

«« NEPP Automotive Grade Resistor Study ««

«« Linh Le, SSAI, Inc. at NASA GSFC ««

«« Zainab Abdullahi, NASA ««

«« Work performed for NASA GSFC, Code 562 ««



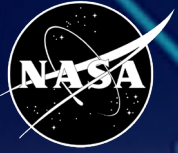
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«« 14 June 2023 ««

NASA Goddard Space Flight Center
Electrical Engineering Division





Acronyms



AEC: Automotive Electronics Council

EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating

EEEE: Electrical, Electronic, Electromechanical, Electro-Optical

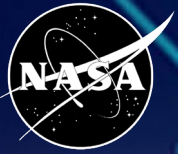
GSFC: Goddard Space Flight Center

NASA: National Aeronautics and Space Administration

NEPP: NASA Electronic Parts & Packaging (Program)

PDA: Percent Defective Allowable

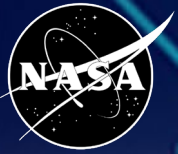
QTY: Quantity



Introduction to the Automotive Electronics Council (AEC)



- “The AEC Technical Committee is a standardization body for establishing standards for high quality/reliability electronic components (Automotive Electronics Council [AEC], 2017).”
- “The scope of the Technical Committee focuses on the creation of qualification standards for integrated circuits, discrete semiconductors, passive electrical components, and various manufacturing support functions (AEC, 2017). “
- “The results of Committee activities are primarily applied to electronic components used in high quality/reliability application markets, such as transportation, military, industrial, computer, telecommunication, and information systems (AEC, 2017).”
- **AEC - Q200: Stress Test Qualification For Passive Components**



AEC-Q200



Sections of AEC-Q200 (Rev. E, March 2023):

- Scope
- General Requirements
- Qualification & Requalification
- Qualification Tests

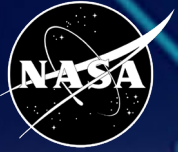
- Table 7:**

- Stress Qualifications for Film Resistors**

- Table 7B-5:**

- Acceptance Criteria for SMD Chip Resistors**

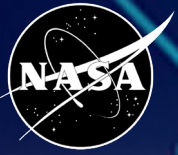
- (Does not include molded flat lead SMD, but
does include coated metal strip)**



