

IPC-D-620

2015 - December

**Design and Critical Process
Requirements for Cable and
Wiring Harnesses**

A standard developed by IPC

Association Connecting Electronics Industries



The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee (TAEC) adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

Notice

IPC Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of IPC from manufacturing or selling products not conforming to such Standards and Publication, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than IPC members, whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by IPC without regard to whether their adoption may involve patents on articles, materials, or processes. By such action, IPC does not assume any liability to any patent owner, nor do they assume any obligation whatever to parties adopting the Recommended Standard or Publication. Users are also wholly responsible for protecting themselves against all claims of liabilities for patent infringement.

IPC Position Statement on Specification Revision Change

It is the position of IPC's Technical Activities Executive Committee that the use and implementation of IPC publications is voluntary and is part of a relationship entered into by customer and supplier. When an IPC publication is updated and a new revision is published, it is the opinion of the TAEC that the use of the new revision as part of an existing relationship is not automatic unless required by the contract. The TAEC recommends the use of the latest revision. Adopted October 6, 1998

Why is there a charge for this document?

Your purchase of this document contributes to the ongoing development of new and updated industry standards and publications. Standards allow manufacturers, customers, and suppliers to understand one another better. Standards allow manufacturers greater efficiencies when they can set up their processes to meet industry standards, allowing them to offer their customers lower costs.

IPC spends hundreds of thousands of dollars annually to support IPC's volunteers in the standards and publication development process. There are many rounds of drafts sent out for review and the committees spend hundreds of hours in review and development. IPC's staff attends and participates in committee activities, typesets and circulates document drafts, and follows all necessary procedures to qualify for ANSI approval.

IPC's membership dues have been kept low to allow as many companies as possible to participate. Therefore, the standards and publications revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards and publications, why not take advantage of this and the many other benefits of IPC membership as well? For more information on membership in IPC, please visit www.ipc.org or call 847/597-2872.

Thank you for your continued support.



IPC-D-620

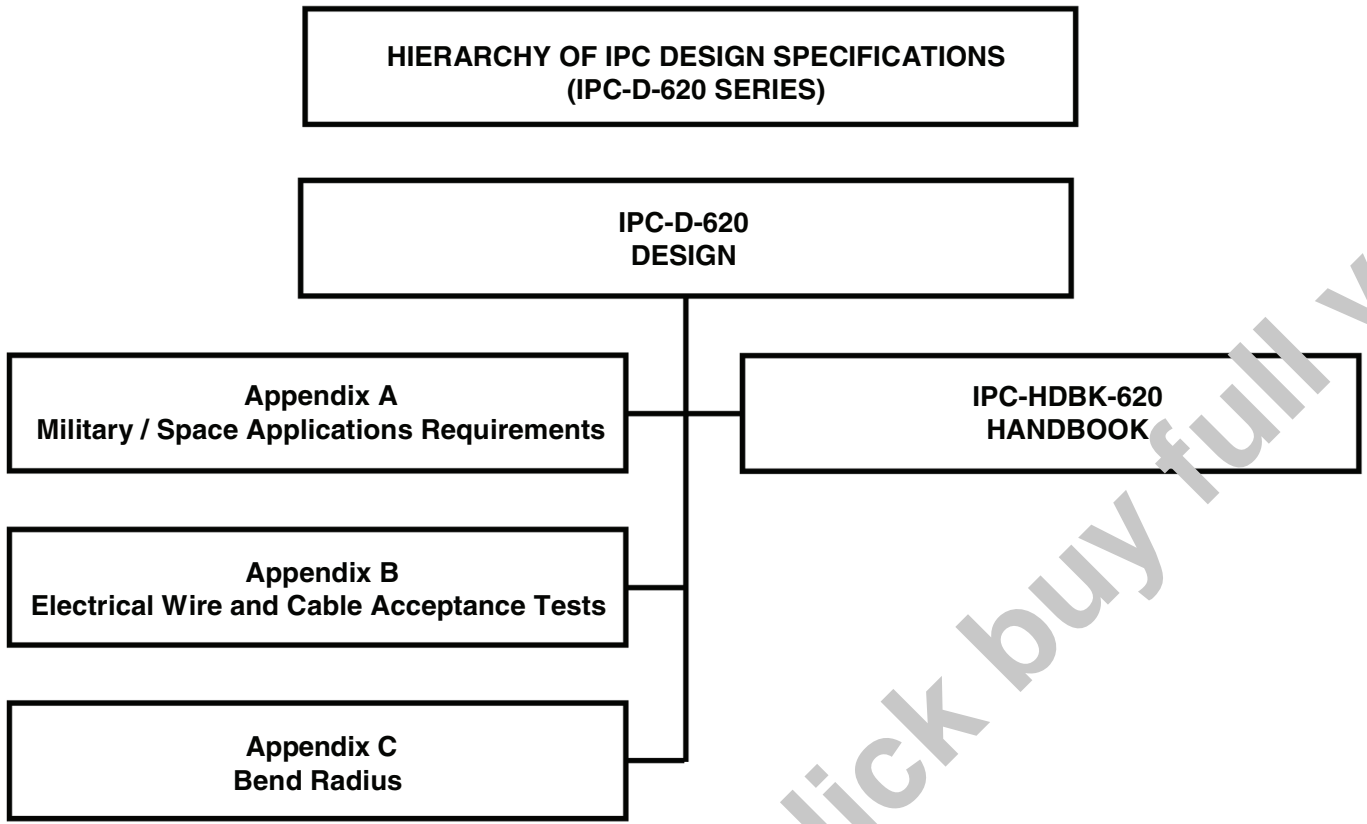
Design and Critical Process Requirements for Cable and Wiring Harnesses

