Design of Automative CAN Bus For Electrical Vehicle

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Abstract

CAN (Controller Area Network)-the internationally standardized serial communication protocol. The automobile industry has introduced various electronic control systems in pursuit of safety, comfort, pollution prevention, and low cost. These control systems, use the CAN Bus to exchange data efficiently via a gateway. The gateway in this case is an EMU-interface. This is an optional interface supplied by the different truck manufacturers .The Data Collection Unit (DCU) can be connected to a vehicle's Engine Control Unit (ECU) via CAN bus (Controller Area Network bus) and provide detailed vehicle information. This paper describes a CAN bus used in a vehicle. The proposed CAN bus automotive network control system hardware flat roof set up based on PIC. The lighting, direct current electromotor, electromagnetic actuator control node tests and can bus PRI intercession test etc. were completed in laboratory. Experimental results prove that this system simulated CAN bus application in automotive network control.

"1. Introduction"

- Controller Area Network (CAN) - serial communications bus designed to provide simple, efficient and robust communications for in-vehicle networks.

- Developed by Robert Bosch GmbH, beginning in 1983, and presented to a wider audience at the Society of Automotive Engineers (SAE) Congress in 1986—effectively the "birth of CAN"
.
- In 1987, the first CAN controller chips were released by Intel (82526) and Philips (82C200). In the early 1990s, Bosch submitted the CAN specification (Bosch,1991) for standardization, leading to publication of the first ISO standard for CAN(11898) in 1993 (ISO, 1993).

- Mercedes was the first automotive manufacturer to deploy CAN in a production car, the 1991 S-class.
- The number of networked Electronic Control Units (ECUs) in Mercedes, BMW, Audi and VW cars went from 5 or less at the beginning of the 1990s to around 40 at the turn of the millennium.

- With this explosion in complexity traditional point-to-point wiring became increasingly expensive to manufacture, install and maintain due to the hundreds of separate connections and tens of kilograms of copper wire required.

- As a result CAN was rapidly adopted by the cost-conscious automotive industry, providing an effective solution to the problems posed by increasing vehicle electronics content. Following on from Mercedes, other manufacturers including Volvo, Saab, BMW, Volkswagen, Ford, Renault, PSA, Fiat and others all adopted CAN technology.

- As a result of the wholesale adoption of CAN by the automotive industry, sales of CAN nodes (8, 16 and 32-bit microcontrollers with on-chip CAN peripherals) grew from just under 50 million in 1999 to over 340 million in 2003—see Fig. 1.1

- By 2004, there were at least 15 silicon vendors manufacturing, in total, over 50 different microprocessor families with on-chip CAN capability.

- Today almost all of the cars manufactured in Europe are equipped with at least one CAN bus. In the United States, the Environmental Protection Agency has mandated the use of CAN, for On Board Diagnostics, in all cars and light trucks sold in the US from model year 2008 onwards.

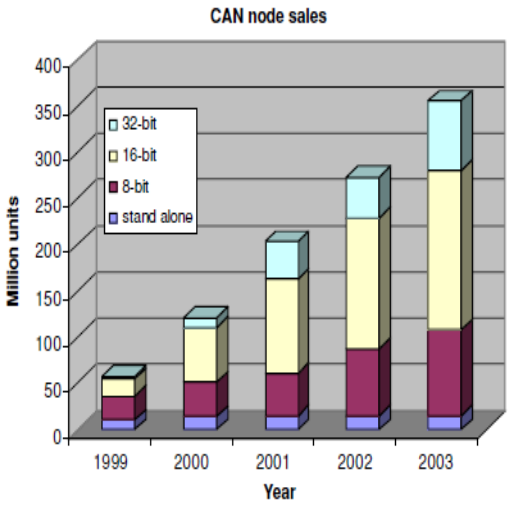

Fig. 1.1 Sales of microcontrollers with on chip CAN peripherals

1. Research and real-time analysis

- CAN is a serial data bus that supports priority based message arbitration and non-preemptive message transmission.
- In the early 1990s, a common misconception about CAN was that although the protocol was very good at transmitting the highest priority message with low latency, it was not possible to guarantee that less urgent signals, carried in lower priority messages, would meet their deadlines.
- CAN (Controller Area Network) is a real-time communications protocol that is now well proven in the automobile industry. Its low costs and robust physical layer also make the protocol attractive for industrial networks.
- The CAN open higher-layer protocol, which is based on CAN, was developed specifically for embedded machine control purposes.
- Standardized in Europe as EN 50325-4, Industrial communication subsystem based on ISO 11898 (CAN) for controller-device interfaces.
- *CAN open*, it has been hugely successful worldwide and provides system integrators and buyers with a high degree of plug-and-play capability for devices within the network.

