SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS5643/1

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S400 Copper Media Interface Characteristics Over Extended Distances

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1. SCOPE:

This SAE Aerospace Standard (AS) establishes guidelines for the use of 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 reference 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 SAE Sxxxx base standard.

1.1 Purpose:

The purpose of this document is to define an approach to using IEEE-1394b 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.

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2. DEFINITIONS AND APPLICABLE DOCUMENTS:

2.1 Acronyms and Definitions:

C: Celsius

dB: Decibels

DC: Direct Current

Ft: Feet

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

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2.2 Government Documents:

The following government documents form a part of this document to the extent specified herein.

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

2.3 Non-Government Documents:

The following non-government documents form a part of this document to the extent specified herein.

IEEE Std 1394-1995	IEEE Standard for a High Performance Serial Bus
IEEE Std 1394a-2000	IEEE Standard for a High Performance Serial Bus, Amendment 1
IEEE Std 1394b-2002	IEEE Standard for a High Performance Serial Bus, High Speed Supplement

2.4 Applicable References:

None.

3. IEEE-1394B REQUIREMENTS, S400 COPPER MEDIA:

The requirements are based on the IEEE Standard for a High Performance Serial Bus (IEEE-1394-1995), Amendment One (IEEE-1394a-2000), and High-Speed Supplement (IEEE-1394b-2002). This section delineates the options selected and interprets any ambiguities.

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3.1 Cable:

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

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 summarized in Table 1.

TABLE 1 - Cable Requirements

Dielectric Withstanding Voltage Conductor/Conductor (Maximum)	1500 VRMS
Dielectric Withstanding Voltage Conductor/Shield (Maximum)	1000 VRMS
Capacitance (Typical) Between Pairs, Ground Floating	12 pF/ Ft
Differential Impedance @ (100 to 500 MHz)	110 ± 6 Ω
Temperature Range	-55 °C to +200 °C
Insertion Loss at 250 MHz (Maximum, With Active Transformer)	6.0 dB
Insertion Loss at 250 MHz (Maximum, With Passive Transformer)	2.0 dB
Time Delay Skew (Maximum) Within Pairs	200 ps

If desired, two additional wires may be utilized in the same cable in order to power the 1394b 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 4.2.1B.2.1 of IEEE-1394b-2002 for guidance on 6-wire implementations.

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3.1.2 Cable Termination:

3.1.2.1 MIL-DTL-38999 Option: The recommended connector type is MIL-DTL-38999 Series 3; the connector shell size may be A (9), B (11), or C (13), depending on the number of 1394b ports at a given LRU or vehicle bulkhead. The connectors shall use #22D contacts, with pins typically used at the LRU and #22D contact sockets by the vehicle cabling. For each connector shell size described in the following sections, all pin locations designated as “not used” shall remain empty and not be utilized for other purposes.

3.1.2.1.1 MIL-DTL-38999, Shell Size A: When cabling containing a single 1394b port needs to pass through bulkheads, a MIL-DTL-38999 Series 3 connector, shell size A (9) may be used (insert arrangement 35, with #22D contacts), as depicted in Figure 1.

Pin	Signal Name	Description
1	Port X1 - TA	Port X1 Receive +
2	Port X1 - TA*	Port X1 Receive -
3	Port X1 - TB	Port X1 Transmit +
4	Port X1 - TB*	Port X1 Transmit –
5	Not Used	N/A
6	Not Used	N/A

FIGURE 1 - Connector Pin-out, MIL-DTL-38999 Series 3 Shell Size A (9)

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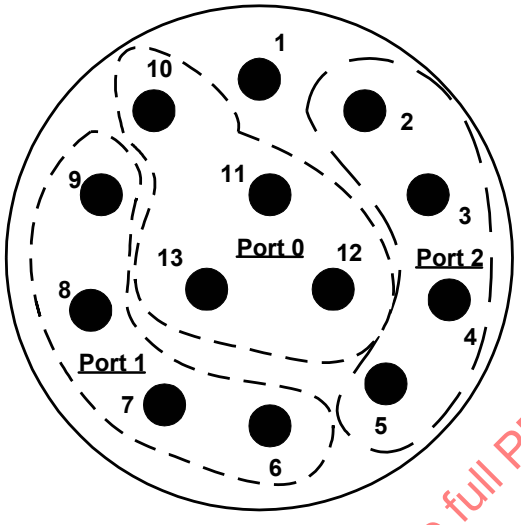
3.1.2.1.2 MIL-DTL-38999, Shell Size B: Typically, LRU connections will use a MIL-DTL-38999 Series 3 Connector shell size B (11), insert arrangement 35, with #22D contacts, as depicted in Figure 2.



