



Document number TS2009008

1394 Connector and Cable Compliant Testing Criteria

Revision 1.0

November 19, 2009

Sponsored by:

1394 Trade Association

Accepted for publication by

1394 Trade Association Board of Directors

Abstract

This specification defines the requirements for 1394 cable and connector compliance test program

Keywords

IEEE 1394, serial bus, compliance, finish, material, electroplating, 6 ckt, 4 ckt, 9 ckt, testing, performance

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Published by

1394 Trade Association
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This included the use of tables, graphs, abstracts and scope statements from IEEE Documents

Foreword

This specification defines the requirements for 1394 copper cable and connector compliance test programs found in IEEE 1394-2008 (known as short haul interconnects that are 4.5 meters maximum length). This document with its new additions will supersede TS 2004003 for the 4 and 6 ckt products.

There are three annexes in this specification. Annex A, B and C are normative and part of this specification.

This specification has not been accepted by the Board of Directors of the 1394 Trade Association. Board of Directors acceptance of this specification does not necessarily imply that all board members voted for acceptance. At the time it accepted this specification, the 1394 Trade Association Board of Directors had the following members:

Max Bassler, Chair
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1 Overview

1.1 Purpose

The goal is to evaluate cable and connector products against the established test criteria for the IEEE 1394 Standards. The verification of dimensional, interchangeability and performance characteristics of connectors and cable assemblies manufactured according to the 1394 standards will enable market acceptance.

1.2 Scope

This document establishes the performance requirements for all short haul copper connectors and cable assemblies up to 4.5 meters long with plugs at both ends manufactured according to IEEE Std 1394-2008. Administrative, regulations, performance validation sequences and procedures and pertinent technical information are included. The new work found in this specification is for the 1394b (Beta & Bilingual) short haul connector and cables assemblies up to 4.5 meters long with plugs at both ends and it incorporates all of the compliance criteria found in the TS2004003 for 4 and 6 circuit short haul connectors and cables (Alpha). The reference to "short haul cables" has been commonly defined as 4.5 meters maximum length in the past.

Cable assemblies with plugs at each end greater than 4.5 m long are not covered by this Standard. Longer cable lengths may be possible if special considerations are given to the actual serial bus topology and meeting signal propagation criteria in IEEE Std 1394-2008.

Reference for longer length cable guidance:

Reference: 4.2.2.2 Cable Assemblies (6 Circuit) IEEE Std 1394-2008 Page 37.

Reference: 4.3.2.2 Cable Assemblies (4 Circuit) IEEE Std 1394-2008 Page 56.

Reference: 4.4.3.2 Cable Assemblies (9 Circuit) IEEE Std 1394-2008 Page 84.

This new document shall not be a cause for re-certification if you have passed the requirements of TS 2004003.

2 Normative references

2.1 Reference scope

The specifications and standards named in this section contain provisions, which, through reference in this text, constitute provisions of this 1394 Trade Association Specification. At the time of publication, the editions indicated were valid. All specifications and standards are subject to revision; parties to agreements based on this 1394 Trade Association Specification are encouraged to investigate the possibility of applying the most recent editions of the specifications and standards indicated below.

2.2 Approved references

The following approved specifications and standards may be obtained from the organizations that control them.

IEEE Std 1394-2008, High Performance Serial Bus

Throughout this document, the term "IEEE 1394" shall be understood to refer to IEEE Std. 1394-2008.

2.3 Reference acquisition

The references cited may be obtained from the organizations that control them:

American National Standards Institute (ANSI), 25 West 43rd Street, 4 floor, New York, NY 10036, USA; (212) 642-4900 / (212) 398-0023 (FAX); <http://www.ansi.org/>

Institute of Electrical and Electronic Engineers (IEEE), 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331, USA; (732) 981-0060 / (732) 981-1721 (FAX); <http://www.ieee.org/>

Electronic Components Association (ECA), 2500 Wilson Boulevard, Arlington, VA 22201, USA; Phone: (703) 907-8024 / (703) 875-8908; (<http://www.ec-central.org/>)

Electronic Industries Alliance (EIA) Organized under ECA Association (<http://www.eia.org/>)

International Electrotechnical Commission (IEC), IEC Central Office, 3, rue de Varembeé, P.O. Box 131 CH – 1211, GENEVA 20 Switzerland; Phone: +41 22 919 02 11 / +41 22 919 03 00 (FAX); (<http://www.iec.ch/>)

3 Definitions

3.1 Conformance Levels

3.1.1 expected: A key word used to describe the behavior of the hardware models *assumed* by this Specification. Other hardware models may also be implemented.

3.1.2 ignored: A keyword that describes bits, bytes, quadlets, octlets or fields whose values are not checked by the recipient.

3.1.3 may: A key word that indicates flexibility of choice with *no implied preference*.

3.1.4 reserved: A keyword used to describe objects (bits, bytes, quadlets, octlets and fields) or the code values assigned to these objects in cases where either the object or the code value is set aside for future standardization. Usage and interpretation may be specified by future extensions to this or other specifications. A reserved object shall be zeroed or, upon development of a future specification, set to a value specified by such a specification. The recipient of a reserved object shall ignore its value. The recipient of an object defined by this specification as other than reserved shall inspect its value and reject reserved code values.

3.1.5 shall: A key word indicating a mandatory requirement. Designers are *required* to implement all such mandatory requirements.

3.1.6 should: A key word indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase *is recommended*.

3.2 Glossary of Terms

The terms used in this document are generally accepted by the electrical and electronics industries and commonly used in electrical connector engineering practice.

