

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

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Reduced Physical Layer, 250K bits/sec, Un-Shielded Twisted Pair (UTP)

Foreword—This series of SAE Recommended Practices have been developed by the Truck & Bus Control and Communications Network Subcommittee of the Truck & Bus Electrical Committee. The objectives of the subcommittee are to develop information reports, recommended practices and standards concerned with the requirements, design and usage of devices which transmit electronic signals and control information among vehicle components. The usage of these recommended practices is not limited to truck and bus applications. Other applications may be accommodated with immediate support being provided for construction and agricultural equipment, and stationary power systems.

These SAE Recommended Practices are intended as a guide toward standard practice and are subject to change to keep pace with experience and technical advances.

TABLE OF CONTENTS

1.	SCOPE	6
2.	REFERENCES	6
2.1	Applicable Documents.....	6
2.1.1	SAE Publication.....	6
2.2	Related Publication	6
2.2.1	ISO Publication.....	6
3.	NETWORK PHYSICAL DESCRIPTION.....	6
3.1	Physical Layer.....	6
3.2	Physical Media.....	7
3.3	Differential Voltage	7
3.4	Bus Levels	7
3.5	Bus Levels During Arbitration	7
3.6	Common Mode Bus Voltage Range	7
3.7	Bus Termination	7
3.8	Internal Resistance.....	7
3.9	Differential Internal Resistance.....	7
3.10	Internal Capacitance	7
3.11	Differential Internal Capacitance	7
3.12	Bit Time	7
3.13	Internal Delay Time.....	7
3.14	CAN Bit Timing Requirements	8
4.	FUNCTIONAL DESCRIPTION.....	9

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5.	ELECTRICAL SPECIFICATION	9
5.1	Electrical Data.....	9
5.1.1	<i>Electronic Control Unit</i>	9
5.1.1.1	<u>Absolute Maximum Ratings</u>	9
5.1.1.2	<u>DC Parameters</u>	9
5.1.1.3	<u>AC Parameters</u>	9
5.1.2	<i>Bus Voltages - Operational</i>	9
5.1.3	<i>Electrostatic Discharge (ESD)</i>	9
5.1.4	<i>Example Physical Layer Circuits</i>	9
5.2	Physical Media Parameters.....	10
5.2.1	<i>Bus Line</i>	11
5.2.2	<i>Topology</i>	11
5.2.3	<i>Terminating Resistor</i>	12
5.3	Connector Specifications.....	12
5.3.1	<i>Connector Electrical Performance Requirements</i>	13
5.3.2	<i>Connector Mechanical Requirements</i>	13
6.	CONFORMANCE TESTS	14
6.1	Recessive Output of the ECUs	14
6.2	Internal Resistance of CAN_H and CAN_L.....	14
6.3	Internal Differential Resistance.....	14
6.4	Recessive Input Threshold of an ECU	14
6.5	Dominant Output of an ECU.....	14
6.6	Dominant Input Threshold of an ECU	14
6.7	Internal Delay Time.....	14
7.	DISCUSSION OF BUS FAULTS	14
7.1	Loss of Connection to Network.....	14
7.2	Node Power or Ground Loss	14
7.3	Unconnected Shield	14
7.4	Open and Short Failures	14
	APPENDIX A.....	15
	APPENDIX B.....	16
	APPENDIX C.....	17
	APPENDIX D.....	18
	APPENDIX E.....	19
	APPENDIX F.....	20

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J1939-15 Document Revision History

Rev Level	Description	By	Date
FEB98	New	K.Brown	2/98
JUL98	Title Page: Changed J1939/15 to "J1939-15" throughout document, updated the "Revised heading" in the header to "JUL98", changed title to "Un-Shielded Twisted Pair (UTP)". Section 2.1.1: Deleted reference to SAE J1113/13 and referenced SAE J1939-11. Section 3.2: Changed median to "media", changed cable description to "un-shielded twisted pair (UTP)". Section 5.1.2: Added the complete text from the same section of J1939-11. Section 5.1.4: Changed requirement to "requirements", changed CAN_Shield to "drain wire CAN_SHLD". Table 1: Changed the title wording to "UN-SHIELDED TWISTED PAIR", added the cable size parameters. Section 5.3: Revised the wording to describe the connectors suitable for use with the J1939-15. Section 5.3.2: Inserted text from the same section of J1939-11. Section 7.3: Added "physical layer". Appendix A: Deleted the circuit diagram pictures and referenced the pictures in J1939-11. Appendix B: Changed wording to read, "does not have EMC shielding material or a drain wire." Appendix C: Changed wording to read, "does not have EMC shielding material or a drain wire." Appendix D: Changed wording to read, "does not have EMC shielding material or a drain wire." Appendix E: Added a row to Table E1, that lists the maximum number of nodes, revised Table E1 format for clarity, changed J1939/11 to "J1939-11" throughout the document. Reference Section: Deleted reference to SAE J1113/13.	K.Brown	6/98
OCT98	Section 2.1.1: Added SAE J1128—Low-Tension Primary Cable. Section 3.14: Added Table 1-AC Parameters of an ECU Disconnected from the Bus Line. Section 5.1.4: Revised wording to reference integrated circuit solutions. Section 5.2: Revised Table 1 Title to Table 2, changed Wire insulation dia. for the 20 AWG, from 2.03mm to 1.90mm, added Lay Length parameter. Section 5.2.2: Revised Table 2 Title to Table 3. Appendix A: Revised wording to reference integrated circuit solutions. Appendix B: Added cable termination procedure for 3-way and typical 2-way connectors. Appendix C: Added cable splice procedure. Appendix D: Added cable repair procedure. Reference Section: Added SAE J1128—Low-Tension Primary Cable.	K.Brown	10/98

