

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2284-3

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High-Speed CAN (HSC) for Vehicle Applications at 500 KBPS

Foreword—The objective of SAE J2284-3 is to define a level of standardization in the implementation of a 500 KBPS vehicle communication network using the Controller Area Network (CAN) protocol. The goal is to achieve a standard Electronic Control Unit (ECU) Physical Layer, Data Link Layer, and Media Design Criteria which will allow ECU and tool manufacturers to satisfy the needs of multiple end users with minimum modification to a basic design. Likewise, end users will benefit in lower ECU cost achieved from the high volumes of the basic design.

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- 1. Scope**—This SAE Recommended Practice will define the Physical Layer and portions of the Data Link Layer of the ISO model for a 500 KBPS High-Speed CAN (HSC) protocol implementation. Both ECU and media design requirements for networks will be specified. Requirements will primarily address the CAN physical layer implementation.

Requirements will focus on a minimum standard level of performance from the High-Speed CAN (HSC) implementation. All ECUs and media shall be designed to meet certain component level requirements in order to ensure the HSC implementation system level performance at 50 KBPS. The minimum performance level shall be specified by system level performance requirements or characteristics described in detail in Section 6 of this document.

This document is designed such that if the Electronic Control Unit requirements defined in Section 6 are met, then the system level attributes should be obtainable.

This document will address only requirements which may be tested at the ECU and media level. No requirements which apply to the testing of the HSC implementation as integrated into a vehicle are contained in this document. However, compliance with all ECU and media requirements will increase the possibility of communication compatibility between separately procured components and will greatly simplify the task of successfully integrating a HSC communication system in a vehicle.

- 2. References**—This specification takes precedence over all conflicts in the documents cited in this section.

- 2.1 Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

- 2.1.1 SAE PUBLICATIONS**—Available from SAE, 400 Commonwealth Drive, Warrendale, Pa. 15096-0001.

SAEJ551-4—Test Limits and Methods of Measurement of Radio Disturbance Characteristics of Vehicles and Devices, Broadband and Narrowband, 150 kHz to 1000 MHz
 SAE J551-11—Vehicle Electromagnetic Immunity—Off-Vehicle Source
 SAE J551-15—Vehicle Electromagnetic Immunity—Electrostatic Discharge (ESD)
 SAE J1113-13—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 13: Immunity to Electrostatic Discharge
 SAE J1113-21—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 21: Immunity to Electromagnetic Fields, 10 kHz to 18 GHz, Absorber-Lined Chamber
 SAE J1113-41—Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers Used On-Board Vehicles
 SAE J1213-1—Glossary of Vehicle Networks for Multiplexing and Data Communications
 SAE J1930—Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms
 SAE J1962—OBD Diagnostic Connector
 SAE J2190—Enhanced Diagnostic Test Modes
 SAE 970295—CAN Bit Timing Requirements

2.1.2 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 7498—Data processing systems—Open systems interconnection standard reference model
 ISO 7637-1—Road vehicles—Electrical disturbance by conduction and coupling
 ISO11898:1993/Amd.1:1995(E)—Road vehicles—Interchange of digital information—Controller area network (CAN) for high speed communication
 ISO 14229—Road vehicles—Diagnostic systems—Specification of diagnostic services

2.1.3 OTHER PUBLICATIONS

Bosch—CAN Specification 2.0, Parts A and B
 CISPR 25—Limits & Methods of Measurement of Radio Disturbance Characteristics for the Protection of Receivers Used On-Board Vehicles

3. **Definitions**—The definitions provided in SAE J1213-1 apply to this document. Additional or modified definitions, acronyms, and abbreviations included in this document or relevant to the communication of information in a vehicle are catalogued in this section.

3.1 **CAN_H**—The CAN_H bus wire is fixed to a mean voltage level during the recessive state and is driven in a positive voltage direction during the dominant bit state.

3.2 **CAN_L**—The CAN_L bus wire is fixed to a mean voltage level during the recessive state and is driven in a negative voltage direction during the dominant bit state.

3.3 **Data Link Layer**—Provides the reliable transfer of information across the Physical Layer. This includes message qualification and error control.

3.4 **Data Link Connector (DLC)**—Provides the electrical connection between Off-Board and On-Board ECUs. For some vehicles, the DLC is the SAE J1962 connector.

3.5 **Dominant State**—The dominant state is represented by a differential voltage greater than a minimum threshold between the CAN_L and CAN_H bus wires. The dominant state overwrites the recessive state and represents a logic “0” bit value

3.6 **Electronic Control Unit (ECU)**—An On- or Off-vehicle electronic assembly from which CAN SAE J2284-3 messages may be sent and/or received.

3.7 **Media**—The physical entity which conveys the electrical (or equivalent means of communication) transmission between ECUs on the network (e.g., unshielded twisted pair wires).

3.8 **Physical Layer**—Concerns the transmission of an unstructured bit stream over physical media: deals with the mechanical, electrical, functional, and procedural characteristics to access the physical media.

3.9 **Protocol**—Formal set of conventions or rules for the exchange of information between ECUs. This includes the specification of frame administration, frame transfer, and physical layer.

3.10 **Radiated Emissions**—Radiated Emissions consists of energy that emanate from the CAN bus wires. Electric field strength in dB μ V/m is the typical measure of radiated emissions.

