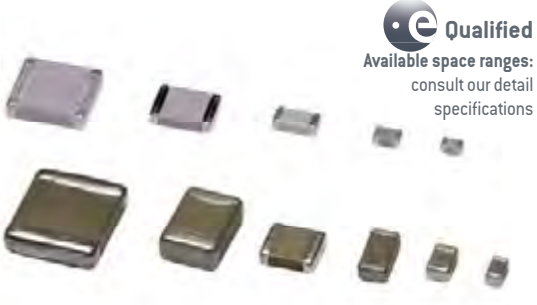
CEC / CNC Series

Low and Medium Voltage Chips Capacitors



Qualified
Available space ranges:
consult our detail specifications

In accordance with the specifications of **CECC 32101** and **NF C 93133** standards

FEATURES

- Case sizes: 0402 - 3040
- NP0, BX, 2C1, X7R dielectrics
- Capacitance range: 1pF to 12µF
- Ag/Pd/Pt, Ni barrier, epoxy terminations available
- RoHS and Non RoHS compliant capacitors available
- Screening in accordance with ESA specifications available

PHYSICAL CHARACTERISTICS

CONSTRUCTION

MLCC capacitors for surface mounting with optional Nickel barrier

MARKING (on request)

Capacitance value coded (from 0805 to 3040 sizes).

PACKAGING (see page 13)

S8* = available for 0402 to 1210 sizes.
S12* = available for 1812 to 2220 sizes.
BA* = available for 0402 to 2220 (except 0907) sizes.

* not available with H, HW and E, terminations

ELECTRICAL SPECIFICATIONS

Description	NP0
Operating temperature	−55°C to +125°C
Climatic category	55 / 125 / 56
Rated voltage (U_{RC})	$10V_{DC}$ to $1,000V_{DC}$
Maximum ΔC/°C over temperature range without DC voltage applied	NA
Maximum ΔC/°C over temperature range with rated voltage applied	NA
Temperature coefficient with or without DC voltage applied	(0±30)ppm/°C
Dielectric withstanding voltage	2.5 U_{RC} for $U_{RC} \leq 500V_{DC}$ 1.6 U_{RC} for $U_{RC} = 1,000V_{DC}$ 1.5 U_{RC} for $U_{RC} = 1,000V_{DC}$
Capacitance	at 1MHz for C ≤ 1,000pF at 1kHz for C > 1,000pF
Dissipation factor at 25°C	≤ 0.015 (150/C + 7)% at 1MHz for C ≤ 50pF ≤0.15% at 1MHz for 50pF < C ≤ 1,000pF ≤0.15% at 1kHz for C > 1,000pF
Insulation resistance at 25°C under U_{RC} for $U_{RC} \leq 500V_{DC}$ under $500V_{DC}$ for $U_{RC} > 500V_{DC}$	≥ 100,000 MΩ for C ≤ 10nF ≥ 1,000 MΩ.µF for C > 10nF
Aging	None

Description	BX	2C1	X7R
Operating temperature	−55°C to +125°C	−55°C to +125°C	−55°C to +125°C
Climatic category	55 / 125 / 56	55 / 125 / 56	55 / 125 / 56
Rated voltage (U_{RC})	$10V_{DC}$ to $500V_{DC}$	$10V_{DC}$ to $500V_{DC}$	$10V_{DC}$ to $1,000V_{DC}$
Maximum ΔC/°C over temperature range without DC voltage applied	±15%	±20%	±15%
Maximum ΔC/°C over temperature range with rated voltage applied	+15% −25%	+20 % −30%	NA
Temperature coefficient with or without DC voltage applied	NA	NA	NA
Dielectric withstanding voltage	2.5 U_{RC}	2.5 U_{RC}	2.5 U_{RC} for $U_{RC} \leq 500V_{DC}$
Capacitance	at 1MHz for C ≤ 100pF at 1kHz for C > 100pF		
Dissipation factor at 25°C	≤2.5% at 1MHz for C ≤ 100pF ≤2.5% at 1kHz for C > 100pF		
Insulation resistance at 25°C under U_{RC} for $U_{RC} \leq 500V_{DC}$ under $500V_{DC}$ for $U_{RC} > 500V_{DC}$	≥ 100,000 MΩ for C ≤ 10nF ≥ 1,000 MΩ.µF for C > 10nF		
Aging	≤ 2.5% per decade hour		

HOW TO ORDER

CNC4	-	C	M	F	56nF	10%	50V	S8	T5
Series	Bismuth	Termination	Marking	Quality level	Capacitance	Tolerance	Rated voltage	Packaging	Reliability level

CEC ••
NP0 Ceramic

CNC ••
BX, 2C1, 2R1/X7R Ceramics

See Ratings and Case code table

Option A
(= bismuth free dielectric) available on request. Please consult us.

