



National Aeronautics and
Space Administration



NEPP/NEPAG DC/DC Converter & Hybrid Working Group

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Introduction

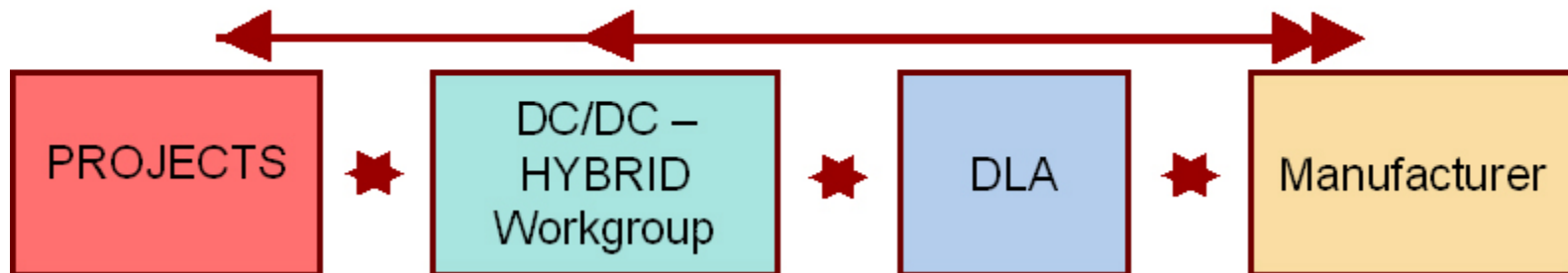


➤ **Mission:** Create & Maintain Working environment for the communication of critical information on key issues regarding the reliability of Hybrid Microcircuits (with specific emphasis on DC/DC Converters) addressing all aspects of product performance specifications, manufacturing, & procurement.

➤ Monthly Teleconferences

- First Wednesday of every month @ 1:00p.m. EST
additional when / as necessary.....
- Usual Attendees: NASA Centers & JPL, Aerospace Corporation,
NAVSEA & DLA(L&M)

ORGANIZATIONAL INTERFACES





Background



➤ **Founded:** Spring 2001 time frame to help reduce risk of using DC-DC converters in hardware across the Agency. Initial thought was to provide forum for users to communicate about their converter experiences & challenges.

- Similar forum to NEPAG meetings
- Lead by Langley EEE Parts personnel,
- Small User forum initially
- Now covers all Hybrids (all MIL-PRF-38534 product)
- Power Converters still primary focus – high risk commodity

➤ **Monthly Teleconferences**

- Customer Focused - additional meetings when/as necessary...
- Topics Address User needs:
- Guest Component Vendor Product Briefings / Participation
- Utilize Govt.Working Group for broader scope issues – such as PIND, Hermeticity, Gas Analysis, Solder Seal...etc...as they apply to other commodities



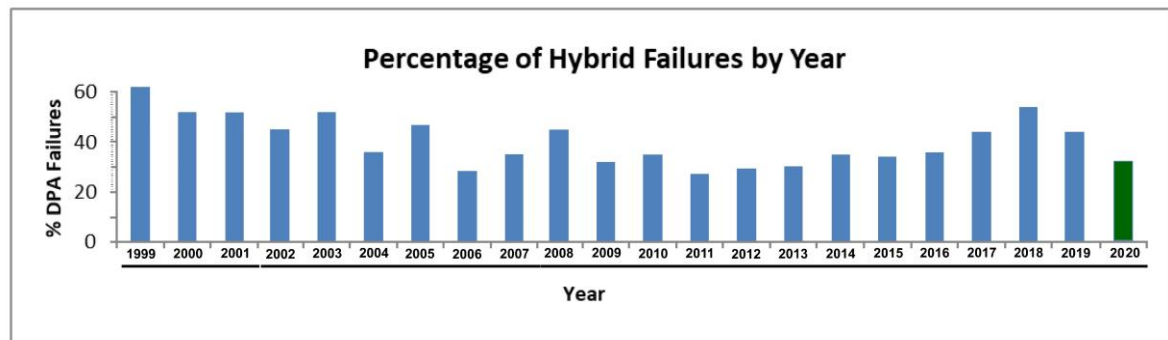
Motivation



➤ Switch Mode Power Supplies (DC/DC Converters)