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J1939-15 Document Revision History

Rev Level	Description	By	Date
DEC98 Ballot	Section 5.1: Referenced Tables 1 through 10 in J1939-11. Section 5.1.2: Referenced Table 5 and Table 6 in J1939-11. Figure 1: Redrawn for clarity. Appendix B: Added step 5 - Slide adhesive-lined heat-shrinkable tubing onto the cable, added step 7 - To maintain cable twisting, Install the adhesive-lined heat-shrinkable tubing over the assembly and apply per manufacturer's recommendation. Cable twisting must begin at least 50 mm from the connector. The maximum distance between the wires, over the untwisted length, is 3 mm, Figure B1 and Figure B2 were redrawn for clarity.	K.Brown	12/98
FEB99 Ballot Comments	Section 5.2: Added Figure 1 - Cable Cross Section and Bend Radius. Table 2: Added note, "0.67 to 0.91 twist per 25.4mm", to clarify lay length. Table 2: Added note (see Figure 1). Table 2: Revise note 3) to state, "For environmental sealing applications, other cable sizes may be available". Table 3: Added note, "The cable stub length for the diagnostic connector is 0.1m minimum for the vehicle, and 2.9m maximum for the off-board diagnostic tool. The total stub length should not exceed 3m." Figure 2: Revised Figure 1 to Figure 2. Figure 3: Revised Figure 2 to Figure 3. Figure C1: Revised drawing to show a better detailed "splice". Appendix F: Added Appendix F, Recommended Configurations for Mixed J1939-15 and J1939-11 Physical Layers.	K.Brown	1/99

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MAY99 Task Force Ballot Comments	Section 3.2: Revised first sentence, "This document defines a physical media of <u>jacketed</u> un-shielded twisted pair (UTP)." Section 3.14: Revised second paragraph, changed "footnote 2)" to "Note 2)." Revised "manufacturers" to "<u>manufacturer's</u>". Table 1: Revised Note 5), "<u>A signal rise/fall time between 200-500ns is required for the J1939-15 network. Signal rise/fall times closer to 500ns are preferred. Slower signal rise/fall times improve the electromagnetic compatibility of the network by reducing radiated emissions and radiated susceptibility.</u>" Section 5.1.4: Revised paragraph to clarify that: A) The J1939-15 circuits are the same at the J1939-11 circuits, B) Signal rise/fall time between 200-500ns is required for the J1939-15, C) The ECU CAN_SHLD terminal will not be connected to the J1939-15 network. Table 2: Revise note 3), "For environmental sealing applications, other cable <u>and component insulation diameters</u> may be available". Added TXL to note 4). Added table border lines for clarity. Revised wire insulation dia. to 2.03mm and cable dia. to 5.3 for the 0.8mm² conductor. Figure 1: Deleted the twisted bonded pair in the figure. Revised cable name to "Jacketed Un-shielded Twisted Pair". Section 5.2.1: Revised section, "The bus line consists of a CAN_H, and CAN_L <u>conductors</u>. The CAN_H <u>conductor wire</u> should be yellow in color while the CAN_L <u>conductor wire</u> should be green." Table 3: Revised Note 1, "<u>To maintain J1939-11 off-board diagnostic tool compatibility</u>, the cable stub length for the diagnostic connector is <u>2.66m maximum</u> for the vehicle, and <u>0.33m maximum</u> for the off-board diagnostic tool. The total stub length should not exceed 3m." Also, Added Note 2. Section 5.3: This section was revised to clarify the connector usage. Figure 3: Drawing was revised to clarify the connector usage. Section 5.3.2: This section was revised to clarify the connector usage. Appendix A: Revised paragraph to clarify that: A) The J1939-15 circuits are the same as the J1939-11 circuits, B) Signal rise/fall time between 200-500ns is required for the J1939-15, C) The ECU CAN_SHLD terminal will not be connected to the J1939-15 network. Added Figure 1-Example of Preferred Signal Rise/Fall Waveform. Appendix B: Revised "manufacturers" to "<u>manufacturer's</u>". Figure C2: Changed cable color from pink to gray. Table E1: Added "Same as J1939-11 or Different" column. Added the note, "<u>see Table 3, Note 2</u>" to the Conditions column for Parameter-Minimum Distance From R_L. Added "Jacketed" to the UTP in the Conditions column. Added Parameter-"Network Connections" row. Added Parameter-"ECU Physical Layer Circuit" row. Added Parameter-"ECU CAN_SHLD terminal" row. Added Parameter-"Signal Rise/Fall Time" row. Appendix F: Totally revised Appendix F to show recommended mixed physical layer networks.	K.Brown	5/99
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1. Scope

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.

The purpose of these documents is to provide an open interconnect system for electronic systems. It is the intention of these documents to allow electronic devices to communicate with each other by providing a standard architecture.

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. The latest issue of SAE publications shall apply.

2.1.1 SAE Publication

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1128—Low-Tension Primary Cable

SAE J1939-11—Physical Layer, 250K bits/sec, Twisted Shielded Pair

2.2 Related Publication

The following publication is provided for information purposes only and is not a required part of this document.

2.2.1 ISO Publication

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

ISO 11898—Road vehicles—Interchange of digital information—Controller Area Network (CAN) for high speed communication.

