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Verification Methods for AS5653 Network Controller

RATIONALE

This documents defines the verification methods that may be applied to verify the Network Controller (NC) meet the requirements of AS5653, Revision B.

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1. SCOPE

This document was prepared by the SAE AS-1A2 Committee to establish techniques for validating the Network Controller (NC) complies with the NC requirements specified in AS5653, Revision B. Note that this verification document only verifies the specific requirements from AS5653 and does not verify all of the requirements invoked by documents that are referenced by AS5653. The procuring authority may require further testing to verify the requirements not explicitly defined in AS5653 and in this verification document.

1.1 Purpose

The purpose of this document is to provide methods for validating that the NC complies with the NC requirements of AS5653. Note that AS5653 makes extensive reference to the various Fibre Channel standards. In the context of the MIL-STD-1760 interfaces, AS5653 is referred to as a “bus”. In the context of Fibre Channel, AS5653 is referred to as a “network”. For this document, the verification methods are FC-4 level protocol tests and do not include electrical tests or Fibre Channel FC-0, FC-1, or FC-2 level tests.

1.2 Application

This document is applicable to AS5653, Revision B only.

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.

AS5653B High Speed Network for MIL-STD-1760

2.1.2 ANSI Accredited Publications

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

FC-AE-1553 ANSI T11.3 Project 1648-DT Fibre Channel – Avionics Environment Protocol for MIL-STD-1553B Notice 2 (FC-AE-1553)

FC-AV ANSI INCITS 356-2002 Fibre Channel – Audio Video

FC-PI ANSI INCITS 352-2002 Fibre Channel – Physical interfaces

FC-SW-4 ANSI T11.3 Project 1674-D Fibre Channel - Switched Fabric – 4

FC-FS-2 ANSI INCITS 373-2003 Fibre Channel – Framing and Signaling – 2

FC-LS-2 ANSI INCITS 2103-D Fibre Channel – Fibre Channel - Link Services – 2

2.1.3 U.S. Military Specifications and Standards

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

MIL-STD-1760E Department of Defense Interface Standard for Aircraft/Store Electrical Interconnection System

2.2 Usage of References

This standard profiles existing Fibre Channel standard and Table 1 describes the relationship of each of the referenced documents.

Table 1 - Purpose of Reference Documents

Referenced Document	Purpose
MIL-STD-1760	This is the parent document defining the aircraft store interface. Referenced by this document for signal assignments, connector details, and contact details.
FC-SW-4	FC-SW-4 defines the switched fabric topology used, the means of assigning addresses, network initialization and Fast Fabric Initialization. AS5653 selects the Fast Fabric Initialization protocol defined in FC-SW-4 Annex D.
FC-PI	FC-PI defines the physical layer.
FC-AV	Profiled to provide specific means to transfer Audio and Video information.
FC-AE-1553	Profiled to provide a file transfer, command and control mechanism.
FC-FS-2	Defines the Fibre Channel Framing and Signalling.

2.3 Acronyms and Abbreviations

The following acronyms and abbreviations are applicable.

AE	Avionics Environment
AE_Port	Avionics Environment Fibre Channel Port
BB_Credit	Buffer-to-Buffer Credit
DFC	Down Fibre Channel
E_D_TOV	Error_Detect_Timeout value
FC	Fibre Channel
FC-AV	Fibre Channel – Audia Video
FFI	Fast Fabric Initialization
FLOGI	Fabric Login
F_Port	Fibre Channel Fabric Port
Gbaud	Gigabaud
h	Hexadecimal
NC	Network Controller
N_Port	Fibre Channel Node Port
NT	Network Terminal
PLOGI	N_Port Login
R_A_TOV	Resource_Allocation_Timeout value
R_T_TOV	Receiver_Transmitter_Timeout value
TDP	Technical Data Package
UFC	Up Fibre Channel
UUT	Unit Under Test (i.e., the device that is to be tested)

3. TEST EQUIPMENT

3.1 Fibre Channel Analyzer

The Fibre Channel Analyzer shall have the following minimum capabilities:

- Two Channel Analyzer that is capable of being connected inline between NC and NT.
- Capture of FC-AE-1553 Fibre channel data at 1.0625 GBaud with a minimum of 1 Megabyte buffer.
- Decoding of FC-AE-1553 Fibre Channel Frames including Headers and Payloads.
- A Mechanism to trigger on any field within the Fibre Channel Header.

3.2 Fibre Channel Tester

The Fibre Channel Tester shall have the following minimum capabilities:

- Emulation of a FC-AE-1553 Switch and Network Terminal function.
- Support of one physical port able to send FC-AE-1553 Fibre Channel frames at 1.0625 GBaud.