Pin	Signal Name	Description
1	Not Used	N/A
2	Port 2 - TA	Port 2 Receive +
3	Port 2 - TA*	Port 2 Receive -
4	Port 2 - TB	Port 2 Transmit +
5	Port 2 - TB*	Port 2 Transmit -
6	Port 1 - TA	Port 1 Receive +
7	Port 1 - TA*	Port 1 Receive -
8	Port 1 - TB	Port 1 Transmit +
9	Port 1 - TB*	Port 1 Transmit -
10	Port 0 - TA	Port 0 Receive +
11	Port 0 - TA*	Port 0 Receive -
12	Port 0 - TB	Port 0 Transmit +
13	Port 0 - TB*	Port 0 Transmit -

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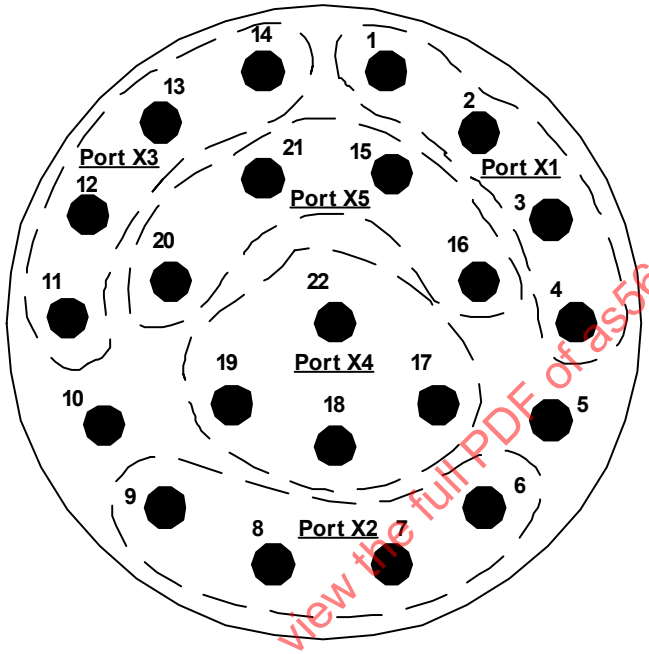
FIGURE 2 - Connector Pin-out, MIL-DTL-38999 Series 3 Shell Size B (11)

Note that the above arrangement utilizes all three ports. It is recommended that all LRUs provide access to all three 1394b ports of a node; even if a LRU is initially planned to be a leaf node, having access to all three ports gives the system integrator flexibility to later change the system architecture and/or to provide a connection point for test instrumentation.

3.1.2.1.3 MIL-DTL-38999, Shell Size C: In applications where up to five 1394b ports must be terminated, a MIL-DTL-38999 Series 3 Connector shell size C (13), insert arrangement 35, with #22D contacts may be used, as depicted in Figure 3.



Pin	Signal Name	Description
1	Port X1 - TA	Port X1 Receive +
2	Port X1 - TA*	Port X1 Receive -
3	Port X1 - TB	Port X1 Transmit +
4	Port X1 - TB*	Port X1 Transmit -
6	Port X2 - TA	Port X2 Receive +
7	Port X2 - TA*	Port X2 Receive -
8	Port X2 - TB	Port X2 Transmit +
9	Port X2 - TB*	Port X2 Transmit -
11	Port X3 - TA	Port X3 Receive +
12	Port X3 - TA*	Port X3 Receive -
13	Port X3 - TB	Port X3 Transmit +
14	Port X3 - TB*	Port X3 Transmit -
17	Port X4 - TA	Port X4 Receive +
18	Port X4 - TA*	Port X4 Receive -
19	Port X4 - TB	Port X4 Transmit +
22	Port X4 - TB*	Port X4 Transmit -
16	Port X5 - TA	Port X5 Receive +
15	Port X5 - TA*	Port X5 Receive -
21	Port X5 - TB	Port X5 Transmit +
20	Port X5 - TB*	Port X5 Transmit -
5,10	Not Used	N/A

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FIGURE 3 - Connector Pin-out, MIL-DTL-38999 Series 3 Shell Size C (13)

3.1.2.1.4 MIL-DTL-38999 Cable Termination: Figure 4 depicts an example of a cable termination method for MIL-DTL-38999 Series 3 connectors with A (9), B (11), and C (13) shell sizes and one to five cable assemblies.