3.3 Acronyms and Abbreviations

AWG	American Wire Gauge
ckt	Circuit
DC	Direct Current
min	minimum
max	maximum
PCB	Printed Circuit Board

4 Certification

4.1 Qualification

Test samples of connectors and cable assemblies must meet all of the requirements specified in the test groups to be successfully qualified. Only the Compliance Logo Program Administrator of the 1394 Trade Association may grant a deviation from the performance specifications in this document and IEEE Std 1394-2008.

4.2 Registration

The 1394 Trade Association shall provide written notification to a manufacturer that a connector or a cable assembly is in conformance with the requirements of this specification upon presentation to the 1394 Trade Association of test documentation for that product which fully satisfies all the requirements of this document. The 1394 Trade Association will also publish on its web site a list of manufacturers and products for which such documentation has been presented. Manufacturers with products on this list may use the 1394 Compliance Logo with the listed product, subject to Compliance Logo Usage terms provided by the 1394 Trade Association.

4.3 Maintenance and Documentation

When a manufacturer is using the 1394 Compliance Logo for a product according to section 4.2, the manufacturer shall make no design changes, component substitutions, material or process changes that affect full compliance with this document, unless such changes are fully qualified as per section 4.1, and the results are presented to the 1394 Trade Association. Products using the Compliance Logo according to section 4.2 shall be tested every 18 months to confirm full compliance as per section 4.1. A new product derived from a previous product that has passed testing as per section 4.1 may be registered according to section 4.2 by providing additional testing data fully covering the performance of those portions of the new product which differ from the previous product, or which are affected by such differences, if the previous product has satisfied section 4.1 within the previous 18 months.

4.4 Enforcement

When presented with adequate evidence of a product that fails to comply as per section 4.1, the 1394 Trade Association shall notify the product's manufacturer in writing of their failure to comply. If the manufacturer does not correct the failure, and the product was previously registered as per section 4.2, the product will be removed from the web site list of compliant products, and the manufacturer will lose the right to use the 1394 Compliance Logo with that product.

5 Verification Procedure

5.1 Test Laboratory

It is the responsibility of the test laboratory to demonstrate its ability to carry out the testing activities to meet the requirements of the 1394 Trade Association. The laboratory must be certified by the 1394 Trade Association according to the requirements for the current 1394 Compliance Logo Program.

The laboratory shall:

Ensure the competency of all people who operated specific equipment, perform tests, and sign test reports

Monitor, control and record environmental conditions as required by this specification so as not to influence the quality of the test results

Use equipment that is calibrated prior to being put into service and maintained according to an appropriate schedule using a qualified calibration service and traceable standards

- 4) Test with equipment that is capable of achieving the accuracy required and shall comply with the specifications established in the test methods

The primary test laboratory may subcontract work to other competent supplier(s) in the event of unforeseen circumstances, workloads or activities that require extra technical expertise. The primary laboratory shall advise and obtain in writing approval of the 1394 Trade Association prior to subcontracting and work. The primary test laboratory shall ensure and be able to demonstrate that its subcontractor is competent to perform the activities assigned.

5.2 Test Samples

The test samples shall be representative of the manufacturer's normal production and shall be selected by the manufacturer at random. Each test sample or part shall be individually identified with a permanent marking that will not be destroyed throughout the test. All submitting manufacturers need to provide the following information:

- 1) Technical Contact (Name, Phone Number and Electronic Mail address)
- 2) PC board sockets, cable plug kits and cable assemblies manufacturer and part numbers
- 3) Cable manufacturer and part number, conductor size and type (AWG and number of strands and insulation material) and outer and signal shield construction
- 4) Cable assembly termination technique, tooling and process information
- 5) Additional special preparation performed

5.3 Sample Distribution

Samples shall be separated into groups according to the applicable sequence and tested according to the conditions indicated.

5.3.1 Socket, Plug and Cable

The number of samples required by each performance group regardless of circuit size is:

Performance Group =>	Number of Samples Required									Total
	A	B	C	D	E	F	G	H	I	
Sockets, unassembled to the Printed Circuit Boards	3	0	0	5	0	0	0	0	0	8
Sockets, assembled to Printed Circuit Boards	0	5	5	0	10	5	5	3	3	36
Plugs, unassembled to cable	3	0	0	0	0	0	0	0	0	3
Cable assembly with one plug at one end 25.4 cm long	3	5	5	0	10	0	5	3	0	31
Cable assembly with one plug at one end 2 m long	0	0	0	5	0	5	0	10	0	20
Cable assembly with plugs at each end 4.5 m long	0	0	0	0	0	0	0	0	3	3

Table 1 – Sample Distribution Intermating

5.3.2 Connector Cross Mating - Sockets and Plugs

All socket and plug samples submitted will be evaluated to verify intermateability while maintaining conformance to the established performance requirements.

The 1394 Trade Association, based on the number of participants included in the test program, will determine the total number of samples.

The number of additional samples required by each performance group regardless of circuit size is:

Performance Group =>	Number of Samples Required									Total
	A	B	C	D	E	F	G	H	I	
Sockets, unassembled to the Printed Circuit Boards	0	0	0	0	0	0	0	0	0	0
Sockets, assembled to Printed Circuit Boards	0	2	2	0	5	2	2	0	0	13
Plugs, unassembled to cable	0	0	0	0	0	0	0	0	0	0
Cable assembly with one plug at one end 25.4 cm long	0	2	2	0	5	0	2	0	0	11
Cable assembly with one plug at one end 2 m long	0	0	0	0	0	2	0	0	0	2
Cable assembly with plugs at each end 4.5 m long	0	0	0	0	0	0	0	0	0	0

Table 2 – Sample Distribution Cross Mating

5.3.3 Alternate Cable Construction and Assembly Techniques

Additional socket and plug samples are required to evaluate alternate cable construction, plug termination methods and cable assembly part numbers.

