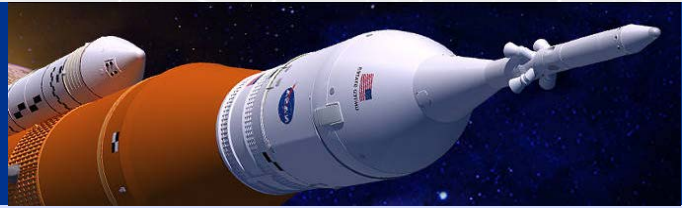
MIL-PRF-19500 Appendix J:

Inclusion of Plastic Encapsulated Discrete Semiconductor Devices for Military Applications Task Group



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Date 04-18-2019

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Agenda

1. Marshall Space Flight Center
2. Example MSFC Projects
3. MIL-PRF-19500 Task Appendix J Group Status
4. Differences in screening and qualification flows
5. Backup data

Marshall Space Flight Center (MSFC)

Charter: Space Launch, Propulsion, Exploration Systems, Materials and Manufacturing, Scientific Research

Photo courtesy of NASA

Life Sciences Glove Box for ISS

Photo courtesy of NASA

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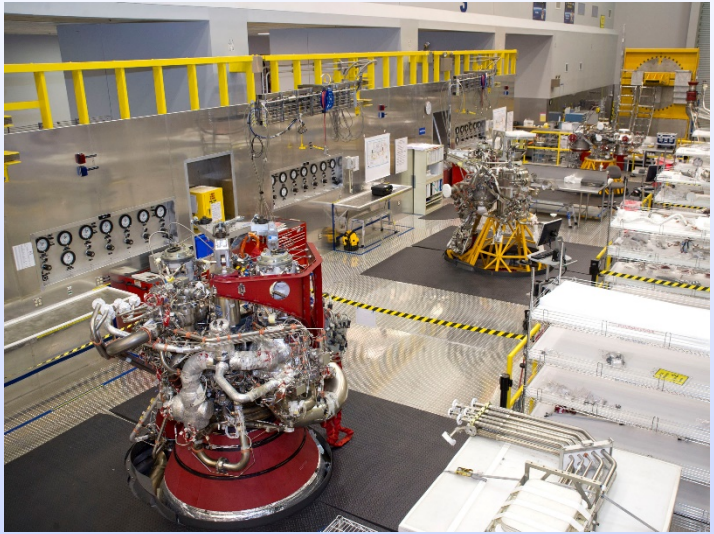
Marshall Space Flight Center (MSFC) Projects



SLS Main Engines
Photo courtesy of NASA

Environmental Controlled Life Support System (ECLSS) used on ISS Photo courtesy of NASA

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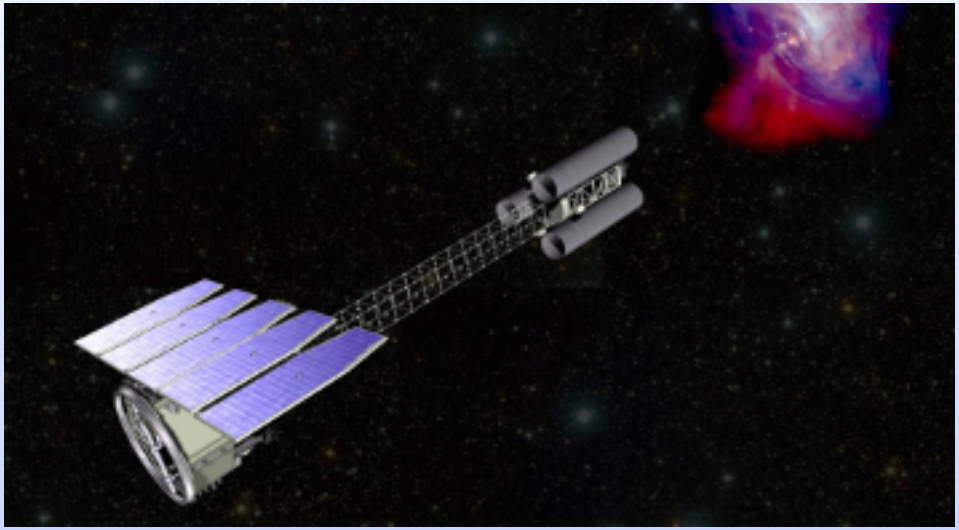
Marshall Space Flight Center (MSFC) Projects



Imaging X-Ray Polar Explorer (IXPE)

