SURFACE VEHICLE STANDARD

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Un-Shielded Balanced Single Twisted Pair Ethernet Cable

RATIONALE

This document has been cancelled because it is superseded by SAE J3117/1.

CANCELLATION NOTICE

This technical report has been declared “CANCELLED” as of July 2023 and has been superseded by SAE J3117/1. By this action, this document will remain listed in the respective index, if applicable. Cancelled technical reports are available from SAE.

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1. SCOPE

This document covers un-shielded balanced single twisted pair data cable intended for use in surface vehicle cables for 100 Mbps Ethernet applications. The tests in this document are intended to qualify cables for normal operation in an automotive environment while maintaining the necessary electrical properties for reliable data transmission.

1.1 Application

The 100 Mbps cable is used for 100BASE-T1 Ethernet PHY applications.

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 J1678 Low Voltage Ultra Thin Wall Primary Cable

SAE EA-1128 Wire Color Charts

2.1.2 ISO Publications

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

ISO 6722-1 Road Vehicles - 60 V and 600 V Single Core Cables - Test methods, dimensions and requirements.

ISO 14572 Road vehicles - Round, sheathed, 60 V and 600 V screened and unscreened single - or multi-core cables - Test methods and requirements for basic- and high-performance cables

2.1.3 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE 802.3bw 100BASE-T1

2.1.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B5423 Standard Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

ASTM B5374 Standard Test Methods for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

2.2 General References

Available from OPEN ALLIANCE website. www.opensig.org

OPEN ALLIANCE Definitions for Communication Channel (Version 2.0)

3. TERMS & DEFINITIONS

For the purposes of this document, the following terms and definitions apply.

3.1 CROSSTALK

A measurement of the unwanted signal transmitted from one aggressor circuit or channel of a transmission system to the victim circuit or channel (for two or more channels in the same bundle).

3.2 IMPEDANCE (Z)

The total opposition to alternating current by an electric circuit, equal to the square root of the sum of the squares of the resistance and reactance of the circuit and usually expressed in ohms, denoted as: Z.

3.3 INSERTION LOSS (ATTENUATION)

The loss of signal power resulting from the insertion of a device in a transmission line and is usually expressed in decibels (dB). This is the s-parameter defined as Sdd_{21} or Sdd_{12}.

3.4 J-UTP

Jacketed (sheathed) Un-shielded Twisted Pair

3.5 LCL, LONGITUDINAL CONVERSION LOSS

A ratio, expressed in decibels (dB), of the differential mode (DM) signal applied between the wires in a pair and the resulting common mode (CM) noise signal reflected at the same end. This is the s-parameter defined as Sdc_{11} and Sdc_{22}.

3.6 LCTL, LONGITUDINAL CONVERSION TRANSMISSION LOSS

A ratio, expressed in decibels (dB), of the differential mode (DM) signal applied between the wires in a pair and the resulting common mode (CM) noise signal transmitted from one end to the other end.
This is the s-parameter defined as Sdc_{21} and Sdc_{12}.

3.7 LOW VOLTAGE (LOW TENSION)

Usually considered to be ≤ 60 V DC (25 V AC).

3.8 MINIMUM WALL (THICKNESS)

The lowest allowable insulation thickness at any point.

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3.9 NOMINAL

A suitable approximate value used to designate or identify a component.

3.10 PHY

Abbreviation for the physical layer device. A PHY connects a link layer device to a physical medium such as a copper cable or optical fiber. A PHY chip (PHYceiver) is commonly found on Ethernet devices. Its purpose is to provide analog signal physical access to the link.

3.11 RETURN LOSS

A ratio expressed in decibels (dB) of the power of the outgoing signal to the power of the reflected or returned signal. This is the s-parameter defined as Sdd_{11} and Sdd_{22}.