- Enormously Complex due to Extreme Miniaturization
- High Risk due to type of Parts, Materials & Process used for assembly
- Paramount Programmatic Penalties [Budget, Time]
- Manufacturing challenges
 - Assembling hundreds of components using various techniques in a hermetic package (typically 1in² – 5in²)
 - Low production numbers
 - High reliability in extreme environments [verified by sampling & screening]

* Data compiled from Hi-Rel Laboratories at Space Parts Working Group Conference presentation (2000-2021)



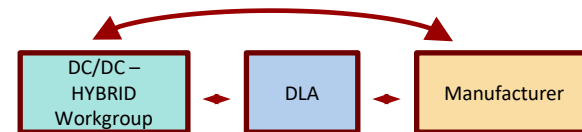


Working Group Key Points



General Topics

- Sharing of data on purchases, requirements, specifications (SMDs vs. SCDs)
 - Customizations by Centers and Product Performance Issues
 - Discussions on Failure Mechanisms, Purchase Lead time and delay issues
- Sharing of information on failures, delays, GIDEPs, etc.
- Updates from Defense Logistics Agency
 - Moves, Consolidations, New ownership
 - Alternate Methods, specification changes/updates
- Attendance at JEDEC / G-12 Conferences (JC-13* Government Liaison)
 - Attend 13.5 Hybrid Working Group Meetings (Virtual Attendance for 2020)



* JC-13 is responsible for standardizing quality and reliability methodologies for solid state products used in military, space, and other environments requiring special-use condition capabilities beyond standard commercial practices. This includes long-term reliability and/or special screening requirements.



Key Points (& more)

➤ General Topics

- Manufacturer Presentations – Existing & New Product Line Introductions
- Radiation performance / Testing
- Review of DLA Audits for certification/re-certification of Manufacturer facilities
 - (No Major Supplier visits for the Last 15 months) (considered alternatives)
 - (Discussed the various aspects of considering Virtual Audits.) (Group was Reluctant)
- Review of Specifications
 - MIL-PRF-38534 (L), General Specification for Hybrid Microcircuits
 - MIL-STD-883, Test Method Standard for Microcircuits (X-ray, PIND, etc...)
 - Continuous Improvement efforts on existing Specification(s)
 - Element Evaluation, Worst Case Circuit Analysis(WCCA)
 - Enhance Quality Assurance Requirements for Space Application grades



Information Analysis



➤ General Topics

- Manufacturer Proposals – Existing Product Line Compliance Challenges
- Radiation performance / Testing
- Review of Element Evaluation Tables & Test Methods
 - (Commercial Element Electronic part screening)
 - (BME Capacitor screening , Tantalum Capacitor Weibull grading)
 - (Subject Matter Expert Consultations)
- Review of Specifications
 - MIL-PRF-38534 (L), Element Evaluation Table Integrity
 - MIL-STD-883, Test Method Standard for Microcircuits
 - Continuous Improvement efforts on existing Specifications
 - Enhance Quality Assurance Requirements for Space Application grades



Monthly Meeting Topics



➤ Specific Monthly General Topics

- Based on Current events, Working Group User Concerns & Visionary
- Hybrid SMD Thermal Datasheet Performance Discrepancies
- Worst Case Circuit Analysis (Wording in 38534 section E.4.2.9)
- Review of Element Evaluation Tables & Alternate Test Methods
 - (Commercial Element Electronic part screening)
 - (BME Capacitor screening , Tantalum Capacitor Weibull grading)
 - (Subject Matter Expert Consultations)
- Review related Issues Associated Hybrid radiography (883-TM2012)
- Review Issues with Wire Bond to Package Lid clearance Verification
- Review Update to EEE-INST-002 (for use in the new 8739.11)



