POWER LINE COMMUNICATION FOR VEHICLE

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***Abstract:** The fully feature loaded vehicle is having more number of sensors, number of BCM to perform featured function of vehicle. For each feature there is sensor or/and load driver behind it. And ECU is collecting data from BCM/sensors in analog or digital format. So sensors are interfaced with ECU via cable, multiple sensor will require multiple wires to interface. Power line communication will transmit data over same power cable which provides power to sensor module. Power line communication is will be the solution for reducing wiring harness of vehicles. As electrical vehicles are becoming popular against IC engine vehicle, the weight of EV is the most critical and one of the design challenges for engineers. PLC is better replacement of harness to reduce number of harness.*

***Keywords:** ECU, BCM, IC engine vehicle, As electrical vehicle, Sensors, Wiring harness, Power line communication (PLC).*

1. INTRODUCATION:

As a dependable alternative networking medium, this study offers an in-vehicle power line communication (PLC) system that allows in-vehicle communication for the transmission of vehicle messages from vehicle control unit to body control module. The Power Line Communication for vehicle system uses an existing 12-volt battery power wires as the communication media, which eliminates the need for an additional signal wires for traditional in-vehicle signal transmission. in order to meet the goal of vehicle message transmission for driving safety we can utilize this technology. We can achieve the reduction of number of wiring harness from vehicle junction box to rear side features (Stop light, reverse light, number plate light, demister, rear wiper, rear indicators) with the safety features like short circuit protection, fault protection and feedback to vehicle control unit.

In existing wiring harness technology, for every BCM function and sensor require power input from battery. Sensors are sending data to vehicle control unit through separate wire. Each sensor and switch is interfaced with vehicle control unit to communicate analog data or/and digital data. Digital data can be On-Off signal generated from limit switches & push buttons. This sensor information is gathered to Power Line Communication transmitter. Transmitter will send gathered information on power wire coming from battery and receiver will catch this data over same power wire and takes appropriet decision or/and data logging function.

This power line communication will reduce the number of wires, complexity of wiring harness design, weight of harness and production of wiring harness. Hence cost will reduce.

2: LITRATURE REVIEW

M. Olivas Carrion, M. Liénard and P. Degauque – "Communication over Vehicular DC Lines: Propagation Channel Characteristics" [1]

This paper investigates the propagation channel characteristics of a power line communication inside a vehicle. Transfer functions have been measured between various points of the DC network in a frequency range extending from 500 kHz up to 70 MHz to deduce the statistical behavior of the path loss, delay spread and coherence bandwidth. The results are compared to those obtained with a deterministic propagation model, simulating the entire cable harness. In a vehicle, data transmission between electronic equipment is now achieved owing to a lot of dedicated cables, Despite the additional cost, an increase of the total weight and the possible lack of reliability of the multiple connections

S. Barmada, M. Raugi, M. Tucci, T. Zheng - "Power Line Communication in a Full Electric Vehicle: Measurements, Modelling and Analysis".[2]

The technological implementation is nowadays done by using different data bus (Local Interconnect Network, Controller Area Network, Media Oriented Systems Transport, FlexRay), depending on the required communication speed and reliability. A modern vehicle of average dimension is characterized by a communication grid of several km, with a constantly increasing number of connection points (more than 200 nowadays). The weight of the wiring harness is second only compared to the engine – gearbox weight. It is not difficult to understand that the complexity of this structure will soon become an issue difficult to manage, also from the diagnostic and maintenance point of view. For this reason the use of power lines to transmit data could reduce this problem, since it would remove part of the cables (or all of them in the best case) for command and control with enormous advantages in terms of weight, space and cost.