The 1394 Trade Association, based on the number of participants included in the test program, will determine the total number of samples.

The number of samples required by each performance group regardless of circuit size is:

Performance Group =>	Number of Samples Required									Total
	A	B	C	D	E	F	G	H	I	
Sockets, unassembled to the Printed Circuit Boards	3	0	0	0	0	0	0	0	0	3
Sockets, assembled to Printed Circuit Boards	0	0	0	0	0	0	0	0	3	3
Plugs, unassembled to cable	3	0	0	0	0	0	0	0	0	3
Cable assembly with one plug at one end 25.4 cm long	3	0	0	0	0	0	0	0	0	3
Cable assembly with one plug at one end 2 m long	0	0	0	0	0	0	0	8	0	8
Cable assembly with plugs at each end 4.5 m long	0	0	0	0	0	0	0	0	3	3

Table 3 – Sample Distribution Cable Construction and Assembly Techniques

5.4 Test Printed Circuit Boards

5.4.1 DC Test Boards

Printed circuit boards for DC testing shall be double sided 1.59-mm thick, glass epoxy FR-4 material. Traces shall be properly sized to minimize possible current heating effects. These boards should be built in accordance with the PCB footprint information found in IEEE 1394-2008 standard.

5.4.2 High-speed Test Boards

Printed circuit boards for high-speed testing shall be controlled impedance with isolated signals and appropriate calibration traces for removing fixture effects. Test laboratories or members shall contact the 1394 Trade Association to obtain the availability and cost of the PC board for use in high speed testing.

Performance Group =>	A	B	C	D	E	F	G	H	I
DC Test Boards	N/R	R	R	R	R	R	N/R	N/R	N/R
High Speed Test Boards	N/R	N/R	N/R	N/R	N/R	N/R	N/R	N/R	R

(R=Required and N/R=Not Required)

Table 4 - Test Boards by Performance Group

5.5 Standard Atmospheric Conditions

Unless otherwise specified, all measurements shall be made within the following ambient conditions:

- 1) Temperature: 18°C to 28°C.
- 2) Atmospheric pressure: 650 to 800 millimeters of mercury.
- 3) Relative humidity: 20% to 80%.
- 4) Special tests may require tighter control of conditions and are specified in the test procedure.

5.6 Test Sequences

5.6.1 Performance Group A: Basic construction, workmanship, dimensions & plating thickness.

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
A1	Visual and dimensional inspection	ANSI/EIA 364-18B-07	Unmated connectors	Dimensional Inspection	6 ckt IEEE Std 1394-2008 Fig. 4.1 to 4.6	No defects that would impair normal operations. No deviation from dimensional tolerances
					4 ckt IEEE Std 1394-2008 Fig. 4-11 to 4-16	
					9 ckt IEEE Std 1394-2008 Fig. 4-24 to 4-40	
A2	Plating Thickness			Plating Thickness	6 ckt Annex A	No deviation from plating materials and thickness specification
					4 ckt Annex B	
					9 ckt Annex C	

Table 5 - Performance Group A

Notes:

- 1) This table was created by using the first two test parameter (A1, A2) in Tables 4-3 (6 ckt), 4-12 (4 ckt) and 4-26 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.2 Performance Group B: DC electrical functionality when subjected to mechanical shock and vibration

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
B1	Mating and unmating forces	ANSI/EIA 364-13D-07	Mount socket rigidly. Insert plug by hand. (Mate Only)	Low Level Contact Resistance	ANSI/EIA 364-23C-06	6 ckt 30 mΩ maximum initial per mated contact
						4 ckt and 9 ckt 50 mΩ maximum initial per mated contact
B2	Vibration	ANSI/EIA 364-28E-06	6 ckt Condition III See Note A	Continuity	ANSI/EIA 364-46B-06	No discontinuity at 1 μs or longer. (Each contact)
			4 ckt Condition II See Note A			
			9 ckt Condition I See Note A			
B3	None			Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact
B4	Mechanical Shock (Specified Pulse)	ANSI/EIA 364-27B-09	6 ckt and 4 ckt Condition G See Note A	Continuity	ANSI/EIA 364-46B-06	No discontinuity at 1 μs or longer. (Each contact) See Note A
			9 ckt Condition A or E See Note A			
B5	None			Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact

Note A - Connectors are to be mounted on fixture to simulate typical usage. The socket shall be mounted to a panel, which is permanently attached to the fixture. For details including how the board is attached to the fixture e.g. bolt pattern, check the related ANSI/EIA specifications. The mounting means shall include accessories such as:

- 1) An insulating member to prevent grounding of the shell to the panel
- 2) A printed circuit board in accordance with the pattern shown in IEEE Std 1394-2008 Annex B or Annex D (6 ckt) or Paragraph 4.3.1.8 and Figures 4-17 and 4-18 (4 ckt) or Paragraph 4.4.1.7 and Figures 4-41 and 4-42 (9 ckt) for the socket being tested. The printed circuit board shall be permanently affixed to the fixture.
- 3) The plug shall be mated with the socket and the other end of the cable shall be permanently clamped to the fixture as shown in IEEE Std 1394-2008 Figure 4-9.
- 4) Shield and contact resistance measurement location as shown in IEEE Std 1394-2008 Figure 4-10 or 4-22.