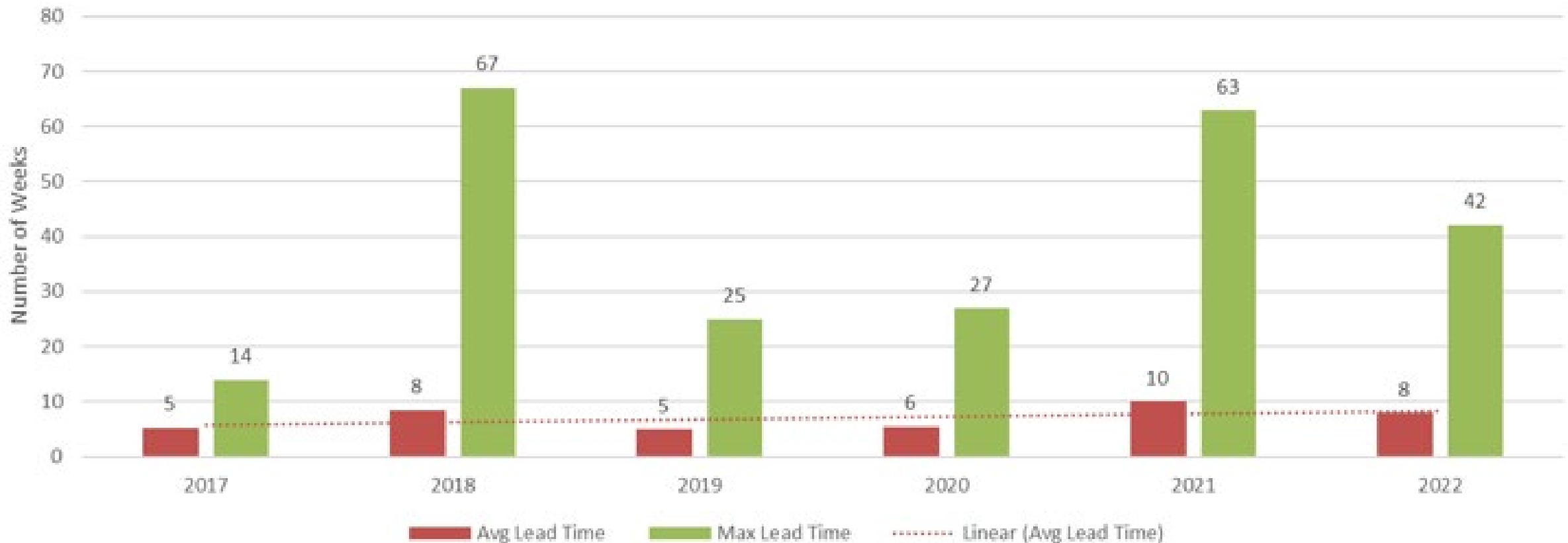
Motivation

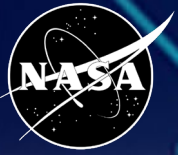


- *Global product shortages and shipping delays are still an obstacle and projects are still expected to meet deadlines that cannot take these global impacts into consideration.*
- *Many projects have found some alternative solutions to still meet deadlines, including the possibility of leveraging test data and requirements used in automotive grade parts.*
- *In addition, automotive grade parts may offer designers a wider range of parts to consider.*

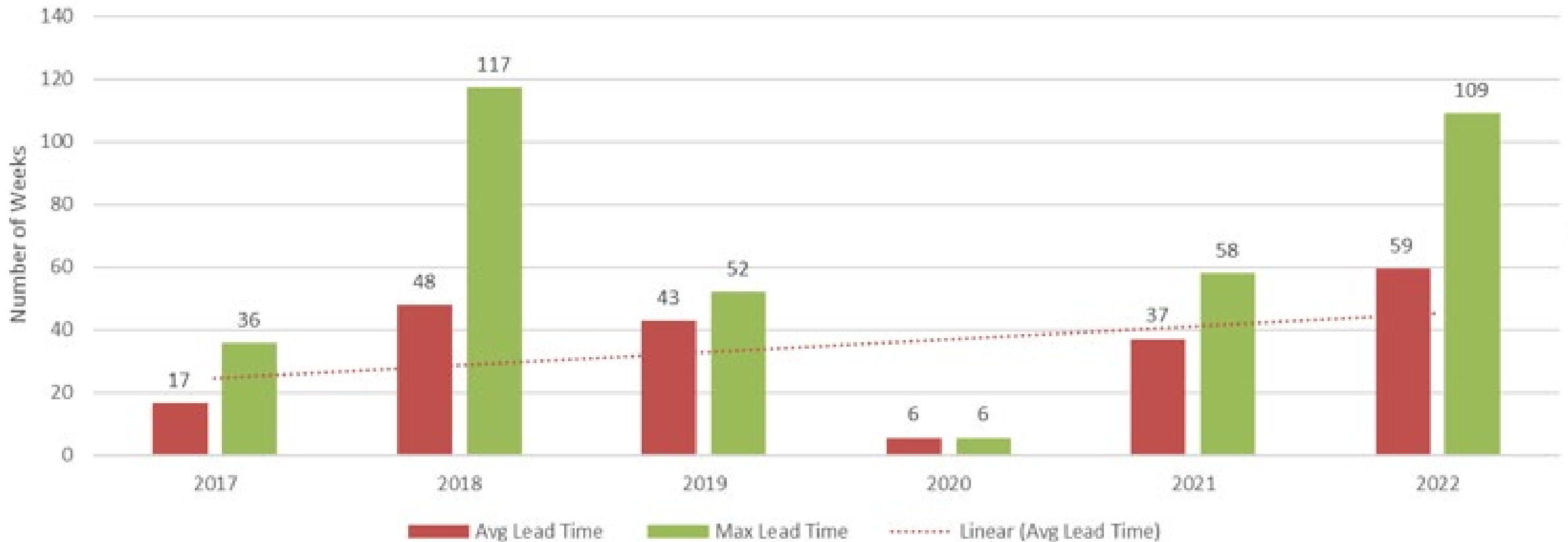


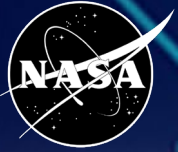
Lead Times of Parts Purchased From One Manufacturer





