Integrated Communications and Thermal Management Microsystem for Advanced Spacecraft

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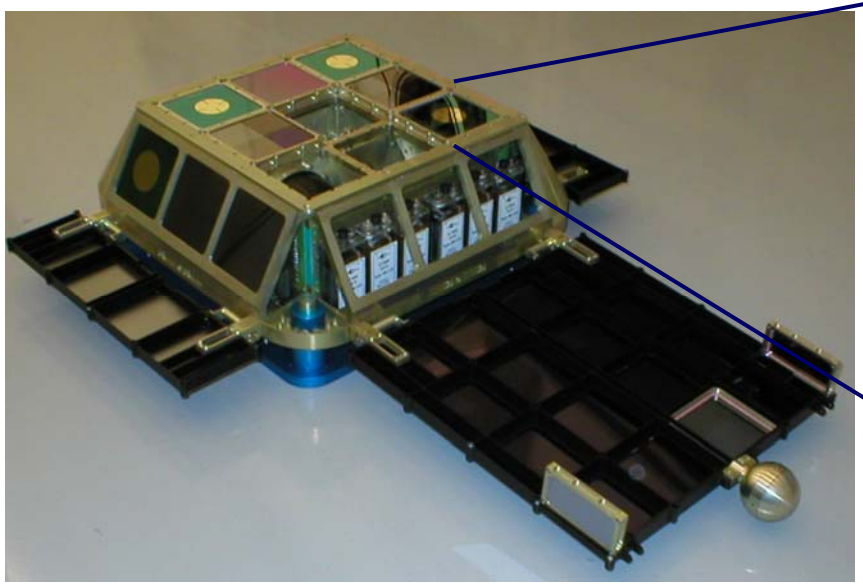

