
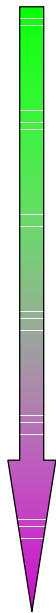


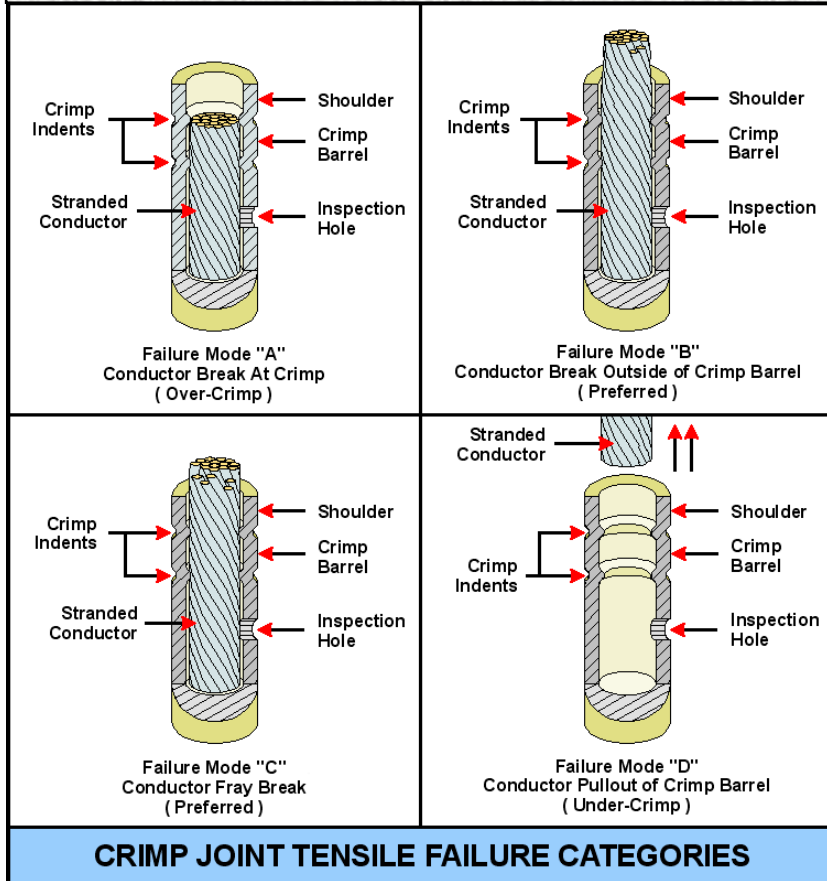


APPENDIX BEND RADIUS TABLE				
Conductor / Cable Type	Optimum Bend Radius (O.D.)	Minimum Bend Radius (O.D.)	Space between constraint point to start of bend (O.D.)	
Coaxial Cable	10	6	6	
Coaxial Cable (Rigid)	3.5	2	6	
Coaxial Cable (Semi-Rigid)	3.5	2	6	
Component Lead (Flat)	2	1	0.5mm (0.020 in.)	
Component Lead (Round)	2	1	2	
Fiber Optic Cable (Flight Applications)	15	10	10	
Fiber Optic Cable (Mission Critical Ground Support)	15	10	10	
Fiber Optic Cable (Hybrid)	20	10	10	
Fiber Optic, Individual (Tight Buffer)	15	10	10	
Flat Cable	10	3	3	
Flat Cable (Shielded)	10	3	3	
Harness (with coaxial cable, fiber optic, or individual conductors 8 AWG or larger)	10	6	6	
Harness (with individual conductors 10 AWG or smaller, no coaxial or fiber optic)	10	3	3	
Harness with polyimide (Kapton®) insulated wires.	15	10	10	
Individual Insulated Conductor	3	2	2	
Multiconductor (Non-shielded)	10	3	3	
Multiconductor (Shielded)	10	6	6	
Polyimide (Kapton®) Insulated	15	10	10	
Ribbon Cable	10	3	3	
Ribbon Cable (Shielded)	10	3	3	
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APPENDIX CRIMP TERMINATIONS						
CRIMP PINS, SOCKETS & LUGS						
Crimp / Conductor Combination ^[*1]		Minimum Axial Strength (Tensile) Pounds Force (Newtons) ^[*2]				
Crimp Barrel Size	Wire Size (AWG)	Silver- or tin-plated Copper Wire	Nickel-plated Copper Wire	Copper Wire	High-Strength Copper Alloy Wire	
	08	08	- N/A -	- N/A -	288.0 (1281.1)	- N/A -
	10	10	- N/A -	- N/A -	159.0 (707.3)	- N/A -
	12	12	112.4 (500)	101.2 (450)	103.2 (459.1)	- N/A -
		14	71.9 (320)	60.7 (270)	65.1 (289.6)	- N/A -
	16	16	51.7 (230)	38.2 (170)	41.2 (183.3)	- N/A -
		18	34.8 (155)	- N/A -	32.0 (142.3)	- N/A -
		20	20.2 (90)	20.2 (90)	20.6 (91.6)	- N/A -
	20	20	20.2 (90)	13.5 (60)	20.6 (91.6)	- N/A -
		22	11.2 (50)	9 (40)	12.8 (56.9)	22.2 (98.7)
		24	9 (40)	6.7 (30)	- N/A -	14.4 (64.0)
	22	22	11.2 (50)	9 (40)	12.8 (56.9)	22.2 (98.7)
		24	9 (40)	5.2 (23)	- N/A -	14.4 (64.0)
		26	- N/A -	- N/A -	- N/A -	8.0 (35.6)
	22D	28	- N/A -	- N/A -	- N/A -	4.8 (21.3)
		24	9 (40)	5.2 (23)	- N/A -	14.4 (64.0)
		26	- N/A -	- N/A -	- N/A -	8.0 (35.6)
	24	28	- N/A -	- N/A -	- N/A -	4.8 (21.3)
		26	- N/A -	- N/A -	- N/A -	10.8 (48)
28		- N/A -	- N/A -	- N/A -	5.6 (25)	
26	26	- N/A -	- N/A -	- N/A -	10.8 (48)	
28	28	- N/A -	- N/A -	- N/A -	5.6 (25)	
	28	- N/A -	- N/A -	- N/A -	5.6 (25)	
SHIELD CRIMPS WITH GROUNDING LEAD ^[*1, *3]						
