Association Connecting Electronics Industries

IPC/JEDEC J-STD-709

Limits for Bromine and Chlorine in Flame Retardants and Polyvinyl Chloride in "Low Halogen" Electronic Products

Proposed Standard for Ballot

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Foreword

Low-halogen technologies are currently not well defined, nor are they mandated as a requirement by any legislation worldwide. The trend towards low-halogen materials in electronic products has created a need for standardization of accepted levels of halogens within electronic materials and systems, as well as agreed upon definitions and optional test methodologies to ensure uniform adoption of low-halogen materials. Should one choose to implement a low-halogen technology, this standard can be utilized to identify industry accepted definitions, optional test methodologies and targeted materials and systems requirements.

Brominated and chlorinated flame retardants (BFRs, CFRs) and polyvinyl chloride (PVC) have been identified for reduction in electronic products With the recent focus on the use of bromine and chlorine, certain companies have begun to offer “halogen-free” materials and components in selected electronic product offerings. While the halogen group contains fluorine, chlorine, bromine, iodine, and astatine, we will use the terms halogen-free and low-halogen to refer only to bromine and chlorine as per the International Electrotechnical Commission (IEC) and IPC definitions of halogen-free (Section 2.0). The term halogen-free has been used, for example, in JPCA-ES-01 and IPC-TM-650 TM *2.3.41 Test Method for Total Halogen Content in Base Materials.*“ In this document the term low-halogen is used rather than halogen-free to identify a material that contains these low concentrations of bromine and chlorine when used in BFRs, CFRs and PVC.

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1 SCOPE

This standard provides definitions, optional test methods, marking and labeling recommendations, and targeted materials and systems to define a low-halogen technology. This document could be used to apply to all materials and parts of electronic equipment including but not limited to:

(1) plastic in construction of various plastic components (substrate , mold compounds, solder masks, underfill materials, etc);

(2) printed board (PB) assemblies (PBAs) including components;

(3) plastic in cables, connectors, sockets, and external wiring;

(4) mechanical plastics (enclosures, fans, etc). and

(5) films, tapes, and adhesives

This standard establishes the maximum limits for the halogens bromine (Br) and chlorine (Cl) when used in BFRs, CFRs and PVC as these are the primary halogens used in electronic components and assemblies. Although the halogens fluorine (F) and iodine (I) may be present in some electronics, they are not included in the scope of this standard. Brominated and chlorinated compounds are most common and also the most likely to be present to achieve flame retardancy, and therefore are the elements for which limits are established. The halogen astatine (At) is also excluded from this standard as it is not used in electronics because it is radioactive and short lived.

Bromine and/or chlorine in materials that may be used during processing, product delivery systems, or packaging, but do not remain within the final product are not included in the scope of this standard.

NOTE 1 : All Printed Board (PB) and substrate laminates must meet Br and Cl requirements for low halogen as defined in IPC-4101B

NOTE 2 : The definition of ”low-halogen” is consistent with the term “halogen-free” as described in IPC 4101*,* the IEC 61249-2 sectional standards related to non-halogenated base material, and the J-STD-609 Marking and Labeling Standard *;* standards currently in use in the electronics industry.

1.1 Purpose

Establish an industry standard for the definition and threshold limits associated with “low-halogen” electronics, including electronic components, electronic assemblies, cables and mechanical plastics, as well as optional analytical testing methods to determine halogen content. Optional marking and labeling recommendations are also included.

2 REFERENCE DOCUMENTS

2.1 IPC

URL: www.ipc.org

IPC-T-50 *Terms and Definitions for Interconnecting and Packaging Electronic Circuits*

IPC-CC-830 *Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies*

IPC-4101 *Specification for Base Materials for Rigid and Multilayer Printed Boards*

IPC/JEDEC J-STD-609 *Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb), Pb-free and Other Attributes*

IPC-TM-650 *TM 2.3.41 Test Method for Total Halogen Content in Base Materials*

2.2 JEDEC

URL: www.jedec.org

JESD88 JEDEC *Dictionary of Terms for Solid State Technology*

2.3 JPCA

URL: www.jpca.org

JPCA–ES–01- *Test Method for Halogen Free Materials*

2.4 JEIA

URL: www.jeia.jp

MC-001 Guideline of Halogen Free Epoxy Molding Compound for Semiconductor

2.5 IEC

URL: www.iec.ch

IEC 61189-2 *Test methods for electrical materials, printed boards and other interconnection structures and assemblies*

