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Brief Bio…

- **Using AEC-Q Semiconductors in Military and Aerospace Applications**
  - By definition, this means they can be used for Medical, downhole, Railway, Industrial, Telecom-datacom –networking of course Automotive and other high reliability applications.
  - Download the entire article here:

Introduction

Lines are blurring between automotive and Mil/Aero electronics.

Both require high reliability under extreme conditions. In some cases AEC-Q is stricter – 3000+ cycles of thermal shock with no cracks or defects of solder joints – so also package tests are included in AEC-Q

Speed and Business issues are often more limiting than anything else

This applies not only from semiconductors but also passive electromechanical

John Chambers Cisco -quotes

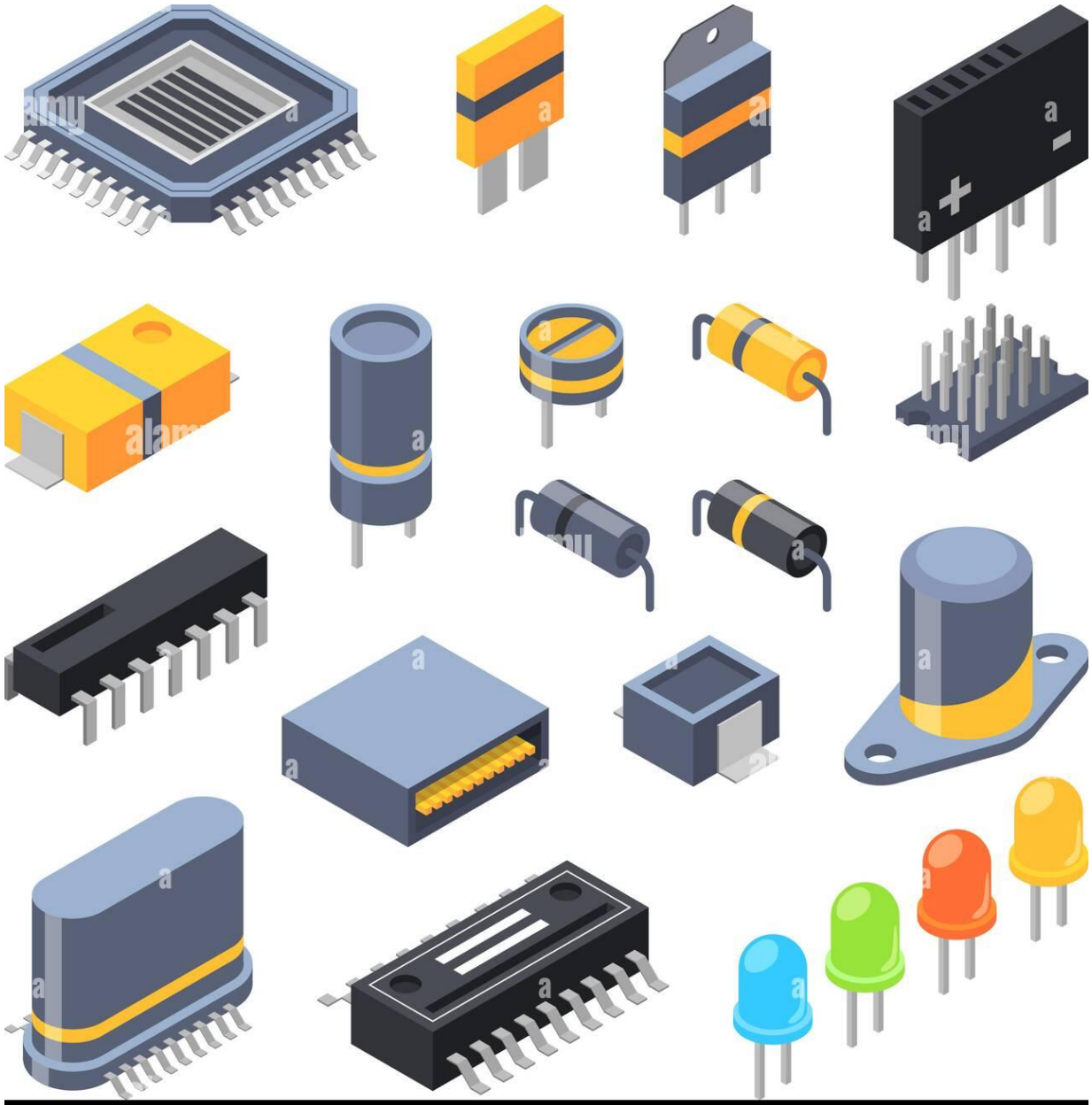
"If you are in the technology business selling to technology customers and you get behind in technology, your world will be impacted in a violent and negative way rapidly"

