EEE Parts Selection for Small Spacecraft Missions

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Risk Class

- Class A: qualification testing & screening required to produce highest reliability and lowest risk, radiation hardness testing required.

  greater than 5 years
- Class B: reliable parts, low risk, radiation hardness testing required.

  medium duration, 2 to 5 years
- Class C: no formal reliability assessment, medium risk, radiation assessment, no additional testing.

  less than 2 years
- Class D: highest risk level, low cost & shorter schedule outweigh risks.

  short duration, less than 1 year

[Refer to NPR 8705.4 for additional details on risk class]

Commercial Parts

- For GSFC projects, this includes parts procured to manufacturer's data sheet specifications.
  - Military drawings- JAN certified
  - Source Control Drawing – SCD
  - Industry Standard Drawings – SAE, TIA
  - Manufacture's high rel parts
  - Commercial Parts

Commercial Parts

- It is the user's responsibility to assess the manufacturer's ability to produce reliable parts.
- Typical GSFC quantities are difficult to procure from manufacturers.

Counterfeit Parts

- May be a concern when purchasing small quantities from distributors.
- Purchase from manufacturers or manufacturers' franchised distributers.
- Perform incoming inspection to look for obvious signs of counterfeiting: black top, sand paper striations on the surface, poorly registered part numbers, reworked leads.

Tin Plating

- Commercial part mfgrs have eliminated Pb in order to comply with Pb-free RoHS.
  - (Restriction of Hazardous Substances 2003/2004)
- Pure Sn finishes can grow conductive whiskers that produce shorts or debris.
- Commercial parts may have no other option.
- Devices with tin finishes need to be recoated with SnPb solder in accordance with GEIA-STD-0006. After recoating the parts are no longer considered Pb-free.

Radiation Effects in Semiconductors

- Data usually not available for commercial devices.
- Commercial production processes can change without notice and without documentation to the customers.
- Mfgrs can source their devices from several facilities – radiation behavior can be different for each.
- Radiation vulnerabilities depend on many factors, including device technology, fabrication process, circuit design and application conditions.

Derating

- Derating is operating a device at less than its maximum rating to prolong its life.

- EEE-INST-002 has tables with derating guidelines for each component type.

Techniques to Improve Chances of Mission Success

- Design with redundancy.
- Use higher rated parts where single point failures exist.
- Use mfgr's high rel, automotive or telecommunication grade components.
- Use mfgrs that are ISO Certified.

- Capacitors
  - Avoid BME (base metal electrode) caps unless infant mortality screening is planned, and
  - Surge current tested solid tantalum caps are recommended for power supply applications.

- Connectors
  - Use only solder mount connectors, not press fit (compliant pin) soldered in place, and
  - Verify that the plastic connector housing does not outgas contaminants, or perform a bakeout.

- EMI Feedthrough Filters
  - Use #6 threaded or larger,
  - Hermetic at both ends is preferred, and
  - Observe torque recommendations, the toroidal cap is easily broken.

- Fuses
  - Use solid body fuses (FM12, for example) for better performance and reliability.

- Magnetics
  - Purchased devices should follow MIL-STD-981 design guidelines and Group A test, if possible,
  - Hand wound, in-house devices should see some environmental stress prior to installation,
  - X-ray potted devices to verify the windings and core are centered within the package and not exposed at the surface, and
  - Verify the potting materials comply with outgassing and contamination requirements, perform a bakeout if they do not.

- Plastic Encapsulated Microcircuits (PEM)
  - Lack of traceability makes lot definition difficult,
  - Not qualified by lot or 100% screened,
  - Not normally rated for radiation,
  - Commercial temp range 0C to 85C,
  - Not hermetic, requires special storage & handling,
  - Leads are tin plated, not compatible with SnPb solder, and
  - Verify ESD rating, if unsure, assume Class 0.

- Semiconductors, Microcircuits and Hybrids
  - Use SnPb or gold lead finishes where possible,
  - Automotive / telecommunication parts have some level of screening & qualification to assure a higher level of reliability,
  - Little or no screening performed on commercial parts,
  - For hybrids, derate the operating conditions, as the mfgr may not have derated the internal elements, and
  - Verify ESD rating, if unsure, assume Class 0.

- Crystal Oscillators
  - Similar concerns to the microcircuits / hybrids,
  - Obtain with a premium swept quartz crystal element for radiation stability,
  - Use devices with at least three crystal mounts for strength and reliability,
  - Derate the operating conditions, as the mfgr may not have derated the internal elements, and
  - Verify ESD rating, if unsure, assume Class 0.

- Relays
  - Check internal and external materials and finishes (mfgrs may use unapproved solders, coatings, paints and unfinished metals inside the case), and
  - Microclean, small particle inspection and PIND are not performed on commercial relays (a trapped particle may cause the relay to fail).

- Resistors
  - Use precision foil resistors only where absolutely necessary.

- Wire and Cable
  - 24 AWG is recommended for harnesses (or 24 AWG with high strength copper alloy), and
  - No solid wire, except for jumpers.

- RF Devices, Active and Passive
  - Usually only available as commercial devices,
  - Wide variation packages and technologies, each with their own issues, and
  - Need to understand the device technology to develop an effective screen.

Reference Documents

- EEE-INST-002, *Instructions for EEE Parts Selection, Screening, Qualification and Derating.*
- GPR-8705.4, *Risk Classification Guidelines for GSFC Payload and Systems.*
- NPR-8705.4, *Risk Classification for NASA Payloads.*
- GEIA-STD-0006, *Requirements for using Solder Dip to Replace the Finish on Electronic Components.*

ISO Certifications

- ISO 9001:2008, *Fundamentals of Quality Management Systems (to be reissued 2015).*
- ISO AS9100-C, *Aerospace Interpretation.*
- ISO/TS 16949, *Automotive Interpretation.*
- ISO/TL 9000 R5.0, *Telecommunication Interpretation.*
- ISO 13485, *Medical Industry Interpretation.*

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