3.11 **Radiated Immunity**—A property that ensures that the CAN bus wires will not suffer degraded functional operation within its intended electromagnetic environment.

3.12 **Recessive State**—The recessive state is represented by an inactive state differential voltage that is approximately 0. The recessive state represents a logic “1” bit value.

4. **Acronyms**

CAN	Controller Area Network
DLC	Data Link Connector
EMC	ElectroMagnetic Compatibility
ESD	Electrostatic Discharge
HSC	High-Speed CAN
KBPS	KiloBits Per Second
ISO	International Standards Organization
OBD-II	On Board Diagnostics (level 2)
SAE	Society of Automotive Engineers

- 5. *System Level Attributes of the Network***—This section describes System Level performance attributes of a 500 KBPS HSC network for automotive vehicle applications. This HSC network is based on ISO 11898:1993 and Amendment 1:1995 with the modifications and additions described as follows:

- 5.1 *Message Format***—All ECU CAN interfaces shall, at a minimum, conform to the Bosch “CAN Specification 2.0 Part A” dated September, 1991. In particular, all CAN chips shall implement “enhanced timing” as specified in Section 9.1 of the Bosch document.

All ECUs that utilize the 11-bit standard frame identifier shall be, at a minimum, passive to the 29-bit extended message identifier. All SAE J2284-3 compliant ECUs that support OBD-II requirements shall fully support a 29-bit extended message identifier.

The encoding of the 11-bit identifier field shall be manufacturer specific. The CAN requirement (see Bosch CAN 2.0 and ISO 11898 CAN documents) specifying that, “the 7 most significant bits (ID-10 - ID-4) must not be all recessive,” shall not be enforced in hardware by SAE J2284-3.

The maximum message frame shall consist of the CAN identifier (CANID) plus 8 data bytes.

- 5.2 *500 KBPS Communication Rate***—The network shall operate at a single communication rate of 500 KBPS.
- 5.3 *Communication Among 16 ECUs***—The network system shall support the transfer of information among as many as 16 ECUs, and as few as two ECUs.
- 5.4 *Topology and Termination***—The wiring topology of this network shall support a linear structure, including daisy-chain configurations. Termination shall always be located at each end of the bus. The topology details are specified in 6.7.
- 5.5 *Unshielded Media***—The network shall operate using a shielded or unshielded twisted wire pair.
- 5.6 *Communication/Survivability Under Faulted Conditions***—(See Table 1.)
- 5.7 *EMC Criteria***—The ECU EMC requirements as specified in 6.11 are intended to satisfy vehicle level EMC compliance when tested in accordance with SAE J551-4, SAE J551-11, and SAE J551-15.

TABLE 1—FAULT BEHAVIOR

DESCRIPTION OF FAILURE	COMMUNICATION BEHAVIOR
One non-terminating ECU becomes disconnected from the bus	Remaining ECUs continue to communicate with no degradation. (Exception = daisy chained network)
ECU loss of power or ground (includes low battery condition)	Remaining ECUs continue to communicate with no degradation.
CPU goes into reset, while its physical layer and IC is still powered	Remaining ECUs continue to communicate with no degradation.
CAN_H wire open	Data communication between ECUs on opposite sides of an interruption is not required. Data communication between ECUs on the same side of an interruption may be possible with reduced signal to noise ratio.
CAN_L wire open	Data communication between ECUs on opposite sides of an interruption is not required. Data communication between ECUs on the same side of an interruption may be possible with reduced signal to noise ratio.
CAN_H shorted to battery	Data communication is not required if V _{batt} is greater than the maximum allowed common mode voltage.
CAN_L shorted to battery	Data communication is not required.
CAN_H shorted to ground	Data communication is not required.
CAN_L shorted to ground	Data communication may be possible with reduced signal to noise ratio.
CAN_H shorted to CAN_L	Data communication is not required.
Loss of one termination	Data communication may be possible with reduced signal to noise ratio.

6. ECU Requirements—This section describes the electrical requirements for an ECU on an HSC network. The requirements described are designed to support the design goals described in Section 5, System Level Attributes.

6.1 Absolute Maximum Ratings—The ECU shall not be guaranteed to perform network communication under these conditions. However, network related electrical components within the ECU shall not suffer permanent damage.

6.1.1 DIRECT VOLTAGE CONNECTION—(See Table 2.)

TABLE 2—ABSOLUTE MAXIMUM BUS WIRE VOLTAGE

Symbol	Minimum	Maximum	Units	Conditions
CAN_L	−3.0	+16	VOLTS	12 V System
CAN_H	−3.0	+16	VOLTS	12 V System

The limits given in Table 2 are the absolute maximum and minimum DC voltages which can be connected to the bus wires without damage to the ECU.

6.1.2 UNPOWERED STORAGE TEMPERATURE—The SAE J2284-3 electrical components within the ECU shall not suffer permanent damage if subjected to storage temperatures between −40 and +150 °C.

6.2 DC Operating Parameters—DC parameters shall be within the defined ranges for four unique conditions:

- Recessive Bus State, ECU disconnected from CAN Bus
- Dominant Bus State, ECU disconnected from CAN Bus
- Recessive Bus State, ECU connected to maximum CAN Bus
- Dominant Bus State, ECU connected to maximum CAN Bus