Department of
Mechanical Engineering
THE UNIVERSITY OF UTAH

Compliant EMI Cover

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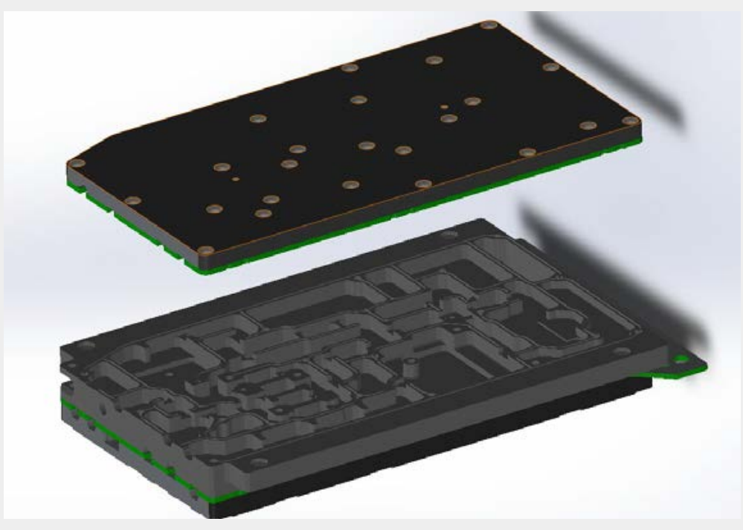
L3HARRIS™

Background

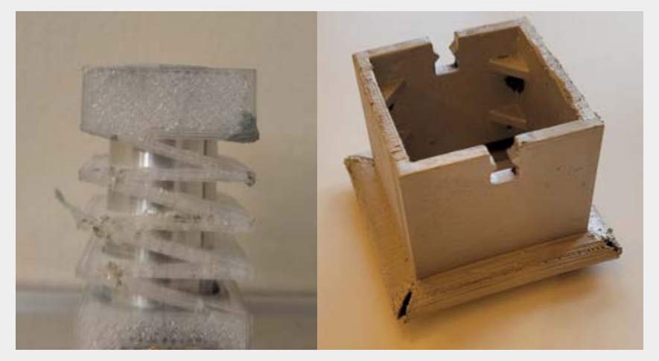
Circuit card assemblies (CCAs) become an increasingly critical component in almost all aspects of technology, and the need to protect them while in use becomes a top priority. Electromagnetic interference (EMI) can damage sensitive CCA components and result in a complete device failure. An EMI cover is designed to protect the CCA from physical elements, vibrations, and to absorb external EMI waves while dissipating heat from the CCA. Additionally, some components on the CCA could cause electromagnetic interference from nearby components, known as crosstalk. This crosstalk should be prevented using shielding that surrounds any EMI emitting components.

Objectives

The objective of our project is to simplify the current EMI cover design utilized by L3Harris. This simplification will eliminate the thermal gel gap filler used for heat transfer and reduce the number of fasteners necessary to seal the cover from internal and external EMI interference and protect it from outside forces. To accomplish this simplification, it was proposed by L3Harris to utilize a compliant mechanism concept. The new compliant mechanisms will aid in reducing fasteners and thermal gap filler material while maintaining adequate contact for heat transfer and EMI shielding. The external cover will protect CCAs from external signals. The EMI Wall will protect CCAs from EMI crosstalk, while the Linear Spring will transfer heat from the CCA.



