Workmanship Project Activities and Future Issues

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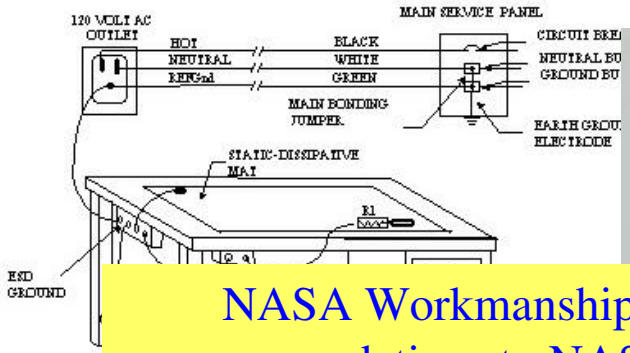
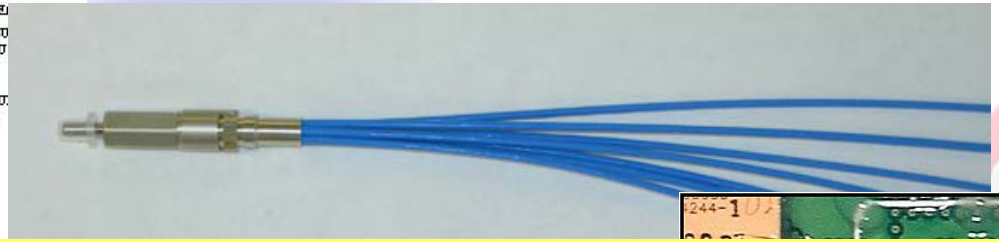
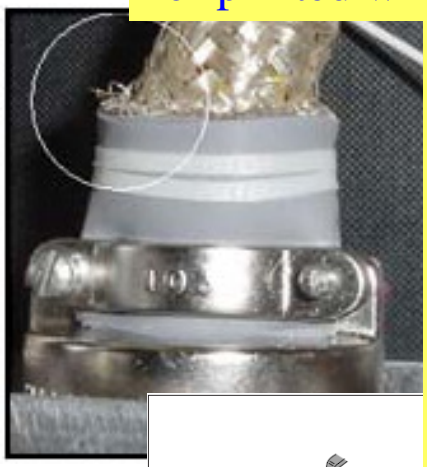
- Workmanship Project - Introduction
- Industry Standards: Lessons Learned
- 3rd Party Qualified Manufacturer List
- Managing Cross-discipline Processes





NASA Workmanship Standards Project Mission: Provide technical recommendations to NASA HQ Office of Safety and Mission Assurance on policy that will drive accurate and consistently-applied quality requirements for printed wiring assemblies, electrical and optical harnesses, and ESD safety



- Printed Wiring Board Design Rules (IPC)
- Printed Wiring Board Acceptance (IPC)
- Soldering (NASA → IPC)
- Polymeric Applications (NASA)
- Electrical Harnesses (NASA → IPC)
- Fiber Optic Harnesses (NASA --> SAE?)
- ESD (ANSI/ESD)
- 3rd Party Qualified Manufacture Listing (Nadcap)