"if you don't innovate, you're dead"

What is needed to qualify parts typically?

- PPAP - Production Part Approval Process
- Reliability Report & MTBF-FIT reports
- Recommended PCB Footprints, Symbology, 3D CAD models, SPICE models, environmental compliance info
- MSL level, ESD levels, COO and supply chain info, CTE of mold compound, lead plating thickness, materials, process and annealing details – aka tin whisker report, Environmental info…
- **It's about having a dialog and understanding your needs!– anything missing?**

Approaches here applies to semiconductors AND passive electromechanical



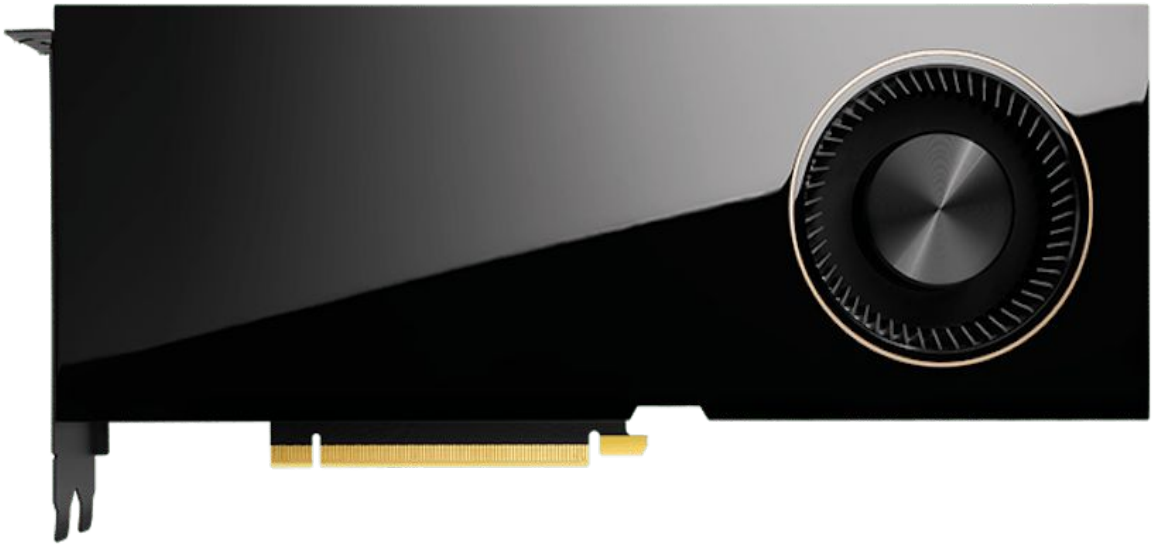
VPX-based and SOSA-aligned rugged mission computer for military applications introduced by Kontron

Designed and manufactured in Europe, HARAKAN-F2-2 is ITAR- and BAFA-free to enable broad deployment flexibility across international defense programs.

Military+Aerospace Electronics

NVIDIA RTX A6000

Military+Aerospace Electronics



Is this Board OR the main processor and VLSI or other devices 883? Are they QPL? Is rigor only reserved for simple devices and Passive Electromechianical? Do you want to use an ancient Processor to achieve “reliability compliance”?

Standards Overview

MIL-STD vs AEC-Q standards define reliability frameworks.

Approaches are different – AEC-Q = zero defects, dialing in the process, ensuring that variance is reduced – thus high volumes are possible –no bad devices or infant mortality –MIL STD was the start point of AEC-Q

MIL-STD – testing and screening out bad devices and infant mortality from the days when that was a thing.

