

Selection Guide

Main Characteristic	Model	Size range	Dielectric	Voltage range	Capacitance range	Temperature range	Coating					Leads				Mounting		Main Applications	Page
							Uncoated	Varnished	Conformal coated	Molded	Self protected	DIL	Ribbon	Axial	Radial	SMD	Through hole		
HIGH CAPACITANCE	R SERIES (CHIPS) High Capacitance Chips Capacitors 	2225 to 45107	X7R	50V to 500V	47nF to 27µF	-55°C to +125°C	•									•		Switch Mode Power Supply, filtering, smoothing, decoupling. • aerospace • space • defence	79
	R SERIES (LEADED) Radial Leaded Conformal Coated Capacitors 	-	X7R	50V to 500V	47nF to 27µF	-55°C to +125°C		•							•		•		83
	TEF SERIES Radial Leaded Conformal Coated Capacitors 	-	NPO	63V to 500V	10nF to 680nF	-55°C to +125°C			•						•		•		86
	SV / SC SERIES High Capacitance Stacked Capacitors 	2225 to 125205	X7R	50V to 500V	47nF to 390µF	-55°C to +125°C	•	•				•	•			•	•		87
	CNC3X SERIES High Capacitance Stacked Capacitors 	2220 to 4040	X7R	16V to 25V	1.2µF to 68µF	-55°C to +125°C	•	•				•				•	•		94
	CEC5X SERIES High Capacitance Stacked Capacitors 	3033 to 80150	NPO	63V to 500V	10nF to 6.8µF	-55°C to +125°C	•	•				•				•	•		96
	TEP / TEV SERIES High Capacitance Stacked Capacitors 	-	NPO	63V to 500V	10nF to 6.8µF	-55°C to +125°C		•							•		•		99
HIGH TEMPERATURE	TCN8X SERIES High Capacitance Molded Stacked Capacitors 	-	X7R	63V to 500V	0.47µF to 120µF	-55°C to +125°C				•					•		•	Oil drilling, motor control, braking systems.	101
	CE / CN SERIES High Temperature Chips Capacitors 	0402 to 3040	NPO X7R	16V to 100V	1pF to 8.2µF	-55°C to +250°C	•									•			106
	SCT SERIES High Temperature Stacked Capacitors 	2225 to 125205	X7R	50V to 500V	47nF to 390µF	-55°C to +215°C	•	•				•				•	•		108
	TCE / TCN MOLDED SERIES HT High Temperature Molded Capacitors 	-	NPO X7R	16V to 100V	1pF to 10µF	-55°C to +220°C				•				•	•		•		113
	TCE / TCN SELF-PROTECTED SERIES High Temperature Self-Protected Capacitors 	-	NPO X7R	25V to 500V	10pF to 3.9µF	-55°C to +250°C					•			•	•		•		115
FEED-THRU	TCH SERIES High Temperature High Voltage Capacitors 	-	NPO X7R	200V to 10kV	10pF to 15µF	-55°C to +250°C	•								•		•	Very low ESL	117
	TBC SERIES Discoidal Capacitors 	-	NPO X7R	25V to 1kV	10pF to 12µF	-55°C to +125°C	•									•			121
	BPM SERIES Planar Array 	-	X7R	25V to 200V	330pF to 68nF	-55°C to +125°C	•									•		Very low ESL, miniaturisation	123

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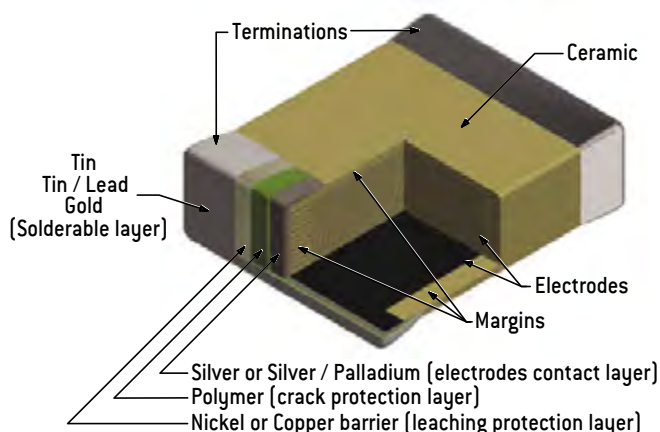
Main Characteristic	Model	Size range	Dielectric	Voltage range	Capacitance range	Temperature range	Coating					Leads				Mounting		Main Applications	Page
							Uncoated	Varnished	Conformal coated	Molded	Self protected	DIL	Ribbon	Axial	Radial	SMD	Through hole		
HIGH Q	XBL SERIES Broadband 	0402	X7R	16V	100nF	-55°C to +125°C	•									•		DC Blocking, Coupling, Bypassing	144
	UBL SERIES Broadband 	0402	X7R	16V	100nF	-55°C to +125°C	•									•			146
	UBZ SERIES Broadband 	0201	X5R X6T	10V	100nF	-55°C to +105°C	•									•			148
	CH SERIES Classic HiQ 	0505 1111	P100	50V to 1.5kV	0.1pF to 1nF	-55°C to +175°C	•						•		•	•		Cellular base station amplifier, MRI.	150
	SH SERIES Super HiQ 	0402 to 1210	NPO	25V to 1.5kV	0.2pF to 1nF	-55°C to +150°C	•						•		•	•		Cellular base station equipment Broadband Point to point/ multi-point radios RF generators	153
	SHD / SHR SERIES Reverse Geometry 	0709 0711	NPO	500V	0.5pF to 100pF	-55°C to +175°C	•									•			156
	NHB SERIES High Self Resonant Frequency 	1111	NPO	500V	0.3pF to 100pF	-55°C to +175°C	•									•			158
	CP SERIES High Power 	2225 4040	P100	200V to 7kV	1pF to 10nF	-55°C to +125°C	•		•				•	•	•	•	•	RF power amplifier Plasma chamber MRI coils	160
	CL SERIES High Power 	2225 to 7065	NPO	200V to 7kV	1pF to 10nF	-55°C to +125°C	•		•				•	•	•	•	•	RF power amplifier Plasma chamber MRI coils	164

ADDITIONAL AVAILABLE RANGES (consult our website)

STANDARD	TCE1X Series 	-	NPO	63V to 100V	0.5pF to 10nF	-55°C to +125°C				•						•		Precision, stability, decoupling	-
	TCN19 Series 	-	2C1	63V to 250V	10pF to 1μF	-55°C to +125°C				•						•		Decoupling	-
	TCN3X Series 	-	2C1	50V to 100V	100pF to 1.8μF	-55°C to +125°C				•						•			-
	LA6 Series 	-	2C1	25V to 63V	100pF to 1μF	-55°C to +125°C				•						•			-
HIGH VOLT.	H Series 	0805 to 6560	NPO X7R	1kV to 10kV	2pF to 390nF	-55°C to +125°C	•		•							•	•	Power supply, voltage multiplier, radars.	-
HIGH CAPACITANCE	CNC5X Series 	3033 to 80150	X7R	63V to 500V	0.1μF to 180μF	-55°C to +125°C	•	•				•				•	•	Switch Mode Power Supply, filtering, smoothing, decoupling. • aerospace • space • defence	-
	CNC8X Series (chips) 	3033 to 33110	X7R	63V to 400V	47nF to 27μF	-55°C to +125°C	•									•			-
	CNC8X Series (DIL) 	3333 to 80150	X7R	63V to 400V	47nF to 180μF	-55°C to +125°C	•	•				•				•	•		-
	TCP / TCV8X Series 	3333 to 80150	X7R	63V to 400V	47nF to 180μF	-55°C to +125°C		•							•		•		-
	TCP / TCV5X Series 	3033 to 80150	X7R	63V to 500V	0.1μF to 180μF	-55°C to +125°C		•							•		•		-
	TCF Series 	-	X7R	63V to 500V	0.1μF to 18μF	-55°C to +125°C			•							•	•		-
HIGH TEMP.	CNC25X Series 	3033 to 5550	X7R	50V	1μF to 33μF	-55°C to +200°C	•	•				•				•	•	Oil drilling, motor control, braking systems.	-
HIGH Q	CNW Series 	-	X7R	100V to 300V	10nF to 1μF	-55°C to +125°C	•						•	•		•	•	Power amplifier	-
	SPT519 / CAW CEW Series 	-	NPO	100V to 300V	10nF to 1μF	-55°C to +125°C	•	•					•	•		•	•		-

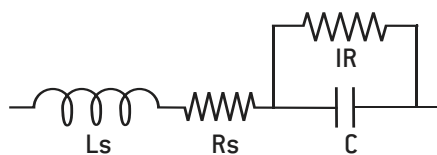
Ceramic Capacitors Technology

MLCC STRUCTURE



EQUIVALENT CIRCUIT

Capacitor is a complex component combining resistive, inductive and capacitive phenomena. A simplified schematic for the equivalent circuit is:



DIELECTRIC CHARACTERISTICS

Insulation Resistance (IR) is the resistance measured under DC voltage across the terminals of the capacitor and consists principally of the parallel resistance shown in the equivalent circuit. As capacitance values and hence the area of dielectric increases, the IR decreases and hence the product $[C \times IR]$ is often specified in $\Omega \cdot F$ or $M\Omega \cdot \mu F$.

