REVISIONS			
SYMBOL	DESCRIPTION	DATE	APPROVAL
- A	Initial Release Revised numbering scheme, separated electrical and mechanical, editorial changes throughout	07/08/2008 07/14/2009	JS JS

SHEET REVISION STATUS

All sheets are at the same revision

ORIGINATOR: Dennis Krus	DATE	FSC: 5910
APPROVED: Dennis Krus	05/27/08	SPECIFICATION CONTROL DRAWING Capacitor, Ceramic, Multilayer Chip, Space Applications
ENGINEERING APPROVAL: Thomas Duffy	07/08/08	
CODE 562 APPROVAL: M. Proctor/GSFC	07/08/08	
CODE 562 SUPERVISORY APPROVAL: K. Sahu/GSFC	07/09/08	**S-311-P-829**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MD 20771

CAGE CODE: 25306

1. SCOPE

1.1 Purpose. This specification defines the general requirements for high reliability, ceramic dielectric, multilayer, fixed value chip capacitors for space, missile and other high reliability applications. It defines the test and qualification parameters for extended range capacitors required by the very low power, low voltage assemblies used for flight.

1.2 Part or Identifying Number (PIN). The complete PIN for the Multilayer Chip Capacitors supplied to this specification shall be specified as follows. Allowable combinations of voltage, capacitance, dielectric type, and package size shall be described in Table I herein.

GSFC Identifier	Ultrasonic Examination (replaces dash character)	Size Code	Dielectric Type	Capacitance	Tolerance	Voltage (Vdc)	Termination	Packaging/Marking
G311P829	A = 100%	A = 0402	N = NPO	XXX Capacitance in picofarads where third digit is number of zeros e.g. 103 equals 10000pF	B = +/- 10pF	1 = 25V	P = PdAg	1 = 7" T/R, unmarked capacitors
	B = Sample	B = 0403	X = X7R		C = /- 25pF	2 = 50V	N = Sn/Pb Solder	2 = 7" T/R, marked capacitors
		C = 0504			D = +/- 50pF	3 = 100V		3 = Waffle Pack, unmarked capacitors
		D = 0603			F = +/- 1%	4 = 5V		4 = Waffle Pack, marked capacitors
		E = 0805			G =+/- 2%	5 = 10V		
		F = 1206			J = +/- 5%	6 = 16V		
		G = 1209			K =+/- 10%			
		H = 1725			L = +20% / -10%			
		J = 2225						

1.2.1 Ultrasonic examination. Devices supplied to this specification shall be subjected to ultrasonic examination in accordance with the manufacturer's standard procedures, and MIL-PRF-123. 100% inspection complies with MIL-PRF-123 requirements; sample testing is per manufacturer's internal procedures.

1.2.2 Dielectric Type. The voltage temperature characteristic shall be referenced to the +25°C value, and shall be applicable over the entire temperature range of -55°C to +125°C. Dielectric type NPO ("N") shall be 0 ±30 ppm/°C, and dielectric type X7R ("X") shall be +15, -15 percent.

1.2.3 Termination. Devices supplied to this specification shall have a termination coating of palladium silver alloy (MIL-PRF-123, type M), or base metal barrier tin-lead solder (MIL-PRF-123, type Z) plated. Tin lead solder plating shall contain a minimum of 4% lead, by mass. Note that the palladium silver alloy termination coating is not recommended for applications using eutectic solder attach methods; PdAg termination coating is appropriate for conductive epoxy mounting techniques only.

1.2.4 Package/Marking. Capacitors supplied to this specification may be supplied as unmarked or marked, as designed by the marking identifier code in the GSFC PIN. Capacitors shall be unmarked, and packaged on 7” tape and reel (identifier code 1), or in waffle packs (identifier code 3). Capacitors shall be marked per the manufacturer’s standard marking procedure and nomenclature (or MIL-PRF-123 nomenclature), and packaged on 7” tape and reel (identifier code 2), or in waffle packs (identifier code 4).

