CMSE 2025

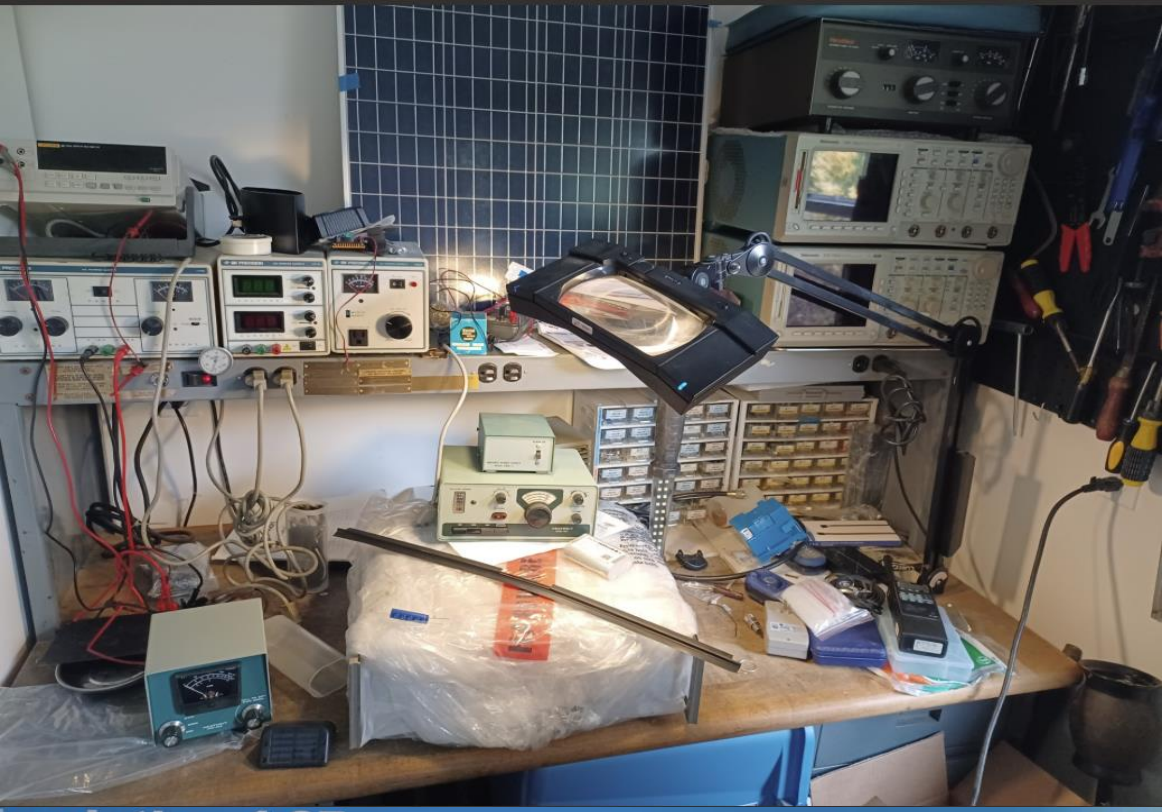
Component Engineering & Its Changing Role

CMSE 2025
April 29, 2025
Los Angeles, Ca

Component Engineering Outline

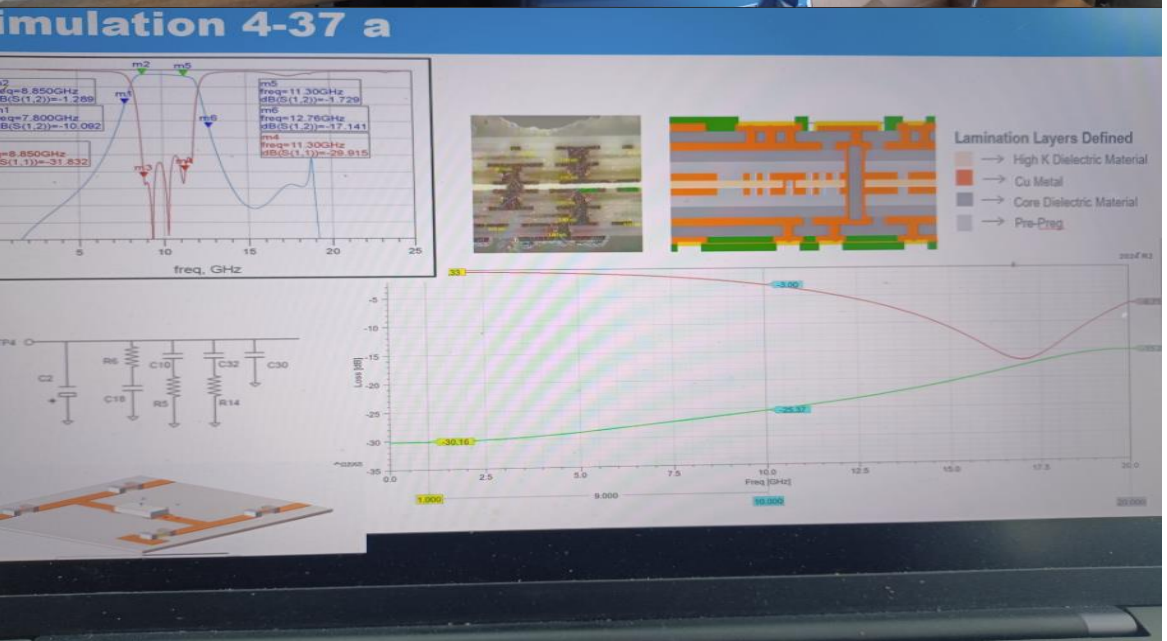
- Component Engineering – the opportunity
- Environmental legislation rules, trends
- Current export technology limitations - ITAR
- Component Reliability basic principles and metrics used = PART GRADES
- Qualifying component suppliers for mil and space
- Risk Analysis & obsolescence management and counterfeit mitigation
- When to use a SCD vs standard components
- What makes a good SCD
- Source Controlled Drawings vs ‘standard’ components
- Parts Data Base & BoM management

Unimaginable Change:



← THE TEST BENCH

TRANSITIONED TO



← SIMULATIONS

Speaking of Change:

TARIFFS

Impact the supply chain:

Cost
Availability
Continuity
Compliance
Obsolescence

Component Engineers role is more important than ever

Component Engineers:

- called upon to guide designers
- provide management options

IN THESE CONDITIONS COMPONENT ENGINEERS MUST WATCH FOR:

Problem / Action	Impact
Sudden supplier changes	New supplier qualification & audits may cause delays. Plan for possible failures
Cost Reduction Fast Tracks	Changes in material and alternate parts may fail internal compliance requirements
Regulatory Risks	New supplier may fail RoHS etc
Lack of visibility	Problems will creep up with little to no warning

Source: Compliancequest Blog

Component Engineering

- Gateway for new Technology to hit engineering
- Engineering resource for cost reduction
- Major contributor to risk reduction
- Defining partner to gain manufacturing efficiency
- Historical center of excellence & knowledge