Sheng-Xiu Lin, Yuan-Hua Zhang, Chao-Tang Yu, Wei-Wen Hu, Liang-Bi Chen, and Wan-Jung Chang – "A DC Power-Line Communication based In-Vehicle Safety Aided System for Rear Vehicles Road Safety" [3]

This paper proposes an in-vehicle safety aided system, which adopts DC power-line communication (DC PLC) as a main transmission channel. The proposed system is composed of a voice-to-text (VTT) module, two embedded computer modules, two DC PLC transceiver modules, a text and video message display module, and a distance measurement module. Moreover, the proposed system is successfully installed and tested in a real vehicle. The experimental results showed that the proposed system can have a data of distance to the adjacent rear vehicle, and display front view video with alerting messages for drivers of rear vehicles. As a result, the proposed system can be applied to alert the drivers of rear vehicles to achieve the purpose of road safety. there is no direct communication scheme among two vehicles. Occasionally, a vehicle driver needs to alert the front vehicle driver though flashing headlight or pressing the horn. However, the vehicle driver could not convey any messages to the vehicle behind him.

Gang-Neng Sung1, Chun-Ming Huang, and Chua-Chin Wang – "A PLC Transceiver Design of In-Vehicle Power Line in Flex Ray-based Automotive Communication Systems" [4]

This paper presents a power line communication (PLC) transceiver design of in-vehicle power line compliant with FlexRay communication systems. FlexRay-based in-vehicle power line communication provides a solution for high reliability without increasing weight, volume and cost of the wiring harnesses. A 16-QAM (Quadrature amplitude modulation) scheme is utilized in the transceiver design. The FlexRay standard is designed for an in-car network. It will not replace the existing network, but it can combine and integrate with existing systems, including CAN (Controller Area Network), LIN (Local Interconnection Network), MOST (Media Oriented System Transport) [1] and J1850 protocol etc. FlexRay requires 10 Mbps data rate in either one of the two channel of an ECU. If a single channel is used alone, the speed of the total data rate will reach 20 Mbps. Fig. 1 shows the feature of FlexRay when used (X-by-wire).

3. PROBLEM STATEMENT

The traditional wire harnessing takes up a lot of space and weight even in compact cars. The wiring harness is one of three heaviest subsystems in many vehicles, as much as 150 lbs in highly contented vehicles. It's very typical for the average vehicle to have 100–120 lbs of wire harness in the vehicle. Today's cars contain some 1,500–2000 copper wires totaling over kilometers in length. The most critical factors for vehicle manufacturing is weight of vehicle and manufacturing process time.

While the automotive industry works to lower the weight and add electronic devices, those circuits also must be reliable enough to ensure safety of critical systems.

4. SCOPE OF THE PROJECT:

Power line communication (PLC) system for vehicle that allows in-vehicle communication for the transmission of sensor messages/data and. Now a day's more sensors are inserted in vehicles as functional safety features PLC will offers low cost, less complexity of wire networking.

This Power line communication will add advantage of lower cost of wires, wiring manufacturing process and hence increase productivity.

This technology is very useful for future electric vehicles (E – Vehicles) because to increase the distance coverage of E – vehicle manufacturers are more focusing on reducing the weight of vehicle so that vehicle can cover more distance in single charge of battery.

5. BLOCK DIAGRAM OF POWER LINE COMMUNICATION

The power line communication block diagram comprises with power line transmitter, power line receiver.

Battery: Vehicle battery is the power supply for all vehicle electronics.

Power supply: power supply is the voltage converter to convert battery voltage to 5V output for digital electronics,

Temperature sensor, Fuel level sensor, Limit switch: These are sensors interfaces to transmitter.

LCD: LCD displays the transmitted and received data form transmitter and receiver respectively.

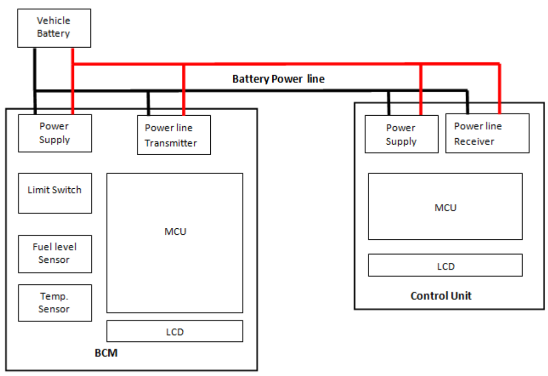

Fig.1 Power Line Communication Block Diagram

Transmitter MCU: Microcontroller unit is to reading the sensors data in analog form and converting in to digital through ADC channel. This converted data is sent to transmitter.

