Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

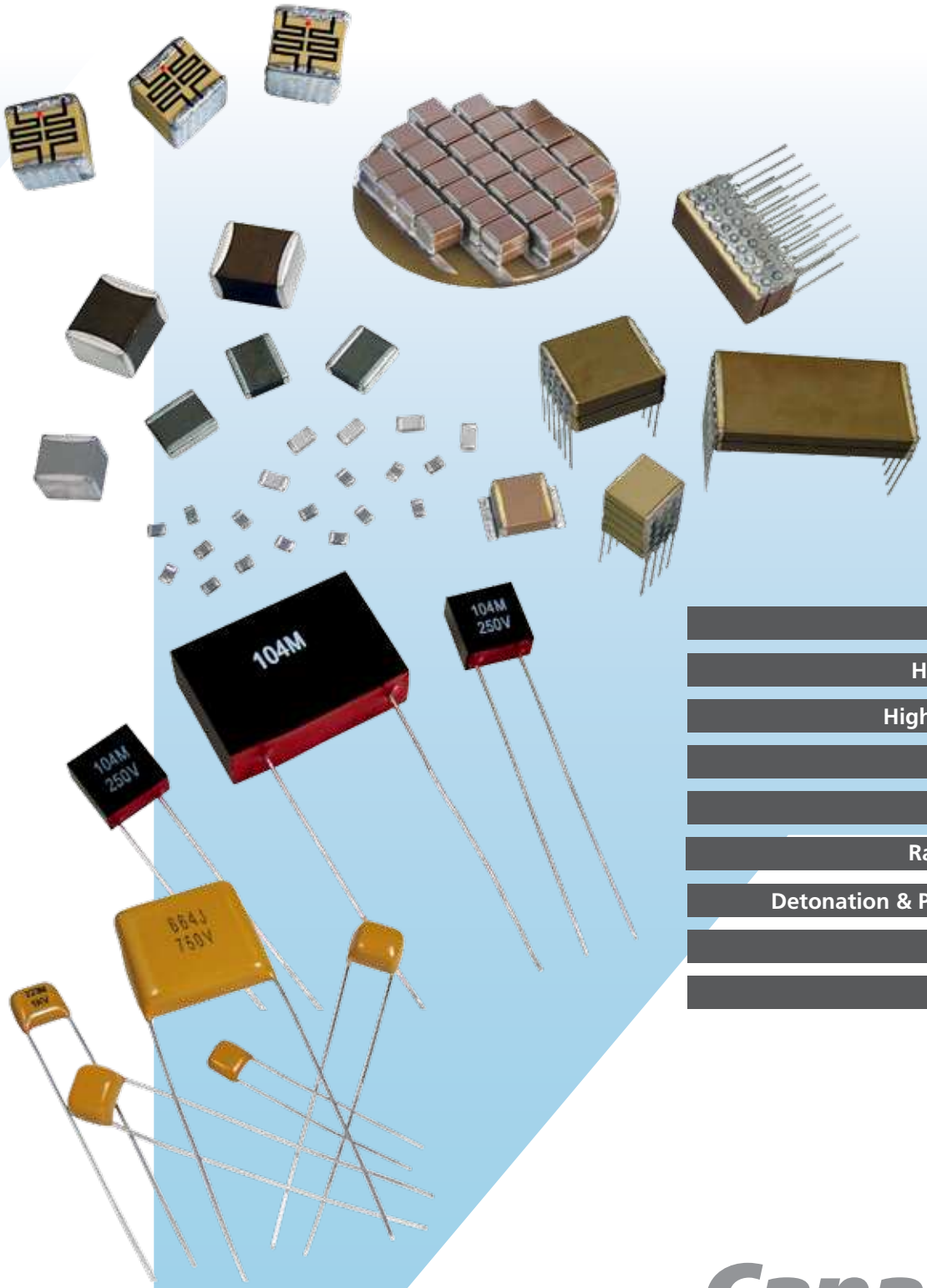
With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

NOVACAP



- Commercial Products
- High Reliability Products
- High Temperature Products
- Application Specific
- Capacitor Assemblies
- Radial Leaded capacitors
- Detonation & Pluse Energy Capacitors
- Specialty Products
- Custom Designs

MLC Capacitors

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Products by Market

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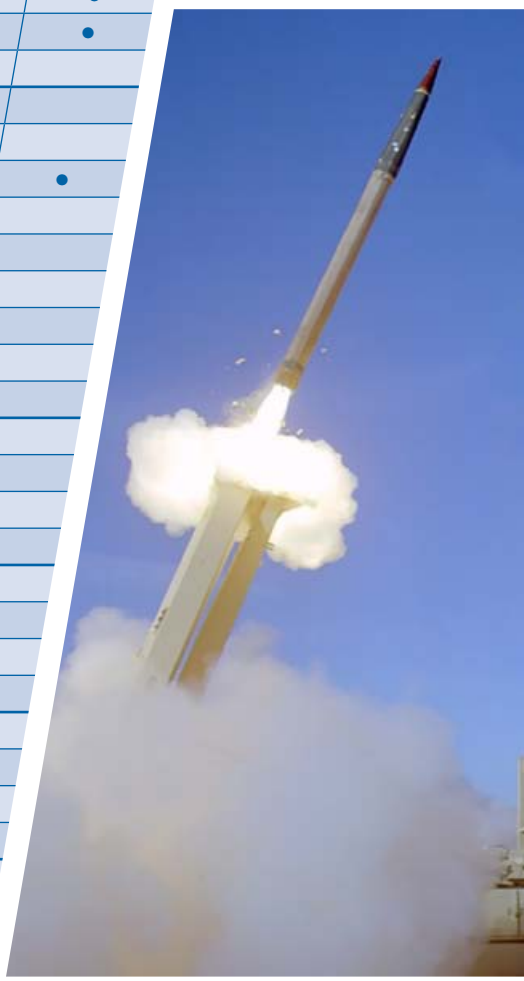


The Company

Novacap manufactures surface mount and leaded Multilayer Ceramic Capacitors (MLC) as well as specialty assemblies for your circuit applications. We are part of Knowles Capacitors, an operating company within Knowles Corporation.

Valencia, California

Our standard sizes range from 0402 to 7565, and we provide voltage ratings from 4V to 10kV.

We are flexible, quick, reliable and innovative! Call us with your particular requirements.

Guaymas, Mexico.

Some of our offerings include:

- Full range of surface mount chip capacitors
- High Reliability capacitors for use in Medical Implantable Devices and Life Support Systems
- High Temperature capacitors for harsh environments such as Oil Exploration, Automotive and Avionics Engine Compartment circuitry
- Custom Capacitor Modules for ratings up to 20kV
- Capacitor Arrays for highly efficient use of board space
- Certified Safety (Y^2, Y^3) and Ring Detect Capacitors for Telecommunications
- High Voltage capacitors, with ratings up to 10kV, designed for Commercial and Military use in Power Supply and Voltage Multiplier circuits
- Pulsed Energy capacitors for Oil Exploration and Detonation
- Radial Leaded capacitors
- Thin Profile capacitors for RFID and smart cards.
- Stacked Capacitor Assemblies for input and output filters in Switch Mode Power Supplies, High Capacitance Discharge Circuitry and High Temperature Filtering and Decoupling

NOVACAP

Technical Summary

Technical Information

Novacap provides application notes throughout this catalog as a guide to chip selection and attachment methods. Refer to the Novacap Technical Brochure found at www.novacap.com for more details. This technical information includes the nature of capacitance, dielectric properties, electrical properties, classes of dielectrics, ferroelectric behavior, test standards, and high reliability test plans. Please do not hesitate to contact the sales office for any product or technical assistance.

Capacitor Size

Size availability is based primarily on capacitance values and voltage rating. Smaller units are generally less expensive. Because mass affects the thermal shock susceptibility of chip capacitors, size selection should consider the soldering method used to attach the chip to the board. Sizes 1812 and smaller can be wave, vapor phase, or reflow soldered. Larger units require reflow soldering.

Chip Selection

Multilayer capacitors (MLC) are categorized by dielectric performance with temperature. The Temperature Coefficient of Capacitance describes the variance of capacitance value with temperature. The choice of components is therefore largely determined by the temperature stability required of the device and the size necessary for the desired capacitance value and voltage rating.

Packaging

Units are available reeled, in waffle pack, or bulk packaged. Bar coded labels are standard for reeled and bulk packaging.

Primary Dielectric Types

C0G/NP0:

Ultra stable Class I dielectric, with negligible dependence of capacitance on temperature, voltage, frequency, and time. Used in circuitry requiring very stable performance.

X7R:

Stable Class II dielectric, with predictable change in properties across a temperature range of -55°C to +125°C. Used as blocking, decoupling, bypassing, and frequency discriminating elements. This dielectric is ferroelectric and provides higher capacitance than Class I materials.

BX:

The military specification for ceramic chip capacitors (MIL-PRF-55681) defines a mid-K stable dielectric designated as BX. The BX specification has voltage temperature limits in addition to temperature limits of capacitance. The BX dielectric is limited to ±15% maximum change in capacitance between 25°C and -55°C or +125°C and also has a voltage restriction of +15% / -25% maximum change in capacitance between 25°C and -55°C or +125°C at rated voltage.

Z5U/Y5V:

General purpose Class III dielectrics with higher dielectric constant and greater variation of properties over temperature and voltage. Very high capacitance per volume is attainable for general purpose applications where stability over a wide temperature range is not critical.

Dielectric Termination Combinations

Dielectric	Code	Palladium Silver	Palladium Silver RoHS	Solderable Palladium Silver RoHS	Nickel Barrier 100% tin RoHS	Nickel Barrier 90/10% tin/lead	Nickel Barrier Gold flash RoHS	FlexiCap™/Nickel Barrier 100% tin RoHS	FlexiCap™/Nickel Barrier 90/10% tin/lead	Copper Barrier 100% tin RoHS	Copper Barrier 90/10% tin/lead	Solderable Silver RoHS
		P	PR	K	N	Y	NG	C	D	B	E	S
C0G/NP0	N/RN	•	•	•	•	•	•	•	•			•
R3L	K	•	•	•	•	•	•	•	•			
X7R	B/RB	•	•	•	•	•	•	•	•			•
X7R BME	BB				•	•	•					
X5R BME	BW				•	•	•					
BX	X	•	•	•	•	•	•	•	•			•
Y5V	Y							•	•			
Z5U	Z							•	•			
C0G/NP0 (Mag free)	M	•	•	•						•	•	
X7R (Mag free)	C	•	•	•						•	•	
X8R	S	•	•	•	•	•		•	•			•
C0G/NP0 (160°C)	F	•	•	•	•	•		•	•			•
C0G/NP0 (200°C)	D			•								•
Class II (160°C)	G	•	•	•	•	•		•	•			•
Class II (200°C)	E			•								•
Pulse Power	P	•	•	•								
R2D	R	•	•	•								

Termination Material

We recommend the following termination types:

Solder Attachment:

N Nickel Barrier, 100% matte tin plated - RoHS

C FlexiCap™ with Nickel Barrier, 100% tin plated - RoHS

Y Nickel Barrier, tin-lead plated

D FlexiCap™ Nickel Barrier, tin-lead plated

B Copper Barrier 100% matte tin plated - RoHS

E Copper Barrier, tin-lead plated

K Solderable Palladium Silver - RoHS (suitable for conductive epoxy attach)

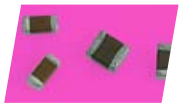
S Solderable Silver - RoHS

Conductive Epoxy attachment:

P Palladium Silver

PR Palladium Silver - RoHS

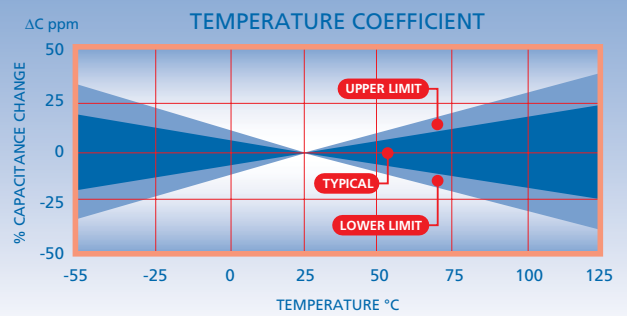
NG Nickel Barrier Gold Flash - RoHS (suitable for soldering attach)



Dielectric Characteristics

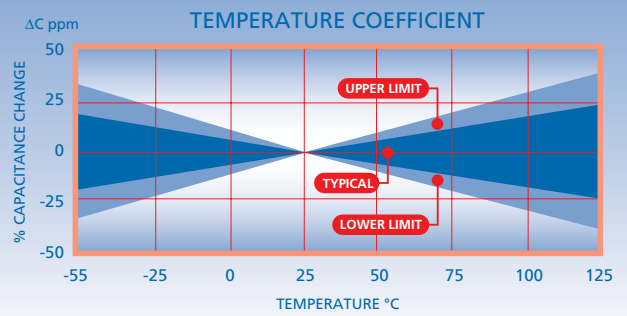
C0G/NP0 (N) Ultra Stable and RoHS 2013 (RN) type

Operating temperature range:		-55°C to 125°C
Temperature coefficient:		0 ±30 ppm/°C
Dissipation factor:		0.1% max @ 25°C
Insulation resistance	@25°C: @125°C:	>100GΩ or >1000ΩF whichever is less >10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C 1MHz for Capacitance ≤100pF



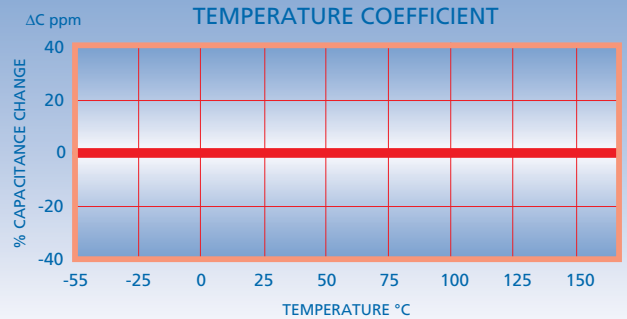
C0G/NP0 (M) Ultra Stable Non Magnetic

Operating temperature range:		-55°C to 125°C
Temperature coefficient:		0 ±30 ppm/°C
Dissipation factor:		0.1% max @ 25°C
Insulation resistance	@25°C: @125°C:	>1000ΩF or >10000ΩF whichever is less >100ΩF or >1000ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C 1MHz for Capacitance ≤100pF



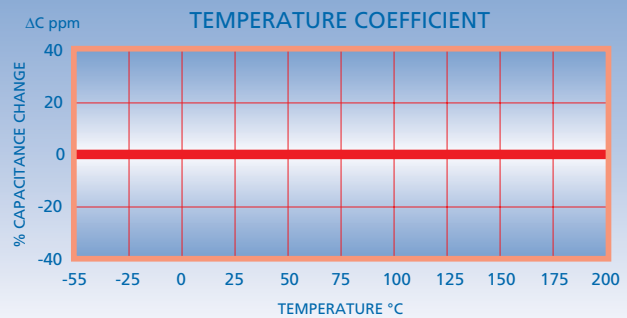
C0G/NP0 (F) Ultra Stable High Temperature (up to 160°C)

Operating temperature range:		-55°C to 160°C
Temperature coefficient:		0 ±30 ppm/°C
Dissipation factor:		0.1% max @ 25°C
Insulation resistance	@25°C: @160°C:	>100GΩ or >1000ΩF whichever is less >1GΩ or >10ΩF whichever is less
Dielectric withstanding voltage	<200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C 1MHz for Capacitance ≤100pF



C0G/NP0 (D) Ultra Stable High Temperature (up to 200°C)

Operating temperature range:		-55°C to 200°C
Temp. coefficient ≤200°C:		0 ±30 ppm/°C
Dissipation factor @ 25°C:		0.1% Max.
Insulation resistance	@25°C: @200°C:	>100GΩ or >1000ΩF whichever is less >1GΩ or >10ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C 1MHz for capacitance ≤100pF



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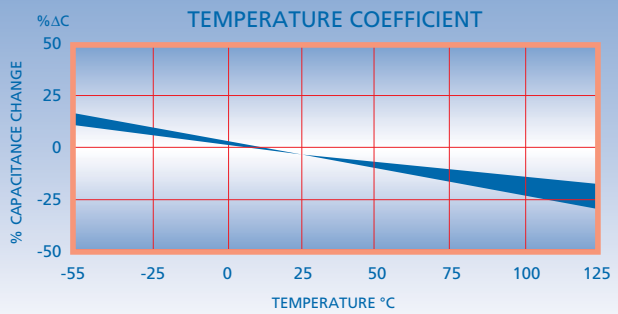
Dielectric Characteristics

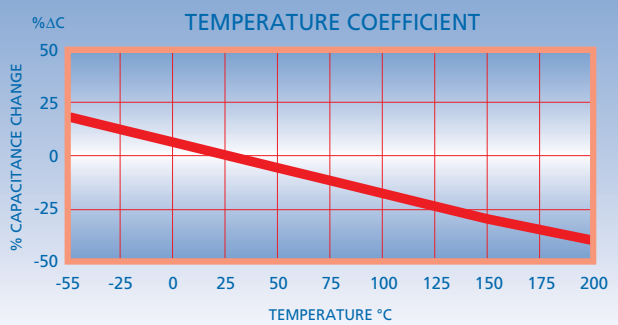
R3L (K) Ultra Stable

Operating temperature range:	-55°C to 125°C
Temperature coefficient:	-2200 ±500 ppm/°C
Dissipation factor:	0.1% max @ 25°C
Insulation resistance @25°C: @125°C:	>1000ΩF or >10000ΩF whichever is less >100ΩF or >1000ΩF whichever is less
Dielectric withstanding voltage ≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:	0% per decade
Test parameters:	1KHz, 1.0 ±0.2 VRMS, 25°C 1MHz for Capacitance ≤100pF



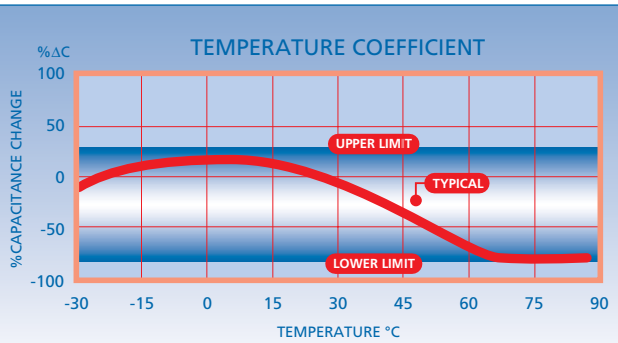
R2D (R) Pulse Energy

Operating temperature range:	-55°C to 200°C
Temperature coefficient:	-2200 ±500 ppm/°C
Dissipation factor:	0.1% max @ 25°C
Insulation resistance @25°C: @200°C:	>100GΩ or >1000ΩF whichever is less >1GΩ or >10ΩF whichever is less
Dielectric withstanding voltage:	120%
Ageing rate:	0% per decade
Test parameters:	1KHz, 1.0 ±0.2 VRMS, 25°C



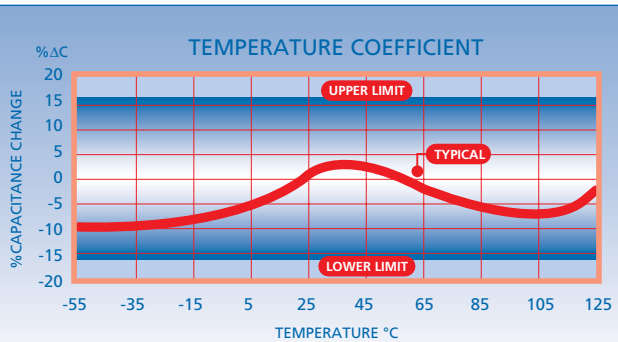
Y5V (Y) General Purpose

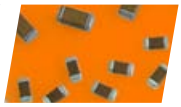
Operating temperature range:	-30°C to 85°C
Temperature coefficient:	+22% -82% ΔC Max.
Dissipation factor >25V rating: ≤25V rating:	5.0% max 7.0% max
Insulation resistance @25%:	>10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage ≤200V: 250V:	250% 150%
Ageing rate:	4.0% per decade
Test parameters:	1KHz, 1.0 ±0.2 VRMS, 25°C



Z5U (Z) General Purpose

Operating temperature range:	+10°C to 85°C
Temperature coefficient:	+22% -56% ΔC Max.
Dissipation factor:	4.0% max @ 25°C
Insulation resistance @25%	>10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage ≤200V: 250V:	250% 150%
Ageing rate:	4.0% per decade
Test parameters:	1KHz, 0.5 ±0.2 VRMS, 25°C

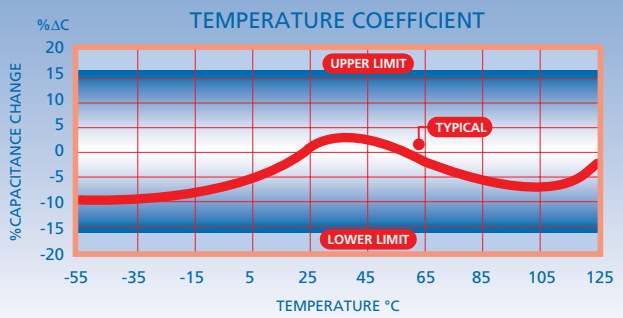


Dielectric Characteristics

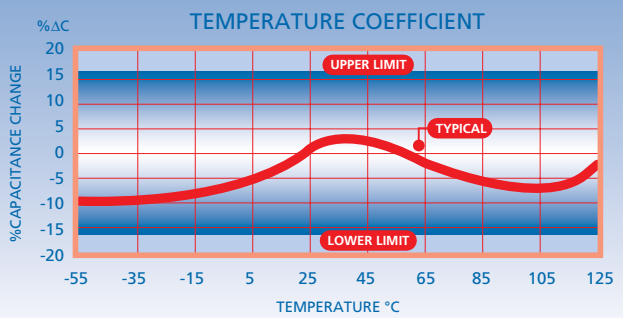
X7R (B) Stable and RoHS 2013 (RB) type

Operating temperature range:		-55°C to 125°C
Temperature coefficient :		±15% ΔC Max.
Dissipation factor	>25V rating: ≤25V rating:	2.5% max 3.5% max
Insulation resistance:	@25°C: @125°C:	>100GΩ or >1000ΩF whichever is less >10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		<2.0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C