Component Engineering

Selection

Design

Life Cycle Management

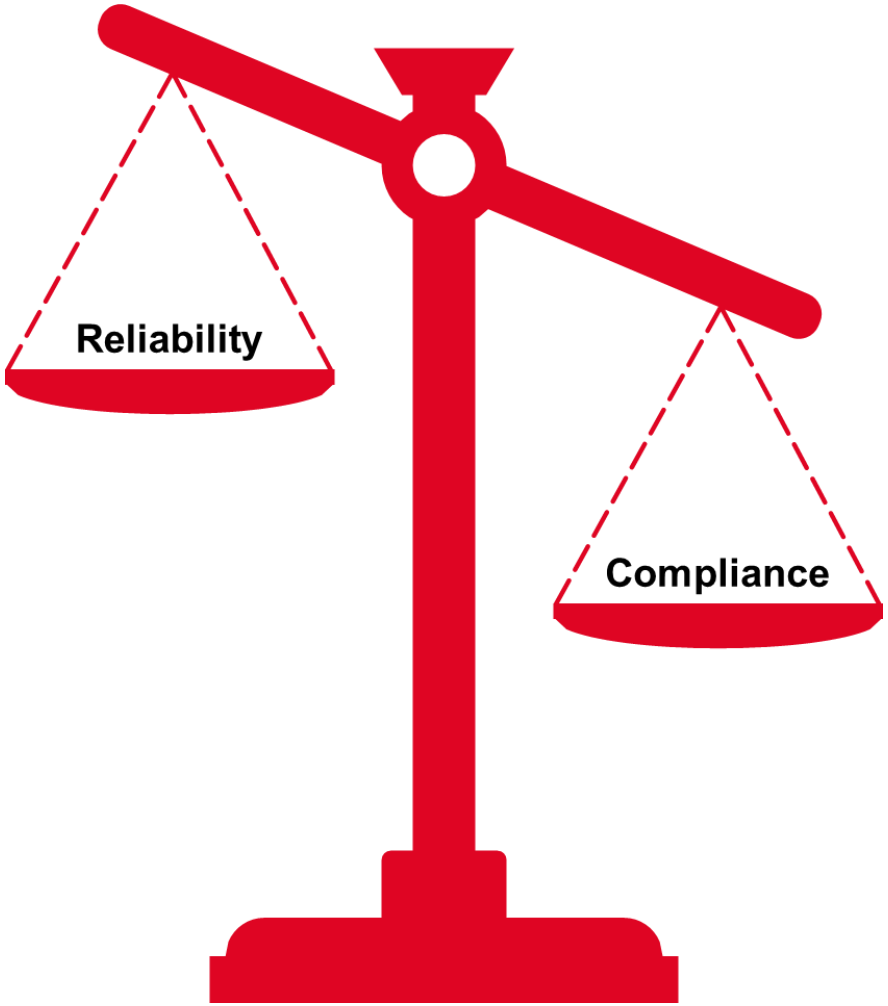
Greatly impacted by

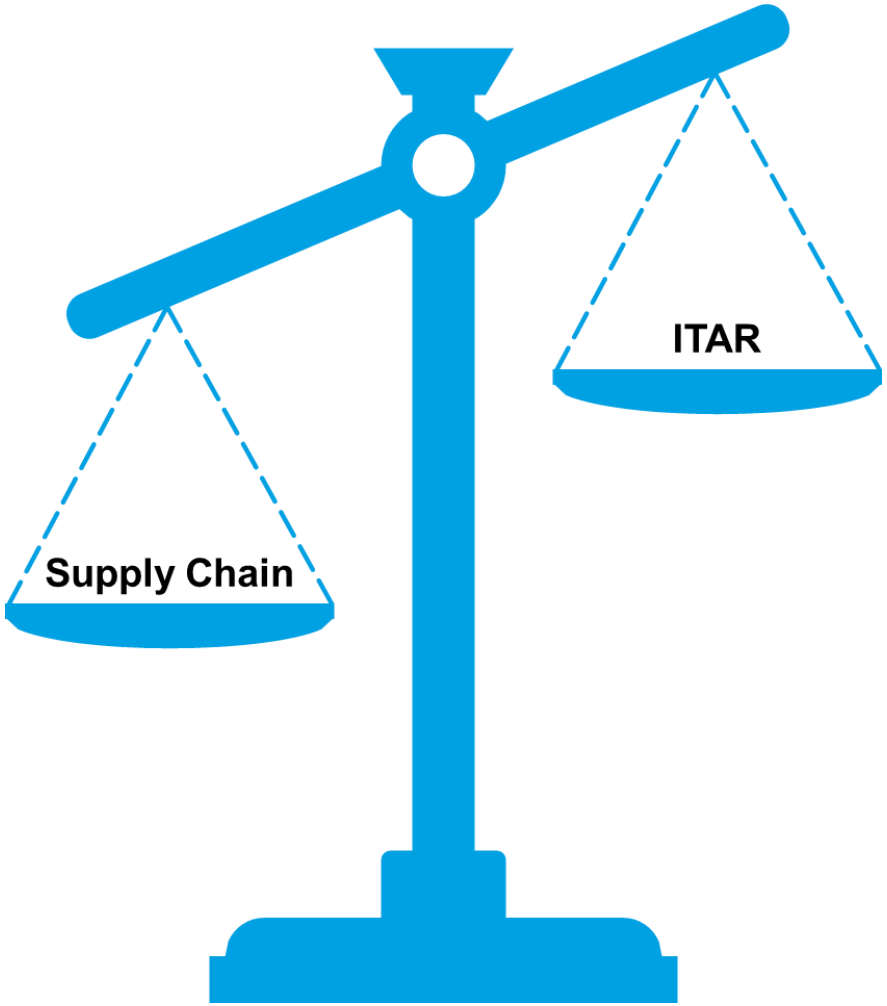
Environmental & Government regulation

PLUS technology evolution

Environmental & Government Regulations

Examples:

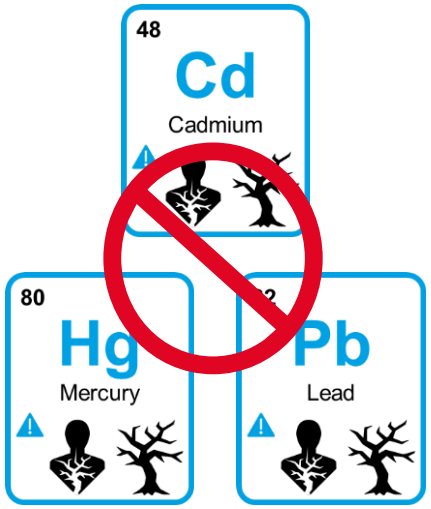




Environmental & Government Regulation

Condition	Intent	Constraint
Military Standards	Define performance with implied reliability	Performance levels guaranteed but limit or exclude COTS parts. Increase cost, lead times and limit cutting edge technology
RoHS, REACH, Conflict Minerals	Reduce hazardous materials used in end devices or component level manufacture, CoO concern	End performance may be limited by modified material systems. CoO requirements and full understanding of traceable supply chain
WEEE, EPA RCRA	Recycling & proper disposal	Understanding of recycling and a general concern towards toxic chemistry needed
Energy Efficiency & Sustainability, Energy Star	Create reduced energy use consumer devices	Though not specific to military, this tends to push certain electronic component growth & designs thus impacting the types of parts available
PFAS	Reduce or eliminate forever chemical use	PFAS elimination is a trend. Design, Test, qualify alternates now
ITAR International Traffic in Arms Regulations	Restricts the export of military electronics and sub-components outside the USA	Component Engineers must ensure components aren't sourced from or designs aren't shared with non approved countries. This may limit the use of cheaper and potentially faster sources of supply

Compliance Regulations

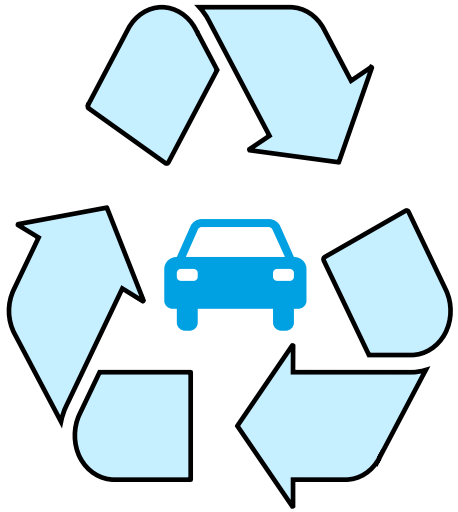


RoHS

REACH

T3 & G

WEEE



ELV

ITAR

Environmental Compliance Regulations - RoHS

What is RoHS?

- RoHS stands for Restriction of Hazardous Substances
- Originated in European Union, restricts hazardous materials found in EEE
- EU marketed products after July 1, 2006 must pass RoHS compliance.

Why is RoHS compliance important?

- The restricted materials are hazardous to the environment and pollute landfills and are dangerous in terms of occupational exposure during manufacturing and recycling.

Which companies are affected by the RoHS Directive?

- Business that sell or distribute applicable EEE products, sub-assemblies, components, or cables directly to EU
- Sell to Re-Sellers/Distributors/Integrators that in Turn Sell Products to EU Countries.

REACH

Registration:

Manufacturers / importers of chemicals must register chemicals - European Chemicals Agency (ECHA)

Evaluation:

ECHA evaluates the registrations to ensure compliance with REACH requirements to clarify initial concerns for human health & the environment

Authorization:

Substances of very high concern (SVHCs), prior authorization may be required before use

Restriction:

If the risks of a substance cannot be adequately managed, authorities can restrict or ban it

WEEE: Waste from Electrical and Electronic Equipment

How are RoHS and WEEE related?

- RoHS Regulates the Hazardous Substances used in the Manufacture of Electrical & Electronic Equipment
- WEEE Regulates the Disposal of this Same Equipment
- WEEE aims to encourage the design of electronic products with environmentally-safe recycling and recovery in mind
- WEEE, also known as Directive 2002/96/EC.
- WEEE mandates the treatment, recovery, recycling of electric & electronic equipment - applicable to EU products

ELV – End of Life Vehicle

RoHS and the ELV Directive related?

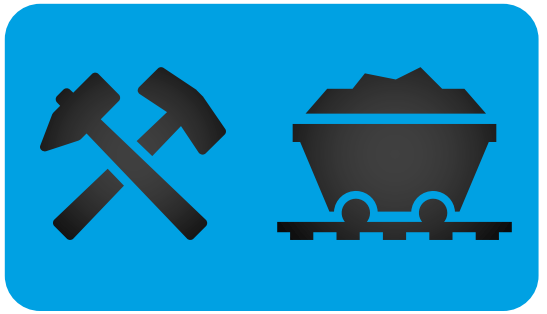
- ELV Directive limits the use of lead, mercury, cadmium, hexavalent chromium
- ELV relates to vehicle electrical cables, wiring, and associated components
- Example:
  - SAE XLP cross-linked polyethylene insulated automotive-use wire types SXL, GXL and TXL comply with this directive
  - BUT PVC-insulated automotive wire types GPT, TWP, SGT and SGX may contain lead and may not be compliant unless specifically requested in purchase specifications

ELV – End of Life Vehicle

RoHS and the ELV Directive related?

- ELV Directive limits the use of lead, mercury, cadmium, hexavalent chromium
- ELV relates to vehicle electrical cables, wiring, and associated components
- Example:
  - SAE XLP cross-linked polyethylene insulated automotive-use wire types SXL, GXL and TXL comply with this directive
  - BUT PVC-insulated automotive wire types GPT, TWP, SGT and SGX may contain lead and may not be compliant unless specifically requested in purchase specifications

T3 & G: Conflict Minerals Regulations



Dodd-Frank Act on conflict minerals

- Law requiring disclosure of conflict minerals originating from the Democratic Republic of the Congo or an adjoining countries
- Under Section 1502, the term “conflict minerals” includes tantalum, tin, gold, or tungsten.
- Congress enacted Section 1502 because of concerns that the exploitation and trade of conflict minerals by armed groups is helping to finance conflict in the DRC region and is contributing to an emergency humanitarian crisis

Conflict Minerals Regulations – Policy example:

KYOCERA AVX

KYOCERA AVX Responsible Minerals Sourcing Policy

General Statement

KYOCERA AVX leads the industry in its commitment to economic, environmental, and social justice as well as ensuring sustainable development. As a part of this commitment, KYOCERA AVX has committed itself to achieve the objectives of the Responsible Business Alliance ("RBA") Code of Conduct. In particular, KYOCERA AVX is fully committed to ensure that the tantalum, tin, tungsten, gold ("conflict minerals") in its products do not directly or indirectly finance or benefit armed groups that are perpetrators of human rights abuses in the Democratic Republic of the Congo or an adjoining country. KYOCERA AVX has committed to this objective for 3TG materials and beyond by establishing and maintaining responsible and transparent supply chains.

KYOCERA AVX is committed to the responsible sourcing of minerals which directs sourcing be conducted in an ethical and sustainable manner that safeguards the human rights in our global supply chain. As part of this commitment, KYOCERA AVX will exercise due diligence on all applicable suppliers in accordance with the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

Requirements

Under this policy, KYOCERA AVX requires all suppliers of any materials listed above to:

1. Adopt a Responsible Minerals Sourcing Policy and make available on their website or provide to us upon request.
2. Implement a due diligence program in accordance with the OECD Due Diligence Guidance

KYOCERA AVX CORPORATE POLICY Proprietary Document			Document Name KYOCERA AVX Responsible Minerals Sourcing Policy	Doc. No. MC-PO-001 Page 2 of 2
Rev.	Date	Prepared by	Final Approval	Changes from Last Revision
1.1	10/18/21	C. Dodd	Signature(s) on file	Revise policy CM
Reviewed & Approved: Signature(s) on file				
Distribution: AVXNet				

for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

3. Identify all smelters/refiners of 3TG minerals as well as other minerals of concern in their supply chain and require that they participate in the Responsible Mineral Initiative's ("RMI") Responsible Mineral Assurance Process.
4. Provide completed applicable RMI Conflict Mineral Reporting Templates at a minimum annually and upon request from KYOCERA AVX directly or through an identified third-party partner.
5. Ensure all smelters/refiners meet the relevant Responsible Mineral Assurance Process Standards required to be classified as conformant or are actively pursuing such designation. The specifics on those standards can be found by using the link below.

   http://www.responsiblemineralsinitiative.org/minerals-due-diligence/standards/
6. Disclose smelter and refiner changes in a timely manner.
7. Remove high-risk smelters/refiners as identified by KYOCERA AVX.
8. Proactively provide updates to KYOCERA AVX when changes to information in their RMI Conflict Mineral Reporting Template or other applicable reporting templates occur.
9. Permit KYOCERA AVX, upon reasonable prior notice, to audit supplier's responsible mineral sourcing due diligence documentation.