The Equivalent Series Resistance (ESR) is the sum of the resistive terms which generate heating when capacitor is used under AC voltage at a given frequency $[f]$.

Dissipation factor (DF) is the ration of the apparent power input will turn to heat in the capacitor:

$$DF = 2\pi f C ESR$$

When a capacitor works under AC voltage, **heat power loss (P)**, expressed in Watt, is equal to:

$$P = 2\pi f C V_{rms}^2 DF$$

The series inductance (Ls) is due to the currents running through the electrodes. It can distort the operation of the capacitor at high frequency where the **impedance (Z)** is given as:

$$Z = R_s + j [L_s \omega - 1/(C \omega)] \text{ with } \omega = 2\pi f$$

When frequency rises, the capacitive component of capacitors is gradually canceled up to the resonance frequency, where :

$$Z = R_s \text{ and } L_s C \omega^2 = 1$$

Above this frequency the capacitor behaves like an inductor.

	P100	NPO	N2200 [C4xx]	BX	2C1	X7R
Dielectric material	Porcelain	Magnesium titanate or Neodymium baryum titanate	Barium zirconate titanate	Baryum titanate [BaTiO ₃]		
Dielectric constant	15 – 18	20 – 85	450	2,000 – 5,000		
Electrode technology	PME (Precious Metal Electrodes): Ag/Pd					
Capacitance variation between –55°C and +125/°C without DC voltage	{100±30}ppm/°C	{0±30}ppm/°C	{–2,200±500}ppm/°C	±15%	±20%	±15%
Capacitance variation between –55°C and +125/°C with DC rated voltage			0 -15%	15% –25%	20% –30%	Not applicable
Piezo-electric effect	None		None	Yes		
Dielectric absorption	None		Few %	Few %		
Thermal shock sensitive	+		+	++		

Ceramic Capacitors Technology

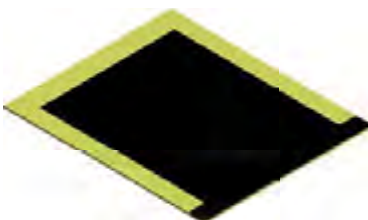
MANUFACTURING STEPS

SLIP CASTING



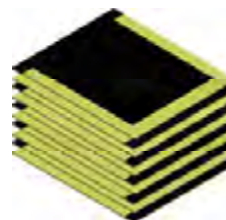
A slurry, a mix of ceramic powder, binder and solvents, is poured onto conveyor belt inside a drying oven, resulting in a dry ceramic sheet.

ELECTRODE SCREEN PRINTING



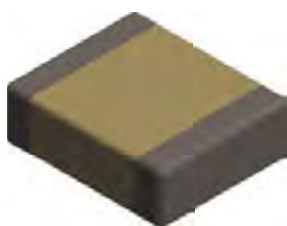
The electrode ink, made from a metal powder mixed with solvents, is printed onto the ceramic sheets using a screen printing process.

STACKING



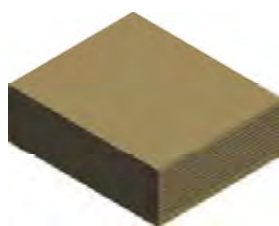
The sheets with electrode printed are stacked to create a multilayer structure.

TERMINATIONS



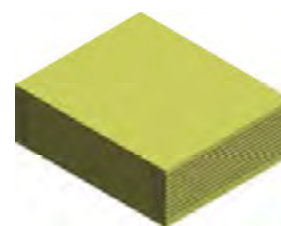
Each terminal of the capacitor is dipped in the termination ink, mix of metal powder, solvents and glass frit and the parts are fired in an oven.

SINTERING



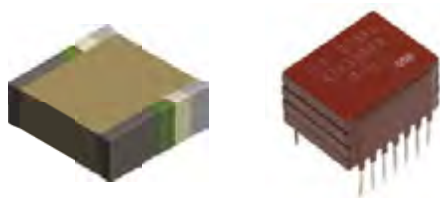
The parts are sintered in an oven with a precise temperature profile which is very important to the characteristics of the capacitors.

PRESSING



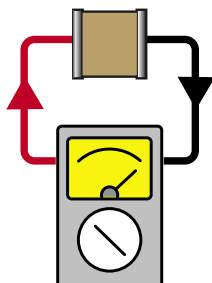
Pressure is applied to the stack to fuse all the separate layers, this created a monolithic structure.

TERMINATIONS PLATING



Stacking + leads soldering + encapsulation
[see pages 10-11]

FINAL TESTING



PACKAGING



User Guide

SMD TERMINATIONS

NON RoHS COMPLIANT	Code	RoHS COMPLIANT	Code	Recommended mounting process							Storage (months)*
Magnetic	Epoxy bonding	Iron soldering	Wave soldering	Vapor phase soldering	Infrared soldering	Wire bonding					
Ag	Q	Ag	QW / P	No	●	●	●	●			18
Ag/Pd/Pt	-	Ag/Pd/Pt	W / A	No	●	●	●				24
Ag/Pd/Pt + dipped Sn/Pb 60/40	H	Ag/Pd/Pt + dipped Sn	HW	No		●					24
Ag + Ni + electrolytic Sn/Pb 95/5	C	Ag + Ni + electrolytic Sn	CW / S	Yes		●	●	●	●		18
Ag + Ni + electrolytic Sn/Pb 60/40	D	-	-	Yes		●	●	●	●		18
-	-	Ag + Cu + electrolytic Sn	C**	No		●	●	●	●		18
Ag + Ni + dipped Sn/Pb 60/40	E	-	-	Yes		●	●				24
Ag + Ni + Au	G	Ag + Ni + Au	GW	Yes	●	●	●	●	●	●	36
Ag + Polymer + Ni + Sn/Pb 95/5	YC	Ag + Polymer + Ni + Sn	YCW	Yes		●	●	●	●		18
Ag + Polymer + Ni + Sn/Pb 60/40	YD	-	-	Yes		●	●	●	●		18
Ag + Polymer + Ni + Au	YG	Ag + Polymer + Ni + Au	YGW	Yes	●	●	●	●	●	●	36

Nickel (Ni) or Copper (Cu) barriers amplify thermal shock and are not recommended for chip sizes larger than 3030.

* Storage must be in a dry environment at a temperature of 20°C with a relative humidity below 50%, or preferably in a package enclosing a desiccant.

** Non magnetic chips series only.

SMD ENVIRONMENTAL TESTS

Ceramic chip capacitors for SMD are designed to meet test requirements of **CECC 32100** and **NF C 93133** standards as specified below in compliance with **NF C 20700** and **IEC 68** standards:

- Solderability: **NF C 20758**, 260°C, bath 62/36/2.
- Adherence: 5N force.
- Vibration fatigue test: **NF C 20706**, 20 g, 10 Hz to 2,000 Hz, 12 cycles of 20 minutes each.
- Rapid temperature change: **NF C 20714**, -55°C to + 125°C, 5 cycles.
- Combined climatic test: **IEC 68-2-38**.
- Damp heat: **NF C 20703**, 93 %, H.R., 40°C.
- Endurance test: 1,000 hours, 1.5 U_{RC}, 125°C.

STORAGE OF CHIP CAPACITORS

TINNED OR NON TINNED CHIP CAPACITORS

Storage must be in a dry environment at a temperature of 20°C with a relative humidity below 50 %, or preferably in a packaging enclosing a desiccant.