Engineering Challenge

Balancing reliability, cost, speed, and documentation differences.

If up screening is needed – better to start with AEC-Q and PPAP vs a cell phone or flat panel TV part and up screening those

Longevity and supply Chain resiliency – which Automotive and Industrial customers share in common with MIL Aero

Why AEC-Q?

- Faster, cheaper, widely available components for modern systems, current technology and being driven by a market that the component companies care about = attention
- **There are now fewer MIL only component suppliers and products in the market than ever before and we see this being the trend going forward. In other words-it does not matter if there is nobody to buy the parts from!**
- Attention = response and meeting requirements from suppliers is driven by $$$
- PPAPs have all needed documentation
- AEC-Q started from MIL standards and added modern requirements

Modern Defense Trends

Rapid development of UAVs, drones, and autonomous systems and new innovative AI based equipment.

Ukraine – shows that low investment and speed can take out high value assets and iteration and outpacing your adversary makes a difference.

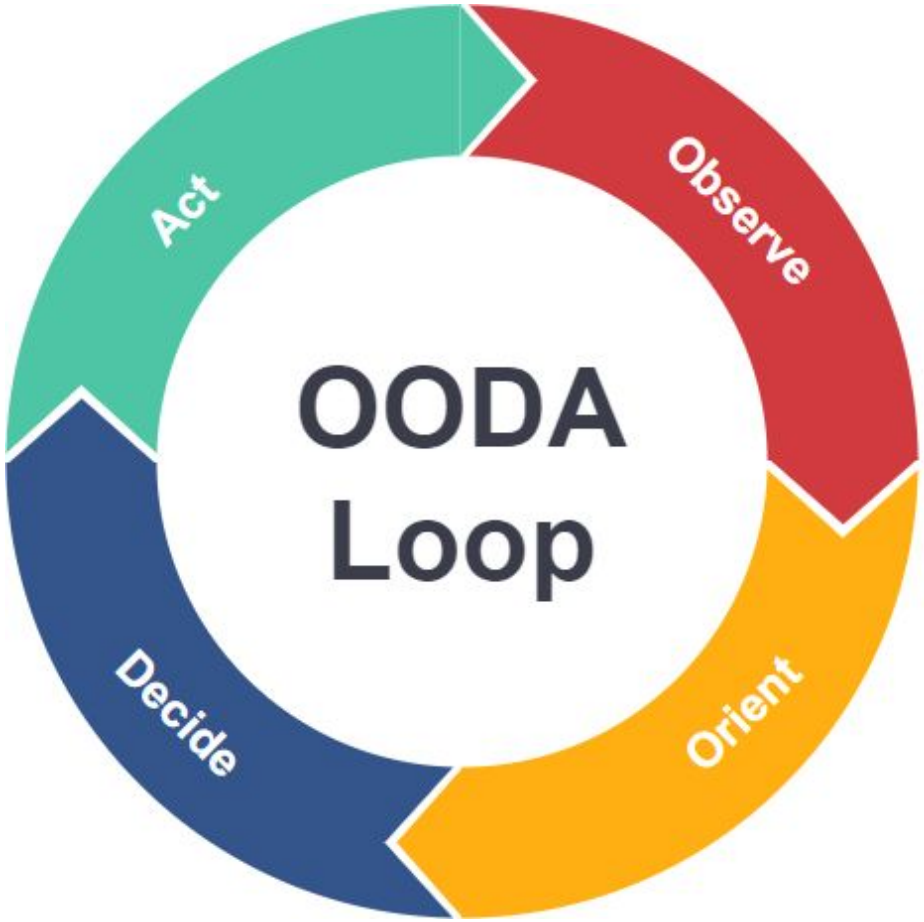
Someone else has a bigger stick than you do to hit suppliers with from different markets – Automotive wields a big stick and has similar or same requirements

OODA Loop Concept

Observe, Orient, Decide, Act — speed is key.

The faster you can cycle through this loop the more likely you are to win.