This document is the property of KYOCERA AVX Components Corporation and must not be copied, or in any way be communicated to persons other than those requiring the information for execution of their duty.

UNCONTROLLED IF PRINTED

Policy Form CQA-005 Rev 5: 10/1/2021

ITAR

International Traffic in Arms Regulations

- ITAR - United States regulation that controls the manufacture, sale, and distribution of defense and space-related articles and services as defined in the US Munitions list
- The list includes rocket launchers, torpedoes, bombs & other military hardware
- ITAR also restricts the plans, diagrams, photos, and other documentation used to build ITAR-controlled military gear - classified as “technical data”
- **ITAR mandates that access to physical materials or technical data related to defense and military technologies is restricted to US citizens only.**

Environmental Compliance Regulations - RoHS

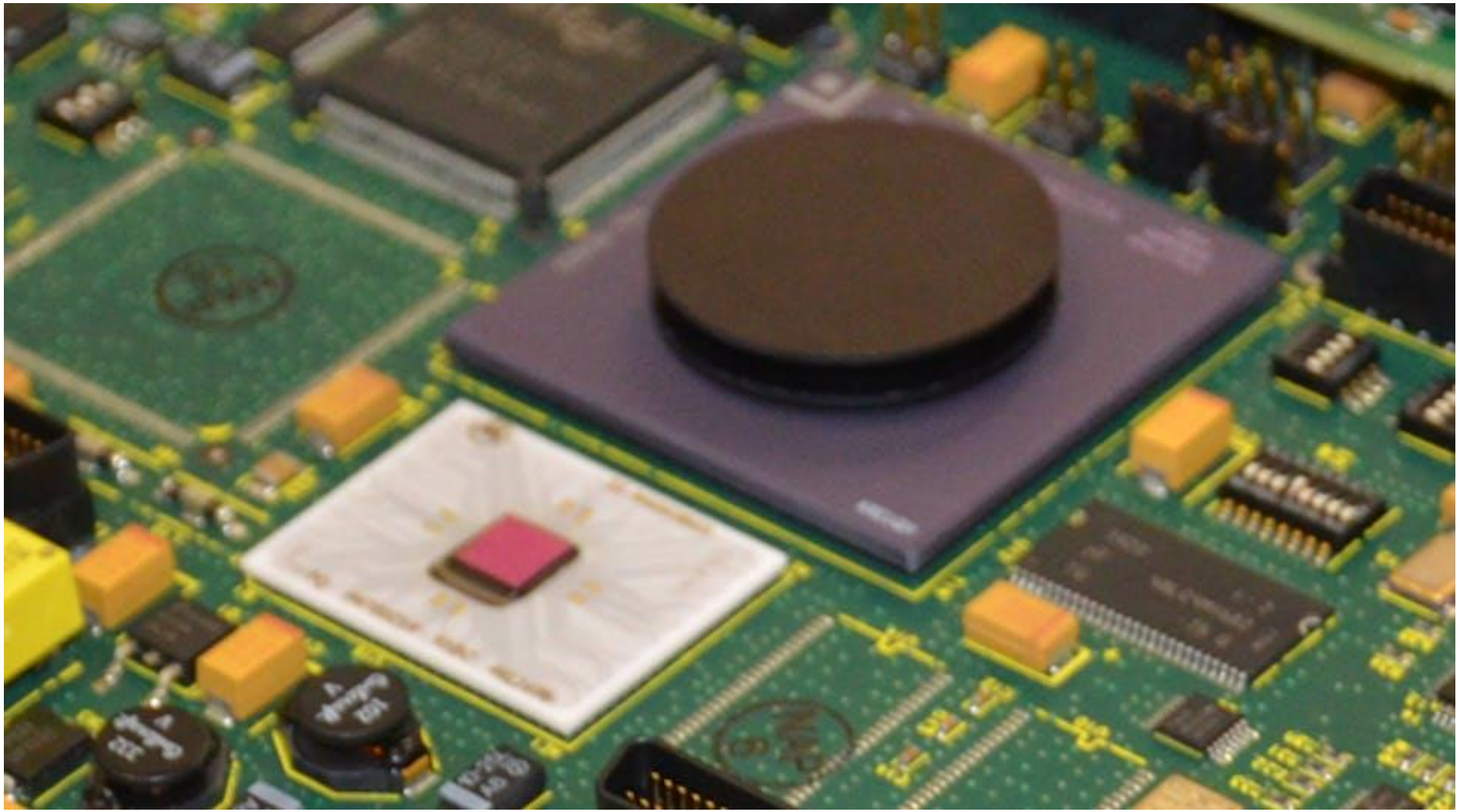
Any company that handles, manufactures, designs, sells, or distributes USML listed items must be ITAR compliant:

- Wholesalers
- Distributors
- Computer Software/ Hardware vendors
- Third-party suppliers
- Contractors

CHAIN of RESPONSIBILITY

- Every company in the supply chain needs to be ITAR compliant
- Example - Company A sells to company B/ Company B then sells that part to a foreign power
- Company A and Company B are in violation of ITAR.

Preparing for Obsolescence



CREDITED SOURCE – William Wong Blog Electronic design February 2024

Preparing for Obsolescence

What To Do
Per GDCA (sustainment support firm) recommendations for designers:

- Plan sustainment early (in Design cycle)
- Budget for sustainment
- Identify your high-risk/critical components
- Manage the big picture
- Strategically plan your design refresh

Preparing for Obsolescence

1) You are not alone

2) Dedicated conferences

3) Understand Component grades

ARTICLE

Component Obsolescence is Rising: Why is it Increasing and How to Proactively Mitigate the Risks

Electronic component obsolescence is one of the biggest threats to supply chain stability.

Companies need to strategize before it impacts their production lines

Depending on the industry, obsolescence can be annoying to critically dangerous to production

Factors Contributing to the Rise in Part Obsolescence in 2025

Relentless pace of technological innovation. Older components quickly become outdated

Attraction of new tech - high-performance, greater efficiency & lower power use

CREDITED SOURCE – Global Electronic Components Distributor | Sourceability
Industry Updates: Kathryn Ackerman_Feb 26, 2025

Factors Contributing to the Rise in Part Obsolescence in 2025 (CONTINUED)

Average lifespan for advanced semiconductors is around 2-5 years, 60% decrease compared to legacy parts

Result is faster end-of-life (EOL) notices for critical components, harder to source essential parts over time

Obsolescence also occurs due to shifting business priorities, such as market demand or M &A

Cost Concerns – sometimes - more beneficial to sell the equipment vs manufacture the parts themselves

Business goals and corporate direction can change under new leadership, shifting away from older production

Geopolitical and economic factors have also significantly exacerbated obsolescence risks

Trade tensions, tariffs, and financial instability can disrupt global supply chains, making it harder for manufacturers to access raw materials or supply chain partners to produce chips.

CREDITED SOURCE – Global Electronic Components Distributor | Sourceability
Industry Updates: Kathryn Ackerman_Feb 26, 2025

Factors Contributing to the Rise in Part Obsolescence in 2025 (CONTINUED)

Datalynq's source: "How to Manage the Complexity of Market Availability for Electronic Components," Rob Picken

Obsolescence has increased by 35%. "In 2023 alone, 328,000 end-of-life (EOL) notices issued

The lifespan of semiconductors has been reduced by 66% from 30 years to just 10.

The Impact of Component Obsolescence on Companies and the Supply Chain

No one safe - reverberates across end users

Electronic component obsolescence leads to:

Increased production costs

Delays

Fast & expensive redesigns

CREDITED SOURCE – Global Electronic Components Distributor | Sourceability
Industry Updates: Kathryn Ackerman_Feb 26, 2025

ARTICLE

The Impact of Component Obsolescence on Companies and the Supply Chain (CONTINUED)

Expensive spot buys

During the semiconductor shortage, when demand far outstripped supply, some companies turned to anyone who offered a supply of critical chips, even Alibaba. It was no surprise, even to the buyer, that the chips were fake and didn't work. Desperation gives counterfeiters a door to slip into even high-reliability supply chains.

MUST PRE PLAN:

High-reliability Manufacturers – commonly use legacy components

More prone to obsolescence – then few options when a part becomes obsolete

Alternates is half the battle – new parts need to pass stringent pre-market approval processes, tests and trials

CREDITED SOURCE – Global Electronic Components Distributor | Sourceability

Industry Updates: Kathryn Ackerman_Feb 26, 2025

The Impact of Component Obsolescence on Companies and the Supply Chain (CONTINUED)

Due to program lifespans of some end products - there may also be a loss of knowledge, engineers retired

High-reliability OEMs, CMs, and EMS often manage through spot buys or last-time buys based on EOL cycle

LTBs require storage

Store electronic components in optimal temperatures, humidity control, preventing electrostatic discharge (ESD)

Obsolescence is inevitable.

Users must heavily invest in proactive inventory management strategies long before parts EOL

Component obsolescence presents a significant risk for all businesses, especially high-reliability industries, which means mitigation efforts must begin long before a component approaches EOL.

CREDITED SOURCE – Global Electronic Components Distributor | Sourceability
Industry Updates: Kathryn Ackerman_Feb 26, 2025

Component Grades

AEC-Q200

DLA

DESC

SCD

DSCC

IECQ-CECC

MIL-PRF

SPECTRUM of COMPONENTS

Commercial Grade

- Manufactured to datasheet specifications only
- Flexibility surrounds the design, materials, processes, and testing
- Manufacturers can and will change designs, materials, processes
- Qualification or testing requirements tend not to be mandatory, components are designed and manufactured for the best performance, cost, or a ratio of both.

