



AEROSPACE STANDARD

AS5643™/1**REV. A**Issued 2004-12
Revised 2019-07

Superseding AS5643/1

(R) S400 Copper Media Interface Characteristics Over Extended Distances

RATIONALE

AS5643/1A was updated to incorporate lessons learned during manufacturing, production, and flight test.

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose.....	3
1.2	Application.....	3
1.3	Interpretation.....	3
2.	REFERENCES.....	3
2.1	Applicable Documents.....	3
2.1.1	SAE Publications.....	3
2.1.2	U.S. Government Publications.....	4
2.1.3	IEEE Publications.....	4
2.2	Acronyms and Definitions.....	4
3.	IEEE-1394-2008 BETA PHYSICAL LAYER REQUIREMENTS, S400 COPPER MEDIA.....	5
3.1	Cable Assembly Requirements.....	5
3.1.1	Cable Wire Configuration.....	5
3.1.2	Cable Interconnects Performance.....	6
3.2	Bus Isolation.....	6
3.2.1	Link Termination.....	6
3.3	Link Signal Specification.....	7
4.	APPLICATION CABLE TERMINATION OPTIONS.....	9
4.1	MIL-DTL-38999.....	9
4.1.1	MIL-DTL-38999, Shell Size A.....	9
4.1.2	MIL-DTL-38999, Shell Size B.....	10
4.1.3	MIL-DTL-38999, Shell Size C.....	12
5.	NOTES.....	19
5.1	Revision Indicator.....	19

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2019 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE AS5643_1A

SAE values your input. To provide feedback
on this Technical Report, please visit
<http://standards.sae.org/AS5643/1A>

Documents

Document Sharing Hub

Figure 1	Example link termination with transformer bus isolation	7
Figure 2	Link measurement points (half connection is shown)	7
Figure 3	Connector pin-out, MIL-DTL-38999 Series 3 shell size A (9)	10
Figure 4	Connector pin-out, MIL-DTL-38999 Series 3 shell size A (9) with alternate quad aligned contact assignments	10
Figure 5	Connector pin-out, MIL-DTL-38999 Series 3 shell size B (11)	11
Figure 6	Connector pin-out, MIL-DTL-38999 Series 3 shell size B (11) with alternate quad aligned contact assignments	12
Figure 7	Connector pin-out, MIL-DTL-38999 Series 3 shell size C (13)	13
Figure 8	Connector pin-out, MIL-DTL-38999 Series 3 shell size C (13) with alternate quad aligned contact assignments	14
Figure 9	Example cable termination method for MIL-DTL-38999 Series 3 connector with A (9), B (11), and C (13) Shell Sizes	15
Figure 10	Strip back cable	17
Figure 11	Attached braidsock and ferrule	18
Figure 12	Place star hub	18
Figure 13	Complete cable assembly	19
Table 1	Cable assembly requirements	5
Table 2	Link signal transmitter characteristics (TP2)	8
Table 3	Link signal receiver characteristics (TP3)	9

1. SCOPE

This SAE Aerospace Standard (AS) establishes guidelines for the use of IEEE-1394-2008 Beta (formerly IEEE-1394b) as a data bus network in military and aerospace vehicles. It encompasses the data bus cable and its interface electronics for a system utilizing S400 over copper medium over extended lengths. This document contains extensions/restrictions to “off-the-shelf” IEEE-1394 standards, and assumes that the reader already has a working knowledge of IEEE-1394.

This document does not identify specific environmental requirements (electromagnetic compatibility, temperature, vibration, etc.); such requirements will be vehicle-specific and even LRU-specific. However, the hardware requirements and examples contained herein do address many of the environmental conditions that military and aerospace vehicles may experience. One should refer to the appropriate sections of MIL-STD-461E for their particular LRU, and utilize handbooks such as MIL-HDBK-454A and MIL-HDBK-5400 for guidance.

This document is referred to as a “slash sheet” and accompanies the AS5643B base standard.