	Wire Size (AWG)	Silver- or tin-plated Copper Wire	Nickel-plated Copper Wire	Copper Wire	High-Strength Copper Alloy Wire	
	20	20.2 (90)	13.5 (60)	20.6 (91.6)	- N/A -	
	22	11.2 (50)	9 (40)	12.8 (56.9)	22.2 (98.7)	
	24	9 (40)	6.7 (30)	- N/A -	14.4 (64.0)	
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Crimping is an efficient and highly reliable method to assemble and terminate contacts, pins, lugs, coaxial connectors and ferrules to stranded conductors for assembly into connector bodies. To ensure the quality of the crimp termination, destructive testing is performed on pre- and post-production run samples. Test values and visual examples of accept / reject criteria follow:

**APPENDIX
CRIMP TERMINATIONS (cont.)**




[*] Notes:

1. Stranded wire only. Crimping of solid wire, and stranded wire that has been solder tinned, is prohibited.
2. For contact-conductor crimp combinations not listed in the table, the tensile strength of the crimp termination shall be no less than 60 percent of the tensile strength of the conductor.
3. Tensile values are for the ground lead-crimp termination only. Tensile tests are not typically performed on the shield-crimp termination.
4. Only full-cycle, ratcheting, non-user-adjustable tools shall be used.
5. Failure Modes: All Failure categories (modes) are acceptable, provided separation failure occurs above the minimum axial (tensile) strength.
6. Conductor breaks at the entrance of the contact wire barrel, caused by conductor cutting because the contact is not held squarely in the tester jaws, shall not be considered a preferred break.

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**APPENDIX
BEND RADIUS TABLE (cont.)**

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**APPENDIX
CRIMP TERMINATIONS (cont.)**

Inspection and verification of assembled connectors shall include contact seating and retention tests, in applications in which the engaging (mating) ends of the pins or socket contacts are accessible.

Push Test: Push testing shall utilize a tool that minimizes the possibility of accidental contact bending and applies a controlled, preset pressure to the contact before releasing the force. Socket testing probes shall be undersized (compared to mating pin diameters) and shall not cause a mating cycle to occur.

Pull Test: Pull force contact retention testing shall be performed only on crimp-contact connectors in which the contact engaging (mating) ends are not accessible.

