High Density EEE for Future Space

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High Density for Space : Context 1 / 2

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- Space industry has entered a race to smallest technology
 - Integration Performance Speed RF Power Flexibility...
- ST has all bricks to support Space
 - Technologies : 65 nm, 28 nm FD SOI, access to smaller FDSOI
 - Tools and know how : Design, Hardening, Librairies, Qualification
 - Test results & flight history : 65 nm, 28 nm FDSOI...
 - Supply Chain : ESCC & DLA certification, renewed facility
 - Ceramic & Organic Wire bonding & Flip Chip
 - Ecosystem for ASIC and ASSP (MPU, FPGA...)





High Density for Space : Context 2 / 2

High Density for Space : a business model issue

- Traditional semiconductor business model :
 - Cost, performance & quality driven by integration & volume
 - Challenged by Moore's law end : raising costs & resources / transistor



Figure 6. Cost per logic gate, with projection for 10nm technology node Source: Jones (2015)

- Space : Model sustainable for all actors is still to be defined
 - Space market primarily limited to Mission Critical (GEO...) + Constellations
 - Other Space : Mass Market or selective case by case

AEC-100 does NOT offer any space guarantees

- **YES**, Space can benefit from Automotive
 - High volume over long time securing quality & longevity
 - AECQ100 quality framework
 - Tools and architectures to mitigate effects of particles
- YES, AECQ100 covers radiation
 - Needed for devices with RAM > 1MBits
 - Characterization, not mitigation
 - Only atmospheric particles, alphas and neutrons
 - Only SEU sea-level
- NO, AEC-Q100 has no space guarantee
 - Space particles have higher ionizing power
 - No TID
 - No space-SEL



AEC - Q100 - REV-G May 14, 2007

Automotive Electronics Council -

Appendix 6: Part Design Criteria to Determine Need for SER Testing

A6.1 Use the following criteria to determine if a part is a candidate for SER Testing:

- a. The part use application will have a significant radiation exposure such as an aviation application or extended service life at higher altitudes.
- SER testing is needed for devices with large numbers of SRAM or DRAM cells (≥ 1 Mbit). For example: Since the SER rates for a 130 nm technology are typically near 1000 FIT/MBIT. a device with only 1,000 SRAM cells will result in an SER contribution of ~1 FIT.

6.2 Examples of factors that would be expected to affect SER results:

- a. Technology shrink to small Leffective
- b. Package mold/encapsulate material
- c. Bump material making die to package connections for Flip Chip package applications,
- Mitigating factors such as implementation of Error Correcting Code (ECC) and Soft Error Detection (SED).

A6.3 Cases where new SER testing may be required:

 Change in basic SRAM/DRAM transistor cell structure (e.g., L_{eff}, well depth and dopant concentration, isolation method, etc.).

Extract Annex SER in AEC-Q100



Out-of-control spacecraft

High Density Automotive for Space

- Use of automotive products in Space is probably limited
 - Standard automotive products are Heavy Ion SEE sensitive
 - Automotive demands cost optimized products
 - Heavy lons cannot be taken into account
 - Some missions might be able use generic product with redundancy
 - Fault tolerant MCU and MPU...
- ST limited support of existing automotive portfolio
 - Standard products & support through distribution
 - Documentation and traceability « As Is »
 - Specific business cases to be analyzed



Space Segmentation Proposal



(1): AECQ100 framework adpated to space. Key variation include : additional radiation characterization, qualification on one assembly lot only, no PPAP...





High Density Tentative Packaging Mapping



High Density for Space : Tentative Business Model

ST Supply Chain

- Rad-hard capable technologies : 65 nm, 28 nmFDSOI, BiCMOS...
- Design platform for rad-hard designs : libraries, IPs, ecosystem
- Packaging : ST Rennes
 - Wire / Flip Chip + Ceramic / Organic subtrate, Qualification, screening...
 - Subcontracted : Bumping, Column...
- Product : High value flexible ASIC & ASSP few quality levels



Cost of Advanced Designs



Thibault Brunet – Aerospace & High Reliability Products 10/1/2018

Rad-Hard (≥ 50 Krad)Ceramic packageESCC / QML QualificationRad-HardClass110



(1): AECQ100 framework adpated to space. Key variation include : additional radiation characterization, qualification on one assembly lot only, no PPAP...



ST Plastic Rad-Hard

ASP

MOQ (unit)

1000

2500

5000

ST Space Companion Chip Roadmap