innodisk

White Paper

J1939-standard CANbus Solutions

The J1939 protocol set is based on CAN 2.0B and offers a high-speed, reliable in-vehicle communication system for heavy-duty applications.

Introduction

In-vehicle communication systems differ in many ways from a standard network system. In addition to strict demands for high-speeds and reliable data transfer, the system must be able to withstand the harsh conditions encountered by vehicles both on-road and off-road. With the advent of IoT, there is an increasing demand for faster and more reliable data transfer to enable fleet management and other cloud-based applications.

J1939 is a vehicle standard for communication that is based on the CANbus automotive protocol.
A J1939 standard system will deliver reliable and high-speed communication and is designed for use in harsh environments. This paper will explain the basic structure of J1939, how CANbus is defined within the standard, and challenges associated with in-vehicle communication.

Background

CANbus

CANbus was released in 1986 and is a message-based, automotive protocol that allows microcontrollers to communicate without the need of a host computer. These microcontrollers are also referred to as Electronic Control Units (ECU) or as nodes. CANbus connects to all nodes through a single twisted wire (CAN-H and CAN-L) (see figure 1). All signals sent from a node reaches all other nodes, where identifiers within each message specifies the receiver(s).

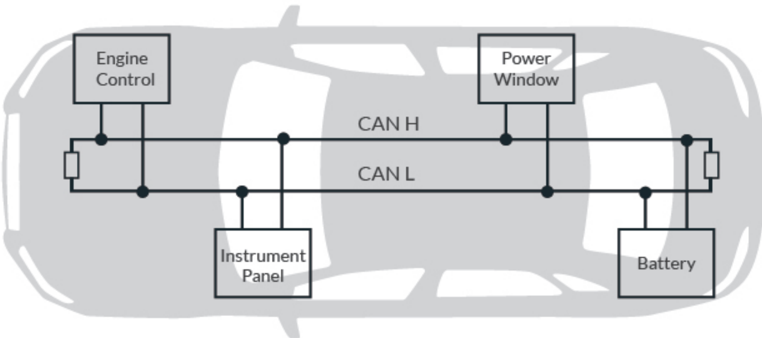


Figure 1: CANbus Basic Structure Example

There are two existing specifications of CANbus, CAN 2.0A and CAN 2.0B (see figure 2). CAN 2.0A has an 11 bit identifier, while CAN 2.0B extends this identifier to 29 bits.

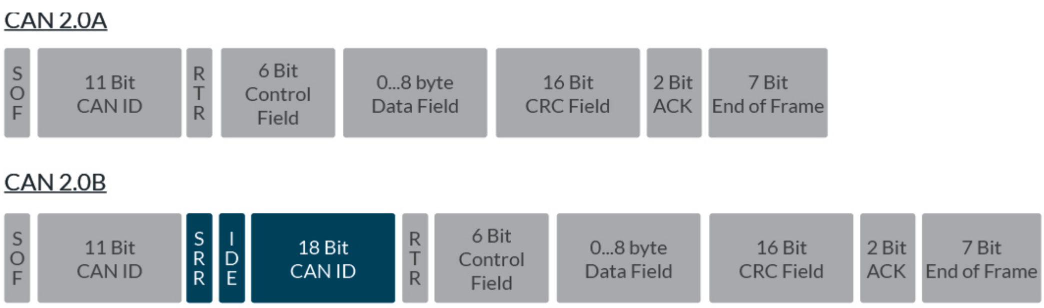


Figure 2: 29-bit CAN 2.0B

J1939

The Society of Automotive Engineers (SAE) J1939 describes a standard vehicle bus for diagnostics and communications in cars, trucks and other heavy-duty vehicles. J1939 was first released in 1994, while CANbus was included in 2000. This set of protocols describes the in-vehicle network all the way from the physical system architecture to communications with software that the user interacts with.

J1939 replaces the older J1708 standard. With a limited network speed of 9600 bits/second, it became clear that J1708 was not suitable for the amount of data and sophistication needed for heavy-duty operations. With data rates up to 250 Kbits/second, J1939 easily fulfills the requirement for high data transfer speed. By 2005 most manufacturers of heavy-duty vehicles had, at least partially, adopted the J1939 protocol as their standard for in-vehicle networking.