2. Components and Construction.

The system proposed consists of major modules namely:

- CAN Driver.
- PIC microcontroller:

It uses Microchip's PIC 18F2480, which is an 8 bit microcontroller with a built-in CAN module. It finds wide application due to its features and low cost.

- a set of sensors
- Power Supply
- I/O Devices

The block diagram of the proposed system is shown in figure 1.2

- ✓ The system is design for monitoring and control of a car system using CAN protocol and have divided the sensors in to 2 parts. The car system has to scan several parameters in a second. If we use only one controller for the job then the system performance is badly reduced also the life of the hardware reduces.
- ✓ To avoid these problems we are developing a CAN based network. In which the sensor hub is divided into small groups of slave nodes.
- ✓ Each slave node will have its own PIC µC and a CAN module controller and a set of sensors.
- ✓ In our system, we have interfaced two nodes. Node1 consist of a PIC microcontroller, CAN controller, buzzer, 16x2 LCD display unit, a relay for door of the car and LED's (green and red).Node2 consist of PIC microcontroller, CAN controller, temperature sensor, fuel sensor, Switches i.e door switch (magnetic) and gas sensor.

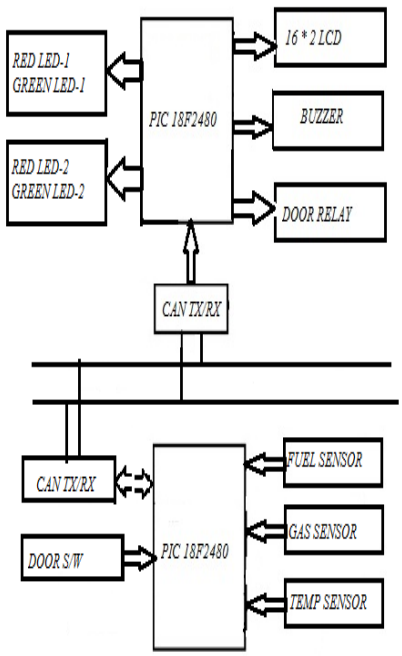

Fig 1.2. Proposed Block Diagram of Automotive CAN Bus for Electrical Vehicle.

- ✓ All the two nodes in a CAN interface bus can share various parameters. Here LCD display all the parameters of sensors and buzzer give indicate the same and Led's will glow as per their colors like red and green.

2.1. Why PIC 18F240 is Preferred?

Table.1 COMPARISION OF CONCONTROLLERS

2.2. CAN Protocol and terminology-

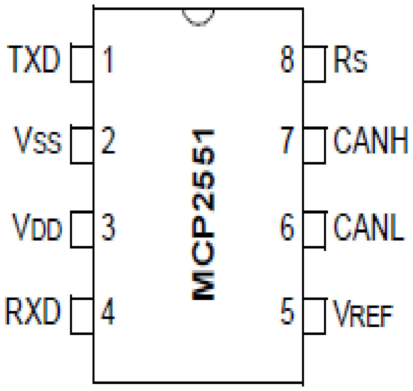

Fig. 2.1 CAN IC.

- The layout of a standard format data frame is shown in Fig. 3 .CAN is an asynchronous multi-master serial data bus that uses Carrier Sense Multiple Access/Collision Resolution (CSMA/CR) to determine access.CAN was designed as a simple and robust broadcast bus capable of operating at speeds of up to 1 Mbit/s. Message transfer over CAN is controlled by 4 different types of *frame*: Data frames, Remote Transmit Request (RTR) frames, Overload frames and Error frames.

- Each CAN data frame is required to have a unique identifier. Identifiers may be 11-bit (standard format) or 29-bit (extended format).

- The identifier serves two purposes beyond simply identifying the message. First, the identifier is used as a priority to determine which message, among those contending for the bus, will be transmitted next.