3.12 S-PARAMETER

Single channel characteristics (port 1,2)		
RL	S_{dd11}, S_{dd22}	Return Loss (differential mode)
IL	S_{dd21}	Insertion Loss (differential mode)
LCL	S_{dc11}, S_{dc22}	Longitudinal Conversion Loss
LCTL	S_{dc12}, S_{dc21}	Longitudinal Conversion Transmission Loss

3.13 TCR, TEMPERATURE CLASS RATING

A class designation based on the long term heat aging (3000 hour) test.

3.14 UTP

Unshielded Twisted Pair

3.15 WCC

Whole communication channel is the complete electrical wire connection between two ECUs.

4. GENERAL

4.1 Classification

4.1.1 Temperature Classes. Four cable classes have been defined in Figure 1 to respond to the various temperatures encountered on vehicles.

Class	Operating Temperature	Equivalent to Temperature Class
A	-40 °C to +85 °C	T1
B	-40 °C to +100 °C	T2
C	-40 °C to +125 °C	T3
D	-40 °C to +150 °C	T4

Figure 1 - Temperature class

4.2 General Test Conditions

Test samples shall be preconditioned for at least 16 hours at a room temperature of 23 °C ± 3 °C. Unless otherwise specified, all tests shall be conducted at this same temperature. All samples shall pass. In the case where the test result is based on an average, the average shall meet the requirement.

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4.3 Ovens

Unless otherwise specified, when an oven is required, it shall be a hot air oven in accordance with ASTM D5374 and D5423. The air contained in the oven shall be completely changed at least 8 times but not more than 20 times per hour at the specified temperature.

4.4 Tolerances

Unless otherwise specified, all values are considered to be approximate.

4.5 Representative Conductor Sizes for Testing

When a test is required, all combinations of conductor size, wall thickness, and insulation formulation shall meet the appropriate requirements.

5. GENERAL SPECIFICATIONS

The finished cable shall meet the requirements for all tests specified in Figure 2 – General Specifications for each cable type.

Clause	Description	Initial tests	Periodic tests(4)
5	GENERAL SPECIFICATIONS		
5.1	Cable Types		
5.1.1	Single Core ISO cable	X(1)	
5.1.2	Single Core SAE cable	X(1)	
5.1.3	Outer Jacket (Sheath)	X(2)	
5.2	Construction	X	X
5.3	Ovality of Jacket (Sheath)	X(2)	X(2)
5.4	Electrical Performance	X	X
5.4.2	Characteristic Impedance	X	X
5.4.3	Insertion Loss	X	X
5.4.4	Return Loss	X	X
5.4.5	Conversion Loss	X	X
Annex B	Communication Channel Performance	X(3)	
Annex C	Alien Crosstalk	X(3)	

Notes:
1. Test the individual core cable to either the ISO 6722-1 or SAE J1678.
2. The usage of this test is established by agreement between customer and supplier.
3. This requirement is established between customer and supplier. Testing on heat aged samples are not required.
4. Electrical performance testing is not required on heat aged samples for Periodic Testing.

Figure 2 - General specifications

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5.1 Cable Types

Each insulated conductor (of the UTP or J-UTP) shall meet the test and performance requirements of the following sections in ISO 6722-1 (2011) or SAE J1678 (2015). (Performance requirements include electrical, mechanical, and environmental requirements)

5.1.1 Single Core ISO cable

The cable shall meet ISO 6722-1 (2011): Section 5.5 ~ 5.22.