Monthly Meeting Topics_(cont'd)



➤ Additional Monthly Topics

- COVID-19 Pandemic Driven Quality/Reliability alternate Methods
 - Virtual Pre-Cap & Customer Source Inspections
 - Discussion on Expectations, Equipment Selection, usage and Methods
- Discussed Vendor Proposed Production Lot Definition
 - 38534 section 6.4.38 (Production Lot Homogeneity)
 - Discussion on Expectations for all aspects (PMP) for Purchase Order single lots
- Discussed Do's and Don'ts for Hybrid Life Test parts
- Review current status of Hybrid Vendor status & pending GIDEPS
- Review & Discuss User Community DPA failures
 - Internal Contamination
 - On-going Prohibited Materials issues (Pb Free Solders for example)



Monthly Meeting Topics_(cont'd)



➤ And Even More Monthly Topics

- We covered “a lot of ground” in 2020-2021 Lockdown Timeframe
- Manufacturer Guest Presentations
 - Wire Bond/Package Lid Clearance Compliance Challenges
 - X-ray Data and Process Verification review
 - Alternate Method Proposals – commercial capacitor testing/element evaluation
- Review of Element Evaluation Tables for Die Thermal Testing
 - Table C-II and C-iii
 - (Tri-Temp Disparity for Rev. L 38534 for Commercial Die Element screening)
 - (Table update introduced concerns over baseline parametric performance versus the maximum and minimum semiconductor and microcircuit dice performance)
- Metrics - 12 Month Timeframe for Meetings
 - 17 Meetings , “Dozens” of Topics, 18 unique, also tending “Walk-On” Issues

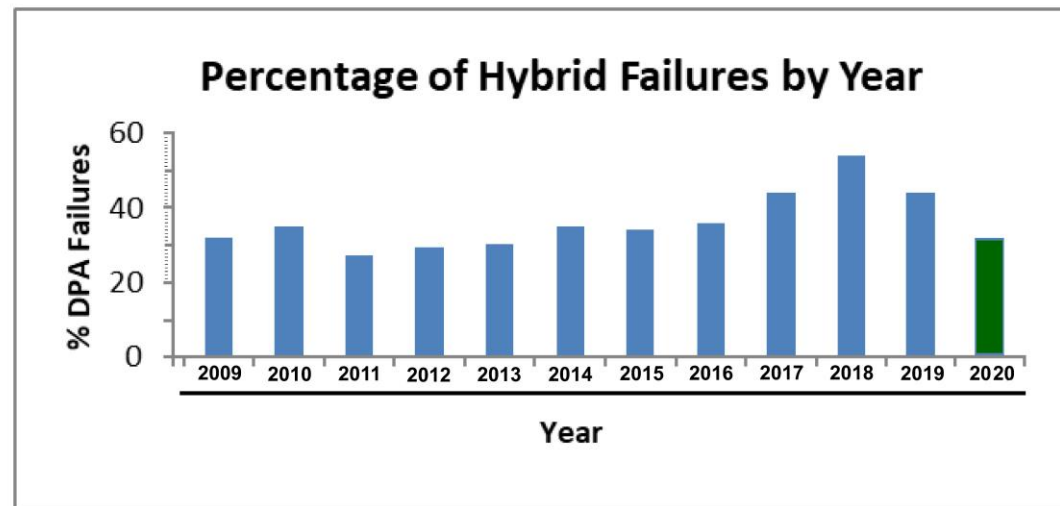


Failure Trends



➤ Single Decade Trending for Hybrid Microcircuits

- Based on DPA Test Results – Snapshot – Relative indicator for trending
- Used as indicator for where triage may be needed.
- Failures for various reasons (in 2020): (of the 32% that failed)
 - 47% failed Internal Visual Inspection, 27% failed X-ray
 - 15 % failed Prohibited Materials, 8% Failed SEM (scanning electronic microscopy)
 - 10% failed Bond Pull, 10% RGA (residual gas analysis), 2% External Visual
 - 7% PIND
 - 3% Hermeticity