Lead Times of Parts Purchased from Another Manufacturer





Proposal



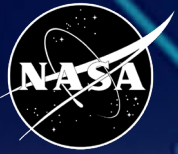
- *Year 1: Focus on Surface Mount Automotive Grade (AEC Q200) Resistors from Different Manufacturers*
- *Gap Assessment Between AEC Q200 and NASA GSFC EEE-INST-002 Qualification Requirements*
- *Perform Evaluation Testing of AEC Q200 Parts Using NASA GSFC EEE-INST-002 Qualification Requirements*
- *Assist Parts Assurance Engineers with Strategies for the Assessment of Alternate Grade EEEE Parts*

Principal Investigator: Linh Le

NASA Co-Investigator(s): Chris Tiu, Zainab Abdullahi

Partners (NASA & Non-NASA Organizations): NASA GSFC Parts Analysis Lab

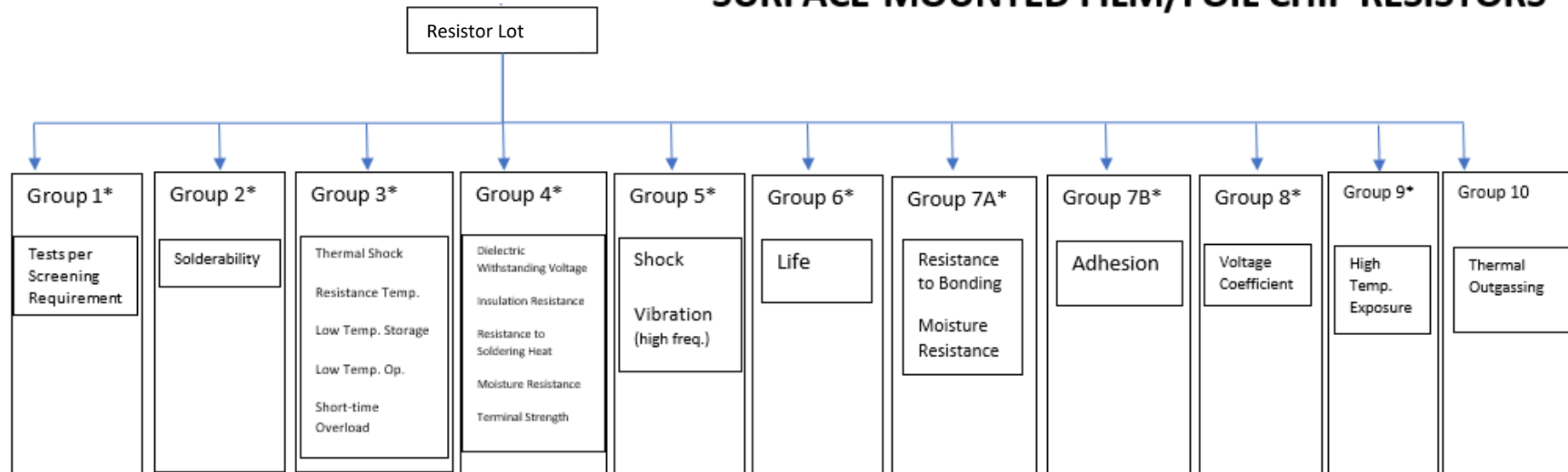
Special thanks to Jay Brusse, Dr. Henning Leidecker, Tim Mondy, Lyudmyla Ochs, and Kellan McCarthy