W = RoHS compliant

-	Ag/Pd/Pt	W	Ag/Pd/Pt
Q	Ag *	QW	Ag
H	Ag/Pd/Pt + dipped Sn/Pb 60/40	HW	Ag/Pd/Pt + dipped Sn
C	Ag + Ni** + electrolytic Sn/Pb 95/5	CW	Ag + Ni + electrolytic Sn
D	Ag + Ni*** + electrolytic Sn/Pb 60/40	-	
E	Ag + Ni**** + dipped Sn/Pb 60/40		
G	Ag + Ni + Au	GW	Ag + Ni + Au
YC	Ag + Polymer + Ni + Sn/Pb 95/5	YCW	Ag + Polymer + Ni + Sn
YD	Ag + Polymer + Ni + Sn/Pb 60/40	-	
YG	Ag + Polymer + Ni + Au	YGW	Ag + Polymer + Ni + Au

* Only 1812 to 3040 sizes
** Only 0402 to 2220 sizes (other sizes on demand)
*** Only 0402 to 1806 sizes (other sizes on demand)
**** Only 2225 to 3040 sizes

- = no marking
M = Marking: capacitance value coded (from 0805 to 3040 sizes).

- = standard quality level
F = Hi-Rel quality: screening in accordance with Exxelia specification

Capacitance value in clear

NP0:
cap. value ≤ 12pF **±0.25pF**
cap. value ≤ 8.2pF **±0.5pF** **±1pF**
cap. value > 22pF **±1%**
cap. value > 12pF **±2%**
cap. value > 8.2pF **±5%** **±10%**
cap. value > 3.9pF **±20%**

BX, 2C1 and X7R:
±5%
±10%
±20%

10V
16V
25V
50V
100V
200V
500V
1000V

Intermediary and higher voltages available on request.

- = Exxelia packaging
S8* = available for 0402 to 1210 sizes.
S12* = available for 1812 to 2220 sizes.
BA* = available for 0402 to 2220 (except 0907) sizes.

* not available with **H, HW** and **E,** terminations

see page 13

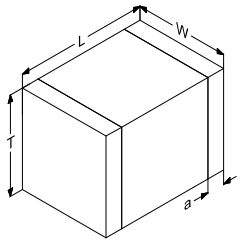
For F parts only. Acc. to Exxelia spec.
-
T5
T6

See page 15

Low and Medium Voltage Chips Capacitors

CEC / CNC Series

DIMENSIONS in inches (mm)



STANDARD RATINGS

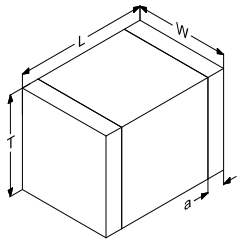
Series		CEC/CNC 19				CEC/CNC 17				CEC/CNC 14			
Size		0402				0403				0603			
Dimensions inches (mm)	L	0.039 ± 0.004 (1 ± 0.1)				0.039 ± 0.004 (1 ± 0.1)				0.063 ± 0.006 (1.6 ± 0.15)			
	W	0.02 ± 0.004 (0.5 ± 0.1)				0.03 ± 0.004 (0.76 ± 0.1)				0.032 ± 0.006 (0.8 ± 0.15)			
	a	0.004 min (0.1) min				0.004 min (0.1) min				0.012 ± 0.008 (0.3 ± 0.2)			
	T max.	0.024 (0.6)				0.032 (0.8)				0.04 (1)			
Dielectric		NPO	BX	2C1	X7R	NPO	BX	2C1	X7R	NPO	BX	2C1	X7R
Min. Capa. value		1pF	68pF			1pF	270pF			1pF	270pF		
Rated voltage (U_{RC})	10V	390pF	15nF	15nF	15nF	1.2nF	47nF	47nF	47nF	3.3nF	120nF	120nF	120nF
	16V	270pF	12nF	12nF	15nF	820pF	39nF	39nF	47nF	2.7nF	120nF	120nF	120nF
	25V	180pF	4.7nF	5.6nF	5.6nF	470pF	15nF	18nF	18nF	1.8nF	56nF	56nF	56nF
	50V	82pF	1.2nF	2.2nF	3.9nF	330pF	3.9nF	5.6nF	12nF	820pF	12nF	18nF	33nF
	63V	68pF	820pF	1.2nF	3.9nF	220pF	2.2nF	3.9nF	12nF	680pF	8.2nF	12nF	33nF
	100V	39pF	330pF	560pF	1.2nF	120pF	1nF	1.8nF	3.3nF	330pF	3.3nF	5.6nF	12nF

