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Definition of “Low-Halogen” For Electronic Products

JS709C

(Revision of JS709B, April 2015)

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION
ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION

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DEFINITION OF "LOW-HALOGEN" FOR ELECTRONIC PRODUCTS

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DEFINITION OF "LOW-HALOGEN" FOR ELECTRONIC PRODUCTS

Foreword

The term "low-halogen" is currently not well defined, nor is it mandated as a requirement by any legislation worldwide at the time of this standard. Nevertheless, to ensure a uniform and consistent understanding throughout the industry of the meaning of "low-halogen", this term needs to be clearly defined as it pertains to materials within electronic products. In this standard, the term "low-halogen" is defined in Clause 4 and is used to identify materials within electronic products that contain low concentrations of bromine and chlorine from brominated and chlorinated flame retardants (BFRs, CFRs) and polyvinyl chloride (PVC). Should one choose to implement a "low-halogen" technology, this standard shall be utilized to identify the industry accepted definition, targeted materials, and systems requirements.

Introduction

Halogenated polymeric materials and compounds are used in various engineering applications, including flame retardation. Several decades of use have proven these materials and compounds to be reliable and cost-effective. The electronic industry seeks to reduce the overall environmental impact of our products by working to develop reliable and cost-effective alternatives to these materials and compounds. However, the timetable for broad-scale adoption of low-halogen materials is difficult to predict, because applications such as complex multilayer PCBs and large molded integrated circuits will require further investigation and qualification of new materials.

The halogen group contains fluorine, chlorine, bromine, iodine, and astatine; however, this document will use the term "low-halogen" to refer only to bromine and chlorine to be consistent with the International Electrotechnical Commission (IEC) and IPC definitions of "halogen-free" (see 2.4). Refer to Annex C for further explanation for exclusion of astatine, iodine and fluorine. In this document, the term "low-halogen" is used to identify a material that contains low concentrations of bromine and chlorine from brominated and chlorinated flame retardants (BFRs, CFRs) and polyvinyl chloride (PVC).

DEFINITION OF "LOW-HALOGEN" FOR ELECTRONIC PRODUCTS

(From JEDEC Board Ballot JCB-18-03, formulated under the cognizance of the JEDEC JC-14.4 Subcommittee on Quality Processes and Methods and the ECA S-1 Passive Components Steering Committee.)

1 Scope

This standard provides terms and definitions for "low-halogen" electronic products that have the potential to contain the halogens bromine (Br) and chlorine (Cl) from the use of BFRs, CFRs, and PVC, and recommends methods for marking and labeling. This standard may be applied to all nonmetallic and nonceramic materials within electronic products including, but not limited to, materials in the following components commonly found in electronic products:

1. Transistors, integrated circuits, modules consisting mainly of integrated circuits (e.g., multichip, hybrid), and memory modules
2. Resistors, capacitors, relays, inductors, and connectors
3. Printed circuit board assemblies (PCBA's) including components
4. Plastic in cables, sockets, switches and external wiring
5. Mechanical plastics (enclosures, fans, etc.)
6. Films, tapes, inks, and adhesives
7. Soldering flux residues (when present)
8. Sound, shock, and vibration dampeners (foams, resins, etc.)

This document establishes the maximum concentration level for the halogens bromine (Br) and chlorine (Cl) from the use of BFRs, CFRs, and PVC. While the halogen group contains fluorine, chlorine, bromine, iodine, and astatine, this document will use the term "low-halogen" to refer only to bromine and chlorine. Refer to Annex C for further explanation for exclusion of astatine, iodine and fluorine.

NOTE The definition of "low-halogen" is different from the term "halogen-free" as described in IEC 61249-2 sectional standard related to non-halogenated base material and as defined in the J-STD-609A marking and labeling standard; standards that pertain only to printed boards and are currently in use in the electronics and solid-state industries.

BFRs, CFRs, and PVC in materials that may be used during processing, in product delivery systems, or in packaging, but do not remain within the final product are not included in the scope of this document.

