



SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-15

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(R) Physical Layer, 250 Kbps, Un-Shielded Twisted Pair (UTP)

RATIONALE

Document is revised to allow unjacketed cable for some installations, clarify minimum node and stub spacing, update ISO references and terminology, and correct table references to SAE J1939-11.

FOREWORD

The set of SAE J1939 Recommended Practice documents define a high-speed ISO 11898 CAN protocol based communications network that can support real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between Electronic Control Units (ECUs) physically distributed throughout the vehicle.

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for use in horizontally integrated vehicle industries. 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, which 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.

The SAE J1939 communications network is intended 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.

This set of SAE Recommended Practices has been developed by the SAE Truck and Bus Control and Communications Network Committee of the SAE Truck and Bus Electrical and Electronics Steering Committee. 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. These SAE J1939 documents are intended as a guide toward standard practice and are subject to change to keep pace with experience and technical advances.

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TABLE OF CONTENTS

1.	SCOPE	4
2.	REFERENCES	4
2.1	Applicable Documents	4
2.1.1	SAE Publications	4
2.2	Related Publications	4
2.2.1	ISO Publications	4
3.	NETWORK PHYSICAL DESCRIPTION	4
3.1	Physical Layer	5
3.2	Physical Media	5
3.3	Differential Voltage	5
3.4	Bus Levels	5
3.5	Bus Levels During Arbitration	5
3.6	Common Mode Bus Voltage Range	5
3.7	Bus Termination	5
3.8	Internal Resistance	5
3.9	Differential Internal Resistance	5
3.10	Internal Capacitance	6
3.11	Differential Internal Capacitance	6
3.12	Bit Time	6
3.13	Internal Delay Time	6
3.14	CAN Bit Timing Requirements	6
4.	FUNCTIONAL DESCRIPTION	7
5.	ELECTRICAL SPECIFICATION	7
5.1	Electrical Data	7
5.1.1	Electronic Control Unit	7
5.1.2	Bus Voltages - Operational	8
5.1.3	Electrostatic Discharge (ESD)	8
5.1.4	Example Physical Layer Circuits	8
5.2	Physical Media Parameters	8
5.2.1	Bus Line	10
5.2.2	Topology	10
5.2.3	Terminating Resistor	11
5.2.4	Shield Termination	12
5.2.5	ECU Type I and Type II Markings	12
5.3	Connector Specifications	12
5.3.1	Connector Electrical Performance Requirements	13
5.3.2	Connector Mechanical Requirements	13
6.	CONFORMANCE TESTS	13
6.1	Recessive Output of the ECUs	13
6.2	Internal Resistance of CAN_H and CAN_L	13
6.3	Internal Differential Resistance	13
6.4	Recessive Input Threshold of an ECU	13
6.5	Dominant Output of an ECU	13
6.6	Dominant Input Threshold of an ECU	13
6.7	Internal Delay Time	13
7.	DISCUSSION OF BUS FAULTS	13
7.1	Loss of Connection to Network	13
7.2	Node Power or Ground Loss	14
7.3	Unconnected Shield	14
7.4	Open and Short Failures	14

8.	NOTES	14
8.1	Revision Indicator	14
APPENDIX A	EXAMPLE PHYSICAL LAYER CIRCUITS	15
APPENDIX B	RECOMMENDED CABLE TERMINATION PROCEDURE FOR JACKETED CABLE	16
APPENDIX C	RECOMMENDED CABLE SPLICE PROCEDURE FOR JACKETED CABLE	17
APPENDIX D	RECOMMENDED CABLE REPAIR PROCEDURE FOR JACKETED CABLE	18
APPENDIX E	COMPARISON OF THE SAE J1939-15 VERSUS THE SAE J1939-11 PHYSICAL LAYER	19
APPENDIX F	SAE J1939-11 COMPLAINT TOOLS AND ECUS USED WITH THE SAE J1939-15 NETWORK	20
Figure 1	Cable cross-section and bend radius	10
Figure 2	Wiring network topology (Type I ECUS only)	10
Figure 3	Wiring network topology (one Type II ECU installed)	11
Figure 4	Wiring network topology (two Type II ECUS installed)	11
Figure 5	An example of SAE J1939-11 connector usage in a SAE J1939-15 network	12
Table 1	AC parameters of an ECU disconnected from the bus line	7
Table 2	Physical media parameters for un-shielded twisted pair cable	9
Table 3	Network topology parameters	11

1. SCOPE

This document describes a physical layer utilizing Unshielded Twisted Pair (UTP) cable with extended stub lengths for flexibility in ECU placement and network topology. Also, connectors are not specified.

CAN controllers used on SAE J1939-15 networks must be restricted to use only Classical Frames as defined in ISO 11898- 1. A network which may have legacy controllers cannot tolerate FD Frames.

These SAE Recommended Practices are intended for light- and heavy-duty vehicles on- or off-road as well as appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to: on- and off-highway trucks and their trailers; construction equipment; and agricultural equipment and implements.