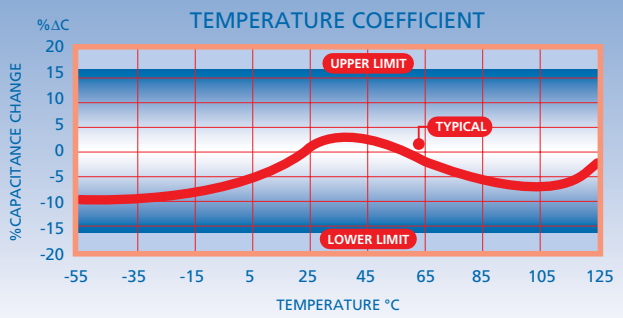
X7R (C) Stable Non Magnetic

Operating temperature range:		-55°C to 125°C
Temperature coefficient:		±15% ΔC Max.
Dissipation factor	>25V rating: ≤25V rating:	2.5% max 3.5% max
Insulation resistance:	@25°C: @125°C:	>100GΩ or >1000ΩF whichever is less >10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		<2.0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C



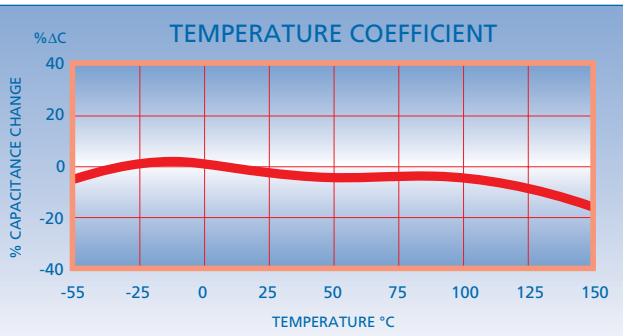
BX (X) Stable

Operating temperature range:		-55°C to 125°C
Temperature coefficient: Temp-voltage coefficient:		±15% ΔC Max. +15% -25% ΔC Max.
Dissipation factor	>25V rating: ≤25V rating:	2.5% max 3.5% max
Insulation resistance:	@25°C: @125°C:	>100GΩ or >1000ΩF whichever is less >10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		<2.0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C



X8R (S) Stable

Operating temperature range:		-55°C to 150°C
Temp. coefficient ≤150°C:		±15% ΔC Max.
Dissipation factor	>25V rating: ≤25V rating:	2.5% max 3.5% max
Insulation resistance	@25°C: @150°C:	>100GΩ or >1000ΩF whichever is less >10GΩ or >100ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		<2.0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C



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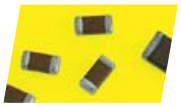
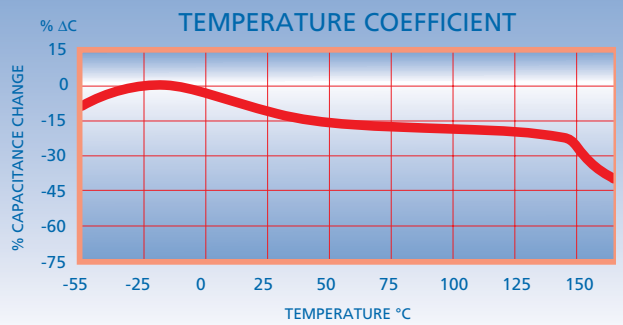
Dielectric Characteristics



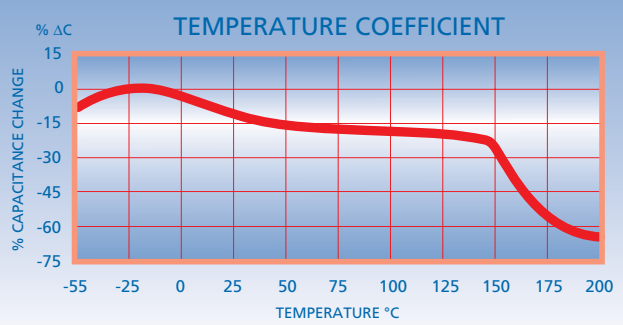
Class II (G) Stable High Temperature (up to 160°C)

Operating temperature range:		-55°C to 160°C
Temperature coefficient up to 160°C:		+15 -40% ΔC Max.
Dissipation factor @ 25°C:		2.5% Max.
Insulation resistance	@25°C: @160°C:	>100GΩ or >1000ΩF whichever is less >1GΩ or >10ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		< 2.0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C



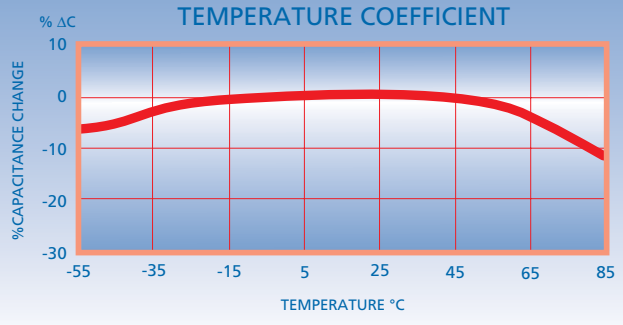
Class II (E) Stable High Temperature (up to 200°C)

Operating temperature range:		-55°C to 200°C
Temperature coefficient up to 200°C:		+15 -65% ΔC Max.
Dissipation factor @ 25°C:		2.5% Max.
Insulation resistance	@25°C: @200°C:	>100GΩ or >1000ΩF whichever is less >1GΩ or >10ΩF whichever is less
Dielectric withstanding voltage	≤200V: 201-500V: >500V:	250% 150% or 500V whichever is greater 120% or 750V whichever is greater
Ageing rate:		< 2.0% per decade
Test parameters:		1KHz, 1.0 ±0.2 VRMS, 25°C



X5R (W) Stable

Operating temperature range:	-55°C to 85°C
Temperature coefficient up to 200°C:	±15% ΔC Max.
Dissipation factor @ 25°C:	5% Max.
Insulation resistance @25%:	>10GΩ or >500ΩF whichever is less
Dielectric withstanding voltage:	250%
Ageing rate:	< 5.0% per decade
Test parameters: Except: 22µF, 47µF & 100µF	1KHz, 1.0 ±0.2 VRMS, 25°C 120KHz, 0.5 ±0.1 VRMS, 25°C




Capacitor Manufacturing Process

RoHS compliance

Novacap routinely monitors world wide material restrictions (e.g. EU / China and Korea RoHS mandates) and is actively involved in monitoring future legislation.

In an effort to meet the RoHS directives and its Recast aimed at reducing hazardous substances (Restriction of Hazardous Substances (RoHS) directive 2012/65/EU), Novacap has introduced new RoHS Lead-Free compliant lines. The new dielectric codes for these are "RN" for C0G/NP0 and "RB" for X7R. This is not a transition from the current product. The current product lines with dielectric codes "N" and "B" will not be phased out and can still be purchased. Please refer to our web site for further details.

Breakdown of material content, SGS analysis reports and tin whisker test results are available on request.

Most Novacap MLCC components are available with non RoHS compliant tin lead (SnPb) solderable termination finish by special request for exempt applications and where pure tin is not acceptable. Other tin free termination finishes may also be available – please refer to Novacap for further details.

Radial components have tin (Sn) plated leads as standard, but Sn/Pb leads are available as a special option. Please refer to the radial section of the catalog for further details.

REACH (Registration, Evaluation, Authorization and restriction of Chemicals) statement

The main purpose of REACH is to improve the protection of human health and the environment from the risks arising from the use of chemicals.

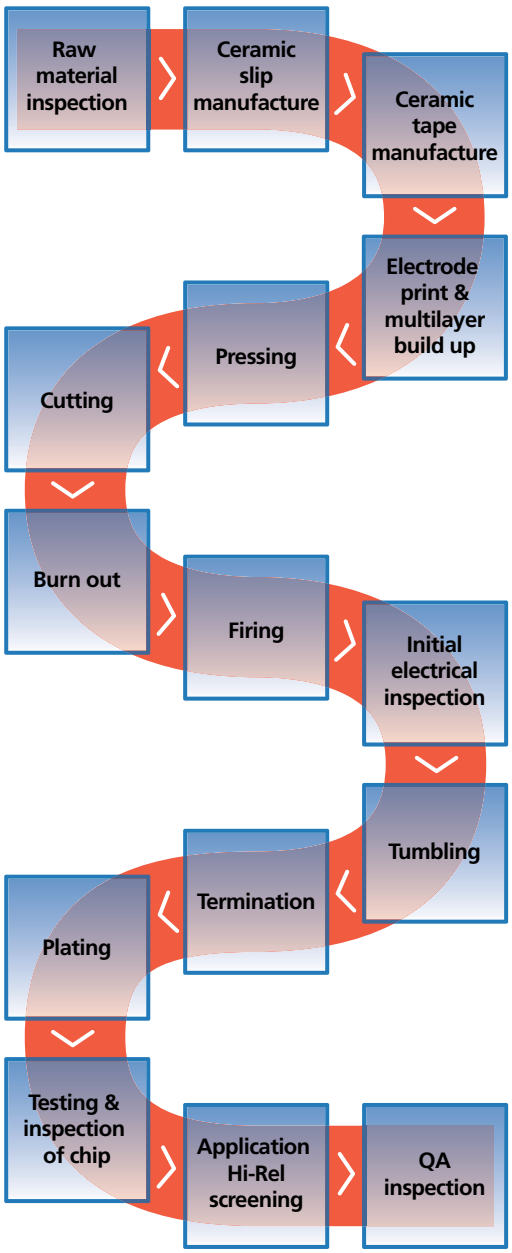
Novacap maintains both ISO14001, Environmental Management System and OHSAS 18001 Health and Safety Management System approvals that require and ensure compliance with corresponding legislation such as REACH.

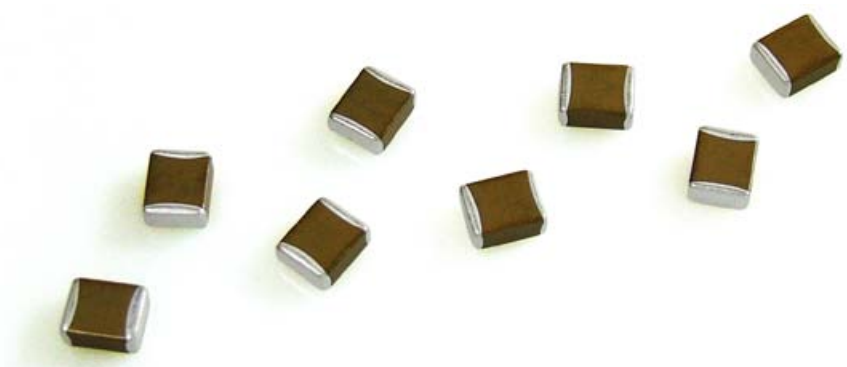
For further information, please contact the sales office.