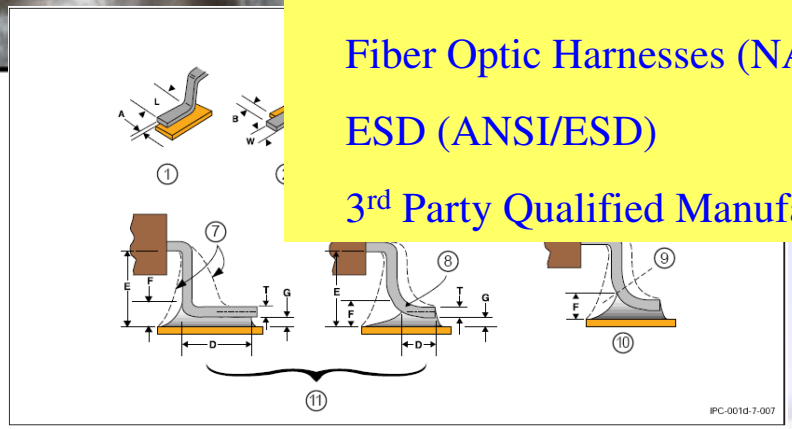
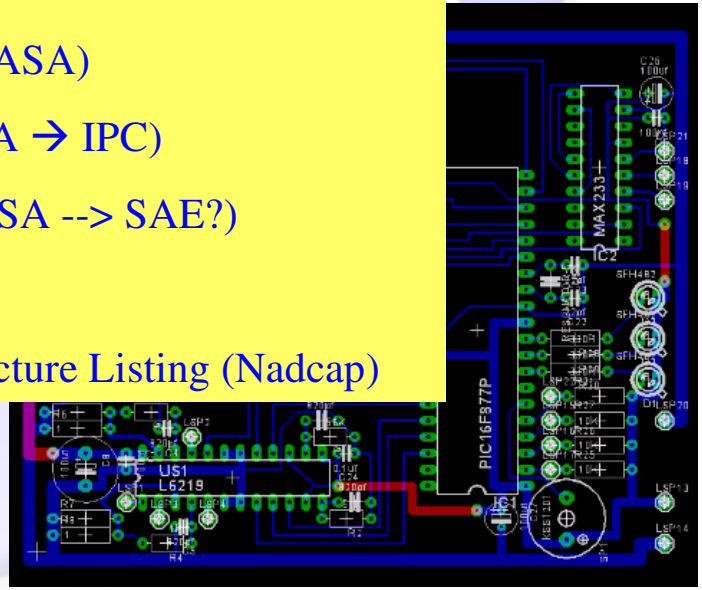


Figure 7-7 Flat, Ribbon, "L," and Gull Wing Leads



OMB Circular 12A:

Integrate a preference for voluntary consensus standards in regulatory and procurement activities in lieu of government-unique standards, unless illegal or impractical.

NPD 8730.5 (Oct. 27, 2005):

Workmanship Standards (listed by reference) apply to fabrication of assemblies which have quality characteristics not wholly visible in the end item and for which conformance can only be established progressively through precise measurements, tests, and controls applied.

Desire is to:

- Institutionalize Workmanship Quality Practices
- Leverage off of industry knowledge base
- Leverage off of industry participation in process
- Leverage off of 3rd party document management

Are Industry Standards Practical? Lessons Learned

(and still learning!)

1. Oppose fragmentation of requirements

Example: ANSI/ESD S20.20

a. *Base document has splintered into many stand-alone documents. Each is coordinated separately. Each must be purchased separately. Meeting 2X yearly. Some session overlap.*

b. *Base document requires site-specific implementation plan. Still have to maintain a NASA document. Already have four created at Center level.*

c. *A check of suppliers' implementation plans needs to be included in mission assurance requirements to make sure the "message is getting out" about the new requirements. Suppliers shouldn't be required to use NASA implementation plans (counter to OMB Circular goals).*

❖ ESD: It's Bigger Than Workmanship. *Need more communication between functions about ESD sensitivity. I&T and in-flight handling showing new concerns.*

Lessons Learned *(and still learning!)*

2. Watch for Copy/Paste from Older Contracts

Ongoing, older contracts predate NPD

Not all contracts impose full suite of Workmanship Standards. This creates a disconnect when defining "Space" requirements.

Long-term suppliers -especially at the SubTier level- are out of alignment with applicable standards when new contracts are let – waivers ensue.

3. Terminology: Voluntary, Consensus (w/Voting), Space Addendum

X Standard is Optional → *✓ Authors are volunteers*

X All Parties Must Agree → *✓ Agreement = no formal objections*

✓ Absent vote = Yes vote

X Space = NASA → *✓ NPD lists Agency-adopted Workmanship Standards, IPC catalog is not the source*

Lessons Learned *(and still learning!)*

4. Suppliers Share Authority for Requirements with Users:

NASA – OEM – SubTier1 – SubTier2

Training Companies

Are the document management rules more favorable to association's target market? (those buying the documents, licensing the training) ←We are working on this.

Is it a conflict of interest when the supplier writes/interprets the acceptance requirements? Already have encountered different interpretations.

5. Certification is being equated with training

Competency, frequency of job performance, visual requirements being under-emphasized. Dropped completely in J-STD-001 rules.