STORAGE IN INDUSTRIAL ENVIRONMENT:

- 2 years for tin dipped chip capacitors,
- 18 months for tin electroplated chip capacitors,
- 2 years for non tinned chip capacitors,
- 3 years for gold plated chip capacitors.

STORAGE IN CONTROLLED NEUTRAL NITROGEN ENVIRONMENT:

- 4 years for tin dipped or electroplated chip capacitors,
- 4 years for non tinned chip capacitors,
- 5 years for gold plated chip capacitors.

Storage duration should be considered from delivery date and not from batch manufacture date. The tests carried out at final acceptance stage (solderability, susceptibility to solder heat) enable to assess the compatibility to surface mounting of the chips.

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LEAD STYLES

SURFACE MOUNTING

DIL LEADS

P style



PL style



L style



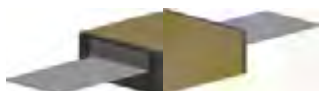
J style



RIBBON LEADS

Micro-strip (type 1)
Short Micro-strip (type 1S)

Axial (Type 2)



Radial (Type 3)



R style



RX style



RJ style



Please contact Exxelia sales for any lead configuration not shown.

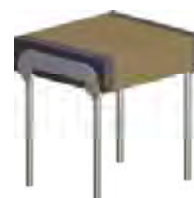
TROUGH-HOLE MOUNTING

AXIAL AND RADIAL

Radial leads (Type 6)



Radial leads (4 leads)



Axial leads (Type 7)



DIL leads: N style



ENCAPSULATION STYLES

Ceramic encapsulation
(selfprotected)

Varnish



Conformal coating

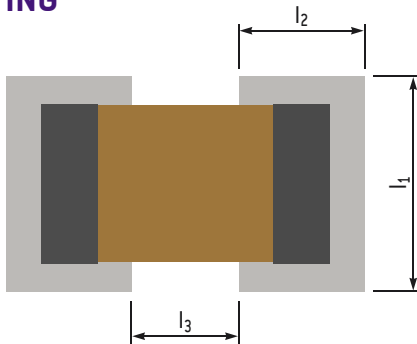


Molding



User Guide

SOLDERING ADVICES FOR REFLOW SOLDERING



Large chips above size 2225 are not recommended to be mounted on epoxy board due to thermal expansion coefficient mismatch between ceramic capacitor and epoxy. Where larger sizes are required, it is recommended to use components with ribbon or other adapted leads so as to absorb thermo-mechanical strains.

Dimensions in inches (in mm)	Reflow soldering						Wave soldering					
	l ₁		l ₂		l ₃		l ₁		l ₂		l ₃	
0402	0.043	(1.1)	0.035	(0.9)	0.012	(0.3)	0.043	(1.1)	0.047	(1.2)	0.012	(0.3)
0403	0.055	(1.4)	0.035	(0.9)	0.012	(0.3)	0.055	(1.4)	0.047	(1.2)	0.012	(0.3)
0504	0.063	(1.6)	0.051	(1.3)	0.016	(0.4)	0.063	(1.6)	0.063	(1.6)	0.016	(0.4)
0603	0.055	(1.4)	0.059	(1.5)	0.02	(0.5)	0.055	(1.4)	0.071	(1.8)	0.02	(0.5)
0805	0.073	(1.85)	0.065	(1.65)	0.024	(0.6)	0.073	(1.85)	0.077	(1.95)	0.024	(0.6)
0907	0.094	(2.4)	0.065	(1.65)	0.035	(0.9)	0.094	(2.4)	0.077	(1.95)	0.035	(0.9)
1005	0.073	(1.85)	0.067	(1.7)	0.039	(1)	0.073	(1.85)	0.079	(2)	0.039	(1)
1206	0.083	(2.1)	0.067	(1.7)	0.059	(1.5)	0.083	(2.1)	0.079	(2)	0.059	(1.5)
1210	0.118	(3)	0.069	(1.75)	0.059	(1.5)	0.118	(3)	0.081	(2.05)	0.059	(1.5)
1605	0.073	(1.85)	0.071	(1.8)	0.087	(2.2)	0.073	(1.85)	0.083	(2.1)	0.087	(2.2)
1806	0.087	(2.2)	0.073	(1.85)	0.102	(2.6)	0.087	(2.2)	0.085	(2.15)	0.102	(2.6)
1812	0.152	(3.85)	0.073	(1.85)	0.102	(2.6)	0.152	(3.85)	0.085	(2.15)	0.102	(2.6)
1825	0.281	(7.15)	0.073	(1.85)	0.102	(2.6)	0.281	(7.15)	0.085	(2.15)	0.102	(2.6)
2210	0.13	(3.3)	0.079	(2)	0.146	(3.7)	0.13	(3.3)	0.091	(2.3)	0.146	(3.7)
2220	0.228	(5.8)	0.079	(2)	0.146	(3.7)	0.228	(5.8)	0.091	(2.3)	0.146	(3.7)
2225	0.281	(7.15)	0.079	(2)	0.146	(3.7)	0.281	(7.15)	0.091	(2.3)	0.146	(3.7)

RECOMMENDED FOOTPRINT FOR SMD CAPACITORS

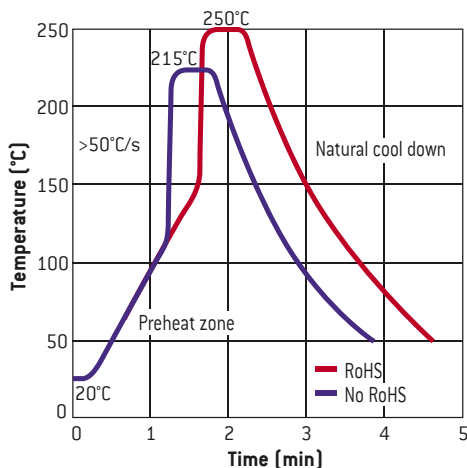
Ceramic is by nature a material which is sensitive both thermally and mechanically. Stresses caused by the physical and thermal properties of the capacitors, substrates and solders are attenuated by the leads.

Wave soldering is unsuitable for sizes larger than 2220 and for the higher ends of capacitance ranges due to possible thermal shock (capacitance values given upon request).

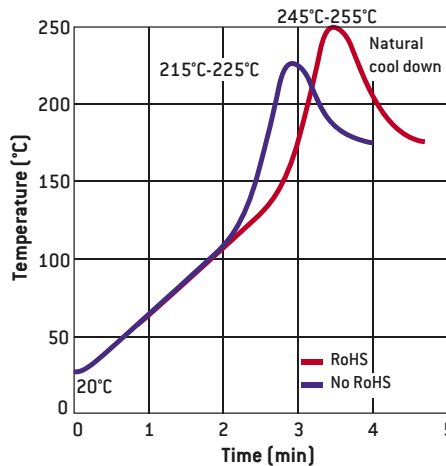
Infrared and vapor phase reflow, are preferred for high reliability applications as inherent thermo-mechanical strains are lower than those inherent to wave soldering.

Whatever the soldering process is, it is highly recommended to apply a thermal cycle, see hereafter our recommended soldering profile:

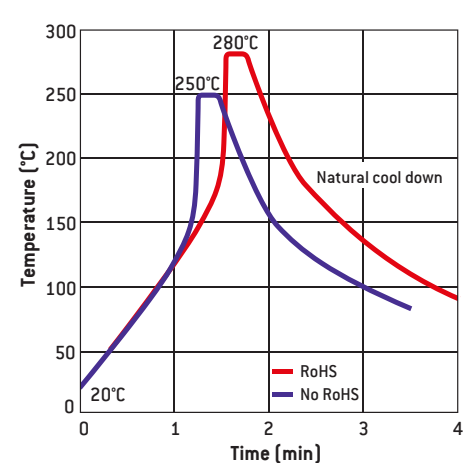
RECOMMENDED VAPOR PHASE REFLOW PROFILE



RECOMMENDED IR REFLOW PROFILE



RECOMMENDED WAVE SOLDERING PROFILE



SOLDERING ADVICES FOR IRON SOLDERING

Attachment with a soldering iron is discouraged due to ceramic brittleness and the process control limitations. In the event that a soldering iron must be used, the following precautions should be observed:

- Use a substrate with chip footprints big enough to allow putting side by side one end of the capacitor and the iron tip without any contact between this tip and the component,
- place the capacitor on this footprint,

- heat the substrate until the capacitor's temperature reaches 150°C minimum (preheating step, maximum 1°C per second),
- place the hot iron tip (a flat tip is preferred) on the footprint **without touching the capacitor**. Use a regulated iron with a 30 watts maximum power. The recommended temperature of the iron is 270 ±10°C. The temperature gap between the capacitor and the iron tip must not exceed 120°C,

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- leave the tip on the footprint for a few seconds in order to increase locally the footprint's temperature,
- use a cored wire solder and put it down on the iron tip. In a preferred way use Sn/Pb/Ag 62/36/2 alloy,
- wait until the solder fillet is formed on the capacitor's termination,
- take away iron and wire solder,
- wait a few minutes so that the substrate and capacitor come back down to

the preheating temperature,

- solder the second termination using the same procedure as the first,
- let the soldered component cool down slowly to avoid any thermal shock.