Table 6 – Performance Group B

Notes:

- 1) This table was created using the test parameters (A3 to A7) in Tables 4-3 (6 ckt), 4-12 (4 ckt) and 4-26 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.3 Performance Group C: DC electrical functionality when subjected to thermal shock and humidity stress

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
C1	Mating and unmating forces	ANSI/EIA 364-13D-07	Mount socket rigidly. Insert plug by hand.	Low Level Contact Resistance	ANSI/EIA 364-23C-06	6 ckt 30 mΩ maximum initial per mated contact
						4 ckt and 9 ckt 50 mΩ maximum initial per mated contact
C2	Thermal Shock	ANSI/EIA 364-32E-08	6 ckt, 4 ckt and 9 ckt Condition I 10 Cycles Mated	Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact
C3	Humidity	ANSI/EIA 364-31C-08	6 ckt Condition C (504 h) Method III (Cycling) nonenergized Omit steps 7a and 7b	Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact
			4 ckt Condition A (96 h) Method II (Cycling) nonenergized Omit steps 7a and 7b			
			9 ckt Condition A (96h) Method II (Steady State) nonenergized			

Table 7 – Performance Group C

Note:

- 1) This table is equivalent to Performance Group B Tables 4-4 (6 ckt), 4-13 (4 ckt) and 4-27 (9 ckt) of IEEE Std 1394-2008.

- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.4 Performance Group D: Insulator integrity when subjected to thermal shock and stress

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
D1	Withstanding Voltage	ANSI/EIA 364-20D-08	6 ckt Test Voltage 500 Vdc ± 50 Vdc Method C Unmated and Unmounted	Withstanding Voltage (Same conditions as D1)	ANSI/EIA 364-20D-08	No flashover. No sparkover. No excessive leakage No breakdown.
			4 ckt and 9 ckt Test Voltage 100 Vdc ± 10 Vdc Method C Unmated and Unmounted			
D2	Thermal Shock	ANSI/EIA 364-32E-08	Condition I 10 Cycles (Unmated)	Withstanding Voltage (Same conditions as D1)	ANSI/EIA 364-20D-08	No flashover. No sparkover. No excessive leakage No breakdown.
D3	Insulation Resistance	ANSI/EIA 364-21D-08	6 ckt Test Voltage 500 Vdc ± 50 Vdc Method C Unmated and Unmounted	Insulation Resistance (Same conditions as D3)	ANSI/EIA 364-21D-08	100 MΩ minimum between adjacent contacts and contacts and shell
			4 ckt and 9 ckt Test Voltage 100 Vdc ± 10 Vdc Method C Unmated and Unmounted			
D4	Humidity	ANSI/EIA 364-31C-08	Condition A (96 h) Method III (Cyclic) nonenergized Omit steps 7a and 7b	Insulation Resistance (Same conditions as D3)	ANSI/EIA 364-21D-08	100 MΩ minimum between adjacent contacts and contacts and shell

Table 8 – Performance Group D**Note:**

- 1) This table is equivalent to Performance Group C Tables 4-5 (6 ckt), 4-14 (4 ckt) and 4-28 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.5 Performance Group E: DC electrical functionality when subjected to mechanically cycling and corrosive gas exposure (REFERENCE)

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
E1	Mating and unmating forces	ANSI/EIA 364-13D-07	Mount socket rigidly. Insert plug by hand (Mate Only)	Low Level Contact Resistance	ANSI/EIA 364-23C-06	6 ckt 30 mΩ maximum initial per mated contact 4 ckt and 9 ckt 50 mΩ maximum initial per mated contact
E2	Continuity	ANSI/EIA 364-46B-06	See Note B	Contact resistance braid to socket shell	ANSI/EIA 364-06C-06	50 mΩ maximum initial from braid to socket shell at 100 mA 5Vdc open circuit maximum
E3	Durability	ANSI/EIA 364-09C-06	6 ckt (a) 4 mated pairs 5 cycles (b) 6 mated pairs 750 cycles automatic cycling to 750 cycles at rate of 500 cycles / h ±50 cycles / h 4 ckt and 9 ckt (a) 4 mated pairs 5 cycles (b) 6 mated pairs 500 cycles automatic cycling to 500 cycles at rate of 500 cycles / h ±50 cycles / h	None		
E4	None			Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact
E5	Continuity	ANSI/EIA 364-46B-06	See Note B	Contact resistance braid to socket shell	ANSI/EIA 364-06C-06	50 mΩ maximum change from initial from braid to socket shell at 100 mA 5Vdc open circuit maximum
E6	Mixed Flowing Gas	ANSI/EIA 364-65A-98	Class II exposures: (a) 4 pairs 1 day unmated (b) 6 pairs 10 days mated	Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact

Table 9 – Performance Group E (REFERENCE)

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or Conditions	Title	ID No.	
E7	Durability	ANSI/EIA 364-09C-06	6 ckt (a) 4 mated pairs 5 cycles (b) 6 mated pairs 750 cycles automatic cycling to 750 cycles at rate of ± 50 cycles / h 4 ckt and 9 ckt (a) 4 mated pairs 5 cycles (b) 6 mated pairs 500 cycles automatic cycling to 500 cycles at rate of 500 cycles / h ± 50 cycles / h	Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 m Ω maximum change from initial per mated contact
E8	Mixed Flowing Gas	ANSI/EIA 364-65A-98	Class II exposures: (a) 4 pairs 10 day mated (b) 6 mated pairs 10 days mated	Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 m Ω maximum change from initial per mated contact
E9	Continuity	ANSI/EIA 364-46B-06	See Note B	Contact resistance braid to socket shell	ANSI/EIA 364-23C-06	50 m Ω maximum change from initial from braid to socket shell at 100 mA 5Vdc open circuit maximum

Note B:

- 1) Shield and contact resistance measurement location see IEEE Std 1394-2008 figure 4-10 or 4-22.