5.1.2 Single Core SAE cable

The cable shall meet SAE J1678 (2015): Section 6.3 ~ 6.16

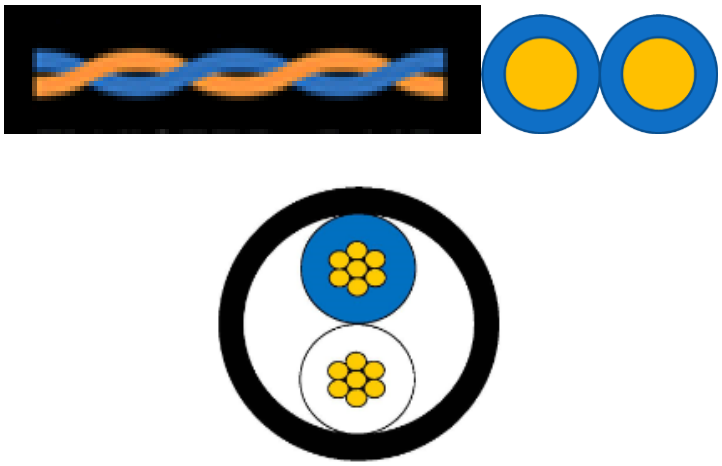

Figure 3 - Un-shielded balanced single twisted pair ethernet cable

5.1.3 Outer Jacket (Sheath)

For the outer jacket (sheath) of the J-UTP cable, the test and requirements shall be according to ISO 14572 (2011) Sections 5.5 and 5.7 – 5.21.

5.2 Construction

The construction of the Ethernet Cable (UTP and J-UTP) will be according to Figure 4 below.

				UTP		J-UTP		
SAE J1678 Size	ISO 6722-1 Size	Stranding	Conductor OD (Max)	Insulated Conductor OD[1]		Insulated Conductor OD[1]		Jacket OD[2]
(SAE No.)	(mm^2)		(mm)	Min (mm)	Max (mm)	Min (mm)	Max (mm)	Max (mm)
26	0.13	7	0.55	0.76	0.91	0.8	0.95	3.5
24	0.22	7	0.70	0.95	1.05	1.05	1.2	3.5
22	0.35	7	0.90	1.2	1.4	1.3	1.5	4.5
20	0.5	19	1.1	1.35	1.6	1.55	1.78	5.0

NOTE 1: Insulated Conductor OD (for each core of the twisted pair)

NOTE 2: The requirement for the J-UTP is based on a round cable.

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Figure 4 - Ethernet cable construction

5.3 Ovality of Jacket (Sheath)

The usage of this test is established by agreement between customer and supplier.

5.3.1 Test

For a jacketed (sheathed) cable, the test and requirements shall be according to ISO 14572 (2011), Section 5.2 “Ovality of Sheath”.

5.3.2 Requirement

The maximum allowable “out of round” shall be 20%.

5.4 Electrical Performance

Testing of the cable's electrical performance shall be follows:

- Initial test of "as received" sample
- Test after long term 3000 hour heat aging at TCR
- Test after short term 240 hour heat aging at TCR + 25 °C

The electrical performance tests can be done on a single sample or different samples from the same lot of twisted pair cable. The oven or test chamber does not have to meet the air exchange of 4.3.

5.4.1 Test Temperature

Initial Test on as received sample	Test Temperature	Test Temperature*	Test Temperature*
Impedance	23 °C	-40 °C	TCR
IL	23 °C	-40 °C	TCR
RL	23 °C	-40 °C	TCR
LCL and LCTL	23 °C	-40 °C	TCR

NOTE*: Condition the sample for at least 30 minutes at the test temperature.

Figure 5 - Test temperature for Initial "as received" sample

After 3000 hours heat aging	Test Temperature
Impedance	23 °C
IL	23 °C
RL	23 °C
LCL and LCTL	23 °C

Figure 6 - Test temperature after 3000 hour heat aging

After 240 hours heat aging	Test Temperature
Impedance	23 °C
IL	23 °C
RL	23 °C
LCL and LCTL	23 °C

Figure 7 - Test temperature after 240 hours heat aging

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5.4.2 Characteristic Impedance

5.4.2.1 Test

Test per OPEN Alliance "Definitions for Communication Channel (Version 2.0)" document.
When testing at temperature extremes (-40 °C & TCR), the sample shall be conditioned for 30 minutes at that temperature prior to testing.

5.4.2.2 Requirement

The characteristic impedance shall be within the limit of Figure 8.

