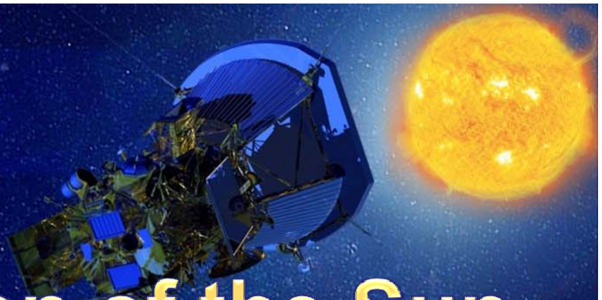
Solar Probe Plus

A NASA Mission to Touch the Sun



Integrated Science Investigation of the Sun Energetic Particles

Preliminary Design Review

05 – 06 NOV 2013

EMI / EMC

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Outline

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- EMC Design Considerations
- EMC Grounding
- EMC Testing
- Heritage CE performance
- Summary

EMC Design Considerations (1/3)

- Power supplies crystal controlled to a frequency window centered at n*50 kHz with n>=3 and 500 ppm wide over all operating conditions and time.
  - The LVPS is synchronized to 200 kHz by a 400 kHz clock provided by the digital boards.
  - EPI-Hi has 58.8 MHz oscillator and EPI-Lo has 40 MHz oscillator. Both evenly divide to 400 kHz.
- Transformers and big inductors are placed as far from Box walls as possible.
- Stable currents to minimize changes in Magnetic Emissions
- Control all current paths inside your box to minimize loop area. Cannot use a solid return plane if a trace is the source. Any circuit over 100 milliamps AC or 1 amp DC will be analyzed.
  - LVPS has AC currents on primary transformer that exceed 100 mA.
  - EPI-Hi op-heaters can draw only about 30 mA @ 33V.

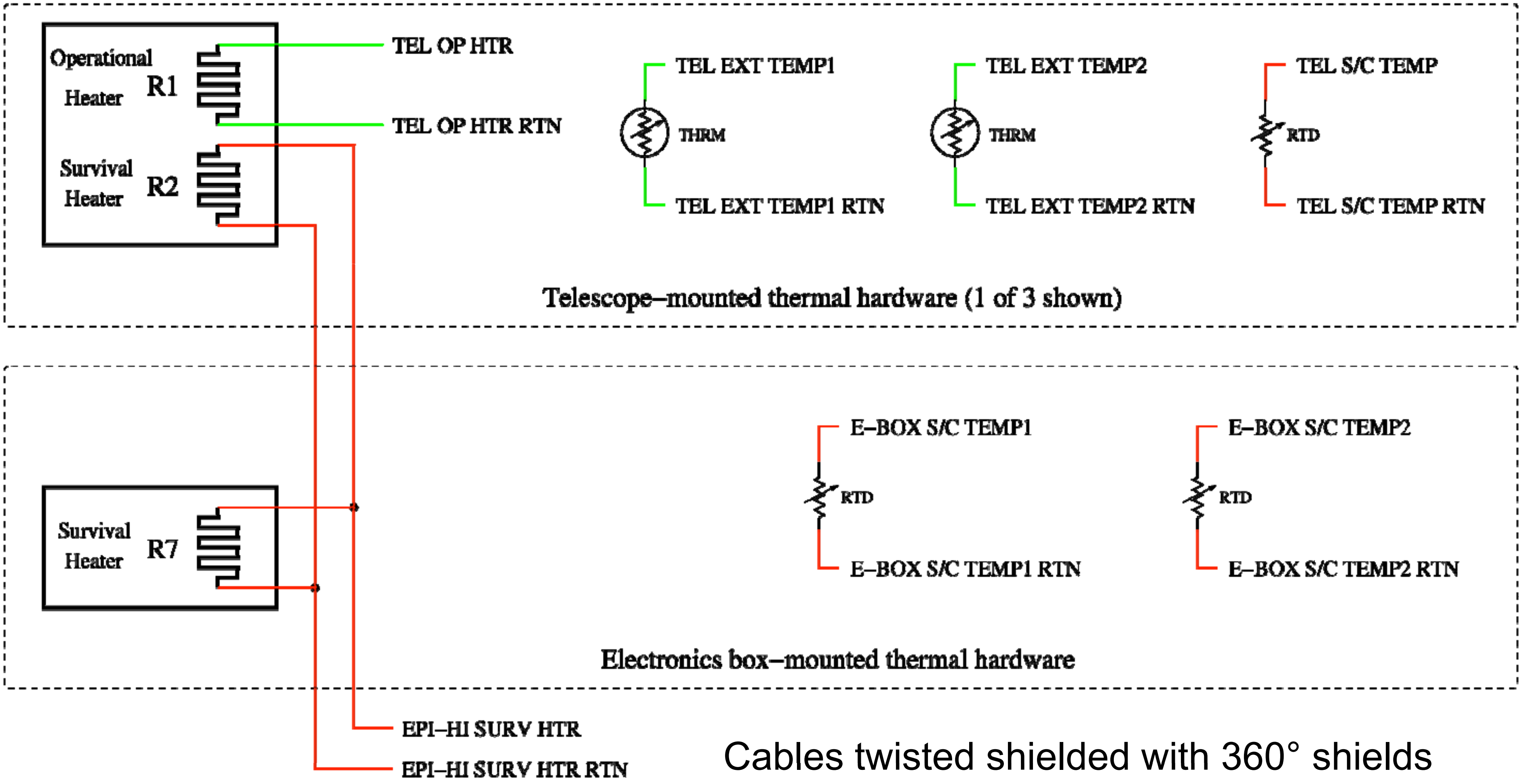
EMC Design Considerations (2/3)