2 Reference documents

2.1 IEC[1]

(IEC 62321 Ed. 1: 2008 *"Electrotechnical products - Determination of levels of six regulated substances (lead, mercury, cadmium, hexavalent chromium, polybrominated* biphenyls, polybrominated diphenyl ethers)

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

EN 14582:2007-06 *Characterization of waste - Halogen and sulphur content - Oxygen combustion in closed systems and determination methods*

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*

2.2 IPC[2]

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

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*

IPC/WP/TR-584A *IPC White Paper and Technical Report on the Use of Halogenated Flame Retardants in Printed Circuit Boards and Assemblies*

2.3 ISO[3]

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

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

2.4 JEDEC[4]

JESD88 *JEDEC Dictionary of Terms for Solid-state Technology*

[1] www.iec.ch
[2] www.ipc.org
[3] www.iso.org
[4] www.jedec.org

2 Reference documents (cont'd)

2.5 JEITA[5]

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

2.6 JPCA[6]

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

3 Terms and definitions

For the purposes of this publication, the following terms and definitions apply. For other terms, the definitions in JESD88 and/or IPC-T-50 apply.

At	astatine
BFR	brominated flame retardant
Br	bromine
Cl	chlorine
CFR	chlorinated flame retardant
F	fluorine
FR	flame retardant
I	iodine
IC	Ion Chromatography
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
PBDE	polybrominated diphenyl ether
PCB	printed circuit board
PCBA	printed circuit board assembly
PPM	parts per million
PTFE	Polytetrafluoroethylene
PVC	polyvinyl chloride
TBBPA	tetrabromobisphenol-A
XRF	x-ray fluorescence

[5] www.jeita.jp
[6] www.jpca.org

3 Terms and definitions (cont'd)

block polymer: A substance composed of block macromolecules **(IUPAC definition)**

brominated/chlorinated flame retardants (BFR/CFR): Flame retardants that contain bromine and/or chlorine.

NOTE These compounds are typically added to or reacted into polymers such as certain epoxy resins and thermoplastics to reduce their flammability. Examples include, but are not limited to, tetrabromobisphenol-A (TBBPA), brominated epoxy resins, and polybrominated diphenyl ethers (PBDEs).

congener (within the context of this standard)**:** A member of the same kind, class or group of compounds with similar structures and similar chemical properties.

copolymer: A polymer derived from more than one species of monomer. **(IUPAC definition)**

electronic device: A device whose operation depends on the conduction of electrons and/or holes in vacuum, gas, or semiconductor.

NOTE Examples of electronic devices include transistors, integrated circuits, hybrid integrated circuits, and modules containing active electronic components.

electronic product: An item containing one or more electronic devices performing major functions.

low-halogen: Meeting the criteria established in clause 4 of this document.

NOTE **Low-halogen electronic products** may still contain some halogens, providing, of course, that each material in them meets the requirements in clause 4.

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.

polymer alloy: A polymer blend (considered to be an alloy) that contains either a crystallizable component or two relatively rigid or amorphous polymers

4 Requirements for low-halogen electronic products

The halogens fluorine (F), iodine (I), and astatine (At) are not covered by this document (see annex C). 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.

For an electronic product to be defined as "low-halogen", each material within the product must meet all of the following requirements.

1) Each material within an electronic product, (excluding printed board laminates) shall contain <1000 ppm (0.1%) by weight of bromine if the bromine source is from BFRs and <1000 ppm (0.1%) by weight of chlorine if the chlorine source is from CFRs, PVC, PVC congeners, PVC block polymers, PVC copolymers, or polymer alloys containing PVC. Higher concentrations of bromine and chlorine are allowed in plastics contained within electronic products (other than printed board laminates contained within those devices) as long as their sources are not flame retardants, PVC, PVC congeners, PVC block polymers, PVC copolymers, or polymer alloys containing PVC.
2) All printed board laminates contained within electronic and electrical products, including those within a passive or solid-state device shall meet the "halogen-free" requirements for Br and Cl as defined in the most current version of one of the following specifications: IEC 61249-2, IPC-4101, JPCA-ES-01.