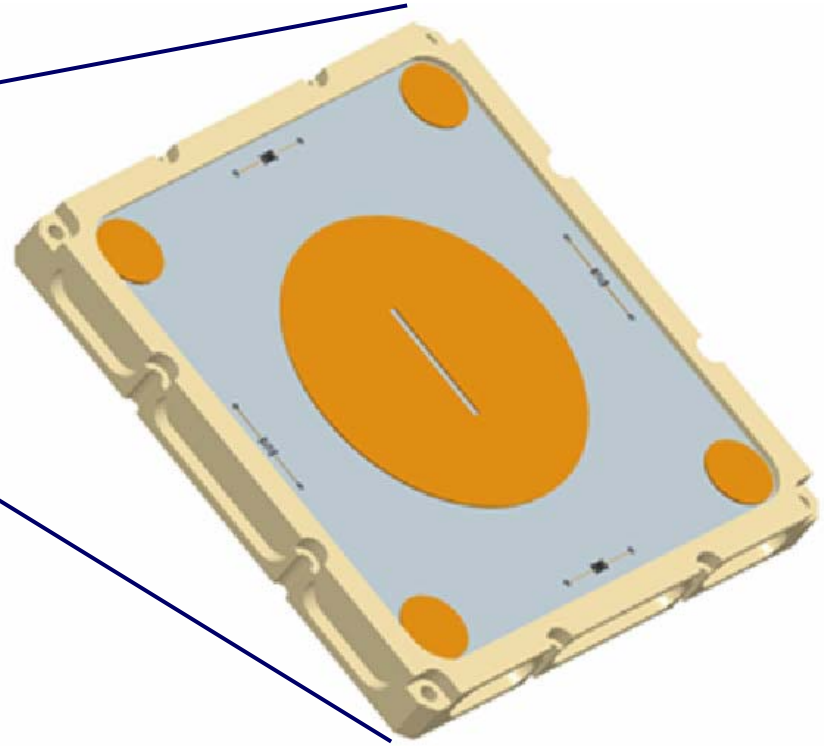

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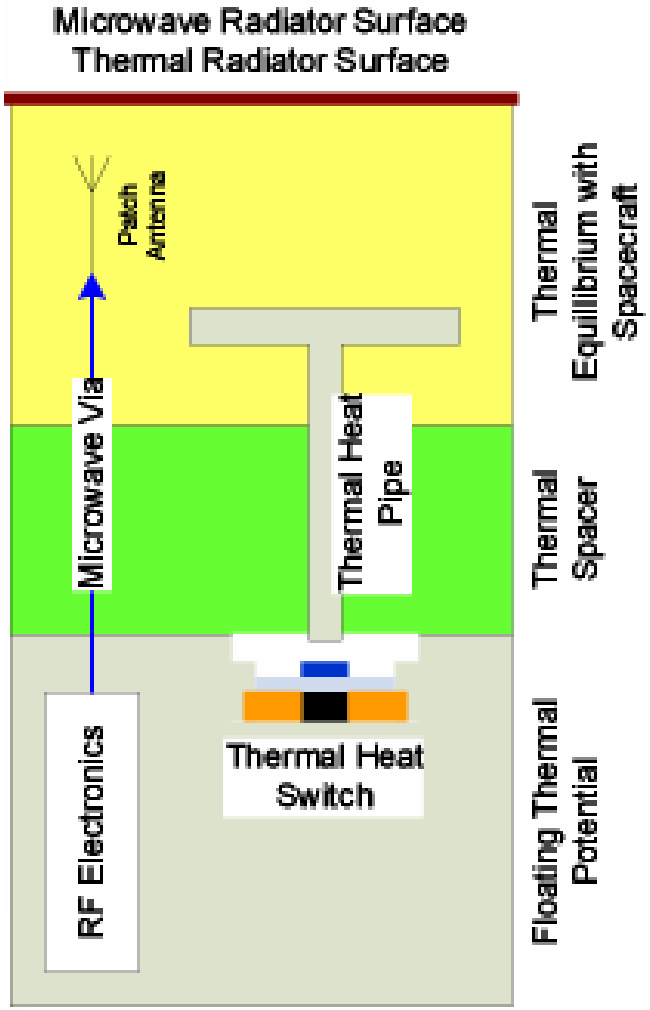
Preliminary Performance Spec.

- Microsystem size 68x68x6.6 mm
- Mass 54 grams (including casing)
- Uplink/downlink data speed of 100kbps/1Mbps
- Flat patch antenna with circular polarization and 6 dBi gain
- Latent heat paraffin heat sink 6.3 g x 260 J/g
- Thermal heat transfer modulation between switch on and off state is 10.

Outline

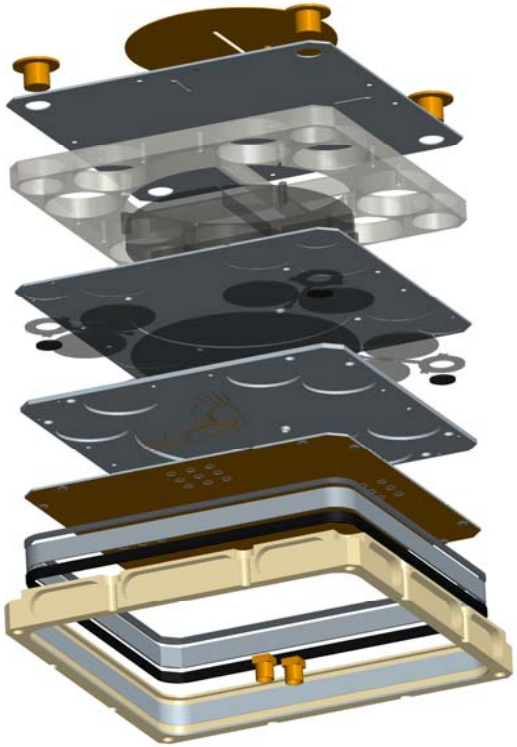
- System Overview
- Anatomical Description
- Multifunctionality
  - Paraffin as a multifunctional material
- Detailed Design
  - Communications
  - Thermal Management
- Conclusions