CONTACT RETENTION TEST ^[*1]			
Contact Sizes		Push Test Force Pounds (Newtons)	Pull Test Force ^[*2] Pounds (Newtons)
 LARGE	12	10 - 12 (44.5 - 53.4)	4 - 7 (17.8 - 31.1)
	16	8 - 10 (35.6 - 44.5)	4 - 7 (17.8 - 31.1)
	20	5 - 7 (22.2 - 31.1)	3 - 5 (13.3 - 22.2)
SMALL	22, 22D, 22M	4 - 6 (17.8 - 26.7)	3 - 5 (13.3 - 22.2)
[*] Notes: 1. For contacts not listed, refer to connector manufacturer's recommendations. 2. The listed values are based on a conductor size of 24 AWG. If a smaller wire gage is used, the listed values should be adjusted accordingly. Wire shall not be pulled to a force in excess of 80 percent of the specified minimum crimp tensile requirement. This requirement must be met to avoid damage to the wire / contact crimp joint.			


**APPENDIX
ENVIRONMENTAL CONDITIONS**

All Flight hardware fabrication operations shall be performed in a controlled environment that limits the entry of contamination. Environmental parameters shall be recorded and documented.


The appropriate temperature and humidity limits for the different assembly operations are given as follows:

ENVIRONMENTAL CONDITIONS	Temperature (°C / °F)		Humidity (% RH)	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
TASK / OPERATION				
Cable & Harness Assembly	20 / 68	30 / 85	30	70
Conformal Coating	18 / 66	29 / 84	30	60
Crimping	18 / 66	32 / 90	10	90
Electrostatic Discharge (ESD) Protection	--N/A--	--N/A--	30 ① 40 ②	70 ① 60 ②
Encapsulating / Potting	18 / 66	29 / 84	30	60
Fiber Optic Cable Assembly	20 / 68	30 / 85	30	70
Hand Soldering (PWB)	20 / 68	30 / 85	30	70
Wire Wrap	18 / 66	32 / 90	10	90
Printed Wiring Board (PWB) Assembly	16 / 65	32 / 90	10	90
Staking	18 / 66	29 / 84	30	60
Surface Mount Technology (SMT)	16 / 65	30 / 85	30	60
Notes: 1. Relative humidity ranges for Electrostatic Discharge (ESD) Protection ① Nominal % R.H. ② Desired % R.H. 2. Special Environmental Requirements. Parts or equipment being processed that require more stringent control of environmental conditions than those stated above, shall have those requirements and controls identified and specified in the engineering documentation.				

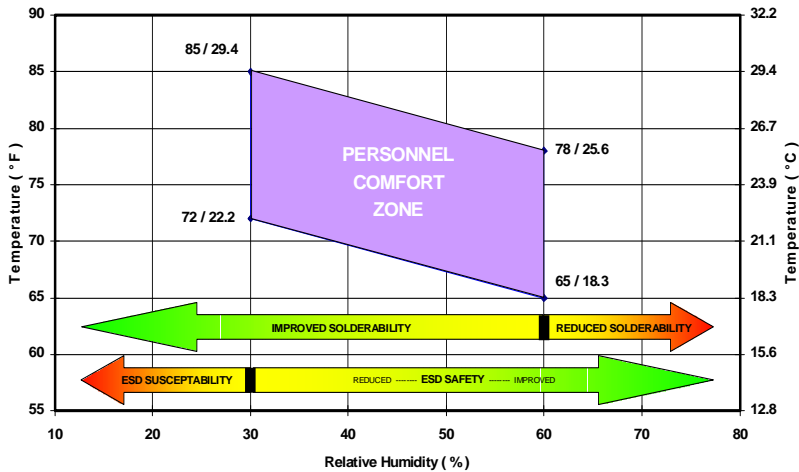
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Environmental Conditions for
High-Reliability Electronics Manufacturing



PERSONNEL COMFORT ZONE

The temperature and humidity of the work area shall be maintained within the limits defined as the comfort zone. The supplier shall monitor and maintain records of the work area temperature and humidity conditions.

LIGHTING

Light intensity shall be a minimum of 1077 Lumens per square meter (Lm/m²) or 100 foot-candles, measured on the work surface. Supplemental lighting may be used to achieve the required lighting levels.


VENTILATION SYSTEM


Areas used for cleaning parts, and areas where toxic or volatile vapors are generated, shall have an adequate ventilation system for removing air contaminants. The ventilation system shall comply with the recommendations and guidelines of the Occupational Safety and Health Administration (OSHA) requirement 29CFR.

REMOTE / FIELD OPERATIONS

In remote / field operations, the required controlled conditions cannot be effectively achieved. Special precautions shall be taken to minimize the effects of the uncontrolled environment on the operation being performed on the hardware. These precautions shall be identified in the appropriate engineering documentation.