OODA Loop



Observe

What is the current situation? What is the reason you want to change? how bad do you want to change?

Orient

Where are you currently at relative to where you want to go? How far is it to your destination?

Decide

What is the exact path you are going to take? How are you going to handle challenges and set backs?

Act

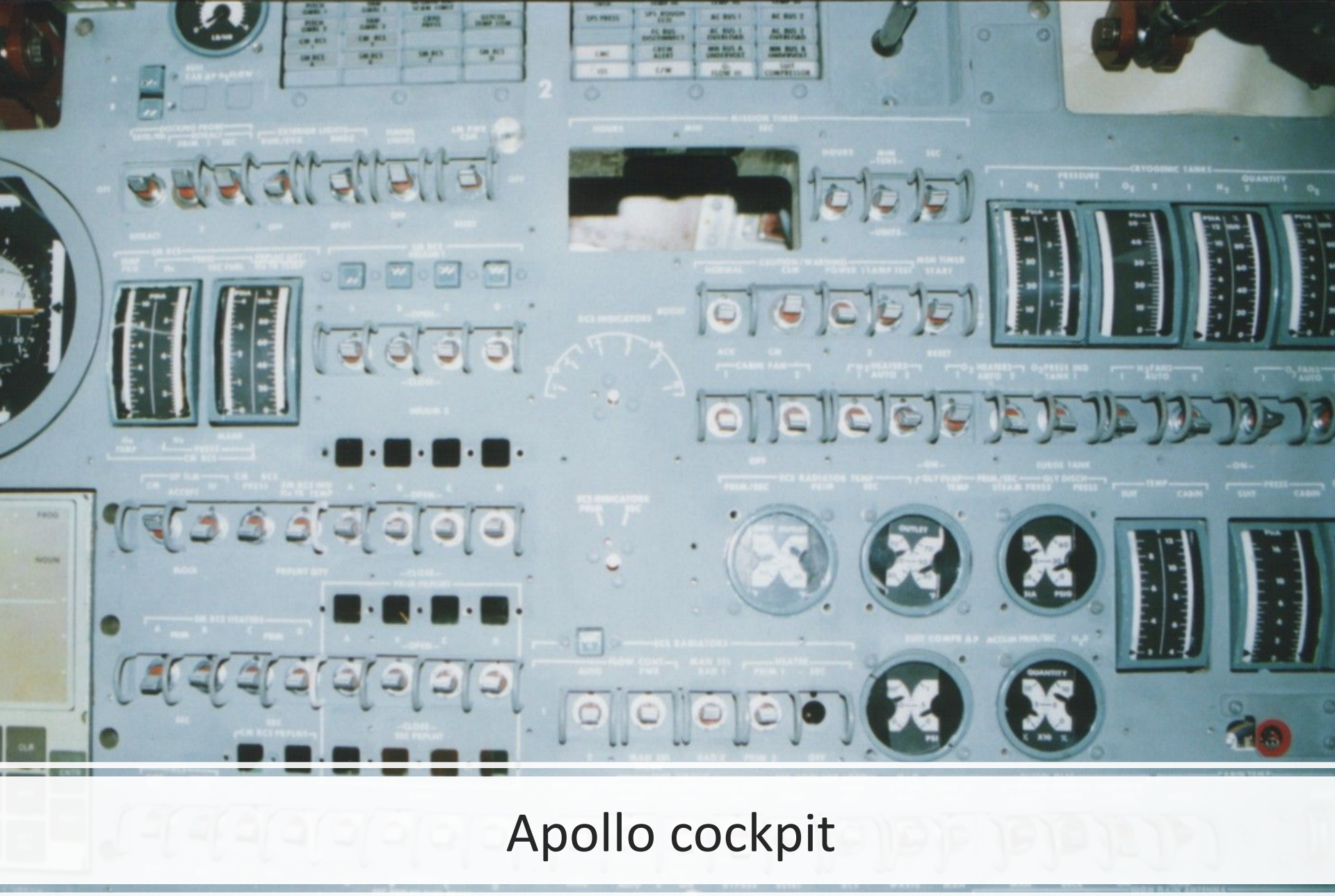
What's the approach and method you will take to implement the decisions? What is your action plan?

