CAPACITOR BASICS VI – Testing / Screening Requirements

Introduction

Ceramic capacitors are considered to be highly reliable, effective components, which offer a number of advantages compared to other capacitor technologies and as such are often employed in a wide variety of extremely demanding applications. That said, like all manufacturing environments, there tends to be a certain amount of variation inherent to the process that will result in differences in the performance characteristics of each device. In truth, even though a lot of capacitors may have been manufactured at precisely the same time, using the same batch of material, tooling and equipment, no two capacitors within that lot are "exactly" the same. Fortunately their differences tend to be inconsequential and certainly well within the acceptable limits of the system or application for which they are intended.

So if manufacturing operations for ceramic capacitors tend to produce highly consistent results, why test at all? There are in fact several reasons, not the least of which would be to ensure that the theoretical design meets customer expectations. In addition, it is important to ensure that some unintended process variable has not inadvertently been introduced to the system, which could alter the anticipated result. Testing also provides confirmation that the materials used to manufacture the capacitor are within specification and that the equipment will operating properly.

Beyond the typical design / process monitors mentioned above, the level to which a capacitor may be inspected and the types of testing utilized are often based on the application for which they are intended. Commercial applications for example are much more inclined to weigh cost above all other factors and as such might limit inspection to a basic outgoing quality test sequence. At the other end of the spectrum, Space level applications are much more inclined to emphasize reliability over price and consequently these types of requirements often include an extensive inspection sequence including Pre-production Qualification testing, In-Process inspection, Group A acceptance testing and ongoing Group B or C retention testing. Some of the more common approaches to inspection are shown in Table I.

The following application note outlines the various test and inspection sequences commonly used for assessing the acceptability of ceramic capacitors. It defines the fundamental intent and basic procedural details of each step and provides generally accepted industry limits for each test. Additional details can be found by referring to the following specifications which formed the basis for this Application Note:

- **MIL-PRF-49467** - Capacitor, Fixed, Ceramic, Multilayer, High Voltage (General Purpose), General Specification for
- **MIL-PRF-39014 -** Capacitor, Fixed, Ceramic Dielectric (General Purpose) Established Reliability and Non-established Reliability, General Specification for
- **MIL-PRF-55681** - Capacitor, Chip, Multiple Layer, Fixed, Ceramic Dielectric, Established Reliability and Non-Established Reliability, General Specification for
- **MIL-PRF-123** - Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability, General Specification for
- **MIL-STD-202** -Test Method Standard, Electronic and Electrical Component Parts
- **EIA-RS-469** – Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors

Table I – Inspection Requirements

Common Test & Inspection Requirements				
In-Process	**Basic Outgoing**	**Group A**	**Group B**	**Qualification**
Dielectric Withstanding Voltage	Dielectric Withstanding Voltage	Thermal Shock	Solderability	Thermal Shock
Insulation Resistance @ +25ºC	Insulation Resistance @ +25ºC	Voltage Conditioning	Low Temperature Storage	Voltage Conditioning
Capacitance	Capacitance	Insulation Resistance @ +125ºC	Voltage – Temperature Coefficient	Insulation Resistance @ +125ºC
Dissipation Factor	Dissipation Factor	Dielectric Withstanding Voltage	Vibration – High Frequency	Dielectric Withstanding Voltage
Visual Inspection	Visual Inspection	Insulation Resistance @ +25ºC	Immersion	Insulation Resistance @ +25ºC
Mechanical Inspection	Mechanical Inspection	Capacitance	Shock – Specified Pulse	Capacitance
		Dissipation Factor	Resistance to Solder Heat	Dissipation Factor
		Visual Inspection	Moisture Resistance	Visual Inspection
		Mechanical Inspection	Resistance to Solvents	Mechanical Inspection
			Life Test	Solderability
				Low Temperature Storage
				Voltage – Temperature Coefficient
				Vibration – High Frequency
				Immersion
				Shock – Specified Pulse
				Resistance to Solder Heat
				Moisture Resistance
				Resistance to Solvents
				Life Test
Additional Test & Inspection Requirements				
Destructive Physical Analysis		Solderability	Vibration – Random	Vibration – Random
Partial Discharge (Corona)		Partial Discharge (Corona)	Reverse Polarity	Reverse Polarity
Ultrasonic Examination		Ultrasonic Examination	Equivalent Series Resistance	Equivalent Series Resistance
Breakdown Voltage				Humidity - Steady State, Low Voltage

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Inspection and Test Definitions

- **Breakdown Voltage –** Breakdown voltage testing is a destructive test performed on a sample basis during the approval phase of a design, or as a means of certifying the basic insulative properties of materials received at incoming inspection. By applying DC voltage in increasing levels, the engineer is also able to verify process capability as it relates to published breakdown characteristics of the dielectric in volts per mil. In addition, this test allows one to gauge the margin of difference between specified breakdown limits and actual breakdown.

  Submersion in a non-contaminating dielectric fluid may be necessary for higher voltage test conditions, especially where surface clearance is minimal and the engineer is attempting to isolate the dielectric.

- **Capacitance –** The most basic characteristic of a capacitor, this test is performed to ensure that the component is in compliance with its specified value. Failure to meet its intended limits can result in unintentional or undesirable performance, especially in those applications where precision circuitry is required. This screen is generally performed at room temperature and a test frequency of 1 MHz for capacitance values of 100 pF or less and 1 kHz for those capacitance values greater than 100 pF.

- **Dissipation Factor (DF / tan δ) –** Dissipation factor or loss tangent is a measurement of dielectric losses within the capacitor. It can be used to differentiate the tendency of certain dielectric materials to absorb energy when an AC signal is applied. Where AC is applied, too high a DF can lead to excessive heating and a potentially shorter life for the device. This test is performed in conjunction with capacitance testing on the same equipment and under the same test parameters.

- **Destructive Physical Analysis (DPA) –** Utilized as a means of confirming the internal integrity of the capacitor, random samples are mounted in a suitable epoxy and cross-sectioned using a sequence of cutting, grinding and polishing methods. Once prepared for examination, an inspector can scrutinize the device for compliance with applicable sections of EIA-RS-469 and part specific design criteria.

- **Dielectric Withstanding Voltage (DWV) –** Also referred to as high potential (high pot) or dielectric strength test, DWV testing is performed to as a means to ensure that the capacitor cannot only operate safely at its intended operating voltage, but that it is also capable of withstanding momentary exposure to common conditions associated with switching, surges or other similar over potential conditions. This test is not intended to cause an electrical breakdown, but rather it serves as a means of determining whether the insulating materials and the design clearances utilized are sufficient enough to ensure proper operation.

  As a cautionary note, it should be pointed out that repeated application of the elevated test voltage may compromise the integrity of certain insulative materials resulting in a reduced performance margin. It is commonly acknowledged that DC test voltages present less risk than AC potentials, but regardless of which method is chosen, it is recommended that subsequent test be performed at a lower potential.

  Submersion in a non-contaminating dielectric fluid may be necessary for higher voltage test conditions, especially where surface clearance is minimal and the engineer is attempting to isolate the capacitor. Of course the use of a dielectric fluid to perform this test assumes that the end customer also intends to utilize a suitable conformal coating during final processing of the end product.

- **Equivalent Series Resistance (ESR) –** Limiting the ESR of a capacitor can be extremely important in a number of applications, especially in smoothing circuitry for switching and linear power supplies, where high levels of current are generally used. The value of a capacitor's ESR has a direct correlation to the amount of heat generated by that device and can play a significant role in the overall performance of the circuit. The temperature rise due to ESR needs to stay within the operational limitations of the capacitor, otherwise not only the capacitor, but the entire assembly may be at risk for damage.

- **Humidity, Steady State, Low Voltage –** This test is important as an accelerated means of evaluating the suitability of the capacitor for use in high humidity environments. Certain materials are sensitive to moisture and depending on their susceptibility to absorption and diffusion of water vapor, have a tendency to deteriorate rapidly when exposed to this type of environment. Absorption of moisture may, for example, initiate swelling of a hygroscopic material resulting in a weakened physical state, or it may deteriorate the electrical properties of the dielectric or other insulative materials used in the manufacture of the capacitor.

- **Immersion –** Immersion testing is performed as means of helping to determine the effectiveness of the seal in a capacitor, whether that seal is intended by design or mechanical integrity. Samples are evaluated by first immersing them into a fresh water or salt water bath, set at widely different temperatures. This exposure subjects the part to both thermal and mechanical stress conditions that will readily detect faulty construction and / or aggravate incipient defects, which under normal conditions might escape detection. Once immersion is complete, the samples are subjected to a visual examination and electrical inspection, where evidence of moisture penetration, corrosion of internal parts or lower insulation resistance would be of concern.

  The choice of fresh water or salt water is dependant on the type of component under test. Where post immersion electrical testing is utilized as a means of detection, the use of salt water tends to facilitate that process.

- **Insulation Resistance (IR) –** The intention of this test is to ensure that the capacitor does not exhibit unintended levels of leakage current that may, over time, lead to the deterioration of the capacitor or adversely affect the performance of the circuit. Measurements confirm the insulative properties of component materials utilized to manufacture the capacitor by applying a pre-defined level of DC voltage across the capacitor and then determining the amount of leakage current present within and / or on the surface of the device. Factors affecting Insulation Resistance measurements include temperature, humidity, surface oxidation or contamination, residual charges within the capacitor, the test voltage, previous conditioning of the device and electrification time.