   NOTE See Annex A for a list of likely uses of flame retardants, PVC, PVC congeners, PVC block polymers, PVC copolymers, or polymer alloys containing PVC within electronic products.

5 Compliance process for low-halogen electronic materials and components

An electronic product often contains many materials / components from a complex and global supply chain. Therefore, all individual entities or suppliers within the chain have to be required to take responsibility for ensuring that the materials / components that they supply meet this standard's requirements. Each supplier / individual entity within the supply chain is only responsible to prove compliance to their respective customer for the material / component that they supply. Any material / component that is declared to be "low-halogen" per Clause 4 herein must be supported by proof that substantiates the claim.

Since there is not a single, simple, cost-effective, and reliable test method that covers the spectrum of materials / components included in electronic products, customers and suppliers should mutually agree on the best method to demonstrate compliance to this document. If analytical testing is used, elemental Br and Cl analysis is the most expedient and cost effective to perform. (IEC 62321 provides screening and analytical test methods for some but not all of the substances within the scope of this document.) If results detect Br or Cl above 1000ppm threshold, the supplier should determine if the source of the Br or Cl is from flame retardants, PVC, PVC congeners, PVC block polymers, PVC copolymers, or polymer alloys containing PVC. The proof of compliance documents may include material declarations, datasheets and / or analytical data.

6 Marking and labeling for “low-halogen” electronic products

6.1 Marking of printed boards

If all materials used in the fabrication of a finished printed board laminate contained within a passive or solid-state device meet the requirements in 4, item 1, and if marking is required, the marking shall be in accordance with J-STD-609.

6.2 Marking of mechanical plastics

Mechanical plastic parts contained within a passive or solid-state device may be marked / labeled in accordance with ISO 11469:2000. Compositions containing flame retardants may be marked per ISO 1043-4:1998.

6.3 Marking of passive and solid-state devices, cables, and other components of an electronic product

Marking is not required on passive or solid-state devices to denote low-halogen status. As an alternative, a part numbering scheme may be used to denote “low-halogen” solid-state devices.

6.4 Marking of electronic products

Marking is not required to denote the low-halogen status.

Annex A (informative) Where BFRs, CFRs, and PVC are used in electronic or electrical products

Brominated flame retardants (BFRs) and, less frequently, chlorinated flame retardants (CFRs) are added to thermoplastics, insulation materials, component mold compounds, solder masks, printed board laminates, and 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. Table A.1 is provided for informative purposes only.

Table A.1 — General presence of bromine and chlorine in BFRs, CFRs, and PVC in electronics and electrical products

Part type	Examples
Mechanical plastic parts (thermoplastics and elastomers)	BFRs/CFRs used in certain acrylonitrile butadiene styrene (ABS), acrylonitrile butadiene acrylester (ASA), high-impact polystyrene (HIPS), polycarbonate (PC), polystyrene (PS), polyimide (PI), polyamide (PA), polybutylene terephthalate (PBT), polypropylene (PP), polyethylene (PE), styrene ethylene butadiene styrene (SEBS) resins, and chloroprene rubber
Cables	BFRs used in cable/wire insulation material PVC used in cable/wire jacketing and overmold
Printed boards, rigid and flexible	BFRs added or reacted into FR-4, other epoxy resins, polyamide, and adhesives
Electronic components *	BFRs added or reacted into FR-4 and other epoxy resins, mold compounds, plastic packages, thermal interface materials, die attach, and underfills
Connectors	BFRs used in certain flame-rated PBT and PA resins
Films, adhesives, tapes	PVC used in certain magnetic tapes
Conduits	BFR’s used in Polypropylene (PP)
Sound, shock, and vibration dampeners (foams, resins, etc.,)	PVC used in shock absorbing or vibration dampening resins
* Plastic in construction of various components (Actives, Discretes, Hybrids, ICs, and Passives, etc.).	

