unit controls its Slaves Backlight modules.

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Each truck and trailer consists of two Backlight modules (Left and Right) operating as slaves. Every Backlight module is configured as: Left/Right and Truck/Trailer.

Master features:

- Remotely turn On/Off each of the backlight lamps/LEDs.
- Detect failures in the lamps.
- Set the Backlights into Sleep and wakeup them up.
- Provisions for future upgrade to multiple trailers network.

Figure 2 depicts a possible configuration for a truck and two trailers.

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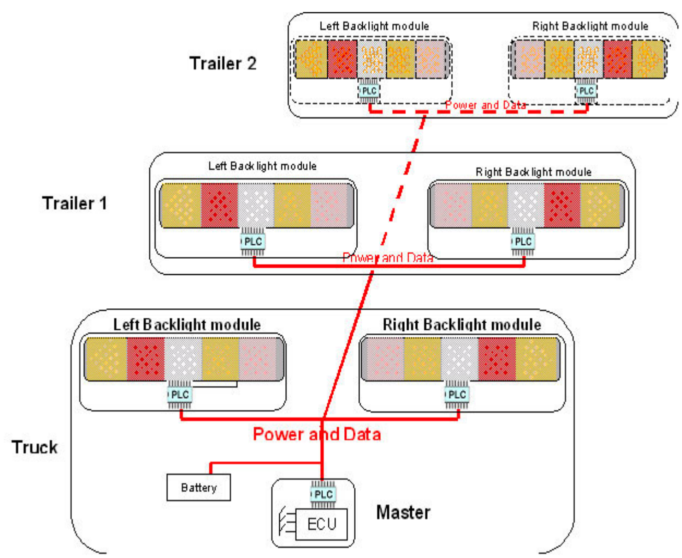

Figure 2 – The Backlights netowrk

II. Backlight DC-LIN communication

The use of DC-LIN in the FP6 SPARC project.

The goal of the European sixth framework program (FP6) SPARC project is to substantially improve traffic safety and efficiency for vehicles carrying heavy goods by using intelligent x-by-wire technologies in the power-train. To provide this standardized concept, an automotive Software/Hardware platform is currently being developed. It is scalable and usable from heavy-goods vehicles down to small passenger cars and can be integrated therein [4].

As part of the project, trailers are autonomous units in the sense that they house their own "intelligence and control mechanism". As a result, a reliable and a redundant link between the truck and its “intelligent” trailer is a must. In this project, the SIG40 and ISL40 DC-LIN devices were used to communicate from the Truck ECU to its backlights and to its Trailer backlights over the existing DC cables at communication rates of 19.2Kbps. It is performed in parallel to another powerline network of 500Kbps used for redundant CAN truck-trailer link. Each of the networks operates on different carrier frequency.

The DC-LIN Devices

The SIG40 and ISL40 semiconductor devices are innovative solution for digital communication over battery-powered line for asynchronous LIN protocol, using original multiplex digital signaling technology. The LIN (Local Interchangeable Network) becomes the main protocol for local networks in automotive. The DC-LIN provides a new economical physical communication layer for asynchronous protocols.

The SIG40 replaces the LIN transceiver and the LIN Data wire. Its 60kbps data rate triples the LIN transfer rate. The SIG40 saves node costs and increases the network capacity. A sleep mode enables power saving. Wakeup messages on the DC line awaken remote devices as required by the LIN protocol.

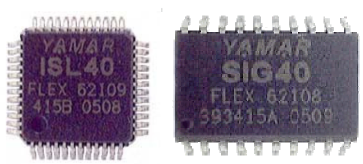

Figure 3 – SIG40 and ISL40 semiconductors

The SIG40 capability of communicating over battery-powered line as a new physical layer of the LIN protocol is useful for a wide range of vehicular applications, such as doors, seats, mirrors, climate control, lights etc.

A unique Signaling technology overcomes the hostile communication conditions of a vehicle battery line. It contains a Signaling Modem, Signaling Coder/Decoder and a Communication Controller overcoming the hostile environment over vehicle battery lines. A Sleep mode reduces the power consumption when there is no bus activity.

The backlights

The backlights are realized with LED to save energy from the vehicle generator. The power was reduced from 210W to 20W. Figure 4 is a picture of the backlight module. The electronics is built within the module.

Figure 4 – Backlight module

The Backlight Network

The backlight network is built from one master and at least two slaves for the Truck Left-Backlights module and Right-Backlights module. The master can access each slave with addressed message, according to its (Left/Right) setup.
When a Trailer is used, the network consists of four slaves – Truck Left and Right Backlights modules and Trailer Left and Right Backlight modules. The Master can access each Slave with addressed message, according to its Left/Right and Truck/Trailer setup..