Series		CEC/CNC 1				CEC/CNC 2						CEC/CNC 18				CEC/CNC 8			
Size		0504				0805						0907				1005			
Dimensions inches (mm)	L	0.049 ± 0.008 (1.25 ± 0.2)				0.079 ± 0.012 (2 ± 0.3)						0.091 ± 0.012 (2.3 ± 0.3)				0.098 ± 0.012 (2.5 ± 0.3)			
	W	0.039 ± 0.008 (1 ± 0.2)				0.049 ± 0.008 (1.25 ± 0.2)						0.071 ± 0.01 (1.8 ± 0.25)				0.049 ± 0.008 (1.25 ± 0.2)			
	a	0.004 min (0.1) min				0.02 ± 0.012 (0.5 ± 0.3)						0.02 ± 0.012 (0.5 ± 0.3)				0.024 ± 0.016 (0.6 ± 0.4)			
	T max.	0.04 (1)				0.052 (1.3)						0.06 (1.5)				0.052 (1.3)			
Dielectric		NPO	BX	2C1	X7R	NPO	NPO Ext.	BX	2C1	X7R	X7R Ext.	NPO	BX	2C1	X7R	NPO	BX	2C1	X7R
Min. Cap. value		1pF	270pF			1pF		1nF				1pF	47pF			1pF	33pF		
Rated voltage (U_{RC})	10V	3.3nF	120nF	120nF	120nF	12nF	-	470nF	470nF	470nF	-	18nF	820nF	820nF	820nF	3.3nF	100nF	100nF	100nF
	16V	3.3nF	120nF	120nF	120nF	12nF	-	470nF	470nF	470nF	-	18nF	680nF	680nF	680nF	3.3nF	100nF	100nF	100nF
	25V	1.8nF	56nF	56nF	56nF	6.8nF	-	220nF	220nF	220nF	-	12nF	330nF	390nF	390nF	2.2nF	68nF	68nF	68nF
	50V	1.2nF	15nF	22nF	33nF	3.3nF	-	56nF	82nF	120nF	-	5.6nF	82nF	120nF	150nF	1.8nF	56nF	56nF	56nF
	63V	820pF	8.2nF	15nF	33nF	2.7nF	-	33nF	47nF	120nF	-	4.7nF	56nF	82nF	120nF	1.8nF	39nF	56nF	56nF
	100V	390pF	3.3nF	6.8nF	12nF	1.5nF	-	12nF	27nF	39nF	-	2.7nF	22nF	39nF	68nF	1nF	12nF	18nF	18nF
	Min. Cap. value	-	-			1pF		390pF				1pF	330pF			1pF	330pF		
	200V	-	-	-	-	390pF	820pF	3.3nF	5.6nF	10nF	22nF	680pF	4.7nF	8.2nF	12nF	390pF	3.9nF	5.6nF	6.8nF
	500V	-	-	-	-	100pF	470pF	-	560pF	1.2nF	5.6nF	180pF	-	1nF	1.5nF	120pF	-	560pF	820pF
	1,000V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

CEC / CNC Series

Low and Medium Voltage Chips Capacitors

DIMENSIONS in inches (mm)