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**APPENDIX
INSPECTION OPTICS**


Inspection aids shall be selected appropriate to the item(s) or task(s) being inspected. Inspections shall be performed, using aids conforming to the following requirements:

1. Microscopes equipped with refractor boxes, oblique illumination (or other 45° angle viewing aids), video cameras, monitors, and/or still photographic capabilities are permissible.
2. Inspection light sources shall provide shadowless illumination.
3. The use of coherent light sources for inspection of fiber optic terminations shall be prohibited.
4. For inspection of solder connections, magnification aids that permit simultaneous viewing with both eyes (stereoscopic) are preferred, but not mandatory.
5. Use only glass optical elements.
6. The use of nondestructive inspection methods (e.g. x-ray, laser, and automated inspection systems) is permissible; however, the process shall be fully documented and shall not damage or degrade parts.

OPTICAL INSPECTION REQUIREMENTS	MAGNIFICATION POWER ^[*1]	
	Lower Limit	Upper Limit
Operation / Task		
Cable & Harness Assembly	4X	10X
Conformal Coating (Requires black-light inspection)	4X	10X
Crimping	4X	10X
Electrostatic Discharge Protection (ESD)	--N/A--	--N/A--
Encapsulating / Potting / Underfill	4X	10X
Fiber Optic Cable Assembly ^[*2]		
a. General	50X	80X
b. Endface / cleaved end inspection	100X	200X
Hand / Through-Hole Soldering (NPTH / PTH / PWB)	4X	10X
Printed Wiring Board (PWB) Assembly	3X	10X
Staking / Bonding	4X	10X
Surface Mount Technology (SMT)		
a. Pre-soldering operations (Assembly / component placement / coplanarity / part alignment / paste testing / tinning)	4X	45X
b. Soldered connections: Land width ≥ 0.65mm (0.025")	10X	25X
c. Soldered connections: Land width < 0.65mm (0.025")	25X	40X
d. Soldered connections: Land width < 0.39mm (0.015")	25X	45X
e. Ball Grid Array (BGA) ^[*3]	4X	45X
f. Chip-On-Board (COB) / Multi-Chip Module (MCM)	10X	200X
Wire Wrap	3X	10X

[*] NOTES:

1. Additional magnification shall be used as necessary to resolve suspected defects.
2. **WARNING:** Extreme caution shall be exercised during the handling and optical inspection of fiber optics. Some light sources used in the testing and operation of fiber optics are extremely intense, may be operating in the visible or invisible spectrum, and can cause serious and permanent eye damage (often without any initial sensation of pain). **Always assume an optical fiber is powered and operational, until confirmed otherwise !!**
3. Three-dimensional (3-D) X-ray laminography is recommended.

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**APPENDIX
HARNESS TIE SPACING**


Discrete wiring assembled into interconnecting cables or harnesses should be properly secured to ensure a highly reliable, robust assembly, providing proper stress relief and conductor support for the intended application.

All harness ties (i.e.: spot, plastic strap, stitch, etc.) shall be snug and properly spaced, without pinching or crushing the insulation, or bunching the conductors. Special attention should be given to harnesses containing coaxial and/or fiber optic cables, as these are extremely impedance-sensitive to crushing / deformation.

HARNESS TIE SPACING		
Harness Outer Diameter [O.D.] mm (inches)	Max. Distance Between Ties mm (inches)	Max. Distance From Connector Or Connector Accessory To First Tie mm (inches)
≤ 6.4 (0.25)	19.1 (0.75)	25.4 – 50.8 (1 - 2)
12.7 (0.5)	38.1 (1.50)	25.4 – 50.8 (1 - 2)
25.4 (1.00)	50.8 (2.00)	50.8 – 76.2 (2 – 3)
> 25.4 (1.00)	76.2 (3.00)	76.2 – 101.6 (3 – 4)


NOTES:


1. Spot ties (lacing) shall consist of a clove hitch, followed by a square knot (or other non-slip knot).
2. Lacing tie ends shall be trimmed. When knots are to be staked, the necessary compounds, as well as any special design requirements shall be specified.
3. Plastic strap / cable ties (i.e.: Ty-Rap®, etc.) should have metal tangs, and shall be of the locking / permanent design. The "ribbed" side of the strap shall be placed against the wires, and tightened to prevent movement on the assembly. Surplus strap ends shall be trimmed flush at the back of the strap head.
4. Ties shall be placed immediately before and immediately after any breakout of a wire or cable from the harness.

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