IPC-4412C

Specification for Finished Fabric Woven from "E" Glass for Printed Boards

Developed by the IPC Woven Glass Reinforcement Task Group (3-12d) of the Printed Board Base Materials Committee (3-10) of IPC

Supersedes:
IPC-4412B WAM3, December 2018

Users of this publication are encouraged to participate in the development of future revisions.

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1 SCOPE

This specification covers finished fabrics woven from ''E'' glass electrical grade glass fiber yarns that are intended as a reinforcing material in laminated plastics for electrical and electronic use. All fabrics covered by this specification are plain weave.

1.1 Purpose This specification determines the nomenclature, definitions, general and chemical requirements for the glass, and physical requirements for finished woven glass fiber fabrics.

1.2 Designation Appendix A provides the user with a cross reference between the IPC-4412 requirements and ISO specifications applicable to woven glass. Appendix B of this standard provides a style designator for each finished fabric glass style, with specifications on yarn, fabric count, thickness and weight in both SI and US system. Fabrics listed in Appendix B also categorize fabrics by their current availability status.

1.3 Classification

CLASS 1 General Electronic Products

Includes products suitable for applications where the major requirement is function of the completed assembly.

CLASS 2 Dedicated Service Electronic Products

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

CLASS 3 High Performance/Harsh Environment Electronic Products

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

1.4 Measurement Units This Standard uses International System of Units (SI) units per ASTM SI10, IEEE/ASTM SI 10, Section 3 [Imperial English equivalent units are in brackets for convenience]. The SI units used in this Standard are millimeters (mm) [in] for dimensions and dimensional tolerances, Celsius (°C) [°F] for temperature and temperature tolerances, grams (g) [oz] for weight, and lumens (lm) [footcandles] for illuminance.

Note: This Standard uses other SI prefixes (ASTM SI10, Section 3.2) to eliminate leading zeroes (for example, 0.0012 mm becomes 1.2 µm) or as an alternative to powers-of-ten (3.6 x 103 mm becomes 3.6 m).

1.5 Definition of Requirements The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance. The word "should" reflects recommendations and is used to reflect general industry practices and procedures for guidance only. Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this Standard. The text takes precedence over the figures.

1.6 Process Control Requirements The primary goal of process control is to continually reduce variation in the processes, products, or services to provide products or processes meeting or exceeding User requirements. Process control tools such as IPC-9191, JESD557 or other User-approved system may be used as guidelines for implementing process control.

Manufacturers of Class 3 products **shall** develop and implement a documented process control system.

A documented process control system, if established, **shall** define process control and corrective action limits. For Class 1 and 2 products, the use of "statistical process control (SPC)" **shall** be optional and should be based on factors such as design stability, lot size, production quantities, and the needs of the manufacturer, See paragraph 4.1 for the quality assurance section regarding SPC.

1.7 Order of Precedence

The contract **shall** take precedence over this Standard, referenced standards and drawings.

In the event of conflict, the following order of precedence applies:

1) Procurement as agreed and documented between customer and supplier.
2) Master drawing reflecting the customer's detailed requirements.
3) When invoked by the customer or per contractual agreement, this standard.

When documents other than this standard are cited, the order of precedence shall be defined in the procurement documents.

The User has the opportunity to specify alternate acceptance criteria.

1.7.1 Conflict In the event of conflict between the requirements of this standard and the applicable drawing(s) and documentation, the applicable user-approved drawing(s) and documentation govern.

Some examples of documentation include the contract, purchase order, technical data package, engineering specification or performance specification. In the event of a conflict between the text of this standard and the applicable documents cited herein, the text of this standard takes precedence. In the event of conflict between the requirements of this standard and drawing(s) and documentation that has not been user approved, this standard governs.

1.7.2 Clause References When a clause in this document is referenced its subordinate clauses apply, unless the requirement references specific subordinate clauses.

1.7.3 Appendices Appendices to this standard are not binding requirements unless separately and specifically required by this standard, the applicable contracts, assembly drawing(s), documentation or purchase orders.

1.7.3.1 Appendix A Cross Reference List
1.7.3.2 Appendix B Finished Fabric Glass Styles SI Units
1.7.3.3 Appendix C Abbreviations and Acronyms

1.8 Use of "Lead" For readability and translation, this document uses the noun lead only to describe leads of a component. The metallic element lead is always written as Pb.

1.9 Abbreviations and Acronyms Periodic table elements are abbreviated in the standard. See Appendix C for full spellings of abbreviations (including elements) and acronyms used in this standard.

1.10 Terms and Definitions Other than those terms listed below, the definitions of terms used in this standard are in accordance with IPC-T-50.

1.10.1 Defect Major A defect that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose.

1.10.2 Defect Minor A defect that is not likely to reduce materially the usability of the unit of product for its intended purpose.

1.10.3 Defect per Hundred Units

$$\frac{\text{Number of Defects}}{\text{Number of Units Inspected}} \text{ X } 100$$

1.10.4 Dielectric Constant (Permittivitty-Dk) for Bulk Form E-Glass The permittivity (dielectric constant-Dk) of bulk form E glass to be used for printed board applications, as a *reference only* value, is 7.1 @ 1 GHz, as measured by IPC-TM-650, Method 2.5.5.9.

1.10.5 E-Glass (Electrical Grade Glass Fiber) E-glass, which is to be used for printed board applications, is a continuous filament glass yarn with a chemical composition* by weight that is within the following limits:

B_2O_3**	5% - 10%
CaO	16% - 25%
Al_2O_3	12% - 16%
SiO_2	52% - 56%
MgO	0% - 5%
Na_2O and K_2O	0% - 2%
TiO_2	0% - 0.8%
Fe_2O_3	0.05% - 0.4%
F_2	0% - 1.0%

* Composition is to be certified by yarn supplier as requested.

**For convenience, the composition of borosilicate glass is often expressed in terms of oxides (B_2O_3, SiO_2, Al_2O_3, Na_2O, CaO, etc.). This does not imply anything about the nature and structure of glass. Borates are network formers and are part of the structure of borosilicate glass. All raw materials are completely consumed during manufacturing, and no raw materials are present in the final product.