

IPC/WHMA-A-620E-S

2023 - October

Space and Military Applications Electronic Hardware Addendum to IPC/WHMA-A-620E

Supersedes IPC/WHMA-A-620D-S
August 2020

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IPC/WHMA-A-620E-S

Space and Military Applications Electronic Hardware Addendum to IPC/WHMA-A-620E

If a conflict occurs
between the English
language and translated
versions of this document,
the English version will
take precedence.

Developed by the IPC/WHMA-A-620 Space and Military Electronic
Assemblies Addendum Task Group (7-31fs) of the Product Assurance
Committee (7-30) of IPC

Supersedes:

IPC/WHMA-A-620D-S -
August 2020
IPC/WHMA-A-620C-S -
March 2018
IPC/WHMA-A-620B-S -
June 2013
IPC/WHMA-A-620AS
with Amendment 1 -
June 2012

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Acknowledgment

Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the IPC/WHMA-A-620 Space and Military Electronic Assemblies Addendum Task Group (7-31fs) of the Product Assurance Committee (7-30) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of IPC extend their gratitude.

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IPC recognizes this A-Team for their exceptional leadership and effort in the development of this standard. IPC A-Teams are dedicated groups of volunteers who undertake a significant amount of work in standards development on behalf of their group.

A special thank you to 7-31FS-AT Space Nutz for their dedication and commitment to this effort. Their support and time during the development of this document is greatly appreciated.

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In memory of Jim Blanche, NASA Marshall Space Flight Center.

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Space and Military Applications Electronic Hardware Addendum to IPC/WHMA-A-620E, Requirements and Acceptance for Cable and Wire Harness Assemblies

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0.1 Scope This Addendum provides modified and additional requirements over those published in IPC/WHMA-A-620E to ensure the performance of cable and wire harness assemblies that must survive the vibration and thermal excursions encountered getting to and operating in the military and space environments.

Where content criteria are not supplemented or replaced, the Class 3 requirements of IPC/WHMA-A-620E apply.

0.1.1 Purpose When required by the contract or engineering documentation, this Addendum supplements or replaces specifically identified requirements of IPC/WHMA-A-620E.

0.1.2 Precedence The contract takes precedence over this Addendum, referenced standards and User-approved drawings. In the event of a conflict between this Addendum and the reference documents cited herein, this Addendum takes precedence. (See IPC/WHMA-A-620E 1.7 Order of Precedence.)

0.1.3 Existing or Previously Approved Designs This Addendum **shall not** constitute the sole cause for the redesign of previously approved designs. When drawings for existing or previously approved designs undergo revision, they should be reviewed and changes made that allow for compliance with the requirements of this Addendum.

0.1.4 Use of this Addendum This Addendum **shall not** be used as a stand-alone document.

Where criteria are not supplemented by this Addendum, the Class 3 requirements of IPC/WHMA-A-620E **shall** apply. Clauses found only in this Addendum will have “[NEW]” after the clause number in IPC/WHMA-A-620ES Table 1. If an IPC/WHMA-A-620E requirement is changed or added by this Addendum, the clause is identified and only the process requirements and defects for that clause are listed in Table 1 of this Addendum, i.e., Acceptable conditions, are not listed. If a feature is not listed as a defect, it **shall** be considered acceptable. Acceptable conditions (except where changed by this Addendum) and Figures are provided in IPC/WHMA-A-620E.

The clauses modified by this Addendum do not include subordinate clauses unless specifically stated, i.e., changes made to 1.4 do not affect 1.4.1 unless 1.4.1 is also addressed in this Addendum. Clauses, Tables, Figures, etc., in IPC/WHMA-A-620E that are not listed in this Addendum are to be used as-published.

When a paragraph refers to an entire chapter, for example the first paragraph in 15.1 Braided of this Addendum, it is the user of the standard’s responsibility to determine which clauses from that chapter are used from IPC/WHMA-A-620E and which clauses are covered by this Addendum.

0.1.5 Lead (Pb)-Free Tin For this document, the definition of lead (Pb)-free tin is tin containing less than 3% Pb by weight as an alloying constituent. See Table 1 of this Addendum 4.1.1.1 Materials and Components – Materials – Solder.

The use of components, assemblies, packaging technology, mechanical hardware and materials identified as having external surfaces (platings, metallization, etc.) of Pb-free tin or assembled with Pb-free tin solder alloys **shall** be prohibited unless documented and controlled through a User-approved Pb-Free Control Plan (LFCP). Solder alloy Sn96.3Ag3.7 is exempt from this requirement for a LFCP.