1.1 Purpose

The purpose of this document is to define an approach to using IEEE-1394-2008 Beta over extended distances in safety-critical/mission-critical applications for military and aerospace vehicles.

This document is controlled and maintained by the SAE with technical support from subsystem vendors.

1.2 Application

The information herein may be used to assist the design, fabrication, and maintenance of the subsystems that interface via the vehicle's network.

1.3 Interpretation

The following interpretations shall be placed upon these words, unless stated otherwise, where they are used in this document.

May: An allowed action.

Shall: A mandatory requirement.

Should: A recommended action.

Will: A declaration of intent.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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.

AS6070/8 Cable, Lightweight Optimized High Speed Data Quad, 110 Ohm, 200 °C

2.1.2 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-HDBK-454A	Department of Defense Handbook, General Guidelines for Airborne Electronic Equipment
MIL-HDBK-5400	Military Handbook, Electronic Equipment, Airborne, General Guidelines
MIL-STD-461E	Department of Defense Interface Standard, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

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-1394-2008 IEEE Standard for a High Performance Serial Bus

IEEE-1394-2008 includes IEEE-1394-1995, Amendment IEEE-1394a-2000, and IEEE-1394b-2002, plus additional information and corrections.

2.2 Acronyms and Definitions

C	Celsius
dB	Decibels
DC	Direct current
Link	The point-to-point connection between two ports
LRU	Line-replaceable unit
MBd	Megabaud
Mbits	Megabits
Mb/s	Megabits per second
MHz	Megahertz
mV	Millivolts
N/A	Not applicable
pF	Picofarad
ppm	Parts per million
ps	Picoseconds
V	Volts
VRMS	Volts root mean square
V _{p-p}	Voltage, peak-to-peak
Ω	Ohms

3. IEEE-1394-2008 BETA PHYSICAL LAYER REQUIREMENTS, S400 COPPER MEDIA

The requirements are based on the IEEE-1394-2008. IEEE-1394-2008 was baselined using IEEE-1394-1995 and amendments IEEE-1394a-2000, IEEE-1394b-2002, and IEEE-1394c-2006. This section delineates the options selected and interprets any ambiguities.

3.1 Cable Assembly Requirements

The cable assembly as defined by this document consists of the cable connector at each end of the cable and everything in between (including inline connectors). Please consult AS6070/8 for bulk cable requirements. The cable assembly requirements are summarized in Table 1.

Table 1 - Cable assembly requirements

Parameter	S400β	Units
Differential Signal Loss		
Active Transformer Maximum	700	mV
Passive Transformer Maximum	235	mV
Insertion Loss Active Transformer		
Insertion Loss Total	8.79	dB
Insertion Loss Cable (including in-lines)	6.0	dB
Insertion Loss Connectors (near and far end)	2.79	dB
Insertion Loss Passive Transformer		
Insertion Loss Total	3.53	dB
Insertion Loss Cable (including in-lines)	2.0	dB
Insertion Loss Connectors (near and far end)	1.53	dB
Differential Skew		
Total	±450	ps
Cable (including in-lines)	±400	ps
Connectors (near and far end)	±50	ps
Jitter (NOTE 1)		
DJ pk-pk	224	ps
RJ RMS	0	ps
RJ pk-pk	0	ps
TJ pk-pk	224	ps
Cross Talk (NOTE 2)		
Total	≤-26	dB

NOTE 1: Refer to Section 9.3.6 of IEEE-1394-2008 for details.

NOTE 2: Refer to Section 4.2.4.7 of IEEE-1394-2008 for details.

3.1.1 Cable Wire Configuration

Cable shall be of quad construction and contain two differential pair transmission lines (positioned on orthogonal axes) with nominal differential impedance of 110 Ω.