Power Line Transmitter: Power line transmitter will send the data received from controller UART over power wire, in the form of high frequency pulses.

Power Line Receiver: Power line receiver will filter out data pulses from power wire. Filtered data pulses are sent to receiver MCU for displaying on LCD.

Receiver MCU: Receiver MCU receives UART pulses from power line receiver and it will display over LCD.

6. OBJECTIVE

1. Design the UART transmitter and receiver for simple communication with two microcontroller system.
2. Interfacing resistive level sensor (potentiometer) and two switches as input to the transmitter controller.
3. Interfacing LCD for transmitter controller to show the transmitting data.
4. Interfacing filtered received data with receiver microcontroller pin and interfacing LCD for showing received data from transmitter to show the complete communication over power wire.

7. FLOW CHART

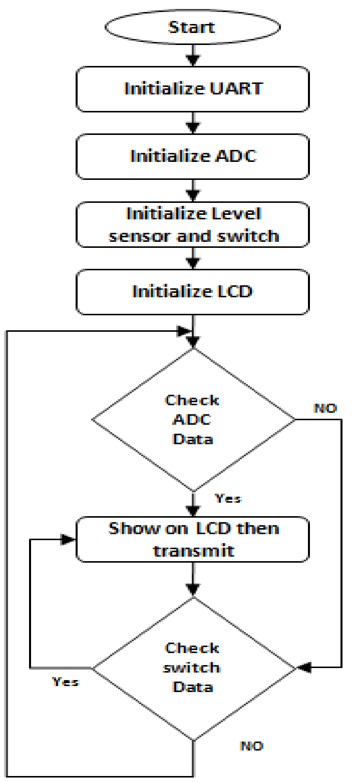

Fig.2 Power Line Transmitter Flowchart

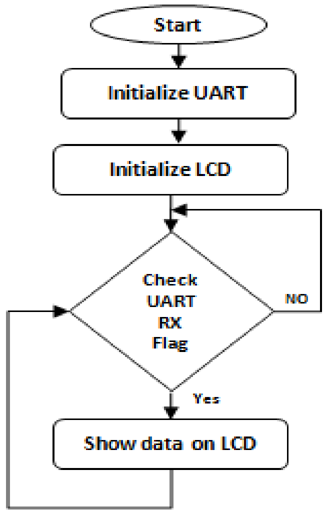

Fig.3 Power Line Transmitter Flowchart

8. SYSTEM WORKING

1. Power line transmitter: Power line transmitter (Vehicle BCM) comprises with power supply section, sensors like level sensor, switch type sensors, LCD display, and 8 bit microcontroller unit.

2. Power line transmitter is getting power supply from vehicle battery. Same battery and battery cables are provided to receiver section of project.

3. Power supply of BCM is providing 5V to microcontroller, sensors and other devices on transmitter board. The transmitter BCM is located on rear side of vehicle.

4. On rear side of vehicle thre are many sensors to send the data to control unit with analog communication happning with single wire.

5. But in this technique all sensors are connected with BCM, receiver board microcontroller will collect the data from sensors and transmit to control unit.

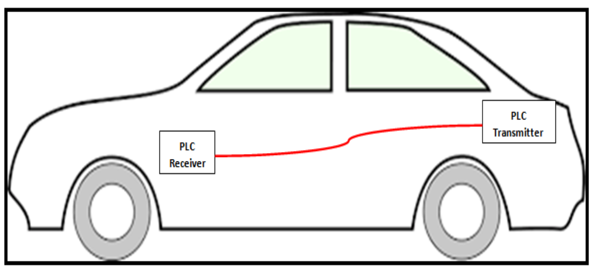

Fig.4 Power Line Transmitter Board

6. Transmitter will send the signal over the power supply wire with high frequency. Now 12VDC and communication signal is travels on same wire. We can see in oscilloscope images in this paper.