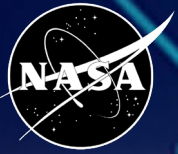
EEE-INST-002 And AEC-Q200 At A Glance



EEE-INST-002 POSSIBLE QUALIFICATION TEST FLOW FOR SURFACE-MOUNTED FILM/FOIL CHIP RESISTORS



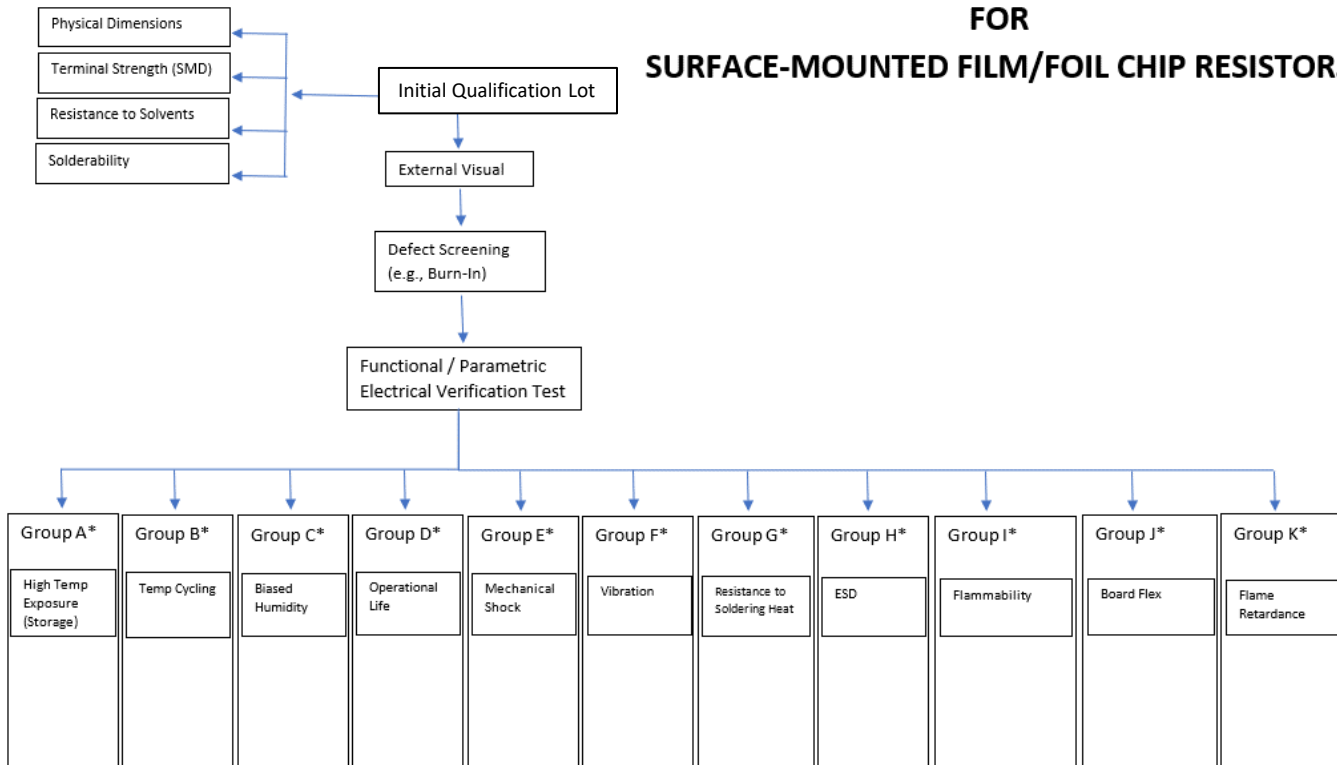
* External visual required before and after tests



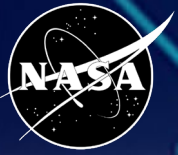
EEE-INST-002 And AEC-Q200 At A Glance



AEC Q200 POSSIBLE QUALIFICATION TEST FLOW FOR SURFACE-MOUNTED FILM/FOIL CHIP RESISTORS



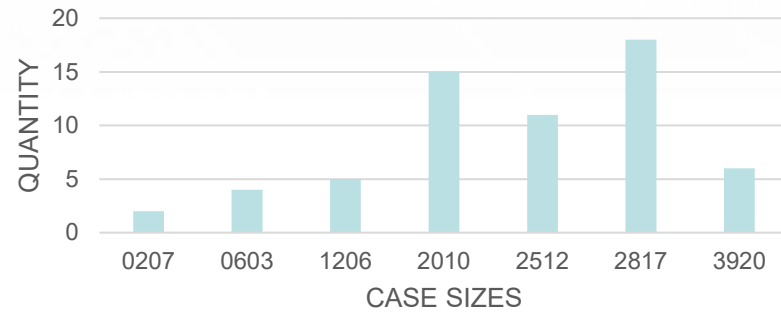
*Electrical verification tests are performed on parts at room temperature before and after the group's listed procedure.



