SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-01 SEP2021

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On-Highway Equipment Control and Communication Network

RATIONALE

This document has been updated with references to SAE publications and formatting changes. SAE J1939-76 was added as an SAE publication.

FOREWORD

The SAE J1939 communications network is defined using a collection of individual SAE J1939 documents based upon the layers of the open system interconnect (OSI) model for computer communications architecture. The SAE J1939-1 on-highway equipment control and communication network document specifies the minimum set of SAE J1939 documents that define the truck and bus control and communications vehicle network as it applies to on-highway equipment.

The SAE J1939 communications network is a high-speed ISO 11898-1 CAN based communications network that supports real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between electronic control units (ECUs) physically distributed throughout the vehicle. SAE J1939 network is the next generation successor to the SAE J1708 and SAE J1587 low speed networks. SAE J1708 and SAE J1587 are older, widely used networks intended to provide simple information exchange, including diagnostic data, between ECUs. SAE J1939 is capable of performing all of the functions of SAE J1708 and SAE J1587 networks, as well as providing control system support.

The SAE J1939 communications network is developed for use in heavy-duty environments and is suitable for horizontally integrated vehicle industries. The SAE J1939 communications network is applicable for light-duty, medium-duty, and heavy-duty vehicles used on-road or off-road, and for appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to, on-highway and off-highway trucks and their trailers, construction equipment, and agricultural equipment and implements. The physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Horizontally integrated vehicles involve the integration of different combinations of loose package components, such as engines and transmissions that are sourced from many different component suppliers. The SAE J1939 common communication architecture strives to offer an open interconnect system that allows the ECUs associated with different component manufacturers to communicate with each other.

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For more information on this standard, visit
https://www.sae.org/standards/content/J1939/01_202109/

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1. SCOPE

SAE J1939-1 specifies the minimum set of SAE J1939 documents that define the Truck and bus control and communications vehicle network as it applies to on-highway equipment. Vehicles covered include all on-highway straight trucks and combination vehicles. A combination vehicle consists of one towing vehicle (tractor) and one or more towed vehicles (trailers and dollies). Dolly axles within the road train are considered to be towed vehicles.

1.1 Purpose

It is the intention of the SAE J1939 family of recommended practices to allow electronic devices to communicate with each other by providing a standard architecture. SAE J1939-01 describes the particular set of SAE J1939 documents used to implement an open interconnect system for electronic systems in a heavy-duty on-highway vehicle.

1.2 Degrees of Openness

A network based upon this document is open to the degree that any two devices which conform to SAE J1939-1 can be connected via the network and communicate with each other without functional interference. Devices that conform to different SAE J1939-x documents may not be capable of communicating directly with one another and in some cases may cause degradation or complete disruption of the entire network.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1939	Serial Control and Communications Heavy Duty Vehicle Network - Top Level Document
SAE J1939-03	On-Board Diagnostics Implementation Guide
SAE J1939-11	Physical Layer, 250 kbps, Twisted Shielded Pair
SAE J1939-13	Off-Board Diagnostic Connector
SAE J1939-14	Physical Layer, 500 kbps
SAE J1939-15	Physical Layer, 250 kbps, Un-Shielded Twisted Pair (UTP)
SAE J1939-16	Automatic Baud Rate Detection Process
SAE J1939-21	Data Link Layer
SAE J1939-31	Network Layer
SAE J1939-71	Vehicle Application Layer
SAE J1939-73	Application Layer - Diagnostics
SAE J1939-76	SAE J1939 Functional Safety Communications Protocol
SAE J1939-81	Network Management

SAE J1939-84 OBD Communications Compliance Test Cases for Heavy Duty Components and Vehicles

SAE J1939DA SAE J1939 Digital Annex

2.2 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 11898-1 Road Vehicles - Controller Area Network (CAN) - Part 1: Data Link Layer and Physical Signaling

ISO 11898-2 Road Vehicles - Controller Area Network (CAN) - Part 2: High-Speed Medium Access Unit

ISO 11992 Road Vehicles - Interchange of Digital Information on Electrical Connections between Towing and Towed Vehicles

ISO 11992-1:2003 Part 1: Physical and Data-Link Layers

ISO 11992-2:2014 Part 2: Application Layer for Brakes and Running Gear

ISO 11992-3:2003 Part 3: Application Layer for Equipment Other Than Brakes and Running Gear

ISO 11992-3:2003 Amd 1:2008

ISO 11992-4:2014 Part 4: Diagnostic Communication

3. DEFINITIONS

Terms and definitions are defined in SAE J1939.

3.1 BRIDGE

A device which stores and forwards messages between two SAE J1939 network segments. The device could be stand alone or the logic could be embedded in a component controller such as an engine control module.

