A Common Approach to Characterizing Electronic Components for Demanding Applications

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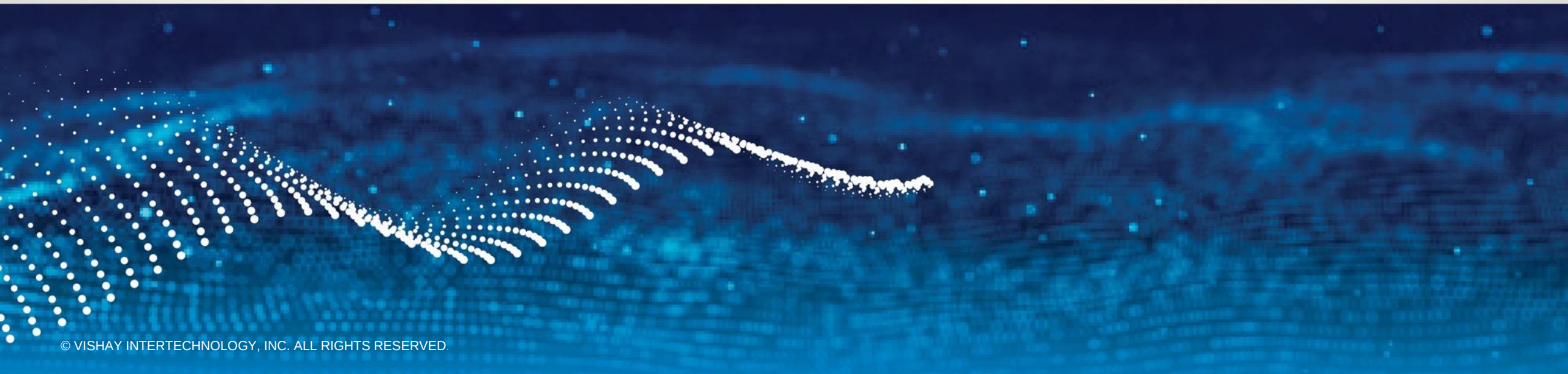


Two Approaches to Device Characterization

Process Driven (Automotive)

- Qualify to a general specification (AEC-Q200)
- Look for process drifts (e.g. SPC)
- Maverick lot detection and response
- Periodic process audits
- Lower cost

Product Driven (MIL spec)

- Driven by a central specification per product for all suppliers
- Defined qualification process
- Defined testing per lot
- Defined reporting per lot
- Higher cost
- Extended per lot testing time

Product Pyramid: “Performance is Paramount”

MIL-123

MIL-PRF-123

Established reliability

Extended qualification (4000 h)

Lot release life test

100% acoustic scan

CDR Series

CDR (MIL-PRF-55681)

Established reliability

Limited sources for 0402 and 0603 body sizes

DSCC Drawings

Broader Product Offering

Includes RF MLCCs (05001, 05002, 05003)

Hi-Reliability

Supplier Specific

Robust Designs / High Reliability

Leverage qualifications from above

Widest product offering

Customer specific products

Tin/Lead Automotive

Limited Suppliers

AEC-Q200 Certification

Sn-Pb termination finish

Whisker prevention

Reliable performance

VISHAY

The DNA of tech.™

Is There a Common Approach?

- How can we bridge differences in “high reliability” products from different suppliers?
- Could a unified test protocol work?
- Is MIL-PRF-38534 Element Evaluation an option?

MIL-PRF-38534, Table C-III-1 Class H

TABLE C-III-1. Capacitors, Ceramic. 1/ 2/

Subgroup	Class		Test	Standard or Specification	Method	Condition	Comments	Quantity	Reference paragraph MIL-PRF-38534
	K	H						(accept number)	
1	X	X	Element Electrical	MIL-PRF-38534			25C	100%	C.3.4.1
2		X	Visual Inspection 3/	MIL-STD-883	2032	H		22 (0)	C.3.4.2
	X			MIL-STD 883	2032	K		100%	
				MIL-PRF-123			Appendix B (Chips)		
				MIL-PRF-49470			Para. 3.8 & 4.8.3 (Stacked)		
	X		Prohibited Material Inspection	MIL-STD-1580	Reqmt. 9.		Insure body (electrodes) & termination inspected for prohibited material.	5 (0)	
	X	X	Device Finish 4/	MIL-PRF-38534				5 (0)	
3	X		Thermal Shock/Temperature Cycle 5/	MIL-STD-202	107	B	20 cycles (-55C to +125C)	100%	C.3.4.3
				MIL-STD-883	1010	C	20 cycles (-65C to +150C)	100%	
	X	X	Device Finish 4/	MIL-PRF-38534				5 (0)	
3		X	Dielectric Withstanding Voltage 3/ 7/	MIL-PRF-123	Para. 3.13		DC rated voltages: >500V ≤ 1000V dc test at 150% min <500Vdc test at 250% min.	10 (0)	
				MIL-PRF-49470	Para. 3.11				
		X	Insulation Resistance 3/ 7/	MIL-PRF-123	Para. 3.14		Room	10 (0)	
				MIL-PRF-49470	Para. 3.10				