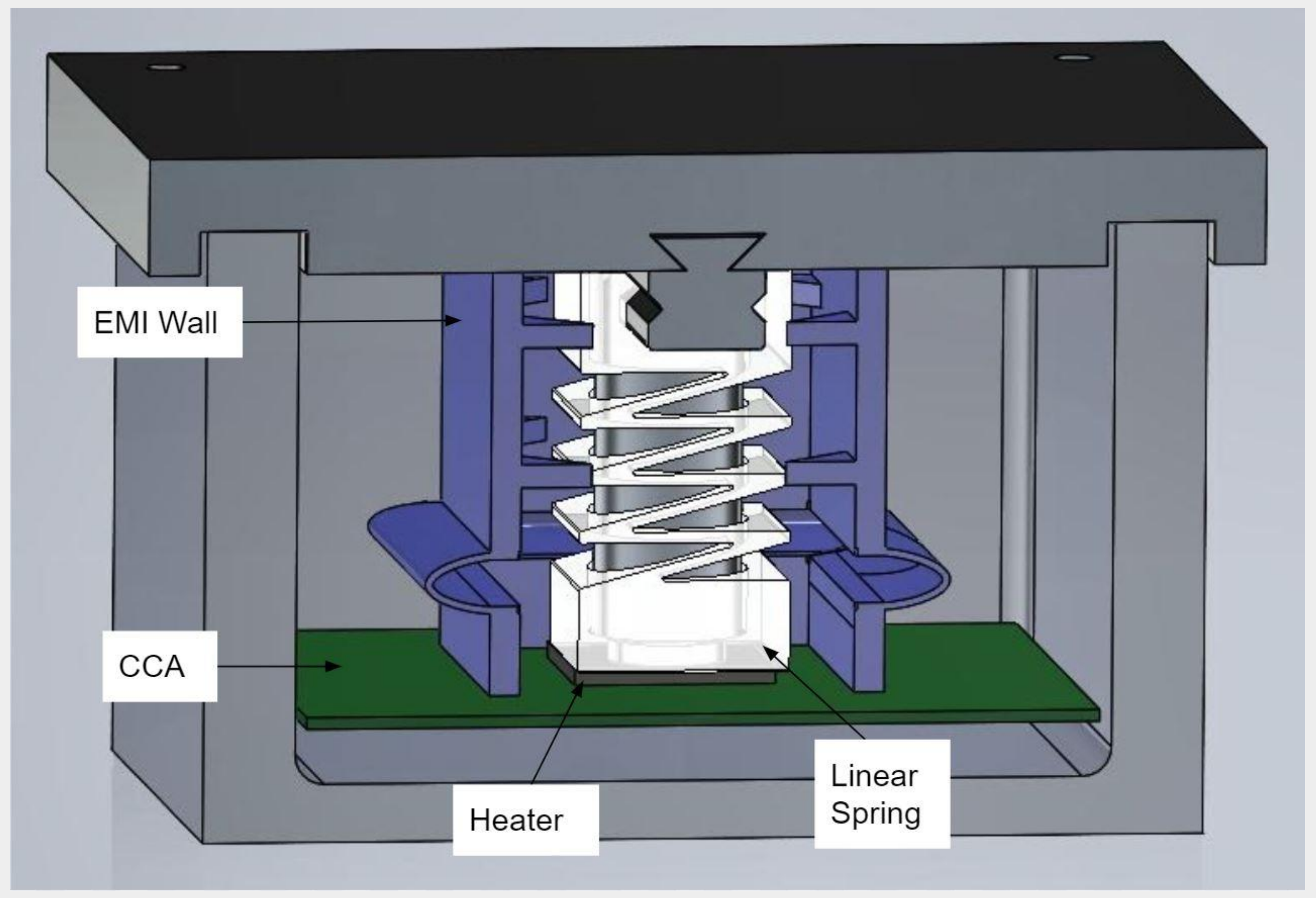
Current EMI Cover Designs



New Design Concept:
Compliant Mechanisms

Metrics & Achievements

Customer Need	Metric	Target Value	Achieved Value(s)
Compliant Part Stiffness	Mechanisms apply less than 10 psi to the circuit card given a displacement of 0.1 inch	< 100 Lbf/in	47.86 Lbf/in
Compliant Part Dimensional Accuracy	Mechanism dimensions must be within ± 0.010" of the CAD model when printed	± 0.010 in	+ 0.009 in
Contact Resistance	Mechanisms electrical resistivity	≤ 2.5 mΩ	0.360 mΩ 358.19 mΩ
Heat Rate	Mechanisms heat transfer flux	> 5 W	6.29 W
Max Temperature	Max circuit card temperature allowed	<100 °C	58.2 °C
Vibration Dampening	Cover maintains integrity of other metrics in vibrational environment [Hz]	>1500 Hz	2000 Hz