Table I. Allowable Capacitance/Voltage Combinations

Case Size	Maximum Working Voltage (Vdc)	NPO Dielectric		X7R Dielectric	
		Maximum Capacitance	Minimum Dielectric Thickness 2/	Maximum Capacitance	Minimum Dielectric Thickness 2/
0402	5 V	NA	NA	0.01 uF	0.4 mils
0402	10 V	NA	NA	8200 pF	0.4 mils
0402	16 V	NA	NA	6800 pF	0.4 mils
0402	25 V	120 pF	0.8 mils	4700 pF	0.8 mils
0402	50 V	100 pF	0.8 mils	3900 pF	0.8 mils
0402	100 V	39 pF	1.0 mils	1200 pF	1.0 mils
0403	16 V	NA	NA	0.022 uF	0.4 mils
0403	25 V	390 pF	0.8 mils	0.015 uF	0.8 mils
0403	50 V	330 pF	0.8 mils	0.012 uF	0.8 mils
0403	100 V	68 pF	1.0 mils	2200 pF	1.0 mils
0504	16 V	NA	NA	0.082 uF	0.4 mils
0504	25 V	1500 pF	0.8 mils	0.047 uF	0.8 mils
0504	50 V	1200 pF	0.8 mils	0.039 uF	0.8 mils
0504	100 V	180 pF	1.0 mils	6800 pF	1.0 mils
0603	5 V	NA	NA	0.10 uF	0.4 mils
0603	16 V	NA	NA	0.043 uF	0.4 mils
0603	25 V	680 pF	0.8 mils	0.027 uF	0.8 mils
0603	50 V	560 pF	0.8 mils	0.022 uF	0.8 mils
0603	100 V	100 pF	1.0 mils	3300 pF	1.0 mils
0805	16 V	NA	NA	0.15 uF	0.4 mils
0805	25 V	2700 pF	0.8 mils	0.10 uF	0.8 mils
1206	16 V	NA	NA	0.39 uF	0.4 mils
1206	25 V	6800 pF	0.8 mils	0.27 uF	0.8 mils
1206	50 V	5600 pF	0.8 mils	0.22 uF	0.8 mils
1209	16 V	NA	NA	0.68 uF	0.4 mils
1209	25 V	0.010 uF	0.8 mils	0.47 uF	0.8 mils
1209	50 V	8200 pF	0.8 mils	0.39 uF	0.8 mils
1725	25 V	0.056 uF	0.8 mils	2.2 uF	0.8 mils
1725	50 V	0.039 uF	0.8 mils	1.8 uF	0.8 mils
1725	100 V	0.018 uF	1.0 mils	0.68 uF	1.0 mils
2225	50 V	0.056 uF	0.8 mils	2.2 uF	0.8 mils
2225	100 V	0.027 uF	1.0 mils	1.0 uF	1.0 mils

Notes:
1. NA indicates “Not Available”
2/ Thickness measured after firing.

2. APPLICABLE DOCUMENTS

2.1 Government specifications, standards, and handbooks. The following Government specifications, standards, and handbooks form a part of this drawing to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, in effect on the date of the contract or purchase order.

STANDARDS

MILITARY

MIL-STD-202	Test Methods for Electronic and Electrical Component Capacitors.

SPECIFICATIONS

MILITARY

MIL-PRF-123	Capacitors, Fixed, Ceramic Dielectric, (Temperature Stable and General Purpose), High Reliability, General Specification

National Aeronautics and Space Administration (NASA)

EEE-INST-002	Instructions for EEE Capacitors Selection, Screening, Qualification and Derating

2.2 Non–Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS in effect on the date of the contract or purchase order. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents in effect on the date of the contract or purchase order.

American National Standards Institute (ANSI)

ANSI/NCSL Z540-1-1994 (R2002)	General Requirements for Calibration Laboratories and Measuring and Test Equipment.

Electrical Overstress/Electrostatic Discharge Association Inc.

EOS/ESD S20.20	For the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Capacitors, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

Electronic Industries Alliance (EIA)

EIA-469	Standard Test Method for Destructive Physical Analysis (DPA) of Ceramic Monolithic Capacitors.

International Organization for Standardization (ISO)

ISO 17025:2000	General Requirements for the Competence of Testing and Calibration Laboratories.

2.3 Order of precedence**.** In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications, specification sheets, or MS sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Individual Item Requirements. Individual item requirements for capacitors supplied to this specification shall be in accordance with the requirements of MIL-PRF-123, and as specified herein. Capacitors supplied to this specification shall meet all performance requirements as specified herein, under all combinations of environmental conditions specified herein.