MIL-PRF-38534, Table C-III-1 Class H

TABLE C-III-1. Capacitors, Ceramic - Continued. 1/ 2/

Subgroup	Class K	Class H	Test	Standard or Specification	Method	Condition	Comments	Quantity (accept number)	Reference paragraph MIL-PRF-38534
3		X	Capacitance 3/ 7/	MIL-PRF-123	Para. 3.11			10 (0)	
				MIL-PRF-49470	Para. 3.13				
		X	Dissipation Factor 3/ 7/	MIL-PRF-123	Para. 3.12			10 (0)	
				MIL-PRF-49470	Para. 3.12				
4 8/	X	X	Wire Bond Evaluation	MIL-STD-883	2011		Where applicable	10 (0) wires or 20 (1) wires	C.3.4.3 C.3.4.6
	X	X	Solderability	MIL-STD-202	208		Where applicable	K- 10 (0), or 20	
				MIL-STD-883	2003				

TABLE C-III-1. Capacitors, Ceramic - Continued. 1/ 2/

1/ Base Metal Electrode (BME) Capacitors used in Class H hybrid devices shall be evaluated in accordance with MIL-PRF-32535. BME capacitors used in Class K hybrid devices shall be evaluated in accordance with MIL-PRF-32535 product level T.

2/ Evaluation in accordance with this table is not required for elements procured as MIL-PRF-123, MIL-PRF-32535 product level T, MIL-PRF-49470 product level T, or MIL-PRF-55681 with Established Reliability failure rate S.

3/ Where MIL-PRF-123 and MIL-PRF-49470 are identified, use of either specification is acceptable. However, remain consistent in selection and use the standard to which the part was made. If MIL-PRF-49470 is used to evaluate Class K elements, then testing shall be in accordance with product level T requirements.

4/ Using a recognized methodology (e.g. method 2037 of MIL-STD-883, JESD-213) verify that finishes containing Tin (Sn) have a minimum of 3% Lead (Pb) by weight per MIL-PRF-38534.

5/ Either test method is acceptable.

6/ Utilize a methodology equivalent to or better than that which is specified in MIL-PRF-123 para. 4.6.1. For stacked components Acoustic Imaging must be done on individual pre-stacked components.

7/ Higher voltage devices (>250V) which are not covered by MIL-PRF-123 or MIL-PRF-49470 shall be examined under the rules established in MIL-PRF-49470.

8/ Testing is destructive.

9/ Interim and Final measure - Capacitance, Insulation Resistance and Dissipation Factor at 25C, Insulation Resistance at 125C.

10/ Consult manufacturer for case sizes not addressed in MIL-PRF-123 or MIL-PRF-49470.

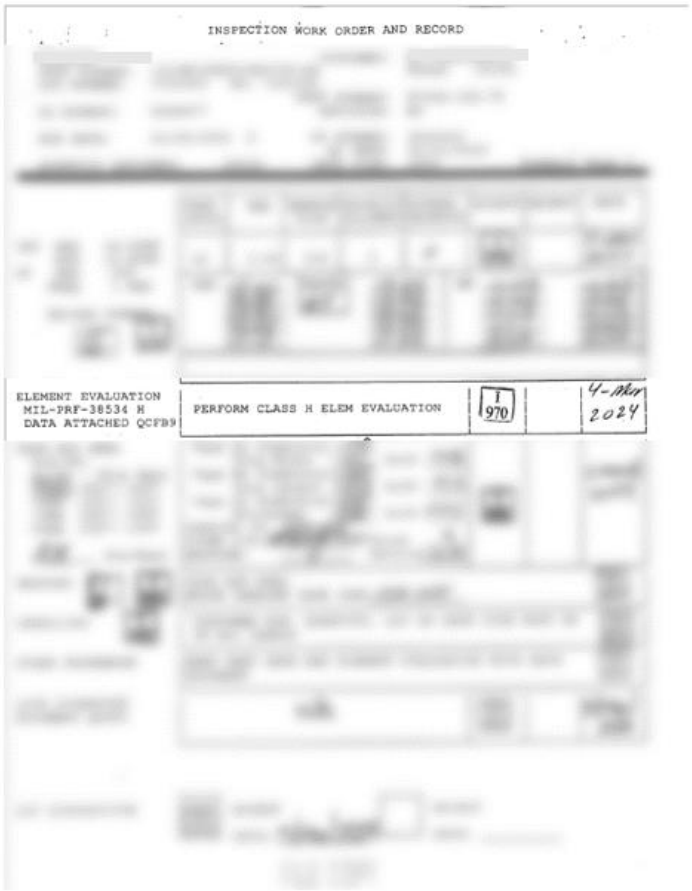
11/ This test is not required to be performed in sequence