STANDARD RATINGS

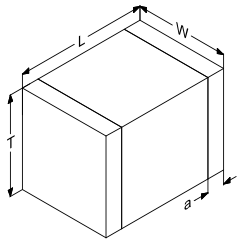
Series		CEC/CNC 12						CEC/CNC 4						CEC/CNC 9				CEC/CNC 3			
Size		1206						1210						1605				1806			
Dimensions inches (mm)	L	0.126 ± 0.016 (3.2 ± 0.4)						0.126 ± 0.016 (3.2 ± 0.4)						0.158 ± 0.02 (4 ± 0.5)				0.177 ± 0.02 (4.5 ± 0.5)			
	W	0.063 ± 0.006 (1.6 ± 0.15)						0.098 ± 0.012 (2.5 ± 0.3)						0.05 ± 0.008 (1.25 ± 0.2)				0.063 ± 0.008 (1.6 ± 0.2)			
	a	0.02 ± 0.012 (0.5 ± 0.3)						0.024 ± 0.016 (0.6 ± 0.4)						0.024 ± 0.016 (0.6 ± 0.4)				0.024 ± 0.016 (0.6 ± 0.4)			
	T max.	0.063 (1.6)						0.071 (1.8)						0.05 (1.25)				0.063 (1.6)			
Dielectric		NPO	NPO Ext.	BX	2C1	X7R	X7R Ext.	NPO	NPO Ext.	BX	2C1	X7R	X7R Ext.	NPO	BX	2C1	X7R	NPO	BX	2C1	X7R
Min. Cap. value		1pF		1.8nF				10pF		2.2nF				10pF	220pF			47pF	390pF		
Rated voltage (U_{RC})	10V	22nF	-	1.2µF	1.2µF	1.2µF	-	56nF	-	2.2µF	2.2µF	2.2µF	-	6.8nF	150nF	150nF	150nF	12nF	330nF	330nF	330nF
	16V	22nF	-	820nF	1.2µF	1.2µF	-	56nF	-	2.2µF	2.2µF	2.2µF	-	6.8nF	150nF	150nF	150nF	12nF	330nF	330nF	330nF
	25V	15nF	-	330nF	680nF	680nF	-	39nF	-	1µF	1µF	1µF	-	4.7nF	100nF	100nF	100nF	8.2nF	220nF	220nF	220nF
	50V	6.8nF	-	150nF	220nF	270nF	-	18nF	-	330nF	470nF	560nF	-	3.9nF	68nF	82nF	82nF	6.8nF	150nF	180nF	180nF
	63V	6.8nF	-	100nF	150nF	180nF	-	15nF	-	180nF	270nF	560nF	-	3.3nF	56nF	68nF	82nF	5.6nF	100nF	150nF	180nF
	100V	3.9nF	-	39nF	68nF	120nF	-	8.2nF	-	82nF	150nF	220nF	-	2.2nF	27nF	27nF	33nF	3.9nF	39nF	56nF	56nF
	Min. Cap. value	1pF		390pF				10pF		470pF				10pF	470pF			47pF	390pF		
	200V	1.2nF	3.3nF	8.2nF	15nF	27nF	68nF	2.2nF	5.6nF	18nF	33nF	56nF	150nF	820pF	6.8nF	10nF	12nF	1.2nF	8.2nF	12nF	18nF
	500V	330pF	1.5nF	820pF	2.2nF	3.9nF	12nF	680pF	2.7nF	1.8nF	3.9nF	8.2nF	27nF	220pF	-	1.2nF	1.5nF	330pF	820pF	1.8nF	2.7nF
	1,000V	120pF	680pF	-	-	560pF	2.7nF	220pF	1nF	-	-	1.2nF	4.7nF	82pF	-	-	-	120pF	-	-	560pF

Series		CEC/CNC 6						CEC/CNC 70				CEC/CNC 5				CEC/CNC 7					
Size		1812						1825				2210				2220					
Dimensions inches (mm)	L	0.177 ± 0.02 (4.5 ± 0.5)						0.177 ± 0.020 (4.5 ± 0.5)				0.224 ± 0.02 (5.7 ± 0.5)				0.224 ± 0.02 (5.7 ± 0.5)					
	W	0.126 ± 0.016 (3.2 ± 0.4)						0.250 ± 0.020 (6.35 ± 0.5)				0.098 ± 0.012 (2.5 ± 0.3)				0.197 ± 0.02 (5 ± 0.5)					
	a	0.024 ± 0.016 (0.6 ± 0.4)						0.024 ± 0.020 (0.6 ± 0.4)				0.024 ± 0.016 (0.6 ± 0.4)				0.024 ± 0.016 (0.6 ± 0.4)					
	T max.	0.071 (1.8)						0.071 (1.8)				0.067 (1.7)				0.071 (1.8)					
Dielectric		NPO	NPO Ext.	BX	2C1	X7R	X7R Ext.	NPO	BX	2C1	X7R	NPO	BX	2C1	X7R	NPO	NPO Ext.	BX	2C1	X7R	X7R Ext.
Min. Cap. value		47pF		3.9nF				100pF	1nF			220pF	1nF			100pF		22nF			
Rated voltage (U_{RC})	10V	82nF	-	4.7µF	4.7µF	4.7µF	-	150nF	4.7µF	4.7µF	4.7µF	39nF	680nF	680nF	680nF	180nF	-	10µF	10µF	10µF	-
	16V	82nF	-	3.3µF	3.3µF	4.7µF	-	150nF	2.7µF	2.7µF	2.7µF	39nF	680nF	680nF	680nF	180nF	-	8.2µF	8.2µF	10µF	-
	25V	39nF	-	2.2µF	2.2µF	2.2µF	-	82nF	2.2µF	2.2µF	2.2µF	22nF	470nF	470nF	470nF	82nF	-	4.7µF	4.7µF	4.7µF	-
	50V	27nF	-	560nF	820nF	1.2µF	-	56nF	1.2µF	1.5µF	1.5µF	18nF	390nF	390nF	390nF	56nF	-	1.2µF	2.2µF	2.7µF	-
	63V	22nF	-	330nF	470nF	1µF	-	47nF	680nF	1µF	1µF	15nF	330nF	390nF	390nF	47nF	-	820nF	1.5µF	2.7µF	-
	100V	15nF	-	150nF	270nF	470nF	-	22nF	270nF	560nF	820nF	10nF	100nF	180nF	180nF	33nF	-	270nF	680nF	1µF	-
	Min. Cap. value	47pF		470pF				82pF	1nF			220pF	1nF			100pF		1.2nF			
	200V	4.7nF	12nF	27nF	47nF	68nF	330nF	8.2nF	56nF	100nF	180nF	3.9nF	27nF	47nF	68nF	10nF	27nF	56nF	120nF	220nF	820nF
	500V	1.2nF	5.6nF	2.7nF	6.8nF	10nF	82nF	2.2nF	5.6nF	12nF	27nF	1nF	2.7nF	5.6nF	8.2nF	2.7nF	15nF	5.6nF	15nF	27nF	180nF
	1,000V	470pF	2.7nF	-	-	2.2nF	22nF	820pF	-	-	3.9nF	470pF	-	-	1.8nF	1nF	6.8nF	-	-	3.9nF	39nF