Developed by the Wire Harness Design Task Group (7-31k)
and IPC-HDBK-620 Handbook Task Group (7-31h) of the
Product Assurance Committee (7-30) of IPC

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

Contact:

IPC
3000 Lakeside Drive, Suite 105N
Bannockburn, Illinois
60015-1249
Tel 847 615.7100
Fax 847 615.7105



FOREWORD

This standard is intended to provide information on the design requirements for cable and wiring harness design, to the extent that they can be applied to the broad spectrum of cable and wiring harness design.

It is therefore crucial that decisions concerning the choice of product classification, wiring technology, connectorization requirements, and performance and reliability requirements be made as early as possible.

IPC-D-620 is supplemented by Appendices A-C and a handbook (IPC-HDBK-620), which provide the engineering rationale and technical guidance on cable and wiring harness design. The User needs, as a minimum, the Design Requirements document (IPC-D-620), and the engineering description of the final product.

As wiring and connector technology changes, specific requirements will be updated or new requirements added to the document set.

The IPC invites input on the effectiveness of the documentation and encourages User response through

The IPC invites input on the effectiveness of the documentation and encourages User response through completion of "Suggestions for Improvement" forms located at the end of each document.

Acknowledgment

Members of the Wire Harness Design Task Group and IPC-HDBK-620 Handbook Task Group worked together to develop this document. We thank them for their dedication and service to this effort. Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the Wire Harness Design Task Group (7-31k) and IPC-HDBK-620 Handbook Task Group (7-31h) 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 the IPC extend their gratitude.

Product Assurance Committee

Chair
Mel Parrish
STI Electronics, Inc.

Vice-Chair
Mike Hill
Viasystems Group, Inc.

Technical Liaison of the IPC Board of Directors

Bob Neves
Microtek (Changzhou) Laboratories

Wire Harness Design Task Group

Chair
Robert W. Cooke
NASA Johnson Space Center

IPC-HDBK-620 Handbook Task Group

Chair
Brett A. Miller
USA Harness, Inc.

A special note of thanks goes to the following individuals for their dedication to bringing this project to fruition. We would like to highlight those individuals who made major contributions to the development of this standard.

Debbie Wade, Advanced Rework
Technology-A.R.T

Sean Keating, Amphenol Limited
(UK)

Lawrence Joy, Amptech, Inc.

Robert Potysman, AssembleTronics
LLC

Agnes Ozarowski, BAE Systems

Joseph Kane, BAE Systems Platform
Solutions

Gerald Leslie Bogert, Bechtel Plant
Machinery, Inc.