  Insuring a sufficient electrification time is critical for capacitor IR measurements, inasmuch as when these devices are first exposed to test voltages they exhibit an instantaneously high leakage current, which over time decreases to a lower steady state level. The rate of decay is dependant on several factors including test voltage, temperature, insulating materials, capacitance and the external circuit load resistance. Attempting to accurately assess the Insulation Resistance characteristics of a

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capacitor may provide misleading or incorrect results if the device has not been adequately charged. With all other factors being equal, a capacitor with a lower capacitance value will achieve a steady state condition faster than a part with a higher capacitance value.

It is also important to note that although they are similar, Insulation Resistance testing is not considered to be the same as the Dielectric Withstanding Voltage test. A clean, dry capacitor may exhibit high levels of insulation resistance, but still fail DWV because of the presence of a mechanical fault. Conversely, a capacitor that fails IR due to substandard material insulative properties or external contamination, may not exhibit questionable performance when exposed to the higher voltage potential associated with DWV.

- **Life Test –** Life test is performed as part of initial qualification and retention testing and is intended as a means of predicting the life expectancy of a capacitor by charging the device to its maximum steady state voltage rating, while exposing it to an elevated ambient temperature for a predetermined length of time. Evidence of uncharacteristic or deteriorative behavior is generally monitored throughout the test and is inspected for upon completion through the use of visual examination, and a variety of electrical tests, including Insulation Resistance at both test and room temperature, DWV, Capacitance and Dissipation Factor.

  Results of this test often assume that the samples have first been subjected to a prescreen sequence which generally includes some level of Burn-In or Voltage Conditioning. Similar to Group A Inspection, these tests will identify for removal any questionable units or failures usually associated with process variation or improper handling. Today's processes tend to be very well defined, which limits the likelihood of encountering these types of failures, but if present, their numbers are usually low and are not generally indicative of overall lot reliability.

- **Low Temperature Storage –** Although specifications generally define an intended range of operating temperatures, capacitors may during storage, be exposed at times to temperatures that are outside of this range. Performance of this test helps to confirm that if a component is exposed to temperatures below the lower operating limit that they are not damaged and will function properly once the temperature has again been returned to the intended operating range.

  This test is not intended to be a thermal shock stress test. Rather it is performed by subjecting the capacitor to a steady state condition at a defined storage temperature for an extended period of time. Once the exposure period is complete the part is returned to room temperature and then examined for evidence of mechanical damage.

- **Shock, Specified Pulse –** This test is conducted as a means of gauging the suitability of components and capacitor assemblies for use in requirements where the device may be exposed to higher levels of mechanical shock as a result of rough handling or transportation, like those often associated with military or aerospace applications. Depending on the function of the device, either a half-sine or saw-tooth shock pulse waveform is specified.

- **Moisture Resistance –** Moisture Resistance testing is a very effective means for evaluating, in an accelerated manner, the resistive properties of capacitors and capacitor assemblies to the deteriorative effects of heat and high humidity conditions often associated with tropical environments. This test differs from Steady-State Humidity testing inasmuch as it provides for alternate periods of

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condensation and drying, which aids in the corrosion process and produces a breathing action which will draw moisture into a partially sealed device. The effectiveness of this test is also increased through the use of higher temperatures, which intensifies the effects of humidity.

This test also allows for the application of a polarizing voltage, which if certain conditions exist, can induce electrolysis, a reaction that can promote eventual dielectric breakdown or corrosion.

After final exposure, samples are allowed to dry for 24 hours at initial ambient conditions and are then subjected to visual inspection and electrical testing, which confirms their suitability for use in high humidity environments.

- **Partial Discharge (Corona) –** Partial discharge testing is a reliable means of detecting for removal capacitors that contain voids, cracks or delaminations and might warrant consideration as a screen for high voltage, system critical applications. Unlike low voltage ceramic capacitors that may operate reliably if they contain flaws, those same defects can become locations of very high electrical and mechanical stress when exposed to high voltage operating conditions and may lead to premature catastrophic failure.

Voids or inclusions within a solid insulating material like ceramic contain a gas and it is the electrical characteristics of this gas that allow for partial discharges to occur. The dielectric constant of the gas-filled void is considerably less than that of the surrounding dielectric and as such, those areas will exhibit a significantly higher electric field. If the voltage stress across the void is increased above the corona inception voltage (CIV) for the gas within the void, than a spark jumps the gap and partial discharge activity may be initiated.

Void or defect size has an impact on the amplitude of the discharge because two different conduction methods are involved. Very small or near microscopic voids exhibit low discharge intensities in the range of 10 pC (Pico Coulombs) and as such these events are characterized by a small spark or a single avalanche of short duration that is not considered detrimental to part reliability. Larger defects on the other hand, exhibit much higher discharge amplitudes at test voltages above the CIV and these discharges differentiate themselves as being the more destructive streamer type events, where a column or stream of charge occurs instead of a single spark.

Although the presence of corona can be detected by using either AC or DC testing, AC is generally the preferred method because in part it is a relatively faster test to perform, it provides for an increased stress level and it allows the examiner to define the discharge extinction voltage for the DUT. Typically a Partial Discharge test threshold of 100 pC or less, industry standard maximum test voltages of at least 320 V (Paschen's minimum) or 0.42 times the DC rating (whichever is greater) and exposure times of approximately 5 seconds or less, are needed to detect harmful defects in the capacitor, where the destructive streamer conduction mechanism will occur.

It should be pointed out that like most test methods employed for the purpose of screening high reliability capacitors, Partial Discharge testing does have certain limitations. Although it is an excellent tool for finding defects between electrodes, it cannot easily detect those same defects in cover sheets, end or side margins or areas near the end of electrodes in floating plate designs. With that in mind, this test sequence is often performed in conjunction with other screening methods like Ultrasonic Visual Examination.

- **Resistance to Soldering Heat –** This test is performed to determine whether the capacitor or capacitor assembly can withstand the effects of the heat to which they will be subjected during their intended soldering process (Ie, Solder reflow, soldering iron, solder dip or wave solder). Unless properly designed to meet their intended process conditions, heat encountered during soldering can adversely affect the electrical and mechanical integrity of the device by reflowing previous solder connections, loosening lead wires, softening insulation or coatings and fracturing the ceramic.

  The heat can be applied either by direct conduction through the termination, by radiation, which may be encountered when a sample is held in close proximity to a solder bath, or both. The solder dip method offers a close approximation to the radiated and conducted conditions encountered during wave soldering,

- **Resistance to Solvents –** Components utilized in electronic applications are quite often exposed to a variety of different solvents used to remove flux, fingerprints and other forms of contamination and this test is performed as a means of verifying that markings and / or color coding will not fade or discolor and render the marking illegible. In addition, this test helps to ensure that protective coatings and encapsulants will not degrade to the point where their electrical or mechanical integrity is compromised.

- **Reverse Polarity –** Although not widely used, this test can provide an effective and simple means of helping to gauge the quality of capacitors manufactured at a potential supplier. Unlike electrolytic capacitors, ceramic capacitors utilized in electronic equipment, are not generally considered to have positive and negative terminals, and as such can be connected with little regard to polarity. That said, a simple reversal of working voltage or DWV voltage can help to detect inconsistencies in a suppliers manufacturing process or problems with the capacitor design itself.

- **Solderability –** This test is performed to determine the suitability of all termination finishes intended for a soldering operation. During their manufacturing process components are exposed to varying levels of humidity and / or elevated temperatures and these conditions can affect the solderability of certain surfaces. Silver platings for example, tend to oxidize during the processing cycle and become less solderable than the original pre-processed surface.

  Solderability testing may require that the samples be preconditioned using a steam age process as defined in Military specifications, or the test may be limited to a simple dip test. Regardless of which approach is chosen, acceptability is verified through a post dip visual inspection that establishes a minimum acceptable coverage area.

- **Temperature Coefficient (TC) –** Dielectric materials utilized for the manufacture of ceramic capacitors exhibit a wide range of performance characteristics, one of which is a parametric change to its room temperature capacitance value when exposed to changes in operating temperature. Performance of this test would confirm that the dielectric type being used in fact meets its defined parameters for temperature coefficient of capacitance.

  Class I dielectrics like NPO (COG) are very stable materials, exhibiting a near linear variation in capacitance, which is generally small and often expressed as a change in "Parts per million per degrees centigrade" (PPM / ºC).

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Class II, Class III and Class IV dielectrics on the other hand, are less stable materials and the observed change in capacitance becomes increasingly significant. For these materials measurements are generally described as a percentage change from the +25ºC reference point. In addition, changes in capacitance do not show a linear progression when transitioned within their defined operating temperature range.

- **Terminal Strength –** This test is utilized as a means of verifying that the design of the terminals and the means by which they have been attached, can safely withstand one or more of the applicable mechanical stresses to which they may be subjected during installation or disassembly in equipment. Inability to meet these requirements may disclose or suggest inadequacies in workmanship, a faulty design, and / or a deficient method of attaching terminals to the body of the part, which could adversely affect the functionality of the terminals or the operation of the capacitor itself.

  Evidence of damage may be disclosed by mechanical distortion of the part, breaking of connections, cracking of coatings or encapsulants surrounding the terminals, and /or changes in electrical characteristics of the device. Confirmation of damage caused by this test may not become apparent until subsequent environmental tests are performed, such as seal, moisture resistance, or life.