Insulated wires for the two differential pairs in the cable shall be color-coded as follows: pair 1 consists of one blue wire and one orange wire (blue x orange), and pair 2 consists of one red wire and one green wire (red x green). For the blue x orange pair, the blue wire connects to the positive signal and the orange wire connects to the negative of a given port; for the red x green pair, the red wire connects to the positive signal and the green wire connects to the negative of a given port.

When connecting between two 1394b nodes, connect from the transmit (TX) of one port to the receive (RX) of the other. For example, for the blue x orange pair, the blue wire connects to TX+ and the orange wire connects to TX- on one end of the cable, and the blue wire connects to RX+ and the orange wire connects to RX- on the other end of the cable.

Cable requirements are in accordance with AS6070/8. If desired, two additional wires may be utilized in the same cable in order to power the 1394 circuitry of a LRU; use white wire for positive (power) and black wire for negative (ground). Wire gauge is dependent upon the LRU power requirements and the cable length. Refer to Section 4.2.1 of IEEE-1394-2008 for guidance on six-wire implementations.

3.1.2 Cable Interconnects Performance

The differential-mode discrete impedance of the signal pairs within the mated connector section shall be measured by TDR with the connector-only differential test fixture at an 80 ps rise time. The recommended procedure is described in K.3 of IEEE-1394-2008 with the following exception in test condition: evaluate differential impedance over a 625 ps exception window with test points at:

- Connector insertion plane -25 ps
- Connector insertion plane (reference point, so offset will be 0 ps)
- Connector insertion plane +100 ps
- Connector insertion plane +300 ps
- Connector insertion plane +600 ps

The exception window is extended -25 ps in front of the beginning of a typical mated connector to evaluate settling performance. Also, in making time domain measurements, multiply all real time values by two to account for the round trip. Impedance in the exception window shall be within the following limits: 110 +40/-40 Ω (differential).

3.1.2.1 Cable Interconnects Optional

IEEE-1394-2008 does specify ruggedized connections; therefore, see Section 4 for examples.

3.2 Bus Isolation

In some applications, isolation of the bus may be required (e.g., for lightning protection). IEEE-1394-2008 Beta does not require DC signaling or coupling; therefore, isolation of the bus is possible. The network may provide isolation by utilizing transformer coupling between nodes. All subsystems that connect to the network shall provide equivalent transformer coupling on the transmit and receive pairs. The shield from the cabling shall be connected to chassis ground and isolated from signal ground of the LRU circuitry.

3.2.1 Link Termination

Every link shall be terminated at both ends with an impedance equal to the selected cable nominal characteristic impedance, as specified in AS6070/8.

NOTE: A PHY silicon manufacture may require termination that is slightly different, for example 56.2 Ω , to accommodate the impedance of the PHY input/output. Please consult the PHY silicon manufacture data sheet for specific requirements.

3.2.1.1 Example Link Termination

Link termination with bus isolation transformers place specific requirements on AS5643/1 implementations. The system implementor should consult the PHY silicon and transformer suppliers data sheets before implementing link termination.

In the example shown in Figure 1, the same termination works for both passive and active transformers.

For an active transformer, the PHY device connects through a transformer with active circuitry for the transmitter and is passive for the receiver. This example also assumes the transformer has integrated termination for both receive and transmit side of the active circuitry. The transmit transmission line is broken up into two sections. The first section extends from the PHY device to the transformer. IEEE-1394 PHY device requires 110 Ω termination at both ends of the transmission line. In the example R4 provides, the 110 Ω termination for the PHY device side and the transformer integrates the 110 Ω termination for the far end. The second section begins at the output side of the active transformer which integrates an impedance matching termination network and extends to the receiver of the attached PHY. The receiving PHY devices should be terminated as described in the following paragraph.

In this example, the termination for the receiver provides both a 110 Ω termination and common mode filter (C1 and R3). It is assumed that the PHY provides an internal bias voltage for the receiver (TPA).

Bilingual PHYs implement a TpBias voltage for each port. Most PHY device data sheets recommend that TpBias be pulled high through a resistor when not used. Please consult the PHY vendors data sheet for details.