3.2 DIAGNOSTIC CONNECTOR

A connector on the vehicle that is used to get access to the vehicle communications network.

3.3 NETWORK INTEGRATOR

The person, company, or entity that manages the overall integration of ECUs into a complete vehicle network.

3.4 GATEWAY

This device permits data to be transferred between two networks with different protocols or message sets. The gateway provides a means to repackage parameters into new message groups when transferring messages from one segment to another.

4. TECHNICAL REQUIREMENTS

4.1 Use of SAE J1939 Documents

Vehicle networks described by the SAE J1939 family of documents follow the seven-layer OSI network architecture with a different document describing each layer used (not all seven layers are used). The SAE J1939-01 on-highway equipment network makes use of the following SAE J1939-related documents:

SAE J1939 — Serial Control and Communications Heavy Duty Vehicle Network - Top Level Document.

This top-level document describes the network in general, the OSI layering structure, the subordinate document structure, and provides control for all preassigned values and names

SAE J1939-03 — On Board Diagnostics Implementation Guide

Describes the implementation of On Board Diagnostics as may be applicable to heavy duty on-highway diesel trucks, which utilize the SAE J1939 network

SAE J1939-11 — Physical Layer 250 Kbps, Shielded Twisted Pair

SAE J1939-13 — Off-Board Diagnostic Connector

Used to access the network with external devices such as diagnostic tools.

SAE J1939-14 — Physical Layer 500 Kbps

Used on the tractor and as a subnetwork on trailers.

SAE J1939-15 — Physical Layer, 250 Kbps, Un-Shielded Twisted Pair (UTP)

Used on the tractor and as a subnetwork on trailers.

SAE J1939-16 — Automatic Baud Rate Detection Process

SAE J1939-21 — Data Link Layer

SAE J1939-31 — Network Layer

SAE J1939-71 — Vehicle Application Layer

Provides the definition of data elements and messages for vehicle functionality.

SAE J1939-73 — Application Layer - Diagnostics

Provides the definition of data elements and messages used for diagnostics and related network support functions.

SAE J1939-76 — SAE J1939 Functional Safety Communications Protocol

SAE J1939-81 — Network Management

Provides definition of handling source addresses and device identities.

SAE J1939DA — SAE J1939 Digital Annex

4.2 Physical Layer Definition

SAE J1939-11, SAE J1939-14, and SAE J1939-15 define physical layer implementations of the ISO 11898 controller area network (CAN) specification that may be used for heavy-duty on-highway vehicle applications. The network integrator shall use either SAE J1939-11, SAE J1939-14, or SAE J1939-15 for the SAE J1939-01 implementation. Any single segment of the vehicle network shall use only one of these physical layers.

Network topology requirements in SAE J1939-11 are relaxed in SAE J1939-15 to provide additional design flexibility to the OEM in the placement of network termination devices and for the use of the diagnostic connector. This allows the OEM to better optimize the cost/performance of their design.

4.2.1 Signal Definition

Electronic devices that connect to the SAE J1939-01 vehicle network shall meet the signal characteristics as specified in SAE J1939-11, SAE J1939-14, and SAE J1939-15. SAE J1939-15 is harmonized with SAE J1939-11, allowing the backwards-compatible interoperation among components. SAE J1939-11, SAE J1939-14, and SAE J1939-15 provide reference designs that are compatible with ISO 11898-2.

4.2.2 Media

The physical media shall meet the requirements of either SAE J1939-11, SAE J1939-14, or SAE J1939-15, as appropriate for the network. Any single segment of the vehicle network shall use only one of these physical layers. The implementer should note that there are specific differences between SAE J1939-11 and SAE J1939-15 in regard to media. SAE J1939-11 specifies a shielded twisted-pair cable media, while SAE J1939-15 specifies an un-shielded twisted-pair cable media. These cable media have been specified with regard to the harsh environment typically encountered in heavy-duty on-highway vehicle applications.

4.2.3 Topology

The network integrator, typically the vehicle OEM, is responsible for the design and implementation of the SAE J1939 network topology in the vehicle, following the requirements within SAE J1939-11, SAE J1939-14, or SAE J3939-15. The implementer should note that there are specific differences between SAE J1939-11, SAE J1939-14, and SAE J1939-15, for example in regard to backbone termination, stub length and number of ECUs allowed. Any single segment of the complete vehicle network shall meet the requirements of either SAE J1939-11, SAE J1939-14, or SAE J1939-15. Also, as specified in SAE J1939-31, network interconnection ECUs shall be used to interconnect different segments into a complete vehicle network topology.