Annex B (informative) Suggested test protocols – Low-halogen process flow

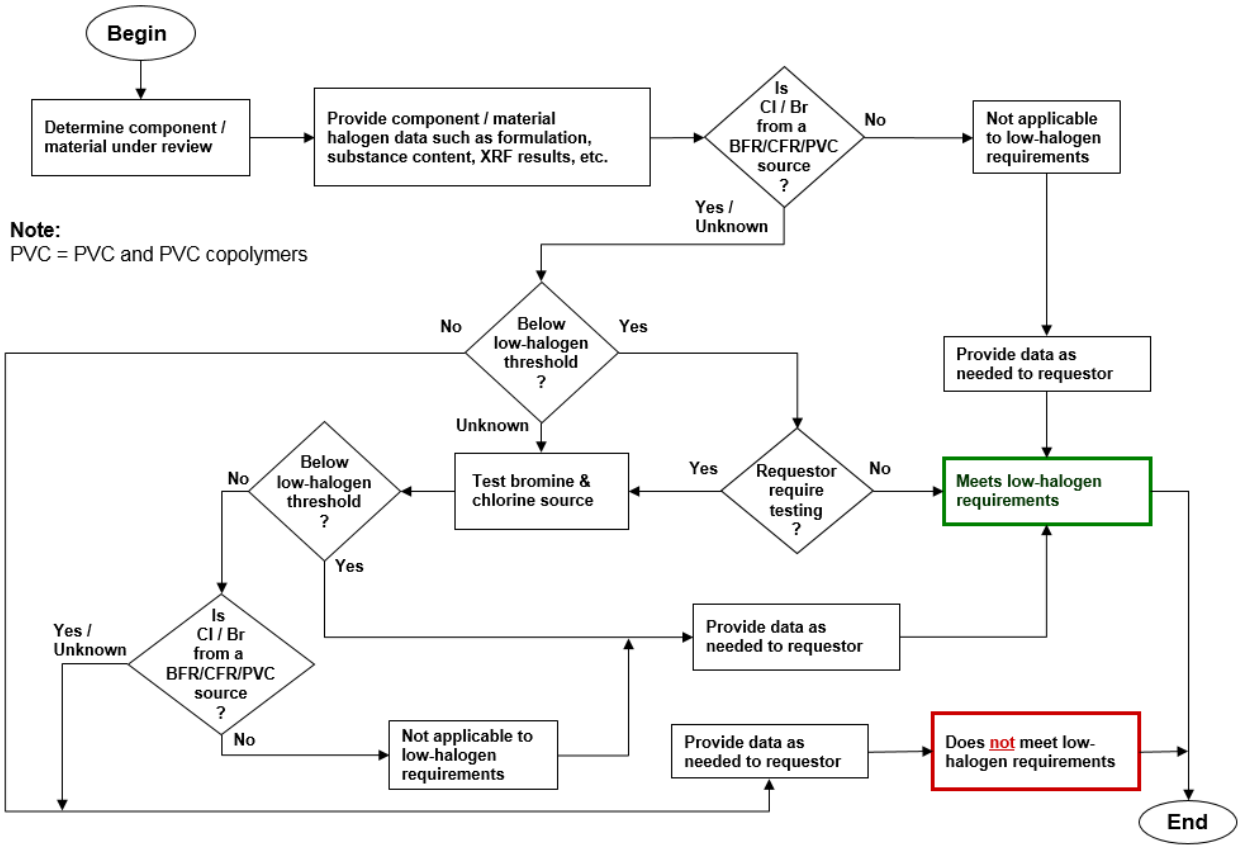

Figure B.1 — Low-halogen Process Flow

B.1 Low-halogen process flow verbiage

Summary of low-halogen compliance determination

Determine component/material under review for low-halogen requirements
Provide component/material halogen data such as formulation, substance content, XRF results, etc.
Is bromine or chlorine from a BFR/CFR/PVC* source?
- No: Not applicable to low-halogen requirements
  - Provide data as needed to requestor
  - (product) Meets "low-halogen" requirements
  - **End** "low-halogen" determination process
- Yes/Unknown: Is it below low-halogen threshold?"
  - No: Provide data as needed to requestor
    - (product) Does not meet "low-halogen" requirements
    - **End** "low-halogen" determination process
  - Yes: Does requestor require testing?
    - No: (product) Meets "low-halogen" requirements
      - **End** "low-halogen" determination process
    - Yes: Test bromine & chlorine source (further proof of compliance may require destructive testing)
      - Is it below low-halogen threshold?
        - Yes: Provide data as needed to requestor
          - (product) Meets "low-halogen" requirements
          - **End** "low-halogen" determination process
        - No: Is it from a BFR/CFR/PVC* source
          - No: Not applicable to low-halogen requirements
            - Provide data as needed to requestor
            - (product) Meets "low-halogen" requirements
            - **End** "low-halogen" determination process
          - Yes/Unknown: Provide data as needed to requestor
            - (product) Does not meet "low-halogen" requirements
            - **End** "low-halogen" determination process
  - Unknown: Test bromine & chlorine source (further proof of compliance may require destructive testing)
    - Is it below low-halogen threshold?
      - Yes: Provide data as needed to requestor
        - (product) Meets "low-halogen" requirements
        - **End** "low-halogen" determination process
      - No: Is it from a BFR/CFR/PVC* source
        - No: Not applicable to low-halogen requirements
          - Provide data as needed to requestor
          - (product) Meets "low-halogen" requirements
          - **End** "low-halogen" determination process
        - Yes/Unknown: Provide data as needed to requestor
          - (product) Does not meet "low-halogen" requirements
          - **End** "low-halogen" determination process

* PVC = PVC and PVC copolymers

Annex C (informative) Clarification for including only bromine and chlorine in the definition of low-halogen materials.

Halogens are not as a group generally hazardous to the environment, so to include all halogens would create demands for verifications that are not needed.