3. Network Physical Description

The J1939-15 physical layer has the same characteristics as the J1939-11 physical layer except as described in this document. It is the responsibility of the vehicle manufacturer to determine when the J1939-15 physical layer should be used versus the J1939-11 physical layer. Appendix E, Table E1 contains a comparison of J1939-15 characteristics versus 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. This maximum number of ECUs is fixed to 10, on a given segment, due to the definition of the electrical parameters given in the present specification.



3.2 Physical Media

This document defines a physical media of jacketed un-shielded twisted pair (UTP). These 2 wires have a characteristic impedance of 120 Ω 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 J1939-11 physical layer.

3.4 Bus Levels

Same as the J1939-11 physical layer.

3.5 Bus Levels During Arbitration

Same as the J1939-11 physical layer.

3.6 Common Mode Bus Voltage Range

Same as the J1939-11 physical layer.

3.7 Bus Termination

Same as the J1939-11 physical layer.

3.8 Internal Resistance

Same as the J1939-11 physical layer.

3.9 Differential Internal Resistance

Same as the J1939-11 physical layer.

3.10 Internal Capacitance

Same as the J1939-11 physical layer.

3.11 Differential Internal Capacitance

Same as the J1939-11 physical layer.

3.12 Bit Time

Same as the J1939-11 physical layer.

3.13 Internal Delay Time

Same as the J1939-11 physical layer.



3.14 CAN Bit Timing Requirements

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

The Signal Rise / Fall Time parameter has been included for clarity and to improve the Electromagnetic Compatibility (EMC) of the physical layer. The Signal Rise / Fall Time can be adjusted for the example discrete circuits per Table 1, Note 2). The Signal Rise / Fall Time can be adjusted for an integrated circuit by following the CAN transceiver manufacturer's instructions.

TABLE 1—AC PARAMETERS OF AN ECU DISCONNECTED FROM THE BUS LINE

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Bit time ¹⁾	t_B	3.998	4.000	4.002	μs	250 Kbit/s
Internal Delay Time ²⁾	t_{ECU}	0.0		0.9	μs	
Internal Capacitance ³⁾	C_{in}	0	50	100	pF	250 Kbit/s for CAN_H and CAN_L relative to Ground
Differential Internal Capacitance ³⁾	C_{diff}	0	25	50	pF	
Available Time ⁴⁾	t_{avail}	2.5			μs	40 m bus length
Signal Rise, Fall Time ⁵⁾	t_R, t_F	200		500	ns	measured from 10% to 90% of the signal

¹⁾ Including initial tolerance, temperature, aging, etc.

²⁾ See J1939-11 for note.

³⁾ See J1939-11 for note.

⁴⁾ See J1939-11 for note.

⁵⁾ A signal rise/fall time between 200-500ns is required for the J1939-15 network. Signal rise/fall times closer to 500ns are preferred. Slower signal rise/fall times improve the electromagnetic compatibility of the network by reducing radiated emissions and radiated susceptibility. The load on the ECU for the purpose of this parameter should be 60 ohms between CAN_H and CAN_L in parallel with 200 pf of capacitance (see Appendix A).

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4. Functional Description

Same as the J1939-11 physical layer.

5. Electrical Specification

5.1 Electrical Data

The parameter specifications in Tables 1 through 10 of J1939-11, must be fulfilled throughout the operating temperature range of every ECU. These parameters allow up to a maximum of 10 ECUs to be connected to a given bus segment.

5.1.1 Electronic Control Unit

Same as the J1939-11 physical layer.

5.1.1.1 Absolute Maximum Ratings

Same as the J1939-11 physical layer.

5.1.1.2 DC Parameters

Same as the J1939-11 physical layer.

5.1.1.3 AC Parameters

Same as the J1939-11 physical layer.

5.1.2 Bus Voltages - Operational

The parameters specified in Table 5 and Table 6 of J1939-11, apply when all ECUs (between 2 and 10) are connected to a correctly terminated bus line. The maximum allowable ground offset between any ECUs on the bus is 2 Volts. The voltage extremes associated with this offset would occur in the dominant state (see Table 6 in J1939-11).

5.1.3 Electrostatic Discharge (ESD)

Same as the J1939-11 physical layer.

5.1.4 Example Physical Layer Circuits

There are many possible discrete and integrated ECU physical layer circuits which meet the previous requirements. The J1939-15 ECU physical layer circuits are the same as the J1939-11 ECU physical layer circuits. The J1939-15 ECU physical layer circuits are required to be adjusted, so the signal rise/fall time is between 200-500ns to improve the J1939-15 network Electromagnetic Compatibility. See Appendix A, Figure A1 for the preferred signal rise and signal fall waveforms.

The J1939-15 network (backbone and stubs) will not be connected to the CAN_SHLD terminal on the ECU physical layer circuit.

Discrete examples of the physical layer circuit are shown in J1939-11, Appendix A. J1939 physical layer integrated CAN Transceiver products are also available from semiconductor manufacturers.