Final Prototype

Testing Methods

Contact Resistance

- Benchmark test to prove feasibility for testing EMI shielding effectiveness (MIL-STD-464C)
- Tested using Digital Ratiometric Micro-Ohmmeter (DRM-40)

Contact Resistance Test

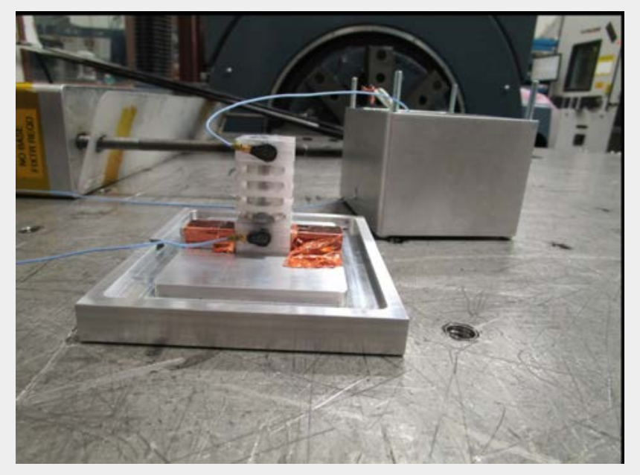
Compliant Part Stiffness

- Measured stiffness during 0.1" compression on Testometric M350
- 3.9 in/min strain rate to simulate assembly
- Stiffness: $k = F/\triangle x$

Compression Test

Vibration Dampening

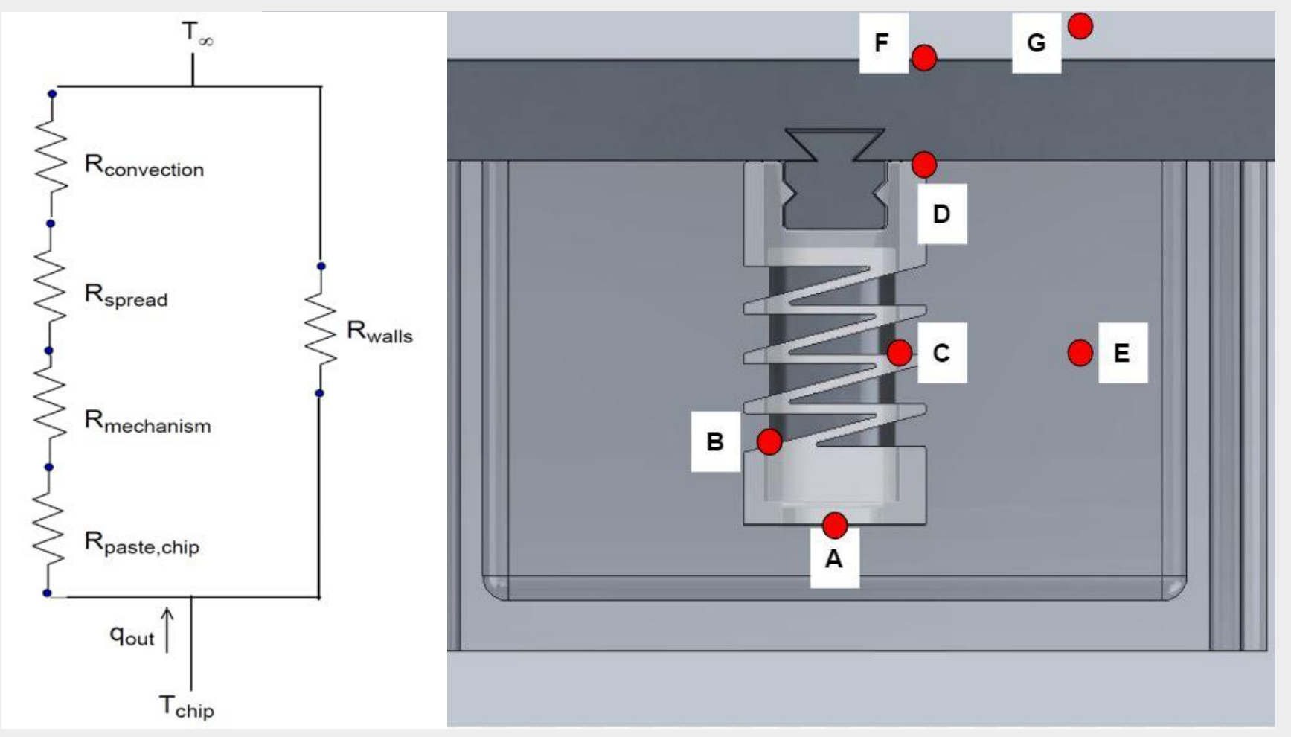
- Response curves generated from vibration up to 2000 Hz.
- Performed on T-2000/VR4 vibration table in line with MIL-STD-810H