3.1.1 Electrodes. All capacitors supplied to this specification shall be manufactured with precious metal electrodes.

3.1.2 Pure Tin. The use of pure tin, as an underplate or final finish, is prohibited both internally and externally. Tin content of capacitor components and solder shall not exceed 96 percent, by mass. Tin shall be alloyed with a minimum of 4 percent lead, by mass.

3.2 Interface Requirements. Capacitors supplied to this specification shall meet the physical dimension requirements as specified in Figure 1, herein.

3.2.1 Dielectric thickness. Dielectric thickness is the actual measured thickness of the fired ceramic dielectric layer. Capacitors supplied to this specification shall have a minimum dielectric thickness of 0.8 mils for 50Vdc rated capacitors, or 1.0 mil for 100Vdc rated capacitors. Capacitors rated below 50Vdc shall meet the dielectric thickness requirement of 0.8 mils, unless specifically identified in Table I. Voids, or the cumulative effect of voids, shall not reduce the total dielectric thickness by more than 50 percent. Maximum dielectric constant shall be 4000 for X7R dielectric; 100 for NPO dielectric.

3.3 Insulation Resistance (IR @ 125°C). Capacitors shall be tested at +125°C and rated voltage in accordance with MIL-STD-202, Method 302. The minimum IR measurement shall be 10,000 Megohms or 100 Megohm-Microfarads.

3.4 Dielectric Withstanding Voltage (DWV). Capacitors shall be tested at two and one half times the rated voltage in accordance with MIL-STD-202, Method 301.

3.5 Insulation Resistance (IR @ 25°C). Capacitors shall be tested at +25°C and rated voltage in accordance with MIL-STD-202, Method 302. The minimum IR measurement shall be 100,000 Megohms or 1,000 Megohm-Microfarads.

3.6 Capacitance. Capacitors shall be tested at +25°C and 1.0 VACrms in accordance with MIL-STD-202, Method 305.

3.7 Dissipation Factor (DF). Dissipation factor shall not exceed 0.15% for all NPO dielectric capacitors, in all voltage ranges. Dissipation factor, for X7R dielectric capacitors, shall not exceed 5.0% at the 5 and 10 volt ratings, 3.5% at the 16 and 25 volt ratings, and 2.5% at the 50 and 100 volt ratings.

3.8 Percent Defective Allowable (PDA). The cumulative PDA after Voltage Conditioning shall be less than 5%. Pieces rejected as out of tolerance for capacitance or visual screening will be removed from the lot, but not counted in the PDA calculation.

3.9 Visual Examination. Visual inspection, in accordance with MIL-PRF-123, Appendix B, shall be performed on 100% of the capacitors delivered to this specification.

3.10 Mechanical Examination. Mechanical inspection, in accordance with the requirements of MIL-PRF-123, shall be performed. An AQL level of 1% (normal inspection plan) shall determine the inspection sample size.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection. Unless otherwise specified in the contract purchase order, the manufacturer of microcircuits supplied against this specification shall be responsible for the performance of all inspection requirements as specified herein. The procuring activity shall retain the right to perform any of the inspections specified herein, where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Test Equipment and Inspection Facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections specified herein shall be established and maintained by the manufacturer. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ANSI/NCSL Z540.1-1994 (R2002) and ISO 17025:2000, or similar system approved by the procuring activity.

4.2 Design and Source Approval. Prior to qualification, the manufacturer's facility shall be subjected to survey, at the option of GSFC. Compliance with ANSI/NCSL Z540.1-1994 (R2002) and ISO 17025:2000 or equivalent is required. In addition, the history and detailed engineering of the specific (part) design shall be reviewed, as well as the documented manufacturing and quality control procedures. Only those source(s) approved in the design and source phase shall be eligible for qualification or award of contract under this specification. Source approval and design approval do not constitute part qualification or an equivalent thereof.

4.2.1 Qualification. Capacitors furnished to this specification shall be product which has been granted qualification approval by NASA/GSFC, and has been listed in the latest revision of the GSFC Qualified Products List Directory (QPLD).

4.2.1.1 QPL Status. Manufacturers supplying capacitors to this specification shall be listed on the version of QPDSIS-123 in effect on the date of purchase order or contract.