- **Thermal Shock –** Thermal shock testing is intended as a means of gauging the ability of components to withstand exposure to high and low temperature conditions and the potential thermal shock associated with alternate exposure between these high and low extremes. This test is intended to simulate those conditions which may be encountered when equipment is transferred to and from heated shelters in arctic areas, or circumstances where equipment may be cycled between warmer and colder temperatures associated with changes in altitude.

  Although it is preferred that the test specimen reach thermal stability at the specified exposure temperature, this may be difficult for certain samples and the test results may be based on the minimum exposure period outline in the procedure.

  Fluctuations in temperature will result in changes in dimensions and physical characteristics of a material, which in itself may present concerns if the material is unable to safely accommodate those changes, but the combination of different material types in a design and their inherent differences in coefficient of thermal expansion may exacerbate any potential issues. Adverse effects of thermal shock include cracking and delamination of components, encapsulants and finishes, compromising of hermetic seals and potential changes in electrical or physical characteristics of the device.

- **Ultrasonic Examination –** This test provides a non-destructive means of performing internal examination and analysis of the capacitor. Several techniques are available for performing this screen with the most common method of examination being C-Mode Scanning Acoustic Microscopy. This inspection method is recognized as a reliable means of detecting internal defects within the capacitor body including microfractures, delaminations and voids.

- **Vibration – High Frequency –** Unless adequate preventative measures are taken in the design and fabrication of equipment intended for use in high vibration environments, systems may encounter undesirable operating characteristics, component fatigue or operational failure due to the possible loosening, wear or physical distortion of components. Although the types of vibration encountered in typical service conditions would not be of a simple harmonic nature, this test has proven to be a reliable means for establishing critical frequencies, modes of vibration and other important data necessary for implementing protective steps against the effects of vibration often encountered in applications involving aircraft, missiles and armored vehicles. Performance of this test will quantify the capacitors ability to forego vibration damage and successful completion validates the effectiveness of anticipatory measures utilized in the manufacturing of the device or system.

- **Vibration – Random –** This test is conducted for the purpose of determining the ability of a component to withstand the dynamic stress conditions exerted on a system when operated in modern field applications. Random vibration simulates a specific type of condition typically encountered in environments produced by missiles, high-thrust jets and rocket engines and as such, it is considered to be a more realistic approach to High Frequency Vibration. That said, the quality engineer may still want to consider the high frequency vibration test, or a combination of both, as the HF test may yield more pertinent design information.

- **Visual** / **Mechanical Inspection –** Visual and Mechanical inspection is utilized as a means of helping to confirm that the produced capacitors in fact meet the design requirements of the applicable specification. It addresses potential concerns regarding the choice of component materials, physical dimensions, construction, marking and workmanship by verifying compliance with the intended requirements.

  For the purpose of performing this test, it is generally assumed that a single inspection lot of capacitors have been manufactured from the same material batch, that components are drawn from the same inventory lot and that the same fixturing is utilized in the production of the units presented for examination. Consequently it is further assumed that acceptability or rejection of the inspection lot can be adequately assessed through examination of a random set of samples

- **Voltage Conditioning (Burn-In) –** Voltage Conditioning or Burn-In is recognized as an effective means of identifying for removal any questionable units or failures that may have been adversely affected by manufacturing extremes associated with process variation and /or improper handling.

  Specifications may have varying requirements depending on whether the capacitor is a low or high voltage device, but generally speaking this inspection is performed by charging the device to a defined steady state voltage, while exposing it to the maximum temperature rating for a predetermined length of time. Evidence of uncharacteristic or deteriorative behavior is generally monitored throughout the test and is inspected for upon completion through the use of visual examination, and a variety of electrical tests, including Insulation Resistance at both test and room temperature, DWV, Capacitance and Dissipation Factor.

  Today's processes tend to be very well defined and the likelihood of encountering these types of infant mortality failures is usually minimal, but if present their numbers tend to be low and not generally indicative of overall lot integrity. Certain specifications may impose a percentage limitation (PDA) which if exceeded would question the reliability of the lot and require further analysis and additional screening as a prerequisite for acceptability.

- **Voltage – Temperature Coefficient (VTC) –** Inasmuch as variations in temperature can alter the capacitance value for capacitors, the application of voltage bias can also influence the devices performance characteristics and as such these two parameters are often combined for the purpose of

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conducting a single test. The affect of voltage on Class I dielectrics is negligible, but for other Classes of dielectrics the application of increasing levels of voltage can result in a significant loss in capacitance values.

Although the temperature coefficient of capacitance is a fixed value and an inherent characteristic of each dielectric material, the designer does have the ability to limit the voltage coefficient portion of VTC by increasing the dielectric thickness and subsequently reducing the voltage stress across the dielectric layer(s). In fact, there are a number of specifications that define a maximum combined loss characteristic. BX dielectric for example, is an X7R dielectric defined as having a maximum VTC of +15 / -25% across the temperature range of -55 to +125ºC, while operated at maximum voltage rating.

Specification Test Requirements

The following tables summarize industry recognized test sequences utilized for the purpose of testing and / or qualifying ceramic capacitor products. Unfortunately, there is not one single specification that covers all variations but utilization of one or more of these specifications even in part, will help to validate the long term reliability of production units.

Catalog – Commercial Grade

Catalog Commercial Grade – Outgoing Test Sequence			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Dielectric Withstanding Voltage	MIL-STD-202, Method 301	2.5 × WVDC @ WVDC ≤ 500 VDC 1.5 × WVDC @ 501 VDC ≤ WVDC ≤ 1250 VDC 1.2 × WVDC > 1250 VDC	100%
Insulation Resistance @ +25ºC	MIL-STD-202, Method 302	WVDC or 500 VDC, W/E is less, 2 minutes	100%
Capacitance	MIL-STD-202, Method 305	1 MHz @ Cap ≤ 100 pF 1 kHz @ Cap > 100 pF	100%
Dissipation Factor	MIL-PRF-49467, Para. 4.8.4	1 MHz @ Cap ≤ 100 pF 1 kHz @ Cap > 100 pF	100%
Visual / Mechanical Inspection	Verification	Materials, Design, Construction, Workmanship, Marking, Dimensions	13 Samples Accept 0 / Reject 1 than 100%

Catalog – Commercial Grade Inspection Notes

- All samples subjected to electrical test shall meet requirements specified in catalog.

Catalog – Hi Reliability / Military Grade

Catalog High Reliability / Military Grade – Outgoing Test Sequence			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Thermal Shock	M202, Method 107, Cond A	5 cycles, Step 3 @ +125ºC	100%
Dielectric Withstanding Voltage	M202, Method 301	2.5 × WVDC @ WVDC ≤ 500 VDC 1.5 × WVDC @ 501 VDC ≤ WVDC ≤ 1250 VDC 1.2 × WVDC > 1250 VDC	100%
Burn-in / Voltage Conditioning	M49467, Figure 2	WVDC @ 125ºC & 96 Hours Minimum	100%
Insulation Resistance @ +25ºC	M202, Method 302	WVDC or 500 VDC, W/E is less, 2 minutes	100%
Capacitance	M202, Method 305	1 MHz @ Cap ≤ 100 pF 1 kHz @ Cap > 100 pF	100%
Dissipation Factor	M49467, Para. 4.8.4	1 MHz @ Cap ≤ 100 pF 1 kHz @ Cap > 100 pF	100%
Visual / Mechanical Inspection	Verification	Materials, Design, Construction, Workmanship, Marking, Dimensions	13 Samples Accept 0 / Reject 1 than 100%

Catalog – Hi Reliability / Military Grade Inspection Notes

- All samples subjected to electrical test shall meet requirements specified in catalog.

Catalog – Space Level Grade

Catalog High Reliability / Military Grade – Outgoing Test Sequence			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Thermal Shock	M202, Method 107, Cond A	5 cycles, Step 3 @ +125ºC	100%
Dielectric Withstanding Voltage	M202, Method 301	2.5 × WVDC @ WVDC ≤ 500 VDC 1.5 × WVDC @ 501 VDC ≤ WVDC ≤ 1250 VDC 1.2 × WVDC > 1250 VDC	100%
Burn-in / Voltage Conditioning	M49467, Figure 2	WVDC @ 125ºC & 96 Hours Minimum	100%
Insulation Resistance @ +25ºC	M202, Method 302	WVDC or 500 VDC, W/E is less, 2 minutes	100%
Capacitance	M202, Method 305	1 MHz @ Cap ≤ 100 pF 1 kHz @ Cap > 100 pF	100%
Dissipation Factor	M49467, Para. 4.8.4	1 MHz @ Cap ≤ 100 pF 1 kHz @ Cap > 100 pF	100%
Partial Discharge / Corona	M49467, Appendix B	CIV ≥(.42xWVDC) RMS @ 100pC	100%
Visual / Mechanical Inspection	Verification	Materials, Design, Construction, Workmanship, Marking, Dimensions	13 Samples Accept 0 / Reject 1 than 100%

Catalog – Space Level Grade Inspection Notes

- For system critical applications Ultrasonic Inspection (C-Sam) is recommended as an inprocess screen.