Lessons Learned *(and still learning!)*

5. Widespread use of J-STD-001 creates a standardization opportunity for NASA

J-STD-001 use in NASA supply chain may be greater than NASA standards'. Potential for uniformity across projects may be higher in Industry system than in NASA-STD system.

Participation in standards development increased by 300%

Will our supply chain flow down Space Addendum requirements to Class 2 & 3 suppliers? Low volume buying makes ***Availability*** *and price compete with Quality*

6. Are we educated consumers?

J-STD-001 compliant ≠ J-STD-001xS

J-STD-001xS ≠ ROTS (R(C)OTS) because,

NASA & DCMA Inspections are still required, pre-approval of plans and processes are still required.

Lessons Learned *(and still learning!)*

7. Effort to support industry standards on behalf of NASA's interests will increase overall Workmanship Project workload.

Meetings are held several times each year with ballot activities following. Schedule is Industry-event driven. (x 7 technology areas: PCB, Soldering, Harness, Polymerics, Fiber Optics, ESD, 3rd Party QML)

Sessions overlap requiring multiple people to cover one technology type.

Need to formulate a committee coverage plan.

3rd Party QML Process for PWB, PWA, Harnesses

- Can an industry group mitigate some of the above concerns?
  - *Consistent interpretation of requirements*
  - *Clarify compliance claims*
  - *Feedback opportunity for process feedback (how the standards are being implemented across the industry)*
  - *Ongoing, self-funding oversight*
- Adapt for low-volume? Smaller companies..
  - *…can take small order and turn it around quickly (same for a re-spin)*
  - *…less likely to "bump" the NASA order in favor of a larger commercial or military order.*
  - *Customer/supplier relationship is more intimate.*
  - *…will not carry Space certifications, will not have the depth of quality practice of large companies.*

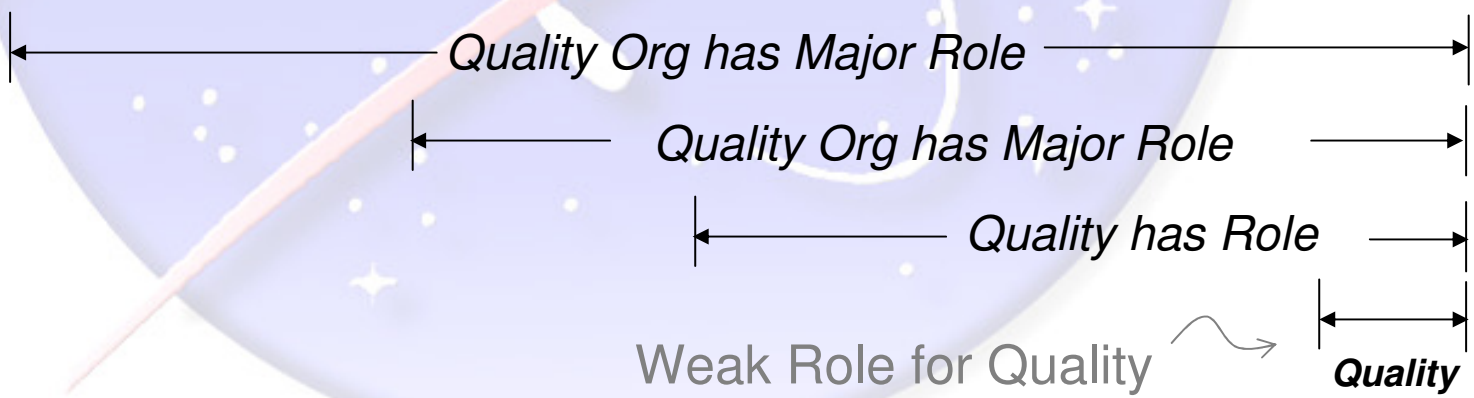
Challenges of Cross-discipline Processes for OSMA Standards