7. Receiver board is getting power supply from same wire for transmitter. Communication signal is superimposed over 12VDC that is filtered by power line receiver.

8. Power line receiver will filter out the communication signal form 12VDC. This filtered signal is buffered and strengthens for driving RX pin of receiver MCU.

9. Receiver MCU will get the transmitted data and data is displayed on LCD the result we will see in result section of this paper.

9. PROJECT SETUP

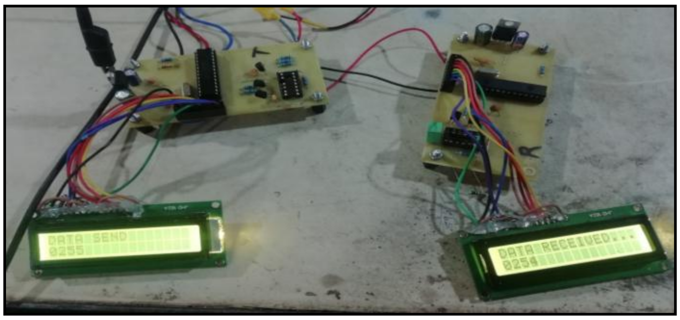

Fig.5 Power Line Project setup

POWER LINE PROJECT SETUP:

In project setup there is two PCBA boards, power line transmitter and power line receiver board. Both boards are interfaced with batter cables only. Thease battery power cable is responsible for communication between them. Transmitted ADC data count is shown over transmitter as well receiver display. The tolerance of received data count is ±2 counts.

10. Power Line Transmitter result waveform

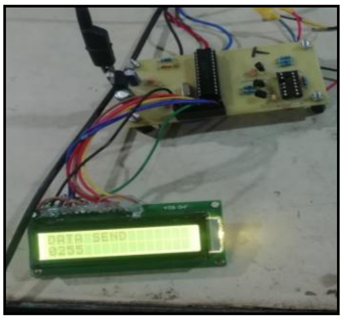

Fig.6 Power Line Transmitter Board

In figure 7 we can see the pulses from TX pin of transmitter board controller. Amplitude is 5V that is microcontroller output here pulses are very clean and distortion free.

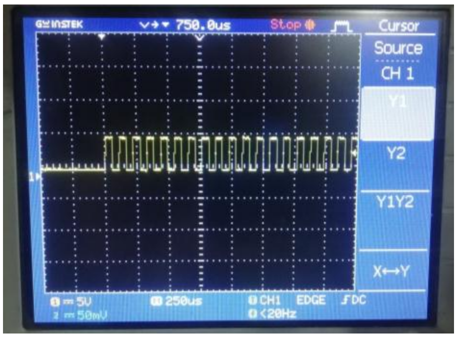

Fig.7 Power Line Transmitter: Pulses at MCU pin

In Figure 8 we can clearly see the signal coupled over 12VDC bus. 5V pulses are superimposed over 12VDC voltage.

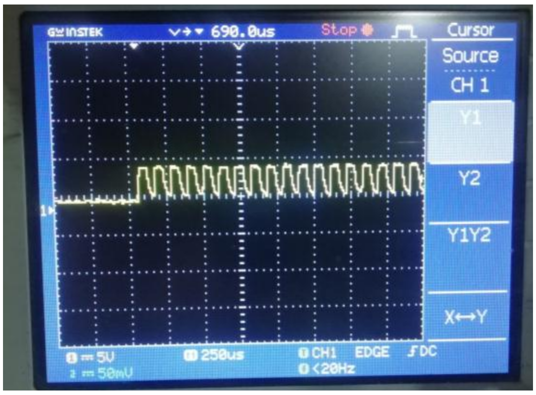

Fig.8 Power Line Transmitter: Pulses on 12V supply line.