MIL-PRF-49467 – General Purpose High Voltage Ceramic Capacitors

MIL-PRF-49467 - Group A Inspection			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Thermal Shock - DWV	**M202, Method 107, Condition A** M202, Method 301	**5 cycles, Step 3 @ +125ºC** 2.5 × WVDC @ WVDC ≤ 500 VDC 1.5 × WVDC @ 501 VDC ≤ WVDC ≤ 1250 VDC 1.2 × WVDC > 1250 VDC	**100%** **10% PDA**
Burn-in / Voltage Conditioning - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M49467, Figure 2** M202, Method 302 M202, Method 302 M202, Method 305 M49467, Para. 4.8.4	**WVDC @ 125ºC & 96 Hours Minimum** WVDC or 500 VDC, W/E is less WVDC or 500 VDC, W/E is less 1 MHz @ Cap ≤ 100 pF or 1 kHz @ Cap > 100 pF 1 MHz @ Cap ≤ 100 pF or 1 kHz @ Cap > 100 pF	**100%** **10% PDA**
Partial Discharge / Corona	**M49467, Appendix B**	**Shall meet minimum CIV requirement** **CIV ≥(.42xWVDC) RMS @ 100pC**	**100%** **10% PDA**
Radiographic Inspection - Molded and Encapsulated only	**M202, Method 209** **M49467, Para 4.8.20**	**Molded / Encapsulated Only**	**Sample** **M49467 Table V**
Visual / Mechanical Inspection	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	**13 Samples** **Accept 0 / Reject 1 than 100%**
Solderability	**M202, Method 208**	**2 Terminals** **95% min coverage – Non concentrated**	**5 Samples** **Accept 0 / Reject 1**

Mil-PRF-49467 Group A Inspection Notes

- All samples subjected to electrical testing shall meet the minimum requirements specified in corresponding M49467 Slash Sheet
- Production lots exceeding a combined 10% DPA limit for the Thermal Shock, Burn-in / Voltage Conditioning and Partial Discharge test sequences constitutes total lot rejection. M49467 does not provide for the option of resubmitting to these test requirements.
- If a reject is found during initial sample inspection for Radiographic Inspection, Visual / Mechanical Inspection or Solderability, M49467 allows for the lot to be 100% screened, reinspected and / or reworked, to eliminate the defect. Reinspected / reworked lots are to be clearly identified and a second sample can be resubmitted to the test with the understanding that if a failure is encountered during the second inspection sequence, the lot shall be rejected without possibility for further resubmittal.
- M55681 allows for the deletion of Visual / Mechanical Inspection and Solderability provided an in-line or process control system for assessing and assuring these parameters can be validated and approved by the qualifying activity

MIL-PRF-49467 - Group B Periodic Inspection						
Subgroup	**Test Sequence**	**Procedure**	**Acceptance Criteria**	**Sample Size**	**Defectives Permitted**	
Subgroup 1 6 months	**Terminal Strength**	**M202, Method 211, Cond. A – 5 lbs**	**No evidence of mechanical damage**	12	1	1
	Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - DWV - Insulation Resistance +25ºC	**M202, Method 210, Cond. C - 260ºC** M202, Method 305 M49467, Para. 4.8.4 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** -1/+6% X7R / -1/+2% or 0.5pF COG Shall not exceed initial specification limits Shall meet specification requirement Shall meet initial +25ºC requirement			
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ±10% X7R / ±0.5% or 5pF COG Shall meet specification requirement ≥10% +25ºC requirement			
Subgroup 2 6 months	**Voltage – Temperature Limits**	**M49467, Para. 4.8.10.2** -55 to +125ºC	**COG @ 0 ppm / ºC ±30 ppm / ºC** **BR (X7R) @ +15/-40% @ WVDC** **BZ (X7R) @ +15/-45% @ 60% WVDC**	6	1	
	Low Temperature Storage	**M49467, Para. 4.8.19** -65ºC@ 8 hours	**No evidence of mechanical damage**			
	Marking Legibility (Laser only)	**M49467, Para. 4.8.1.1**	**Marking to remain legible**			
Subgroup 3 6 months	**Resistance to Solvents**	**M202, Method 215**	**No obliteration of marking**	4	1	
Subgroup 4 3 months	**Life Test** - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 108, WVDC, 2k hrs, 125ºC** M202, Method 302 M202, Method 302 M202, Method 305 M49467, Para. 4.8.4	**No mechanical damage / Marking legible** Not less than spec req't @ 0, 250, 1k & 2k hrs Not less than spec requirement ±20% X7R / ±3% or 0.5pF COG ≤3% X7R / 0.2% COG	10 Min per style	1	
	Partial Discharge (Corona)	**M49467, Appendix B** **CIV ≥(.42xWVDC) RMS @ 100pC**	**Shall meet minimum CIV requirement**			

MIL-PRF-49467 Periodic Group B Inspection Notes

- Samples shall be selected from lots that have passed Group A Inspection
- Samples to be representative of capacitor styles manufactured during selection period in approximate ratio of capacitors produced
- Delivery of production units is generally not delayed pending results of inspection
- In event of failure, manufacturer to notify qualifying source / customer of failure and take appropriate corrective action to eliminate root cause.
- Acceptance and shipment of product shall be discontinued until such time as corrective action has been implemented, and additional samples have been submitted to all of Group B or if permitted, specific Subgroup where failure occurred.

MIL-PRF-49467 - Qualification Inspection						
Group	**Test Sequence**	**Procedure**	**Acceptance Criteria**	**Sample Size**	**Defectives Permitted**	
Group I	**Thermal Shock** - DWV	**M202, Method 107, Condition A** M202, Method 301	**5 cycles, Step 3 @ +125ºC** Shall meet specification requirement	All Units	N/A	
	Burn-in / Voltage Conditioning - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M49467, Figure 2** M202, Method 302 M202, Method 302 M202, Method 305 M49467, Para. 4.8.4	**WVDC @ 125ºC & 96 Hours Minimum** Not less than spec requirement Not less than spec requirement Within the tolerance specified Shall not exceed the value specified			
	Partial Discharge / Corona	**MIL-PRF-49467, Appendix B** CIV ≥ (0.42xWVDC) RMS @ 100 pC	**Shall meet minimum CIV requirement**			
	Radiographic Inspection	**M202, Method 209, 10X Mag**	**Shall meet construction & workmanship**			
Group II	**Visual / Mechanical Inspection**	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	89	1	
	Capacitance	**M202, Method 305** 1 MHz @ Cap ≤100 pF 1 kHz @ Cap >100 pF	**Within tolerance specified**			
	Dissipation Factor	**M49467, Para. 4.8.4**	**Shall not exceed value specified**			
	Dielectric Withstanding Voltage	**M202, Method 301** 2.5 × WVDC @ WVDC ≤ 500 VDC 1.5 ×WVDC @ 501VDC ≤WVDC≤1250 VDC 1.2 × WVDC > 1250 VDC	**Shall meet specification requirement**			
	Insulation Resistance @ +25ºC	**M202, Method 302** WVDC or 500 VDC, W/E is less	**Not less than spec requirement**			
Group III	**Low Temperature Storage**	**M49467, Para. 4.8.19** -65ºC@ 8 hours	**No evidence of mechanical damage**	6	1	
	Solderability	**M202, Method 208**	**2 Terminals** **95% min coverage – Non concentrated**			
	Marking Legibility (Laser only)	**M49467, Para. 4.8.1.1**	**Marking to remain legible**			
Group IV	**Voltage – Temperature Limits**	**M49467, Para. 4.8.10.1** WVDC & -55 to +125ºC	**COG @ 0 ppm / ºC ±30 ppm / ºC @ WVDC** **BR (X7R) @ +15/-40% @ WVDC** **BZ (X7R) @ +15/-45% @ 60% WVDC**	12	1	1
	Vibration – High Frequency	**M202, Method 204, Cond D @ 200 VDC**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**			
	Immersion - DWV - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 104, Condition B** M202, Method 301 M202, Method 302 M202, Method 305 M49467, Para. 4.8.4	**No mechanical damage & marking legible** Shall meet specification requirement Shall meet initial +25ºC requirement ±10% X7R / ±0.5% or 5pF COG Shall not exceed initial limits			
Group V	**Shock – Specified Pulse**	**M202, Method 213, Cond. I**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**	12	1	
	Terminal Strength	**M202, Method 211, Cond. A – 5 lbs**	**No evidence of mechanical damage**			

	Resistance to Solder Heat	**M202, Method 210, Cond. C – 260ºC**	**No evidence of mechanical damage**			
	- Δ Capacitance	M202, Method 305	-1/+6% X7R / -1/+2% or 0.5pF COG			
	- Dissipation Factor	M49467, Para. 4.8.4	Shall not exceed initial specification limits			
	- DWV	M202, Method 301	Shall meet specification requirement			
	- Insulation Resistance +25ºC	MIL-STD-202, Method 302	Shall meet initial +25ºC requirement			
	Moisture Resistance	**M202, Method 106, 20 cyc, 100 V, 7b n/a**	**No evidence of mechanical damage**			
	- Δ Capacitance	M202, Method 305	±10% X7R / ±0.5% or 5pF COG			
	- DWV	M202, Method 301	Shall meet specification requirement			
	- Insulation Resistance	M202, Method 302	≥10% +25ºC requirement			
Group VI	**Fungus**	**M810, Method 508**		4	1	
	Resistance to Solvents	**M202, Method 215**	**No obliteration of marking**	6		
Group VII	**Life Test**	**M202, Method 108, WVDC 2k hrs, 125ºC**	**No mechanical damage / Marking legible**	48	1	1
	- Insulation Resistance +125ºC	M202, Method 302	Not less than spec req't @ 0, 250, 1k & 2k hrs			
	- Insulation Resistance +25ºC	M202, Method 302	Not less than spec requirement			
	- Δ Capacitance	M202, Method 305	±20% X7R / ±3% or 0.5pF COG			
	- Dissipation Factor	M49467, Para. 4.8.4	≤3% X7R / 0.2% COG			
	Partial Discharge / Corona	**MIL-PRF-49467, Appendix B** CIV ≥ (0.42xWVDC) RMS @ 100 pC	**Shall meet minimum CIV requirement**			

MIL-PRF-49467 Qualification Inspection Notes

- Reference MIL-PRF-49467 for additional details related to specific test requirements
- Radiographic Inspection is limited to molded and encapsulated styles only
- A sample unit having one or more defects shall be charged as a single defect
- Delivery of production units is generally not delayed pending results of inspection
- Certification of compliance for Fungus test is acceptable. If certification is provided total sample size is reduced to 85 pieces.
- Generally speaking qualification of a specific design extends by similarity qualification of other designs with the same dielectric material, same voltage rating and less than or equal to capacitance values.