Automotive Grade

- AEC-Q200 is a Stress Test Qualification for Passive Components per Automotive Electronics Council (AEC)
- AEC-Q200 qualified parts require the manufacturer to test parts & save results as outlined in AEC - Q200
- Tests are performed at different temperatures and dependent on the ability of the passive component to pass or fail at a particular temperature will result in a grading between Grade 0 -> Grade 4. These grades correspond with different automotive applications from Non-Automotive to All Automotive.
- **IF changes are made to either the product or process NOTIFICATION, ACCEPTANCE AND REQUALIFICATION ARE REQUIRED to supply AEC-Q200 qualified passive Electronic Components**

EDITED SOURCE – EPCI
https://passive-components.eu/wp-content/uploads/2021/03/COTS-Automotive-Capacitors-Procurement-and-Evaluation-Case-Study-for-SME-Space-Hardware-Manufacturer.pdf

SPECTRUM of COMPONENTS

IECQ-CECC

- Historically preference of European companies designing products for an intended use in Hi-Rel markets
- Common for multiple manufacturers to provide parts to a particular CECC specification therefore providing consistent quality and performance specifications. Some reduction in the number of suppliers due to limited business levels.
- Qualification granted BY IECQ-CECC system when the manufacturer can meet the specification plus routine periodic testing such as: Visual, Dimensions, Value, Destructive Physical analysis, Solderability.
- Once qualified a periodic test program requires mandatory tests such as: High Temperature Exposure, Temperature Cycling, Operational Life, Thermal Shock, etc. Plus, periodic audits of the manufacturers quality management systems are required by an independent certification body.
- CECC qualified parts can only be sold and released by authorized distributors which the manufacturers appoint.
- Only distributors who are appointed by the manufacturer and audited can sell products to CECC

EDITED SOURCE – EPCI
https://passive-components.eu/wp-content/uploads/2021/03/COTS-Automotive-Capacitors-Procurement-and-Evaluation-Case-Study-for-SME-Space-Hardware-Manufacturer.pdf

Automotive vs ESCC Specifications Delta Analysis

Tantalum and MLCC Class II Capacitors

Tantalum	AECQ-200	Tantalum ESCC 3012	MLCC ESCC 3009
Burn-In	Not Required	168h level B with Serialisation	96h 2xVr
100% X-Ray	Not Required	Level B	Not Required
Electrical Measurement RT	At 25±5°	At +22 ± 3°C	At +20 ± 2°C
Storage 1000hrs, no BIAS	Hi Temp 125°C	-55/85/125	Not Required
Temp Cycling -55/+125°C	1000 cycles	5 cycles	10 cycles
Humidity	85/85 1k hrs, Vr biased	56days damp heat	85/85 1k hrs, 1.5V
Operation Life	125°C, 2/3Vr Ta; 125°C Vr MLCC, 1k hrs	125°C, 2/3Vr and 85°C Vr 2k hrs	125°C 2xVr 2k hrs
Mechanical Shock	1500g for 0.5s	50g 11ms	Not Required
Vibration	5g 20 min 12 cycles	20g 20min 12 cycles	Not Required
Resistance to soldering heat	260°C for 10s	Not Required	Not Required
Solderability	+235°C 4s	+235°C 4s	+235°C 4s
Electrical Characterization	-55/85/125°C Ta, 125°C MLCC	-55/85/125	125°C
Terminal Strength	17.7N 60s	5N 10s	5N 10s
Climatiq Sequence	Not Required	Dry Heat, Damp Heat, Cold, Low Air Pressure	Not Required
Board Flex	MLCC only, 60s holding time	NA	Not Required
Beam Load Test	MLCC only	NA	Not Required
Surge Voltage	Not Required	1000 cycles 33Ω	Not Required

EDITED SOURCE – EPCI
https://passive-components.eu/wp-content/uploads/2021/03/COTS-Automotive-Capacitors-Procurement-and-Evaluation-Case-Study-for-SME-Space-Hardware-Manufacturer.pdf

SPECTRUM of COMPONENTS

DLA Land and Maritime, DESC, and DSCC Drawings

- Intended for use when military QPL products are not available
- Part must be purchased to DSCC part numbers to assure that all performance requirements and tests are met.
- DESC & DSCC suppliers are typically listed on the QPL or has agreed on an inspection program to the referenced MIL- PRF and is detailed in the scope of the drawing.
- ESCC QPL The ESCC QPL (European Space Components Coordination, Qualified Parts List) makes available space components which have been fully evaluated, qualified and maintained with regards to the required standards for use in European Member states space programs.
- Qualified Component types and Manufacturers must meet strict controls the design, process control, inspection and documentation.
- Additional testing can be stipulated via the part number or on the purchase order in the form of LVT (Lot Validation Testing) and LAT (Lot Acceptance Test) EPPL

EDITED SOURCE – EPCI
https://passive-components.eu/wp-content/uploads/2021/03/COTS-Automotive-Capacitors-Procurement-and-Evaluation-Case-Study-for-SME-Space-Hardware-Manufacturer.pdf

SPECTRUM of COMPONENTS

MIL-PRF

- Developed & Maintained by United States Military
- Performance Specifications for the Functional Requirements + Predictable Quality Levels
- MIL PRF Parts are Listed on a QPL (Qualified Product List). Manufacturers QA Systems, Manufacturing & Performance Must be DLA Approved.
- Subsequent Lot Basis Testing is Mandatory for the Manufacturer to Maintain Qualification.
- Designs are not Allowed to Change Without Extensive Testing, Documentation and DLA Approval

Exponential Failure Rate [Level % per 1000 hr]	M = 1%	P = 0.1%	R & U = 0.01%	S & V = 0.001%	
Weibull Failure Rate [Level % per 1000 hr]	A = NON ER	B = 0.1%	C = 0.01%	D = 0.001%	T = 0.01% Space

E.R Customers Using Solid Tantalum Capacitors Typically Add a Surge Current Screening.

This Test Subjects Tantalum Capacitors to a Peak Current to Remove Parts Which May Fail on Start-Up

Screening Options	A = 10 Cycles, +25°C	B = 10 Cycles, -55°C & +85°C	C = 10 Cycles, -55°C & +85°C Before Weibull	Z = None Required

EDITED SOURCE – EPCI
https://passive-components.eu/wp-content/uploads/2021/03/COTS-Automotive-Capacitors-Procurement-and-Evaluation-Case-Study-for-SME-Space-Hardware-Manufacturer.pdf

MIL-PRF-32535: A List of Alternate Parts
– NOTE NOT EQUILIVANT PARTS

Institution	Spec. Name	Specification Details
NASA	S-311-P-838	Space-Level BME X7R MLCC
ESA / ESCC*	ESCC QPL 3009/04	0402 to 2220 SMT MLCC
Automotive Electronics Council	AEC-Q200	Auto Grade MLCCs

Description	Commercial	Automotive	ESCC-Space
Material	No Restrictions, Frequent Changes	Change Notice Requires PCN	**No Change Allowed:** Requalification / Re-Audit
Chip Dimensions	No Restrictions	Minimum Thickness Constraint	Minimum Thickness **No Change Allowed:** Requalification
Design	No Restrictions, Frequent Changes	Major Changes Requires PCN	**No Change Allowed:** Requalification / Re-Audit
Margins	≥ 75 µm	≥ 100 µm	≥170 µm
Cover Layers	≥ 75 µm	≥ 100 µm	≥112 µm
Dielectric Thickness	No Restrictions, Frequent Changes	Major Change Requires PCN	**No Change Allowed:** Requalification

Alternate Part Comparison
– NOTE NOT EQUILIVANT PARTS

	Commercial	Automotive	Space
Mechanical	• 2mm Board Flex • Smallest margins and Cover Layer	• 2mm Board Flex • Superior Material Set • Balanced Dimensions for Performance and Cost	• 5mm Board Flex as Standard • Conservative Design Employs Largest margins / Cover Layers, and Thick Dielectric Layers
Electrical	• Highest CV Range per Case Size • High Voltage Coefficient Factor VC • Voltage Breakdown Closer to V_R	• Consistent Temperature and Voltage Characteristics • Reasonable CV Range	• Lower CV Range • Good Ripple Current Handling • Higher Breakdown Voltage • Best VC Performance
Reliability	• No Ratings. 1000 hr Life Test for Small Sample • No PCN Process	• Ratings Based on 1000 hr Life Test and Generic Data for a Family of Parts • PCN Process	• Ratings Based on 4000 hr Life Test and Lot Group B Test (100hrs) • No Changes: Full Qualification

Alternate Part Comparison

– NOTE NOT EQUILIVANT PARTS

Test	Commercial	Automotive	M32535-Level
Operating Temperature	-55°C to +125°C	-55°C to +125°C	-55°C to +125°C
Capacitance	Within Specific Limits	Within Specific Limits	Within Specific Limits
Dissipation Factor	≤ 10% (≥ 50 RV), ≤ 12.5% (< 50 RV)	≤ 10% (≥ 50 RV), ≤ 12.5% (< 50 RV)	≤ 3% (≥ 50 V), ≤ 5% (16 - 25 V), ≤ 7.5% (10 V), ≤ 10% (4 - 6.3 V)
IR (+25°C)	100,000 MΩ or 1000 MΩ-µF	MIL-STD-202	MIL-STD-202
Hot IR (+125°C)			MIL-STD-202
Dielectric Withstanding V	250% of RV for 1-5 Seconds	250% of RV	250 - 400% of RV for 5 +1 Seconds
Board Flex	2mm Deflection for 30 Seconds	AEC-Q200-005, 60 Seconds	2mm $_{min.}$ for 60 Seconds
Solderability	≥ 95% Coverage	J-STD-002	MIL-STD-202
Solder Heat Resistance	C ≤ +7.5%, DF, IR, DWV Meets IL	J-STD-002	MIL-STD-202
Thermal Shock	C ≤ +7.5%, DF, IR, DWV Meets IL, 5 Cycles		MIL-STD-202, 100 Cycles
Operational Life	C ≤ 12.5%, DF ≤ 2 x IL, IR > 0.3 x IL, (1.5x or 2x RV) 1000 hrs	MIL-STD-202, 1000 hrs	MIL-STD-202, 4000 hrs, C ≤ 20%, DF ≤ IL, IR / Hot IR IR > 0.3 x IL
Temp. Humidity Bias	C ≤ 12.5%, DF ≤ 2 x IL, IR > 0.3 x IL, (85/85) 1000 hrs	MIL-STD-202, (85/85) 1000 hrs	MIL-STD-202, (85/85) 1000 hrs
DPA		EIA-469	EIA-469
Visual Examination		MIL-STD-883	MIL-PRF-32535 Appendix B
Physical Dimension	Within Specific Limits	JESD22	MIL-PRF-32535 Appendix B

Alternate Part Comparison

– NOTE NOT EQUILIVANT PARTS

Test	Commercial	Automotive	M32535-Level
Material			MIL-STD-790
Design			MIL-PRF-32535 Appendix B
Construction		MIL-STD-883	MIL-PRF-32535 Appendix B
Marking		MIL-STD-883	MIL-PRF-32535 Appendix B
Workmanship		MIL-STD-883	MIL-PRF-32535 Appendix B
Terminal Strength		MIL-STD-202 $_{(Leaded)}$, AEC-Q200-006 $_{(SMD)}$	MIL-STD-202
Mechanical Shock		MIL-STD-202	
Vibration		MIL-STD-202, 5g's, 20 Minutes, 12 Cycles, 10 - 2000 Hz	
ESD		AEC-Q200-200 or ISO / DIS 10605	
Beam Load Test		AEC-Q200-003	
Resistance to Solder Heat		MIL-STD-202	MIL-STD-202
Shear Stress		AEC-Q200-006	MIL-PRF-32535, 60 Seconds
Csam			2x 100% Acoustic Micro Inspection
Thermal Shock / Cycle			100% x 20 Cycles
Voltage Conditioning (125°C)			100% 2x RV for 168 - 264 hrs
Hot IR (125°C)			100% @125°C
Dielectric Voltage Breakdown			6x Rated Voltage or 1,200 V_{DC}, Whichever is Less

SPECTRUM of COMPONENTS

COTS, COTS-Plus

- Designed and Manufactured to Commercial Standards
- ADDITIONAL Up-Screening

  AND/OR
  - Typically in “Accordance” to a Particular MIL-PRF Specification
  - May Include Known Methods Specific to the Manufacturer Resulting Increased Reliability
- Manufacturers Publish Expected Failure Rates of the COTS Part and Compare to Commercial Alternates Typically, Infant Mortality Failures are Reduced Thus Providing a Higher Reliability Component
- Further Options for Reliability Grading, Surge Current Tests, Group Tests etc. are Typically Offered as Options

EDITED SOURCE – EPCI
https://passive-components.eu/wp-content/uploads/2021/03/COTS-Automotive-Capacitors-Procurement-and-Evaluation-Case-Study-for-SME-Space-Hardware-Manufacturer.pdf

SCD

Why?

