



National Aeronautics and  
Space Administration



# NEPP/NEPAG DC/DC Converter & Hybrid Working Group

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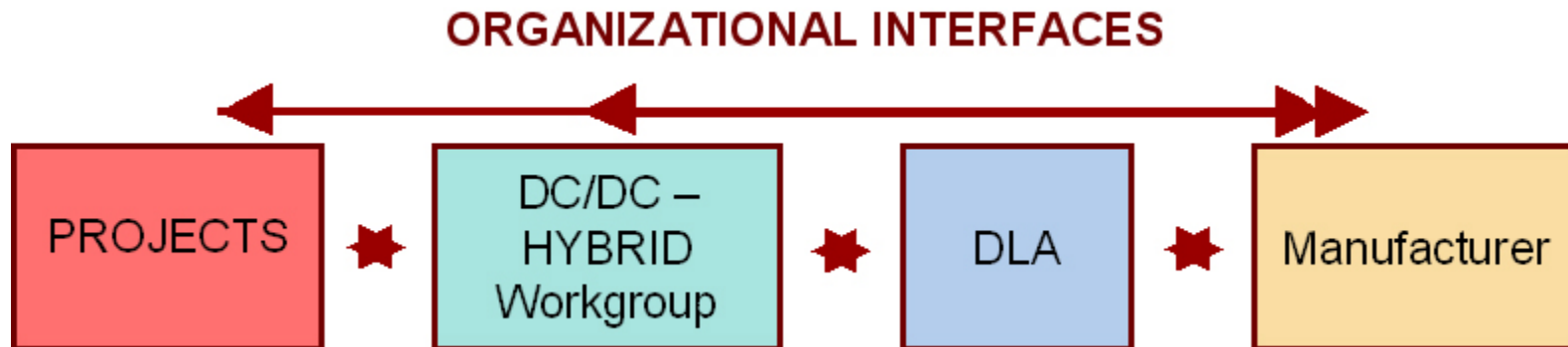




# Introduction



- **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)





# 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



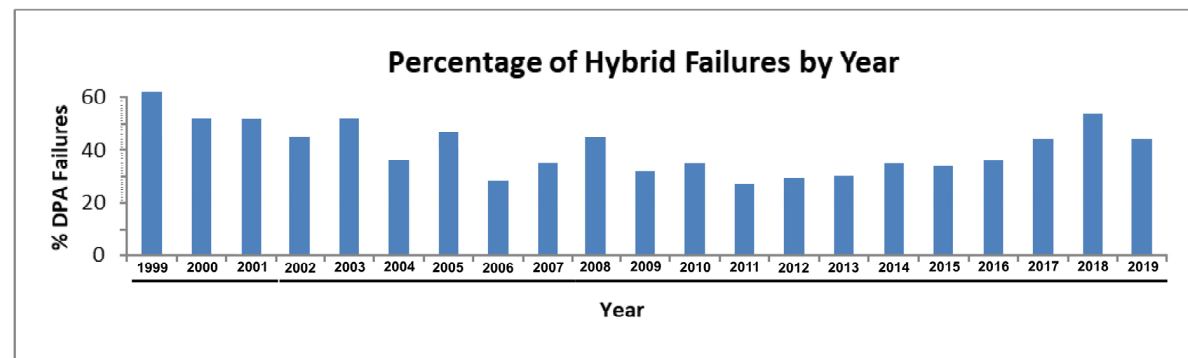
# Motivation



## ➤ 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 1in<sup>2</sup> – 5in<sup>2</sup>)
  - 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 (2000-2020)



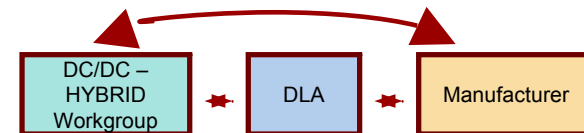


# Working Group Key Points



## ➤ 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 updates
- Attendance at JEDEC / G-12 Conferences (JC-13\* Government Liaison)
  - Attend 13.5 Hybrid Working Group Meetings



\* 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
  - ( Major DC-DC Converter supplier move 2019 (Redmond, Wa.)
  - ( Major Oscillator supplier move 2020 (Culver City, Ca.)
- Review of Specifications
  - MIL-PRF-38534, 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