* Data compiled from Hi-Rel Laboratories at Space Parts Working Group Conference presentation (2000-2020)



Performance Specification



➤ DLA Approved QML-38534 Vendor Listing

- 31 approved vendors (Typically we discuss the top 5)
- Various functions in addition to DC-DC converters
 - Optical Imaging Detectors, RF, Amplification, Opto-couplers, Motor Controllers, Digital Communications
 - Dilemma: Products with single die and few passive parts – look like MIL-PRF-38535 type product, are qualified and approved as MIL-PRF-38534

➤ Current Specification at Revision Level - L

- Approved December 2019 – Change Summary was about 40+
 - About 2 years of work to address related issues, rewording and change coordination (for element evaluation, worst case circuit analysis, periodic conformance, etc....)
- Significant Changes
 - Major updates to Element Evaluation Tables (“Big Theme” for 2020)
 - 5 year Periodicity requirement for Group C testing
 - Attempted to Address “existing inventory” for compliance
to new revision level L



Performance Changes +



➤ Current Specification at Revision Level – L (continued)

- Rev L (Hybrid User community is very reluctant to change at this time)
- Element Evaluation tables are considered strong and unchanged
 - Only minor typos are considered needing attention – no philosophical
- For Class K: “Group C inspection will be performed periodically within a maximum of five years for periodic re-qualification”.
- Wire bonding evaluation testing – **X-ray verification methods possible improvements**
- In Progress for Rev M
 - Restoring / Enhancing Worst Case Circuit Analysis (WCCA) requirements
 - Rev K removed “Worst case” from “circuit design analysis” requirement
 - Add WCCA parameters such as initial tolerances, temperature, aging, radiation (if applicable)



Current Actions



➤ Audits

- No H & K Hybrid Audits since early last year [NASA Representation]
 - CoViD-19 Travel Impact has limited FY2020 audits (only 2)
(In preparation for CoViD-19 restrictions rescinding – User community has audit “wish list” queue for major suppliers)
 - Urgent audit of manufacturer experiencing issues (as necessary)
 - or when factory/production lines are physically moved
 - Under review during typical audit
 - Derating Plan / Stress Analysis
 - Failure Analysis (Customer returns)
 - Testing
 - Reports available on NASA SAS website
 - Still Working with JC-13.5 to get WCCA approach/wording changes implemented & ensure standardization of all hybrids application reliability performance.



Future Actions



➤ **Military Specifications**

- MIL-STD-883 TM 2017 (Internal Inspections – Hybrids)
- Gen Spec for Hybrids (MIL-PRF-38534) next revision level
 - Completed of Rev L work – no major changes envisioned (typos?)
 - Get WCCA and Production Lot definitions Updated ...taking awhile.
 - Need to consider Retrospective review of changes in order to....

➤ **Continuous Improvements to Selection Tool(s)**

- Over 1500+ DC-DC converter SMD's
- Need to include Point of Load converters
- Understand custom environmental performances
(temperature, linear derating, WCCA etc...)



Thoughts Moving Forward



- **Where do we need to be 5 years from now.**
 - Vendor Audit Performance/Analysis and Prioritization
 - Ensure Spec. for Hybrids (MIL-PRF-38534) is “clean”/no loop holes
 - Better Selection tools for Hybrids to aid in reducing application risk

 - When do we start planning for the use of COTs related to Hybrids?

 - We need to ensure continued involvement from all NASA Centers!
 - Application & Product failure data needed for awareness/metrics
 - Need information on procurements, failures, CSI’s , lessons learned, etc.
 - Virtual Inspection Tools – We can Thank CoVid for this inspiration.



QUESTIONS / FEEDBACK