4.2.2 Requalification. Requalification shall be imposed following any change in design, manufacture, materials, or quality control procedures as reviewed and approved during qualification. Requalification shall be required if it is demonstrated that any stipulation initially presented in the manufacturer's certification no longer applies. Inspection discrepancies that are not suitably explained by failure analysis, or by other means, shall also be considered a basis for disqualification by GSFC.

4.3 Classification of inspections. Inspections required by this specification shall be classified as follows.

a. In Process Inspection
b. Group A Inspection
c. Group B Inspection

4.3.1 Inspection of product for delivery. Inspection of product for delivery to this specification shall consist of in-process inspection, Group A inspection, and Group B inspection.

4.3.2 Inspection lot. An inspection lot shall be defined in accordance with MIL-PRF-123, and shall consist of all capacitors of a single nominal capacitance and voltage rating of one design, from the same dielectric material batch, and processed as a single lot through all manufacturing steps on the same equipment.

4.4 In-Process Inspection. In-process inspection shall be as specified in MIL-PRF-123, Table X, and as specified herein.

4.4.1 Destructive Physical Analysis (DPA). Destructive physical analysis (pre-termination) shall be performed on each inspection lot of capacitors supplied to this specification. DPA shall be performed in accordance with the requirements of MIL-PRF-123; sample size shall be as specified in MIL-PRF-123. Analysis shall verify compliance with manufacturer's internal design requirements as well as the requirements of ANSI EIA 469.

4.5 Group A Inspection. Group A inspection shall be performed each inspection lot of capacitors supplied to this specification. Group A inspection shall consist of the following tests, performed in the order shown.

4.5.1 Thermal Shock. 100% of devices supplied to this specification shall receive thermal shock, in accordance with MIL-STD-202, Method 107, Test Condition A, except the temperature in step 3 shall be +125°C, and number of cycles shall be twenty (20), minimum.

4.5.2 Voltage Conditioning. 100% of devices supplied to this specification shall receive voltage conditioning. Voltage conditioning shall consist of applying twice the rated voltage to the capacitors at the maximum rated temperature of +125°C +4°C/-0°C, for a minimum of 168 hours and a maximum of 264 hours. Voltage conditioning may be terminated at any time during the 168 to 264 hour time interval, provided that the number of failures detected during the last 48 hours of test is less than 0.1%, or one piece. Resistors may be used in lieu of fuses specified by MIL-PRF-123.

4.5.3 Electrical Performance. After completion of voltage conditioning, all capacitors shall be subjected to electrical inspection. Tests shall be performed in the following sequence:

Insulation resistance at +125°C, per paragraph 3.3. herein.
Dielectric Withstanding Voltage, per paragraph 3.4 herein.
Insulation Resistance at +25°C, per paragraph 3.5 herein.
Capacitance, per paragraph 3.6 herein.
Dissipation Factor, per paragraph 3.7 herein.

4.5.4 Percent Defective Allowable (PDA). PDA shall be calculated per paragraph 3.8 herein.

4.5.5 Visual and Mechanical Inspection. Visual inspection shall be performed on 100% of the capacitors supplied to this specification, as specified in paragraph 3.9 herein. Mechanical inspection shall be performed on a sample of the deliverable capacitors supplied to this specification, per paragraph 3.10 herein.

4.6 Group B Inspection. Group B inspection shall be performed on each inspection lot of capacitors delivered against this specification. Capacitors used for Group B inspections shall have successfully passed all Group A inspections. Group B inspection shall consist of the following tests, performed in the order shown, and as specified in MIL-PRF-123. Sample sizes shall be as follows.

4.6.1 Subgroup 1 sample size. For capacitors with dielectric thickness equal to or greater than 0.8 mils (reference Table I herein), sample size shall be forty-five (45) with zero (0) rejects allowed. For capacitors with dielectric thickness less than 0.8 mils (reference Table I herein), sample size shall be one hundred, twenty-five (125) with zero (0) rejects allowed.

4.6.1.1 Thermal Shock. Capacitors shall be tested in accordance with MIL-STD-202, Method 107, Test Condition A-3, except the temperature in step 3 shall be +125°C.

4.6.1.2 Life Test. Capacitors shall be tested in accordance with MIL-STD-202, Method 108. Ambient temperature during testing shall be +125°C, +4°C, -0°C.