Typical, contemporary implementations include a single network segment that interconnects all powertrain ECUs, some of which may also have subnetworks. Older vehicle model year implementations may feature only one network segment. Due to OBD requirements implemented in 2016, the baud rate of the regulated pins at the SAE J1939-13 connector need to be at 500K, and the ECM has to be accessible on these pins. SAE J1939 does not specify a method to connect a towed device (trailer) to the network, but ISO 11992 can be used for this if needed. In this situation, a bridge device would be required to interface between the SAE J1939 network segment and the ISO 11992 network segment.

Gateways translate from SAE J1939 subnetworks to various other networks. The gateway provides a means to repackage parameters into new message groups when transferring messages from one segment to another. Systems that use networks with multiple baud rates can use gateways to allow communication between the networks if information between these networks needs to be shared between the networks. Gateways can also be used to connect networks that use the same baud rate as well.

4.2.4 Diagnostic Connector

The diagnostic connectors defined in SAE J1939-13 shall be used as described therein. The Type I (black or grey) vehicle mounted diagnostic connector is used for 250 Kbps networks while the Type II (green) vehicle mounted diagnostic connector is used with 500 Kbps networks.

A Type II diagnostic plug connector on a service tool will mate with a Type II or Type I vehicle mounted diagnostic receptacle. A Type I (black or grey) diagnostic plug connector on a service tool will only mate with a Type I vehicle mounted diagnostic receptacle. Diagnostic tools can be developed to auto detect the network baud rate per SAE J1939-16.

4.3 Data Link Layer Definition

The data link layer on SAE J1939 vehicle networks shall conform to SAE J1939-21.

4.4 Network Layer Definition

SAE J1939-31 defines the network layer provisions in the SAE J1939 family of specifications. The overall vehicle network may consist of multiple network segments, and as noted in discussion of topology, Network Interconnection ECUs as described in SAE J1939-31 shall be used to connect the different network segments together.

4.5 Application Layer

There are two documents that define the application layer functionality that may be implemented on a heavy duty on-highway vehicle.

SAE J1939-71 and SAE J1939DA define various data elements and messages used for vehicle control and communications. These parameters shall be available while the vehicle is powered on as well as with the engine running. This is required for hybrid vehicles and for features such as engine off while vehicle stopped.

SAE J1939-73 defines various diagnostic services and data content for diagnostics messages on a SAE J1939 network. The data elements and messages defined in SAE J1939-71 and SAE J1939-73 can be considered as a dictionary of the possible information that can be communicated on a SAE J1939 network. The components on the vehicle and their supported functionality determine what actual data elements and messages will be present on a network. The network integrator has the responsibility to assure that all network devices adhere to these application documents, with regard to correct data content and message structures and timing.

4.6 On Board Diagnostics (OBD) Considerations

Many heavy-duty on-highway vehicles that utilize an SAE J1939 network may be subject to regulatory requirements for OBD. SAE J1939-03 has been developed to provide guidelines for the implementation of OBD on heavy-duty vehicles that use the SAE J1939 family of standards. Implementers should review the specific regulations for the markets where their products will be sold to determine applicability. Refer to specification SAE J1939-84 for OBD communications compliance.

4.7 Network Management Considerations

SAE J1939-81 describes network management facilities for devices on a SAE J1939 network. Network management in the SAE J1939 network is concerned with the management of source addresses and the association of those addresses with an actual function and the detecting and reporting of network related errors. All devices that operate on a SAE J1939 network have to meet at least the minimum network management requirements per SAE J1939-81.

4.8 Use of Subnetworks

The network may consist of a single physical layer as shown in Figure 1, as a primary network with one or more subnetworks connected to it, or as multiple subnetworks as shown in Figure 2. The particular devices shown in these figures are only for illustrative purposes; the exact set of devices used may vary considerably from vehicle to vehicle. Either SAE J1939-11, SAE J1939-14, or SAE J1939-15 physical layers may be used for the primary network or subnetworks. A bridge is used whenever a subnetwork connects to a primary network or to another subnetwork. An example of bridge placement is at every trailer or dolly which will provide address assignment and electrically isolate the trailer subnetwork from the primary network. Not explicitly illustrated, but implied, is that dollies utilize the same bridge and subnetwork structure as trailers. Figure 3 illustrates the use of these different physical layers within a typical truck with trailers connected.