IEC 61249-2 *Materials for printed boards and other interconnecting structures* sectionals:

Part 2-21: Reinforced base materials, clad and unclad - Non-halogenated epoxide woven E-glass reinforced laminated sheets of defined flammability (vertical burning test), copper-clad

Part 2-22: Reinforced base materials clad and unclad - Modified non-halogenated epoxide woven E-glass laminated sheets of defined flammability (vertical burning test), copper-clad

Part 2-23: Reinforced base materials, clad and unclad - Non-halogenated phenolic cellulose paper reinforced laminated sheets, economic grade, copper clad

Part 2-26 Reinforced base materials clad and unclad - Non-halogenated epoxide non-woven/woven E-glass reinforced laminated sheets of defined flammability (vertical burning test), copper-clad

Part 4-2: Sectional specification set for prepreg materials, unclad - Multifunctional epoxide woven E-glass prepreg of defined flammability

IPart 4-5: Sectional specification set for prepreg materials, unclad - Polyimide, modified or unmodified, woven E-glass prepreg of defined flammability

Part 4-11: Sectional specification set for prepreg materials, unclad - Non-halogenated epoxide, woven E-glass prepreg of defined flammability

Part 4-12: Sectional specification set for prepreg materials, unclad - Non-halogenated multifunctional epoxide woven E-glass prepreg of defined flammability

2.6 ISO

URL: www.iso.org

ISO 11469:2000 *Plastics – Generic identification and marking of plastics products*

ISO 1043-4:1998 *Plastics -- Symbols and abbreviated terms -- Part 4: Flame retardants*

3 TERMS AND DEFINITIONS

Other than those terms listed below, the definitions of terms used in this standard are in accordance with IPC-T-50 and/or JESD88.

3.1 Plastic

Any of a group of synthetic or natural organic compounds produced by polymerization, optionally combined with additives (organic or inorganic fillers, modifiers, etc) into a homogeneous material capable of being molded, extruded, or cast into various shapes and films.

3.2 Congener

One of many variants of a common chemical structure, including copolymers, block copolymers, and derivatives, that have minor differences in geometry and substituents, but have a substantially similar chemical structure. Includes every possible isomer.

4 WHERE BROMINE AND CHLORINE ARE USED IN ELECTRONIC PRODUCTS

Brominated flame retardants (BFRs), and less frequently chlorinated flame retardants (CFRs), are added to thermoplastics, insulation materials, component mold compounds, solder masks, printed circuit board laminates, or other plastic materials to achieve a desired flame retardancy (e.g. UL 94 V-0). In addition, polyvinyl chloride (PVC) is commonly used as the base resin for certain cable jacketing and vibration dampening materials. See Table 4-1.

Table 4-1 General Presence of Bromine and Chlorine in BFRs, CFRs and PVC In Electronics

Part Type	Potential Use
Mechanical Plastic Parts (thermoplastics)	BFRs/CFRs used in certain flame retardants ABS, HIPS, PC, PS, Polyimide (PI), polyamide (PA) and PBT resins
Cables	BFRs used in cable/wire insulation material PVC used in cable/wire jacketing and overmold
Printed Circuit Boards	BFRs added or reacted into FR-4 and other epoxy resins. Certain solder masks, cover coat, and conformal coatings also contain halogens. Chlorinated organic materials are used in the commercial manufacture of epoxy resins and sodium chloride is a byproduct from this process.
Electronic Components	BFRs added or reacted into FR-4 and other epoxy resins, mold compounds, plastic packages, , thermal interface materials, die attach, underfills. Certain solder masks, cover coats and conformal coatings also contain halogens.
Connectors	BFRs used in certain flame-rated PBT and PA resins
Films, Adhesives, Tapes	PVC used in certain magnetic tapes Certain polymers containing bromine for optical properties Polymers containing chlorine or chlorine residuals in certain adhesives
Vibration dampening parts	PVC used in shock absorbing or vibration dampening resins

5 DEFINITION OF LOW-HALOGEN ELECTRONICS

The halogens fluorine (F), iodine (I), and astatine (At) are not covered by this standard. Bromine (Br) and Chlorine (Cl) refer to all oxidation states of these elements. Bromine (Br) and Chlorine (Cl) in materials that may be used during processing but do not remain within the final product are not included in this definition.