- All Cables outside the metal box must be twisted shielded with 360° shields terminated to the Box with less than 20 mOhms.
  - EPI-Lo has no external cables.
  - EPI-Hi has an external thermal harness for thermal hardware mounted on 3 telescopes and E-box (shown on page 6).
- EMI Backshells not required by EME but shield must cover connector fully.
  - EPI-Lo and EPI-Hi boxes designed to accommodate backshells for S/C data and power connectors.
- Connector shell to Box resistance before mated < 5 mOhms
- Any cable outside the spacecraft body attached to a device must have either 13 mils shielding or DDD first circuit protection.
  - EPI-Lo has no external cables.
  - EPI-Hi’s external thermal harness will have adequate shielding.
  - S/C data / power cable shielding 8 mils (TBR). S/C interfaces designed to handle DDD.

EMC Design Considerations (3/3)

- All use of Magnetic Materials (Nickel, 400 Series CRSS, etc) must be identified and approved by the project. High Phosphor Nickel coating is allowed because it is not magnetic.
  - EPI-Lo has Nickel grids. Working with Project to develop magnetic mitigation plan.
  - EPI-Hi has no major Nickel parts, only Ni-plated connectors.

EPI-Hi Thermal Harness Diagram



Cables twisted shielded with 360° shields terminated to the Box with less than 20 mOhms.

EMC Grounding

- Primary power supplies isolated by >1 MΩ .
- Secondary power supply returns tied to chassis with <2.5 mΩ in only the Box using the power.
- Grounding Diagrams will show all chassis grounds, primary and secondary power feeds and returns, shields, and signals with returns.
- ID all connector pins with first circuits.
- Connectors unused in flight shall have a conductive cover with less that 10 mΩ from cover to Box chassis.
- “Conductive” Box exterior
  - Exterior on EPI-Lo will be MLI StaMet outer finish, and Z93C55 white conductive paint.
  - Exterior on EPI-Hi will be MLI and radiator surfaces.
- Box design must be at least tongue and groove. EMI gaskets on flat joints is acceptable.
  - EPI-Lo utilizes overlap joints and copper tape as necessary to seal seams.
  - EPI-Hi enclosure uses overlap joints, light-tight by design, and copper tape as necessary.