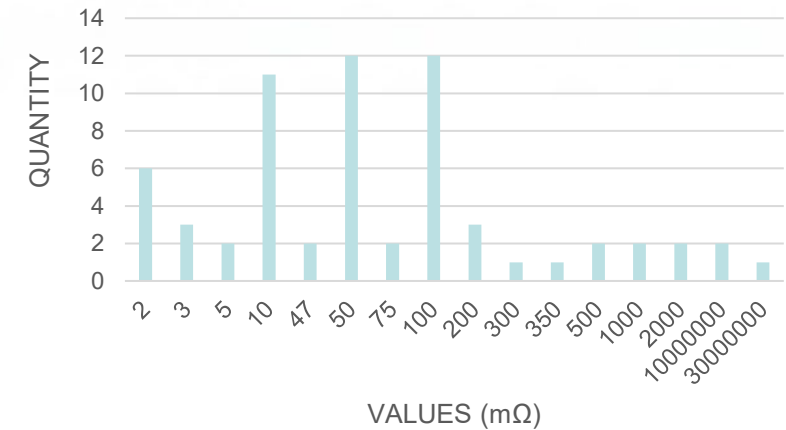
Previous NASA GSFC Parts Analysis Lab Evaluations of Automotive Grade Resistors



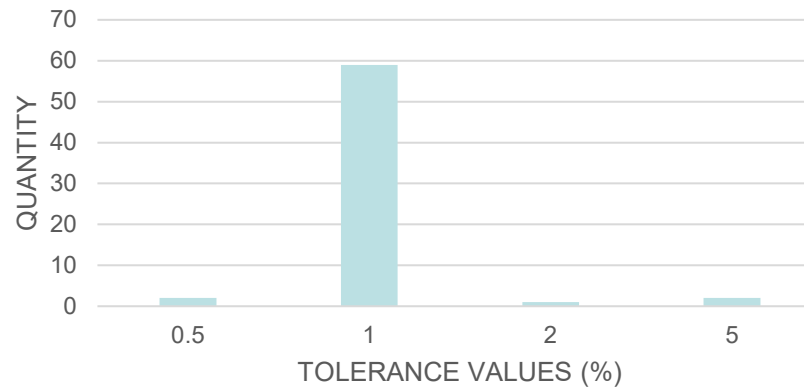
CASE SIZES



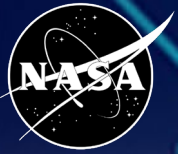
RESISTANCE VALUES



TOLERANCE VALUES



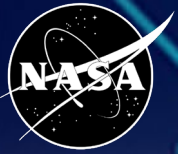
Special Thanks to Kellan McCarthy



Parts Selection



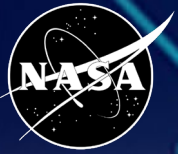
Manufacturer	Part Number	Chip Size	Resistance(Ohms)	Tolerance(%)	Wattage (W)	Type (Thin Film, Thick Film, Metal Strip)
A	PART A	2512	0.1	0.50%	1	Metal Strip (Current Sense)
B	PART B	1206	49.9	1%	0.25	Thick Film
C	PART C	0603	49.9	1%	0.1	Thick Film
B	PART D	1206	1000	1%	0.25	Thick Film
D	PART E	0603	100000	1%	0.1	Thick Film
B	PART F	1206	100000	1%	0.25	Thick Film
C	PART G	0603	1000	1%	0.1	Thin Film
B	PART H	1206	10000	1%	0.25	Thin Film
C	PART I	0603	10000	1%	0.1	Thin Film