OODA in Engineering

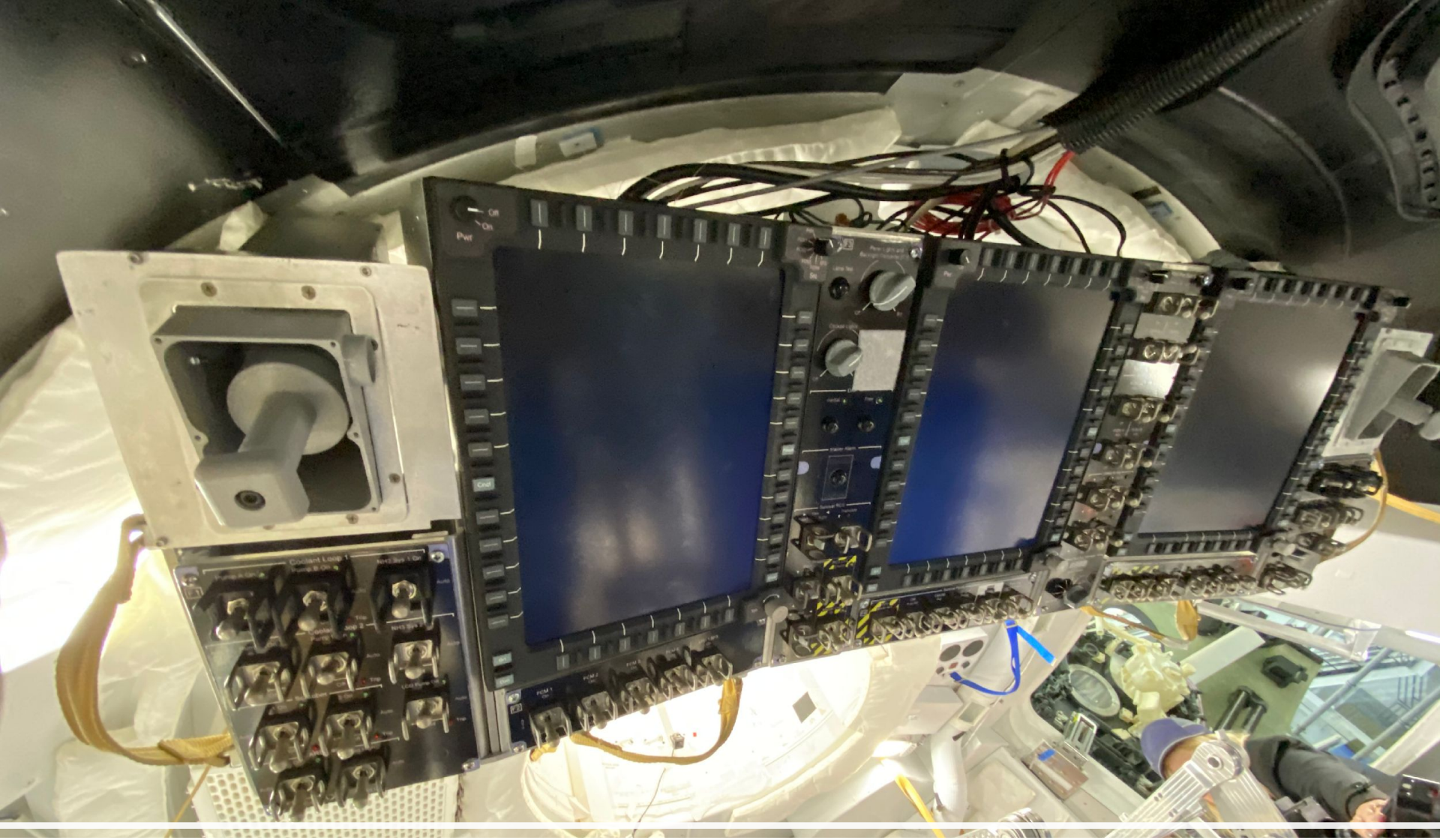
- Speed and execution with quality and reliability wins
- Iteration quickly is important
- If you can’t get parts and build systems, it doesn’t matter
- Obsolete parts and systems from yesterday’s technology don’t help things
- Balancing both business and technology concerns
- Modern Technology is about faster, cheaper, better and speed – traditionally the MIL Aero market has not been wired for Speed but that is changing due to market forces and battlefield changes.
- Making an AI processor out of 74XX logic and 2N2222 transistors to get QPL isn’t practical