0.1.6 Red Plague (Cuprous Oxide Corrosion) Red Plague (cuprous oxide corrosion) can develop in silver-coated soft or annealed copper wire when a galvanic cell forms between the copper base metal and the silver coating in the presence of moisture (H₂O) and oxygen (O₂). Once initiated, the sacrificial corrosion of the copper base conductor can continue indefinitely in the presence of oxygen. The color of the corrosion by-product (cuprous oxide crystals) may vary depending on the different levels of oxygen available, but is commonly noted as a red/reddish-brown discoloration on the silver coating surface.

The use of silver-coated copper wire and cable **shall** require the implementation of a User-approved Red Plague Control Plan (RPCP). See IPC-WP-113 for technical guidance and a generic RPCP template.

0.1.7 White Plague (Fluorine Attack) During the manufacturing of fluoropolymer-insulated electrical wires and cables made with tin-coated, silver-coated, or nickel-coated copper or copper alloy conductors, the extrusion of fluorocarbon resin to form the insulation jacket occurs at a temperature high enough that oxidative degradation of the polymer may occur, possibly resulting in the evolution or outgassing of a number of materials, including carbonyl fluoride (COF₂), an extremely reactive compound. This outgassing from the insulation is both internal, e.g., to the wire strand/cable bundle, and external, e.g., to the surrounding environment. In the presence of trace atmospheric moisture, e.g., humidity, the carbonyl-difluoride hydrolyzes to generate carbon dioxide (CO₂) and hydrogen fluoride (HF). The hydrogen fluoride (HF) will then hydrate to form concentrated hydrofluoric acid (HF aq), an extremely corrosive agent that attacks metal and metal oxides, including, but not limited to, conductors, contacts, connector shells, etc.

The use of fluoropolymer-insulated copper wire and cable may require the implementation of a User-approved White Plague Control Plan (WPCP). See IPC-WP-114 for technical guidance and a generic WPCP template.



Table 1 IPC/WHMA-A-620E Space and Military Applications Requirements

A-620E Reference	Space and Military Applications Requirements (as changed by this Addendum)
1.1	Scope This standard prescribes practices and requirements for the manufacture of cable, wire and harness assemblies. This standard does not provide criteria for cross-section or x-ray evaluation. Exception: Non-Destructive Evaluation (NDE) shall be required when an item is subject to the requirements of 4.3.2.2 Solder Connection – Soldering Anomalies – Partially Visible or Hidden Solder Connections. If a conflict occurs between the English and translated versions of this document, the English version will take precedence. The illustrations in this document portray specific points noted in the title of each section. A brief description follows each illustration. The development committee recognizes that different parts of the industry have different definitions for some terms used herein. For the purposes of this document, the terms cable and wire harness are used interchangeably. IPC/WHMA-A-620 can be used as a stand-alone document for purchasing products, however it does not specify frequency of in-process inspection or frequency of end product inspection. No limit is placed on the number of process indicators or the number of allowable repair/rework of defects. Such information should be developed with a statistical process control plan (see IPC-9191).
1.2	Purpose This standard describes materials, methods, tests and acceptability criteria for producing crimped, mechanically secured, or soldered interconnections and the related assembly activities associated with cable and harness assemblies. The intent of this document is to rely on process control methodology to ensure consistent quality levels during the manufacture of products. Any method that produces an assembly conforming to the acceptability requirements described in this standard may be used. Standards may be updated at any time using revisions or amendments. The use of an amendment or newer revision is not automatically required. The revision in effect shall be as specified by the User. Note: This clause is unchanged from IPC/WHMA-A-620E. It is included here to clarify that the Purpose of the Space Addendum does not replace nor alter Purpose of IPC/WHMA-A-620E.
1.3	Classification If an IPC/WHMA-A-620E clause is not addressed by this Addendum, the Class 3 requirement in IPC/WHMA-A-620E shall apply. See 0.1.4 Use of this Addendum.
1.5.1.2.1	Disposition Disposition is the determination of how defects should be treated. Dispositions include, but are not limited to, rework, use as is, scrap or repair. Each disposition of “use as is” or “repair” shall be approved by the User. Repairs shall be conducted in accordance with documented procedures approved by the User. Each repair shall be approved by the User prior to implementation. Note: Disposition requirements should be identified in the contract.
1.6	Process Control A documented process control system shall be developed and implemented. Process control tools such as IPC-9191, EIA-557-1 or other User-approved system may be used as guidelines for implementing process control. The documented process control system shall define process control and corrective action limits. This may or may not be a “statistical process control” system, see IPC/WHMA-A-620E 1.6.1 Statistical Process Control. The use of “statistical process control” (SPC) is optional and should be based on factors such as design stability, lot size, production quantities, and the needs of the company. Verification of acceptability to this standard shall be based on 100% inspection of the assemblies, including crimps, solder connections and each successive level of assembly, e.g., securing, shielding, connectorization. Visual inspection may be supplemented by the measurement of characteristics appropriate to the product being assembled, e.g., go/no-go gauges, pull force measurements, torque measurement. Process control methodologies shall be used in the planning, implementation and evaluation of the manufacturing processes used to produce cables and wire harness assemblies. The philosophy, implementation strategies, tools and techniques may be applied in different sequences depending on the specific company, operation, or variable under consideration to relate process control and capability to end product requirements. When a decision or requirement is to use a documented process control system, failure to implement process corrective action and/or the use of continually ineffective corrective actions shall be grounds for disapproval of the process and associated documentation.