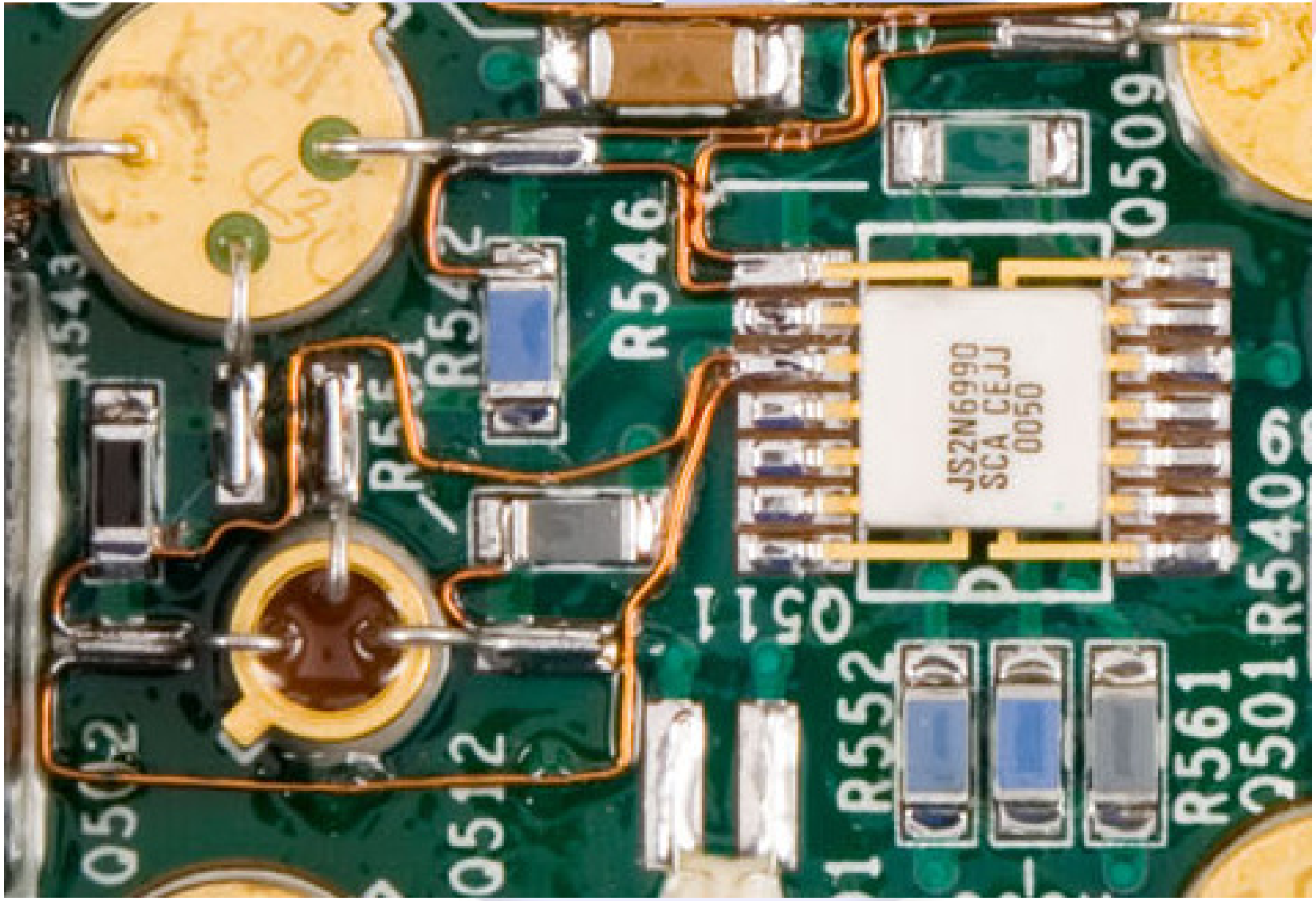
- Design Rules in Workmanship Standards?
- Area Array and Lead-free solder joints
- Commercial cPCI Qual: can it ever be qualified?
- DC/DC Converters: recognizing and mitigating application errors

Can Workmanship Requirements Address Lessons Learned that are Considered Design Rules?

- IPC rejects this approach
- Design rules evolved from lessons learned
- Variety of approaches across the Agency for packaging design, qualification and Workmanship quality assurance.