Market Shift – new needs

- From strict MIL parts and hand-built gold plated approaches to flexible, cost-effective solutions.
- The pace of advanced technology is faster than ever before and access to this for MIL Aero applications is more critical than ever before – nobody wants to fight yesterday's war with yesterday's technologies and tools



Apollo cockpit



Artimis cockpit

MIL Limitations

- High cost, long lead times, slow-time- speed, fewer sources for anything, not enough volume to drive interest and innovation. (cost of FABs in Semiconductors)
- Suppliers are not interested in this market as a stand alone as a general rule
- Might be non-optional in some programs and if up screening is not allowed you might be stuck with it.

AEC-Q Strengths

- High volume, lower costs, modern technology, interest and attention of suppliers, volumes, speed, speed of innovation (already working on it for other high volume markets = interest)
- No business case, marketing proposal or investors presentation today says anything about MIL Aero electronics market on it

Standards Comparison
See article for table comparison

MIL: absolute reliability and sometimes things like glass to metal seals and radiation hardness – test it and screen out the bad ones and infant mortality parts – proven – its been around for decades – strict trace ability

AEC-Q: statistical reliability, PPAPS, zero defects, sampling, process controls – have no bad ones or infant mortality parts –zero defects even at high volumes. Traceability is very strict due to automotive recall requirements – so similar

Temperature, Packaging and other

MIL: wider temps (perhaps some AEC-Q parts are -55 to +175), not hermetic could screen RAD hardness - Wide Bandgap parts excel in this area!!

AEC-Q: plastic – advances in mold compounds have been extraordinary, and in high Shock and vibration applications (bond wires are not suspended in air) – smart artillery shells example G forces off the charts

If Rad hardness needed on AEC-Q we will send you samples test them and let us know. (it's the die and technology which determines)

Key AEC-Q Benefits

- Availability, cost - efficiency, speed, current technology availability and supply stability

Suitable Applications

Radar, ground systems, troop portable gear, Radios, UAVs, AI, power systems, modules which are built and sold into the MIL Aero market, computing, avionics and more.

Example – Military Power supply – inside the molded module can be AEC-Q parts as long as the module meets –exceeds standards its unlikely anyone cares of the parts are not Full MIL STD parts.

Not Suitable For

- Space, radiation-heavy, mission-critical systems
- Could you up screen? Perhaps but for man rated space programs you likely want space rated parts.
- I have been involved in part qualification for rocket guidance computers and no problems whatsoever –so???

Design Considerations

- Derating, margin analysis, and robust design practices
- Upgraded parts cannot compensate for a marginal design. It's better to have a very high-quality design to start with.
- You can't test and screen in quality and reliability. Zero defect parts with the best designs are usually the best path. Current AQLs are <3 PPB

Additional Testing

- Thermal, vibration, burn-in, HTOL, HALT, HAST required but can also be done at the system level in my experience. Again, PPAP is your friend when using AEC-Q parts.

Lifecycle Management

- Plan for obsolescence and long-term support
- This is easier to do on AEC-Q parts because its often negotiated into the contracts and requires 10+ years after the EOL of a part along with extensive notification and LTBs
- Finance and operations departments can’t wait to cull underperforming components and don’t care what the part goes into – if volumes are low they EOL it – regardless - this is a big risk in MIL parts

Hybrid Strategies

- Combine AEC-Q with extra testing for MIL-level reliability
- Up screening is a very viable option if needed in most cases it’s a suitable approach
- Is it really necessary? Case by case basis usually.