"BFR/CFR and PVC-Free" Definition:

A **Component** must meet all of the following requirements to be defined as "BFR/CFR and PVC-Free":

1) All Printed Board (PB) and substrate laminates shall meet Br and Cl requirements for low halogen as defined in IPC-4101B. Printed Board (PB) and substrate laminates do not include the solder mask . Solder mask is considered a plastic material (Section 2 below).

2) For components other than Printed Board (PB) and Substrate laminates:

- **Each plastic within the component** contains < 1000 ppm (0.1%) of Bromine [if the Bromine (Br) source is from BFRs] and < 1000 ppm (0.1%) of Chlorine [if the Chlorine (Cl) source is from CFRs, PVC or PVC congeners]. Higher concentrations of Br and Cl are allowed in **plastics of components** other than Printed Board (PB) and Substrate laminates as long as their sources are not BFRs, CFRs, PVC or PVC congeners.

- For discrete components that do not contain Printed Board (PB) or substrate laminates or plastics, the components shall contain <1000 ppm (0.1%) of Bromine [if the Bromine (Br) source is from BFRs] and <1000 ppm (0.1%) of Chlorine [if the Chlorine (Cl) source is from CFRs, PVC or PVC congeners].

3) Although the elemental analysis for Br and Cl can be performed by any analytical method with sufficient sensitivity and selectivity, the presence or absence of BFRs, CFRs, PVC and PVC congeners must be verified by any acceptable analytical techniques and/or material declaration that allow for the unequivocal identification of the specific Br or Cl compounds, or by appropriate material declarations agreed to between customer and supplier.

Note : PVC congeners are included in this definition to clarify that PVC copolymers and other derivatives that are chemically very similar to PVC are not acceptable alternatives to PVC for the purposes of this low halogen definition.

6 TEST METHODOLOGY CONSIDERATIONS FOR DETERMINING BROMINE AND CHLORINE CONTENT IN ELECTRONICS

6.1 Test methods

Methods for the determination of levels of Br and Cl in BFRs, CFRs and PVC may be different based on the specific classification requirements, and/or size of the item being tested. Levels of bromine (Br) and chlorine (Cl) shall be determined by any appropriate standard analytical method with sufficient resolution such as ICP / MS or IC.

A two tiered test strategy is recognized as the best approach to determine both the concentration of Br and Cl (whether above or below the 1000 ppm targets) as well as the source. Handheld XRF may be used as a screen tool, but should not be used or relied upon as a definitive test method. Material declaration may be used to determine the source of the Br or Cl.

It should be recognized that there can be significant levels of error associated with various bromine and chlorine test methods. In addition, there can be contamination based on handling.

Care should be taken when selecting a test method. It is necessary to understand the applicable country and/or accepted industry definition(s) and for the supplier and customer to reach agreement on a testing method. In an effort to reduce the possibility of duplicative testing and overall costs of testing in the supply chain, customers are encouraged to recognize any standard analytical method (rather than insisting on use of only one particular method).

The inclusion of a test method section in this standard should not be interpreted as a requirement that there be testing. Instead, the intent is to standardize appropriate test methods. Material Declarations and/or other types of product certifications provided by suppliers may be used in the place of testing.

7 MARKING AND LABELING FOR LOW-HALOGEN ELECTRONICS

7.1 Marking of Components/Sockets/Connectors/Cables

If the materials used in the manufacture of the finished component/technologies meet the requirements in Section 5, the component may be marked using a scheme that is consistent with what is outlined in J-STD-609, or with other distinguishing marking scheme. As an alternative to marking of components, a new part numbering scheme may be used to denote that a given part is low-halogen.

7.2 Marking of Printed Boards (PBs)

If all materials used in the fabrication of a finished Printed Board (PB) meet the requirements in Section 5 and if marking is required, the marking **shall** be in accordance with J-STD-609.

7.3 Marking of Mechanical Plastics

Mechanical plastic parts may be marked/labeled in accordance with ISO 11469:2000. Compositions containing flame retardants may be marked per ISO 1043-4:1998.