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5.2 Physical Media Parameters

The following sections describe the characteristics of the cable, termination, and topology of the network. (See Table 2)

TABLE 2—PHYSICAL MEDIA PARAMETERS FOR UN-SHIELDED TWISTED PAIR CABLE

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Impedance	Z	108	120	132	Ω	Three meter sample length measured at 1 Mhz between the two signal wires, using open/short method.
Specific Resistance	r_b	0	25	50	m Ω /m	1) measured at 20 °C
Specific Line Delay	t_p		5.0		ns/m	2)
Specific Capacitance	c_b	0	40	75	pF/m	
<u>Cable size</u>						3)
0.5mm ² Conductor (20 AWG)	a_c	0.508			mm ²	4) (see Figure 1)
Wire insulation dia.	d_{ci}	1.90		2.8	mm	
Cable diameter	d_c	5.08		7.6	mm	
0.8mm ² Conductor (18 AWG)	a_c	0.760			mm ²	4) (see Figure 1)
Wire insulation dia.	d_{ci}	2.03		3.05	mm	
Cable diameter	d_c	5.3		8.2	mm	
Temperature Range	°C	-40		+125	deg C	5)
Lay Length		28	33	38	mm	0.67 to 0.91 twist per 25.4mm
Cable Bend Radius	r	4x dia. of cable			mm	90 degree bend radius without cable performance or physical degradation. (see Figure 1)

- 1) The differential voltage on the bus line seen by a receiving ECU depends on the line resistance between it and the transmitting ECU. Therefore, the total resistance of the signal wires is limited by the bus level of the parameters of each ECU.
- 2) The minimum delay time between two points of the bus line may be zero. The maximum value is determined by the bit time and the delay times of the transmitting and receiving circuitry.
- 3) For environmental sealing applications, other cable and component insulation diameters may be available. Design engineers should ensure compatibility between cables, connectors and contacts.
- 4) Meet performance requirements of SAE J1128 for types TXL, GXL, or SXL.

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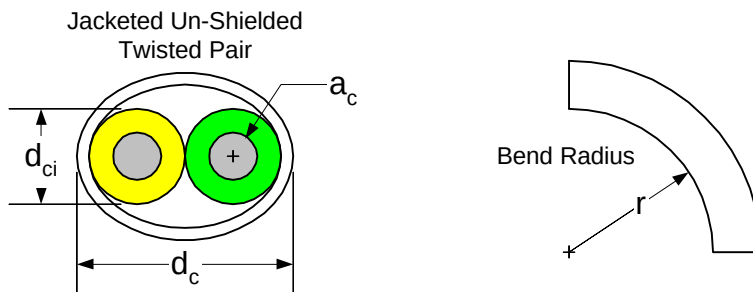


FIGURE 1—CABLE CROSS-SECTION AND BEND RADIUS

5.2.1 Bus Line

The bus line consists of a CAN_H, and CAN_L conductors. The CAN_H conductor wire should be yellow in color while the CAN_L conductor wire should be green. In addition, the cable must meet the following minimum requirements.

5.2.2 Topology

The wiring topology of this network should be as close as possible to a linear structure in order to avoid cable reflections. In practice, it may be necessary to connect short cable stubs to a main backbone cable, as shown in Figure 2. To minimize standing waves, nodes should not be equally spaced on the network and cable stub lengths, dimension S in Figure 2, should not all be the same length. The dimensional requirements of the network are shown in Table 3.

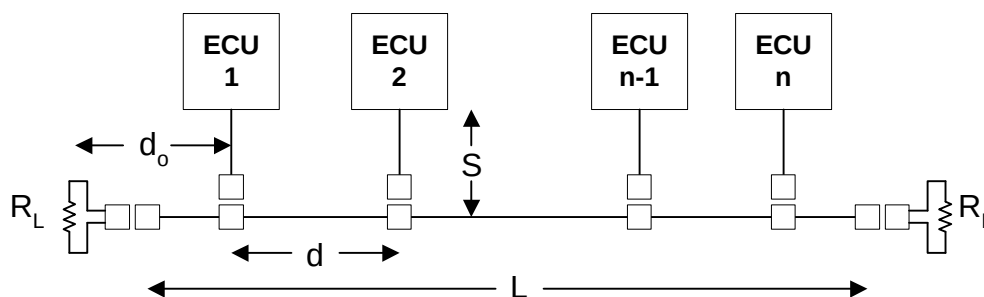


FIGURE 2—WIRING NETWORK TOPOLOGY

TABLE 3—NETWORK TOPOLOGY PARAMETERS

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Bus Length	L	0		40	m	not including cable stubs
Cable Stub Length	S	0		3	m	Note 1
Node Distance	d	0.1		40	m	
Minimum Distance from R_L	d_0	0			m	Note 2

Note 1: To maintain J1939-11 off-board diagnostic tool compatibility, the cable stub length for the diagnostic connector is 2.66m maximum for the vehicle, and 0.33m maximum for the off-board diagnostic tool. The total stub length should not exceed 3m.

Note 2: The topology of the network must be maintained. This may be done by installing terminating resistors (R_L) at each end of the network backbone where such a resistor can either be discrete or installed in an ECU (node).

A discrete resistor provides additional flexibility in defining the network topology and is preferred in most cases.

A resistor within one or two ECUs may be more economical where the topology and the ECUs that contain R_L are under the control of the vehicle manufacturer.

5.2.3 Terminating Resistor

Same as the J1939-11 physical layer.

5.3 Connector Specifications

The type of connector is not specified for implementing the J1939-15 network and a “standard” connector is not required. An ECU may be connected to the network with either a hard splice or connector. If a connector is used, the connector shall meet the Connector Electrical Performance Requirements in J1939-11. If the three-way connector described in the J1939-11 document is installed on the J1939-15 network, the drain wire CAN_SHLD terminal will not be used and a sealing plug will be installed.

It is the responsibility of the vehicle manufacturer to design the network with different keying structures to eliminate the possibility of connecting the network in a method that would be detrimental to proper communications. The connectors shall provide for the electrical connections of CAN_H and CAN_L conductor wires.