Mary Bellon, Boeing Research &
Development

Leo Lambert, EPAC Corporation

Stephen Fribbins, Fribbins Training
Services

Cindy Brenda Hale, Raytheon
Company

B.J. Franco, Honeywell Aerospace

Richard Rumas, Honeywell Canada

T. John Lase, L-3 Communications

Darren Coe, Lockheed Martin

Schuyler Williams, Lockheed Martin
Missile & Fire Control

Jeff Rowe, Lockheed Martin Mission
Systems & Training

Dominik R. Alder, Lockheed Martin
Space Systems Company

Gregg Owens, Millenium Space
Systems

Robert Humphrey, NASA Goddard
Space Flight Center

Robert Cooke, NASA Johnson Space
Center

James Blanche, NASA Marshall
Space Flight Center

Garry McGuire, NASA Marshall
Space Flight Center

Randy McNutt, Northrup Grumman
Corp.

Kathy L. Johnston, Raytheon Missile
Systems

George Millman, Raytheon Missile
Systems

David Hillman, Rockwell Collins

Erik Quam, Schlumberger Well
Services

Mel Parrish, STI Electronics, Inc.

Barrie Dunn, Ph. D., University of
Portsmouth

Brett Miller, USA Harness, Inc.

Bud Bowen, Winchester Electronics
Division

Members of Wire Harness Design Task Group

Doug Rogers	Stephen Fribbins, Fribbins Training Services	William Draper, Moog Inc.
Constantino Gonzalez, ACME Training & Consulting	Frederick Santos, General Dynamics Mission Systems	Edward Rios, Motorola Solutions
Rhonda Troutman, Actronix Inc.	Carl Olson, Harting, Inc. of North America	Robert Humphrey, NASA Goddard Space Flight Center
Debbie Wade, Advanced Rework Technology-A.R.T	Cory Jenkins, Harting, Inc. of North America	Robert Cooke, NASA Johnson Space Center
Vu Nguyen, Amphenol Canada Corp	B.J. Franco, Honeywell Aerospace	James Blanche, NASA Marshall Space Flight Center
Sean Keating, Amphenol Limited (UK)	Loshniban Thavasigamani, Honeywell Aerospace Avionics Malaysia Sdn Bhd	Charles Gamble, NASA Marshall Space Flight Center
Lawrence Joy, Amptech, Inc.	Richard Rumas, Honeywell Canada	Garry McGuire, NASA Marshall Space Flight Center
Robert Potysman, AssembleTronics LLC	Bob Teegarden, Honeywell International - Torrance	Blanca Janet Canales, Northrop Grumman
Gary Lawless, AssembleTronics LLC	Riley Northam, Honeywell Technology Solutions Inc.	Mahendra Chandan, Northrop Grumman Aerospace Systems
Douglas Hooper, Astronics - Luminescent Systems Inc.	Stephen Tisdale, Intel Corporation	Randy McNutt, Northrop Grumman Corp.
Agnieszka Ozarowski, BAE Systems	Ife Hsu, Intel Corporation	Sandra Fortune, Northrop Grumman Corporation
Thomas Cleere, BAE Systems Platform Solutions	Alan Young, Jet Propulsion Laboratory	Michael Kunysz, Northrop Grumman SSES
Joseph Kane, BAE Systems Platform Solutions	Theodore John Laser, L-3 Communications	Toshiyasu Takei, NSK Co., Ltd.
Dave Harrell, Ball Aerospace & Technologies Corp.	Brooke Archuletta, L-3 Communications	Patrick Ryan, Panduit Corp.
Kenneth Monroe, Barco, Inc.	Shelley Holt, L-3 Communications	Kevin Schuld, Peregrine Semiconductor
Gerald Leslie Bogert, Bechtel Plant Machinery, Inc.	Robert Fornerio, L-3 Communications	Matt Garrett, Phonon Corporation
Mary Bellon, Boeing Research & Development	Kim Seva, L-3 Communications Technology-West	Cindy Brenda Hale, Raytheon Company
Zenaida Valianu, Celestica	Corren Cox, Lockheed Martin	Roger Miedico, Raytheon Company
Jason Keeping, Celestica	Schuyler Williams, Lockheed Martin Missile & Fire Control	Kathy Johnston, Raytheon Missile Systems
Kevin Denning, Cirris Systems Corporation	Daniel Eifert, Lockheed Martin Missile & Fire Control	Martin Scionti, Raytheon Missile Systems
Bill Downton, Cirris Systems Corporation	Vijay Kumar, Lockheed Martin Missile & Fire Control	Steve Musante, Raytheon Missile Systems
Miguel Dominguez, Continental Temic SA de CV	Robert Stringer, Lockheed Martin Missiles & Fire Control	Lance Brack, Raytheon Missile Systems
David Gillies, Data Cable Company, Inc.	Steven Nolan, Lockheed Martin Mission Systems & Training	George Millman, Raytheon Missile Systems
Jennifer Warner, Commun LaBarge Technologies, Inc.	Dominik Alder, Lockheed Martin Space Systems Company	Charles Scharnberg, Raytheon Missile Systems
Mark Northrup, Dynamic Research and Testing Laboratories, LLC	Gregg Owens, Millennium Space Systems	Gilbert Shelby, Raytheon Systems Company
Ferris Walker, EEI Manufacturing Services	Mary Lou Sachenic, Moog Inc.	
Gabriel Rosin, Elbit Systems Ltd.		
Leo Lambert, EPTAC Corporation		