Table 1 IPC/WHMA-A-620E Space and Military Applications Requirements (cont.)

A-620E Reference	Space and Military Applications Requirements (as changed by this Addendum)																													
1.10	Personnel Proficiency All instructors, operators and inspection personnel shall be proficient in the tasks to be performed. Objective evidence of that proficiency shall be maintained and be available for review. Objective evidence should include records of training to the applicable job functions being performed, work experience, testing to the requirements of IPC/WHMA-A-620E and this Addendum, and/or results of periodic reviews of proficiency. Training shall be in accordance with the IPC/WHMA-A-620-Space Addendum Training and Certification Program or a supplier developed program that shall be made available for review and approval upon request by the User. All training shall be traceable to a Master IPC Trainer (MIT).																													
1.12.2.1	Lighting Illumination at the surface of workstations should be at least 1000 Lux (approximately 93 foot candles). Supplemental lighting may be necessary to assist in visual inspection. The light source shall provide shadowless illumination of the area being viewed unless directional or oblique lighting is specifically required.																													
1.12.2.2	Magnification Aids Magnification power for assembly inspection shall be at least the minimum inspection power specified in IPC/WHMA-A-620E-S Tables 1-1 and 1-2. Other magnification powers within the inspection range may be used. The magnification power requirement is based on the gauge of the wire being inspected. For assemblies with mixed wire sizes, the greater magnification may be used for the entire assembly. If the presence of a defect cannot be determined at the inspection power, the item is acceptable. The referee magnification power is intended for use only after a defect has been determined but is not completely identifiable at the inspection power. Magnification aids shall be capable of rendering true colors, proportional dimensions and adequate resolution at the chosen magnification to perform the specified inspection. The tolerance for magnification aids is ± 15% of the selected magnification power. Magnification aids should be maintained and calibrated as appropriate (see IPC-OI-645). IPC/WHMA-A-620E-S Table 1-1 Magnification Aid Applications – Wire and Wire Connections¹ <table><tr><th rowspan="2">Wire Size AWG Diameter mm [inch]</th><th colspan="2">Magnification Power</th></tr><tr><th>Inspection Range</th><th>Maximum Referee</th></tr><tr><td>Larger than 14 AWG >1.63 mm [0.064 in]</td><td>Magnification not required</td><td>1.75X</td></tr><tr><td>14 to 22 AWG 1.63 to 0.64 mm [0.064 to 0.025 in]</td><td>1.5X – 3X</td><td>4X</td></tr><tr><td><22 to 28 AWG <0.64 to 0.32 mm [<0.025 to 0.013 in]</td><td>3X – 7.5X</td><td>10X</td></tr><tr><td>Smaller than 28 AWG <0.32 mm [<0.013 in]</td><td>10X</td><td>20X</td></tr></table> Note 1: Referee magnification power is intended to be used only to verify a product rejected at the inspection magnification. For assemblies with mixed wire sizes, the greater magnification may be (but is not required to be) used for the entire assembly. IPC/WHMA-A-620E-S Table 1-2 Magnification Aid Applications – Other <table><tr><td>Solder joint cleanliness (with or without cleaning processes)</td><td>4X – 10X</td></tr><tr><td>Solder joint cleanliness (no-clean processes)</td><td>Magnification not required, Note 1</td></tr><tr><td>Encapsulation, Staking</td><td>Magnification not required, Notes 1, 2</td></tr><tr><td>Component</td><td>Magnification not required, Notes 1, 2</td></tr><tr><td>Marking</td><td>Magnification not required, Note 2</td></tr><tr><td>Assembly</td><td>No magnification required, Note 1</td></tr></table> Note 1: Visual inspection may require the use of magnification, e.g., for very small features, to determine contamination affects form, fit, or function. Note 2: If magnification is used it is limited to 4X maximum.	Wire Size AWG Diameter mm [inch]	Magnification Power		Inspection Range	Maximum Referee	Larger than 14 AWG >1.63 mm [0.064 in]	Magnification not required	1.75X	14 to 22 AWG 1.63 to 0.64 mm [0.064 to 0.025 in]	1.5X – 3X	4X	<22 to 28 AWG <0.64 to 0.32 mm [<0.025 to 0.013 in]	3X – 7.5X	10X	Smaller than 28 AWG <0.32 mm [<0.013 in]	10X	20X	Solder joint cleanliness (with or without cleaning processes)	4X – 10X	Solder joint cleanliness (no-clean processes)	Magnification not required, Note 1	Encapsulation, Staking	Magnification not required, Notes 1, 2	Component	Magnification not required, Notes 1, 2	Marking	Magnification not required, Note 2	Assembly	No magnification required, Note 1
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	Inspection Range	Maximum Referee																												
Larger than 14 AWG >1.63 mm [0.064 in]	Magnification not required	1.75X																												
14 to 22 AWG 1.63 to 0.64 mm [0.064 to 0.025 in]	1.5X – 3X	4X																												
<22 to 28 AWG <0.64 to 0.32 mm [<0.025 to 0.013 in]	3X – 7.5X	10X																												
Smaller than 28 AWG <0.32 mm [<0.013 in]	10X	20X																												
Solder joint cleanliness (with or without cleaning processes)	4X – 10X																													
Solder joint cleanliness (no-clean processes)	Magnification not required, Note 1																													
Encapsulation, Staking	Magnification not required, Notes 1, 2																													
Component	Magnification not required, Notes 1, 2																													
Marking	Magnification not required, Note 2																													
Assembly	No magnification required, Note 1																													