Novacap's "Green" Policy

It is Novacap policy to comply with the global environmental directives pertaining to the use of hazardous materials in manufacturing and to that end can supply products meeting RoHS standards – details can be found throughout this catalog.

Process flow diagram for Novacap ceramic chip capacitors





MIL-PRF-123 Periodic Lot Testing

Test Name	Test Method	Details	Sample Size	Rejects Allowed
Electrical Characteristics				
Capacitance/Dissipation Factor	MIL-STD-202 M305	1Vrms, 1kHz	325	0
Insulation Resistance	MIL-STD-202 M302	Rated Voltage 1000 MΩ - µF min	325	0
Dielectric Withstanding Voltage	MIL-STD-202 M301	2.5x Rated Vdc min	325	0
Group A - Subgroup 1				
Thermal Shock	MIL-PRF-123 4.6.6.1 MIL-STD-202 M107	20 cycles -55°C to +125°C	325	5% PDA (16 pcs) and < 0.2% (0 pcs) in last 48 hrs
Voltage Conditioning	MIL-PRF-123 4.6.6.2	2x Rated Vdc, 125°C, 168-264 Hours		
Group A - Subgroup 2				
"Visual and mechanical inspection; material, physical dimensions, design, construction, marking and workmanship".	MIL-PRF-123 4.6.3	Parts must pass criteria	20	0
Group A - Subgroup 3				
Destructive Physical Analysis	MIL-PRF-123 4.6.11	Parts must pass criteria	10	0
Group B - Subgroup 1				
Thermal Shock	MIL-PRF-123 4.6.6.1 MIL-STD-202 M107	100 cycles -55°C to +125°C	200	Report
Life Test	MIL-PRF-123 4.6.19 MIL-STD-202 M108	2xVdc, 125°C, 1000 Hours		
Group B - Subgroup 2				
Humidity, Steady State Low Voltage	MIL-PRF-123 4.6.16.1 MIL-STD-202 M103	85% RH, 85°C, 240 Hrs, 1.3V	12	0
Group B - Subgroup 3				
Voltage - Temperature Limits	MIL-PRF-123 4.6.15	-55°C -25°C -125°C 1Vrms ±15%(X7R), ±30ppm (C0G)	**12**	**1**
Moisture Resistance	MIL-PRF-123 4.6.16.2 MIL-STD-202 M106	20 cycles 25V 1st 10 cycles		
Group C - Subgroup 2 Chip Devices				
Terminal Strength	MIL-PRF-123 4.6.12.2 MIL-STD-202 M211	Pull test, nail leads, x-x kg	**6**	**1**
Solderability	MIL-PRF-123 4.6.13.2 MIL-STD-202 M208 J-STD 002C	8 Hr Steam Age, SAC305 at 255°C, 5 seconds, 95% coverage	**6**	
Resistance To Soldering Heat	MIL-PRF-123 4.6.14.2 MIL-STD-202 M210	60/40 Tin/Lead at 230°C, 2 five second dips	**6**	

C0G and X7R test packages available on request.

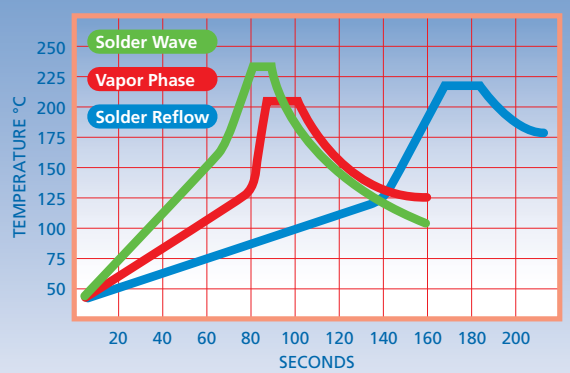
Bonding of capacitors to substrates can be categorized into two methods, those involving solder, which are prevalent, and those using other materials, such as epoxies and thermo-compression or ultrasonic bonding with wire.

The amount of solder applied to the chip capacitor will influence the reliability of the device. Excessive solder can create thermal and tensile stresses on the component which could lead to fracturing of the chip or the solder joint itself. Insufficient or uneven solder application can result in weak bonds; rotation of the device off line or lifting of one terminal off the pad (tombstoning).

There are practical limitations on capacitor sizes that prohibit reliable direct mounting of chip capacitors larger than 2225 to a substrate. Without mechanical restriction, thermally induced stresses are released once the capacitor attains a steady state condition, at any given temperature. Capacitors bonded to substrates, however, will retain some stress, due primarily to the mismatch of expansion of the component to the substrate; the residual stress on the chip is also influenced by the ductility and hence the ability of the bonding medium to relieve the stress. Unfortunately, the thermal expansions of chip capacitors differ significantly from those of substrate materials. At 25°C to 300°C, capacitors typically range in expansion coefficient from 8.3 x 10-6 to 12.2 x 10-6 in/in/°C, while 99% Alumina is approximately 6.0 x 10-6 in/in/°C and P.C. board is typically 16.0 x 10-6 in/in/°C.

Soldering

The volume of solder is process and board pad size dependent. Soldering methods commonly used in the industry, and recommended, are Reflow Soldering, Wave Soldering, and to a lesser extent, Vapor Phase Soldering. All these methods involve thermal cycling of the components and



Recommendations

Preheat/Cooling rates not to exceed 120°C /minute with ΔT spikes to max temperature not to exceed 100°C for 1812 size and smaller.

therefore the rate of heating and cooling must be controlled to preclude thermal shocking of the devices. In general, rates which do not exceed 120°C per minute and a T spike of 100°C maximum for any soldering process on sizes 1812 and smaller is advisable. Other precautions include post soldering handling, primarily avoidance of rapid cooling with contact with heat sinks, such as conveyors or cleaning solutions.

Wave Soldering exposes the devices to a large solder volume; hence the pad size area must be restricted to accept an amount of solder which is not detrimental to the chip size utilized. Typically the pad width is 66% of the component width, and the length is .030" (.760 mm) longer than the termination band on the chip. For example, an 0805 chip which is .050" wide and has a .020" termination band therefore requires a pad .033" wide by .050" in length. Opposing pads should be identical in size to preclude uneven solder fillets and mismatched surface tension forces which can misalign the device. It is preferred that the pad layout results in alignment of the long axis of the chips at right angles to the solder wave, to promote even wetting of all terminals. Orientation of components in line with the board travel direction may require dual waves with solder turbulence to preclude cold solder joints on the trailing terminals of the devices, as these are blocked from full exposure to the solder by the body of the capacitor.

Novacap publishes a technical brochure which provides detailed information on the properties of ceramic chip capacitors, dielectric behavior, product classifications, test and quality standards, and other information relevant to their use.

The Novacap technical brochure is available upon request. For quick reference see the brochure on the Novacap website at www.novacap.com

Restrictions in chip alignment do not apply to Solder Reflow or Vapor Phase processes, where the solder volume is controlled by the solder paste deposition on the circuit pads. Novacap has adopted the IPC-SM-782 methodology for solder reflow land patterns. The Novacap recommended solder pads brochure is available for reference on our website. Large chips are more prone to thermal shock as their greater bulk will result in sharper thermal gradients within the device during thermal cycling. Units larger than 1812 experience excessive stress if processed through the fast cycles typical of solder wave or vapor phase operations. Solder reflow is most applicable to the larger chips as the rates of heating and cooling can be slowed within safe limits.

Attachment using a soldering iron requires extra care, particularly with large components, as thermal gradients are not easily controlled and may cause cracking of the chip. Precautions include preheating of the assembly to within 100°C of the solder flow temperature; the use of a fine tip iron which does not exceed 30 watts and limitation of contact of the iron to the circuit pad areas only.

Bonding

Hybrid assembly using conductive epoxy or wire bonding requires the use of silver palladium or gold terminations. Nickel barrier termination is not practical in these applications, as intermetallics will form between the dissimilar metals. The ESR will increase over time and may eventually break contact when exposed to temperature cycling.

Cleaning

Chip capacitors can withstand common agents such as water, alcohol and degreaser solvents used for cleaning boards. Ascertain that no flux residues are left on the chip surfaces as these diminish electrical performance.

FlexiCap™ Polymer Termination

FlexiCap™ termination

MLCCs are widely used in electronic circuit design for a multitude of applications. Their small package size, technical performance and suitability for automated assembly makes them the component of choice.

However, despite the technical benefits, ceramic components are brittle and need careful handling on the production floor. In some circumstances they may be prone to mechanical stress damage if not used in an appropriate manner. Board flexing, depanelization, mounting through hole components, poor storage and automatic circuit testing may all result in cracking.

Careful process control is important at all stages of circuit board assembly and transportation - from component placement to test and packaging. Any significant board flexing may result in stress fractures in ceramic devices that may not always be evident during the board assembly process. Sometimes it may be the end customer who finds out - when equipment fails!

The solution - FlexiCap™

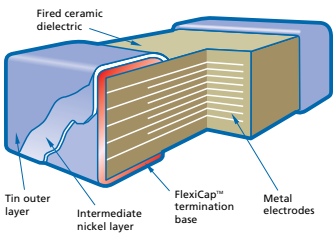
FlexiCap™ was developed as a result of listening to customers' experiences of stress damage to MLCCs from many manufacturers, often caused by variations in production processes.

Our answer is a proprietary flexible epoxy polymer termination material, that is applied to the device under the usual nickel barrier finish. FlexiCap™ will accommodate a greater degree of board bending than conventional capacitors.

FlexiCap™ termination

All capacitance ranges are available with FlexiCap™ termination material offering increased reliability and superior mechanical performance (board flex and temperature cycling) when compared with standard termination materials. FlexiCap™ capacitors enable the board to be bent almost twice as much before mechanical cracking occurs.

FlexiCap™ is also suitable for Space applications having passed thermal vacuum outgassing tests.



FlexiCap™ MLCC cross section

FlexiCap™ benefits

With traditional termination materials and assembly, the chain of materials from bare PCB to soldered termination, provides no flexibility. In circumstances where excessive stress is applied - the weakest link fails. This means the ceramic itself may fail.

The benefit to the user is to facilitate a wider process window - giving a greater safety margin and substantially reducing the typical root causes of mechanical stress cracking.

FlexiCap™ may be soldered using your traditional wave or reflow solder techniques and needs no adjustment to equipment or current processes.

Novacap has delivered millions of FlexiCap™ components and during that time has collected substantial test and reliability data, working in partnership with customers world wide, to eliminate mechanical cracking.

An additional benefit of FlexiCap™ is that MLCCs can withstand temperature cycling -55°C to 125°C in excess of 1,000 times without cracking.

FlexiCap™ termination has no adverse effect on any electrical parameters, nor affects the operation of the MLCC in any way.

● Picture taken at 1,000x magnification using a SEM to demonstrate the fibrous nature of the FlexiCap™ termination that absorbs increased levels of mechanical stress.

