Tomasz DLUGOSZ

Wroclaw University of Technology, Poland

New filter separation efficiency in CAN bus

***Abstract**. Controller Area Network bus design in automobile need to take into account aspects on electromagnetic compatibility for components and system. With filter and connecting approaches considerations are presented in the work for protection of CAN bus system.*

***Streszczenie.** Proces projektowania magistrali komunikacyjnych CAN wymaga uwzględnienia zagadnień kompatybilnościowych i odpowiednich wymogów dotyczących zarówno poszczególnych komponentów, jak i całego systemu. Niniejszy artykuł dotyczy projektowania filtrów mających na celu ochronę magistrali CAN przed zakłóceniami elektromagnetycznymi (**Nowa skuteczność filtracji w magistrali CAN**).*

Keywords: CAN bus, filter design, electromagnetic compatibility.
Słowa kluczowe: magistrala CAN, projektowanie filtrów, kompatybilność elektromagnetyczna.

Introduction

Electronic devices have been making rapid inroads in automotive products over last years. Modern automobiles sometimes have even 70 electronic control units for various subsystems (engine control, airbags, windows, doors, mirrors, etc.). Such big number of devices in one vehicle forced development of systems that can manage it. There are a lot of different systems that can be used in advanced control-networking systems, for example: CAN (Controller Area Network) [1], InterBus-S [2], Profibus [3], LonWorks [4], KNX [5]. One of the most popular standard used in cars and trucks is CAN bus [6]-[8]. The CAN bus was originally developed by Bosch for reliable low cost serial communication in vehicles, basically to reduce wiring costs. CAN has also the advantages of high efficiency data transmission, communication accuracy and stability, excellent error detection and processing ability and field anti-jamming ability.

Technology and data transmission

CAN is the serial communication net, which can effectively support real time control, belongs to the field bus. Its topology is based on the usage of copper twisted pair cable. Bus's maximum length is 40m and the connections between the bus and sensors should not exceed 0,3m [9] [10].

The exchange of information in the network based on CAN bus occurs either through broadcasting or addressing. Broadcasting is based on the notion of sending information to all nodes. In this case, frame containing information is sent by the sender, and it does not contain receiver's information. This type of procedure allows faster exchange of information on the network by reducing the amount of time necessary for reading and interpreting of information about the addressee in the receiving part of the network. Broadcasting, as a means for addressing, is used only in frames with high priority containing particularly important information (for example periodic pressure measurements). This is done in order to prevent an overwhelming amount of broadcasts which can occur in networks with large topology. The network independently decides whether the broadcasted information is required [9].

There are two types of frames (Fig. 1):

- version 2.0A that uses 11 identification bits in frame's header – Standard CAN (SCAN),
- version 2.0B that uses 29 identification bits in frame's header – Extended CAN (ECAN).

Unfortunately, there can be some disturbances that will influence on presented frames and the whole communication in automobile.

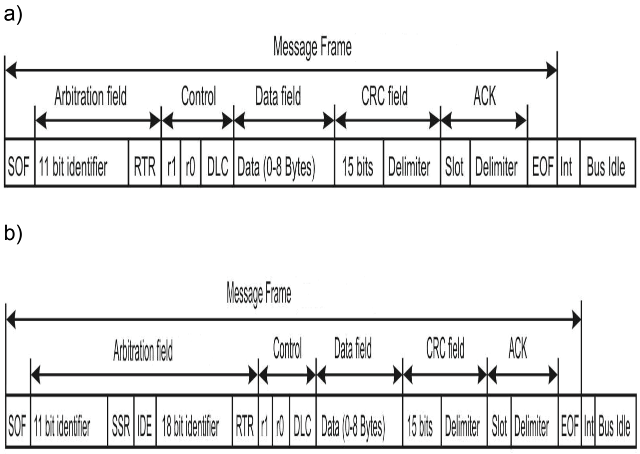

Fig. 1. Various types of frames in CAN bus: a) frame 2.0A (SCAN), b) frame 2.0B (ECAN) [9]
where: SOF - Start Of Frame, RTR - Remote Transmission Request, DLC - Data Length Code, CRC - Cyclic Redundancy Check, EOF - End Of Frame, Int - Intermission field, SSR - Substitute Remote Request.

Interferences in vehicle

It is well known that electromagnetic interferences exist everywhere, also in automobile, including disturbances between automobile and its surroundings, between automobiles, between human body and automobile. Interference can be also found between parts, components, systems in the machine [11]-[13].