Astatine, is radioactive with a half-life of less than nine hours and the estimated total amount in the world is approximately 30 grams, so is of no interest for electronic or electrical products.

Iodine containing FR's have very good flame retardant properties. The trend is that for the halogens the FR properties increase as you go down the Group VII elements. However, for electronic and electrical type of applications, the iodine containing FR decomposes at a temperature that is too low to be very effective. This is primarily a result of the weak carbon-to-iodine bond

The brominated and chlorinated flame retardants are normally organic substances that are both persistent and bio-accumulative. Therefore, it is necessary to focus on this usage of halogens in electronic and electrical products.

As PVC cannot always be collected to be combusted under controlled circumstances, there is a market demand to be able to choose whether or not the product may contain PVC therefore this specific application of chlorine is included.

PTFE (i.e., Teflon®) is commonly used in electronics, but as this material is not bio-accumulative, there is within the current knowledge, no need to include fluorine in the definition of "low-halogen".

Annex D (informative) Differences between JS709C and JS709B

This annex briefly describes most of the changes made in this standard JS709C, compared to its predecessor, JS709B (April 2015). Some minor editorial changes like punctuation changes are not included.

Annex B is updated including the flowchart for low-halogen process flow and the flow verbiage (B.1). Specific changes are as follows:

- Remove “Sub-component or sub-material information required?” and remove redundancy “Provide content data such as formulation, material content, component content, …”
- Change the order of diamond boxes between “Low Halogen determination (less than threshold)?” and “Is it a BFR/CFR/PVC Source?” This change makes the flow easier to understand.
- Remove the flowchart note “*Unknown = For applicable material(s) that have unknown BFR or CFR content, destructive testing for Br and Cl content is required”. The note is covered in the flowchart.
- Update the flow verbiage (B.1) to align with the new flowchart
- Make editorial changes to comply with JEDEC style manual, grammar corrections, and wording changes for clarity.

D.1 Differences between JS709B and JS709A

The major differences are the addition of clarifying definitions and acronyms, the citing of more pertinent industry standards and adding clarity to the scope and Annexes.

Standard Improvement Form JEDEC JS709C

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1. I recommend changes to the following:

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The referenced clause number has proven to be:

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2. Recommendations for correction:

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