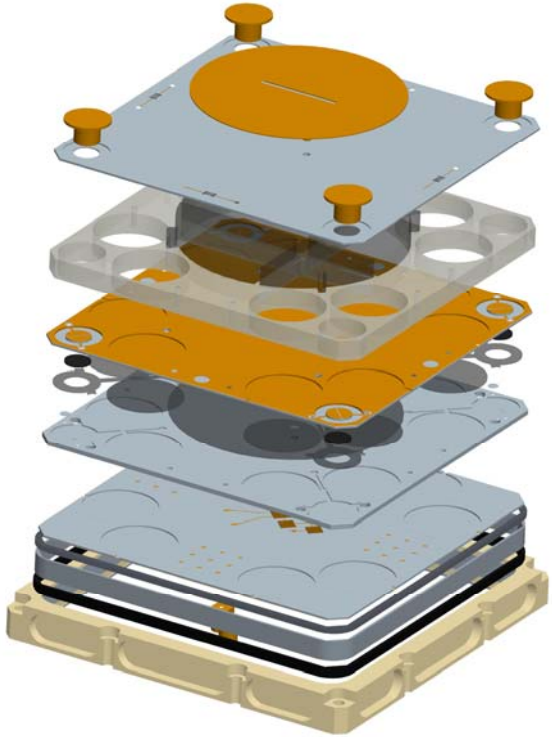
System Overview

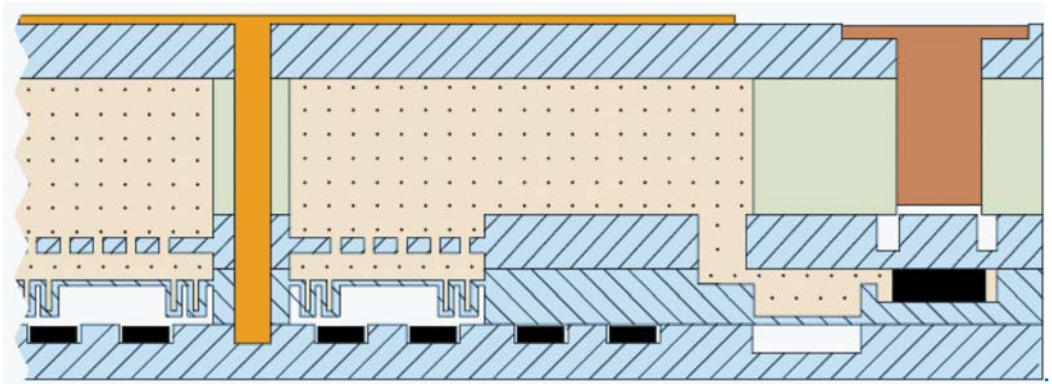


- Communications and thermal management
- Essentially three functional layers
  - Electronics and heat switch at a floating thermal potential
  - Antenna spacer and thermal spacer
  - Patch antenna, thermal radiator surface with a well defined thermal interface to spacecraft chassis

Anatomical Description







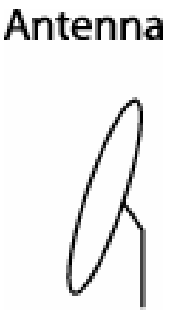
Multifunctionality

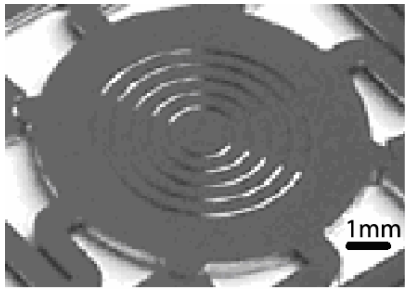
- Communication function
- Thermal management
- Structure
- Concurrent triple usage of paraffin
  - Low loss antenna substrate
  - Thermal heat storage
  - Actuator for thermal conductance switch