Table 1 IPC/WHMA-A-620E Space and Military Applications Requirements (cont.)

A-620E Reference	Space and Military Applications Requirements (as changed by this Addendum)
1.16	Materials and Processes The materials and processes used to assemble, manufacture, handle and store cable and wire harness assemblies shall be selected such that their combinations produce products acceptable to IPC/WHMA-A-620E and this Addendum. When major elements of the proven processes are changed, e.g., flux, cleaning media or system, soldering system, tooling, marking, etc., validation of the acceptability of the change(s) shall be performed and documented. The method of validation shall be agreed upon between the Manufacturer and User. Changes shall be approved by the User prior to use. Connector mating surfaces and harness assemblies shall be protected. Limited shelf life items shall be stored and controlled in accordance with material supplier recommendations or in accordance with the Manufacturer's documented procedures for controlling shelf life and shelf life extensions. For adhesives, potting material and other polymers: • The material specification or other documented procedure shall be followed for mixing and curing. • Material shall be used within the pot life (working time) specified by the material supplier or used within the time period indicated by a documented system. • When curing conditions, e.g., temperature, time, infrared (IR) intensity, vary from the material manufacturer's recommended instructions, they shall be documented and available for review. • Items exposed to uncured silicone material shall not be used for processing other material. An authorized exception is allowed only in cases where equipment is used for co-curing processes and the Manufacturer has demonstrated through system tests that non-silicone material properties have not changed and design requirements are met. Use of these processes shall be approved by the User prior to use. • A mix record shall be created for each mixed batch of multi-part polymers used. At a minimum, this record shall include the date mixed, Manufacturer's part number and lot/date code, shelf-life expiration date (of all parts of the mix) and the mix ratio for all constituents used. • For one-part polymers, the Manufacturer's part number, lot/date code and shelf life expiration date shall be documented. • Materials shall be cured in accordance with a documented cure schedule and within the thermal limitations of the hardware. Objective evidence of full cure for each batch of material shall be documented. A witness sample may be used for this verification. • If used, non-liquid fillers, e.g., thickening agents, thermal property enhancers, shall be treated to remove detrimental moisture and other volatiles. • Non-porous containers and mixing tools shall be used. Containers and mixing tools shall be selected such that their use in combination cannot introduce contamination into the mix, e.g., a metal stirrer can scrape shavings from a plastic container. Note: Specific criteria regarding application and/or acceptance requirements are included where applicable throughout this document. The electrical and mechanical integrity of components and assemblies shall be retained after exposure to processes employed during manufacture and assembly, e.g., handling, baking, fluxing, soldering, and cleaning.
3.1	Stripping Wire insulation may be removed using chemical, thermal (including laser) or mechanical strippers using a manual, semi or full automated process. Chemical insulation stripping agents shall: • Be used only for solid wire. • Be neutralized or removed prior to tinning or soldering. • Not cause degradation to the wire. Note: To prevent continuing degradation of the wire surface, the residue of chemical insulation stripping products should be removed within three (3) hours of the completion of chemical stripping.