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MIL-PRF-39014 – Established (ER) and Non Established (non-ER) Ceramic Capacitors

MIL-PRF-39014 - Group A Inspection			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Thermal Shock	**M202, Method 107, Condition A**	**5 cycles, Step 3 @ +125ºC**	**100%**
Burn-in / Voltage Conditioning - Insulation Resistance +125ºC - DWV - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M39014, Figure 2** M202, Method 302 M202, Method 301 M202, Method 302 M202, Method 305 M39014, Para. 4.7.4	**2.0 x WVDC @ 125ºC & 96 +4 / -0 Hours** WVDC@ 2 minutes max charge time 2.5 × WVDC @ 5 ± 1 sec WVDC@ 2 minutes max charge time 1 MHz @ Cap ≤ 100 pF or 1 kHz @ Cap > 100 pF 1 MHz @ Cap ≤ 100 pF or 1 kHz @ Cap > 100 pF	**100%** **8% PDA**
Radiographic Inspection	**M202, Method 209** **M39014, Para 4.8.20**	**Failure Rate Level S only**	**100%**
Visual / Mechanical Inspection	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	**Sample per M39014 Table IV** **Accept 0 / Reject 1 than 100%**
Solderability	**M202, Method 208**	**2 Terminals** **95% min coverage – Non concentrated**	**5 Samples** **Accept 0 / Reject 1**

Mil-PRF-39014 Group A Inspection Notes

- All samples subjected to electrical testing shall meet the minimum requirements specified in corresponding M39014 Slash Sheet
- M39014 allows for exclusion of Thermal Shock, Burn-in / Voltage Conditioning and Radiographic Inspection test sequences if manufacturer performs tests equal to or more stringent than those specified at an acceptance level that is equal to or more stringent than specified in M55681.
- Production lots exceeding the 8% DPA limit may be resubmitted to the Burn-in / Voltage Conditioning test sequence at 100% and a 3% PDA. Resubmitted lots must be clearly identified and failure to meet the reduced PDA limit constitutes total lot rejection,
- If a reject is found during initial sample inspection for Visual / Mechanical Inspection or Solderability, M39014 allows for the lot to be 100% screened, reinspected and / or reworked to eliminate the defect. Reinspected / reworked lots are to be clearly identified and a second sample can be resubmitted to the test with the understanding that if a failure is encountered during the second inspection sequence, the lot shall be rejected without possibility for further resubmittal.
- M39014 allows for the deletion of Visual / Mechanical Inspection and Solderability provided an in-line or process control system for assessing and assuring these parameters can be validated and approved by the qualifying activity

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MIL-PRF-39014 - Group B Periodic Inspection					
Subgroup	**Test Sequence**	**Procedure**	**Acceptance Criteria**	**Sample Size**	**Defectives Permitted**
Subgroup 1 2 months	**Voltage – Temperature Limits**	**M39014 Para. 4.7.9.2** -55 to +125ºC	**Limits ss defined in M39014 Slash Sheet**	18	1
	Vibration – High Frequency	**M202, Method 204, Cond D** **@ 125% × WVDC**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**		
	Immersion - DWV - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 104, Cond B** M202, Method 301 @ 2.5 × WVDC M202, Method 302 @ WVDC M202, Method 305 M39014, Para. 4.7.4	**No mechanical damage & marking legible** Shall meet specification requirement Shall meet initial +25ºC requirement ≤ ±10% Shall not exceed initial limits		
	Salt Atmosphere (Corrosion)	**M202, Method 101, Cond B**	**No mechanical damage & marking legible** **90% protected by finish**		
Subgroup 2 2 months	**Shock – Specified Pulse**	**M202, Method 213, Cond. I**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**	18	1
	Terminal Strength	**M202, Method 211,** Cond. A – 5 lbs & Cond C - 1 lbs Radial lead or Cond D Axial lead	**No evidence of mechanical damage**		
	Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - Insulation Resistance +25ºC	**M202, Method 210, Cond. B – 20 sec** M202, Method 305 M39014, Para. 4.7.4 M202, Method 302	**No evidence of mechanical damage** As defined in M39014 Slash sheet Shall not exceed initial specification limits Shall meet initial +25ºC requirement		
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance +25ºC	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ≤ ±10% Shall meet specification requirement ≥10% +25ºC requirement		
Subgroup 3 2 months	**Marking Legibility (Laser only)**	**M39014, Para. 4.7.1.1**	**Marking to remain legible**	4	0
	Resistance to Solvents	**M202, Method 215**	**No obliteration of marking**		
Subgroup 4 2 months	**Life Test @ 2 × WVDC** - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 108, WVDC, 4k hrs, 125ºC** M202, Method 302 M202, Method 302 M202, Method 305 M39014 Para. 4.7.4	**No mechanical damage / Marking legible** Not less than spec req't @ 0, 250, 1k & 2k hrs Not less than spec requirement As defined in M39014 Slash sheet ≤3% X7R / 0.2% COG	5 Min per style	M39014 Para 4.6.2.1.1.2

Mil-PRF-39014 Periodic Group B Inspection Notes

- Samples shall be selected from lots that have passed Group A Inspection
- Samples select for Subgroup 4, Life Test to be the highest capacitance value for each capacitor style manufactured during submission period.
- Delivery of production units is generally not delayed pending results of inspection
- In event of failure, manufacturer to notify qualifying source / customer of failure and take appropriate corrective action to eliminate root cause. Acceptance and shipment of product shall be discontinued until such time as corrective action has

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been implemented, and additional samples have been submitted to all of Group B or if permitted, specific Subgroup where failure occurred.

- M39014 allows for provision whereby certain tests can be discontinued or the selection frequency reduced if manufacturer can demonstrate test compliance for 5 consecutive submissions

MIL-PRF-39014 - Qualification Inspection

Group	Test Sequence	Procedure	Acceptance Criteria	Sample Size	Defectives Permitted	
Group I	**Thermal Shock**	**M202, Method 107, Condition A**	**5 cycles, Step 3 @ +125ºC**	All Units	N/A	
	Burn-in / Voltage Conditioning	**M39014, Figure 2**	**2 × WVDC @ 125ºC & 96 +4 / -0 Hours**			
	- Insulation Resistance +125ºC	M202, Method 302	Not less than spec requirement			
	- DWV	M202, Method 301	Shall meet specification requirement			
	- Insulation Resistance +25ºC	M202, Method 302	Not less than spec requirement			
	- Capacitance	M202, Method 305	Within the tolerance specified			
	- Dissipation Factor	M49467, Para. 4.8.4	Shall not exceed the value specified			
	Radiographic Inspection	**M202, Method 209, 10X Mag**	**Shall meet construction & workmanship**			
Group II	**Visual / Mechanical Inspection**	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	192	1	
	Capacitance	**M202, Method 305** 1 MHz @ Cap ≤100 pF 1 kHz @ Cap >100 pF	**Within tolerance specified**			
	Dissipation Factor	**M39014, Para. 4.7.4**	**Shall not exceed value specified**			
	Dielectric Withstanding Voltage	**M202, Method 301** 2.5 × WVDC @ 5 ± 1 sec	**Shall meet specification requirement**			
	Barometric Pressure	**M202, Method 105, Condition D – 100 VDC**	**No evidence Flashover or damage**			
	Insulation Resistance @ +25ºC	**M202, Method 302** WVDC	**Not less than spec requirement**			
Group III	**Low Temperature Storage**	**M39014, Para. 4.7.20** -65ºC@ 8 hours	**No evidence of mechanical damage**	6	1	1
	Solderability	**M202, Method 208**	**2 Terminals** **95% min coverage – Non concentrated**			
Group IV	**Voltage – Temperature Limits**	**M39014, Para. 4.7.9** WVDC & -55 to Max Operating temperature	**Limits ss defined in M39014 Slash Sheet**	18	1	
	Vibration – High Frequency	**M202, Method 204, Cond D** **@ 125% × WVDC**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**			
	Immersion	**M202, Method 104, Condition B**	**No mechanical damage & marking legible**			
	- DWV	M202, Method 301	Shall meet specification requirement			
	- Insulation Resistance +25ºC	M202, Method 302	Shall meet initial +25ºC requirement			
	- Δ Capacitance	M202, Method 305	≤ ±10%			
	- Dissipation Factor	M49467, Para. 4.8.4	Shall not exceed initial limits			
	Salt Atmosphere (Corrosion)	**M202, Method 101, Cond B**	**No mechanical damage & marking legible** **90% protected by finish**			