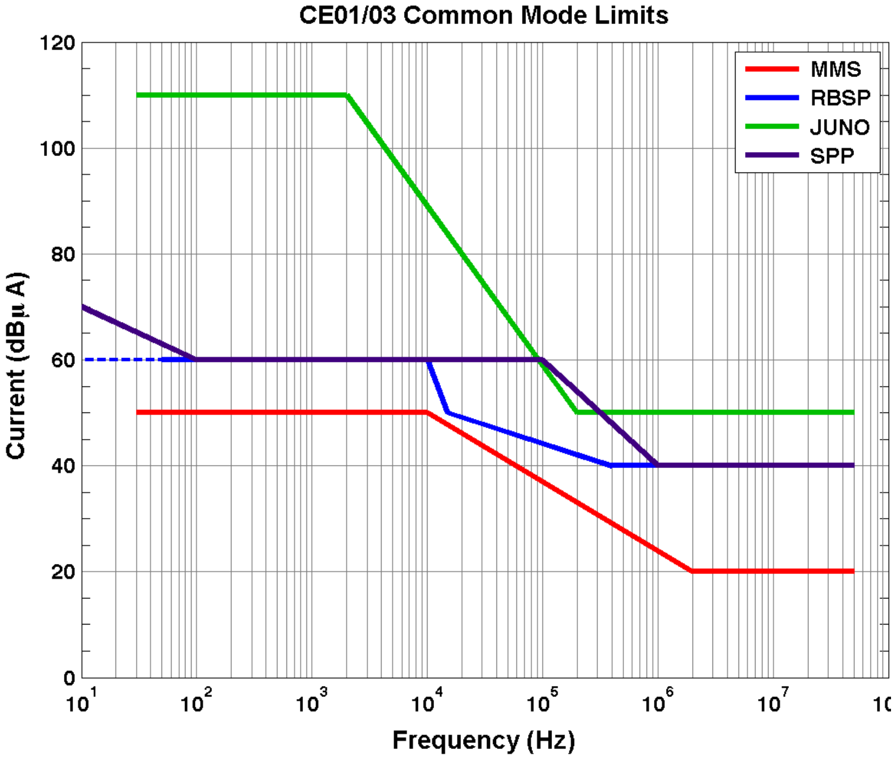
EMC Testing

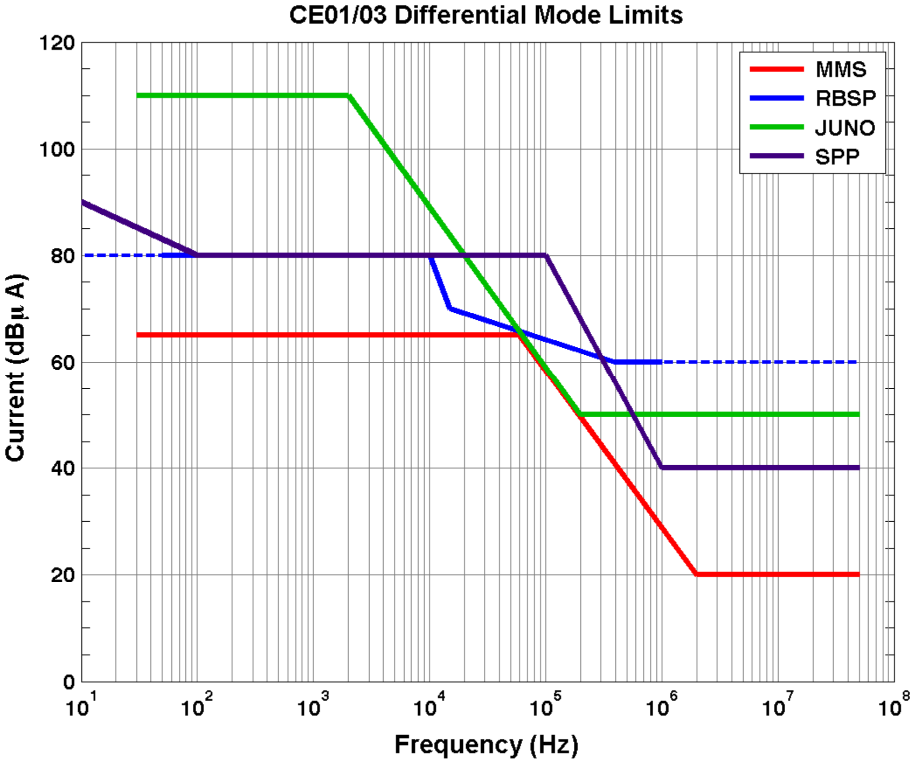
- Early Testing (Breadboard, Card level, Engineering Model (EM)) can identify a problem when it can still be fixed without major schedule slip.
- Doing conducted emissions (CE) can find most issues.
- Initial CE test on LVPS will occur in Q1 2014. EPI-Hi and EPI-Lo will test EM units for CE in Q4 2014.

Required Tests:	Bonding & Isolation
Conducted Emissions:	CE-01, CE-02, CE-07
Conducted Susceptibility:	CS-01, CS-02, CS-06
Radiated Emissions:	RE-01, RE-02, Mag Sniff
Radiated Susceptibility:	RS-03, ESD

LVPS CE Predicted Performance

Based on heritage supply that meets MMS requirements


CE01/03 Common Mode Limits


CE01/03 Differential Mode Limits

Summary

- EMI/EMC design considerations being followed
- No CE issues expected
    - Early testing will allow time to mitigate
- EPI-Lo Ni grid concerns mitigated with careful handling, use of non-magnetic tools, and testing