Paula Jackson, Raytheon UK	Mel Parrish, STI Electronics, Inc.	Sharon Ventress, U.S. Army Aviation & Missile Command
Caroline Ehlinger, Rockwell Collins	Terry Clitheroe, Surface Mount Circuit Board Association	Dave Scidmore, Unlimited Services, Inc.
Debie Vorwald, Rockwell Collins	Rick Hawthorne, TE Connectivity	Daniel Adducchio, US Air Force Research Lab
David Hillman, Rockwell Collins	Guy Murphy, TE Connectivity Canada Ltd.	Brett Miller, USA Harness, Inc.
Gaston Hidalgo, Samsung Electronics America	John Tinker, Teledyne Reynolds	Bud Bowen, Winchester Electronics Division
Erik Quam, Schlumberger Well Services	Jennifer Day, U.S. Army Aviation & Missile Command	
Christopher Sowards, Sikorsky Aircraft		

Members of IPC-HDBK-620 Handbook Task Group

Constantino Gonzalez, ACME Training & Consulting	Cory Jenkins, Harting, Inc. of North America	Gregg Owen, Millennium Space Systems
Rhonda Troutman, Actronix Inc.	B.J. Franco, Honeywell Aerospace	Daniel Foster, Missile Defense Agency
Debbie Wade, Advanced Rework Technology-A.R.T	Loshniban Thavasigamani, Honeywell Aerospace Avionics Malaysia Sdn Bhd	Mary Lou Sichenik, Moog Inc.
Vu Nguyen, Amphenol Canada Corp	Richard Rumas, Honeywell Canada	Edward Rios, Motorola Solutions
Sean Keating, Amphenol Limited (UK)	Bob Teegarden, Honeywell International - Torrance	Robert Humphrey, NASA Goddard Space Flight Center
Robert Potysman, AssembleTronics LLC	Riley Northam, Honeywell Technology Solutions, Inc.	Robert Cooke, NASA Johnson Space Center
Agnieszka Ozarowski, BAE Systems	Alan Young, Jet Propulsion Laboratory	James Blanche, NASA Marshall Space Flight Center
Thomas Cleere, BAE Systems Platform Solutions	Theodore John Laser, L-3 Communications	Charles Gamble, NASA Marshall Space Flight Center
Dave Harrell, Ball Aerospace & Technologies Corp.	Brooke Annuletta, L-3 Communications	Garry McGuire, NASA Marshall Space Flight Center
Gerald Leslie Bogert, Bechtel Plant Machinery, Inc.	Shelley Holt, L-3 Communications	Blanca Janet Canales, Northrop Grumman
Zenaida Valianu, Celestica	Robert Fornefeld, L-3 Communications	Randy McNutt, Northrop Grumman Corp.
Kevin Denning, Cirris Systems Corporation	Kim Souva, L-3 Communications Telemetry-West	Sandra Fortune, Northrop Grumman Corporation
Bill Downton, Cirris Systems Corporation	William Fox, Lockheed Martin Missile & Fire Control	Michael Kunysz, Northrop Grumman SSES
Miguel Dominguez, Continente Temic SA de CV	Schuyler Williams, Lockheed Martin Missile & Fire Control	Toshiyasu Takei, NSK Co., Ltd.
David Gillies, Data Cable Company, Inc.	Daniel Eifert, Lockheed Martin Missile & Fire Control	Patrick Ryan, Panduit Corp.
Mark Northrop, Dynamic Research and Testing Laboratories, LLC	Vijay Kumar, Lockheed Martin Missile & Fire Control	Kevin Schuld, Peregrine Semiconductor
Gabriel Kozin, Elbit Systems Ltd.	Steven Nolan, Lockheed Martin Mission Systems & Training	Cindy Brenda Hale, Raytheon Company
Lee Lambert, EPTAC Corporation	Dominik Alder, Lockheed Martin Space Systems Company	Kathy Johnston, Raytheon Missile Systems
Frederick Santos, General Dynamics Mission Systems		Martin Scionti, Raytheon Missile Systems
Carl Olson, Harting, Inc. of North America		

