Space components vs parts for automotive applications

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Content

• Automotive methodology overview

• Space vs. Automotive qualification methodologies comparison

• Quality targets

• Ways forward
Automotive business model

Car Makers continuously challenging IC suppliers...
... to establish quality in the market place

Share of electronic components
- Electronic modules: 50
- Components: 300/module
- Overall: 15000/car

Design complexity
- Time to market: 2-3 years
- System options/car type
- Various cars
- Numerous soft variants
- ISO-26262: Functional safety of road vehicles

Life cycle
- Car series: 5/8 years
- Spare parts: 10-15 years
- Component longevity: 5/8 years
Automotive Quality Assurance
Robustness to harsh environment...
... at cost of industrial products

Space quality process flow

Automotive quality process flow

High process control (Cpk>1.66) + AIAG / PPAP (Production Part Approval Process) = Estimated (build-in) Quality

Automotive Quality Shipment
- Statistically established
- Most measurements during development and ramp-up

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High Reliability / Zero Defects in the cars

AEC-Q100 is the qualification baseline ...

... but Zero Defects goals require extended assessment methods

- Safe Launch Dispositions
  - Extra controls
  - Outliers screening
  - PAT (part average testing)
  - Burn-in

- AEC-Q100 Stress Test Qualification

- Predictable Risk (Intrinsic Failure)

- Unpredictable Risk (Extrinsic Failure)

- 2016 target: 531 PPB

- 959 PPM ; CL=90%

- 2500h @ 125°C

- ZVEI SAE-J1879 Robustness Validation Handbook

- Mission Profile requirement versus Component Life Time for Potential EOL Failure Mechanisms
Qualification methodology comparison

Policies

- Organization & survey committees
- Set of requirement specifications and test methods
- Qualification certificate for a specific domain
- Periodical survey audits from space agencies

ESCC & DLA surveys and controls

Customer/Manufacturer mutual agreement

- Nothing equivalent
- AEC-Q100 & JESD
- Mutual qualification (Manufacturer/Customer)
- Customer audits
Qualification methodology comparison

Product Qualification (1/2)

**Long lifetime**

*3 wafer lots*

*Preceded by an evaluation lot*

- Wearout reliability tests @20 years at 110°C
- Electrical: ESD CDM/HBM, LU
- SEM (each wafer lot)
- Internal visual inspections
- TID/SEE

**Lifetime application dependent**

*3 wafer lots*

*Also some evaluation tests*

- 15 years @85°C / 15% operating
- Same
- N/A
- N/A
- N/A
Qualification methodology comparison
Product Qualification (2/2)

Visual Inspections

- Life test 2000h/125°C
- Specific tests for NVM (cycling, endurance...)
- Packaging/assembly tests
  - Ceramic
  - Plastic
- External Visual Inspections

Automatic inspections

- Equivalent 1000h/125 or 150°C (> in terms of device-hours)
- Equivalent
- N/A
- Equivalent (except outgassing)
- Automatic
Qualification methodology comparison

Documentation/data control

- TRB set up by the company, including
  - Change Notification System
  - Qualification monitoring review
  - Customer returns analysis...

- Periodical reporting to agencies

- Agency alert system

- Qualification package and Radiation report

- Each Flight Model delivery done with data package (screening data and qualification summary)

- Change Notification System vs AEC-Q100

- N/A

- N/A

- PPAP

- NA
Quality targets

- Quality by inspections
- Small qualification sampling
- Temp. Range -55/125°C
- 20 years at 110 °C
- Radiation hardening

- Quality by process control
- Large qualification sampling
- Temp. Range -40/125°C
- Typical = 15 years at 85 °C
- No radiation tolerance
Level 1: reuse of Automotive parts for Space

- Use “as is”
- No design change
- Use Automotive part manufacturing flows
- Additional qualification & up-screening

Material out-gassing
Radiation testing
Additional screening tests upon request

+ Leverage on automotive quality commitments
- Low cost

- No Space specific IP
- No space specification
- Lower temperature range
- No / low radiation tolerance
- Lead-free terminals
Level 2: upgrading existing Automotive products for Space

**Wafer Processing:**
- Long technology life time
- Repeatability
- Capability

**Packaging:**
- Fits Space qualification standards
- In line inspections

**ATMEGAS128 radiation tolerant product**
- CQFP64 and TQPF64 package
- SEL = 60 Mev.cm²/mg
- TID = 30 krad (evaluation)
- Qualification = Jun-16

**Temperature range**
- TID

**Cost**
Level 3: upgrading Automotive designs for Space

- Proven robust design platform
- Faster design cycle
- N/A

Product Design: port onto radiation proven library, add IPs

➔ ARM M7 micro-controller SAMV71RHBD
  ➔ Automotive SAM7 platform
  ➔ Adding 1553 and Space Wire
  ➔ On ATMX150RHA
    ▪ Latch-up free
    ▪ TID = 300 krad tested
  ➔ Ceramic or plastic packaging options
  ➔ Samples on Q1-17