Table 9 – Performance Group E (REFERENCE) (Continued)

Note:

- 1) This table is equivalent to Performance Group D Tables 4-6 (6 ckt), 4-15 (4 ckt) and 4-29 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.6 Performance Group F: DC electrical functionality and unmating forces when subjected to temperature life stress

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
F1	Mating and Unmating Forces	ANSI/EIA 364-13D-07	Mount socket rigidly. Insert receptacle by hand	Mating only.		
			Auto rate: 25 mm/min	Unmating only	ANSI/EIA 364-13D-07	6 ckt: Unmating force: 9.8 N min to 39.2 N max
						4 ckt: Unmating force: 4.9 N min to 39 N max
						9 ckt: Unmating force: 10 N min to 39 N max
F2	None			Low Level Contact Resistance	ANSI/EIA 364-23C-06	6 ckt: 30 mΩ maximum initial per mated contact
						4 ckt and 9 ckt: 50 mΩ maximum initial per mated contact
F3	Continuity	ANSI/EIA 364-46B-06	See Note B	Contact resistance braid to socket shell	ANSI/EIA 364-06C-06	50 mΩ maximum change from initial from braid to socket shell at 100 mA 5Vdc open circuit maximum
F4	Temperature Life	ANSI/EIA 364-17B-99	6 ckt Condition 4 (105 °C) Method A 250 h (mated)	Low Level Contact Resistance	ANSI/EIA 364-23C-06	30 mΩ maximum change from initial per mated contact
			4 ckt and 9 ckt Condition 2 (79 °C) Method A 96 h (mated)			
F5	Continuity	ANSI/EIA 364-46B-06	See Note B	Contact resistance braid to socket shell	ANSI/EIA 364-06C-06	50 mΩ maximum change from initial from braid to socket shell at 100 mA 5Vdc open circuit maximum
F6	Mating and Unmating Forces	ANSI/EIA 364-13D-07	Mount Socket rigidly	Mating and Unmating Forces (Unmating only)	ANSI/EIA 364-13D-07	6 ckt: Unmating force: 9.8 N min to 39.2 N max
						4 ckt: Unmating force: 4.9 N min to 39 N max
						9 ckt: Unmating force: 10 N min to 39 N max

Note B:

- 1) Shield and contact resistance measurement location see IEEE Std 1394-2008 figure 4-10 or 4-22.

Table 10 – Performance Group F

Note:

- 1) This table is equivalent to Performance Group E Tables 4-7 (6 ckt), 4-16 (4 ckt) and 4-30 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.7 Performance Group G: Unmating forces when subjected to mechanically cycling

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
G1	Mating and Unmating Forces	ANSI/EIA 364-13D-07	Mount Socket rigidly. Insert Plug by hand.			
G2	Durability	ANSI/EIA 364-09C-06	6 ckt Automatic cycling to 1500 cycles at rate of 500 cycles / h \pm 50 cycles / h	Mating and Unmating Forces (Unmating only)	ANSI/EIA 364-13D-07	6 ckt: Unmating force: 9.8 N min to 39.2 N max
			4 ckt and 9 ckt Automatic cycling to 1000 cycles at rate of 500 cycles / h \pm 50 cycles / h			4 ckt: Unmating force: 4.9 N min to 39 N max
						9 ckt: Unmating force: 10 N min to 39 N max

Table 11 – Performance Group G**Note:**

- 1) This table is equivalent to Performance Group F Tables 4-8 (6 ckt), 4-17 (4 ckt) and 4-31 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.8 Performance Group H: General tests

Suggested procedures to test miscellaneous but important aspects of the interconnect system are given in Table 12. Since the tests listed below may be destructive, separate samples shall be used for each test. The number of samples to be used is listed under the test title.

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
H1	Electrostatic Discharge (3 Cable assemblies with plug at one end 25.4 cm long and 3 Sockets)	IEC 61000-4-2 (Edition 2, 12-2008)	1.0-8.0 kV in 1.0 kV steps. Use 8 mm ball probe. (Unmated)	Evidence of discharge		No evidence of discharge to any of the contacts; discharge to the shield is acceptable
H2	Cable axial pull test (5 Cable assemblies with plug at one end 2 m long)	ANSI/EIA 364-38C-08	6 ckt Fix Plug housing and apply a 98 N load for one minute on cable axis	a. Continuity	ANSI/EIA 364-46B-06	No discontinuity at 1 μ s or longer. (Each contact)
			4 ckt Fix Plug housing and apply a 49 N load for one minute on cable axis			
			9 ckt Fix Plug housing and apply a 50 N load for one minute on cable axis	b. Visual		