Steve Musante, Raytheon Missile
Systems

Lance Brack, Raytheon Missile
Systems

George Millman, Raytheon Missile
Systems

Charles Scharnberg, Raytheon
Missile Systems

Paula Jackson, Raytheon UK

Caroline Ehlinger, Rockwell Collins

Debie Vorwald, Rockwell Collins

Gaston Hidalgo, Samsung Electronics
America

Mary James, Schlumberger Well
Services

Erik Quam, Schlumberger Well
Services

Mel Parrish, STI Electronics, Inc.

Terry Clitheroe, Surface Mount
Circuit Board Association

Rick Hawthorne, TE Connectivity

Guy Murphy, TE Connectivity
Canada Ltd.

John Tinker, Teledyne Reynolds

Jennifer Day, U.S. Army Aviation &
Missile Command

Sharon Ventress, U.S. Army Aviation
& Missile Command

Dave Scidmore, Unlimited Services,
Inc.

Daniel Adducchio, US Air Force
Research Lab

Brett Miller, USA Harness, Inc.

Table of Contents

1 GENERAL	1	4.4 Toxic Products and Formulations	11
1.1 Scope	1	4.5 Foreign Object Debris (FOD) Control Plan	11
1.2 Purpose	1	4.6 Prohibited/Restricted Usage Parts, Materials, Processes (PMP)	11
1.3 Performance/Product Classification	1	4.6.1 Acetic Acid Cure RTV Silicone Sealants, Adhesives, and Coatings	11
1.4 Definition of Requirements	2	4.6.2 Beeswax Wax (ALL TYPES)	11
1.4.1 Design Requirement Format (A/N)	2	4.6.3 Beryllium (Be)	11
1.4.2 Requirements Flowdown	2	4.6.4 Cadmium (Cd)	11
1.4.3 Commercial Off-The-Shelf (COTS)	2	4.6.5 Crimping Of Solder-Tinned and Soldered Conductors	12
1.4.4 Existing or Previously Approved Designs	2	4.6.6 Cuprous Oxide Corrosion (Red Plague) (Figure 4-1)	12
1.5 Measurement Units and Applications	2	4.6.7 Fluorine Attack (White Plague) (Figure 4-2)	12
1.5.1 Line Drawings and Illustrations	3	4.6.8 FN/HN Grade Polyimides (Kapton®) Insulated Wiring	13
1.6 Definition of Terms	3	4.6.9 Glass/Glasslike Materials (Figure 4-3)	13
1.7 Engineering Documentation	3	4.6.10 Use of Lead-Free Tin (Sn) Materials and/or Processes (Figure 4-4)	13
1.8 Order of Precedence	3	4.6.11 Lock Washers (Tooth Type) (Figure 4-5)	14
1.8.1 Conflict	3	4.6.12 Magnesium (Mg)	14
1.8.2 Clause References	3	4.6.13 Mercury (Hg)	14
1.9 Appendices A-C	3	4.6.14 Micro-D Connectors	14
1.10 Approval of Departures from Standards and Requirements	3	4.6.15 Natural Rubber Materials	14
2 APPLICABLE DOCUMENTS	4	4.6.16 Polyvinyl Chloride (PVC)	15
2.1 Aerospace	4	4.6.17 Silver (Ag)	15
2.2 Commercial	4	4.6.18 Splices (Figure 4-6)	15
2.3 Federal	5	4.6.19 Zinc (Zn)	16
2.4 Military Handbooks	5	4.7 Wire & Cable	16
2.5 Military Specifications	5	4.7.1 Conductor Sizing	16
2.6 Reference	5	4.7.2 Conductor Material and Coating	17
3 DESIGN PHILOSOPHY (Figure 3-1)	7	4.7.3 Multi-Conductor Cables	17
3.1 General Design Requirements	7	4.7.4 Coaxial Cables	17
3.2 System Requirements Specification (SyRS)	8	4.7.5 Optical Fiber, Optical Fiber Cable, and Optical Fiber Assemblies (Figure 4-7)	18
3.2.1 Document Interface Control (ICD)	8	4.8 Connectors (Figure 4-8)	18
3.2.2 Performance and Reliability	9	4.8.1 Mating Provisions	19
3.2.3 Workmanship	9	4.8.2 Moisture Protection	19
3.2.4 Environmental Requirements	9	4.8.3 Pin Assignment	19
3.2.5 Packaging, Handling, Shipping, and Transportation (PHS&T)	9	4.8.4 Protection of Connectors	20
3.2.6 Documentation Requirements	9	4.8.5 Protection of Severed Electrical Circuits	20
3.2.7 Intellectual Property (IP) Control Requirements	9	5 ELECTRICAL REQUIREMENTS	20
4 SELECTION OF PARTS, MATERIALS AND PROCESSES	10	5.1 Derating	20
4.1 Commonality	10	5.2 Coronal Discharge (Suppression)	21
4.2 Flammability	10		
4.3 Outgassing	10		