Vibration Test

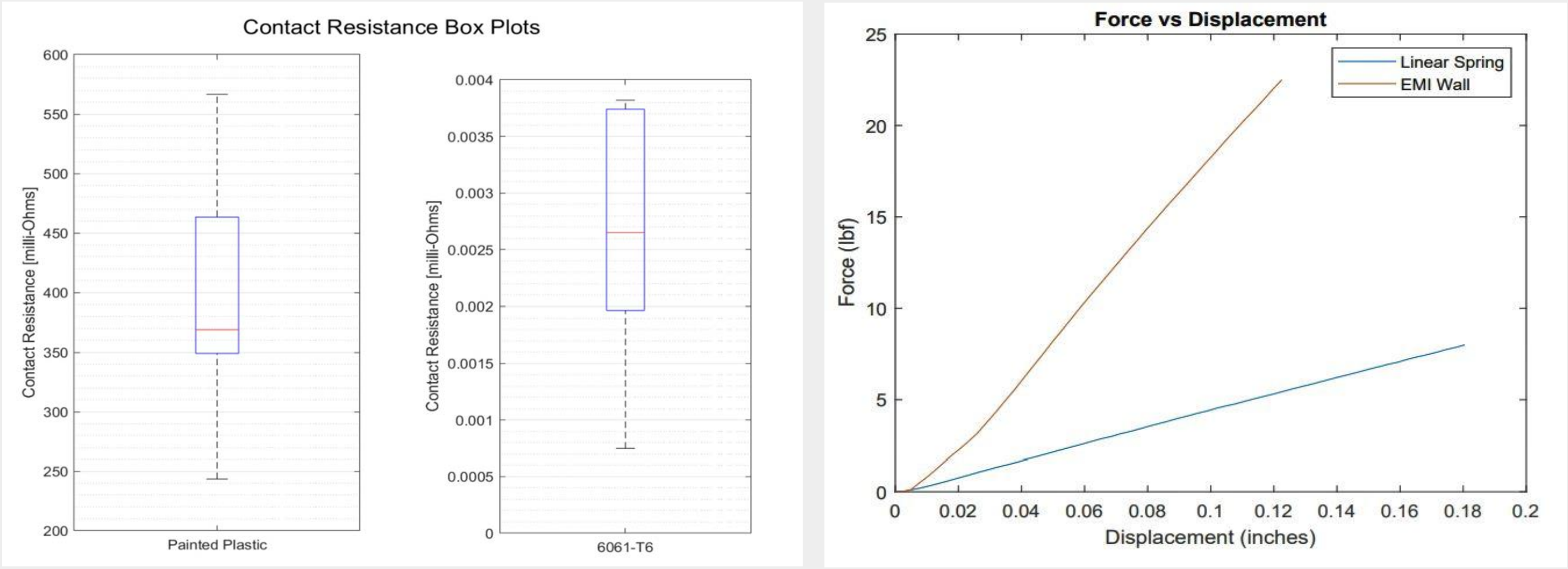
Heat Transfer

- Measured temperature using an Omegasoft TC-08 DAQ and 8 thermocouples
- Key Model Equations
  $Q_{out} = (T_{chip} - T_{\infty})/R_{total}$
  $R_{conduction} = L/(K*A)$
  $R_{convection} = 1/(h*A)$