PACKAGING

TAPE AND REEL

The films used on the reels correspond to standard IEC 60286-3. Films are delivered on reels in compliance with document IEC 286-3 dated 1991.

Minimum quantity is 250 chips.

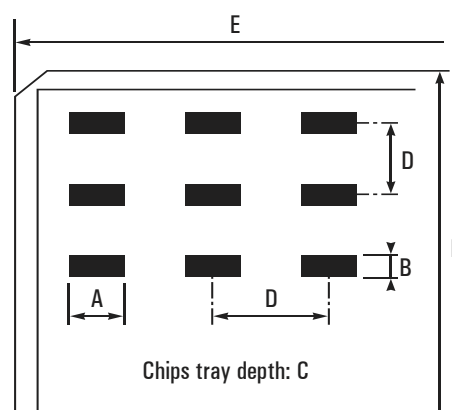
Maximum quantities per reel are as follows:

- Super 8 reel - Ø 180: 2,500 chips.
- Super 8 reel - Ø 330: 10,000 chips.
- Super 12 reel - Ø 180: 1,000 chips.

Reel marking complies with CECC 32100 standard:

- Model.
- Rated capacitance.
- Capacitance tolerance.
- Rated voltage.
- Batch number.

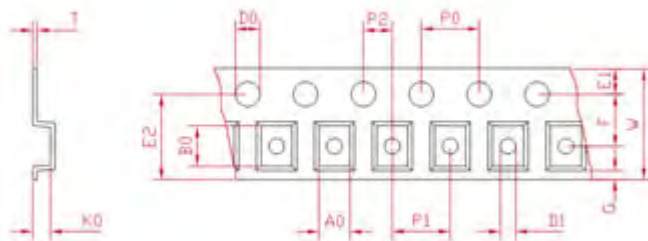
TRAY PACKAGES



DIMENSIONAL CHARACTERISTICS OF CHIPS TRAY PACKAGES

Sizes	Nr. of chips/ package	Oriented chips	Dimensions in inches (in mm)				
			A	B	C	D	E
0402	100	No	0.112 (0.302)		0.065 (1.65)	0.167 (4.24)	2 (50.8)
0403	100	No	0.112 (0.302)		0.065 (1.65)	0.167 (4.24)	2 (50.8)
0504	100	Yes	0.059 (1.5)	0.045 (1.14)	0.035 (0.89)	0.167 (4.24)	2 (50.8)
0603	340	Yes	0.1 (2.54)	0.06 (1.52)	0.045 (1.14)	0.167 (4.24)	2 (50.8)
0805	100	Yes	0.1 (2.54)	0.06 (1.52)	0.045 (1.14)	0.167 (4.24)	2 (50.8)
1206	100	No	0.14 (3.56)	0.14 (3.56)	0.06 (1.52)	0.167 (4.24)	2 (50.8)
1210	100	Yes	0.14 (3.56)	0.14 (3.56)	0.06 (1.52)	0.167 (4.24)	2 (50.8)
1812	100	No	0.25 (6.35)	0.25 (6.35)	0.13 (3.3)	0.345 (8.76)	4 (101.6)
2220	25	Yes	0.24 (6.1)	0.265 (6.73)	0.07 (1.78)	0.345 (8.76)	2 (50.8)
	100	Yes	0.25 (6.35)	0.25 (6.35)	0.13 (3.3)	0.345 (8.76)	4 (101.6)
	25	Yes	0.24 (6.1)	0.265 (6.73)	0.07 (1.78)	0.345 (8.76)	2 (50.8)

HIGH Q CAPACITORS TAPE AND REEL PACKAGING SPECIFICATIONS



Sizes	Type (1)	W±0.3 inches (mm)	F±0.05 inches (mm)	P1±0.1 inches (mm)	T max. inches (mm)	Reel Size inches (mm)	Quantity per Reel
A (0505)	H	0,315 (8)	0,138 (3.5)	0,157 (4)	0,010 (0,25)	7,087 (180)	3'000
A (0505)	V	0,315 (8)	0,138 (3.5)	0,157 (4)	0,010 (0,25)	7,087 (180)	3'000
S (0603)	H	0,315 (8)	0,138 (3.5)	0,157 (4)	0,016 (0,4)	7,087 (180)	4'000
F (0805)	H	0,315 (8)	0,138 (3.5)	0,157 (4)	0,016 (0,4)	7,087 (180)	4'000
B (1111)	H	0,315 (8)	0,138 (3.5)	0,157 (4)	0,012 (0,3)	7,087 (180)	1'000
B (1111)	V	0,315 (8)	0,138 (3.5)	0,157 (4)	0,010 (0,25)	7,087 (180)	1'000
X (2225)	H	0,472 (12)	0,138 (5.5)	0,472 (12)	0,018 (0,45)	12,992 (330)	500
E (4040)	H	0,945 (24)	0,453±0,004 (11.5±0.1)	0,630 (16)	0,018 (0,45)	12,992 (330)	700
E (4040)	V	1,260 (32)	0,559±0,004 (14.2±0.1)	0,945 (24)	0,022 (0,55)	15 (381)	350

(1): Horizontal (H) or Vertical (V) orientation in cavities.

User Guide

EIA STANDARD CAPACITANCE VALUES

Following EIA standard, the values and multiples that are indicated in the chart below can be ordered. E48, E96 series and intermediary values are available upon request.

E6 (± 20%)	E12 (± 10%)	E24 (± 5%)
10	10	10
		11
		12
15	12	13
		15
		16
22	15	18
		20
		22
33	18	24
		27
		30
47	22	33
		36
		39
68	27	43
		47
		51
100	33	56
		62
		68
150	39	75
		82
		91

Voltage (V)	Code	Letter code
25	250	A
40	400	B
50	500	C
63	630	D
100	101	E
200	201	G
250	251	H
400	401	K
500	501	L
1,000	102	M
2,000	202	P
3,000	302	R
4,000	402	S
5,000	502	T
7,500	752	U
10,000	103	W

EIA CAPACITANCE CODE

The capacitance is expressed in three digit codes and in units of pico Farads (pF). The first and second digits are significant figures of the capacitance value and the third digit identifies the multiplier.

For capacitance value < 10pF, R designates a decimal point.