5.3	Electrical Bonding	21	8.4	Dimensioning and Tolerance	31
5.4	Shield Design and Grounding	22	9	DEFINITIONS AND ACRONYMS	32
5.4.1	Electromagnetic Pulse (EMP) Environment	22	9.1	Accessories	32
5.4.2	Category IV Circuits	22	9.2	Adapter	32
5.4.3	Category I, II, III, and V Circuits (No EMP)	23	9.3	Ambient (Laboratory/Test)	32
5.4.4	Ungrounded/Floating Shield Terminations (No EMP)	23	9.4	ANSI American National Standards Institute	32
5.4.5	Magnetic Shields	23	9.5	ASTM American Society for Testing and Materials	32
5.5	Circuit Isolation	23	9.6	American Wire Gage	32
5.5.1	Group-Grounding of Individual Shield Terminations	23	9.7	Barrel (Contact Wire Barrel)	32
5.5.2	Separation of Redundant Systems (Figure 5-1)	24	9.8	Bend Radius	32
6	ASSEMBLY/FABRICATION REQUIREMENTS	25	9.9	Bend Radius, Long-Term	32
6.1	Wire Terminations	25	9.10	Bend Radius, Short-Term	32
6.1.1	Splices (Use Of)	25	9.11	Bonding, Electrical	32
6.1.2	Dead-Ending	25	9.12	Bubble Pack	32
6.1.3	Insulation Compatibility with Sealing and Servicing	26	9.13	Cable, Biaxial (Twin-Lead)	32
6.2	Form Layout Fixture	26	9.14	Cable, Coaxial	32
6.3	Forming Wires into Cables and Harnesses	26	9.15	Cable, Coaxial, Flexible	32
6.4	Wire Lay	26	9.16	Cable, Coaxial, Formable/Hand-Formable	32
6.5	Bend Radius	26	9.17	Cable, Coaxial, Semi-Rigid	33
6.6	Cable/Harness Management (Installation/Routing)	26	9.18	Cable, Flat	33
6.7	Protection and Support	27	9.19	Cable, Fiber Optic	33
6.8	Etching Fluoropolymer-Insulated Electrical Wire	28	9.20	Cable, Hybrid	33
6.9	Identification and Marking	28	9.21	Cable, Multiconductor	33
6.9.1	Cable and Harness Assemblies	28	9.22	Cable, Shielded	33
6.9.2	Optical Cable	29	9.23	Category I Circuit	33
6.9.3	Connectors	29	9.24	Category II Circuit	33
6.9.4	Clamp Locating Marks	29	9.25	Category III Circuit	33
7	QUALITY ASSURANCE (QA) REQUIREMENTS	29	9.26	Category IV Circuit	33
7.1	Responsibility for Inspections and Tests	29	9.27	Category V Circuit	33
7.2	Classification of Inspections and Tests	29	9.28	Circuit, Critical Signal	34
7.3	Workmanship, Acceptance, and Testing	29	9.29	Circuit, Power	34
7.4	Qualification	30	9.30	Circuit, Signal	34
7.5	Time-Critical or Limited-Life	30	9.30.1	Low-Level Signals	34
8	DOCUMENTATION	30	9.30.2	High-Level Signals	34
8.1	Data	30	9.30.3	High-Frequency Signals	34
8.2	Connector Orientation (Clocking)	31	9.31	Circular Mil Area (CMA)	34
8.3	Connector Pin-Out	31	9.32	Collectable Volatile Condensable Material (CVCM)	34
			9.33	Commercial-Off-The-Shelf (COTS)	34
			9.34	Connector, Backshell	34
			9.35	Connector, Body	34
			9.36	Connector, Grommet	34
			9.37	Connector, Contact Insert	35
			9.38	Contact, Insertable/Removable	35

9.39	Contact, Pin	35	9.79	Scoop-Proof (Connector)	37
9.40	Contact, Socket	35	9.80	Service Life	37
9.41	Contaminant	35	9.81	Shelf Life	37