Paraffin

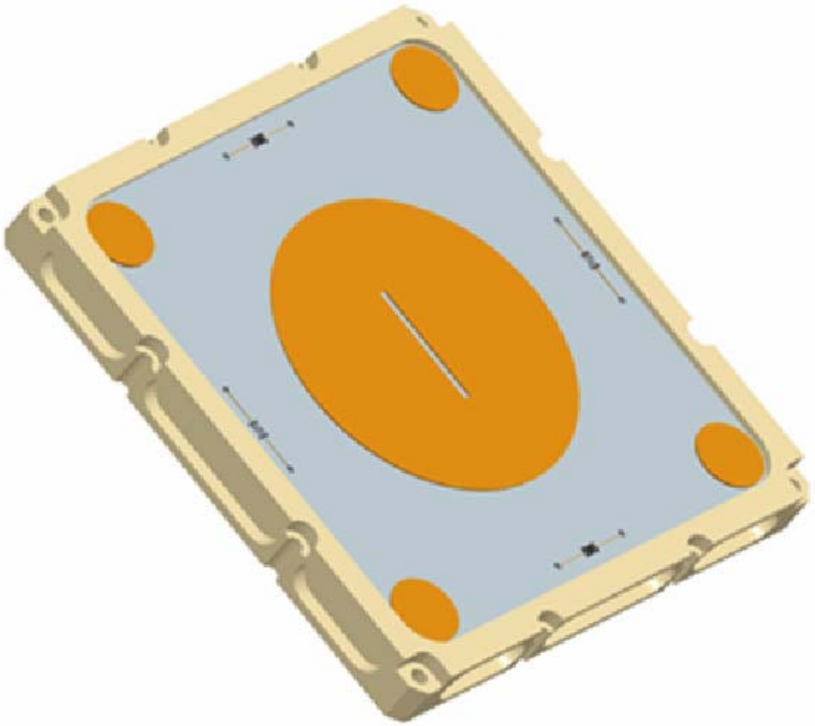
Paraffin as a multifunctional material

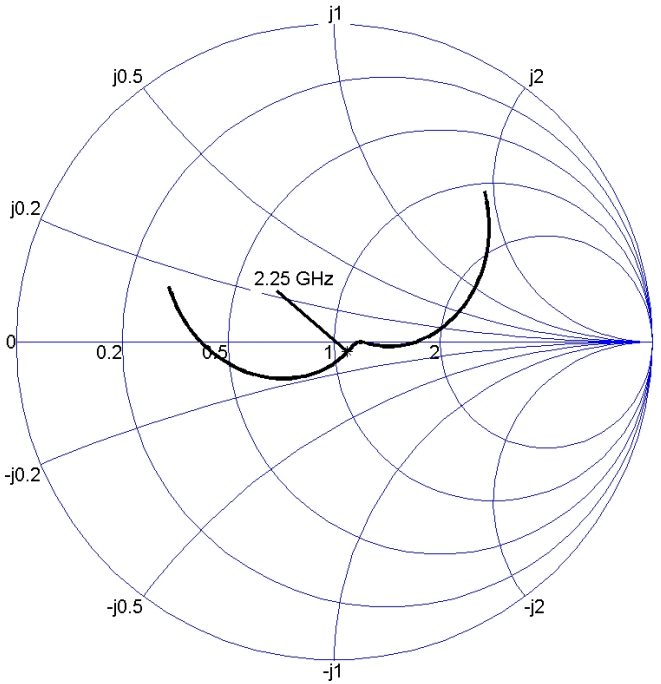
- Paraffin as a low cost and low loss microwave substrate material
- Inherent heat storage using paraffin latent heat
- Large stroke and high force actuator in microsystems