Conclusion

- AEC-Q enables faster, cost-effective, reliable Mil/Aero designs and is the modern way
- There are not more and more options coming available on the market for MIL only parts with few exceptions.
- AEC-Q parts can provide many advantages with few disadvantages that can be easily overcome for new MIL Aero designs as well as keeping existing designs in production

The Taiwan Semiconductor advantage when using AEC-Q100 devices in high reliability applications

Experience

- 47 years experience manufacturing high reliability discrete semiconductors
- Decades of experience manufacturing to AEC-Q100 standard

Facilities

- Front-end and Back-end factory locations in Taiwan and China
- All TSC-owned factories manufacture to AEC-Q100/AEC-Q101 standards and facilities certified to ISO9001, IATF16949, ISO14000, and AIAG

Quality

- Maintain certifications with many Tier 1 automotive & industrial customers
- Systems and processes meet VDA6.3 Process Audit specifications
- Defect rate of less than 2ppb

Logistics

- Global Logistic warehouses in Europe, North America, and Asia to support supply chain efficiency
- Robust global distribution channel

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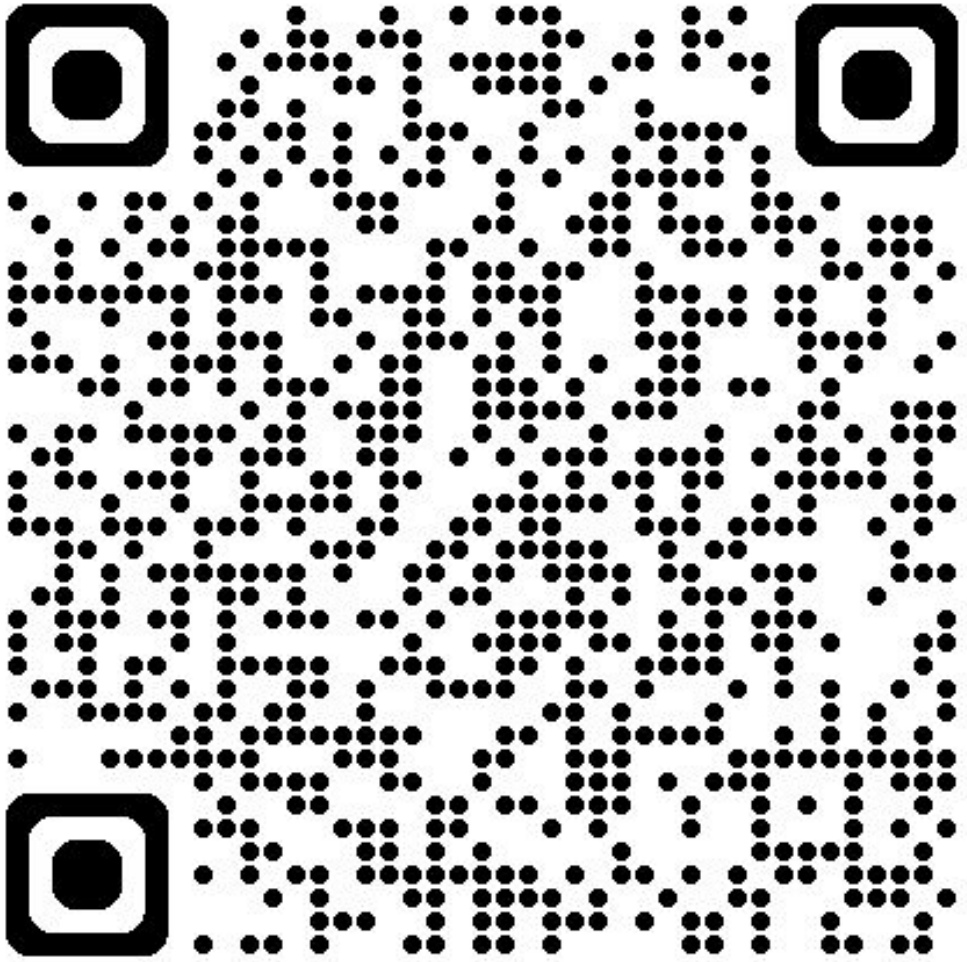


Q&A