Available on the following ranges:

- All High Reliability ranges
- Standard and High Voltage chips
- X8R High Temperature capacitors

Summary of PCB bend test results

The bend tests conducted on X7R have proven that the FlexiCap™ termination withstands a greater level of mechanical stress before mechanical cracking occurs.

The AEC-Q200 test for X7R requires a bend level of 2mm minimum and a cap change of less than 10%.

Product X7R	Typical bend performance under AEC-Q200 test conditions
Standard termination	2mm to 3mm
FlexiCap™ termination	Typically 8mm to 10mm

Application notes

FlexiCap™ may be handled, stored and transported in the same manner as standard terminated capacitors. The requirements for mounting and soldering FlexiCap™ are the same as for standard SMD capacitors.

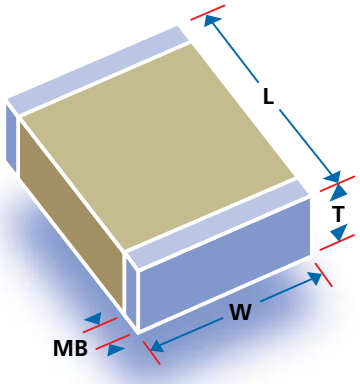
For customers currently using standard terminated capacitors there should be no requirement to change the assembly process when converting to FlexiCap™.

Based upon board bend tests in accordance with IEC 60384-1 the amount of board bending required to mechanically crack a FlexiCap™ terminated capacitor is significantly increased compared with standard terminated capacitors.

It must be stressed however, that capacitor users must not assume that the use of FlexiCap™ terminated capacitors will totally eliminate mechanical cracking. Good process controls are still required for this objective to be achieved.

Product not available for 200°C applications.

Chip Dimensions



Dimensions - inches (mm)

Size	Length (L)	Width (W)	Max. Thickness (T)*	Termination Band (MB)
0402	0.040 ± 0.004 (1.02 ± 0.102)	0.020 ± 0.004 (0.508 ± 0.102)	0.024 (0.610)	0.010 ± 0.006 (0.254 ± 0.152)
0504	0.050 ± 0.006 (1.27 ± 0.152)	0.040 ± 0.006 (1.02 ± 0.152)	0.044 (1.12)	0.014 ± 0.006 (0.356 ± 0.152)
RF0505	0.055 +0.015 -0.010 (1.4 +0.38 -0.25)	0.055 ± 0.015 (1.40 ± 0.381)	0.057 (1.45)	0.014 ± 0.006 (0.356 ± 0.152)
0603	0.060 ± 0.006 (1.52 ± 0.152)	0.030 ± 0.006 (0.762 ± 0.152)	0.035 (0.889)	0.014 ± 0.006 (0.356 ± 0.152)
0805	0.080 ± 0.008 (2.03 ± 0.203)	0.050 ± 0.008 (1.27 ± 0.203)	0.054 (1.37)	0.020 ± 0.010 (0.508 ± 0.254)
0907	0.090 ± 0.008 (2.29 ± 0.203)	0.070 ± 0.008 (1.78 ± 0.203)	0.060 (1.52)	0.020 ± 0.010 (0.508 ± 0.254)
1005	0.100 ± 0.008 (2.54 ± 0.203)	0.050 ± 0.008 (1.27 ± 0.203)	0.054 (1.37)	0.020 ± 0.010 (0.508 ± 0.254)
RF1111	0.110+0.025 -0.010 (2.79 +0.64 -0.25)	0.110 ± 0.015 (2.79 ± 0.381)	0.102 (2.59)	0.020 ± 0.010 (0.508 ± 0.254)
1206	0.125 ± 0.008 (3.18 ± 0.203)	0.060 ± 0.008 (1.52 ± 0.203)	0.064 (1.63)	0.020 ± 0.010 (0.508 ± 0.254)
1210	0.125 ± 0.008 (3.18 ± 0.203)	0.100 ± 0.008 (2.54 ± 0.203)	0.065 (1.65)	0.020 ± 0.010 (0.508 ± 0.254)
1515	0.150 ± 0.015 (3.81 ± 0.381)	0.150 ± 0.015 (3.81 ± 0.381)	0.130 (3.30)	0.030 ± 0.015 (0.762 ± 0.381)
1808	0.180 ± 0.012 (4.57 ± 0.305)	0.080 ± 0.008 (2.03 ± 0.203)	0.065 (1.65)	0.024 ± 0.014 (0.610 ± 0.356)
1812	0.180 ± 0.012 (4.57 ± 0.305)	0.125 ± 0.008 (3.18 ± 0.203)	0.065 (1.65)	0.024 ± 0.014 (0.610 ± 0.356)
1825	0.180 ± 0.012 (4.57 ± 0.305)	0.250 ± 0.015 (6.35 ± 0.381)	0.080 (2.03)	0.024 ± 0.014 (0.610 ± 0.356)
2020	0.200 ± 0.015 (5.08 ± 0.381)	0.200 ± 0.015 (5.08 ± 0.381)	0.180 (4.57)	0.024 ± 0.014 (0.610 ± 0.356)
2221	0.220 ± 0.015 (5.59 ± 0.381)	0.210 ± 0.015 (5.33 ± 0.381)	0.080 (2.03)	0.030 ± 0.015 (0.762 ± 0.381)
2225	0.220 ± 0.015 (5.59 ± 0.381)	0.250 ± 0.015 (6.35 ± 0.381)	0.080 (2.03)	0.030 ± 0.015 (0.762 ± 0.381)
2520	0.250 ± 0.015 (6.35 ± 0.381)	0.200 ± 0.015 (5.08 ± 0.381)	0.180 (4.57)	0.030 ± 0.015 (0.762 ± 0.381)
RF2525	0.230 +0.020 -0.012 (5.84 +0.51 -0.30)	0.250 ± 0.015 (6.35 ± 0.381)	0.165 (4.19)	0.030 ± 0.015 (0.762 ± 0.381)
3333	0.330 ± 0.017 (8.38 ± 0.432)	0.330 ± 0.017 (8.38 ± 0.432)	0.250 (6.35)	0.030 ± 0.015 (0.762 ± 0.381)
3530	0.350 ± 0.018 (8.89 ± 0.457)	0.300 ± 0.015 (7.62 ± 0.381)	0.250 (6.35)	0.030 ± 0.015 (0.762 ± 0.381)
4040	0.400 ± 0.020 (10.2 ± 0.508)	0.400 ± 0.020 (10.2 ± 0.508)	0.300 (7.62)	0.040 ± 0.020 (1.02 ± 0.508)
4540	0.450 ± 0.023 (11.4 ± 0.584)	0.400 ± 0.020 (10.2 ± 0.508)	0.300 (7.62)	0.040 ± 0.020 (1.02 ± 0.508)
5440	0.540 ± 0.027 (13.7 ± 0.686)	0.400 ± 0.020 (10.2 ± 0.508)	0.300 (7.62)	0.040 ± 0.020 (1.02 ± 0.508)
5550	0.550 ± 0.028 (14.0 ± 0.711)	0.500 ± 0.025 (12.7 ± 0.635)	0.300 (7.62)	0.040 ± 0.020 (1.02 ± 0.508)
6560	0.650 ± 0.033 (16.5 ± 0.838)	0.600 ± 0.030 (15.2 ± 0.762)	0.300 (7.62)	0.040 ± 0.020 (1.02 ± 0.508)
7565	0.750 ± 0.038 (19.1 ± 0.965)	0.650 ± 0.033 (16.5 ± 0.838)	0.300 (7.62)	0.040 ± 0.020 (1.02 ± 0.508)

* Non standard thicknesses are available - consult the sales office for details.

Chip Marking System

If required, we can mark capacitors with the EIA 198 two digit code to show the capacitance value of the part. On chips larger than 3333, or for leaded encapsulated devices, ink marking is available. However, for chip sizes 0805 through to 3333 identification marking is accomplished by using either laser or ink jet printer. This system does not degrade the ceramic surface, or induce microcracks in the part.

Marking for other sizes may be available upon special request to determine if applicable; please contact the sales office.

Marking is an option, and needs to be specified when ordering by using the letter M in the part number code, see page 15 for details.

Two position alpha numeric marking is available on chip sizes 0805 through 3333.
The marking denotes retma value and significant figures of capacitance (see table) eg: A5 = 100,000pF.

Three position alpha numeric marking is available on chip sizes 1206 and larger.
The making denotes Novacap as vendor (N), followed by the standard two digit alpha numeric identification.

Marking Code - value in picofarads for alpha-numeric code

Number		0	1	2	3	4	5	6	7
Letter	A	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000
	B	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000
	C	1.2	12	120	1,200	12,000	120,000	1,200,000	12,000,000
	D	1.3	13	130	1,300	13,000	130,000	1,300,000	13,000,000
	E	1.5	15	150	1,500	15,000	150,000	1,500,000	15,000,000
	F	1.6	16	160	1,600	16,000	160,000	1,600,000	16,000,000
	G	1.8	18	180	1,800	18,000	180,000	1,800,000	18,000,000
	H	2.0	20	200	2,000	20,000	200,000	2,000,000	20,000,000
	J	2.2	22	220	2,200	22,000	220,000	2,200,000	22,000,000
	K	2.4	24	240	2,400	24,000	240,000	2,400,000	24,000,000
	L	2.7	27	270	2,700	27,000	270,000	2,700,000	27,000,000
	M	3.0	30	300	3,000	30,000	300,000	3,000,000	30,000,000
	N	3.3	33	330	3,300	33,000	330,000	3,000,000	33,000,000
	P	3.6	36	360	3,600	36,000	360,000	3,600,000	36,000,000
	Q	3.9	39	390	3,900	39,000	390,000	3,900,000	39,000,000
	R	4.3	43	430	4,300	43,000	430,000	4,300,000	43,000,000
	S	4.7	47	470	4,700	47,000	470,000	4,700,000	47,000,000
	T	5.1	51	510	5,100	51,000	510,000	5,100,000	51,000,000
	U	5.6	56	560	5,600	56,000	560,000	5,600,000	56,000,000
	V	6.2	62	620	6,200	62,000	620,000	6,200,000	62,000,000
	W	6.8	68	680	6,800	68,000	680,000	6,800,000	68,000,000
	X	7.5	75	750	7,500	75,000	750,000	7,500,000	75,000,000
	Y	8.2	82	820	8,200	82,000	820,000	8,200,000	82,000,000
	Z	9.1	91	910	9,100	91,000	920,000	9,200,000	92,000,000
	a	2.5	25	250	2,500	25,000	250,000	2,500,000	25,000,000
	b	3.5	35	350	3,500	35,000	350,000	3,500,000	35,000,000
	d	4.0	40	400	4,000	40,000	400,000	4,000,000	40,000,000
	e	4.5	45	450	4,500	45,000	450,000	4,500,000	45,000,000
	f	5.0	50	500	5,000	50,000	500,000	5,000,000	50,000,000
	m	6.0	60	600	6,000	60,000	600,000	6,000,000	60,000,000
	n	7.0	70	700	7,000	70,000	700,000	7,000,000	70,000,000
	t	8.0	80	800	8,000	80,000	800,000	8,000,000	80,000,000
	y	9.0	90	900	9,000	90,000	900,000	9,000,000	90,000,000