TECHNOLOGY HAS EVOLVED FASTER THAN MIL PRF DOCUMENTATIONS
APPLICATION HAS SPECIAL NEEDS WELL BEYOND E.R. DOCUMENTS

AN SCD PROVIDES:

Detailed Description of a Commercially Created Part

To the Supplier

- Requirements of expected device performance, qualification, maintenance of qualification & shipment

To the End User

- Way to ID parts from multiple suppliers all capable of meeting an ‘ADVANCED specification’
- Reference doc for engineering/design and purchasing to ensure part(s) meet end needs
- Platform for further development or possible standardization:
  - SCDs can evolve into the basis of a PRF (given time, need and DLA efforts)

Advanced Technology Trends Within the Passive Supplier Community

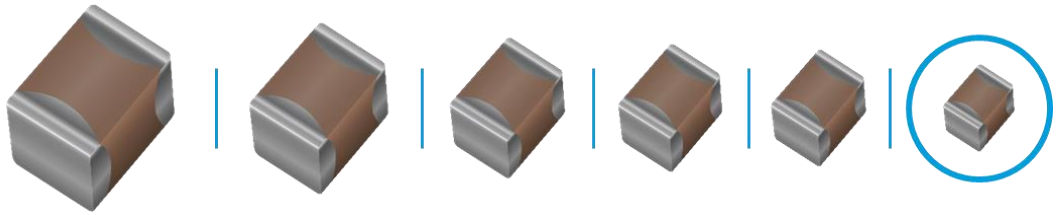
EXAMPLES:

- Miniaturization
- New Device Configurations & Types
- Integration
- New Material Systems
- Expanded Test Scenarios (Radiation, High Temperature)
- Simulation Tools Electrical, Thermal, EM & 3D Models Common

Passive Component Technology Trend:

Miniaturization

- impact of miniaturized passives is of extreme importance
- 10 x 10 part use example is shown below:



Size	Typical Chip Size (mm)	Mounting Area Ratio*	Weight (g/100pcs)	Weight Down Ratio
0805	2.0 x 1.25	100.0%	2.346	100.0%
0603	1.6 x 0.8	56.0%	0.901	38.4%
0402	1.0 x 0.5	25.7%	0.281	12.0%
0201	0.6 x 0.3	12.0%	0.043	1.8%
01005	0.4 x 0.2	7.1%	0.010	0.4%
008004	0.25 x 0.125	4.2%	0.001	0.1%

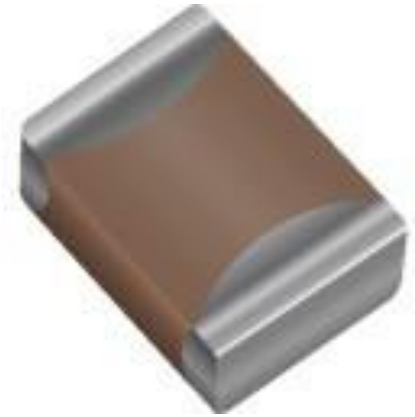
This technology advancement will impact military & COTS parts

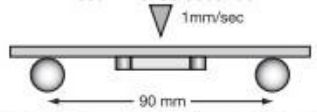
Source Control Drawing Differs:

Source Control Drawing Section	Application	Requirements	Qual Procedure	Acceptance Criteria	P/N Definition	Supply Sources
Details Contained Within Drawing Section	If Contractually Allowed- Provide a Brief Description of End Use	End Use Performance Defined in All Use Conditions- e.g Radiation, Temperature, Transient Fields etc.	Qualification Procedure: Tests, Test Sequences, and Conditions Fully Defined. In Some Cases, Test Equipment Listed	Accept / Reject Criteria Fully Defined	Possibly Contract Defined or Manufacturer Defined. Typically, Concentrated on Date Code Tracking	P/N to Fully Reflect Component Manufacturer-Source of Supply to the End User

EXAMPLE:
SCD on 'Certain' NP0 MLCCs

	Commercial	MM Series
Administrative	Standard part numbers; no restriction on who purchases these parts	Specific series part number, used to control supply of product
Lot Qualification Destructive Physical Analysis (DPA)	As per EIA RS469	Increased sample plan – stricter criteria
Visual/Cosmetic Quality	Standard process and inspection	100% inspection
Application Robustness	Standard sampling for accelerated wave solder on X7R dielectrics	Increased sampling for accelerated wave solder on X7R and NP0 followed by lot by lot reliability testing
Design/Change Control	Required to inform customer of changes in: form fit function	KYOCERA AVX will qualify and notify customers before making any change to the following materials or processes: Dielectric formulation, type, or supplier Metal formulation, type, or supplier Termination material formulation, type, or supplier Manufacturing equipment type Quality testing regime including sample size and accept/ reject criteria

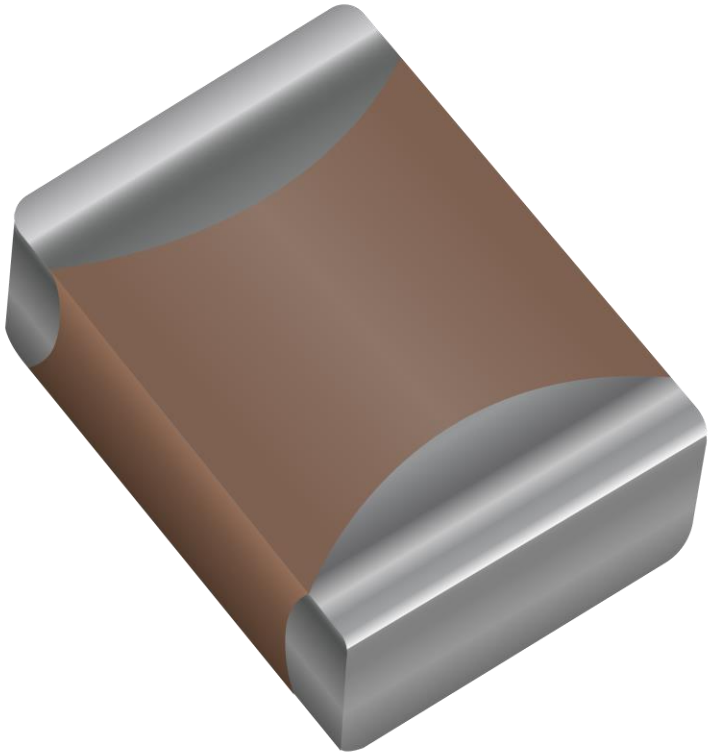


Parameter/Test		NP0 Specification Limits	Measuring Conditions	
Operating Temperature Range		-55°C to +125°C	Temperature Cycle Chamber	
Capacitance		Within specified tolerance	Freq.: 1.0 MHz ± 10% for cap ≤ 1000 pF 1.0 kHz ± 10% for cap > 1000 pF Voltage: 1.0Vrms ± .2V	
Q		<30 pF: Q≥ 400+20 x Cap Value ≥30 pF: Q≥ 1000		
Insulation Resistance		100,000MΩ or 1000MΩ - µF, whichever is less	Charge device with rated voltage for 60 ± 5 secs @ room temp/humidity	
Dielectric Strength		No breakdown or visual defects	Charge device with 300% of rated voltage for 1-5 seconds, w/charge and discharge current limited to 50 mA (max) Note: Charge device with 150% of rated voltage for 500V devices.	
Resistance to Flexure Stresses	Appearance	No defects	Deflection: 2mm Test Time: 30 seconds 	
	Capacitance Variation	±5% or ±.5 pF, whichever is greater		
	Q	Meets Initial Values (As Above)		
	Insulation Resistance	≥ Initial Value x 0.3		
Solderability		≥ 95% of each terminal should be covered with fresh solder	Dip device in eutectic solder at 230 ± 5°C for 5.0 ± 0.5 seconds	
Resistance to Solder Heat	Appearance	No defects, <25% leaching of either end terminal	Dip device in eutectic solder at 260°C for 60 seconds. Store at room temperature for 24 ± 2 hours before measuring electrical properties.	
	Capacitance Variation	≤ ±2.5% or ±.25 pF, whichever is greater		
	Q	Meets Initial Values (As Above)		
	Insulation Resistance	Meets Initial Values (As Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Thermal Shock	Appearance	No visual defects	Step 1: -55°C ± 2°	30 ± 3 minutes
	Capacitance Variation	≤ ±2.5% or ±.25 pF, whichever is greater	Step 2: Room Temp	≤ 3 minutes
	Q	Meets Initial Values (As Above)	Step 3: +125°C ± 2°	30 ± 3 minutes
	Insulation Resistance	Meets Initial Values (As Above)	Step 4: Room Temp	≤ 3 minutes
	Dielectric Strength	Meets Initial Values (As Above)	Repeat for 5 cycles and measure after 24 hours at room temperature	
Load Life	Appearance	No visual defects	Charge device with twice rated voltage in test chamber set at 125°C ± 2°C for 1000 hours (+48, -0). Remove from test chamber and stabilize at room temperature for 24 hours before measuring.	
	Capacitance Variation	≤ ±3.0% or ± .3 pF, whichever is greater		
	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		
Load Humidity	Appearance	No visual defects	Store in a test chamber set at 85°C ± 2°C/ 85% ± 5% relative humidity for 1000 hours (+48, -0) with rated voltage applied. Remove from chamber and stabilize at room temperature for 24 ± 2 hours before measuring.	
	Capacitance Variation	≤ ±5.0% or ± .5 pF, whichever is greater		
	Q	≥ 30 pF: Q≥ 350 ≥10 pF, <30 pF: Q≥ 275 +5C/2 <10 pF: Q≥ 200 +10C		
	Insulation Resistance	≥ Initial Value x 0.3 (See Above)		
	Dielectric Strength	Meets Initial Values (As Above)		