Parameter	Symbol	Minimum (ohm)	Nominal (ohm)	Maximum (ohm)
Impedance	Z	90	100	110

Figure 8 - Characteristic impedance

5.4.3 Insertion Loss (IL)

Test per OPEN Alliance “Definitions for Communication Channel (Version 2.0)” document.
When testing at temperature extremes (-40 °C & TCR), the sample shall be conditioned for 30 minutes at that temperature prior to testing.

5.4.3.1 The requirement is shown in Figure 9.

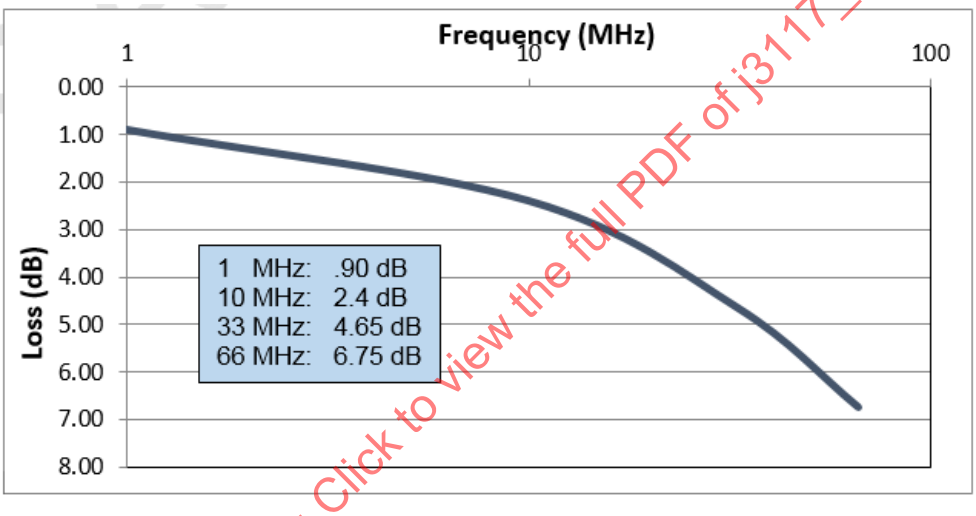

Figure 9 - Insertion loss requirement

5.4.4 Return Loss (RL)

Test perOPEN Alliance “Definitions for Communication Channel (Version 2.0)” document.
When testing at temperature extremes (-40 °C & TCR), the sample shall be conditioned for 30 minutes at that temperature prior to testing.

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5.4.4.1 The requirement is shown in Figure 10.