Design → Mfg → Qualify → CM Des. & Mfrg → Define Quality Requirements → Inspect




R546
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SMT Area Array & Lead-Free Solder

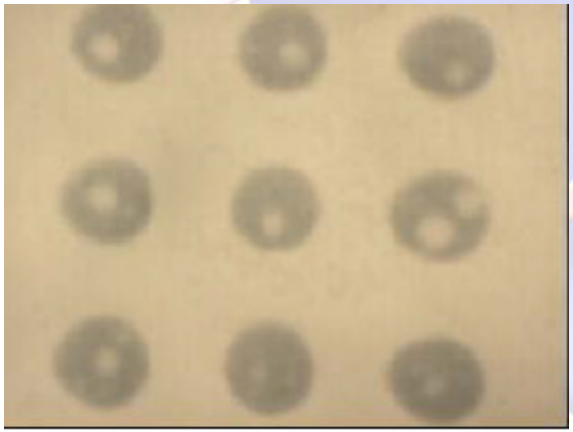
J-STD-001: offset, wetting, voiding for BGA

Board design for application conditions has large effect

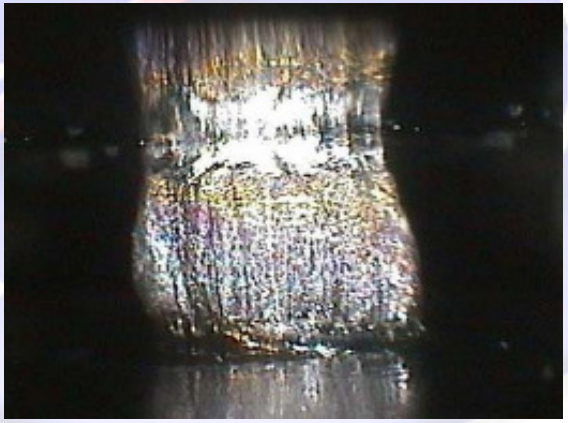
Basis is evaluation, not usage. NASA field failures/defects TBD

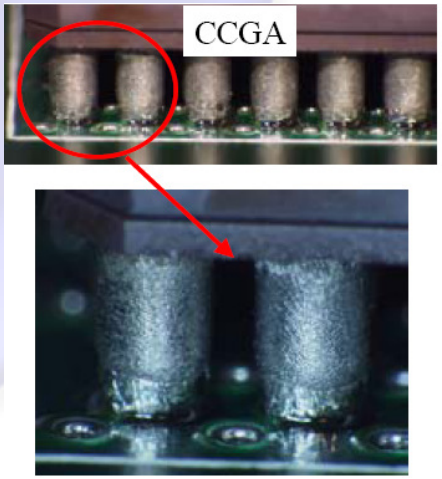
Lead-free formulations still quite dynamic

Need to update soldering inspection criteria to align with appearance of good and bad lead-free solder joints.



X-Ray, Voids in BGA 's



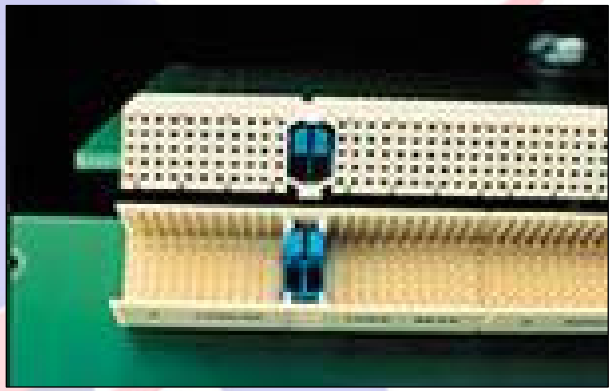


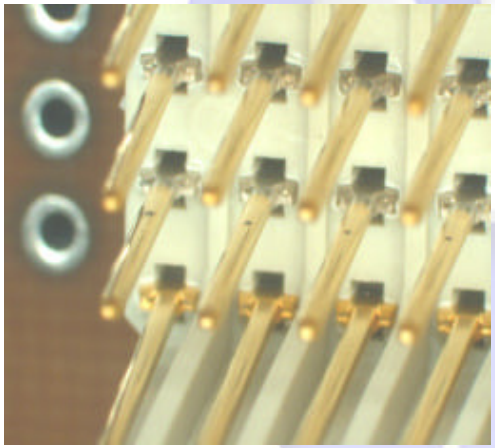
Commercial cPCI – Can It be Qualified?

No clamping to keep connector halves together

Fretting of the contacts during vibration cause increase in contact resistance, FOD.