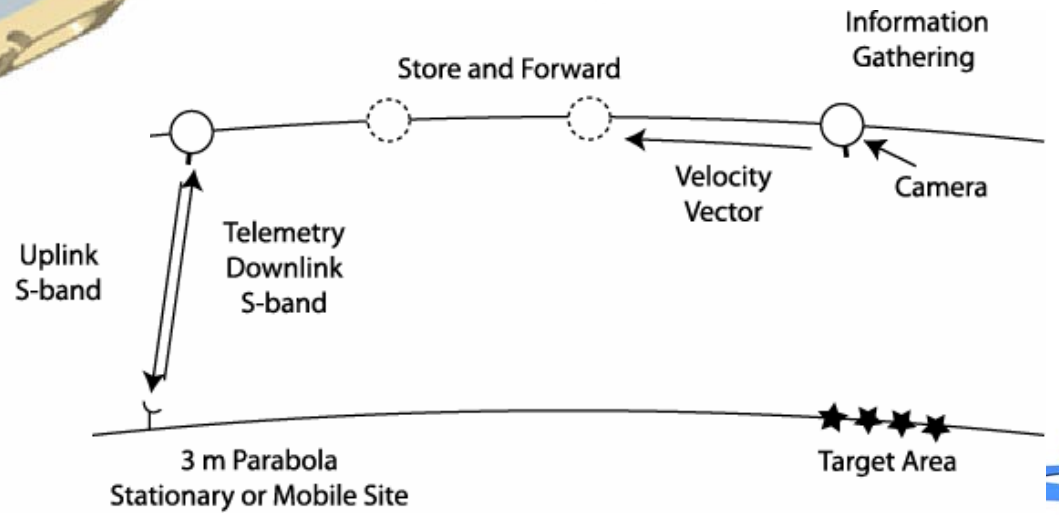




Detailed Design – Communications







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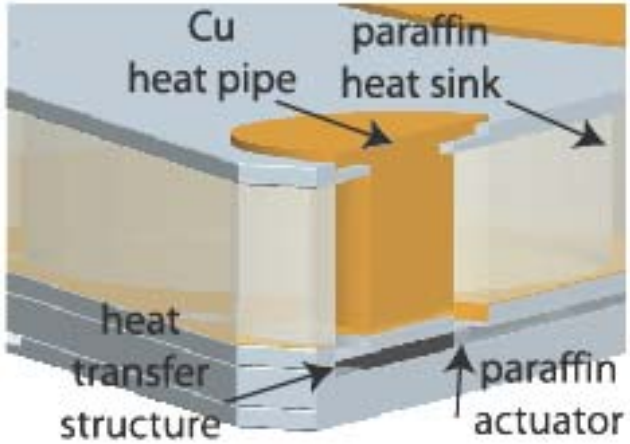
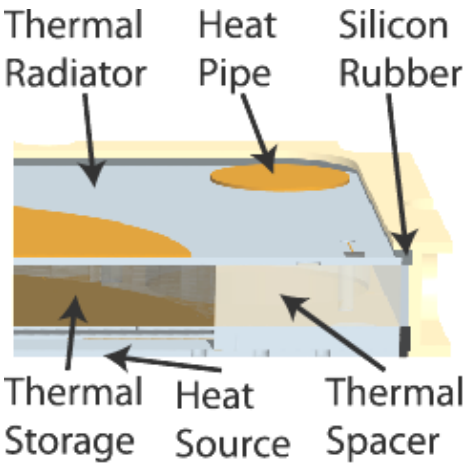
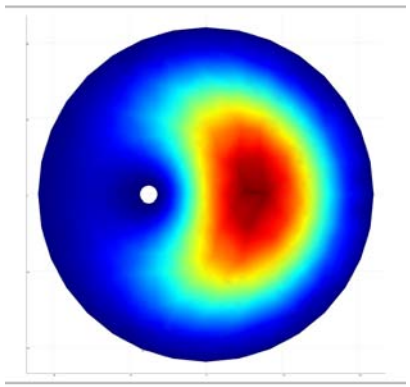
Detailed Design – Thermal Management

- Absorption of transient heat flows by latent heat
- During phase change, a 15% increase in paraffin volume
- Thermomechanical design of expansion chambers
- By design, switch is actuated when 75% of latent heat is consumed







Conclusions

- An Integrated Communications and Thermal Management Microsystem for Advanced Spacecraft has been presented
- Paraffin as a multifunctional material
- Communication performance 1Mbit/100kbit
- Heat storage 6.3 g x 260 J/g
- Floating thermal potential for electronics
- Thermal modulation of 10 for the thermal switch layer