See examples below:

EIA code	Capacitance value		
	in pF	in nF	in µF
2R2	2.2	0.0022	0.0000022
6R8	6.8	0.0068	0.0000068
220	22	0.022	0.000022
470	47	0.047	0.000047
181	180	0.18	0.00018
221	220	0.22	0.00022
102	1,000	1	0.001
272	2,700	2.7	0.0027
123	12,000	12	0.012
683	68,000	68	0.068
124	120,000	120	0.12
564	560,000	560	0.56
335	3,300,000	3,300	3.3
825	8,200,000	8,200	8.2
156	15,000,000	15,000	15
686	68,000,000	68,000	68
107	100,000,000	100,000	100
227	220,000,000	220,000	220

PART MARKING TOLERANCE CODES

Use the following tolerance code chart for part markings:

Tolerance	Letter code
±0.25pF	CU
±0.5pF	DU
±1pF	FU
±1%	F
±2%	G
±5%	J
±10%	K
±20%	M

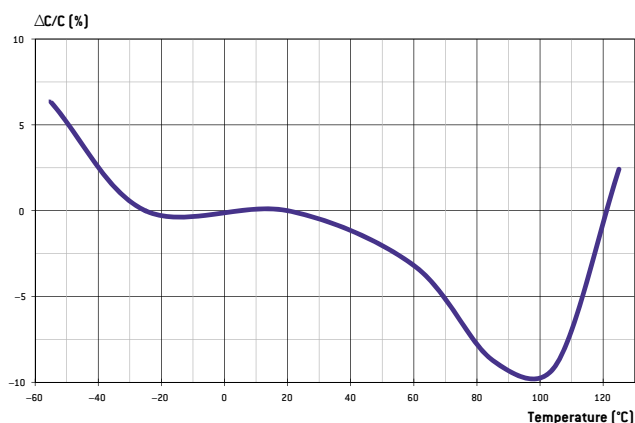
PART MARKING VOLTAGE CODES

Use the following voltage code chart for part markings:

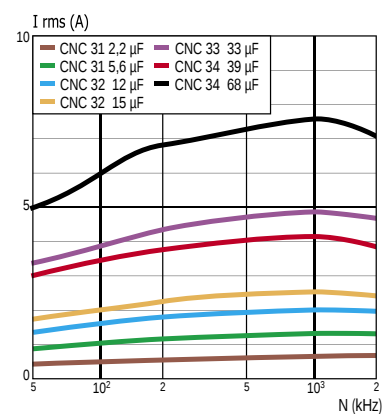
General Information

TYPICAL CURVES: CNC3X Series

TYPICAL TEMPERATURE COEFFICIENT

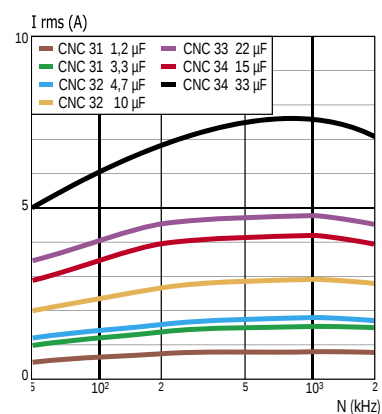
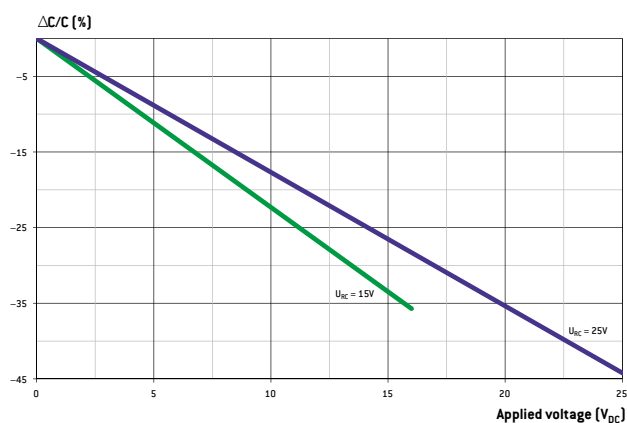


MAXIMUM CURRENT VS FREQUENCY



$U_{RC} = 16V$ DC (Typical curves for $\Delta\theta = 20^{\circ}C$).

TYPICAL VOLTAGE COEFFICIENT

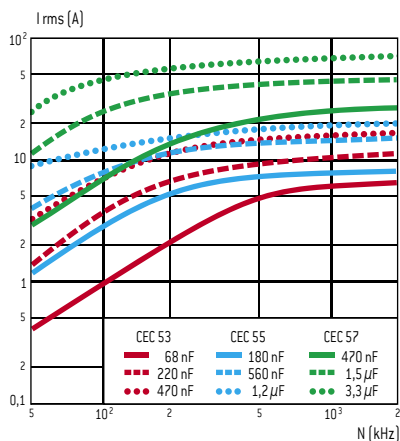


$U_{RC} = 25V$ DC (Typical curves for $\Delta\theta = 20^{\circ}C$).

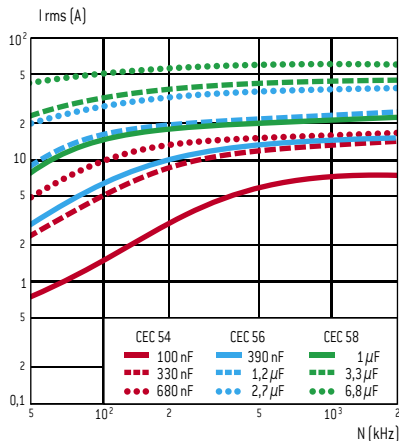
General Information

TYPICAL CURVES: CEC5X Series

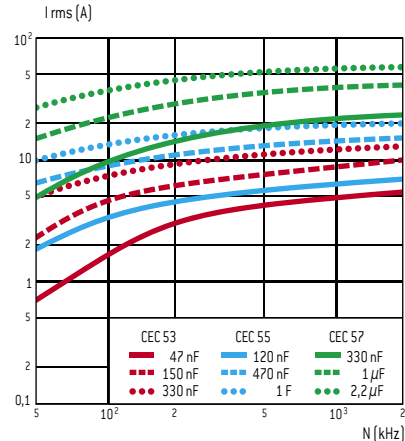
NPO: CURRENT VS FREQUENCY



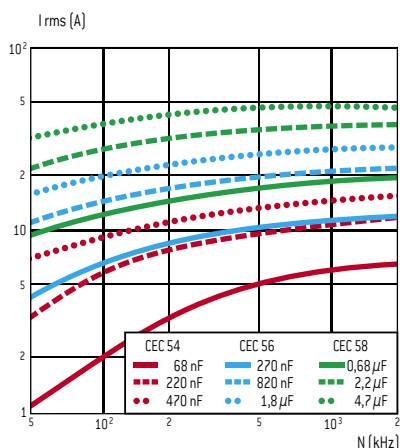
$U_{RC} = 63 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).



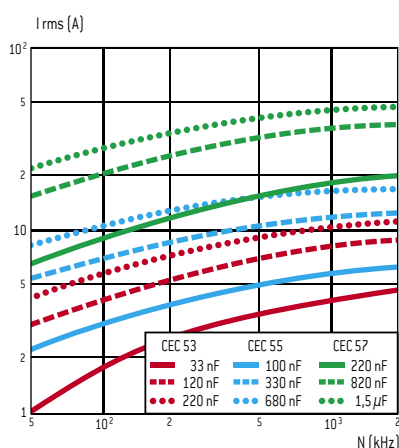
$U_{RC} = 63 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).



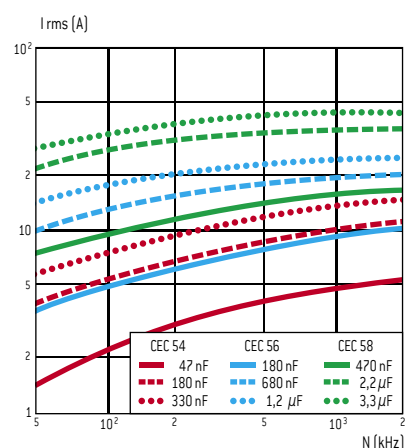
$U_{RC} = 100 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).



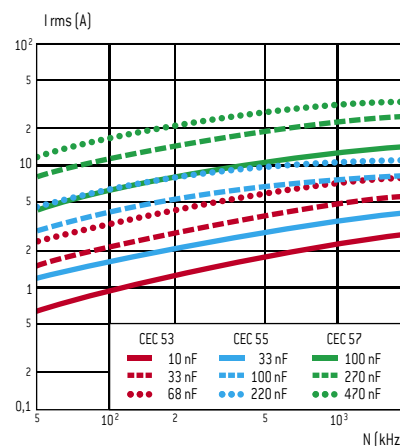
$U_{RC} = 100 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).



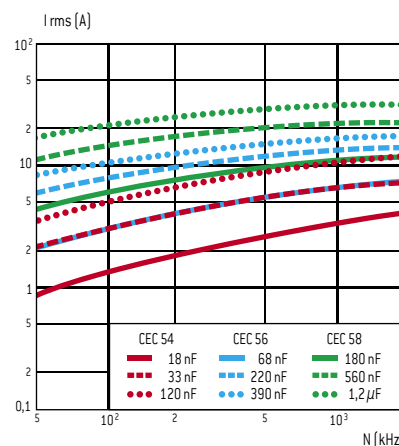
$U_{RC} = 200 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).