Screening Test Flow



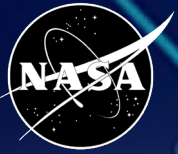
EVENT NAME	EVENT DESCRIPTION	STANDARD
External Visual	External visual per Table 2A of EEE-INST-002 on QTY: 13	Table 2A of EEE-INST-002
Mechanical Inspection (Qty : 3)	Critical physical dimensions per Table 2A of EEE-INST-002	Table 2A of EEE-INST-002
*Prohibited Materials Analysis (Qty : 3)		
Initial DCR (QTY: 100%)	MIL-STD-202, Method 303 Read and record resistance at 25C degrees ΔR : within specified tolerance range of part	Table 2A of EEE-INST-002 MIL-STD-202, Method 303
Thermal Shock (QTY: 100%)	MIL-STD-202, Method 107 Level 1 - 25 cycles High temperature - max. rated operating Low temperature - min. rated operating	Table 2A of EEE-INST-002 MIL-STD-202, Method 107
Final DCR (QTY:100%)	MIL-STD-202, Method 303 Read and record resistance at 25C degrees ΔR : within specified tolerance range of part	Table 2A of EEE-INST-002 MIL-STD-202, Method 303
Percent Defective Allowable (PDA)	Level 1 - 5%	



Qualification Test Flow



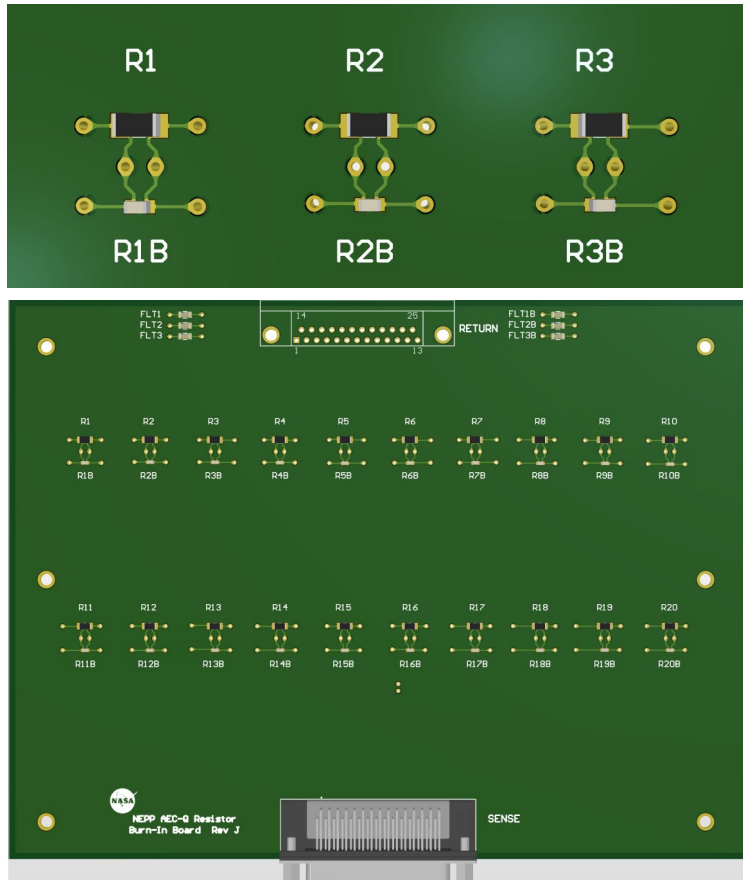
EVENT NAME	EVENT DESCRIPTION	STANDARD
Group 1 Screening to Table 2	Screening to Table 2	Table 2A of EEE-INST-002
Group 6 Life	Life (Qty : 20) (shall be from 100% screened parts) MIL-STD-202, Method 108 Time: 1000 hours Test temperature: 70C Voltage: rated voltage Operating conditions: 90 min ON, 30 min OFF ΔR : equal to or greater than ____ % Record data at 0 hrs, 100 hrs, 250 hrs, 500 hrs, 1000 hrs	Table 3A of EEE-INST-002 MIL-STD-202, Method 108