2. REFERENCES

General information regarding this series of recommended practices is found in SAE J1939.

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 J1128	Low-Voltage Primary Cable
SAE J1939-11	Physical Layer, 250 Kbps, Twisted Shielded Pair
SAE J1939-13	Off-Board Diagnostic Connector

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 ISO Publications

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

ISO 11898-1:2015	Road vehicles - Controller area network (CAN) - Part 1: Data link layer and physical signalling
ISO 11898-2:2016	Road vehicles - Controller area network (CAN) - Part 2: High-speed medium access unit
ISO 16845-1:2016	Road vehicles - Controller area network (CAN) conformance test plan -- Part 1: Data link layer and physical signalling

3. NETWORK PHYSICAL DESCRIPTION

The SAE J1939-15 physical layer has the same characteristics as the SAE J1939-11 physical layer except as described in this document. It is the responsibility of the vehicle manufacturer to determine when the SAE J1939-15 physical layer should be used versus the SAE J1939-11 physical layer. Appendix E, Table E1 contains a comparison of SAE J1939-15 characteristics versus SAE J1939-11.

3.1 Physical Layer

The physical layer is a realization of an electrical connection of a number of ECUs (Electronic Control Units) to a network. The total number of ECUs will be limited by electrical loads on the bus line.

Stubs, being un-terminated, create signal reflections on the network. A total of up to ten ECUs on a network segment is considered to present low risk of coincident reflections of sufficient magnitude to create bit errors and error frames. Up to 30 ECUs may be connected on a network segment if special care is taken to vary the spacing between stubs to avoid the effects of reflections. Consideration must also be given to EMC performance which may be affected by the total stub length.

The SAE J1939-15 network was designed as a reduced SAE J1939-11 network for connecting standard ECUs on a vehicle (e.g., Engine, ABS, Transmission). The SAE J1939-15 network allows the vehicle integrator to design a reduced network to meet design and cost goals with comparable performance to the SAE J1939-11 network.

3.2 Physical Media

This document defines a physical media of un-shielded twisted pair (UTP). In most cases, a jacket provides needed dimensional consistency as well as abrasion and other environmental protections for the signal wires within. For locations where additional physical protection is not needed and the cable/harness manufacturer provides other means or construction techniques that ensure dimensional and impedance consistency, the jacket may be omitted.

The two wires have a characteristic impedance of $120\ \Omega$ and are symmetrically driven with respect to the electrical currents. The designations of the individual wires are CAN_H and CAN_L. The names of the corresponding pins of the ECUs are also denoted by CAN_H and CAN_L, respectively.

3.3 Differential Voltage

Same as the SAE J1939-11 physical layer.

3.4 Bus Levels

Same as the SAE J1939-11 physical layer.

3.5 Bus Levels During Arbitration

Same as the SAE J1939-11 physical layer.

3.6 Common Mode Bus Voltage Range

Same as the SAE J1939-11 physical layer.

3.7 Bus Termination

The bus is electrically terminated at each end with a load resistor denoted by R_L . SAE J1939-11 requires that R_L be located external to ECUs. This Recommended Practice, J1939-15, defines Type I and Type II ECUs. Type I ECUs shall not contain the bus termination resistor R_L . Type II ECUs shall contain the bus termination resistor and if used shall be located only at one or both ends of a SAE J1939-15 network. Type II ECUs shall be clearly marked as specified in 5.2.5.

3.8 Internal Resistance

Same as the SAE J1939-11 physical layer.

3.9 Differential Internal Resistance

Same as the SAE J1939-11 physical layer.

3.10 Internal Capacitance

Same as the SAE J1939-11 physical layer.

3.11 Differential Internal Capacitance

Same as the SAE J1939-11 physical layer.

3.12 Bit Time

Same as the SAE J1939-11 physical layer.

3.13 Internal Delay Time

For those networks utilizing a diagnostic stub which may exceed 3 m, ECU delay time is reduced to 0.7 μ s.

3.14 CAN Bit Timing Requirements

The CAN bit timing requirements for the SAE J1939-15 are the same as the SAE J1939-11 physical layer, except Table 1 below should be used, which includes the Signal Rise/Fall Time parameter.

If a discrete circuit is used, the Signal Rise/Fall Time should be adjusted per Table 1, Note 2.

Some transceiver chips offer faster rise and fall times than are given in Table 1 without an increase in EMI. If emissions control or slope control is not integral to the transceiver, EMI performance must be equivalent.

The Signal Rise/Fall Time parameter has been included for clarity and to improve the Electromagnetic Compatibility (EMC) of the physical layer. The primary parameter for electromagnetic emission is the unbalance of the signals at CAN_H and CAN_L. To verify that the signals are balanced, the maximum voltage imbalance between CAN_H and CAN_L should not exceed 10 mV_{pp}. The differential voltage can be measured with ac-coupling and an oscilloscope: CAN_H minus CAN_L inverted.

Transceivers meeting the requirements of ISO 11898-1 are compatible with SAE J1939-15.