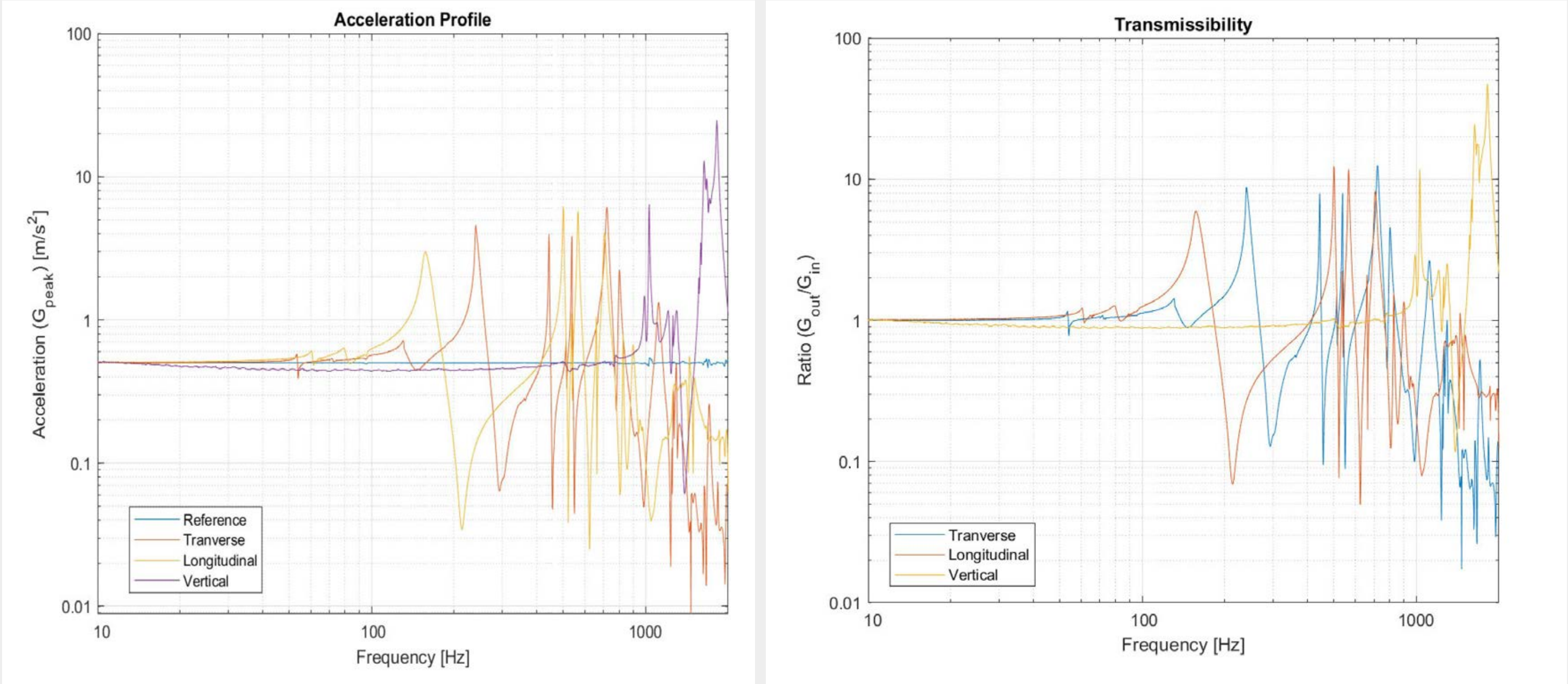


Thermal resistance network (left) and heat test setup (right). Red dots are probe placements