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A J1939-11 compliant ECU may require a three-way connector described in the J1939-11 document for connecting onto the J1939-15 network. If the three-way connector is required, the mating connector will not contain the drain wire CAN_SHLD terminal and a sealing plug will be installed. Figure 3 shows some examples of the J1939-11 three-way connector concept used in a J1939-15 network. The J1939-11 connector used to connect the ECU to the 'backbone' of the network is called the 'Stub Connector' and is designated "A" in Figure 3. The J1939-11 connector used to connect the termination resistor to the ends of the backbone cable is called the 'Through Connector' and is designated "B" in Figure 3. ECU 1 in Figure 3 is installed onto the J1939-15 'backbone' using a splice. ECU 2 in Figure 3 is installed onto the J1939-15 'backbone' using a two-way connector concept. ECU 3 in Figure 3 is installed onto the J1939-15 'backbone' using a J1939-11 three-way connector concept including a terminating resistor.

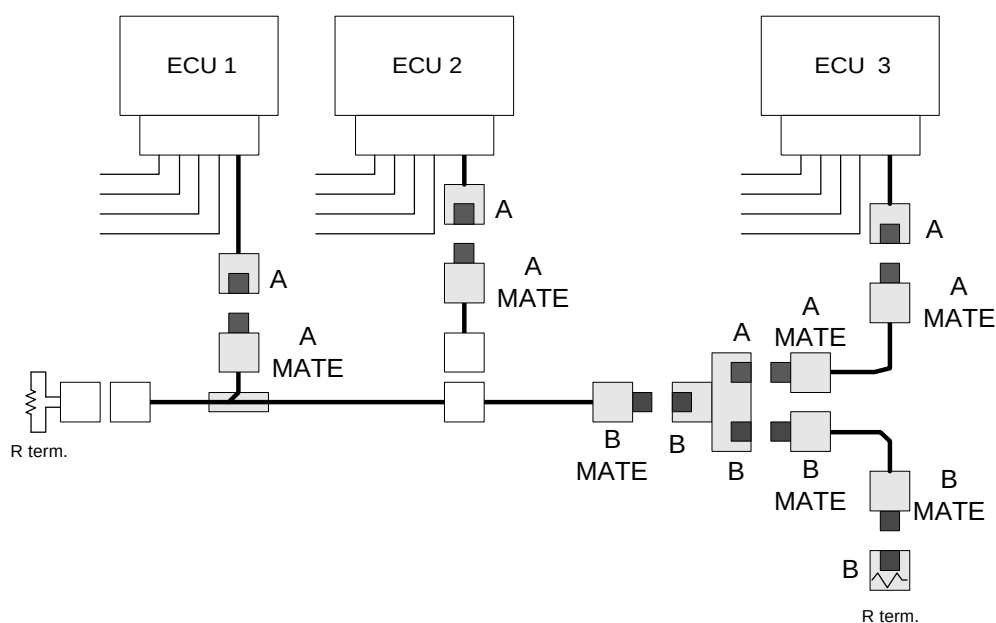


FIGURE 3—AN EXAMPLE OF J1939-11 CONNECTOR USAGE IN A J1939-15 NETWORK

5.3.1 Connector Electrical Performance Requirements

Same as the J1939-11 physical layer.

5.3.2 Connector Mechanical Requirements

When connectors are used in a cable network, the connectors should have locking, polarizing, and retention devices that meet the requirements of the specific application. These connectors should also incorporate environmental protection appropriate for the application.

6. Conformance Tests

Same as the J1939-11 physical layer.

6.1 Recessive Output of the ECUs

Same as the J1939-11 physical layer.

6.2 Internal Resistance of CAN_H and CAN_L

Same as the J1939-11 physical layer.

6.3 Internal Differential Resistance

Same as the J1939-11 physical layer.

6.4 Recessive Input Threshold of an ECU

Same as the J1939-11 physical layer.

6.5 Dominant Output of an ECU

Same as the J1939-11 physical layer.

6.6 Dominant Input Threshold of an ECU

Same as the J1939-11 physical layer.

6.7 Internal Delay Time

Same as the J1939-11 physical layer.

7. Discussion of Bus Faults

Same as the J1939-11 physical layer.

7.1 Loss of Connection to Network

Same as the J1939-11 physical layer.

7.2 Node Power or Ground Loss

Same as the J1939-11 physical layer.

7.3 Unconnected Shield

Not Applicable to the J1939-15 physical layer.

7.4 Open and Short Failures

Same as the J1939-11 physical layer.



APPENDIX A

EXAMPLE PHYSICAL LAYER CIRCUITS

There are many possible discrete and integrated ECU physical layer circuits which meet the previous requirements. The J1939-15 ECU physical layer circuits are the same as the J1939-11 ECU physical layer circuits. The J1939-15 ECU physical layer circuits are required to be adjusted, so the signal rise/fall time is between 200-500ns to improve the J1939-15 network Electromagnetic Compatibility. See Figure A1 for the preferred signal rise and signal fall waveforms.

The J1939-15 network (backbone and stubs) will not be connected to the CAN_SHLD terminal on the ECU physical layer circuit.

Discrete examples of the physical layer circuit are shown in J1939-11, Appendix A. J1939 physical layer integrated CAN Transceiver products are also available from semiconductor manufacturers.