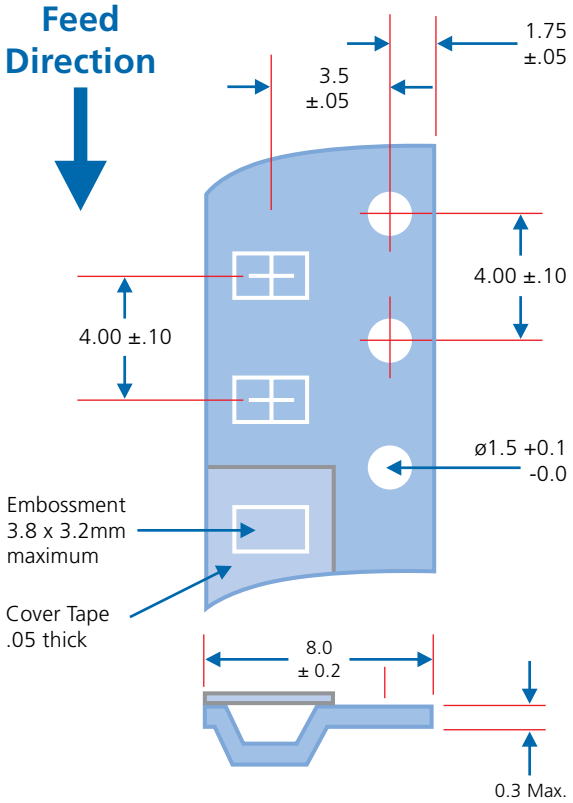
Chip Tape and Reel Details

Novacap chip capacitors are available packaged in 8mm to 24mm embossed carrier, per EIA 481. Specify the reeled option (T) in the Novacap part number code. Chips are also supplied in bulk or waffle pack.

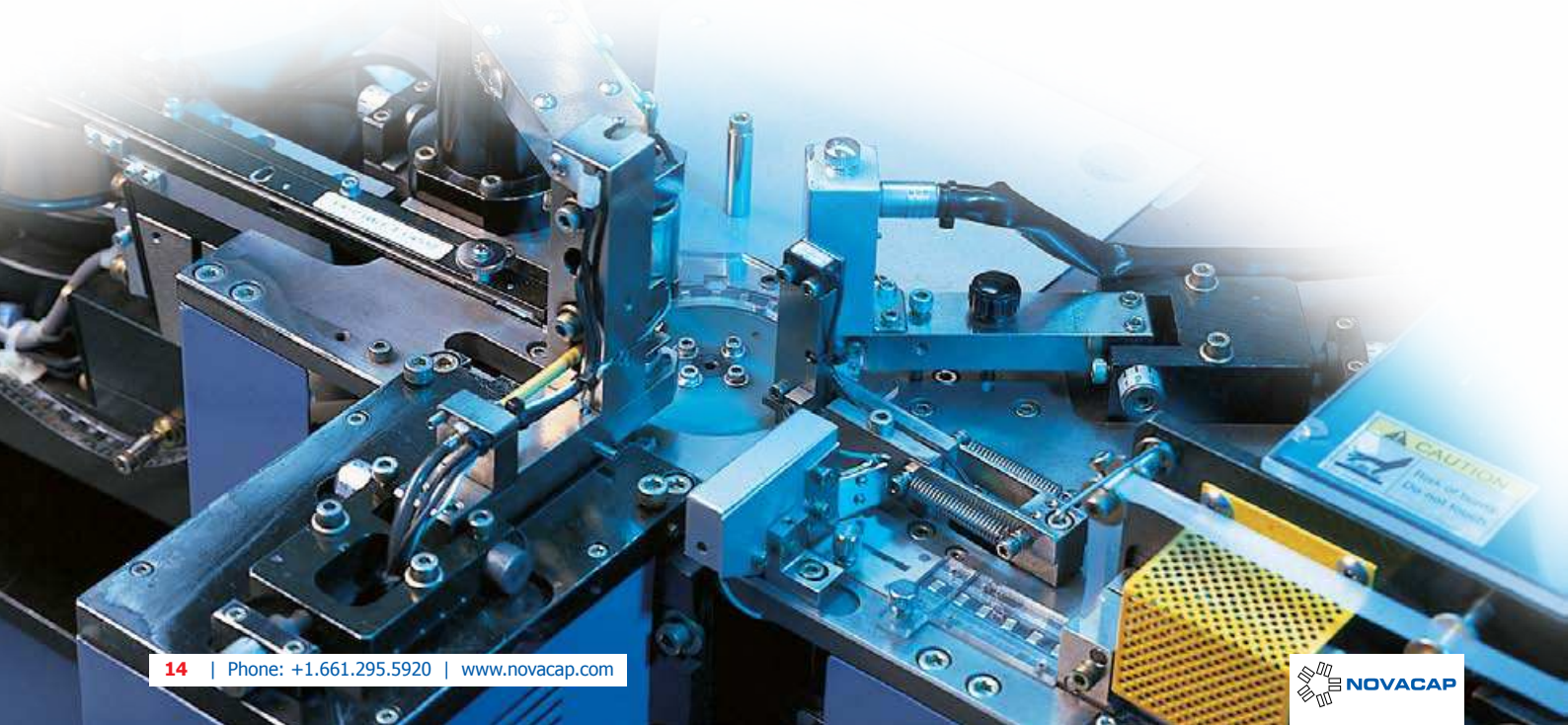
Units per reel (typical)

Chip size	Tape width	Tape pocket pitch	Units per reel*	
			7"(178mm) dia.	13"(330mm) dia.
0402	8 mm	2 mm	10,000	•
0504	8 mm	4 mm	3,000-4,000	15,000
0603	8 mm	4 mm	3,000-4,000	15,000
0805	8 mm	4 mm	3,000-4,000	15,000
1005	8 mm	4 mm	2,000-4,000	15,000
1206	8 mm	4 mm	2,000-4,000	15,000
1210	8 mm	4 mm	2,000-3,000	10,000
1505	12 mm	4 mm	2,000-3,000	10,000
1808	12 mm	4 mm	2,000-3,000	10,000
1812	12 mm	8 mm	1,000	10,000
1825	12 mm	8 mm	1,000	5,000
2221	12 mm	8 mm	1,000	5,000
2225	12 mm	8 mm	1,000	5,000
2628	16 mm	12 mm	•	1,000
3333	16 mm	12 mm	•	1,000
3530	16 mm	12 mm	•	1,000
4040	16 mm	12 mm	•	1,000

* Quantity per reel varies with chip thickness. Thicker chips (typically higher capacitance values) will result in lesser quantities. Please specify preferred reel size when ordering.



Dimensions for 8mm tape with 4mm pitch.



Chip Ordering Information

Prefix	Case Size	Dielectric	Capacitance	Capacitance Tolerance	Voltage	Termination	Special Thickness	High Reliability Testing	Packaging	Marking		High Reliability Test Criteria
XX	1206	N	472	J	101	N	X050	H	T	M	-	HB

Capacitance Code

1st two digits are significant, third digit denotes number of zeros, R = decimal
Examples:

- 1R0 = 1.0pF
- 120 = 12pF
- 471 = 470pF
- 102 = 1,000pF
- 273 = 0.027µF
- 474 = 0.47µF
- 105 = 1.0µF

Special Thickness

None	Standard thickness as per Novacap catalog specifications
X	Denotes a special thickness other than standard. Specify in inches if required. (As shown above **X** = 0.050")

Packaging

None	Bulk
T	Tape & Reel
W	Waffle Pack

Marking

None	Unmarked
M	Marked *Marking not available on sizes ≤ 0603

High Reliability Testing

None	Standard product
H	High Reliability Testing
H	High Temp Screening

Hi-Reliability Testing Criteria

HB	MIL-PRF-55681 Group A
HV	MIL-PRF-49467 Group A
HS	MIL-PRF-123 Group A

Dielectric Codes

N	C0G/NP0	Ultra Stable
M	C0G/NP0	Ultra Stable Magnetic Free
F	C0G/NP0	High Temp. (up to 160°C)
D	C0G/NP0	High Temp. (up to 200°C)
K	R3L	Ultra Stable
R	R2D	Pulse Energy
Y	Y5V	General Purpose
Z	Z5U	General Purpose
B	X7R	Stable
C	X7R	Stable Magnetic Free
X	BX	MIL
S	X8R	High Temp. (up to 150°C)
E	Class II	High Temp. (up to 200°C)
G	Class II	High Temp. (up to 160°C)
W	X5R	Stable
RN	Lead free C0G/NP0	Ultra Stable
RB	Lead free X7R	Stable
BB	X7R BME	Stable
BW	X5R BME	Stable

Voltage Code

1st two digits are significant, third digit denotes number of zeros. For example:

- 160 = 16 Volts
- 101 = 100 Volts
- 501 = 500 Volts
- 102 = 1,000 Volts
- 502 = 5,000 Volts
- 103 = 10,000 Volts

Termination Codes

P	Palladium Silver	
PR	Palladium Silver*	
K	Solderable Palladium Silver*	
N	Nickel Barrier*	100% tin
Y	Nickel Barrier	90% tin, 10% lead
NG	Nickel Barrier Gold Flash*	
C	FlexiCap™/Nickel Barrier*	100% tin
D	FlexiCap™/Nickel Barrier	90% tin, 10% lead
B	Copper Barrier*	100% tin
E	Copper Barrier	90% tin, 10% lead
S	Silver*	

* Indicates RoHS terminations

Capacitance Tolerance Codes

Code	Tolerance (* Not RF series)		C0G/NP0 N	C0G/NP0 M	C0G/NP0 F/D	R3L K	R2D R	Y5V Z5U Y/Z	X7R B	X7R C	BX X	X8R S	Class II E/G	X5R W	Positive VTC P
B	±0.10pF	Cap. Value <10pF	•	•											
C	±0.25pF		•	•		•									
D	±0.50pF		•	•		•									
F	±1%		•	•	•										
G	±2%		•	•	•	•									
J	±5%		•	•	•	•	•		•*	•	•*	•	•		
K	±10%		•	•	•	•	•		•	•	•	•	•	•	•
M	±20%		•		•	•	•	•	•	•	•	•	•	•	•
Z	+80% -20%		•				•	•	•*						•
P	+100% -0%		•				•	•	•*						•

Prefix Definitions

None	Standard chip	
RF	Improved ESR Capacitor	p. 23
LS	Y³ Certified Safety Capacitor	p. 42 - 43
ES	Y² Certified Safety Capacitor	p. 42 - 43
ST	Stacked Capacitor Assembly	p. 48 - 53
SM	Stacked Hi-Rel Capacitor Assembly	p. 48 - 53
CR	Cap-Rack Capacitor Array	p. 54
RC	Bleed Resistor	p. 58 - 61

Commercial Chip - C0G 16Vdc to 10kVdc

A range of commercial MLC chip capacitors in Ultra stable EIA Class I C0G, or NP0, dielectric. C0G chips are used in precision circuitry requiring Class I stability and exhibit linear temperature coefficient, low loss and stable electrical properties with time, voltage and frequency.