Group V	**Shock – Specified Pulse**	**M202, Method 213, Cond. I**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**	18	1	
	Terminal Strength	**M202, Method 211,** Cond. A 5 lbs & Cond C - 1 lbs Radial lead or Cond D Axial lead	**No evidence of mechanical damage**			
	Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - Insulation Resistance +25ºC	**M202, Method 210, Cond. B – 20 sec** M202, Method 305 M39014, Para. 4.7.4 M202, Method 302	**No evidence of mechanical damage** As defined in M39014 Slash sheet Shall not exceed initial specification limits Shall meet initial +25ºC requirement			
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ≤ ±10% Shall meet specification requirement ≥10% +25ºC requirement			
Group VI	**Fungus**	**M810, Method 508**		4	1	
	Resistance to Solvents	**M202, Method 215**	No obliteration of marking	6		
Group VII	**Life Test-** Accelerated @ 2× WVDC **Life Test -** Rated @ WVDC - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 108, WVDC, 1k hrs, 125ºC** **M202, Method 108, WVDC, 1k hrs, 125ºC** M202, Method 302 M202, Method 302 M202, Method 305 M39014 Para. 4.7.4	**No mechanical damage / Marking legible** **No mechanical damage / Marking legible** Not less than spec req't @ 0, 250, 1k & 2k hrs Not less than spec requirement As defined in M39014 Slash sheet ≤3% X7R / 0.2% COG	37 102	1	

MIL-PRF-39014 Qualification Inspection Notes

- Reference MIL-PRF-39014 for additional details related to specific test requirements
- A sample unit having one or more defects shall be charged as a single defect
- Delivery of production units is generally not delayed pending results of inspection
- Certification of compliance for Fungus test is acceptable. If certification is provided total sample size is reduced to 85 pieces.
- Life test sample size for accelerated conditions @ 37 pieces and for rated conditions @ 102 pieces.
- Sample units having been subjected to Life testing at accelerated conditions shall be continued on test for a total of 4000 hours.
- Sample units having been subjected to Life testing at rated conditions shall be continued on test for a total of 32,000 hours.
- Generally speaking qualification of a specific design extends by similarity qualification of other designs with the same dielectric material, same voltage rating and less than or equal to capacitance values.

MIL-PRF-55681– Established (ER) and Non Established (non-ER) MLC Capacitors

MIL-PRF-55681 - Group A Inspection			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Burn-in / Voltage Conditioning - DWV - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M39014, Figure 2** M202, Method 301 M202, Method 302 M202, Method 305 M55681, Para. 4.8.5	**2.0 x WVDC @ Max rated ºC & 100 +25 / -0 Hours** WVDC dependant – Ref M55681 Para 3.6.a WVDC @ 100,000 MΩ or 1000 MΩ - µF, W/E less 1 MHz BP & BG ≤ 1000 pF & BX ≤ 100 pF otherwise 1 kHz 1 MHz BP & BG ≤ 1000 pF & BX ≤ 100 pF otherwise 1 kHz	**100% 8% PDA**
Insulation Resistance +125ºC	**M202, Method 302**	**WVDC** BR, BX, BZ @ 10,000 MΩ or 100 MΩ - µF, W/E less BP @ 1,000 MΩ or 10 MΩ - µF, W/E less BG as specified	**M55681, Table X, Column A Accept 0 / Reject 1 than 100%**
Visual / Mechanical Inspection	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	**M55681, Table X, Column B Accept 0 / Reject 1 than 100%**
Equivalent Series Resistance - ESR (UHF) – When specified - ESR (RF) – When specified	**M55681, Appendix A** M55681, Para 4.8.7 M55681, Para 4.8.8	**Same ESR as equivalent nonleaded device**	**6 Samples Accept 0 / Reject 1**
Solderability	**M202, Method 208**	**2 Terminals Nonleaded @ 85% min coverage – Non concentrated Leaded @ 90% coverage – Non concentrated**	**13 Samples Accept 0 / Reject 1**

Mil-PRF-55681 Group A Inspection Notes

- All samples subjected to electrical testing shall meet the minimum requirements specified in corresponding M55681 Slash Sheet
- Specification allows for exclusion of Burn-in / Voltage Conditioning test sequence if manufacturer performs tests equal to or more stringent than those specified at an acceptance level that is equal to or more stringent than specified in M55681.
- Production lots exceeding the 8% DPA limit may be resubmitted to the Burn-in / Voltage Conditioning test sequence at 100% and a 3% PDA. Resubmitted lots must be clearly identified and failure to meet the reduced PDA limit constitutes total lot rejection,
- If a reject is found during initial sample inspection for Insulation Resistance @ +125ºC, Visual / Mechanical Inspection, Equivalent Series Resistance or Solderability, M55681 allows for the lot to be 100% screened, reinspected and / or reworked to eliminate the defect. Reinspected / reworked lots are to be clearly identified and a second sample can be resubmitted to the test with the understanding that if a failure is encountered during the second inspection sequence, the lot shall be rejected without possibility for further resubmittal.
- M55681 allows for the deletion of Visual / Mechanical Inspection and Solderability provided an in-line or process control system for assessing and assuring these parameters can be validated and approved by the qualifying activity

MIL-PRF-55681 - Group C Periodic Inspection

Subgroup	Test Sequence	Procedure	Acceptance Criteria	Sample Size	Defectives Permitted
Subgroup 1 6 months	**Temperature Coefficient Capacitance Drift**	**M55681, Para 4.8.20** -55 to +125ºC	**BG @ 90 ± 20 PPM / ºC** **BP @ 0 ± 30 PPM / ºC** **BR, BX, BZ @ ± 15%**	12	0
	Voltage – Temperature Limits	**M55681, Para 4.8.20** -55 to +125ºC	**BG @ 90 ± 20 PPM / ºC @ WVDC** **BP @ 0 ± 30 PPM / ºC @ WVDC** **BR @ +15/-40%, BX @+15/-25% @ WVDC** **BZ @ +15 / -45% @ 0.6 × WVDC**		
	Thermal Shock **Immersion** - DWV - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 107, Cond A** **M202, Method 104, Cond B** M202, Method 301 @ 2.5 × WVDC M202, Method 302 @ WVDC M202, Method 305 M55681, Para. 4.8.5	**5 cycles, Step 3 @ +125ºC** **No mechanical damage & marking legible** Shall meet specification requirement ≥30% initial requirement ±10% X7R / ±0.5% or 0.5pF BG/BP Shall not exceed initial limits		
Subgroup 2 6 months	**Resistance to Solder Heat** - Δ Capacitance - Dissipation Factor - Insulation Resistance +25ºC	**M202, Method 210, Cond. B /J – 20 sec** M202, Method 305 M55681, Para. 4.8.5 M202, Method 302	**No evidence of mechanical damage** M55681 Para 3.16 Shall not exceed initial specification limits Shall meet initial +25ºC requirement	12	0
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ±10% X7R / ±0.5% or 0.5pF BG/BP Shall meet specification requirement ≥30% initial requirement		
Subgroup 3 6 months	**Life Test @ 2 × WVDC** - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 108, WVDC, 2k hrs, 125ºC** M202, Method 302 M202, Method 302 M202, Method 305 M55681, Para. 4.8.5	**No mechanical damage / Marking legible** Not less than 30% spec req't @ 1k & 2k hrs Not less than 30% spec requirement ±10% X7R / ±2% or 0.5pF BG & BP ≤3% X7R / 0.2% BG/BP	25 Min per Style	M55681Para 4.7.1.2
Subgroup 4 Initial lot	**Terminal Strength - When Spec'd**	**M202, Method 211, Cond B – 5 Bends**	**No evidence of mechanical damage**	12	0
	Series Resonance -When Spec'd	**M55681, Para 4.8.20** 100 MHz to 10,000 MHz	**M55681, Para 3.21 & Figure 2**		
Subgroup 5 6 months	**Humidity, Steady State, Low Volt** - Insulation Resistance +25ºC - Δ Capacitance	**M202, Method 103, Cond A (85/85, 1.3V)** M202, Method 302 M202, Method 305	**No mechanical damage & marking legible** Shall meet initial requirement ±10% X7R / ±0.3% or 0.3pF BG/BP	12	0

Mil-PRF-55681 Periodic Group C Inspection Notes

- Samples shall be selected from lots that have passed Group A Inspection
- Samples select for Subgroup 4, Life Test to be the highest capacitance value for each capacitor style manufactured during submission period.
- Delivery of production units is generally not delayed pending results of inspection
- In event of failure, manufacturer to notify qualifying source / customer of failure and take appropriate corrective action to eliminate root cause. Acceptance and shipment of product shall be discontinued until such time as corrective action has been implemented, and additional samples have been submitted to all of Group B or if permitted, specific Subgroup where failure occurred.