Photo courtesy of NASA

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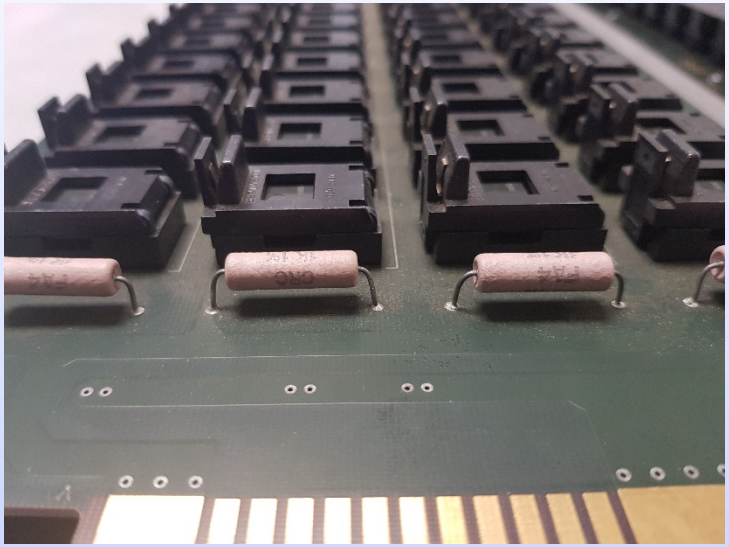
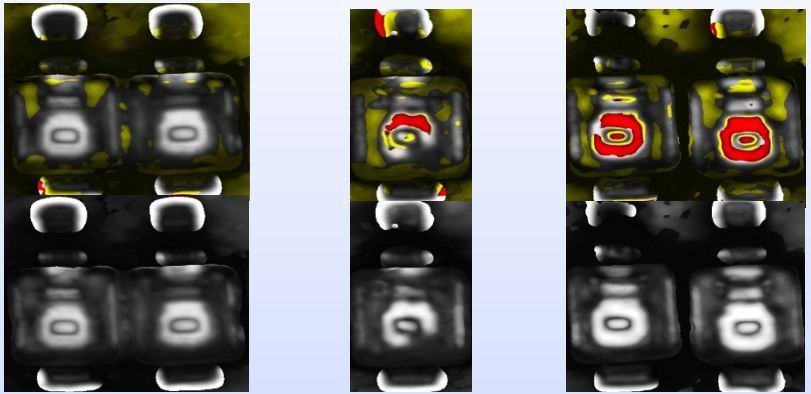
Microchip Technologies



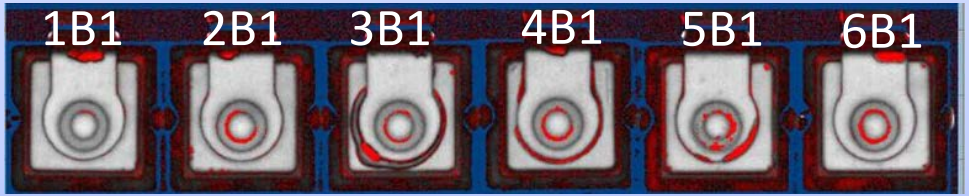
Burn-in board for plastic encapsulated discrete semiconductors

Photo courtesy of Microchip Technologies



Acoustic microscopy images of plastic encapsulated discrete semiconductors

Photos courtesy of Microchip Technologies



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19500 Appendix J Task Group

- Started to address need for military grade PEDs in government programs.
- Commercial PEDs
  - No control over changes
  - End of Life
  - Lower operating temperature range
  - Costly screening and qualification testing required for each lot

- Purpose: To develop a non-hermetic, non-cavity PED screening and qualification requirements for MIL-PRF-19500.
- Conducting teleconferences twice a month to keep document effort moving forward in between JEDEC meetings.

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19500 Appendix J Task

- MIL-PRF-19500 Appendix J is not the same as the SAE AS6294/3 and AS6294/4 PEDS screening and qualification documents for commercial discrete semiconductors.

- Manufacturers will have to be qualified by Defense Logistics Agency (DLA) Land and Maritime in order to supply military qualified non-hermetic MIL-PRF-19500 devices to the government user community.
  - Periodic recertification audits by DLA are required.

- Initial DLA Land and Maritime device qualification will be for JANTXV-like and JANTX-like levels only. Part numbering scheme not defined yet.

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19500 Appendix J Screening Differences

- Non-hermetic screening flow follows the hermetic screening with differences listed below and as shown in the following slides:
  - Temperature cycling is performed at a lower temperature range than hermetic devices.
  - High Temperature Reverse Bias performed at lower temperature of 125°C ambient temperature or 80 percent of maximum operating temperature if maximum temperature is less than 150°C.
  - Burn-in performed at lower temperature of 125°C junction temperature or 80 percent of maximum operating temperature if maximum temperature is less than 150°C.