Note that these are the minimum requirements for the Fibre Channel Analyzer and Fibre Channel Tester. This does not preclude the testing or procuring authority to combine these two functions into a single test device to support automated testing and other established test capabilities.

4. GENERAL VERIFICATION METHOD REQUIREMENTS

The following sections outline the verification methods for verifying that the Unit Under Test (UUT) which is the NC performs per the requirements specified in AS5653B. Each section is organized in the following format:

Purpose: This section provides a general description of the verification activity.

AS5653B Requirements Paragraph: This section references the section number and requirement(s) from AS5653B for which this section is validating.

Verification Criteria: This section outlines the criteria that will be used to evaluate whether the NC meets the specified requirement(s).

Verification Method: This section outlines the method to verify that the NC meets the specified requirement(s).

Notes: This section provides any other information (as applicable).

4.1 Port Designation

Purpose: This method verifies that the NC is designated as the appropriate ports as defined in AS5653.

AS5653B Requirements Paragraph: 3.1

Verification Criteria: The NC is considered to have passed if it designated as a port in accordance with Table 3 of AS5653.

Verification Method:

1. Verify that the NC is an N_Port as follows:
 - a. Connect Fibre Channel Tester with a Fibre Channel Analyzer and a simulated/actual N_Port/AE_Port as a source of stimulus to command the NC to execute the tests below.
 - b. Verify NC is sending out a FLOGI Request.

Notes: See Section 5.13 for FLOGI Request verification.

4.2 Upper Layer Protocols

Purpose: This method verifies that the NC only implements Upper Layer Protocols as defined in AS5653.

AS5653B Requirements Paragraph: 3.3

Verification Criteria: The NC is considered to have passed if the NC only implements Upper Layer Protocols as defined in AS5653.

Verification Method:

1. Analyze the NC TDP and verify that only the following Upper Layer Protocols are used by the NC:
 - a. FC-AE-1553
 - b. If the NC implements audio and video functions as defined in FC-AV, the NC shall only use Frame Header Control Protocol (FHCP).

Notes: None

4.3 Video Transfer

Purpose: This method verifies that the NC only executes Video Transfers as defined in AS5653.

AS5653B Requirements Paragraph: 4.1.1

Verification Criteria: If the NC implements video transfers, the NC shall meet the requirements as defined in AS5653.

Verification Method:

1. Analyze the NC TDP to verify implementation if required by the NC System Specification:
 - a. Use Fibre Channel industry best practices for verification of the FC-AV Annex A requirements.

Notes: N/A

4.4 Audio Transfer

Purpose: This method verifies that the NC only executes Audio Transfers as defined in AS5653.

AS5653B Requirements Paragraph: 4.1.2

Verification Criteria: If the NC implements audio transfers, the NC shall meet the requirements as defined in AS5653.

Verification Method:

1. Analyze the NC TDP to verify implementation if required by the NC System Specification:
 - a. Use Fibre Channel industry best practices for verification of the FC-AV Audio requirements.

Notes: N/A

4.5 FC-AE-1553 Profiling – FC-FS-2 Features

Purpose: This method verifies that the NC only implements the FC-FS-2 features as defined in FC-AE-1553.

AS5653B Requirements Paragraph: 4.1.5, 1st Shall

Verification Criteria: The NC is considered to have passed if the NC only implements the required as required and invocable as of AS5653 and does not implement the prohibited FC-FS-2 features as defined in FC-AE-1553.

Verification Method:

1. For the Required and Invocable features, verify that the NC executes the following:
 - a. Connect Fibre Channel Tester with a Fibre Channel Analyzer and a simulated/actual N_Port/AE_Port as a source of stimulus.
 - b. Verify NC sends a proper NT to NT Command.
2. For the Prohibited, analyze the NC TDP and verify the following:
 - a. The prohibited features in FC-FS-2 as defined in FC-AE-1553 are not implemented.

Notes: N/A

4.6 FC-AE-1553 Profiling – FC-AE-1553 Allowed Features

Purpose: This method verifies that the NC only executes FC-AE-1553 as defined in Table 4 and Table 5 of AS5653.

AS5653B Requirements Paragraph: 4.1.5, 2nd Shall

Verification Criteria: The NC is considered to have passed if the NC only implements the Allowed Features as defined in Table 4 and Table 5 of AS5653.