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- M55681 allows for provision whereby certain tests can be discontinued or the selection frequency reduced if manufacturer can demonstrate test compliance for 5 consecutive submissions

MIL-PRF-55681 - Qualification Inspection

Group	Test Sequence	Procedure	Acceptance Criteria	Sample Size	Defectives Permitted
Group I	**Burn-in / Voltage Conditioning** - DWV - Insulation Resistance +125ºC - Capacitance - Dissipation Factor - Insulation Resistance +25ºC	**M39014, Figure 2** M202, Method 301 M202, Method 302 M202, Method 305 M55681, Para. 4.8.5 M202, Method 302	**2.0 x WVDC @ Max rated ºC & 100 +25 / -0 Hours** WVDC dependant – Ref M55681 Para 3.6.a WVDC @ 10,000 MΩ or 100 MΩ - µF, W/E less 1MHz BP/BG ≤ 1000 pF & BX ≤ 100pF otherwise 1 kHz 1MHz BP/BG ≤ 1000 pF & BX ≤ 100pF otherwise 1 kHz WVDC @ 100,000 MΩ or 1000 MΩ - µF, W/E less	85	N/A
	Equivalent Series Resistance - ESR (UHF) – Hi Freq only - ESR (RF) – Hi Freq only	**M55681, Appendix A** M55681, Para 4.8.7 M55681, Para 4.8.8	**Same ESR as equivalent nonleaded device**		
	DWV	**M202, Method 301**	**WVDC dependant – Ref M55681 Para 3.6.a**		
	Visual / Mechanical Inspection	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**		
Group II	**Solderability**	**M202, Method 208 – 2 Terms** Non-Leaded Leaded	**Meet minimum coverage requirement** 85% min coverage – Non concentrated 90% coverage – Non concentrated	6	1
Group III	**Voltage – Temperature Limits**	**M55681, Para 4.8.20** -55 to +125ºC	**BG @ 90 ± 20 PPM / ºC @ WVDC** **BP @ 0 ± 30 PPM / ºC @ WVDC** **BR @ +15/-40%, BX @+15/-25% @ WVDC** **BZ @ +15 / -45% @ 0.6 × WVDC**	18	
	Temperature Coefficient Capacitance Drift (Hi freq only)	**M55681, Para 4.8.20** -55 to +125ºC	**BG @ 90 ± 20 PPM / ºC** **BP @ 0 ± 30 PPM / ºC** **BR, BX, BZ @ ± 15%**		
	Thermal Shock **Immersion** - DWV - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 107, Cond A** **M202, Method 104, Cond B** M202, Method 301 @ 2.5 × WVDC M202, Method 302 @ WVDC M202, Method 305 M55681, Para. 4.8.5	**5 cycles, Step 3 @ +125ºC** **No mechanical damage & marking legible** Shall meet specification requirement ≥30% initial requirement ±10% X7R / ±0.5% or 0.5pF BG/BP Shall not exceed initial limits		
Group IV	**Resistance to Solder Heat** - Δ Capacitance - Dissipation Factor - Insulation Resistance +25ºC	**M202, Method 210, Cond. B /J** M202, Method 305 M55681, Para. 4.8.5 M202, Method 302	**No evidence of mechanical damage** ±10% X7R / ±0.5% or 0.5pF BG or -1.0 / +2.0% or 0.5 pF BP Shall not exceed initial specification limits Shall meet initial +25ºC requirement	9	
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ±10% X7R / ±0.5% or 0.5pF BG/BP Shall meet specification requirement ≥30% initial requirement	9	

Group V	Life Test @ 2 × WVDC - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	M202, Method 108, 2000 hrs, 125ºC M202, Method 302 M202, Method 302 M202, Method 305 M55681, Para. 4.8.5	No mechanical damage / Marking legible ≥30% spec req't @ 1k & 2k hrs ≥30% spec requirement ±10% X7R / ±2% or 0.5pF BG/BP ≤3% X7R / 0.2% BG/BP	25	M55681Para 4.7.1.2
Group VI	Fungus	M810, Method 508		6	
Group VII	Terminal Strength - When Req'd	M202, Method 211, Cond B 5 Bends	No evidence of mechanical damage	18	0
	Series Resonance -When Req'd	M55681, Para 4.8.20 100 MHz to 10,000 MHz	M55681, Para 3.21 & Figure 2		
Group VIII	Humidity, Steady State, LVolt - Insulation Resistance +25ºC - Δ Capacitance	M202, Method 103, Cond A - 85/85 M202, Method 302 M202, Method 305	No mechanical damage & marking legible Shall meet initial requirement ±10% X7R / ±0.3% or 0.3pF BG/BP	12	0

Mil-PRF-55681 Qualification Inspection Notes

- All sample units to be subjected to the Group I tests and then divided for balance of Groups II through VIII.
- All samples subjected to Group I electrical testing shall meet the minimum requirements specified in corresponding M55681 Slash Sheet
- Failures in excess of those allowed shall be cause for refusal to grant qualification.
- If Group VII Terminal Strength or Series Resonance is specified, Group I sample size to be increased to 103 pieces total
- ESR (UHF) is not applicable to high frequency styles with capacitance values less than 1 pF
- ESR (RF) is not applicable to high frequency capacitors
- Certification of compliance for Fungus test is acceptable. If certification is provided total sample size is reduced by 6 pieces.

MIL-PRF-123 – Temperature Stable and General Purpose High Reliability Capacitors

MIL-PRF-123 – In-Process Inspection			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Non Destructive Internal Exam	M123 Para 4.6.1, EIA-RS-469 Ultrasonic Examination	Cracks, Delaminations, Voids	100%
Pre-Termination DPA	M123 Para 4.6.2, EIA-RS-469	Cracks, Delaminations, Voids, Chip outs, Exposed Electrodes, Striations, Dielectric Thickness	M123 Table XIV
Visual / Mechanical Inspection	Verification	Materials, Design, Construction, Workmanship, Marking, Dimensions	100%
Pre-Encap Terminal Strength	M123, Para 4.6.4 M123 Appendix C	Leaded Capacitors Only Shall meet minimum Lead Pull Requirement	5 samples
Post Term / Pre Encap DPA	M123, Para 4.6.11 M123 Appendix A & B EIA-RS-469	Cracks, Delaminations, Chip outs, Exposed Electrodes, Striations Solder Joints / Bridging / Excess, Metallization, Dielectric Thickness	M123 Table XVII, Grp I Accept 0 / Reject 1

MIL-PRF-123 - Group A Inspection			
Test Sequence	**Procedure**	**Detail**	**Sample Size**
Thermal Shock	**M202, Method 107, Condition A**	**20 cycles, Step 3 @ +125ºC**	**100%**
Voltage Conditioning @ +125ºC - Insulation Resistance +125ºC - DWV - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M123, Figure 4** M202, Method 302 M202, Method 301 M202, Method 302 M202, Method 305 M123, Para. 4.6.8	**2.0 x WVDC @ 125ºC & 168 – 264 Hours** WVDC 2.5 × WVDC @ 5 ± 1 sec WVDC 1MHz BP/BG ≤ 1000 pF & X7R ≤ 100pF otherwise 1 kHz 1MHz BP/BG ≤ 1000 pF & X7R ≤ 100pF otherwise 1 kHz	**100%** **PDA per M123 Table XVI**
Voltage Conditioning @ +85ºC - Insulation Resistance +85ºC - DWV - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M123, Figure 4** M202, Method 302 M202, Method 301 M202, Method 302 M202, Method 305 M123, Para. 4.6.8	**2.0 x WVDC @ 125ºC & 168 – 264 Hours** WVDC 2.5 × WVDC @ 5 ± 1 sec WVDC 1MHz BP/BG ≤ 1000 pF & X7R ≤ 100pF otherwise 1 kHz 1MHz BP/BG ≤ 1000 pF & X7R ≤ 100pF otherwise 1 kHz	**100%** **PDA per M123 Table XVI**
Radiographic Inspection	**M123, Para 4.6.5** **M123 Appendix D**	**Encapsulated Capacitors Only**	**100%**
Visual / Mechanical Inspection	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	**20 samples** **Acc 0 / Rej 1 than 100%**
Destructive Physical Analysis	**M202, Para 4.6.11** **M202 Appendix A & B** **EIA-RS-469**	**Cracks, Delaminations, Chip outs, Exposed Electrodes, Striations Solder Joints / Bridging / Excess, Metallization, Dielectric Thickness**	**M202 Table XVII** **Accept 0 / Reject 1**

Mil-PRF-123 Group A Inspection Notes

- All samples subjected to electrical testing shall meet the minimum requirements specified in corresponding M123 Slash Sheet
- +85ºC Volt Conditioning only required for solder coated, non leaded MLCC where VC performed prior to metallization.
- Voltage Conditioning may be discontinued anytime between 168 and 264 hours provided that the number of failures detected in the last 48 hours meets the PDA requirements of M123, Table XVI
- Voltage Conditioning failures shall be determined by blown fuses or Hot IR failures

MIL-PRF-123 - Group B Inspection

Subgroup	Test Sequence	Procedure	Acceptance Criteria	Sample Size	Defectives Permitted
Subgroup 1	**Thermal Shock**	**M202, Method 107, Condition A**	**100 cycles, Step 3 @ +125ºC**	M123 Table XIX	M123 Table XIX
	Life Test @ 2 × WVDC - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance @ 250 Hrs - Δ Capacitance @ 1k Hrs - Dissipation Factor @ 250 Hrs - Dissipation Factor @ 1k Hrs	**M202, Method 108, WVDC, 1k hrs, 125ºC** M202, Method 302 M202, Method 302 M202, Method 305 M202, Method 305 M123, Para. 4.6.8 M123, Para. 4.6.8	**No mechanical damage / Marking legible** ≥50% spec req't @ 250 hrs & ≥ 30% @ 1k hrs ≥50% spec req't @ 250 hrs & ≥ 30% @ 1k hrs ±15% X7R / ±0.3% or 0.3pF BG / BP ±20% X7R / ±0.5% or 0.5pF BG / BP Shall not exceed 3Spec limit ≤3% X7R / 0.15% BG/BP		
Subgroup 2	**Humidity, Steady State, LVolt** - Insulation Resistance +25ºC - Δ Capacitance	**M202, Method 103, Cond A - 85/85** M202, Method 302 M202, Method 305	**No mechanical damage & marking legible** Shall meet initial requirement ±10% X7R / ±0.3% or 0.3pF BG/BP	12	0
Subgroup 3	**Voltage – Temperature Limits**	**M123, Para 4.6.15** -55 to +125ºC & WVDC	**BG @ 90 ± 20 PPM / ºC** **BP @ 0 ± 30 PPM / ºC** **BR @ +15/-40%** **BX @ +15/-25%**	12	1
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ±10% X7R / ±0.3% or 0.3pF BG/BP Shall meet specification requirement ≥50% initial requirement		

Mil-PRF-123 Group B Inspection Notes

- All samples subjected to Sub-Group I electrical testing shall meet the minimum requirements specified in corresponding M123 Slash Sheet
- Group B Inspection performed on samples that have been subjected to and have passed Group A Inspection
- Shipment of production units is not permitted until completion of Subgroup 1000 hours life.