19500 Appendix J Screening Differences Cont.'d

- Non-hermetic screening flow follows the hermetic screening with differences listed below and as shown in the following slides:
  - Radiography as specified.
  - 100 percent Acoustic Microscopy screening is required for non hermetic JANTXV and JANTX no hermeticity testing required

19500 Appendix J Screening Flow

Screen	JANTXV/JANTX Hermetic	JANTXV-like/JANTX-like Non-hermetic
• Internal Visual	Yes	Yes
• High Temperature Non-operating life	Optional	Optional
• Temperature Cycling	Condition C*	Condition G**

* Method 1051 condition C temperature range is -55°C to +175°C

** Method 1051 condition G temperature range is -55°C to +150°C or maximum storage temperature.

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19500 Appendix J Screening Flow Cont.'d

Screen	JANTXV/JANTX Hermetic	JANTXV-like/JANTX-like Non-hermetic
• Surge	Yes	Yes
• Thermal Impedance	Yes	Yes
• PIND	Optional	Not applicable

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19500 Appendix J Screening Flow Cont.'d

Screen	JANTXV/JANTX Hermetic	JANTXV-like/JANTX-like Non-hermetic
• Interim Electrical Parameters	Yes	Yes
• High Temperature Reverse Bias	Yes	Yes*
• Interim Electrical Parameters	Yes	Yes

*Minimum Tj of 125°C or 80% of maximum operating temperature if less than 150°C

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19500 Appendix J Screening Flow Cont.'d

Screen	JANTXV/JANTX Hermetic	JANTXV-like/JANTX-like Non-hermetic
• Interim Electrical Parameters	Yes	Yes
• Burn in	Yes (Tj = 135°C typical)	Yes*

* Minimum Tj of 125°C or 80% of maximum operating temperature if less than 150°C.

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19500 Appendix J Screening Flow Cont.'d

Screen	JANTXV/JANTX Hermetic	JANTXV-like/JANTX-like Non-hermetic
• Final Electrical Parameters	Yes	Yes
• Radiography	As specified	As specified
• Hermeticity	Yes	Not applicable
• Acoustic Microscopy	Not applicable	Yes

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19500 Appendix J Screening Flow Cont.'d

Screen	JANTXV/JANTX Hermetic	JANTXV-like/JANTX-like Non-hermetic
• External Visual	No	Yes
• Case Isolation	As specified	Not applicable

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19500 Appendix J Group A Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Temperature cycling is performed at a lower temperature range than hermetic devices.
  - Added Autoclave or unbiased HAST option testing for small die flow
  - 100 percent Acoustic Microscopy screening is required for non hermetic JANTXV-like and JANTX

19500 Appendix J Group A Qualification Differences

- Group A subgroup 1, small die flow
  - Highly Accelerated Stress Testing
    - 130C/85% RH t = 96 hours, or
    - 110C/85% RH t = 264 hours, or
    - Autoclave – 121C/100% RH t = 96 hours
  - Temperature cycling test condition G instead of condition C

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19500 Appendix J Group B Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Temperature cycling is performed at a lower temperature range than hermetic devices.
  - Life testing (340 hours) performed at lower temperature (- 125°C or 80 percent of maximum operating temperature
  - Acoustic Microscopy screening is required as part of the decap design verification process.
  - Added Autoclave or unbiased HAST option testing for non small die flow products.
  - Added glass transition (Tg) temperature test.

19500 Appendix J Group B Qualification Differences

- Group B subgroup 2
  - Preconditioning per J-STD-020
  - Temperature cycling 500 cycles
- Group B subgroup 4
  - Acoustic Microscopy
  - Design verification using MIL-STD-750 test method 2075 and 1580 for plastic criteria
- Group B subgroup 7
  - Glass transition temperature Tg

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19500 Appendix J Group C Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group C subgroup 2
    - Preconditioning per J-STD-020
    - Temperature cycling 500 cycles
  - Group C subgroup 3
    - Moisture sensitivity level
    - Highly Accelerated Stress Testing
    - Temperature cycling test condition G instead of condition C

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19500 Appendix J Group E Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group E subgroup 1
    - Preconditioning per J-STD-020
    - High Temperature Storage life
    - HAST or Temperature Humidity Bias (THB)
    - Temperature cycling 700 cycles versus 500 for hermetic devices
  - Group E subgroup 9
    - Acoustic Microscopy
    - Moisture sensitivity level
    - Acoustic microscopy