4.6.2 Subgroup 2 sample size. Sample size shall be twelve (12) with zero (0) rejects allowed.

4.6.2.1 Humidity Steady State Low Voltage Test (HSSLV). Capacitors shall be tested in accordance with MIL-STD-202, Method 103, Condition A, with the exceptions and clarifications specified in MIL-PRF-123, paragraph 4.6.16.1.

4.6.3 Subgroup 3 sample size. Sample size shall be twelve (12) with zero (0) rejects allowed.

4.6.3.1 Voltage Temperature Limits. Capacitors shall be tested in accordance with MIL-PRF-123.

4.6.3.2 Moisture Resistance Test. Moisture resistance testing is only applicable to capacitors with a package size (nominal) of 0805 and larger. Capacitors shall be tested in accordance with MIL-STD-202, Method 106, with the exceptions and clarifications specified in MIL-PRF-123, paragraph 4.6.16.2.

4.6.4 Group B Samples. Capacitors used for Group B inspections shall not be delivered as flight material. Test samples, or their remains, shall be packaged separately and delivered with the Group B data package.

4.6.5 Deliverable data package. Each shipment of capacitors supplied to this specification shall contain the following information as a minimum.

- Certificate of Conformance
- DPA report
- Attribute summary data for Group A and Group B inspections
- Variables data for Group B, life test and humidity steady state low voltage testing

4.6.6

SIZE	L (Inches)	W (Inches)	THICKNESS MAX (T) (Inches)	METALIZATION BAND (M.B.) (Inches)
0402	0.040 ± 0.004	0.020 ± 0.004	0.024	.004 min. band .015 min. space
0403	0.040 ± 0.010	0.030 ± 0.010	0.030	.004 min. band .015 min. space
0504	0.050 ± 0.010	0.040 ± 0.010	0.040	.005 min. band .015 min. space
0603	0.063 ± 0.006	0.032 ± 0.006	0.035	.005 min. band .025 min. space
0805	0.080 ± 0.010	0.050 ± 0.010	0.050	0.020 ± 0.010
1206	0.126 ± 0.008	0.063 ± 0.008	0.059	0.020 ± 0.010
1209	0.126 ± 0.008	0.095 ± 0.010	0.065	0.020 ± 0.010
1725	0.175 ± 0.013	0.250 ± 0.018	0.065	0.020 ± 0.010
2225	0.220 ± 0.015	0.250 ± 0.018	0.080	0.020 ± 0.010

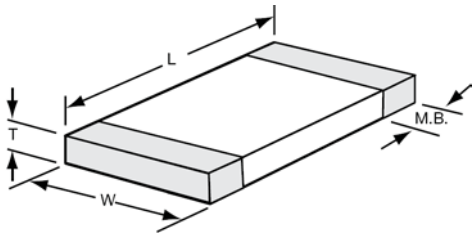

Figure 1. Mechanical Configuration.

5. PREPARATION FOR DELIVERY

5.1 Packaging Requirements. Capacitors shall be clean, dry, and packaged as per the part number designation, in an electrostatic discharge (ESD) safe package, in a secure manner that will afford adequate protection against corrosion, deterioration, and physical damage during common carrier shipment to the procuring activity. These packages shall conform to the applicable carrier rules and regulations.

6.0 NOTES

6.1 Ordering data. Acquisition documents shall specify the following minimum information.
a) number, title, and date of this specification
b) Goddard part number
c) quantity

6.2 Notice. When GSFC drawings, specification, or other data are used for any purpose other than in connection with a definitely related GSFC procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; the fact that GSFC might have formulated, furnished, or in any way supplied the said drawings, specification, or other data is not to be regarded by implication or otherwise in any manner licensing the holder or any person or corporation, or conveying any right or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian: QPLD Administrator
Capacitors, Packaging, and Assembly Technologies Office, Code 562
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6.3 Approved Source(s) of Supply. Identification of the suggested source(s) of supply hereon is not to be construed as a guarantee of present or continued availability as a source of supply for the item.

6.4 Use and Application Information. Capacitors supplied to this specification are not in complete compliance with MIL-PRF-123. Capacitors supplied to this specification have not received the qualification, and periodic qualification maintenance, as those procured to MIL-PRF-123. The use of these capacitors in Level 1 projects or in critical single string applications is not recommended without a thorough understanding of the application and analysis of the risks by the cognizant engineering functions.