Rad-Hard Plastic for Constellations

STMicroelectronics
March 2019
A Change of Paradigm

**Historical Geostationary Satellites**
- Limited number of satellites
- Long life time
- High quality & cost
- Component level quality
- Radiation Hardened electronics
- Ceramic package preferred

**Low Earth Orbit Constellations**
- Higher number of satellites
- Shorter life time
- Mission dependent system cost
- System level cost / quality tradeoff
- Mission dependent Radiation Hardness
- Plastic package authorized
New Space: a semiconductor supplier perspective

- Classical semiconductor business model
  - Volume and integration key to better cost, performance & quality
    - Volume = Munit / hour
  - Challenged by Moore’s law end for high density products
    - raising costs & resources / transistor

- A proven model for traditional space
  - Funded development + high added value products balancing low quantity
    - ECSS-Q-ST-6013 when no qualified product: very low quantity and/or high development cost

- New Space: a possible sweet spot depending on criticality & radiation hardness
  - Higher quantity and system level quality might allow competitive cost of ownership
  - Proliferation of quality level is in contradiction with semiconductor driving forces
EEE components Space Segmentation

Quality – Quantity – Price – Radiation Hardness

Price is not cost of ownership
Cost of ownership depends on quantity

Class 1

QML-V/Y

Organic / Plastic for Class 1 (1)

Low Criticality
Low requirements
Low to medium quantities
Typically : Small satellites

COTS

High Criticality
High requirements
Low to medium quanities
Typically : GEO satellites

Rad-Hard for LEO

Criticality at system level
Medium requirements
Higher quantities
Typically : Constellation

Constellation

Auto

Commercial

Bubble area : selling price – Bubble density : Radiation Hardness

(1) If justified by delta performance vs QML

Bubble area : selling price – Bubble density : Radiation Hardness

(1) If justified by delta performance vs QML
The New Space Sweet Spot

Rad-Hard Products
- Rad-Hard by Design
- Limited product portfolio
- Long life time
- Security of Supply
- Limited technologies portfolio
- Stable to declining market
- Low volumes driving high price
- Known cost of ownership
- Unified agency standards

COTS Products
- Radiation up-screen by wafer/lot
- Enlarged product portfolio
- Short to medium Life time
- Limited security of supply
- New technologies
- Growing market
- Higher volumes driving price down
- Variable cost of ownership
- Industry driven qualification
STMicroelectronics is strategically engaged to support the new market of Low Earth Orbit space integrated circuits, thanks to his strong experience and position in Rad-Hard market.

ST's products and competence centers support developments: Grenoble, Catania, and Rennes.

New product line LEO is started to develop product portfolio of Analog & Mixed-Signal and Logic products.

These new products will be packaged in plastic packages with assembly in ST's high volume back-end manufacturing site, on assembly line used for AEC-Q100 qualified products.
Rad-Hard for LEO : Key Feature

- Plastic Packages
- Bonding with Gold Wires
- Finishing: Ni/Pd/Au (*whisker free*)
- Assembly on lines used for AEC-Q100 qualified products
- Guaranteed at 50 krad(Si) + SEL free @ 43 MeV.cm²/mg
- AEC-Q100 based qualification, screening, quality assurance and Logistic
  - Qualification : Based on AEC-Q100 + Radiation
  - Screening : Based on AEC-Q100 + Radiation
  - Quality Assurance : Based on AEC-Q100
  - Logistic : Typical MOQ = 1000 pieces
### ST Proprietary Manufacturing

<table>
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<th>Design Mask preparation</th>
<th>Front-End</th>
<th>Back-End Assembly</th>
<th>Final Test</th>
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<tr>
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- **Assembly reports**: -40°C, +25°C, +125°C
- **AECQ100-like**: TID on each new lot SEE on qualification lot
Rad-Hard for LEO : Roadmap

• Starting with Analog, Logics and Voltage Regulators
• 3 new products each Quarter

<table>
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<tr>
<th>CP</th>
<th>Function</th>
<th>Plastic Package</th>
<th>Sample</th>
<th>Flight Model</th>
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Thank You