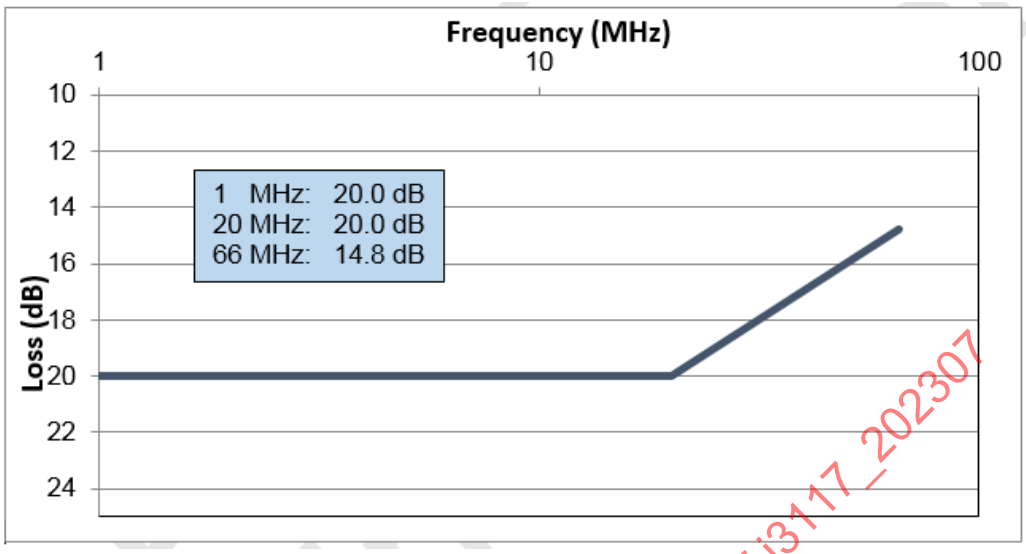

Figure 10 - Return loss requirement

5.4.5 Conversion Loss (LCL and LCTL)

Test per OPEN Alliance “Definitions for Communication Channel (Version 2.0)” document.
When testing at temperature extremes (-40 °C & TCR), the sample shall be conditioned for 30 minutes at that temperature prior to testing.

5.4.5.1 The requirement is shown in Figure 11.

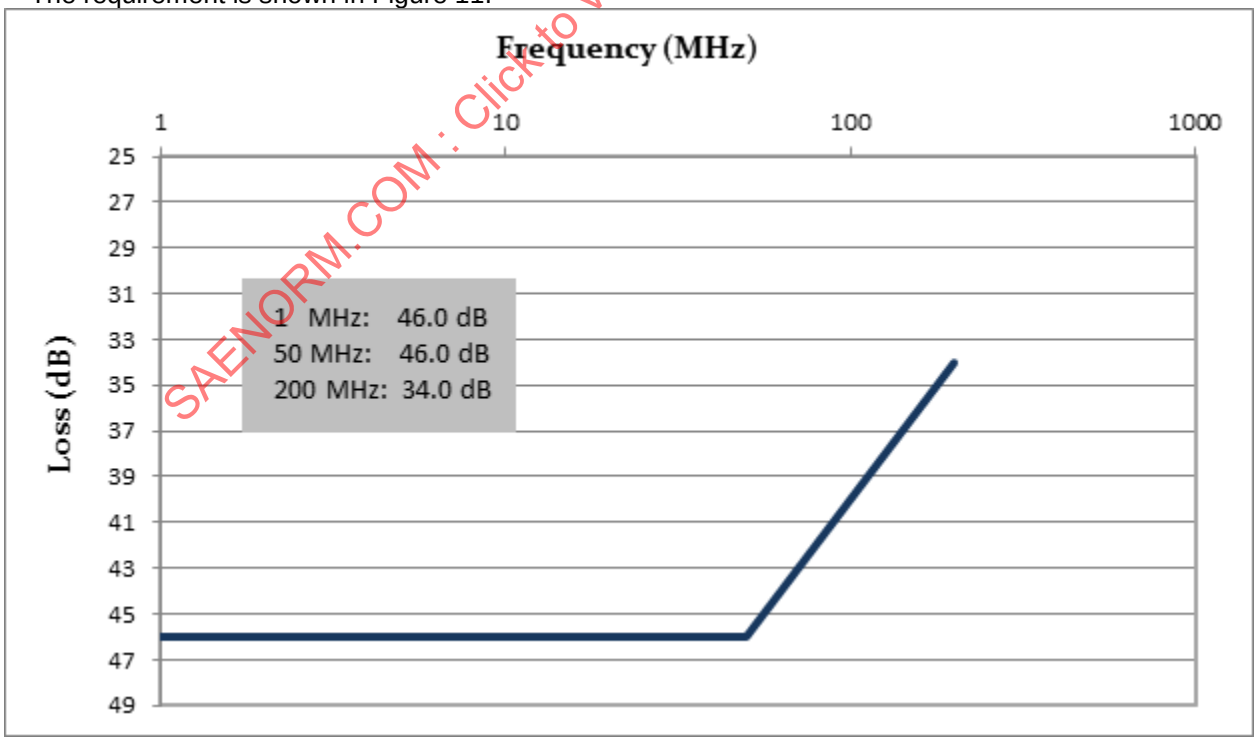

Figure 11 - Conversion loss requirement (LCL and LCTL)

Appendicies A, B, C *are informative references, where the usages or applications are agreed between customer and supplier.*

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6. NOTES

6.1 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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