12/ Use sample sizes specified in MIL-PRF-123 Table XVII for group 1.

Use of MIL-PRF-38534, Class H Element Evaluation Exists Now

Lot Paperwork Example


INSPECTION WORK ORDER AND RECORD


INSPECTION WORK ORDER AND RECORD

ELEMENT EVALUATION MIL-PRF-38534 H DATA ATTACHED QCFB9

PERFORM CLASS H ELEM EVALUATION


ELEMENT EVALUATION MIL-PRF-38534 CLASS H

Use of MIL-PRF-38534, Class H Element Evaluation Exists Now

Catalog Offering – Supplier P “HR Caps”

High Reliability "HR" Capacitors

For applications where reliability, but not full military screening is required, Presidio recommends its high reliability "HR" capacitors. The "HR" code signifies use of the test program below, or the use of a customer Source Control Document (SCD) that includes voltage conditioning.

Quality Assurance Provisions
Every lot undergoes the following inspection and tests:

- **Voltage Conditioning:** All parts receive a voltage conditioning at 2X rated voltage and 125°C for a minimum of 8 hours. An accelerated voltage conditioning, following MIL-PRF-55681 guidelines, may be used at Presidio's discretion.
- **Capacitance:** All parts are tested at 25°C and 1VACRMS in accordance with Method 305 of MIL-STD-202.
- **Dissipation Factor (DF):**

Voltage Rating	NPO	BX	X7R	Y5V
10	N/A	2.5%	5%	10%
16 / 25	.15%	2.5%	3.5%	7%
≥ 50	.15%	2.5%	2.5%	5%

- **Dielectric Withstanding Voltage (DWV):** All parts are tested at 2.5X rated voltage in accordance with Method 301 of MIL-STD-202, or according to EIA/MIL Standards.
- **Insulation Resistance (IR @ 25°C):** All parts are tested at 25°C and rated voltage in accordance with Method 302 of MIL-STD-202. The minimum IR required is 100,000 megohms or 1,000 megohm-microfarads.
- **Visual:** Performed on pieces in accordance with Presidio internal workmanship criteria.
- **Mechanical:** Level 1 AQL 1% in accordance with Presidio's catalog.
- **Element Evaluation (optional):** A MIL-PRF-38534 Appendix C Passive Element Class H element evaluation is available where the customer requires this testing. Element evaluation is not required on each lot, and must be specified on the purchase order.
- **Operating Temperature Range:** -55°C to +125°C

Certificate of Compliance:

- A Certificate of Compliance will be sent with each shipment.

- **Element Evaluation (optional):** A MIL-PRF-38534 Appendix C Passive Element Class H element evaluation is available where the customer requires this testing. Element evaluation is not required on each lot, and must be specified on the purchase order.

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Use of MIL-PRF-38534, Class H Element Evaluation Exists Now

Catalog Offering – Supplier V, “Hi-Rel”

ORDERING INFORMATION

VJ1206	Y	104	J	L	A	A	T	### (2)
CASE CODE	DIELECTRIC	CAPACITANCE NOMINAL	CAPACITANCE TOLERANCE	TERMINATION	DC VOLTAGE RATING (1)	MARKING	PACKAGING	PROCESS CODE
0402 0603 0805 1206 1210 1808 1812 1825 2220 2225 3640	A = C0G (NP0) G = X5R Y = X7R	Expressed in picofarads (pF). The first two digits are significant, the third is a multiplier. **Examples:** 1R0 = 1.0 pF 103 = 10 000 pF 104 = 100 000 pF	C = ± 0.25 pF D = ± 0.50 pF F = ± 1 % G = ± 2 % H = ± 3 % J = ± 5 % K = ± 10 % M = ± 20 % **Note:** C0G (NP0): C, D < 10 pF F, G, H, J, K ≥ 10 pF X7R, X5R: J, K, M	X = Ni barrier 100 % tin plated L = Ni barrier with tin lead plated finish min. 4 % lead F, E = AgPd (3)	Y = 6.3 V Q = 10 V J = 16 V X = 25 V A = 50 V B = 100 V C = 200 V P = 250 V E = 500 V N = 600 V	A = unmarked	C = 7" reel / paper tape T = 7" reel / plastic tape J = 7" reel (low quantity) P = 11 1/4" / 13" reel / paper tape R = 11 1/4" / 13" reel / plastic tape O = 7" reel / flamed paper tape I = 11 1/4" / 13" reel / flamed paper tape **Note:** “I” and “O” are used for “E” and “F” terminations, sizes 0402 / 0603 / 0805	68, 5G, 2L, 2M, 2MP, CLH