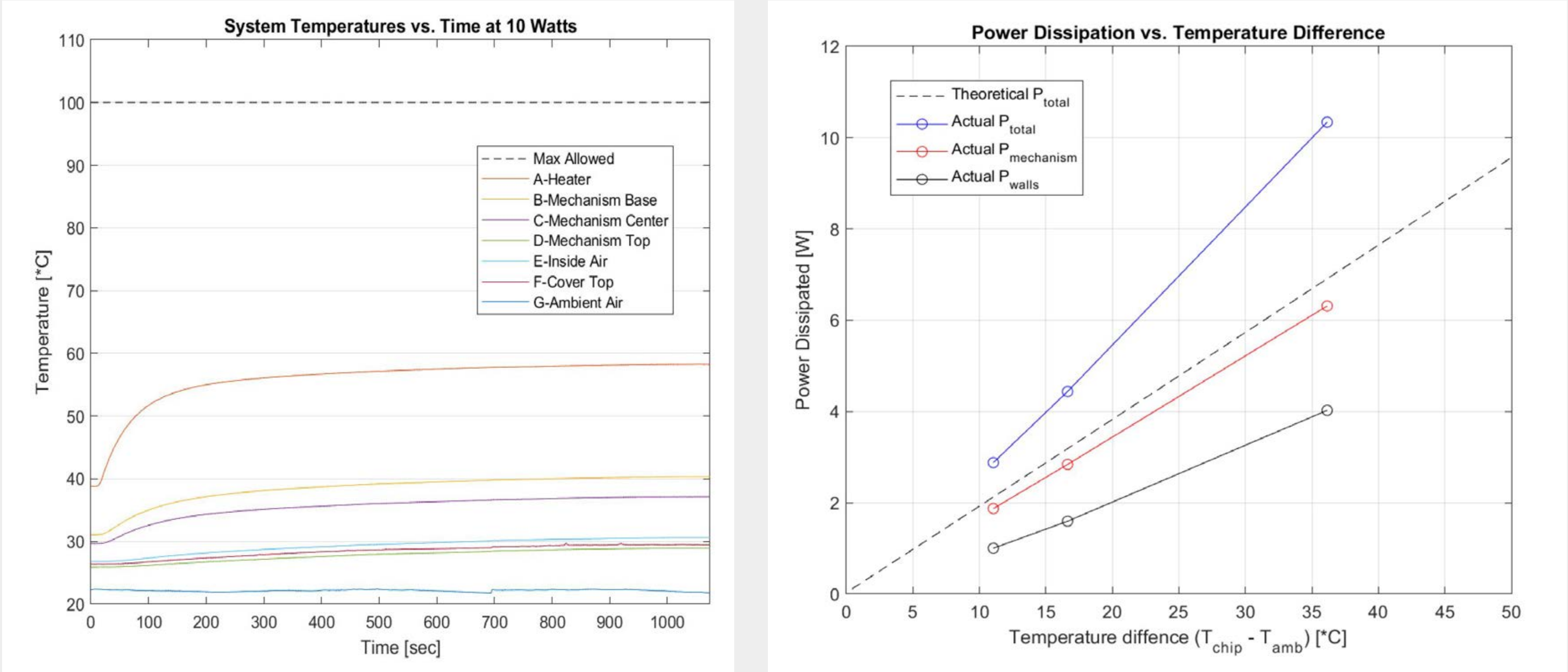
Results



Contact resistance test results, used as an EMI shielding base line (left), Force vs Displacement curve of both mechanisms (right)



Vibration response curves: sine sweep 0.5G 10-2000Hz, acceleration profile (left) and transmissibility (right). Test setup in line with MIL-STD-810H.



System temperature profiles vs time (left). Power dissipations vs temperature difference (right).

Conclusion

The Linear Spring mechanism and outer EMI cover proved effective in meeting the customer needs while the EMI Wall mechanism failed in meeting contact resistance. The EMI Wall mechanism needs a better conductive coating, possibly through plating or advanced metal printing methods to meet EMI resistance requirements. The compliant mechanisms concept met most of our metrics and merits further exploration to multiple CCA geometries.