Designed for surface mount application with nickel barrier terminations making them suitable for solder wave and reflow solder board attachment as well as vapor phase attachment for part sizes 2225 or smaller. Silver-palladium terminations are also available for hybrid use with conductive epoxy.

Standard EIA case sizes and available C/V values are listed below - special sizes, thicknesses and other voltage ratings are available; please contact the sales office for information.

Capacitance and voltage selection for popular chip sizes

Size	0402	0504	0603	0805	1005	1206	1210	1515	1808		1812		1825	
Min cap.	0R3	0R5	0R3	0R5	0R5	3R0	5R0	3R0	5R0	5R0	100	100	150	150
Tmax inches:	0.024	0.044	0.035	0.054	0.054	0.064	0.065	0.130	0.065	0.080*	0.065	0.100*	0.080	0.140*
mm:	0.61	1.12	0.89	1.37	1.37	1.63	1.63	3.02	1.63	2.03	1.63	2.54	2.03	3.56
16V	271	222	152	562	822	153	273	473	393	393	563	563	104	104
25V	221	182	122	472	682	123	273	393	333	333	563	563	104	104
50V	181	152	102	392	562	123	223	333	223	273	393	393	104	104
100V	181	152	102	392	562	103	183	333	153	223	273	393	683	823
200V	101	821	561	182	272	562	103	223	103	153	183	273	473	683
250V	560	561	331	152	222	392	822	223	682	103	153	223	393	563
300V	•	•	•	821	122	272	472	153	472	562	103	153	223	473
400V	•	•	•	821	122	182	472	103	472	472	103	123	223	333
500V	•	•	•	821	122	182	392	822	472	472	103	123	223	273
600V	•	•	•	681	102	152	332	682	392	472	822	103	183	183
800V†	•	•	•	681	102	152	332	682	392	472	822	103	183	183
1kV†	•	•	•	471	391	102	222	562	222	332	472	822	103	153
1.5kV†	•	•	•	•	•	561	122	392	122	182	272	472	562	103
2kV†	•	•	•	•	•	391	821	272	821	122	182	272	272	562
3kV†	•	•	•	•	•	•	•	122	391	471	821	122	122	222
4kV†	•	•	•	•	•	•	•	681	221	271	471	821	681	122
5kV†	•	•	•	•	•	•	•	•	•	•	•	•	391	821
6kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
7kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
8kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
10kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•

† Units rated above 800V may require conformal coating to preclude arcing over chip surface

Commercial Chip - C0G 16Vdc to 10kVdc

- For dielectric characteristics see page 4.
- For dimensions see page 12.
- For termination options see pages 3 & 15.
- For capacitance tolerances available see page 15.
- For ordering information see page 15.

Note: Maximum capacitance values are shown below as 3 digit code: 2 significant figures followed by the no. of zeros e.g. 183 = 18,000pF. R denotes decimal e.g. 2R7 = 2.7pF.

Capacitance and voltage selection for popular chip sizes

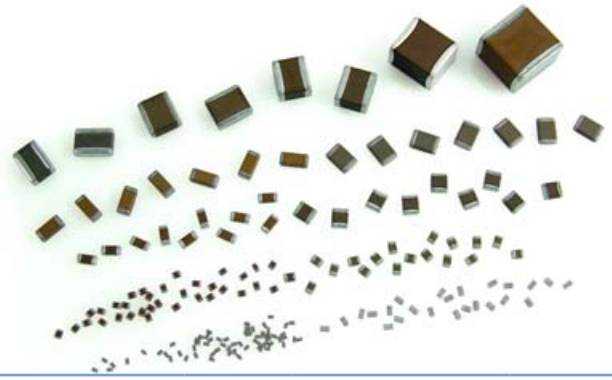
2020	2221	2225		2520	3333	3530	4040	4540	5440	5550	6560	7565	Size
270	270	270	270	390	390	390	390	390	390	390	560	101	Min cap.
0.180 4.57	0.080 2.03	0.080 2.03	0.150* 3.81	0.180 4.57	0.250 6.35	0.250 6.35	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	:inches Tmax :mm
683	104	124	124	104	184	184	334	334	394	394	684	824	16V
683	104	124	124	104	184	184	334	334	394	394	684	824	25V
683	104	124	124	104	154	184	274	334	394	394	684	824	50V
563	683	823	104	823	124	154	224	274	274	274	474	564	100V
563	473	563	823	683	104	124	184	224	274	274	474	564	200V
473	393	473	683	563	104	124	184	204	224	224	394	474	250V
393	223	273	563	473	823	104	154	184	224	224	394	474	300V
333	223	273	393	393	563	823	124	154	184	184	334	394	400V
273	223	273	333	393	473	683	104	124	154	184	274	334	500V
153	183	273	273	223	393	393	823	823	104	154	224	274	600V
153	183	273	273	183	333	333	563	683	823	124	184	224	800V†
103	103	153	223	123	273	273	563	563	683	104	154	184	1kV†
822	562	822	153	103	183	223	393	393	393	563	823	124	1.5kV†
472	272	392	822	562	153	153	273	333	333	473	683	104	2kV†
222	122	182	332	272	822	103	183	223	223	333	473	683	3kV†
122	681	102	182	152	332	562	123	123	123	183	273	393	4kV†
821	391	561	122	102	222	332	682	822	822	123	183	223	5kV†
•	•	•	•	•	182	182	392	392	472	562	103	123	6kV†
•	•	•	•	•	•	122	272	272	332	472	682	822	7kV†
•	•	•	•	•	•	102	222	222	272	332	562	682	8kV†
•	•	•	•	•	•	821	152	182	182	272	392	472	9kV†
•	•	•	•	•	•	681	122	152	152	222	332	392	10kV†

* Denotes non standard chip thickness.
Order code needs to have an 'X' inserted together with the dimension in inches e.g. X080 where dimension is 0.080"

Commercial Chip - R3L 16Vdc to 5kVdc

A range of commercial MLC chip capacitors in R3L dielectric. This is a Class I temperature compensating N2200 dielectric with an energy density that exceeds conventional Class I materials. R3L has a predictable negative temperature coefficient, low loss, stable electrical properties with time, voltage, and frequency.
The components are non-piezoelectric and are well suited for repetitive high current and pulse type applications.

With exceptionally low ESR, ESL, and low signal distortion applications include power supply filtering, energy storage, coupling/decoupling and snubber.



Capacitance and voltage selection for popular chip sizes

Size	0402	0504	0603	0805	1206	1210	1515	1808	1812	1825	2020
Min cap.	1R5	2R2	2R2	2R2	8R2	220	220	220	390	680	101
Tmax inches:	0.024	0.044	0.035	0.054	0.064	0.065	0.130	0.065	0.065	0.080	0.180
mm:	0.61	1.12	0.89	1.37	1.63	1.63	3.02	1.63	1.63	2.03	4.57
16V	391	472	222	103	223	473	823	473	104	184	154
25V	391	472	222	103	223	473	823	473	104	184	154
50V	391	472	222	103	223	393	683	333	683	184	154
100V	391	472	222	103	223	393	683	333	683	154	124
200V	221	272	122	472	123	223	473	223	393	104	104
250V	121	152	821	332	103	183	473	183	333	823	823
300V	•	•	•	222	562	123	333	103	223	563	683
400V	•	•	•	182	392	103	223	103	223	563	683
500V	•	•	•	182	392	822	223	822	183	473	563
600V	•	•	•	152	272	682	123	682	153	333	393
800V†	•	•	•	821	152	392	103	392	103	153	223
1kV†	•	•	•	471	102	222	822	222	562	123	153
1.5kV†	•	•	•	•	471	122	392	122	272	682	103
2kV†	•	•	•	•	271	561	182	561	122	332	562
3kV†	•	•	•	•	•	•	102	271	681	152	272
4kV†	•	•	•	•	•	•	471	151	331	821	152
5kV†	•	•	•	•	•	•	•	•	•	561	102

† Units rated above 800V may require conformal coating to preclude arcing over chip surface

Commercial Chip - R3L 16Vdc to 5kVdc

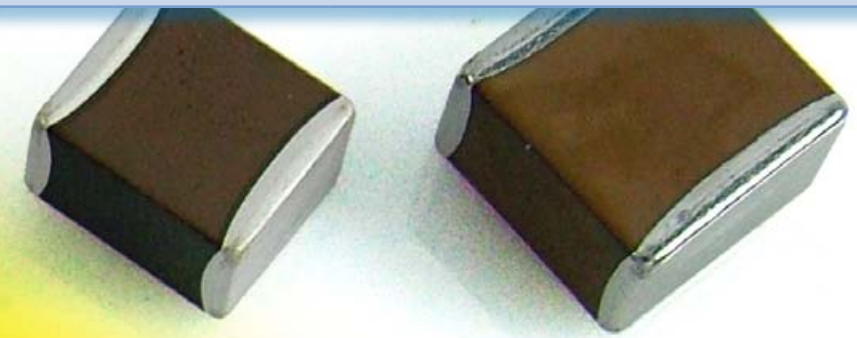
- For dielectric characteristics see page 5.
- For dimensions see page 12.
- For termination options see pages 3 & 15.
- For capacitance tolerances available see page 15.
- For ordering information see page 15.

Note: Maximum capacitance values are shown below as 3 digit code: 2 significant figures followed by the no. of zeros e.g. 183 = 18,000pF. R denotes decimal e.g. 2R7 = 2.7pF.

Capacitance and voltage selection for popular chip sizes

2221	2225	2520	3333	3530	4040	4540	5440	5550	6560	7565	Size
101	101	101	151	151	151	151	151	151	221	391	Min cap.
0.080 2.03	0.080 2.03	0.180 4.57	0.250 6.35	0.250 6.35	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	:inches Tmax :mm
184	224	224	334	334	564	564	684	824	125	185	16V
184	224	184	334	334	564	564	684	824	125	185	25V
184	224	184	334	334	564	564	684	824	125	185	50V
154	184	184	334	334	474	564	684	824	125	155	100V
104	124	154	224	224	394	394	474	684	105	125	200V
823	104	124	184	184	334	334	394	564	824	105	250V
563	683	104	184	184	274	274	334	474	684	824	300V
473	563	823	154	154	224	224	274	394	564	684	400V
393	473	683	124	124	224	224	274	334	474	564	500V
333	393	563	104	104	184	184	224	274	394	474	600V
223	273	393	563	563	104	124	124	184	274	334	800V†
123	153	223	473	473	823	104	104	154	224	274	1kV†
562	822	123	333	333	563	563	563	104	154	184	1.5kV†
332	392	682	223	223	393	473	473	683	104	124	2kV†
152	182	332	103	103	223	273	273	393	563	683	3kV†
821	102	182	682	682	123	153	153	223	273	393	4kV†
561	821	122	392	392	822	103	103	123	183	223	5kV†

† Units rated above 800V may require conformal coating to preclude arcing over chip surface



Commercial Chip - X7R 16Vdc to 10kVdc

A range of commercial MLC chip capacitors in Stable EIA Class II dielectric. Class II X7R chips are used as decoupling, by-pass, filtering and transient voltage suppression elements and exhibit +/-15% temperature coefficient and predictable variation of electrical properties with time, temperature and voltage.