Verification Method:

1. For Table 4 Invocable Requirements, verify that the NC executes the following:
 - a. Connect Fibre Channel Tester with a Fibre Channel Analyzer and a simulated/actual N_Port/AE_Port as a source of stimulus to command the NC to execute the tests below.
 - b. For NT-to-NT Transfers, verify that the NC sends a proper NT to NT Command.
 - c. For Broadcast, verify that the NC sends a proper Broadcast Command.

2. For Table 4 Prohibited requirements, analyze the NC TDP and verify the following Upper Layer Protocols are used by the NC:
 - a. Analyze the NC TDP to verify that NC prohibits the following functions:
 - i. NC to monitor NT-to-NT Transfer
 - ii. Multicast
 - iii. NT status response to broadcast exchanges.
3. For Table 5, analyze the NC TDP and verify that the PRLI Service Parameters are set as defined in Table 5 of ASA5653.

Notes: See Section 5.8 for NT to NT Command.

4.7 FC-AE-1553 Profiling – Physical Port Connection

Purpose: This method verifies that the NC is connected to the Physical Port Zero of the Switch.

AS5653B Requirements Paragraph: 4.1.5, 3rd Shall

Verification Criteria: The NC is considered to have passed if the NC is physically connected to Port Zero of the Switch.

Verification Method:

1. When the NC is installed as part of the entire system, inspect the NC to verify that it is only connected to Port Zero of the Switch.

Notes: N/A

4.8 FC-AE-1553 Profiling – NC-to-NT or NT-to-NT Exchange

Purpose: This method verifies that when using NC-to-NT or NT-to-NT exchange formats that the correct command word bit is set per AS5653.

AS5653B Requirements Paragraph: 4.1.5, 4th Shall

Verification Criteria: The NC is considered to have passed if the NC used the correct command word settings as defined in AS5653.

Verification Method:

1. Verify that the NC is setting the correct command word settings as follows:
 - a. Connect Fibre Channel Tester with a Fibre Channel Analyzer and a simulated/actual N_Port/AE_Port as a source of stimulus to command the NC to execute the tests below.
 - b. Stimulate the NC to send a NC-to-NT transfer command and verify the command word is the command word bit “NT Burst Size Request” has a value of logic “1” and the command word bit “Delayed NT Burst Size Request” has a value of logic “0”.
 - c. Stimulate the NC to send a NT-to-NT transfer command and verify the command word is the command word bit “NT Burst Size Request” has a value of logic “1” and the command word bit “Delayed NT Burst Size Request” has a value of logic “0”.

Notes: N/A

4.9 FC-AE-1553 Profiling – Single Frame Sequences

Purpose: This method verifies that the NC only sends commands via single-frame sequences.

AS5653B Requirements Paragraph: 4.1.5, 5th Shall

Verification Criteria: Verify that the NC meets the requirements as defined in AS5653 to send payload data of less than or equal to 2048 bytes (512 words) in a single-frame sequence.

Verification Method:

1. Verify that the NC is sending single-frame sequences as follows:
 - a. Connect Fibre Channel Tester with a Fibre Channel Analyzer and command the NC to send a payload with 2040 bytes.
 - b. Verify using the Fibre Channel Analyzer that the NC sent the 2040 bytes of data as a single-frame sequence which includes FC-AE-1553 Command and Data.
 - c. Then command the Fibre Channel Tester with a Fibre Channel Analyzer to command the NC to send a payload with 2072 bytes.
 - d. Verify using the Fibre Channel Analyzer that the NC sent a separate FC-AE-1553 Command Sequence and FC-AE-1553 data sequence.

Notes: By commanding the NC to send more than 2048 bytes of data, the NC will invoke the Burst Mode Transfer capability as defined in AS5653.

4.10 FC-AE-1553 Profiling – Concurrent Exchanges

Purpose: This method verifies that the NC only executes Audio Transfers as defined in AS5653.

AS5653B Requirements Paragraph: 4.1.5, 6th Shall and 7th Shall

Verification Criteria: During multiple concurrent exchanges, verify that the NC meets the requirements as defined in AS5653.

Verification Method:

1. Analyze the NC TDP to verify multiple concurrent exchanges to the same NC are on different subaddresses as follows:
 - a. Verify that the NC is prohibited from sending concurrent exchanges to the same subaddress.

Notes: The Fibre Channel network is a full duplex network consisting of an UFC line and DFC line that allows concurrent exchanges and this requirement has been implemented to simulate the logical operation of MIL-STD-1553.

4.11 Order of Delivery

Purpose: This method verifies that the NC can support at least two priority levels as defined in AS5653.

AS5653B Requirements Paragraph: 4.3.2, 4.3.8, 4.3.11

Verification Criteria: The NC is required to implement at least two priority levels for Fibre Channel command messages and receive messages.