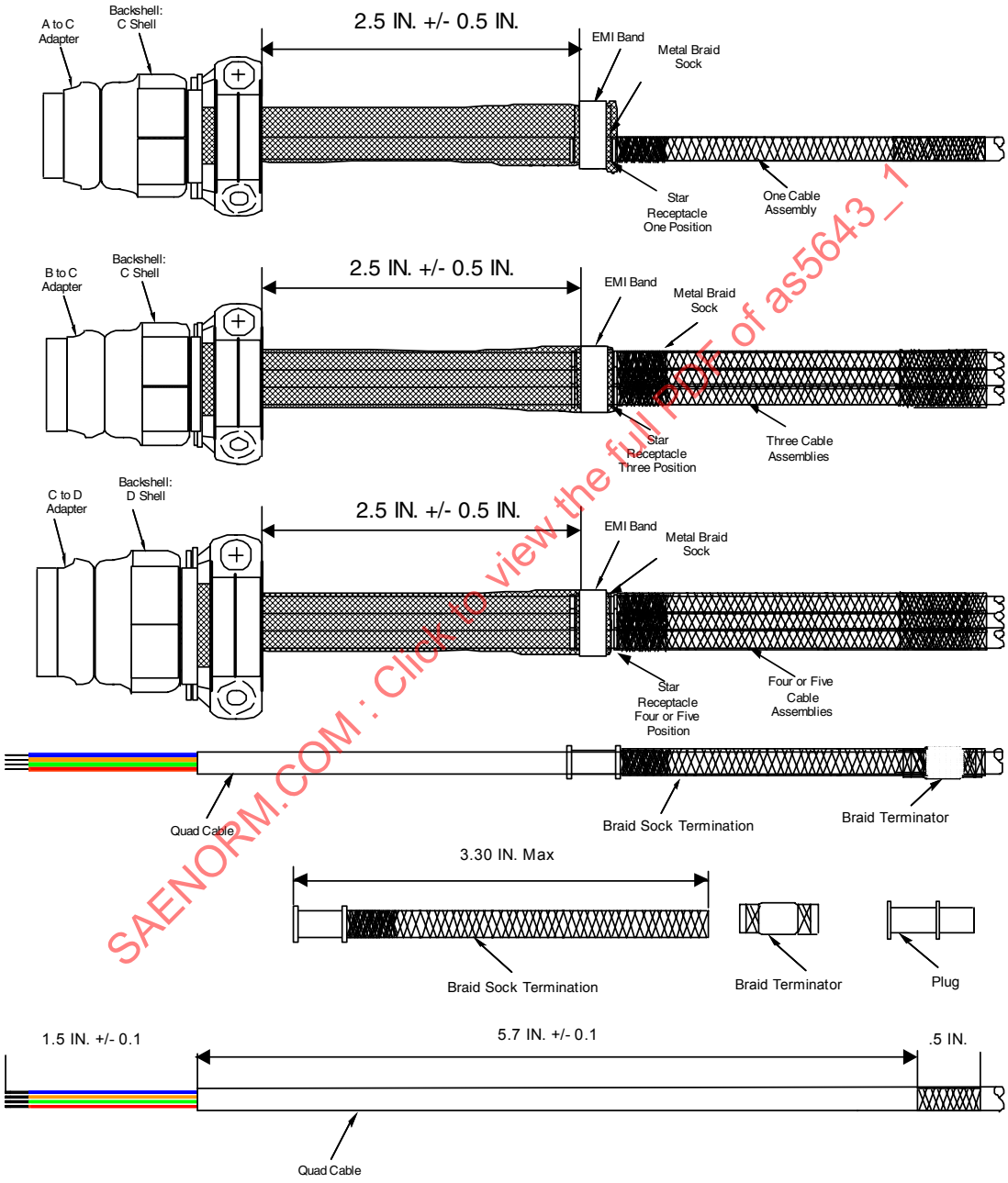

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FIGURE 4 - Example Cable Termination Method for MIL-DTL-38999 Series 3 Connector With A (9), B (11), and C (13) Shell Sizes

3.1.2.2 Quadrax MIL-DTL-38999 and ARINC 600 High Density Option: MIL-DTL-38999 and ARINC Style connectors provide the ability to increase Input/Output density by providing the option to support multiple and independent 1394b ports within the same connector insert. The Quadrax insert contains four #24 AWG pin contacts with a 360° shield. Quadrax contacts are available as inserts that mount into standard #8 cavities in ARINC or MIL-DTL-38999 style connectors or as Printed Circuit Board (PCB) contact version that can be soldered directly to a board..