Press-fit board connections do not allow solder joint inspection (not intended for soldering).





Hypertronics developed version for space users which does not have these problems ("qualified" by GSFC)

Hypertronics not an <u>exact</u> footprint match (FFF)

Commercial version continues to proliferate as military or commercial designs are adapted for space use. (**PICMG2.0** spec)

"Improved" reliability depends on innovative (*TBD*) board/mounting design to keep contact halves together (effort is now on ending usage).

DC/DC Converters: Off the Shelf Designs are Not Plug & Play

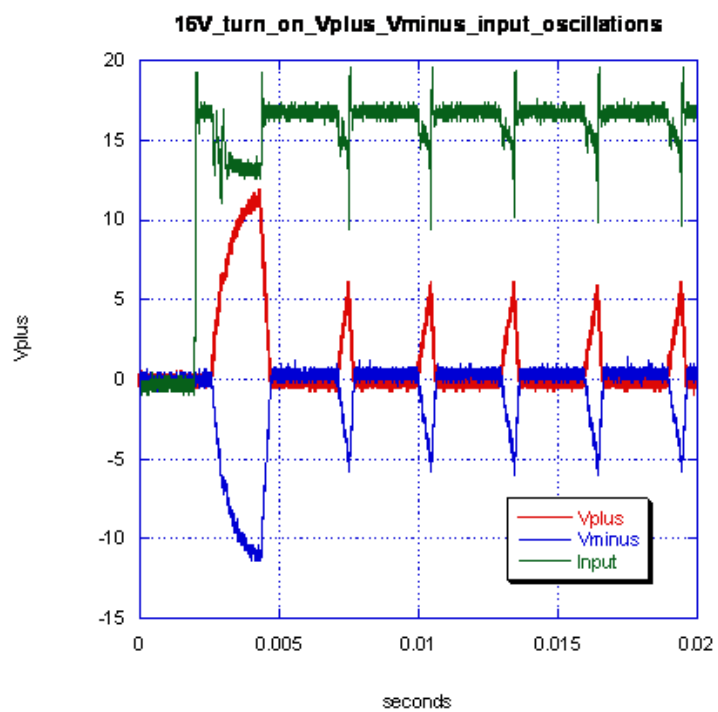
Failure due to misapplication/under-characterization 5X higher than perception.

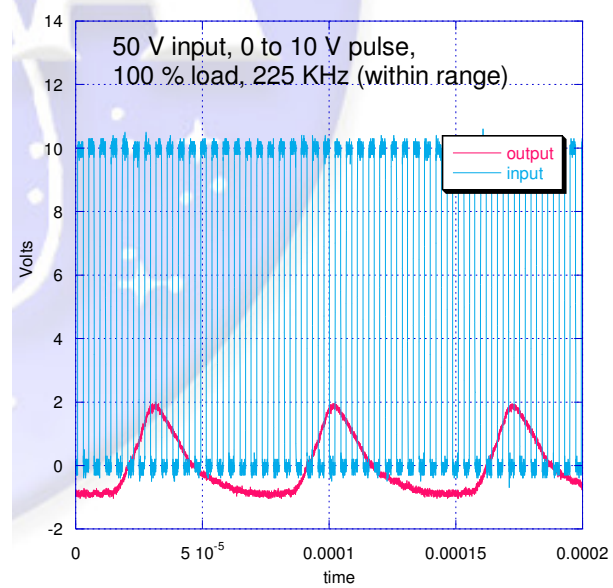
(app: 5 vs 27, qual: 14 vs 30)

Unsafe regions: Vin low, Load < 20%, input filters under-damped, gain margin low, Zout of EMI filter (input shorted) > Zin Converter (Vin min, full load), low frequency synch signal.

Datasheets are ~50% incomplete, Acceptance testing is done to the datasheet.

Guideline to be published ~ June 2008





Summary

Urgency to build a strong NASA presence on Industry Standards committees

Investigate effectiveness of a 3rd party QML program

Challenges in capturing best design practices which result in reproducible, acceptable quality attributes (area array and lead-free)

Challenges of managing known quality problems that are design-driven (cPCI)

Expanding effectiveness of quality controls through better design/performance analysis (DCDC)