Table 12 – Performance Group H

Phase	Test			Measurement to be performed		Requirements Performance Level
	Title	ID No.	Severity or condition	Title	ID No.	
H3 6 ckt	Cable Flexing (5 cable assemblies with plugs at one end 2 m long)	ANSI/EIA 364-41D-08	6 ckt Condition I dimension X=3.7 times the cable diameter; 100 cycles in each of two planes. See IEEE Std 1394-2008 Figures 4-23 for cable flex test fixture	a. Withstanding Voltage	ANSI/EIA 364-20D-08	No flashover. No sparkover. No excessive leakage No breakdown.
				b. Insulation Resistance	ANSI/EIA 364-21D-08 Test Voltage 500 Vdc ± 50 Vdc Method C Unmated and Unmounted	100 MΩ minimum between adjacent contacts and contacts and shell
				c. Continuity	ANSI/EIA 364-46B-06	No discontinuity at 1 μs or longer. (Each contact)
				d. Visual		No jacket tears or visual exposure of shield. No jacket movement greater than 1.5 mm at point of exit.
H3 4 ckt 9 ckt	Cable Flexing (5 cable assemblies with plugs at one end 2 m long)	ANSI/EIA 364-41D-08	4 ckt and 9 ckt Condition I dimension X=5.5 times the cable diameter; 100 cycles in each of two planes. See IEEE Std 1394-2008 Figure 4-23 (4 ckt) or Figure 4-51 (9 ckt) for cable flex test fixture	a. Withstanding Voltage	ANSI/EIA 364-20D-08	No flashover. No sparkover. No excessive leakage No breakdown.
				b. Insulation Resistance	ANSI/EIA 364-21D-08 Test Voltage 100 Vdc ± 10 Vdc Method C Unmated and Unmounted	100 MΩ minimum between adjacent contacts and contacts and shell
				c. Continuity	ANSI/EIA 364-46B-06	No discontinuity at 1 μs or longer. (Each contact)
				d. Visual		No jacket tears or visual exposure of shield. No jacket movement greater than 1.5 mm at point of exit.

Table 12 – Performance Group H (Continued)

Note:

- 1) This table is equivalent to Performance Group G Tables 4-9 (6 ckt), 4-18 (4 ckt) and 4-32 (9 ckt) of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.6.9 Performance Group I: High speed electrical functionality

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Severity or conditions	Title	ID No.	
I1	Impedance (Cable)	IEEE Std 1394-2008 Annex K.3	6 ckt and 4 ckt 200 ps rise time at 1 ns and 2.5 ns beyond the connector launch plane	Differential Mode (Cable)	IEEE Std 1394-2008 Annex K.3	6 ckt and 9 ckt $Z_{TPA} = 110 \Omega \pm 6 \Omega$ $Z_{TPB} = 110 \Omega \pm 6 \Omega$ $Z_{TPA1} = Z_{TPA2} \pm 4\%$ $Z_{TPB1} = Z_{TPB2} \pm 4\%$ $Z_{TPACM} = 33 \Omega \pm 6 \Omega$ $Z_{TPBCM} = 33 \Omega \pm 6 \Omega$
			9 ckt 80 ps rise time beyond the connector launch plane		9 ckt IEEE Std 1394-2008 4.4.4.2	4 ckt $Z_{TPA} = 110 \Omega \pm 6 \Omega$ $Z_{TPB} = 110 \Omega \pm 6 \Omega$ $Z_{TPA1} = Z_{TPA2} \pm 4\%$ $Z_{TPB1} = Z_{TPB2} \pm 4\%$
I2	Impedance (Connector)	IEEE Std 1394-2008 Annex K.3	6 ckt and 4 ckt 500 ps rise time at 50 ps, 100 ps and 150 ps beyond the connector launch plane	Differential Mode (Connector)	IEEE Std 1394-2008 Annex K.3.2	6 ckt and 4 ckt $Z_{TPAconn} = 110 \Omega \pm 25 \Omega$ $Z_{TPBconn} = 110 \Omega \pm 25 \Omega$
			9 ckt 80 ps rise time beyond the connector launch plane		9 ckt IEEE Std 1394-2008 4.4.4.2	9 ckt $Z_{TPAconn} = 110 \Omega \pm 15 \Omega$ $Z_{TPBconn} = 110 \Omega \pm 15 \Omega$
I3	Attenuation	IEEE Std 1394-2008 Annex K.4	6 ckt and 4 ckt L = 4.5 m at 100 MHz, 200 MHz and 400 MHz	Attenuation	IEEE Std 1394-2008 Annex K.4.2 & K.4.3	6 ckt and 4 ckt 100 MHz < 2.3 dB 200 MHz < 3.2 dB 400 MHz < 5.8 dB
			9 ckt L = 4.5 m at 250 MHz, 400 MHz, 800 MHz, 1500 MHz, 3000 MHz, 4000 MHz		9 ckt IEEE Std 1394-2008 4.4.4.3	9 ckt 250 MHz < 3.30 dB 400 MHz < 4.10 dB 800 MHz < 6.20 dB 1500 MHz < 10.0 dB 3000 MHz < 16.8 dB 4000 MHz < 21.0 dB
I4	Velocity of Propagation Delay	IEEE Std 1394-2008 Annex K.5	Per meter average over 50 MHz, 100 MHz and 200 MHz	Differential Mode	IEEE Std 1394-2008 Annex K.5.2 & K.5.3	6 ckt and 4 ckt $V_{TPA} \leq 5.05 \text{ ns / m}$ $V_{TPB} \leq 5.05 \text{ ns / m}$
				Common Mode	9 ckt IEEE Std 1394 Paragraphs 4.4.4.3 and 4.4.4.5	9 ckt $V_{TPACM} \leq 5.05 \text{ ns / m}$ $V_{TPBCM} \leq 5.05 \text{ ns / m}$