Counterfeit Products

Buyers

- Responsibility to only purchase products from:
  - Authorized distributors
  - Manufacturers directly



Manufacturers:

- Have detailed lot tracking and date code schemes
- Even with the above – manufacturers are unable to take responsibility for products that are not purchased from authorized distributors or from the manufacturer directly
- Manufacturers can not assist in evaluating questionable products with no supply pedigree

Counterfeit Products:

Use Tools Such As:

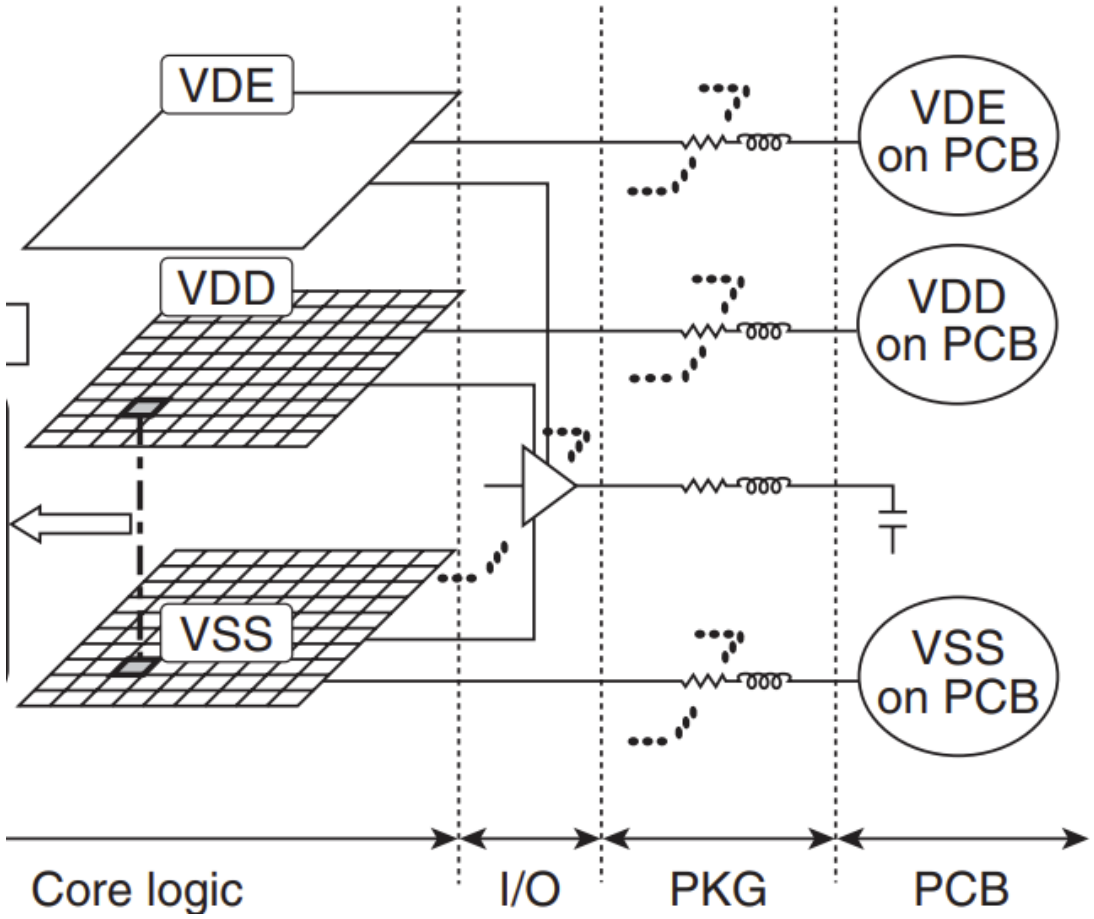
- External test labs
- Visual Inspection - Look for clear marking, physical deformities, signs of resurfacing
- Increased electrical inspection
- X-Ray – Look for consistent die size, wire bond integrity, case integrity, markings
- Scanning Acoustic Microscope – look for signs of blacktopping (overcoating sanded surfaces)

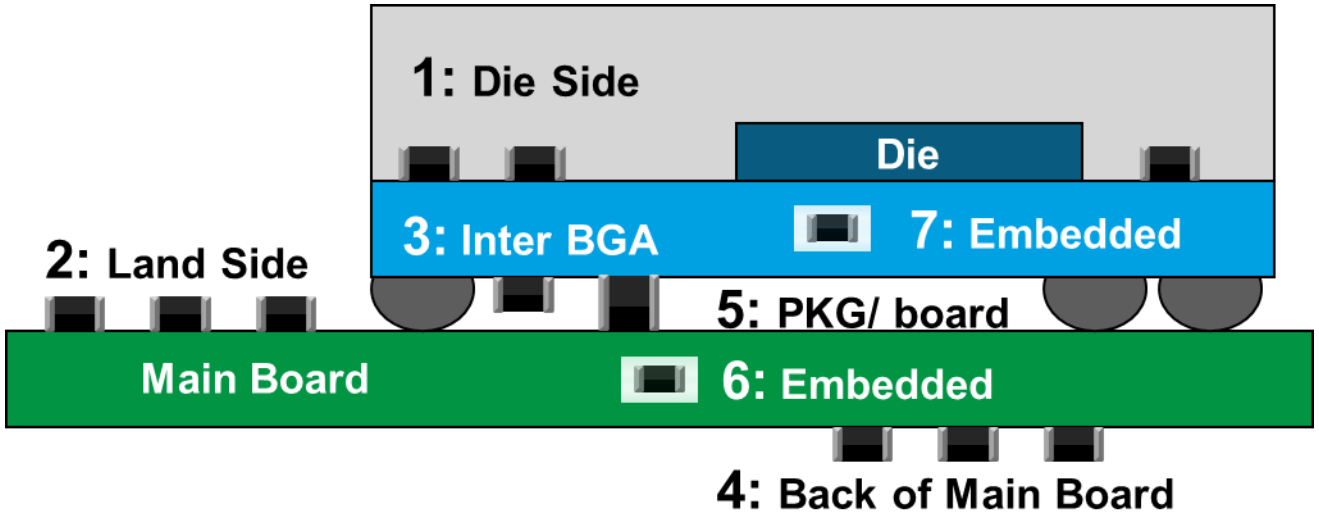
Greatly Impacted by

Advanced Technology Trends Within the Active Supplier Community

- Miniaturization
- Wide-bandgap semiconductors
- 2.5d / 3d Integration – RF Digital Analog die stacked sip
- New package types - chiplets
- Ai enabled actives creating real time remote processing nodes
- New test types

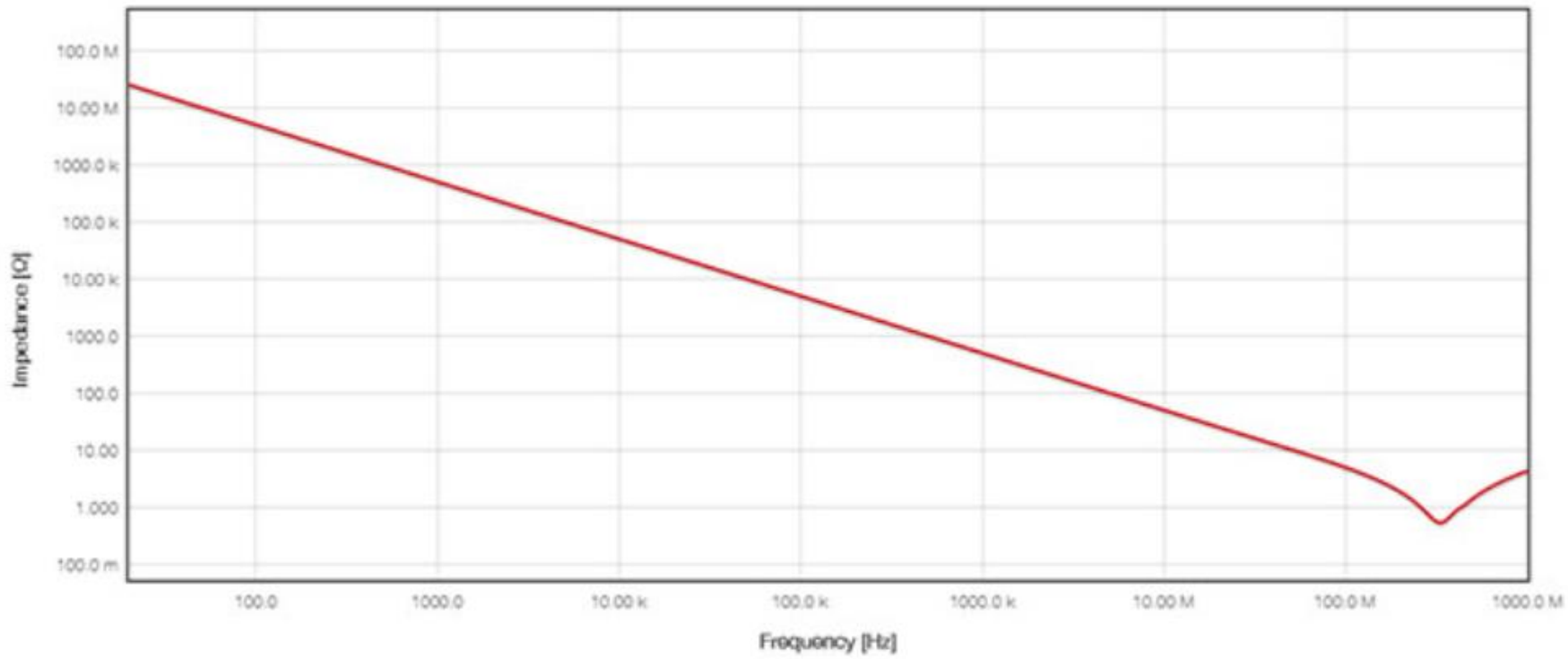
Increasing Role of Simulation & Modeling





Example of part simulation

IMPEDANCE | ESR | TEMPERATURE | DC BIAS | RIPPLE CURRENT | EQ CIRCUIT DIAGRAM | CASE DIMENSIONS



Example of part simulation

- Pad Dimension - **MnO2 + POLY**

- CSV Chart Data - **Capacitance**
- CSV Chart Data - **Impedance & ESR**
- CSV Chart Data - **DF (Dissipation Factor)**
- CSV Chart Data - **Ripple Voltage**
- CSV Chart Data - **Ripple Current**
- CSV Chart Data - **DCL (Leakage Current)**