Propagation of conducting interference can be realized through wires or traces with co-resistance in circuit, such as that co-used power supply, co-used ground, isolated components and connecting lines between different function parts. Inductive interferences are divided accordance with inductive electric components of parts, such as interference generated by coils in bundle and motor, electric relay, or by inductive magnetic interferences, for instance, asynchronous motor, electric surf pulse like huge energy instant disturbance by turning on/off inductive coil switch

Interferences can be located in following systems:

- power system,
- ignition system,
- auxiliary electronic devices and systems.

If there are so many sources of interferences then question arises how to design CAN bus? There can be found standards that should be used in design process, for example ISO7637-3 [14], which allow limiting disturbances. Companies also made their own EMC standards, very often stricter than the national ones (Ford, BMW, Peugeot).

CAN bus system design

CAN bus design where four nodes are located in vertical and a horizontal direction is presented in Fig. 2. Presented bus is a control system of electric driving windows in car. Each node may be a component, a circuit, or even a small network, varied on design requirement. Left rode is primary unit performing the task moving up-down not only present window, but the far windows. Each node has its own independent microprocessor and CAN bus system comprise inter-buses. Bus is primary line propagating signals whereas nodes may be both disturbance sources and victims of interferences [13].

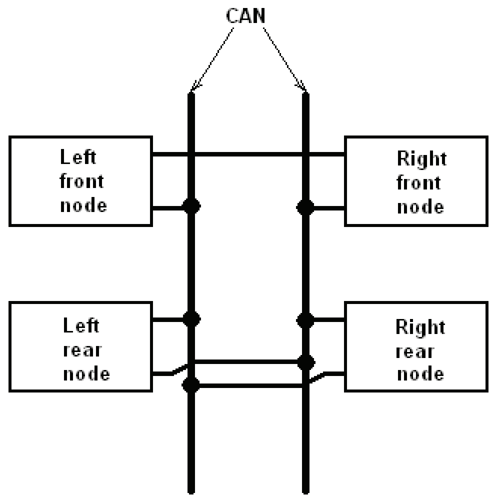

Fig. 2. CAN bus in vehicle

In literature are described various methods for protection against interferences in bus, like grounding or widening gap distance between line but when very good results are required than a new filter circuit should be used (Fig. 3). It will reduce possible common mode interferences and differential mode interferences [13].

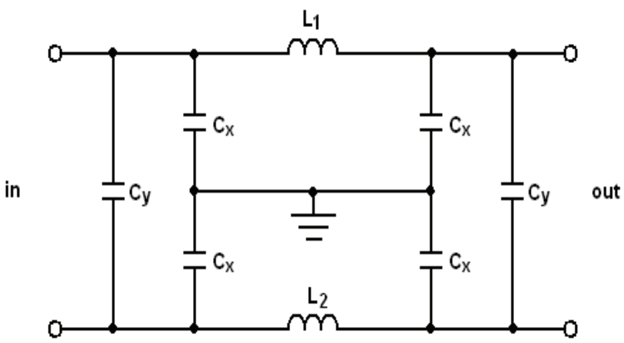

Fig. 3. Filter against interferences

Presented filter is inserted into shielding layer between two signal lines what allows to cut off propagation ring formed by shielding layer through ground line. It also allows stopping interference from acting on signals in bus. To increase circuit's resistance and protect it from high frequency interferences that enter into circuit at connecting ferrite-bead are used at terminals of two lines in CAN bus. At the same time filter suppress common mode interferences and differential mode interferences whereas. The filter guarantees very well protection of device from interference too. No negative influence on normal work state of the CAN bus was observed [13].

Conclusion

There is no doubt that systems like CAN bus are indispensable in modern cars. Very important is undisturbed functioning of such system. In this paper some approach and method helpful in design CAN bus are presented.

Apart from taking regular approaches, based on feature analysis, protecting CAN bus from interferences, shielding enclosure, and a special filter are employed for nodes control circuit resisting against electromagnetic interference Verification in prototype of automobile has been implemented for electromagnetic compatibility design of CAN bus shown predictive effect protecting the object from electromagnetic interferences.

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***Author**: Dr Tomasz Dlugosz, Institute of Telecommunications, Teleinformatics & Acoustics, Wroclaw University of Technology, Wroclaw 50-370, Poland, e-mail: tomasz.dlugosz@ pwr.wroc.pl*