$U_{RC} = 200 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).



$U_{RC} = 500 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).

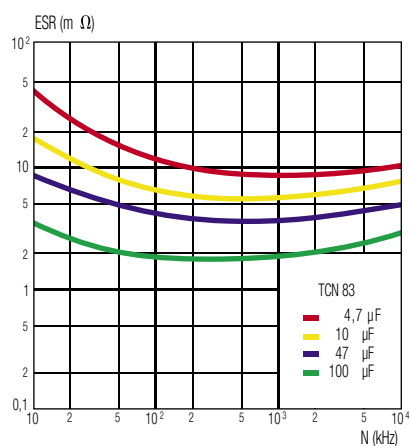


$U_{RC} = 500 V_{DC}$ (Typical curve for $\Delta\theta = 20^\circ C$).

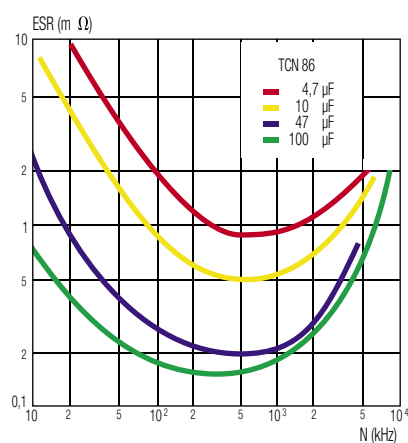
General Information

TYPICAL CURVES: TCN8X Series

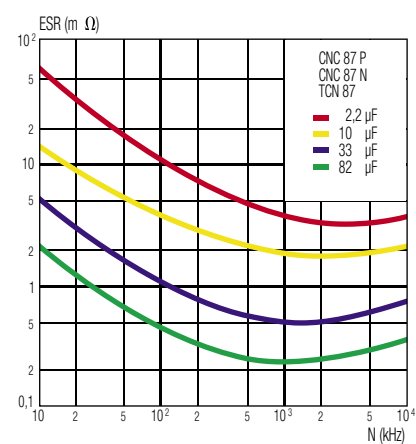
TCN83: TYPICAL EQUIVALENT SERIAL RESISTANCE (ESR) VS FREQUENCY (N)



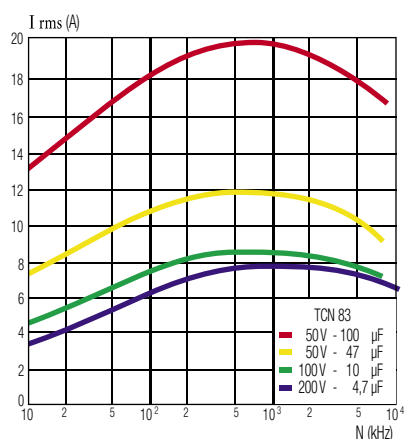
TCN86: TYPICAL EQUIVALENT SERIAL RESISTANCE (ESR) VS FREQUENCY (N)



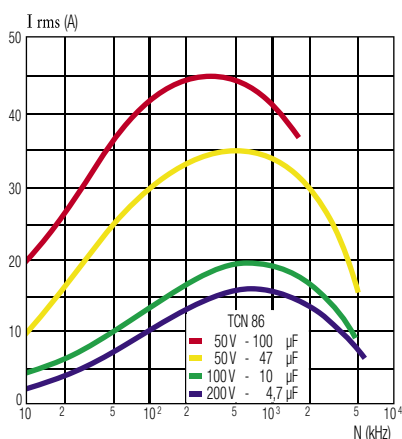
TCN87: TYPICAL EQUIVALENT SERIAL RESISTANCE (ESR) VS FREQUENCY (N)



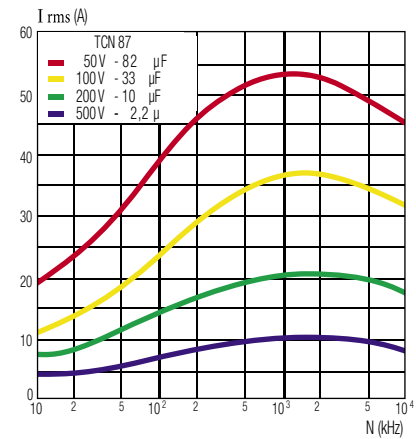
TCN83: CURRENT (I_{RMS}) VS FREQUENCY (N)
TYPICAL CURVES FOR $\Delta\theta \leq 20^\circ\text{C}$



TCN86: CURRENT (I_{RMS}) VS FREQUENCY (N)
TYPICAL CURVES FOR $\Delta\theta \leq 20^\circ\text{C}$



TCN87: CURRENT (I_{RMS}) VS FREQUENCY (N)
TYPICAL CURVES FOR $\Delta\theta \leq 20^\circ\text{C}$



High Capacitance Chips Capacitors

R Series (Chips)



FEATURES

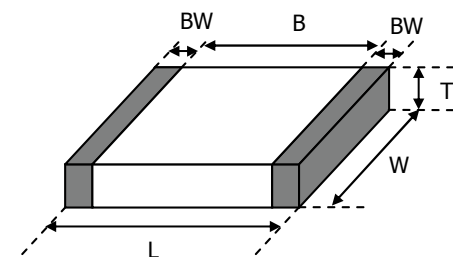
- Multilayer chip ceramic capacitors
- Dielectric type II
- Capacitance range: 47nf to 27 μ F
- Voltage range: 50 V_{DC} to 500 V_{DC}

PACKAGING

«BLISTER» BOXES:

For all products, special «blister» boxes are used to optimize the protection of the parts during the carriage and the storage. Depending upon the termination (with or without connection) and the size, the number of the parts in each box is defined. Please, consult us for more details.

DIMENSIONS in inches (mm)



ELECTRICAL SPECIFICATIONS

Description	«X» Series (type II)	«T» Series (type II)
CECC	2R1	2R1
EIA	X7R	X7R
Exxelia Temex Code	X	T
Operating temperature range	-55°C to +125°C	-55°C to +125°C
Maximum $\Delta C/\%C$ over Temperature range without voltage applied	$\pm 15\%$	$\pm 15\%$
Ageing	$\leq 2.5\%$ per decade hour	$\leq 2.5\%$ per decade hour
Dissipation Factor (DF)	$\leq 2.5\%$	$\leq 2.5\%$
Voltage proof	$U_R \leq 200$ V: $2.5 \times U_R$ $U_R > 200$ V: $2.0 \times U_R$	$U_R \leq 200$ V: $2.5 \times U_R$ $U_R > 200$ V: $2.0 \times U_R$
Insulation Resistance (IR) at 25°C under U_R	100G Ω or 1000 Ω .F whichever is the less	100G Ω or 1000 Ω .F whichever is the less
Insulation Resistance (IR) at 125°C under U_R	10G Ω or 100 Ω .F whichever is the less	10G Ω or 100 Ω .F whichever is the less
Measurement Conditions for C and DF at 20°C	≤ 100 pF: 1MHz / 1Vrms (no bias) > 100 pF: 1KHz / 1Vrms (no bias)	≤ 100 pF: 1MHz / 1Vrms (no bias) > 100 pF: 1KHz / 1Vrms (no bias)
Capacitance versus applied Voltage and Temperature	See page 68	See page 68

HOW TO ORDER

501	R	6560	X	105	K	P	-	-RoHS
Rated voltage	Series	Exxelia size code	Dielectric code	Capacitance	Tolerance	Termination	Coating	RoHS compliant
500: 50 V 101: 100 V 201: 200 V 501: 500 V	R: High Capacitance Chips	2225 3033 3740 5440 5550 6560 6080 8060 45107	X = X7R T = X7R	1 st two digits represent significant figures; last digit specifies the number of zeros to follow. Examples: 104: 0.1 μ F 335: 3.3 μ F 276: 27 μ F	K = $\pm 10\%$ M = $\pm 20\%$	P (RoHS) Ag, non magnetic. Lead status: 0% Pb. T (not RoHS) P termination with Sn/Pb/Ag solder dipping, non magnetic Lead status: 36% Pb.	Not applicable	- = Not RoHS compliant For P termination, only the RoHS version exists. The RoHS suffix can be added for information.