J1939 expands on the CANbus protocol by establishing a standard for the higher level layers in the communication network. The J1939 system allows for up to 30 nodes or electronic control units (ECU). Figure 3 shows the breakdown of the J1939 message format. Put simply, the message identifier is designed to be able to differentiate between destination specific and broadcast format. This is done by predefining ranges for each format. In other words, the message sent from one ECU can either be broadcasted to all other ECUs (a request for information etc.) or will be sent to a specific ECU connected to the system.

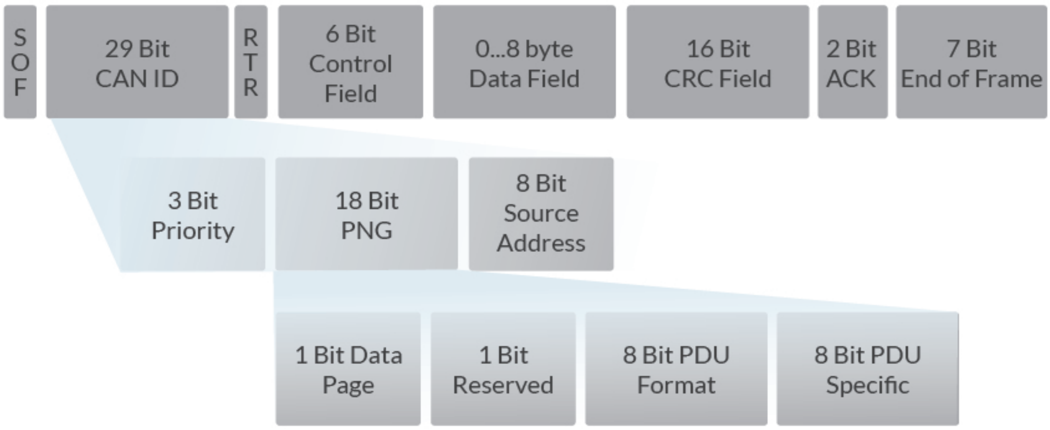


Figure 3: J1939 Message Format

The J1939 standard is based on the CAN 2.0B specifications with a baud rate of 250Kb/s. Other than the message identifier, the message structure is the same; however, the CAN specification only supports up to eight bytes of data per message. J1939 solves this by allowing for larger data amounts through higher level transport protocols. The message is sent in multiple packets, for a maximum size of 1785 bytes.

OSI Network Layer Model

To understand the relation between CANbus and the SAE J1939 standard, one first needs to understand how a network is structured. This is better explained through the Open Systems Interconnection (OSI) network layer model (See figure 3). From this perspective, CANbus makes up the physical and the data link layer (1 and 2). The physical layers describes such things as the mechanical and electrical characteristics of the system, while the data link, layer concerns the reliable transfer of information across the physical layer.

J1939 defines these two levels, but also adds on the network and transport layer (3 and 4), as well as the application layer (7). The network and transport layer are higher level protocols for message transmissions, and the applications layer is the protocols that directly communicates with the software, making it the closest layer to the user.