MIL-PRF-123 - Group C Periodic Inspection					
Subgroup	**Test Sequence**	**Procedure**	**Acceptance Criteria**	**Sample Size**	**Defectives Permitted**
Subgroup 1 Leaded 2 Months	**1a - Terminal Strength**	**M202, Method 211, Cond A – 2 Kg** **Cond C – Radial Lead / DIP units** **Cond D – Axial Lead**	**No evidence of mechanical damage**	6	1
	1b - Solderability	**M202, Method 208 – 2 Terminals**	**Meet minimum coverage requirement** 90% coverage – Non concentrated	6	
	1c - Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - Insulation Resistance @ +25ºC	**M202, Method 210, Cond B** M202, Method 305 M123, Para 4.6.8 M202, Method 302	**No evidence of mechanical damage** -1.0 / +6% X7R / -1.0 +2.0% or 0.5pF BG / BP Shall not exceed initial specification limits Not less than initial +25ºC requirement	6	
	1c – Resistance to Solvents	**M202, Method 215**	**No mech damage / obliteration of marking**		
Subgroup 2 Chip Caps 2 Months	**2a - Terminal Strength**	**M202, Method 211, Cond A** **M123 Table 5 – 1 to 2 Kg**	**No evidence of mechanical damage**	6	1
	2b - Solderability	**M202, Method 208 – 2 Terminations**	**Meet minimum coverage requirement** 85% min coverage – Non concentrated	6	
	2c - Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - Insulation Resistance @ +25ºC	**M202, Method 210, Cond B – 230 ºC** M202, Method 305 M123, Para 4.6.8 M202, Method 302	**No evidence of mechanical damage** -1.0 / +6% X7R / -1.0 +2.0% or 0.5pF BG / BP Shall not exceed initial specification limits Not less than initial +25ºC requirement	6	

Mil-PRF-123 Group C Inspection Notes

- Samples shall be selected from lots that have passed Group A Inspection and been submitted to Group B Inspection.
- In event of failure, manufacturer to notify qualifying source / customer of failure and take appropriate corrective action to eliminate root cause. Acceptance and shipment of product shall be discontinued until such time as an approved corrective action has been implemented. Final acceptance shall be withheld until successful completion of Group C showing that corrective action was successful.
- Samples to be maintained by manufacturer for minimum 10 years.

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MIL-PRF-123 - Qualification Inspection					
Group	**Test Sequence**	**Procedure**	**Acceptance Criteria**	**Sample Size**	**Defectives Permitted**
Group I	**Radiographic Inspection** Leaded only @ X10 Magnification	**M123, Para 4.6.5** **M123 Appendix D**	**Shall meet construction & workmanship**	**All**	**N/A**
	Thermal Shock	**M202, Method 107, Condition A**	**100 cycles, Step 3 @ +125ºC**	**186 Min**	**100% PDA per M123 Table XVI**
	Voltage Conditioning @ +125ºC - Insulation Resistance +125ºC - DWV - Insulation Resistance +25ºC - Capacitance - Dissipation Factor	**M123, Figure 4** M202, Method 302 M202, Method 301 M202, Method 302 M202, Method 305 M123, Para. 4.6.8	**2.0 x WVDC @ 125ºC & 168 – 264 Hours** Shall meet initial requirement @ WVDC 2.5 × WVDC @ 5 ± 1 sec Shall meet initial requirement @ WVDC 1MHz BP/BG ≤ 1000 pF & X7R ≤ 100pF or 1 kHz 1MHz BP/BG ≤ 1000 pF & X7R ≤ 100pF or 1 kHz		
Group II	**Visual / Mechanical Inspection**	**Verification**	**Materials, Design, Construction, Workmanship, Marking, Dimensions**	15	1
	Destructive Physical Analysis	**M123, Para 4.6.11** **M123 Appendix A & B** **EIA-RS-469**	**Cracks, Delaminations, Chip outs, Exposed Electrodes, Striations Solder Joints / Bridging / Excess Metallization, Dielectric Thickness**		
Group IIIa Leaded	**Terminal Strength**	**M202, Method 211, Cond A – 2 Kg** **Cond C – Radial Lead / DIP units** **Cond D – Axial Lead**	**No evidence of mechanical damage**	12	1
	Solderability	**M202, Method 208 – 2 Terminals**	**Meet minimum coverage requirement** 90% coverage – Non concentrated		
	Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - Insulation Resistance @ +25ºC	**M202, Method 210, Cond B** M202, Method 305 M123, Para 4.6.8 M202, Method 302	**No evidence of mechanical damage** -1.0 / +6% X7R / -1.0 +2.0% or 0.5pF BG / BP Shall not exceed initial specification limits Not less than initial +25ºC requirement		
Group IIIb MLCC	**Terminal Strength**	**M202, Method 211, Cond A** **M123 Table 5 – 1 to 2 Kg**	**No evidence of mechanical damage**	12	1
	Solderability	**M202, Method 208 – 2 Terminations**	**Meet minimum coverage requirement** 85% min coverage – Non concentrated		
	Resistance to Solder Heat - Δ Capacitance - Dissipation Factor - Insulation Resistance @ +25ºC	**M202, Method 210, Cond B – 230 ºC** M202, Method 305 M123, Para 4.6.8 M202, Method 302	**No evidence of mechanical damage** -1.0 / +6% X7R / -1.0 +2.0% or 0.5pF BG / BP Shall not exceed initial specification limits Not less than initial +25ºC requirement		

Group IV	**Voltage – Temperature Limits**	**M123, Para 4.6.15** -55 to +125ºC & WVDC	**BG @ 90 ± 20 PPM / ºC** **BP @ 0 ± 30 PPM / ºC** **BR @ +15/-40%** **BX @ +15/-25%** **M123 Table VI (Cap < 20 pF)**	12	1
	Moisture Resistance - Δ Capacitance - DWV - Insulation Resistance	**M202, Method 106, 20 cycles, 7b N/A** M202, Method 305 M202, Method 301 M202, Method 302	**No evidence of mechanical damage** ±10% X7R / ±0.3% or 0.3pF BG/BP Shall meet specification requirement ≥50% initial requirement		
Group V	**Humidity, Steady State, LVolt** - Insulation Resistance +25ºC - Δ Capacitance	**M202, Method 103, Cond A - 85/85** M202, Method 302 M202, Method 305	**No mechanical damage & marking legible** Shall meet initial requirement ±10% X7R / ±0.3% or 0.3pF BG/BP	12	0
	Vibration – High Frequency Leaded only	**M202, Method 204, Cond E** **@ 125% × WVDC**	**No evidence of mechanical damage** **No ≥0.5 msec intermittent, O/C or S/C**		1
	Resistance to Solvents	**M202, Method 215**	**No mechanical damage / obliteration of marking**		
Group VI	**Life Test @ 2 × WVDC** - Insulation Resistance +125ºC - Insulation Resistance +25ºC - Δ Capacitance - Dissipation Factor	**M202, Method 108, 4000 hrs, 125ºC** M202, Method 302 M202, Method 302 M202, Method 305 M123, Para. 4.6.8	**No mechanical damage / Marking legible** ≥50% spec req't @ 250 hrs ≥30% @ 1k, 2k & 4k hrs ≥50% spec req't @ 250 hrs ≥30% @ 1k, 2k & 4k hrs ±15% X7R / ±0.3% or 0.3pF BG/BP @ 250 hrs ±20% X7R / ±0.5% or 0.5pF BG/BP @ 1k, 2k & 4k hrs Shall not exceed spec value @ 250 hrs ≤3.0% X7R/ 0..15% BG/BP @ 1k, 2k & 4k hrs	123	1

Mil-PRF-123 Qualification Inspection Notes

- All samples subjected to Group I electrical testing shall meet the minimum requirements specified in corresponding M123 Slash Sheet
- Samples shall be selected from lots that have been subjected to In-Process screening defined in M123.
- A sample unit having one or more defects will be charged as a single defect.
- Additional samples over the 186 pieces minimum required for Group I should be included to compensate for allowable PDA fallout.
- 12 additional samples shall be required for non leaded devices.
- DPA samples shall be divided with 10 pieces subjected to M123 Para. 4.6.11.1 Group 1 and 5 pieces subjected to M123 Para 4.6.11.2 Group 2
- Failures in excess of those allowed shall be cause for refusal to grant qualification.
- Samples and documentation to be maintained by manufacturer for minimum 10 years