R Series (Chips)

High Capacitance Chips Capacitors

STANDARD RATINGS

Dimensions Inches (mm)	Exxelia size code	2225								3033								3740								Capacitance value coded (C _R)
	L	0.224 ± 0.016 (5.7 ± 0.4)								0.291 ± 0.02 (7.4 ± 0.5)								0.378 ± 0.02 (9.6 ± 0.5)								
	W	0.252 ± 0.016 (6.4 ± 0.4)								0.315 ± 0.02 (8 ± 0.5)								0.386 ± 0.02 (9.8 ± 0.5)								
	BW min.	0.112 (0.3)								0.019 (0.5)								0.019 (0.5)								
	BW max.	0.056 (1.4)								0.079 (2)								0.079 (2)								
U _R	50 V		100 V		200 V		500 V		50 V		100 V		200 V		500 V		50 V		100 V		200 V		500 V			
Dielectric	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T		
47nf	0.119 (3)																								473	
56	0.119 (3)																								563	
68	0.119 (3)																								683	
82	0.119 (3)																								823	
100					0.071 (1.8)	0.119 (3)	0.091 (2.3)					0.099 (2.5)				0.103 (2.6)					0.119 (3)	104				
120					0.071 (1.8)	0.119 (3)	0.091 (2.3)					0.099 (2.5)				0.103 (2.6)					0.119 (3)	124				
150					0.079 (2)	0.130 (3.3)	0.091 (2.3)					0.099 (2.5)				0.103 (2.6)					0.119 (3)	154				
180	0.071 (1.8)	0.071 (1.8)		0.079 (2)	0.150 (3.8)	0.103 (2.6)					0.126 (3.2)				0.103 (2.6)					0.079 (2.1)	0.119 (3)	0.103 (2.6)	184			
220	0.071 (1.8)	0.071 (1.8)		0.099 (2.5)	0.177 (4.5)	0.111 (2.8)					0.126 (3.2)				0.103 (2.6)					0.079 (2.1)	0.119 (3)	0.103 (2.6)	224			
270	0.071 (1.8)	0.071 (1.8)		0.099 (2.5)	0.091 (2.3)	0.123 (3.1)					0.079 (2.1)		0.138 (3.5)		0.103 (2.6)					0.079 (2.1)	0.119 (3)	0.103 (2.6)	274			
330	0.071 (1.8)	0.071 (1.8)		0.119 (3)	0.091 (2.3)			0.079 (2.1)	0.079 (2.1)		0.079 (2.1)		0.165 (4.2)	0.111 (2.8)	0.079 (2.1)	0.079 (2.1)		0.079 (2.1)	0.130 (3.3)		0.103 (2.6)	334				
390	0.071 (1.8)	0.071 (1.8)		0.119 (3)	0.091 (2.3)			0.079 (2.1)	0.079 (2.1)		0.079 (2.1)		0.123 (3.1)		0.079 (2.1)	0.079 (2.1)		0.079 (2.1)	0.138 (3.5)		0.103 (2.6)	394				
470	0.071 (1.8)	0.071 (1.8)		0.130 (3.3)	0.091 (2.3)			0.079 (2.1)	0.079 (2.1)		0.079 (2.1)		0.091 (2.3)	0.138 (3.5)	0.079 (2.1)	0.079 (2.1)		0.079 (2.1)	0.158 (4)		0.103 (2.6)	474				
560	0.079 (2)	0.079 (2)		0.154 (3.9)	0.099 (2.5)			0.079 (2.1)	0.079 (2.1)		0.099 (2.5)		0.091 (2.3)	0.079 (2.1)		0.079 (2.1)		0.079 (2.1)	0.169 (4.3)		0.115 (2.9)	564				
680	0.079 (2)	0.091 (2.3)	0.079 (2)	0.091 (2.3)	0.122 (3.1)		0.079 (2.1)		0.079 (2.1)	0.119 (3)		0.091 (2.3)	0.079 (2.1)		0.079 (2.1)		0.099 (2.5)		0.134 (3.4)		684					
820	0.079 (2)	0.091 (2.3)	0.079 (2)	0.091 (2.3)	0.126 (3.2)		0.079 (2.1)		0.079 (2.1)	0.138 (3.5)		0.095 (2.4)	0.079 (2.1)		0.079 (2.1)		0.099 (2.5)		0.091 (2.3)	0.150 (3.8)		824				
1 µF	0.087 (2.2)	0.091 (2.3)	0.087 (2.2)	0.091 (2.3)			0.099 (2.5)		0.099 (2.5)		0.103 (2.6)		0.079 (2.1)		0.079 (2.1)		0.119 (3)		0.091 (2.3)			105				
1.2	0.099 (2.5)	0.091 (2.3)	0.099 (2.5)	0.091 (2.3)			0.099 (2.5)		0.099 (2.5)		0.115 (2.9)		0.079 (2.1)		0.079 (2.1)		0.138 (3.5)		0.091 (2.3)			125				
1.5	0.119 (3)	0.091 (2.3)	0.119 (3)	0.091 (2.3)			0.111 (2.8)		0.091 (2.3)	0.111 (2.8)	0.091 (2.3)	0.134 (3.4)		0.079 (2.1)		0.091 (2.3)	0.079 (2.1)	0.091 (2.3)	0.158 (4)	0.103 (2.6)			155			
1.8	0.126 (3.2)	0.091 (2.3)	0.126 (3.2)	0.091 (2.3)			0.111 (2.8)		0.091 (2.3)	0.111 (2.8)	0.091 (2.3)			0.099 (2.5)		0.091 (2.3)	0.099 (2.5)	0.091 (2.3)	0.181 (4.6)	0.111 (2.8)			185			
2.2	0.315 (3.8)	0.103 (2.6)	0.315 (3.8)	0.103 (2.6)			0.111 (2.8)		0.091 (2.3)	0.111 (2.8)	0.091 (2.3)			0.099 (2.5)		0.091 (2.3)	0.099 (2.5)	0.091 (2.3)	0.126 (3.2)				225			
2.7	0.115 (2.9)		0.115 (2.9)				0.130 (3.3)		0.095 (2.4)	0.130 (3.3)	0.095 (2.4)			0.111 (2.8)		0.091 (2.3)	0.111 (2.8)	0.091 (2.3)	0.142 (3.6)				275			
3.3	0.126 (3.2)		0.126 (3.2)				0.150 (3.8)		0.099 (2.5)	0.150 (3.8)	0.099 (2.5)			0.111 (2.8)		0.091 (2.3)	0.111 (2.8)	0.091 (2.3)					335			
3.9							0.111 (2.8)		0.111 (2.8)				0.130 (3.3)		0.091 (2.3)	0.130 (3.3)	0.091 (2.3)							395		
4.7							0.123 (3.1)		0.123 (3.1)				0.138 (3.5)		0.091 (2.3)	0.138 (3.5)	0.091 (2.3)							475		
5.6													0.142 (3.6)		0.103 (2.6)	0.142 (3.6)	0.103 (2.6)							565		
6.8															0.119 (3)		0.119 (3)								685	
8.2															0.142 (3.6)		0.142 (3.6)								825	
10															0.150 (3.8)		0.150 (3.8)								106	
12																									126	

The thickness T_{max} in inches (in mm) is indicated in the cells.