Network Activity

During network operation, whenever its ECU issues a new backlight command, the Master has to update the slaves accordingly and then sense the Backlight lamps for verifying their proper operation. The Master has to be ready to distribute a new backlight command as soon as it is issued. Therefore between any sequences of backlight updates, the master senses its ECU for new backlight commands. This simple measure ensures response time in the range of 10mS to a backlight command. The master has to detect if a new trailer (slaves) has been connected or if a trailer was disconnected.
Each slave has its own identification (ID) number, with the trailer slaves having higher ID numbers. Multiple slaves will be addressed in descending order of ID, starting from the slave with the highest ID. This will minimize the time required for updating the trailer backlights (which are first observed by other vehicles).

Network performance

When operating at 19.2Kbps, message from master to a slave takes 3.2mS. Message from a slave to master takes 3.3mS
A wakeup message takes 150mS

Master tasks

Master has to perform the following tasks during network operation:

- Sense for newly arrived backlight (BL) commands.
- Whenever a backlight command is detected, the master performs the following:

1. Send write messages with the new lamp command to the relevant slaves.
2. Send read messages to each of the slaves to sense the status of their lamps.
3. Check for newly arrived backlight commands between read messages. If a new backlight command has been issued, discard the read procedure, and return to Step 1.

4. Upon receiving all responsive slaves, update the ECU with the updated lamp status.

- Every 100mSec, update the slaves with the last issued command (same as step 1 above) and detect trailer connection/disconnection. The latter operation is executed as follows: read the status of the slave with the highest known ID, N, in order to detect disconnection; likewise, access slave ID N+1 to find if a trailer has been connected. Update the ECU accordingly.
- Update the ECU of any abnormalities.

Slave tasks

During network operation, a slave performs the following tasks:

- Listen on the DC-Line for messages from the master.
- Upon detecting a write message addressed to it, the slave will command its lamps accordingly.
- Upon detecting a read message addressed to it, the slave will respond with the status of its lamps.
- Upon detecting a change frequency message, the slave will switch its carrier frequency accordingly.
- Upon detecting a sleep message the slave will enter sleep mode.
- Upon detecting a wake-up message the slave will return to normal operation mode.

The LIN Protocol for Backlights

Frame Structure

The general structure of a frame is based on the LIN standard and shown in figure 5. A frame is constructed of a break followed by four fields (bytes), labeled as in the figure.

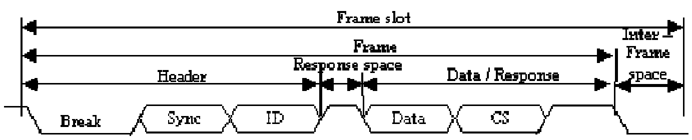

Figure 5 - Frame Structure

Each field, except for the break field (which is longer than one byte), is transmitted as a serial byte, LSB first. Each byte starts with a start bit which is encoded as zero (dominant) and ends with a stop bit which is encoded as a bit one (recessive).

Backlight Control Messages

Several types of messages are used for communication between a master and its backlight slaves:
Read – Get the backlights status.
Write - Write a command to one of its slave backlights.
Sleep - The device enters into Sleep mode.
Wakeup – Wakes the Backlight modules from Sleep mode.

Towing a PLC trailer with ordinary truck

In order to control the backlight modules of a PLC-enabled trailer by an ordinary truck, a Backlight-gateway (BL-GW) is required.

Figure 6 – Truck Backlight-gateway

The Backlight gateway is installed on the truck J12098 connector. Any change in one of its backlight pins will generate a message to the corresponding Backlight modules lamps of the trailers. The BL-GW consists of dummy loads that simulate the lamps that the ordinary truck expects on this connector. Figure 6 is the picture of the BL-GW.

In case of a persistent communication failure, the BL-GW will not receive a respond from its trailers Backlight modules. In that case, the BL-GW will disconnect one of the dummy loads thus generating an indication of a lamp failure for the driver.

III. Conclusion

A Backlight system operating over the power line enables simple installation, saves harness by use of single powerline wire for both power and control.
The communication protocol between Truck master ECU controls both the Truck Backlight modules and the Trailer Backlight modules. Allowing remote detection of lamps failure. Sleep mechanism keep power down when system is not used.
The communication protocol is compatible with the LIN standard. The power line communication is based on DC-LIN technology implemented in the SIG40 and ISL40 devices.

References

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[2] **ISO/DIS 11992-3, Road** vehicles — Interchange of digital information on electrical connections between towing and towed vehicles — Part 3: Application layer for equipment other than braking and running gear, 2001-05-04.

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