3.1.2.2.1 ARINC 600 Quadrax Options: Table 2 and Figure 5 illustrate examples of ARINC 600 style connector inserts that have size #8 contacts and support the use of Quadrax inserts. Figure 6 shows the Quadrax PCB Contact installed into an ARINC 600 connector.

TABLE 2 - ARINC 600 Series Insert Options for Size 8 Contacts

ARINC Shell Size	Insert Arrangement	Quantity of Size 8 Contacts
ARINC 600 Shell Size 1	30T2	2
ARINC 600 Shell Size 2/3	120T2	2
ARINC 600 Shell Size 2/3	6Q6	6
ARINC 600 Shell Size 2/3	28Q8	8
ARINC 600 Shell Size 2/3	10Q10	10
ARINC 600 Shell Size 2/3	11Q11	11

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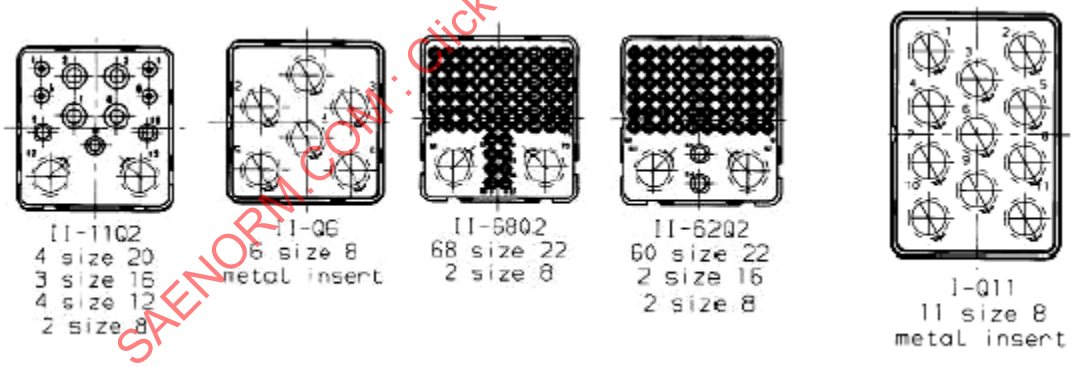

FIGURE 5 - Example of ARINC 600 Style Inserts with #8 Contacts

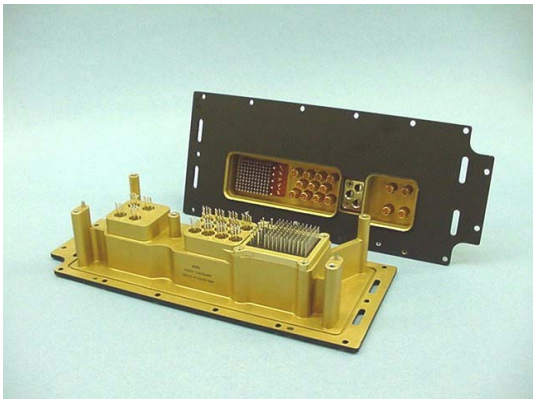

FIGURE 6 - Quadrax PCB Version Installed in ARINC 600 Style Connector

3.1.2.2.2 MIL-DTL-38999 Quadrax Options: Figure 7 illustrates examples of MIL-DTL-38999 style connector inserts that have size #8 contacts and support the use of Quadrax inserts.

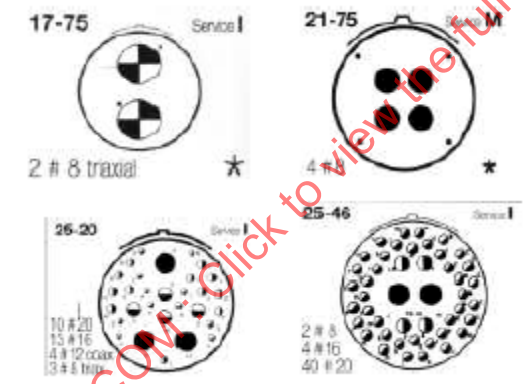

FIGURE 7 - Example of MIL-DTL-38999 Connector Inserts that Support Quadrax Inserts

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