- Second, the identifier may be used by receivers to filter out messages they are not interested in, and so reduce the load on the receiver's host microprocessor

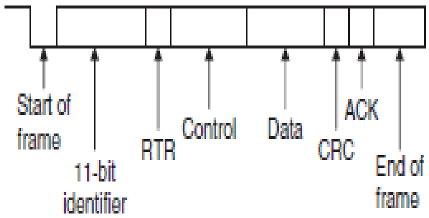

Fig.2.2 Standard data frame

SR. NO	PARAMETER	PIC	AVR	ARM
1	Power consumption	low	more	moderate
2	ADC Conversion	fast	good	Good
3	Programming	easy	complex	moderate
4	Available	easy	NA	NA
5	Cost	chip	high	moderate
6	Instruction set	small	more	Many

- CAN is similar to the protocol used in Ethernet LAN. When Ethernet detects a collision, the sending nodes simply stop transmitting and wait a random amount of time before trying to send again. CAN protocol, however, solves the collision problem using the principle of arbitration, where only the highest priority node is given the right to send its data.

3. Priority based arbitration

- The CAN physical layer supports two states termed *dominant* ('0') and *recessive* ('1').If two or more CAN controllers are transmitting at the same time and at least one of them transmits a '0' then the value on the bus will be a '0'. This mechanism is used to control access to the bus and also to signal errors.

- The CAN protocol calls for nodes to wait until a *bus idle period*4 is detected before attempting to transmit.

- If two or more nodes start to transmit at the same time, then by monitoring each bit on the bus, each node can determine if it is transmitting the highest priority message (with a numerically lower identifier) and should continue or if it should stop transmitting and wait for the next bus idle period before trying again.

- As the message identifiers are unique, a node transmitting the last bit of the identifier field, without detecting a '0' bit that it did not transmit, must be transmitting the highest priority message that was ready for transmission at the start of arbitration. This node then continues to transmit the remainder of its message, all other nodes having backed off.

- The requirement for a node to be able to overwrite a recessive bit, and the transmitting node detect this change, limits the combination of physical length and speed of a CAN bus.

- The duration of each bit must be sufficient for the signal to propagate the length of the network. This limits the maximum data rate to 1 Mbit/s for a network upto 40m in length or to 125 Kbit/s for a 500 m long network. The arbitration mechanism.

- employed by CAN means that messages are sent as if all the nodes on the network shared a single global priority based queue.

4. PIC Microcontroller CAN Interface

In the proposed model there would be two sections Node1 and Node2.

- The Node1 part would contain the engine temperature sensor, fuel sensor and emergency switches.

- The PIC would be connected to the CAN transceiver .The Node2 part would be connected to the PIC which in turn is connected to GPS receiver and the PC with which mobile is connected.

- The data can be transmitted as well as received between the two nodes using CAN protocol.

- CAN Protocol was designed specifically for automotive applications but is now also used in other areas. The main reason for Bosch to come up with CAN is to reduce the harness in vehicle. Before CAN bus all the controllers and sensors were connected peer to peer.

- Controller-area network (CAN) is a computer network protocol and bus standard designed to allow microcontrollers and devices to communicate with each other without a host computer. CAN is a serial communication protocol.

- The CAN bus may be used in vehicles, automation to connect engine control unit and transmission, or (on a different bus) to connect the door locks, climate control, seat control, light control etc.

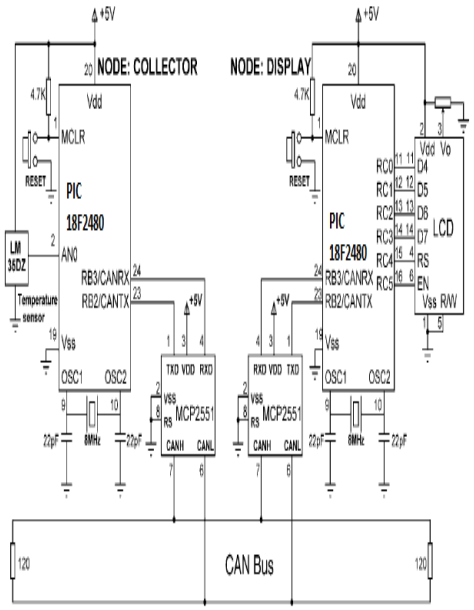

Fig.4.1 CAN interface with PIC.

4. Conclusion

The CAN topology is selected for communicating around the electric vehicle since the CAN protocol is optimized for systems that need to transmit and receive a relatively small amount of information reliably to any or all other nodes on the network. Since the protocol is message-based, all nodes on the bus receive every message, regardless of whether the node required the data or not. Fast robust message transmission with fault confinement is the big plus for CAN because faulty nodes will automatically drop off the bus, which does not allow any faulty node to bring down the network.

5. References

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