19500 Appendix J Group E Qualification Differences

- Non-hermetic qualification flow = hermetic (except as noted)
  - Group E subgroup 10
    - Glassivation temperature - Tg
    - Plastic evaluation per MIL-STD-883 method 5011
    - Construction analysis per SAE AS6294/3 (pending release)
    - Outgassing and flammability per NASA-STD-6001

19500 Appendix J Task Group Future Plans

Current plan:

- Continue with the twice monthly teleconferences/webex meetings
- Develop a list of test methods for inclusion in MIL-STD-750

Future work:

- Goal is to have draft ready to turn over to JEDEC by May 2019 JEDEC task group meeting. DLA Land and Maritime will send the draft appendix J out as an EP Study prior to the May 2019 SAE/JEDEC meetings.

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Thank You!!

We would like to express our gratitude to the NASA NEPAG and SLS programs, Government Working Group, and Microchip Technologies for their continued support of this effort.

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19500 Appendix J

Back up Slides

19500 Appendix J Group A Qualification Differences

- Group A subgroup 1 small die flow

Temperature cycling (air to air) 4/	1051	Test condition G, or maximum storage temperature, whichever is less, 25 cycles. 22 devices, c = 0
Autoclave or, UHAST or, UHAST		121C/100%RH t = 96 hrs, or 130C/85% RH t = 96 hrs, or 110C/85%RH t =264 hrs

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19500 Appendix J Group B Qualification Differences

– Group B subgroup 2

Subgroup 2		
Preconditioning	JEDEC JESD22-A113	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier.
Temperature cycling (air-to-air)	1051	Test condition G, or maximum storage temperature, whichever is less. (500 cycles).
Electrical measurements		Group A, subgroup 2.

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19500 Appendix J Group B Qualification Differences

– Group B subgroup 4

<u>Subgroup 4</u> Acoustic microscopy Decap internal visual (design verification)	 J-STD-035 2075	 Visual criteria in accordance with qualified design. Plastic concerns for 2075. Refer to MIL-STD-1580 Requirement 16 for plastic microcircuits,

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19500 Appendix J Group B Qualification Differences

- Group B subgroup 7

Subgroup 7 Glass transition temperature	ASTM 1640	

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19500 Appendix J Group C Qualification Differences

– Group C subgroup 2

Subgroup 2		
Preconditioning	JEDEC JESD22-A113	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier.
Temperature cycling (air-to-air)	1051	Test condition G, or maximum storage temperature, whichever is less. (500 cycles).
Electrical measurements		Group A, subgroup 2.

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19500 Appendix J Group C Qualification Differences

– Group C subgroup 3

Subgroup 3		
Preconditioning	JEDEC JESD22-A113	Test condition per JEDEC J-STD-020 Condition as specified and documented by supplier.
Temp cycle Air to air	1051	Test condition G (-55C/+150C), or maximum storage temperature, whichever is less. (100 cycles).
Highly Accelerated Stress Test (HAST, Biased) or Temp Humidity Bias	JEDEC JESD22-A110	130C/85%RH, biased, 96 hours or 110C/85%RH, biased, 264 hours or 85C/85%RH, biased, 1000 hours
Electrical measurements		Group A, subgroup 2.

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19500 Appendix J Group E Qualification Differences

- Group E subgroup 9

Subgroup 9			
Acoustic Microscopy	JEDEC J-STD-035	Delamination >10%	10 devices from MSL sample. C = 0
Moisture Sensitivity Level Classification	JEDEC J-STD-020	Test is performed to determine moisture sensitivity level per JEDEC J-STD-020. Conditions will be used based on supplier data available. Moisture level will be the lowest numerical level (1-6) that has no failures based on pass/fail criteria in J-STD-020.	45 devices, c = 0
Acoustic Microscopy 3/	JEDEC J-STD-035	Delamination >10%, no additional delamination from pre-stress.	10 devices from previous Acoustic Microscopy C = 0
Electrical Measurements		Group A, subgroup 2.	45 devices, c = 0

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19500 Appendix J Group E Qualification Differences

- Group E subgroup 10

Subgroup 10		
Glassivation Temperature (Tg)	ASTM E1640	
Plastic evaluation	883/5011	Type I electrically conductive or Type II electrically insulative
Construction analysis	SAE6294/3	A construction analysis as per SAE6294/3 (pending release) is recommended
Outgassing	ASTM E595	

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