13. Power Line Receiver result waveform

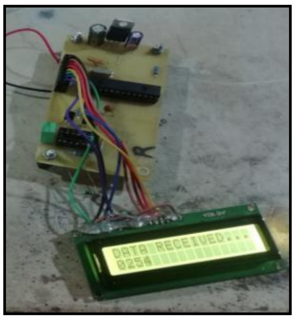

Fig.9 Power Line Transmitter Board

The pulses received form transmitter are so noisy and having distortions. So this received distorted signal pulses are fed to buffer filter which complements the received pulses for RX pin of receiver controller we will see in next result.

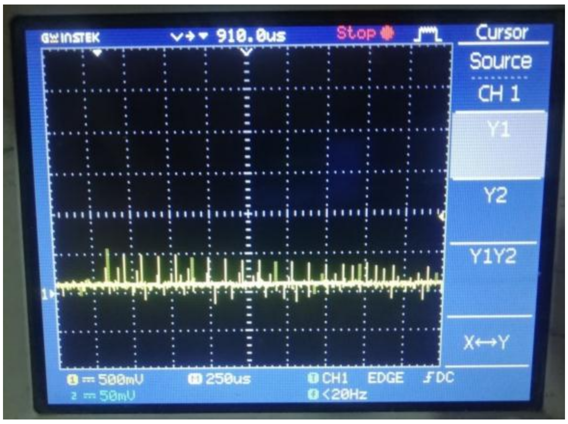

Fig.10 Power Line Receiver: pulses received from transmitter

The captured pulses are shown in figure 11 are the pulses at RX pin of receiver microcontroller. These are narrowed because of distortion and fast discharging characteristic of capacitor these pulses are capable to drive the TX pin of controller to decode the message sent by transmitter.

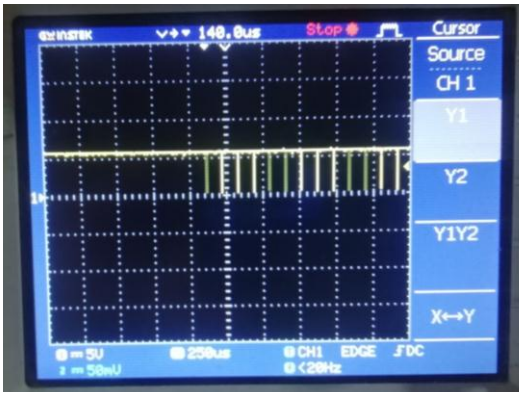

Fig.11 Power Line Receiver: pulses at RX pin of receiver MCU

11. CONCLUSION

We have developed a 12V DC-based PLC system for in-car communication in order to make a reliable alternative networking method for vehicle in this study. The fundamental aim of this work for an application is to give vehicle message delivery via an PLC system for driving safety feature. Electrical wiring harness is used in power line communications technology to transmit data at fast speeds. It can provide the data rate, performance, flexibility, dependability, and cost-effectiveness required for vehicle networking.

12. FUTURE WORK

Power line communication (PLC) system for vehicle that allows in-vehicle communication for sensor messages/data. The system is providing speed of data for messages and small data packets of data which can transmit the sensor data like digital count over power line. We can enhance this system for real time high speed data in MbPS rating to achive the video streaming from rear parking camera. This Power line communication will add advantage of lower cost of wires, wiring manufacturing process and hence increase productivity.

This technology is very useful for future electric vehicles to reducing the weight of vehicle so that vehicle can cover more distance in single charge of battery.

13. PROPOSED WORK OUTCOMES

The advantage of the Power line communication is to transmit and receive communication signal over 12DC power supply wire. Communication over power supply wire will allow to reduce the number of wire require to send sensor data from rear side of vehicle. Reduction in number of wire will lead to reduce weight, complexity and cost of wiring harness in vehicle.

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