9.42	Crimp	35	9.82	Solder Sleeve	38
9.43	Crimping	35	9.83	Smart Short	38
9.44	Critical Pressure Environment	35	9.84	Splice (v)	38
9.45	Design Authority	35	9.85	Stranded Conductor	38
9.46	Dielectric Withstanding Voltage (DWV)	35	9.86	System Requirements Specification (SRS)	38
9.47	Electrical, Electronic and Electromechanical (EEE)	35	9.87	Tailoring	38
9.48	Electro-Explosive Device (EED)	35	9.88	Tin Pest (a.k.a. Tin Disease/Tin Plague)	38
9.49	Electro-Explosive Device Signal (EEDS)	35	9.89	Total Mass Loss (TML)	38
9.50	Electronic Industries Alliance (EIA)	35	9.90	Volts Direct Current (V dc)	38
9.51	High Voltage (HV)	35	9.91	Wire Diameter (d)	38
9.52	Hot Swap (Electrical Function: Mate First/Break Last)	36	9.92	Wire Dress	38
9.53	Interchangeable Item	36			
9.54	Interface Control Document or Interface Control Drawing (ICD)	36	APPENDIX A	Military/Space Applications Requirements	44
9.55	Institute of Electrical and Electronics Engineers (IEEE)	36	APPENDIX B	Electrical Wire and Cable Acceptance Tests	47
9.56	Intellectual Property (IP)	36	APPENDIX C	Bend Radius	49
9.57	Interconnecting and Packaging Electronic Circuits (IPC)	36			
9.58	Lay	36		Figures	
9.59	Length of Lay	36	Figure 3-1	Wire, Cables, and Harnesses	7
9.60	Limited Life	36	Figure 3-2	Cable and Harness Design Process	10
9.61	Lock Wire	36	Figure 4-1	Red Plague (Cuprous Oxide Corrosion)	12
9.62	Mean Time To Failure (MTTF)	36	Figure 4-2	White Plague (Fluorine Attack)	12
9.63	Military Standard (MIL-STD)	36	Figure 4-3	Glass/Glass-Like Materials (e.g., Fuses)	13
9.64	National Aeronautics and Space Administration (NASA)	36	Figure 4-4	Tin Whiskers on Cardguide	13
9.65	NASA Standard (NASA-STD)	36	Figure 4-5	Lock Washer (Internal/Split/External Tooth) ...	14
9.66	Objective Evidence (OE)	36	Figure 4-6	In-Line Lash Solder Splice	15
9.67	Offgassing	36	Figure 4-7	Fiber Optic Cable	18
9.68	Operational Life	36	Figure 4-8	Exploded View of an Assembled Connector ..	18
9.69	Packaging, Handling, Storage, and Transportation (PHS&T)	37	Figure 5-1	Group Grounding of Individual Shield Terminations	24
9.70	Qualification	37	Figure 6-1	Example of a Pre-Formed Heat-Shrinkable Branch Boot	27
9.71	Radiofrequency (RF)	37	Figure 8-1	Connection Orientation (Clocking)	31
9.72	Radiofrequency Interference (RFI)	37			
9.73	Red Plague (Cu ₂ O)	37		Tables	
9.74	Red Plague Control Plan (RPCP)	37	Table 1	Derating (Class 3, Military Space)	39
9.75	Relative Humidity (RH)	37	Table 2	Summary of Circuit Categories and Shielding Requirements	40
9.76	Root Mean Square (a.k.a. Quadratic Mean) (RMS or rms)	37	Table 3	Bond Classification	41
9.77	Safety Cable	37	Table 4	Types of Splices	42
9.78	Safety Wire (Lock Wire)	37	Table 5	Electrical Creepage and Clearance Distance ...	43
			Table A1	Military/Space Applications Requirements	45