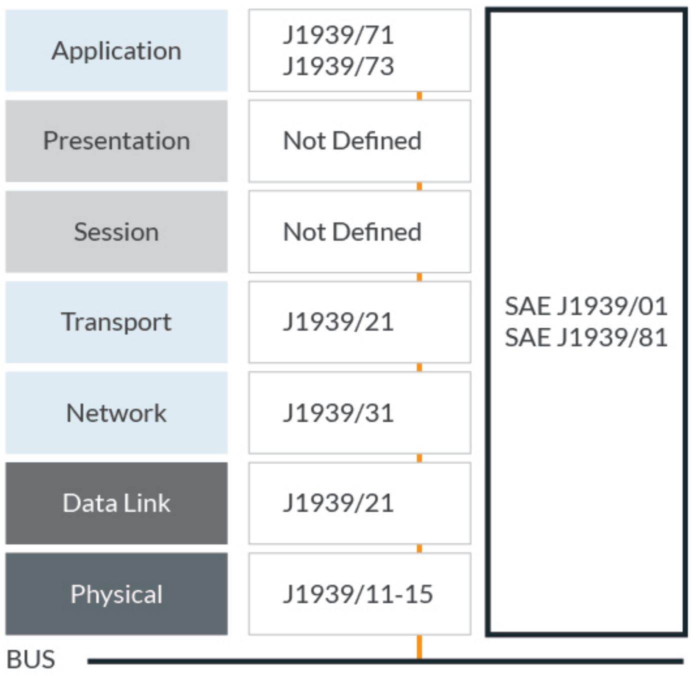


Figure 4: OSI model

Applications

Due to the robust and stable nature of the J1939 protocols it is suited for a wide variety of applications:

- Heavy-duty vehicles (in-vehicle network)
  - Military
  - Truck-trailer connection
  - Agriculture/ Forestry
  - Mining
- Truck-Trailer Connection
- Fleet Management Systems
- Recreational Vehicles
- Marine Navigation Systems
- Stationary system using vehicle components

Challenges

There are several factors that need to be in place for the successful implementation of a vehicle communication system – especially so in harsh environments.

An efficient and robust in-vehicle communication protocol

In-vehicle communication systems have to be durable and efficient. Vehicles are susceptible to wear and damages over time due to shock and vibration, as well as temperature variations. In harsh environments and in off-road scenarios the wear is even higher.

Fleet Management

The Internet of Things is a strong driving force for innovation in the automotive industry. Fleet management is an umbrella term for real-time monitoring and control of a vehicle fleet. These measures help streamline operations through more efficient fuel management, vehicle telematics, driver management, maintenance etc. This is only possible by having reliable data from every vehicle in the fleet readily available. Fleet management requires a fast in-vehicle system that can reliably transfer data to the cloud.

Software

Every in-vehicle application is unique. Any communication system implemented has to be customizable to allow for tweaking and adding in-system functions. As such, there needs to be a way for the user to easily access and alter system settings.

Solutions

Robustness

The J1939 standard is designed for use in harsh conditions. The CANbus physical layer consists of a single cord of double-twisted wire that that connects all ECUs. This allows for a simple setup where signal strengths remain strong. The upper network layers of J1939 define robust error detection and fault confinement.

The physical layer of SAE J1939 reflects the original design goal for use in heavy-duty environments. However, it also excels at other applications such as generator sets using vehicle-derived components and other stationary applications.

Efficient Communications

Compared to similar systems standards, J1939 provides high speed and flexibility for in-vehicle communication. This quick access to onboard data ensures reliable data transfer for IoT applications such as fleet management. This real-time data helps the user to more efficiently manage their application. With a J1939-standard system fully implemented, management is simplified and the overall efficiency increases.

Software API

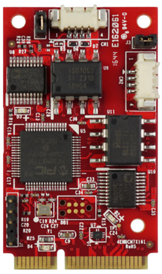
The J1939 is flexible and leaves a lot of room for customization. A J1939 application programming interface (API) is a software-based user interface that allows the operator to alter system settings. This allows the user to calibrate individual components, run self-diagnostics and other component configurations.

Conclusion

The J1939 protocol set is a well-tested and reliable setup for in-vehicle communications. CANbus provides a robust method of messaging between the different ECUs while J1939 expands on the limitations of CANbus by adding higher-level protocols that includes transport, network and application layers.

The Innodisk Solution

EMUC-B202



Rugged Hardware Design
· Complies with EN61000-4-5 2.5kV Surge protection
· Complies with IEC 60950-1:2005 + A1: 2009 + A2:2013 2.5kV HiPOT protection
· Complies with EN61000-4-2 (ESD) Air-15kV, Contact-8kV
· Supports use in temperatures from −40℃ to 85℃

Full Software Support
· J1939 API with complete sample code and GUI utility
· Support X86 and ARM(by project) system
· Support Windows, Linux, QNX

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