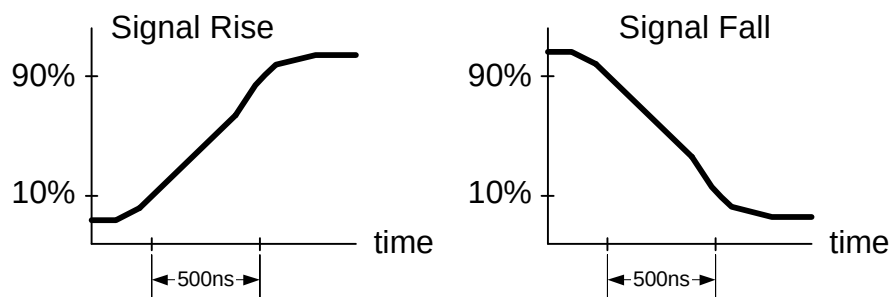


FIGURE A1—EXAMPLE OF PREFERRED SIGNAL RISE/FALL WAVEFORMS

APPENDIX B

RECOMMENDED CABLE TERMINATION PROCEDURE

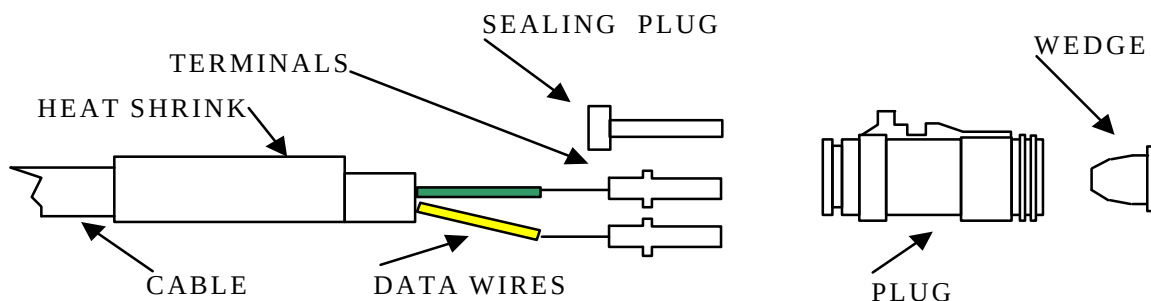


FIGURE B1—CABLE TERMINATION 3 CAVITY CONNECTOR

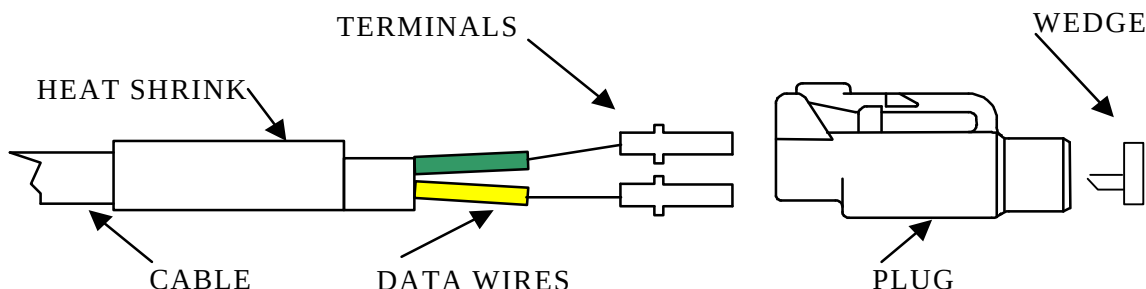


FIGURE B2—CABLE TERMINATION OF A TYPICAL 2 CAVITY CONNECTOR

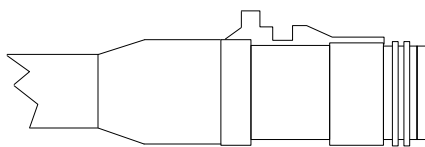


FIGURE B3—TYPICAL FINISHED ASSEMBLY

1. Install sealing plug in un-used cavity of connector if it is a 3 pin (not required for 2 pin) type.
2. Remove cable outer jacket approximately 40-100 mm.
3. Strip insulation from wires $7 \text{ mm} \pm 0.8 \text{ mm}$.
4. Crimp a terminal on each wire per manufacturer's recommendation.
5. Slide adhesive-lined heat-shrinkable tubing onto the cable.
6. Install terminals into connector body per manufacturer's instructions. Isopropyl alcohol may be used to aid in assembly.
7. To maintain cable twisting, install the adhesive-lined heat-shrinkable tubing over the assembly and per manufacturer's recommendation. Cable twisting must begin at least 50 mm from the maximum distance between the wires, over the untwisted length, is 3 mm. Wedge in front of connector body per manufacturer's instructions.