Designed for surface mount application with nickel barrier terminations making them suitable for solder wave and reflow solder board attachment as well as vapor phase attachment for part sizes 2225 or smaller. Silver-palladium terminations are also available for hybrid use with conductive epoxy.

Standard EIA case sizes and available C/V values are listed below - special sizes, thicknesses and other voltage ratings are available; please contact the sales office for information.

Capacitance and voltage selection for popular chip sizes

Size	0402	0504	0603	0805	1005	1206	1210	1515	1808		1812		1825	
Min cap.	121	121	121	121	121	121	121	151	151	151	151	151	471	471
Tmax inches: mm:	0. 024 0.61	0.044 1.12	0.035 0.89	0.054 1.37	0.054 1.37	0.064 1.63	0.065 1.63	0.130 3.02	0.065 1.63	0.080* 2.03	0.065 1.63	0.100* 2.54	0.080 2.03	0.140* 3.56
16V	562	393	273	124	154	334	474	125	684	824	125	155	185	225
25V	472	333	223	104	124	274	474	105	564	564	105	125	155	225
50V	472	333	223	104	124	274	474	824	394	564	824	125	155	225
100V	472	333	223	683	823	184	334	684	274	394	564	824	125	185
200V	222	153	103	333	473	104	184	564	184	224	334	564	824	155
250V	152	103	682	273	393	683	124	394	124	154	224	394	684	125
300V	•	•	•	153	183	473	823	274	823	104	154	224	474	824
400V	•	•	•	123	123	273	563	224	563	823	104	184	334	564
500V	•	•	•	123	822	223	563	154	563	683	104	154	334	474
600V	•	•	•	822	822	183	393	124	393	563	683	124	224	394
800V†	•	•	•	472	472	103	273	823	273	333	473	683	124	274
1kV†	•	•	•	272	272	682	153	563	153	223	273	473	823	154
1.5kV†	•	•	•	•	•	222	472	183	472	682	822	153	273	563
2kV†	•	•	•	•	•	102	222	822	272	332	472	682	123	273
3kV†	•	•	•	•	•	•	•	152	561	821	122	222	272	472
4kV†	•	•	•	•	•	•	•	122	331	391	681	122	152	272
5kV†	•	•	•	•	•	•	•	•	•	•	•	•	821	182
6kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
7kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
8kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	
10kV†	•	•	•	•	•	•	•	•	•	•	•	•	•	•

† Units rated above 800V may require conformal coating to preclude arcing over chip surface

Commercial Chip - X7R 16Vdc to 10kVdc

- For dielectric characteristics see page 6.
- For dimensions see page 12.
- For termination options see pages 3 & 15.
- For capacitance tolerances available see page 15.
- For ordering information see page 15.

Note: Maximum capacitance values are shown below as 3 digit code: 2 significant figures followed by the no. of zeros e.g. 183 = 18,000pF.

Capacitance and voltage selection for popular chip sizes

2020	2221	2225		2520	3333	3530	4040	4540	5440	5550	6560	7565	Size
471	471	471	471	102	102	102	102	102	102	102	222	222	Min cap.
0.180 4.57	0.080 2.03	0.080 2.03	0.150* 3.81	0.180 4.57	0.250 6.35	0.250 6.35	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	0.300 7.62	:inches Tmax :mm
185	155	225	275	355	525	525	825	905	106	126	206	256	16V
155	125	185	225	325	505	505	755	805	106	106	186	226	25V
155	125	185	225	325	425	425	705	755	905	106	156	206	50V
155	125	155	225	275	405	405	625	685	825	905	126	186	100V
125	684	105	185	225	355	355	565	625	705	825	825	156	200V
105	564	824	155	185	325	325	505	605	685	805	825	126	250V
824	394	474	105	125	225	225	475	505	575	705	755	106	300V
564	274	394	684	824	125	125	255	275	305	375	545	875	400V
474	274	334	564	684	105	105	185	185	185	225	335	475	500V
274	224	274	474	394	684	684	155	155	155	225	275	395	600V
224	124	154	334	274	474	394	684	824	105	155	225	275	800V†
154	823	104	224	184	334	334	564	684	684	105	155	185	1kV†
393	273	333	683	563	124	124	274	334	344	474	684	824	1.5kV†
273	123	153	333	273	823	683	154	184	184	274	394	474	2kV†
472	272	332	682	822	333	273	473	563	683	823	124	184	3kV†
272	152	152	332	472	183	153	223	333	393	473	823	104	4kV†
152	821	102	222	272	123	103	123	183	223	333	473	563	5kV†
•	•	•	•	•	682	562	822	123	153	223	333	393	6kV†
•	•	•	•	•	472	472	562	822	103	153	223	273	7kV†
•	•	•	•	•	•	332	472	682	822	123	153	223	8kV†
•	•	•	•	•	•	272	332	472	562	103	123	183	9kV†
•	•	•	•	•	•	182	272	392	472	682	103	123	10kV†

* Denotes non standard chip thickness.
Order code needs to have an 'X' inserted together with the dimension in inches e.g. X080 where dimension is 0.080"

Commercial Chip - BX

Manufactured with layer thickness, and minimal voltage coefficient, to meet BX requirements. BX characteristics are identical to X7R dielectric with the added restriction that the Temperature-Voltage Coefficient (TVC) does not exceed -25% DC at rated voltage, over -55°C to 125°C operating temperature.

High Reliability Testing available: HB = MIL-PRF-55681 Group A. HK = MIL-PRF-38534 Class K. HS = MIL-PRF-123 Group A

- For dielectric characteristics see page 6.
- For dimensions see page 12.
- For termination options see pages 3 & 15.
- For capacitance tolerances available see page 15.
- For ordering information see page 15.

Note: Maximum capacitance values are shown below as 3 digit code: 2 significant figures followed by the no. of zeros e.g. 183 = 18,000pF.

BX - Capacitance and Voltage Selection

Size	0402	0504	0603	0805	1005	1206	1210	1808	1812	1825	2221	2225
Min cap.	121	121	121	121	121	121	121	151	151	471	471	471
16V	562	393	273	104	124	274	474	564	105	185	155	225
25V	472	333	223	104	124	274	474	564	105	155	125	185
50V	182	183	123	473	683	124	274	274	564	125	125	155
100V	681	682	472	183	183	473	104	104	184	394	334	474
200V	221	182	122	562	822	153	273	333	563	104	823	124
250V	•	681	391	182	272	472	103	103	223	563	473	683
300V	•	•	•	122	122	332	562	682	123	393	333	473
400V	•	•	•	681	681	182	332	392	562	183	183	223
500V	•	•	•	391	471	102	222	222	392	123	103	153

Commercial Chip - Z5U & Y5V

General purpose Class III dielectrics, very stable with time, exhibiting +22% to -56% (Z5U) and +22% -82% (Y5V) temperature coefficients with very high capacitance density - typically aging less than 4% per decade.

They find application in by-pass and decoupling functions along with other applications where capacitance change over the operating temperature range is not critical.

FlexiCap™ is the preferred termination to reduce the chance of mechanical cracking due to board flexure.

Z5U/Y5V - Capacitance and Voltage Selection

Size	0402	0504	0603	0805	1005	1206	1210	1808	1812	1825	2221	2225
Min cap.	121	121	121	471	681	681	681	222	332	103	103	103
16V	563	474	334	125	185	225	475	565	106	226	186	226
25V	473	394	224	105	155	225	395	395	685	186	156	226
50V	333	224	154	684	105	185	335	335	565	156	126	186
100V	103	823	563	224	334	474	105	105	185	395	395	475
200V	682	223	153	563	823	154	334	334	564	155	155	185
250V	222	183	123	473	683	104	224	224	394	105	105	125

Commercial Chip - RF Series BX & X7R

A range of commercial MLC chip capacitors with improved ESR performance. This series has been designed for rugged environments in high power broadband coupling and switching power supplies. The Class II ceramic dielectric (BX or X7R dependant on chip size) affords high volumetric efficiency with negligible piezoelectric effects.

Please consult the Sales Office if your specific requirement exceeds our catalog maximums (size, capacitance value, and voltage).

- For dielectric characteristics see page 6.
- For dimensions see page 12.
- Termination options: P = Palladium/Silver
  N = Nickel barrier 100% Tin (RoHS)
  Y = Nickel barrier 90% Tin/10% Lead
  B = Copper barrier 100% Tin (RoHS)
  E = Copper barrier 90% Tin/10% Lead
- Capacitance tolerances available ± 10%, ± 20%
- For ordering information see page 15.

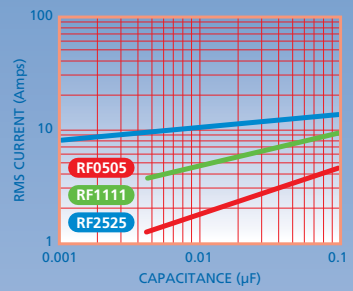
Note: Maximum capacitance values are shown below as 3 digit code: 2 significant figures followed by the no. of zeros e.g. 183 = 18,000pF.

RF Series BX & X7R Capacitance and Voltage Selection

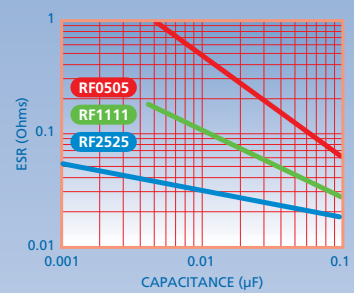
Size	0505	1111	2525				
Tmax inches - mm:	0.057 - 1.45*	0.102 - 2.59*	0.165 - 4.19*				
Dielectric	**BX**	**BX**	**X7R**				
Rated Voltage	50	50	100	150	200	250	300
471	•						
561	•						
681	•						
821	•						
102	•						
122	•						
152	•						
182	•						
222	•						
272	•						
332	•						
392	•						
472	•	•					
502	•	•					
562	•	•					
682	•	•					
822	•	•					
103	•	•					•
123		•					•
153		•					•
183		•					•
223		•					•
273		•					
333		•				•	
393		•				•	
473		•				•	
503		•					
563		•					
683		•				•	
823		•			•		
104		•			•		
124					•		
154					•		
224					•		
334				•			
474				•			
564				•			
684				•			
824			•				
105			•				

* Denotes non standard chip thickness. Order code needs to have an 'X' inserted together with the dimension in inches e.g. X057 where dimension is 0.057"

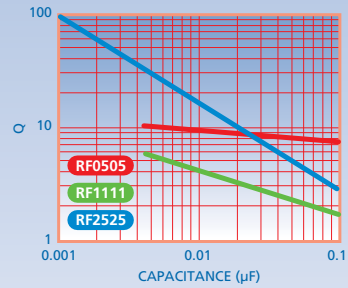
CURRENT RATING VS. CAPACITANCE



ESR VS. CAPACITANCE



Q VS. CAPACITANCE



SERIES RESONANCE VS. CAPACITANCE