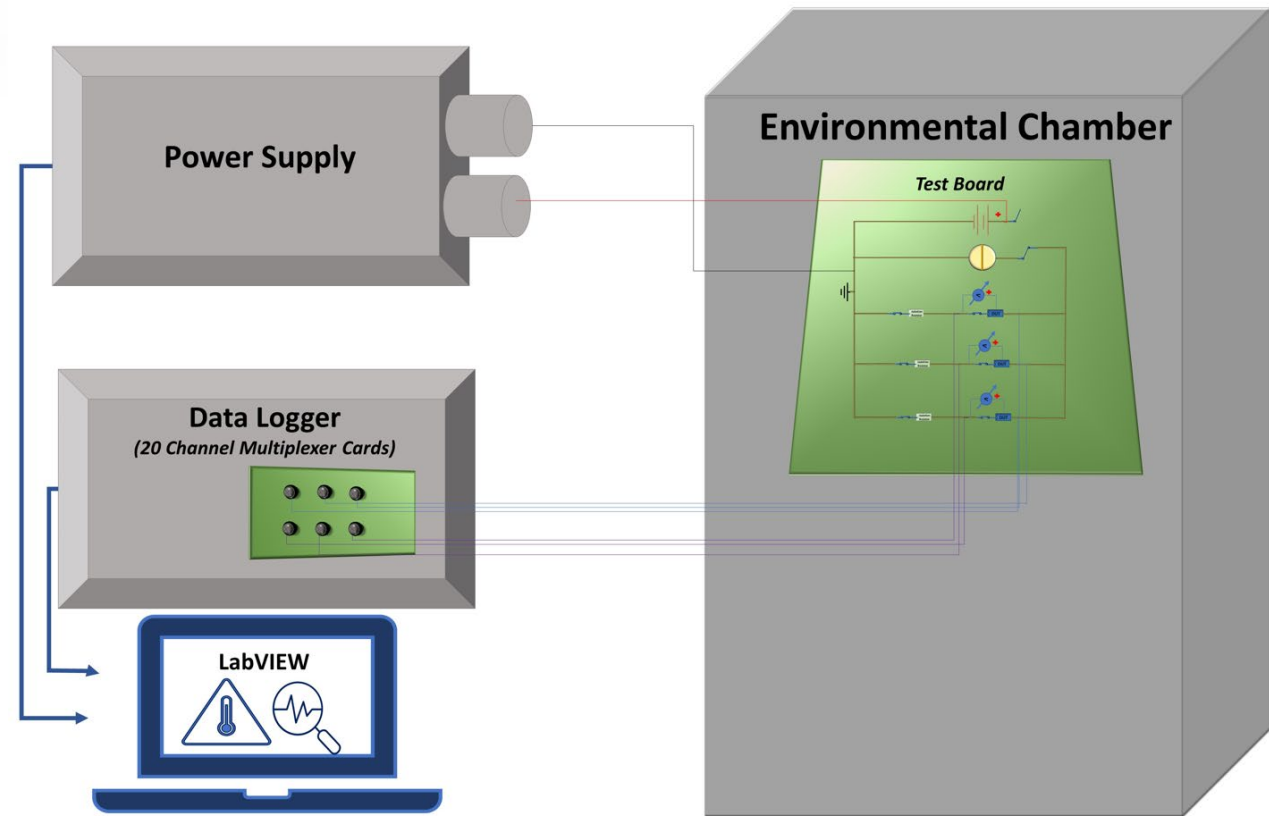
Q3 – Test Setup

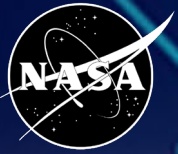


Designed Boards



General Setup Block Diagram

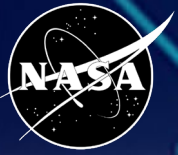




Status for Remainder of Q3 and Q4



- **Complete testing**
 - Perform External Visuals and Mechanical Inspections on all parts
 - Perform initial DCR measurements
 - Solder parts and wires to boards
 - Position boards in chamber
 - Connect wires and boards to power supply, data logger, and computer
 - Perform test runs and adjust settings
 - Run tests
 - Perform DCR measurements after testing is completed
- **Perform data analysis (Weibull)**
- **Write report**



Other Possible Related Research Opportunities



- **Test more specifically by changing only one parameter:**
 - **Use different manufacturers but have multiple sets of same**
 - **Values,**
 - **Sizes,**
 - **Tolerances**
- **Accelerated stress testing at higher powers and temperatures than specified in order to force failures and derive acceleration factors for power and temperature for some of the types of resistor technologies being evaluated**