- Series S-parameters
- Shunt S-parameters

- PN SPICE Model
- SPICE Models Bundle

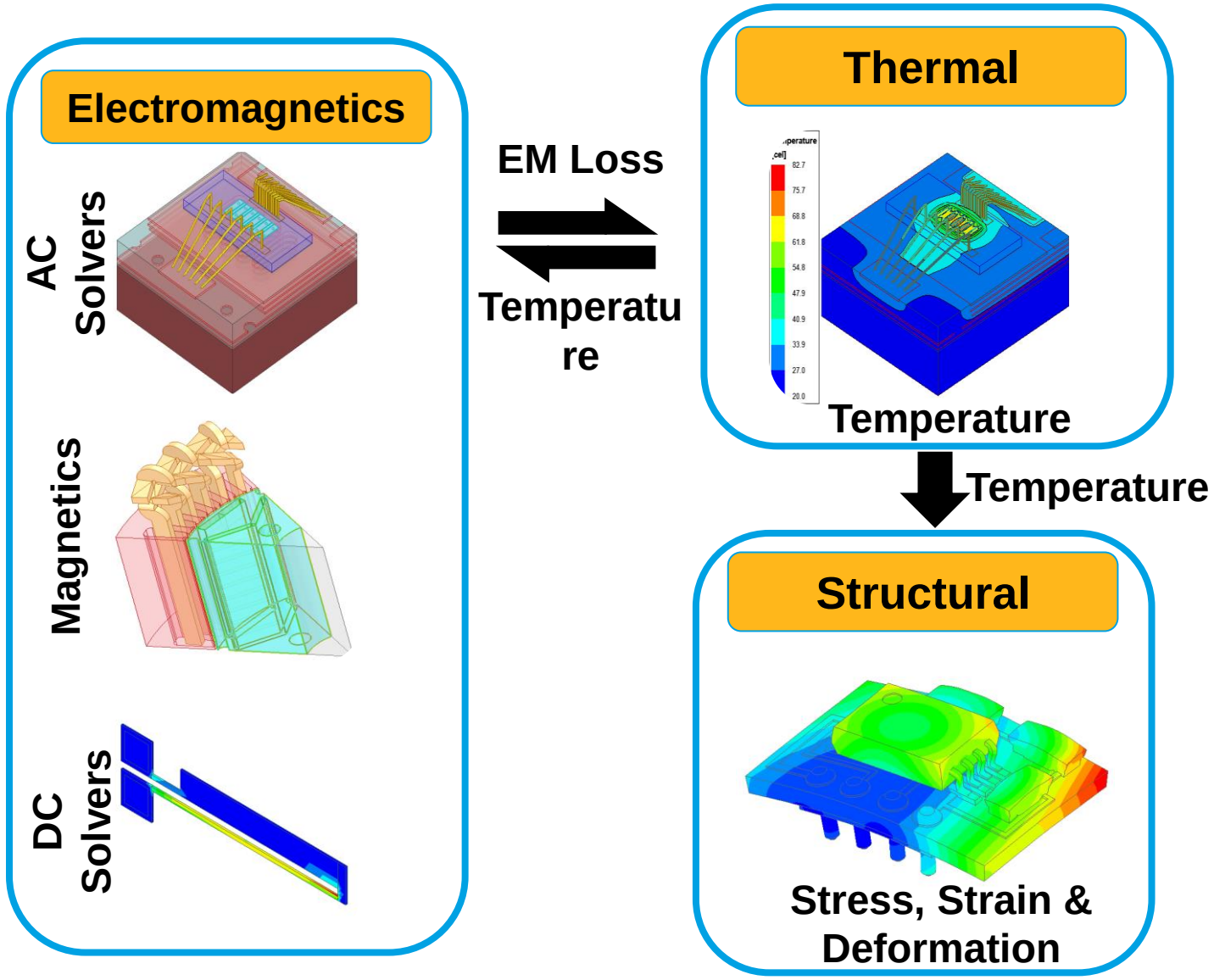
- 3D STP Model

Powering Innovation That Drives Human Advancement

Multiphysics Simulation for Capacitors… The Why

Multiphysics Workflows

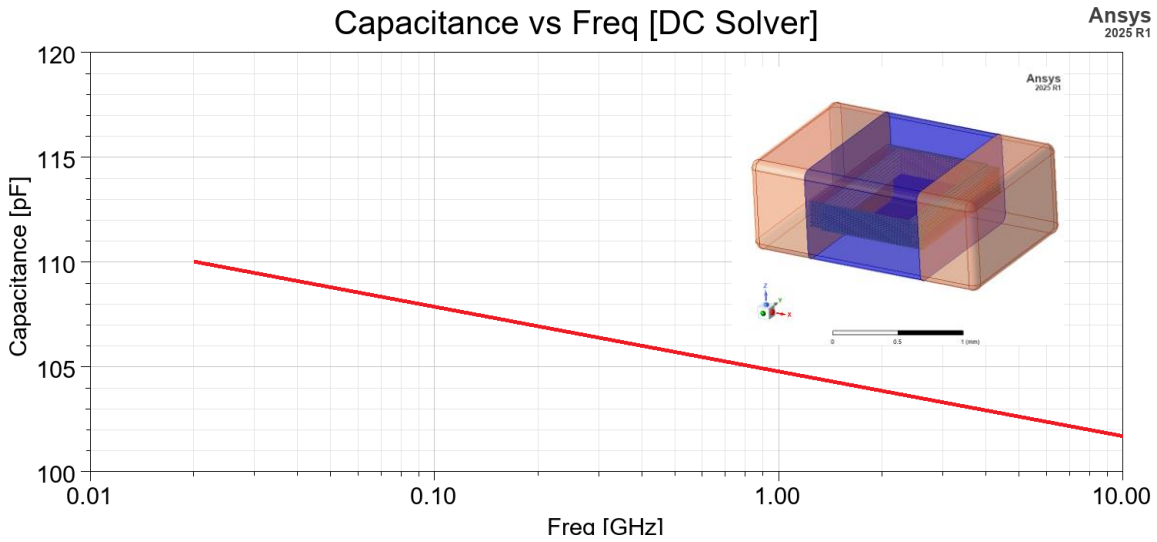
- Multiphysics workflows are becoming more necessary than ever due to:
  - Component Performance Increases
  - Reduction in Size
  - Higher Power consumption
  - Higher Power Densities
  - Reliability Requirements
  - Materials

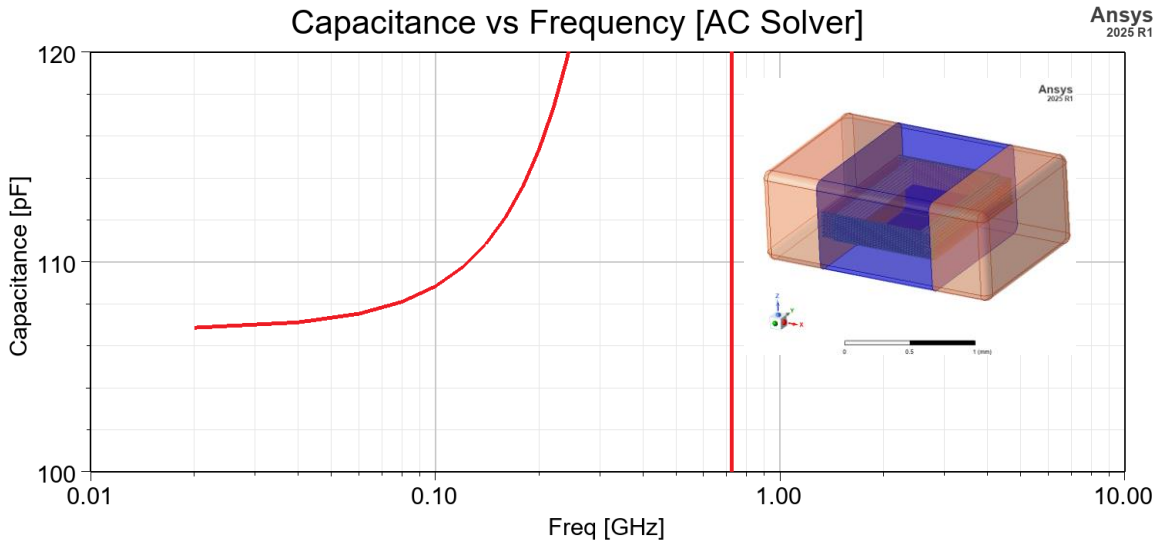


Electromagnetic Simulation

Surface Mount Devices are simulated frequently for electrical performance

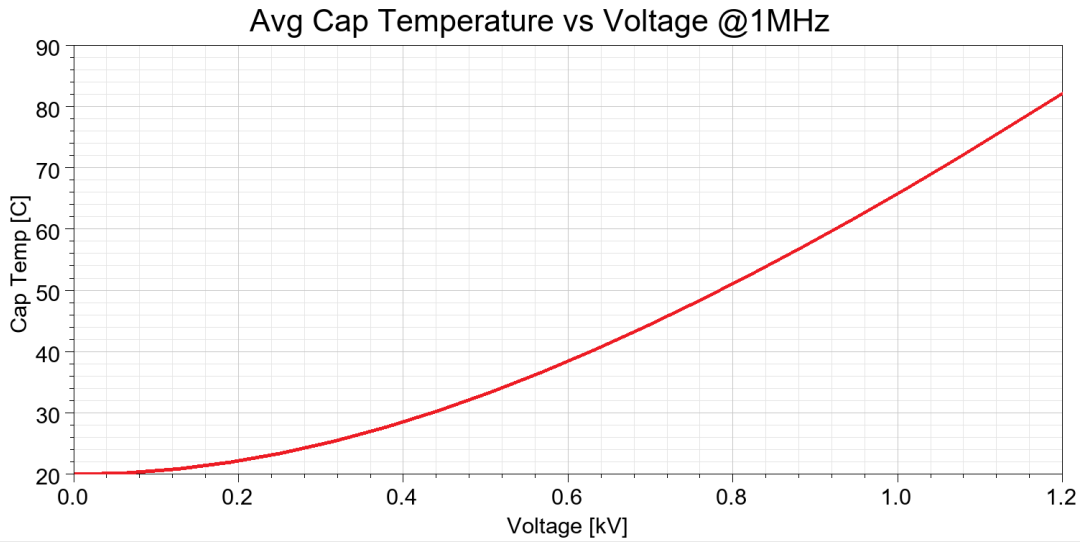
- DC solvers: Capacitance and Inductance
  - Provide generally easy & fast simulations and reliable low frequency values
  - No Self Resonance extraction as Capacitance and Inductance are solved independently
- AC solvers: Coupled E & H Fields
  - Provide fast simulations and accurate dispersive values across spectral domain
  - Successfully extract self-resonances
  - Note the self-resonance ~7GHz for this Capacitor