Table 13 – Performance Group I

5.6.9 Performance Group I: High speed electrical functionality (Continued)

Phase	Test			Measurements to be performed		Requirements Performance Level
	Title	ID No.	Title	ID No.	Title	
I5	Skew	IEEE Std 1394-2008 Annex K.6.2 ANSI/EIA 364-103-06	6 ckt and 4 ckt Between signal pairs at 50 MHz, 100 MHz and 200 MHz	Skew	IEEE Std 1394-2008 Annex K.6.2 ANSI/EIA 364-103-06	6 ckt and 4 ckt Skew \leq 400 ps
			9 ckt 70 ps rise time		9 ckt IEEE Std 1394-2008 Paragraph 4.4.4.5	9 ckt IEEE Std 1394-2008 Figure 4-61
I6	Crosstalk	IEEE Std 1394-2008 Annex K.8 ANSI/EIA 364-90-07	6 ckt and 4 ckt 1 MHz to 75 MHz	Crosstalk	IEEE Std 1394-2008 Annex K.8.2 ANSI/EIA 364-90-07	4 ckt and 6 ckt $X_{AB} \leq -26$ dB $X_{AB^*} \leq -26$ dB $X_{A^*B} \leq -26$ dB $X_{A^*B^*} \leq -26$ dB
			9 ckt Connector: 80 ps rise time Cable Assembly: 160 ps rise time			9 ckt Connector: $X_{next}, X_{fext} \leq 3\%$ Cable: $X_{next}, X_{fext} \leq 5\%$
I7	Power pair dc resistance (6 ckt & 9 ckt)	6 ckt & 9 ckt IEEE Std 1394-2008 Annex K.7.3	9 ckt Type 1 Cable assembly and Type 3 Cable assembly	Power pair dc resistance (6 ckt & 9 ckt)	6 ckt IEEE Std 1394-2008 Annex K.7.3	6 ckt $R_V \leq 0.333 \Omega$ $R_G \leq 0.333 \Omega$
					9 ckt IEEE Std 1394-2008 4.4.4.7	9 ckt 1.5 A at 30 Vdc

Table 13 – Performance Group I (Continued)**Note:**

- 1) This table is created using information contained in Section 4 and Annex K of IEEE Std 1394-2008.
- 2) All ANSI/EIA test ID numbers referenced were updated to the most recent ID numbers.

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5.7 Visual Examination

Visual examination of the test samples for acceptable workmanship and physical damage that will prevent mechanical and electrical operation shall be performed initially and after each environmental and stress test.

Workmanship generally accepted by the electrical and electronics industry and commonly used in electrical connector and cable assembly evaluation is required for all samples submitted for qualification. Any deviation from these accepted physical and or workmanship standards during the qualification program shall be deemed as failure.

Additionally, the Manufacturer's Name or Logo shall be on each sample.

5.8 Data Measurements

All contact positions shall be measured. Sample identification and contact position number shall identify the data measurements. The results of each test shall be recorded as data.

Unless otherwise specified in the specific procedures used, measurements following exposure shall be performed within 24 hours and after the samples have recovered to room ambient conditions. The test samples shall be handled in a manner so as not to disturb the contact interface. It is preferred to perform measurements without handling the test samples. Unless otherwise specified, the specimen shall remain mated to the specimen that they were mated for the initial measurements throughout the exposures.

5.9 Failure Analysis

Connector and cable assembly failures may be analyzed at the end of the testing. Test sequence shall not be interrupted until completion. Failures attributed to operator error, equipment, and test printed circuit boards; etc. shall not be classified as a connector failure.

The test laboratory and the manufacturer will jointly review the failed samples and conduct the failure analysis. In performing the failure analysis, samples may remain mated, then potted and sectioned followed by examination. The manufacturer should be consulted for conducting destructive failure analysis such as potting and cross sectioning. The test laboratory and the manufacturer will jointly compile a failure analysis report and establish a corrective action plan and prepare a schedule to resubmit samples.

If the test laboratory and the manufacturer disagree on the failure analysis results and cannot come to resolution, a summary of the failure analysis report and the corrective action plan that does not contain any confidential information of the manufacturer shall be sent to the Quality Review Board (QRB) of the 1394 Trade Association. The QRB will review the report and make recommendations for resolving the disputes between the test laboratory and the manufacturer.

All failure analysis results, conclusions and corrective actions shall remain property of the submitting manufacturer.

5.10 Test Report

The testing laboratory shall prepare a test report for review and approval by the Compliance Logo Program Administrator of 1394 Trade Association and the submitting manufacturer. A final test report will be supplied to both the Compliance Logo Program Administrator of 1394 Trade Association and the submitting manufacturer in both hard copy and electronic format. Competitive manufacturer's data will not be included except in cross mating tests. All competitive manufacturer identities will be eliminated from the report.

All test report results and conclusions shall remain confidential property of the submitting manufacturer.

The test report shall contain a performance group description, summary of the results, discussion of any test problems, conclusions, test data, test procedures including severity of the conditions, test equipment used in the testing, schematics, photographs, etc. as applicable.

Also included in the report shall be:

- 1) Test laboratory completing the evaluation
- 2) PC board socket, cable plug kit and cable assembly manufacturer, product descriptions and product reference IDs that shall be traceable to commercial product numbers by the TA for purpose of granting the compliance logos.
- 3) Cable manufacturer and product descriptions and product reference IDs that shall be traceable to commercial product numbers by the TA for purpose of granting the compliance logos, conductor size and type (AWG and number of strands and insulation material) and outer and signal shield construction.
- 4) Cable assembly termination technique, tooling and process information
- 5) Printed circuit test board manufacturer and part number
- 6) Additional special preparation performed

5.11 Test Sample Disposition

Following the successful completion of the test sequences, each test sample shall be separately packaged in clear plastic and retained by the test laboratory for not less than one year. Manufacturer, sample identification and test report information shall be included on each package. These archived samples are only for the reference use of the test laboratory and the submitting manufacturer.