This Page Intentionally Left Blank

Design and Critical Process Requirements for Cable and Wiring Harnesses

1 GENERAL

1.1 Scope This document provides design and critical process requirements and technical insight that have been removed from the acceptance standards for cable and wire harness assemblies. Reference materials listed in this text are among those considered as required reading. The User is encouraged to obtain all relevant referenced materials as this document cannot (nor can any single document) cover every material, process, environment, performance, or safety aspect that affect a given design.

1.2 Purpose “Design Requirements for Cable and Wiring Harnesses” is the cable and wiring harness and systems-level design requirements companion to IPC/WHMA-A-620, “Requirements and Acceptance for Cable and Wire Harness Assemblies,” and its associated space addendum.

The intent of this document is to set forth the general design requirements for electrical wiring harnesses and cable assemblies. This document is intended for use by the design engineer, manufacturing engineer, quality engineer, or other individual responsible for the tailoring of specific requirements of this document to the applicable performance class.

It is not the intent of this document to exclude any alternate or contractor-proprietary documents or processes that meet or exceed the baseline of requirements established by this document. Use of alternate or contractor-proprietary documents or processes **shall** [A1A2A3] require review and prior approval of the User.

For purposes of this document:

- The Designer is the design agent for the User.
- The User is the individual, organization, company, contractually designated authority, or agency responsible for the procurement or design of electrical/electronic/electromechanical (EEE) hardware, and having the authority to define the class of equipment and any variation or restrictions to the requirements of this document (i.e., the originator/custodian of the contract detailing these requirements). The User is considered the Design Authority.
- The Supplier is considered the individual, organization or company which provides the Manufacturer (assembler) components (electrical, electronic, electromechanical, mechanical, printed boards, etc.) and/or materials (solder, flux, cleaning agents, etc.).
- The Manufacturer is considered the entity that provides a service or product to the User.

1.3 Performance/Product Classification This document recognizes that electrical wiring harnesses and cable assemblies are subject to performance/product classifications by intended end-item use. Three general end-product classes have been established to reflect differences in producibility, complexity, functional performance requirements, and verification (inspection/test) frequency. It **should** be recognized that there may be requirement overlaps between classes.

The User is responsible for defining the product class required, whether compliance to any of the A through C Appendices is required, and to indicate any exceptions to specific parameters where appropriate.

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.