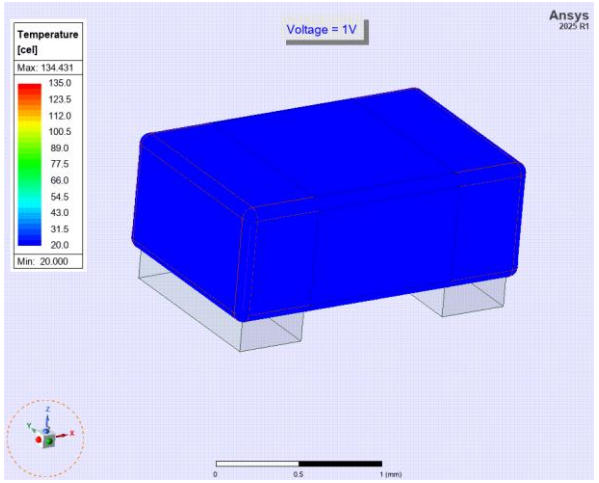


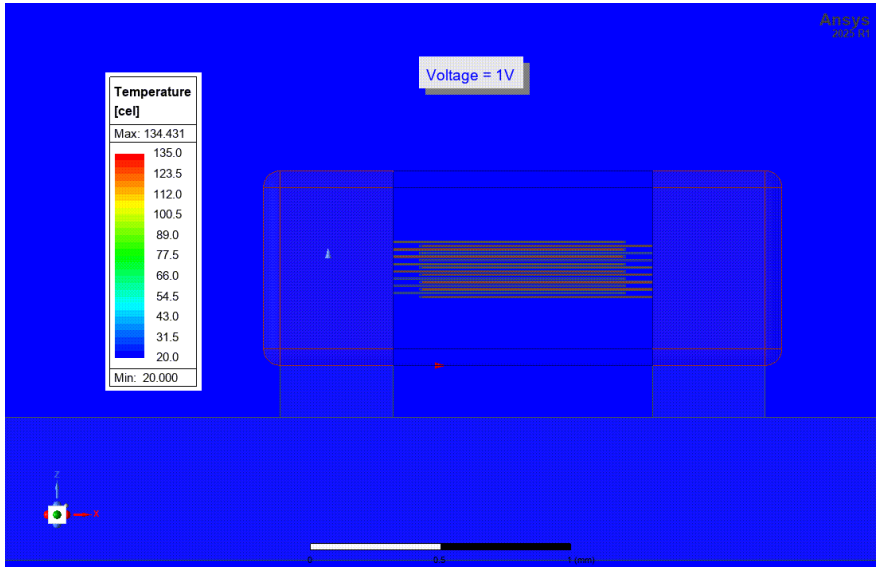


Thermal Simulation

- Accurate thermal simulations are necessary for a wide array of requirements
  - Solving SteadyState thermal for this Capacitor
- This simulation loads the capacitor with increasing distributed loss loads from the electrical simulation
  - The Power loss densities [Volume & Surface] are mapped as initial conditions
  - Using a Computational Fluid Dynamic solver, the accurate convection is captured for accurate temperature
- Note that resulting temperature is non-uniformly distributed

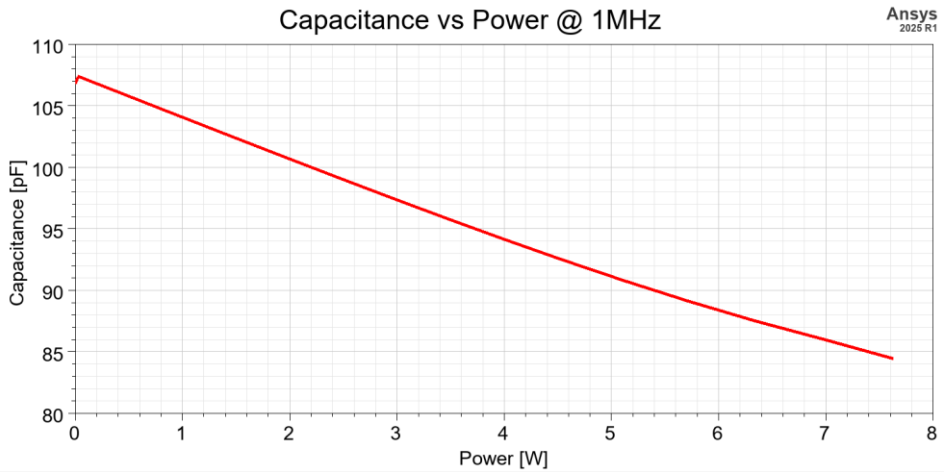


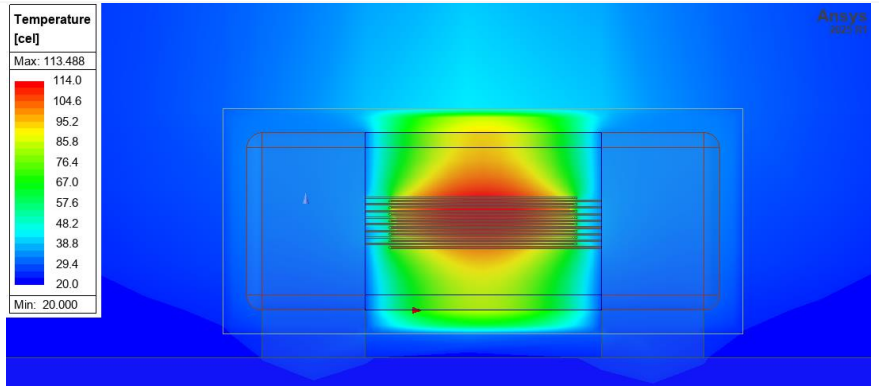


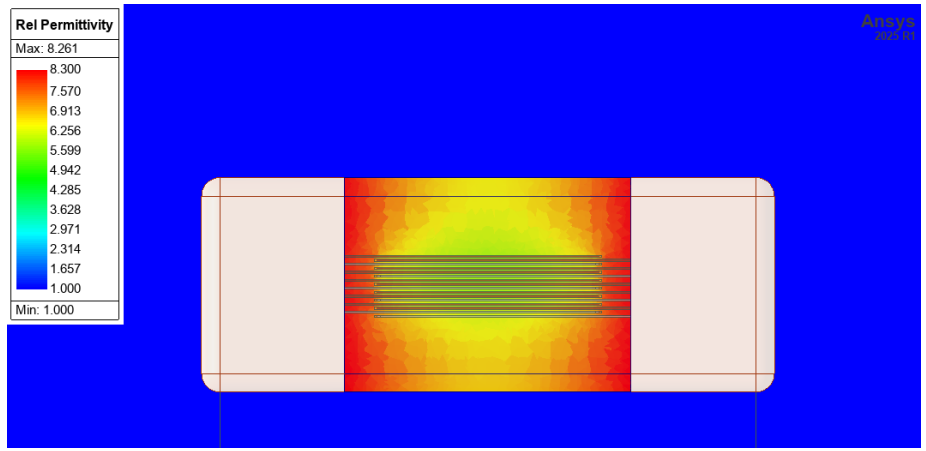


Electrothermal Simulation

- Material Electrical properties are inherently dispersive with temperature
  - Requires an electrothermal analysis
    - In this case, a power source varying to 7.6W
    - One expects Capacitance to decrease as temperature increases
      - Ceramic atomic Lattice spacing will increase with temperature, causing permittivity to decrease
    - This simulation spatially varies the material's electrical properties non-uniformly based on the temperature distribution and re-simulates EM to recompute the capacitance at this operating temperature
      - This simulation shows 6.6W load @ 1MHz

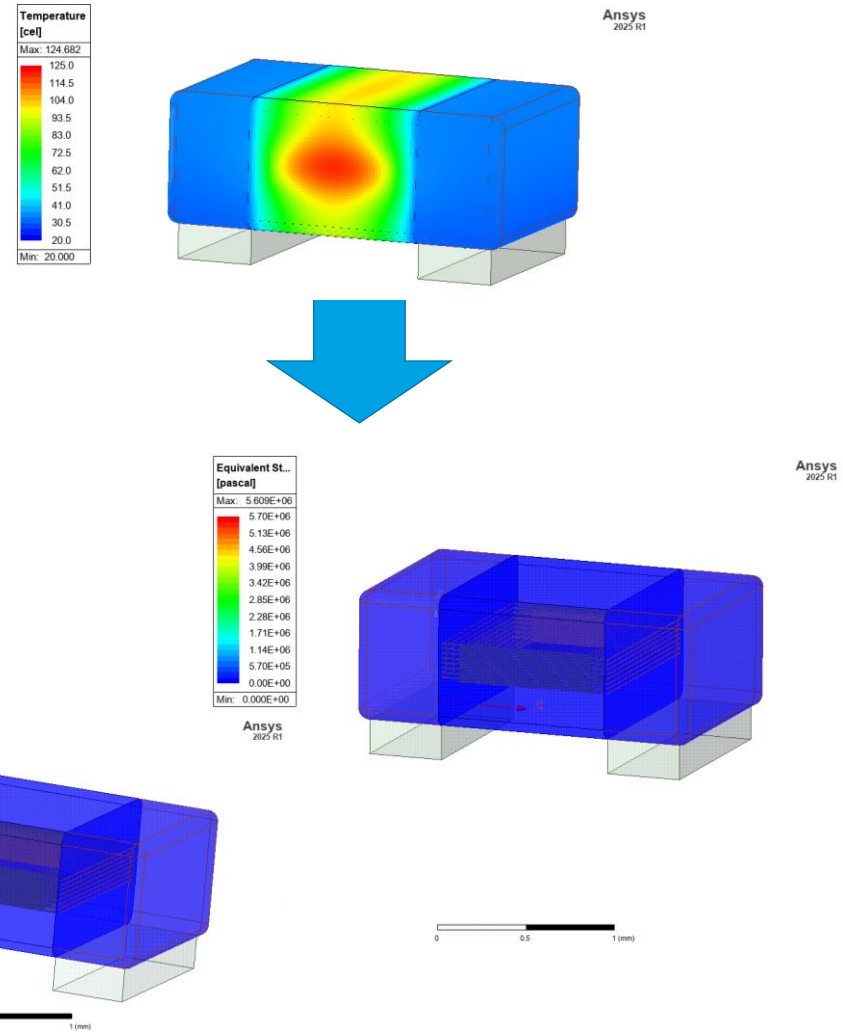






CTE Deformation Simulation

- Coefficient of Thermal Expansion due to Thermal
  Load simulations
  - Important to ensure material properties are
    both thermally and structurally matched for
    maximum integrity
- This simulation takes the spatially varying temperature with a 7.6W load @ 1MHz and
  maps this as an initial condition
- Resulting stress, strain & deformation analysis



Powering Innovation That Drives Human Advancement

Multiphysics Simulation for Capacitors… The Why


Ansys

Summary

Component engineering is a critical function

CE job requirements are driven by technology, design trends and regulations

CE function will be relied upon massively in 2025 & beyond