High Capacitance Chips Capacitors

R Series (Chips)

STANDARD RATINGS

	Exxelia size code	5550								6560								6080								Capacitance value coded (C ₀)
Dimensions Inches (mm)	L	0.539 ± 0.02 (13.7 ± 0.5)								0.665 ± 0.032 (16.9 ± 0.8)								0.591 ± 0.032 (15 ± 0.8)								
	W	0.484 ± 0.02 (12.3 ± 0.5)								0.610 ± 0.032 (15.5 ± 0.8)								0.778 ± 0.0322 (19.8 ± 0.8)								
	BW min.	0.019 (0.5)								0.019 (0.5)								0.019 (0.5)								
	BW max.	0.079 (2)								0.079 (2)								0.079 (2)								
U _R	50 V		100 V		200 V		500 V		50 V		100 V		200 V		500 V		50 V		100 V		200 V		500 V			
Dielectric	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T		
270nf							0.099 (2.5)	0.103 (2.6)							0.099 (2.5)	0.103 (2.6)									274	
330							0.099 (2.5)	0.103 (2.6)							0.099 (2.5)	0.103 (2.6)									334	
390							0.099 (2.5)	0.103 (2.6)							0.099 (2.5)	0.103 (2.6)									394	
470							0.119 (3)	0.103 (2.6)							0.099 (2.5)	0.103 (2.6)									474	
560							0.119 (3)	0.103 (2.6)					0.099 (2.5)		0.099 (2.5)	0.103 (2.6)									564	
680							0.119 (3)	0.103 (2.6)					0.099 (2.5)		0.099 (2.5)	0.103 (2.6)					0.119 (3)	0.103 (2.6)			684	
820					0.119 (3)		0.138 (3.5)	0.103 (2.6)					0.099 (2.5)		0.119 (3)	0.103 (2.6)					0.119 (3)	0.103 (2.6)			824	
1 µF	0.099 (2.5)		0.099 (2.5)		0.119 (3)		0.166 (4.2)	0.111 (2.8)	0.099 (2.5)		0.099 (2.5)		0.099 (2.5)	0.103 (2.6)	0.119 (3)	0.103 (2.6)					0.119 (3)	0.103 (2.6)			105	
1.2	0.099 (2.5)		0.099 (2.5)		0.119 (3)	0.103 (2.6)	0.185 (4.7)	0.130 (3.3)	0.099 (2.5)		0.099 (2.5)		0.099 (2.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					0.138 (3.5)	0.103 (2.6)			125	
1.5	0.099 (2.5)		0.099 (2.5)		0.119 (3)	0.103 (2.6)		0.142 (3.6)	0.099 (2.5)		0.099 (2.5)		0.099 (2.5)	0.103 (2.6)	0.158 (4)	0.119 (3)					0.119 (3)		0.158 (4)	0.103 (2.6)	155	
1.8	0.099 (2.5)		0.099 (2.5)		0.119 (3)	0.103 (2.6)		0.162 (4.1)	0.099 (2.5)		0.099 (2.5)		0.099 (2.5)	0.103 (2.6)	0.178 (4.5)	0.119 (3)					0.119 (3)		0.178 (4.5)	0.103 (2.6)	185	
2.2	0.099 (2.5)		0.099 (2.5)		0.119 (3)	0.103 (2.6)			0.099 (2.5)		0.099 (2.5)		0.099 (2.5)	0.103 (2.6)		0.130 (3.3)					0.119 (3)	0.103 (2.6)	0.178 (4.5)	0.103 (2.6)	225	
2.7	0.099 (2.5)		0.099 (2.5)		0.138 (3.5)	0.103 (2.6)			0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.119 (3)	0.103 (2.6)		0.150 (3.8)					0.119 (3)	0.103 (2.6)		0.130 (3.3)	275	
3.3	0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.158 (4)	0.111 (2.8)			0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.119 (3)	0.103 (2.6)		0.170 (4.3)					0.119 (3)	0.103 (2.6)		0.154 (3.9)	335	
3.9	0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.123 (3.1)				0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)			0.119 (3)		0.119 (3)		0.138 (3.5)	0.103 (2.6)		0.174 (4.4)	395	
4.7	0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)	0.138 (3.5)				0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.158 (4)	0.103 (2.6)			0.119 (3)		0.119 (3)		0.158 (4)	0.103 (2.6)			475	
5.6	0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)	0.162 (4.1)				0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.115 (2.9)				0.119 (3)		0.119 (3)		0.158 (4)	0.103 (2.6)			565	
6.8	0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)					0.099 (2.5)	0.103 (2.6)	0.099 (2.5)	0.103 (2.6)	0.130 (3.3)				0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)	0.178 (4.5)	0.119 (3)			685	
8.2	0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)	0.150 (3.8)				0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)	0.142 (3.6)				825	
10	0.150 (3.8)	0.103 (2.6)	0.150 (3.8)	0.103 (2.6)					0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)					0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)	0.150 (3.8)				106	
12	0.158 (4)	0.111 (2.8)	0.158 (4)	0.111 (2.8)					0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					126	
15	0.126 (3.2)		0.126 (3.2)						0.158 (4)	0.103 (2.6)	0.158 (4)	0.103 (2.6)					0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					156	
18									0.103 (2.6)		0.103 (2.6)						0.103 (2.6)		0.103 (2.6)						186	
22									0.119 (3)		0.119 (3)						0.111 (2.8)		0.111 (2.8)						226	
27									0.142 (3.6)		0.142 (3.6)						0.130 (3.3)		0.130 (3.3)						276	

The thickness Tmax in inches (in mm) is indicated in the cells.

R Series (Chips)

High Capacitance Chips Capacitors

STANDARD RATINGS

	Exxelia size code	8060								45107								Capacitance value coded (C _R)					
Dimensions inches (mm)	L	0.78 ± 0.032 (19.8 ± 0.8)								0.425 ± 0.02 (10.8 ± 0.5)													
	W	0.587 ± 0.032 (14.9 ± 0.8)								1.083 max (27.5 max)													
	BW min.	0.019 (0.5)								0.019 (0.5)													
	BW max.	0.079 (2)								0.079 (2)													
U _R	50 V		100 V		200 V		500 V		50 V		100 V		200 V		500 V								
Dielectric	X	T	X	T	X	T	X	T	X	T	X	T	X	T	X	T							
270nf																	274						
330																	334						
390																	394						
470																	474						
560																	564						
680									0.119 (3)	0.103 (2.6)									0.138 (3.5)	0.123 (3.1)	684		
820									0.119 (3)	0.103 (2.6)									0.119 (3)	0.119 (3)	0.138 (3.5)	0.123 (3.1)	824
1 µF									0.119 (3)	0.103 (2.6)	0.119 (3)		0.119 (3)		0.119 (3)	0.119 (3)	0.150 (3.8)	0.123 (3.1)	105				
1.2									0.138 (3.5)	0.103 (2.6)	0.119 (3)		0.119 (3)		0.119 (3)	0.119 (3)	0.150 (3.8)	0.123 (3.1)	125				
1.5									0.119 (3)	0.158 (4)	0.103 (2.6)	0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.158 (4)	0.123 (3.1)	155				
1.8									0.119 (3)	0.178 (4.5)	0.103 (2.6)	0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.178 (4.5)	0.123 (3.1)	185				
2.2									0.119 (3)	0.103 (2.6)	0.178 (4.5)	0.103 (2.6)	0.119 (3)	0.119 (3)	0.119 (3)	0.138 (3.5)	0.119 (3)	0.123 (3.1)	225				
2.7									0.119 (3)	0.103 (2.6)		0.130 (3.3)	0.119 (3)	0.119 (3)	0.119 (3)	0.150 (3.8)	0.119 (3)	0.123 (3.1)	275				
3.3									0.119 (3)	0.103 (2.6)		0.154 (3.9)	0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.158 (4)	0.119 (3)	0.158 (4)	335			
3.9	0.119 (3)		0.119 (3)		0.138 (3.5)	0.103 (2.6)		0.174 (4.4)	0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.158 (4)	0.119 (3)				395					
4.7	0.119 (3)		0.119 (3)		0.158 (4)	0.103 (2.6)			0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)	0.158 (4)	0.119 (3)				475					
5.6	0.119 (3)		0.119 (3)		0.158 (4)	0.103 (2.6)			0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)		0.119 (3)				565					
6.8	0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)	0.178 (4.5)	0.119 (3)			0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)		0.158 (4)				685					
8.2	0.119 (3)	0.103 (2.6)	0.119 (3)	0.103 (2.6)		0.142 (3.6)			0.119 (3)	0.119 (3)	0.119 (3)	0.119 (3)						825					
10	0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)		0.150 (3.8)			0.138 (3.5)	0.119 (3)	0.138 (3.5)	0.119 (3)						106					
12	0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					0.138 (3.5)	0.119 (3)	0.138 (3.5)	0.119 (3)						126					
15	0.138 (3.5)	0.103 (2.6)	0.138 (3.5)	0.103 (2.6)					0.138 (3.5)	0.119 (3)	0.138 (3.5)	0.119 (3)						156					
18		0.103 (2.6)		0.103 (2.6)						0.119 (3)		0.119 (3)						186					
22		0.111 (2.8)		0.111 (2.8)						0.119 (3)		0.119 (3)						226					
27		0.130 (3.3)		0.130 (3.3)														276					

The thickness T_{max} in inches (in mm) is indicated in the cells.