Annex A (Normative)

IEEE 1394-2008 (6 ckt) Finish & Dimensional Requirements

A.1 Contact finish on plug and socket contacts

It is necessary to standardize the electroplated finish on the contacts to assure the compatibility of plugs and sockets from different sources. The following standardized electroplatings are compatible, and one should be used on contacts.

- 1) 0.76 μm (30 μin), minimum gold, over 1.27 μm , minimum, nickel.
- 2) 0.05 μm (2 μin), minimum, gold, over 0.76 μm (30 μin) minimum, palladium, over 1.27 μm (50 μin), minimum, nickel.
- 3) 0.05 μm (2 μin), minimum, gold, over 0.76 μm (30 μin) minimum, palladium-nickel alloy (80% Pd-20% Ni), over 1.27 μm (50 μin), minimum, nickel

NOTE –

- Selective plating on contacts is acceptable. In that case, one of the above electroplatings shall cover the complete area of contact, including the contact wipe area.
- Copper strike is acceptable under the nickel electroplate.
- Palladium strike is acceptable over the nickel electroplate.

A.2 Termination finish on plug and socket contacts

It is acceptable to use an electroplate of 3.04 μm (120 μin) tin or tin alloy over a minimum thickness of 1.27 μm (50 μin) nickel. A copper strike is acceptable under the nickel.

A.3 Shell finish on plugs and sockets

It is necessary to standardize the plated finish on the shells to insure compatibility of products from different sources. Both shells shall be electroplated with a minimum of 3.03 μm (120 μin) of tin or tin alloy, or a galvanically compatible alloy, over a suitable underplate.

Note:

Annex A was copied from sections 4.2.1.5, 4.2.1.6, 4.2.1.7 in IEEE Std. 1394-2008 with the following changes:

- 1). Deleted "tin-lead" in section 4.2.1.6 and added "tin or tin alloy" for termination finish on plug and socket contacts.

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Annex B
(Normative)

IEEE 1394-2008 (4 ckt) Finish & Dimensional Requirements

B.1 Contact finish on plug and socket contacts

It is necessary to standardize the electroplated finish on the contacts to assure the compatibility of plugs and sockets from different sources. The following standardized electroplatings are compatible, and one should be used on contacts.

- 1) 0.76 μm (30 μin), minimum gold, over 1.27 μm , minimum, nickel.
- 2) 0.05 μm (2 μin), minimum, gold, over 0.76 μm (30 μin) minimum, palladium, over 1.27 μm (50 μin), minimum, nickel.
- 3) 0.05 μm (2 μin), minimum, gold, over 0.76 μm (30 μin) minimum, palladium-nickel alloy (80% Pd-20% Ni), over 1.27 μm (50 μin), minimum, nickel

NOTE –

- Selective plating on contacts is acceptable. In that case, one of the above electroplatings shall cover the complete area of contact, including the contact wipe area.
- Copper strike is acceptable under the nickel electroplate.
- Palladium strike is acceptable over the nickel electroplate.

B.2 Termination finish on plug and socket contacts

It is acceptable to use an electroplate of 3.04 μm (120 μin) tin or tin alloy over a minimum thickness of 1.27 μm (50 μin) nickel. A copper strike is acceptable under the nickel.

B.3 Shell finish on plugs and sockets

It is necessary to standardize the plated finish on the shells to insure compatibility of products from different sources. Both shells shall be electroplated with a minimum of 3.03 μm (120 μin) of tin or tin alloy, or a galvanically compatible alloy, over a suitable underplate.

Note:

Annex B was copied from sections 4.3.1.4, 4.3.1.5, 4.3.1.6 in IEEE Std. 1394-2008 with the following changes:

- 1). Deleted "tin-lead" in section 4.2.1.6 and added "tin or tin alloy" for termination finish on plug and socket contacts.

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Annex C (Normative)

IEEE 1394-2008 (9 ckt) Finish & Dimensional Requirements

C.1 Contact finish on plug and socket contacts

It is necessary to standardize the electroplated finish on the contacts to assure the compatibility of plugs and sockets from different sources. The following standardized electroplatings are compatible, and one should be used on contacts.

- 1) 0.76 μm (30 μin), minimum gold, over 1.27 μm , minimum, nickel.
- 2) 0.05 μm (2 μin), minimum, gold, over 0.76 μm (30 μin) minimum, palladium-nickel alloy (80% Pd-20% Ni), over 1.27 μm (50 μin), minimum, nickel

NOTE –

- Selective plating on contacts is acceptable. In that case, one of the above electroplatings shall cover the complete area of contact, including the contact wipe area.
- Copper strike is acceptable under the nickel electroplate.
- Palladium strike is acceptable over the nickel electroplate.

C.2 Termination finish on plug and socket contacts

It is acceptable to use an electroplate of 3.04 μm (120 μin) tin or tin alloy over a minimum thickness of 1.27 μm (50 μin) nickel. A copper strike is acceptable under the nickel.

C.3 Shell finish on plugs and sockets

It is necessary to standardize the plated finish on the shells to insure compatibility of products from different sources. Both shells shall be electroplated with a minimum of 3.03 μm (120 μin) of tin or tin alloy, or a galvanically compatible alloy, over a suitable underplate.

Note:

Annex C was copied from sections 4.4.1.3, 4.4.1.4, 4.4.1.5 in IEEE Std. 1394-2008.

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