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APPENDIX C

RECOMMENDED CABLE SPLICE PROCEDURE

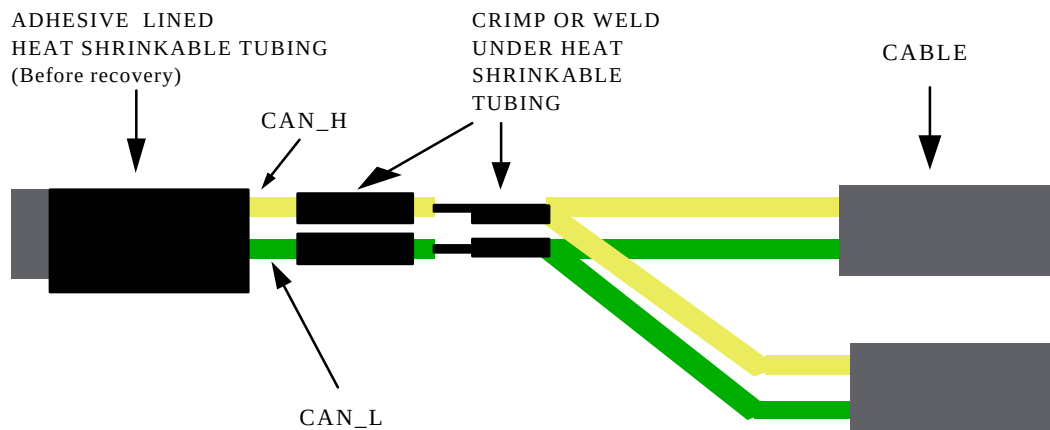


FIGURE C1 - CABLE SPLICE

1. Cut the end of the cable cleanly. Measure back approximately 40-100 mm and mark the cable jacket. Remove this section of cable jacket.
2. Remove $7\text{ mm} \pm 0.8\text{ mm}$ of insulation on the data wire CAN-H.
3. Measure back approximately 21 mm on data wire CAN-L and cut it. Remove $7\text{ mm} \pm 0.8\text{ mm}$ of insulation on this wire.
4. Repeat steps 1 through 3 for the other two cables that will be spliced, but **Replace** CAN-H with CAN-L in step 2, and **Replace** CAN-L with CAN-H in step 3. (The overall length of the assembly is minimized by offsetting the crimps or welds)
5. Slide the two pieces of insulating heat-shrinkable tubing over the CAN-H and CAN-L data wires.
6. Slide the one piece of adhesive-lined heat-shrinkable tubing onto the cable.
7. Crimp, or weld, the three CAN-H data wires together, and the three CAN-L data wires together.
8. Solder the connections if desired.
9. Center the insulating heat-shrinkable tubing over the two crimped or welded data wires.
10. Center the adhesive-lined heat-shrinkable tubing over the assembly and apply per manufacturer's recommendation.



FIGURE C2 - SEALED CABLE SPLICE-FINISHED ASSEMBLY

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APPENDIX D

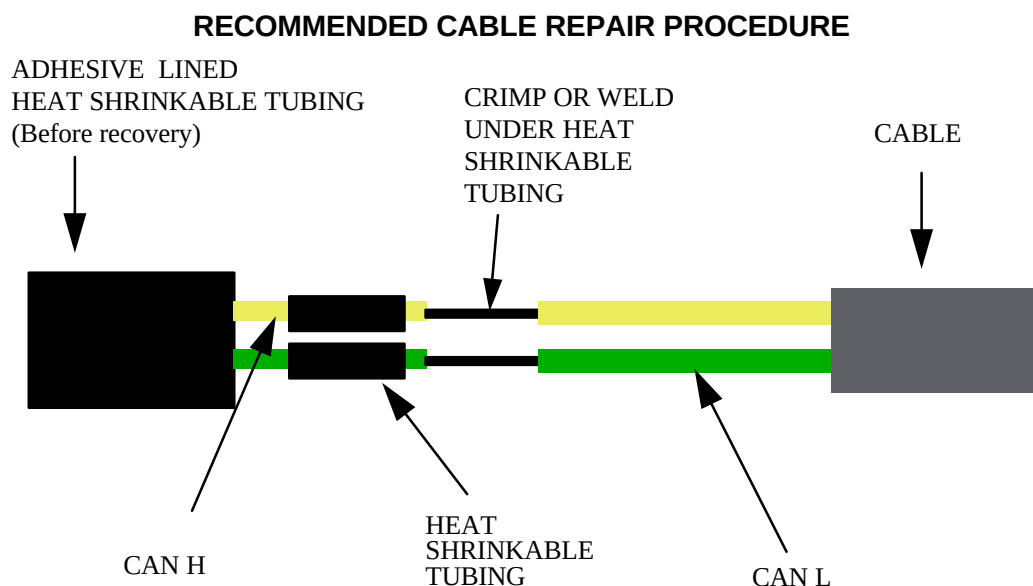


FIGURE D1 - CABLE SPLICE

- A. Cut the end of the cables cleanly. Measure back approximately 40-100 mm and mark the cable jacket. Remove this section of cable jacket.
- B. Strip the insulation of both data wires back $7 \text{ mm} \pm 0.8 \text{ mm}$.
- C. Repeat this procedure for the other cable.
- D. Install one end of a crimp on each of the data wires, on either cable.
- E. Slide the (2) pieces of insulating heat-shrinkable tubing over the crimps and onto the data wires.
- F. Slide the (1) piece of adhesive-lined heat-shrinkable tubing onto the cable.
- G. Insert the wires from the other cable into the appropriate crimp and install the crimp, maintaining polarity (CAN-H, CAN-L).
- H. Center the insulating heat-shrinkable tubing over the two crimps and install the tubing per the manufacturer's recommendation.
- I. Center the adhesive-lined heat-shrinkable tubing over the assembly and apply per manufacturer's recommendation.