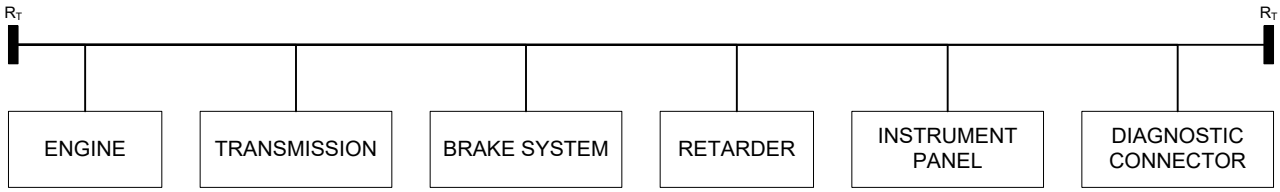

Figure 1 - Example of vehicle network using single network (devices shown are for example only)

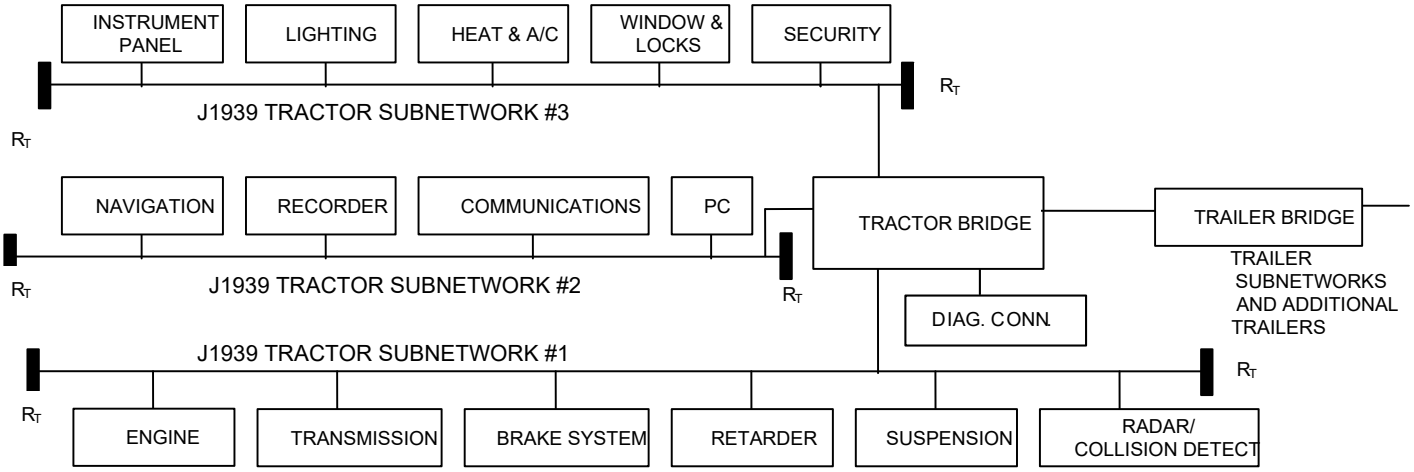

Figure 2 - Example of vehicle network using multiple subnetworks (devices shown are for example only)

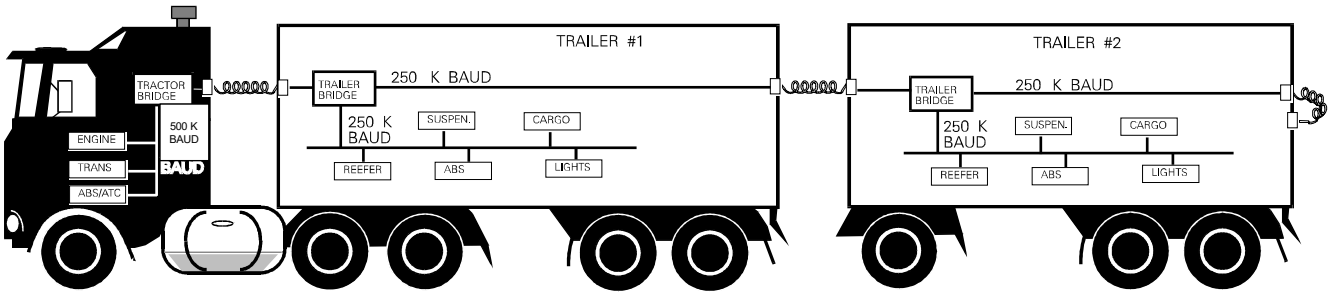

Figure 3 - Example of a possible on-highway truck implementation (devices shown are for example only)

The number of subnetworks and the selection of devices to be connected to each are left to the vehicle manufacturer to define. The use of SAE J1939 on any towed vehicle (trailer or dolly) will automatically result in the use of at least two subnetworks, one for the tractor and one for the towed vehicle.

The decision to use multiple subnetworks on the tractor may be driven by the number or types of devices to be supported. The bridge between these subnetworks can be used to filter messages between them, effectively isolating one subnetwork from the other with the exception of those messages that are allowed to pass through the bridge. The tractor and trailer bridges may also include the ability to filter messages on each side of it that are not applicable to the vehicle on the other side. For instance, there is no need to transmit the majority of engine or transmission messages back to the towed vehicle. A gateway may also be used to pass information between networks that have different protocols, message sets, or different baud rates.

5. NOTES

5.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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