Notes

(1) DC voltage rating should not be exceeded in application. Other application factors may affect the MLCC performance. Consult for questions: mlcc@vishay.com

(2) **68:** MIL-PRF-55681 Group A C of I, subgroups 1, 2, 4 attribute data provided with shipment. ***No Group C testing performed***
5G: Voltage conditioning only. Generic CoC (no data)
2L: MIL-PRF-55681 Group A C of I, provided with shipment.
Group C testing is performed based on MIL-PRF-55681 periodic maintenance schedule. ***No Group C data provided***
2M: MIL-PRF-55681 Group A, subgroups 1, 2, 4. Group A subgroups 1, 2, 4 attribute data provided with shipment.
MIL-PRF-55681 Group C, testing subgroups 1, 2, 3, 5 is performed on each lot. Shipment held until tests are complete.
No Group C data provided
2MP: MIL-PRF-[illegible] ute data provided with shipment.
MIL-PRF-55681 Group C, testing subgroups 1, 2, 3, 5 performed on each lot. Shipment held until tests are complete.
Group C test summary data is included with shipment (fee applies)
CLH: 100 % voltage condition. Tested and inspected in accordance with MIL-PRF-38534, Table C-III-1 Class H

(3) Termination code “E” is for conductive epoxy / reflow assembly
Termination code “E” is for conductive epoxy assembly only

Use of MIL-PRF-38534, Class H Element Evaluation Exists Now

Catalog Offering – Supplier V, “Lead-Bearing, Automotive Grade”

ORDERING INFORMATION

VJ0805	Y	102	K	L	A	A	C	32 (3)
CASE CODE	DIELECTRIC	CAPACITANCE NOMINAL CODE	CAPACITANCE TOLERANCE	TERMINATION	DC VOLTAGE RATING (1)	MARKING	PACKAGING	PROCESS CODE
0402 0603 0805 1206 1210	A, D = C0G (NP0) (2) Y = X7R	Expressed in picofarads (pF). The first two digits are significant, the third is a multiplier. An “R” indicates a decimal point. **Examples** 4R7 = 4.7 pF 102 = 1000 pF	B = ± 0.10 pF C = ± 0.25 pF D = ± 0.5 pF F = ± 1 % G = ± 2 % J = ± 5 % K = ± 10 % M = ± 20 % **Note** C0G (NP0): B, C, D < 10 pF F, G, J, K ≥ 10 pF X7R: J, K, M	L = Ni barrier with tin lead plated finish min. 4 % lead	J = 16 V X = 25 V A = 50 V B = 100 V C = 200 V P = 250 V E = 500 V L = 630 V	A = unmarked	T = 7" reel / plastic tape C = 7" reel / paper tape J = 7" reel (low quantity) R = 11 1/4" / 13" reel / plastic tape P = 11 1/4" / 13" reel / paper tape	

Notes

(1) DC voltage rating should not be exceeded in application. Other application factors may affect the MLCC performance. Consult for questions: mlcc@vishay.com

(2) Consult Selection Chart table for correct dielectric code

(3) **32** = AEC-Q200 qualified with tin / lead termination finish

32H = AEC-Q200 qualified with tin / lead termination finish and tested and inspected in accordance with MIL-PRF-38534, Table C-III-1 Class H

Conclusion

- Historically, high-rel products have been supplied to a central specification
  - Same qualification process, testing, and reporting across all suppliers
  - This works, but could be a costly solution with long lead-times
  - Outside these specifications, products have different characteristics
- Basing the level on a process basis is an option
  - Shorter lead-times and less costly solutions
- There still seems to be a request for common testing
- A common approach across all suppliers could be MIL-PRF-38534 Element Evaluation

THANK YOU