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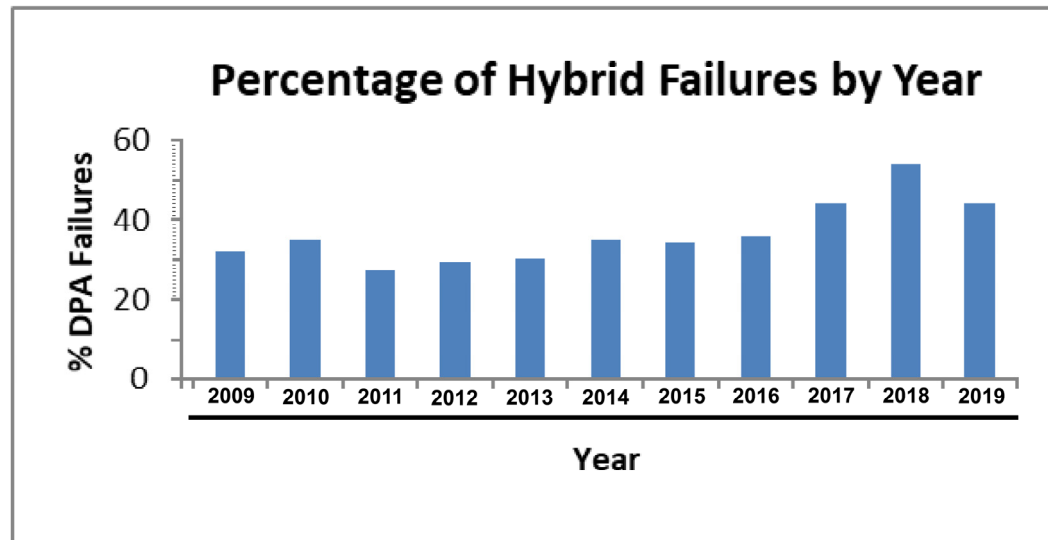


# Failure Trends



## ➤ 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 2019): (of the 46% that failed)
  - 38% failed Internal Visual Inspection, 14% failed X-ray
  - 15 % failed Prohibited Materials, 10% Failed SEM (scanning electronic microscopy)
  - 9% failed Bond Pull, 7% RGA (residual gas analysis), 2% External Visual
  - 2% PIND
  - 2% Hermeticity
  - 2% Pre-SEM



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



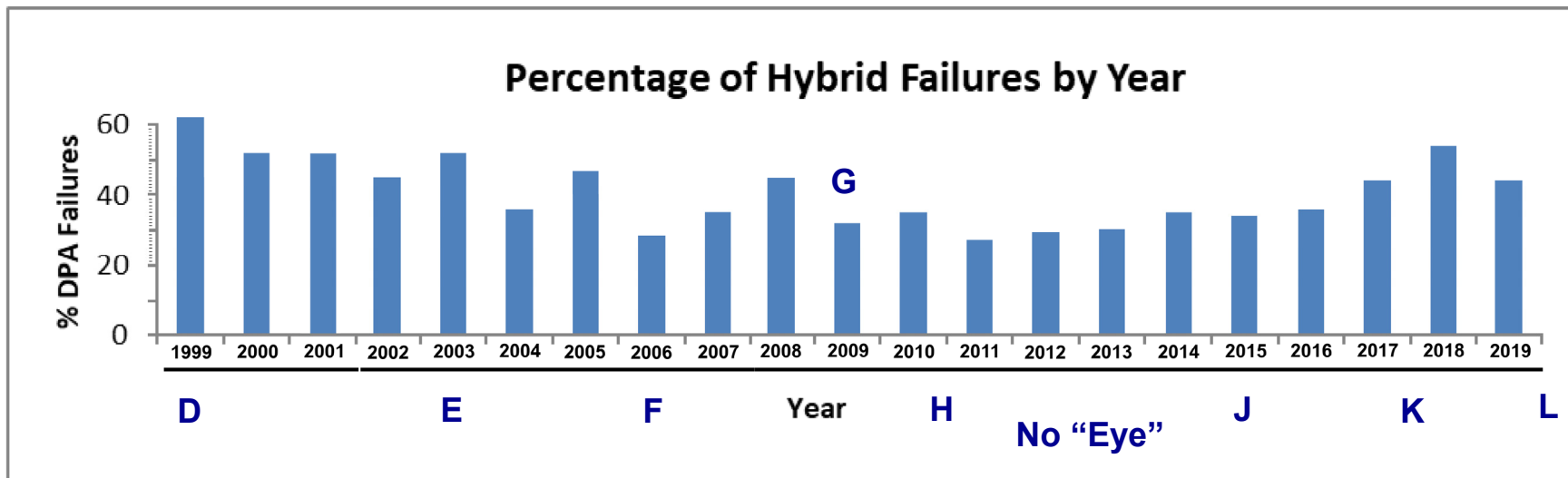


# Failure Trends (& more)



## ➤ Two Decade Trending for Hybrid Microcircuits

- MIL-PRF-38534 rev(D) applicable for 1999
- MIL-PRF-38534 rev(K) applicable for 2019 (rev L released in Dec.'19)
  - Letters below: Denote what MIL-PRF-38534 revision was in effect



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

**There is more trending analysis work to be done here !**



# Performance Specification



## ➤ DLA Approved QML-38534 Vendor Listing

- 31 approved vendors
- 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
  - 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 (change highlights)
  - Added new Element Evaluation tables
    - Should motivate manufacturers to use QML elements
  - For Class K: “Group C inspection will be performed periodically within a maximum of five years for periodic re-qualification”.
  - Wire bonding evaluation testing shall be same as assembly methods
  
- 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

- 3 Class H & K Hybrid Audits since last year [NASA Representation]
  - CoViD-19 Travel Impact has limited FY2020 audits (only 2)  
( 5 re-audits are in the 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
  - 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 last spring/summer/fall
  - Need to consider Retrospective review of changes in order to....
  - Formulate new proposed changes to address previous unfinished business due to release date schedule pressures

## ➤ **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.



# QUESTIONS / FEEDBACK