FIGURE D2 - CABLE SPLICE-FINISHED ASSEMBLY

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APPENDIX E

Comparison of the J1939-15 versus the J1939-11 Physical Layer

TABLE E1—Comparison J1939-15 vs J1939-11

Parameter	Network	Min	Max	Units	Conditions	Same as J1939-11 or Different
Bus Length	J1939-15 J1939-11	0 0	40 40	m m	not including cable stubs	Same
Cable Stub Length	J1939-15 J1939-11	0 0	3 1	m m		Different
Node Distance	J1939-15 J1939-11	0.1 0.1	40 40	m m		Same
Minimum Distance from R _L	J1939-15 J1939-11	0 0		m m	See Table 3, Note 2.	Different
Number of Nodes	J1939-15 J1939-11		10 30			Different
Physical Media	J1939-15 J1939-11				Jacketed Un-shielded Twisted Pair (UTP) Shielded Twisted Pair (STP)	Different
Network Connections	J1939-15 J1939-11				Connector must meet requirements in sections 5.3, 5.3.1, and 5.3.2 Required 3-way connector concept	Different
ECU Physical Layer Circuit	J1939-15 J1939-11					Same
ECU CAN_SHLD Terminal	J1939-15 J1939-11				Not connected to network Connected to network drain wire	Different
Signal Rise/Fall Time	J1939-15 J1939-11				200-500ns Required 200-500ns Recommended	Different

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APPENDIX F

J1939-11 Compliant Tools and ECUs Used With the J1939-15 Network

A mixed physical layer can occur when either a J1939-11 compliant diagnostic tool or a J1939-11 compliant ECU (with pigtail cable) is connected to the J1939-15 network. The following figures show the recommended mixed physical layer configurations. Figure F1 shows a typical mixed physical layer configuration of a J1939-11 compliant diagnostic tool connected to the J1939-15 network. Figure F2 shows a typical mixed physical layer configuration of a J1939-11 compliant ECU (using a J1939-11 pigtail and 3-way connector) connected to the J1939-15 network. The J1939-11 part of the connection will contain a CAN_SHLD terminal and drain wire, but the J1939-15 mating part of the network will not contain a CAN_SHLD terminal or drain wire.

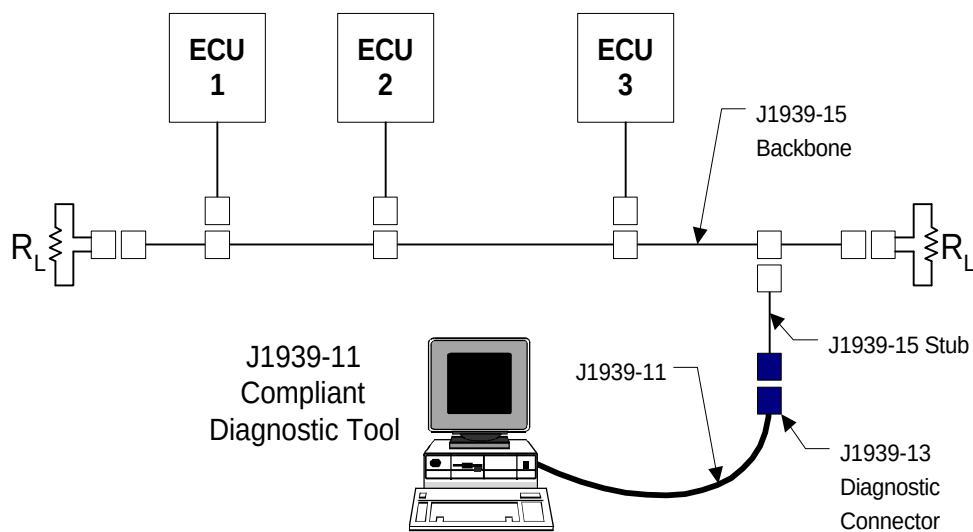
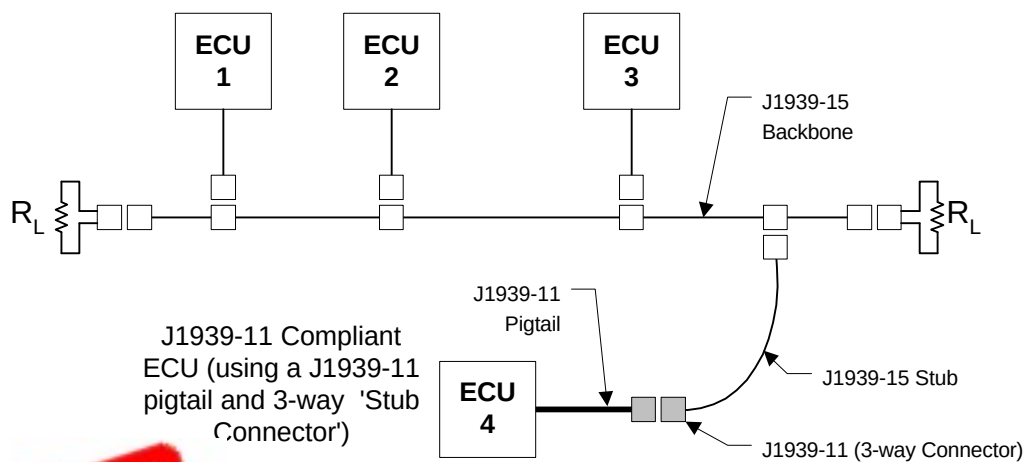


FIGURE F1—J1939-11 Tool Connected to the J1939-15 Network



J1939-11 pigtail and 3-Way Connector) Connected to the J1939-15 Network

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SAE J1939-15 Revised MAY99

Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—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.

The purpose of these documents is to provide an open interconnect system for electronic systems. It is the intention of these documents to allow electronic devices to communicate with each other by providing a standard architecture.

Reference Section

SAE J1128—Low-Tension Primary Cable

SAE J1939-11—Physical Layer, 250K bits/sec, Twisted Shielded Pair

ISO 11898—Road vehicles—Interchange of digital information—Controller Area Network (CAN) for high speed communication.

Developed by the SAE Truck and Bus Control and Communications Network Subcommittee

Sponsored by the SAE Truck and Bus Electrical and Electronics Committee