Low and Medium Voltage Chips Capacitors

CEC / CNC Series

DIMENSIONS in inches (mm)



STANDARD RATINGS

Series		CEC/CNC 71				CEC/CNC W				CEC/CNC X				CEC/CNC 72			
Size		2225				2528				3030				3040			
Dimensions inches (mm)	L	0.224 ± 0.02 (5.7 ± 0.5)				0.250 ± 0.020 (6.35 ± 0.5)				0.299 ± 0.02 (7.6 ± 0.5)				0.299 ± 0.02 (7.6 ± 0.5)			
	W	0.250 ± 0.020 (6.35 ± 0.5)				0.276 ± 0.020 (7 ± 0.5)				0.299 ± 0.02 (7.6 ± 0.5)				0.4 ± 0.02 (10.16 ± 0.5)			
	a	0.024 ± 0.020 (0.6 ± 0.4)				0.024 ± 0.020 (0.6 ± 0.4)				0.024 ± 0.016 (0.6 ± 0.4)				0.024 ± 0.016 (0.6 ± 0.4)			
	T max.	0.079 (2)				0.079 (2)				0.079 (2)				0.079 (2)			
Dielectric		NP0	BX	2C1	X7R	NP0	BX	2C1	X7R	NP0	BX	2C1	X7R	NP0	BX	2C1	X7R
Min. Cap. value		150pF	1.5nF			270pF	2.7nF			390pF	4.7nF			680pF	8.2nF		
Rated voltage (U_{RC})	10V	180nF	5.6µF	5.6µF	5.6µF	220nF	6.8µF	6.8µF	6.8µF	330nF	10µF	10µF	10µF	470nF	12µF	12µF	12µF
	16V	180nF	3.3µF	3.3µF	4.7µF	220nF	3.9µF	3.9µF	3.9µF	330nF	6.8µF	6.8µF	6.8µF	470nF	8.2µF	8.2µF	8.2µF
	25V	100nF	2.2µF	2.2µF	3.9µF	120nF	2.7µF	2.7µF	2.7µF	180nF	3.9µF	3.9µF	3.9µF	270nF	5.6µF	5.6µF	5.6µF
	50V	68nF	1.2µF	1.5µF	2.2µF	82nF	1.5µF	1.8µF	1.8µF	120nF	2.7µF	2.7µF	2.7µF	150nF	3.3µF	3.9µF	3.9µF
	63V	56nF	820nF	1.2µF	1.5µF	68nF	1µF	1.5µF	1.8µF	100nF	1.5µF	2.2µF	2.2µF	120nF	2.2µF	2.7µF	3.3µF
	100V	33nF	390nF	680nF	1.2µF	33nF	390nF	820nF	1.2µF	56nF	680nF	1.2µF	1.5µF	82nF	1µF	1.8µF	2.2µF
	200V	12nF	68nF	120nF	270nF	15nF	82nF	150nF	270nF	22nF	150nF	270nF	470nF	33nF	180nF	390nF	560nF
	500V	3.3nF	5.6nF	15nF	33nF	3.9nF	8.2nF	18nF	33nF	6.8nF	12nF	33nF	68nF	8.2nF	22nF	56nF	100nF
	1,000V	1.2nF	-	-	4.7nF	1.5nF	-	-	5.6nF	2.7nF	-	-	10nF	3.3nF	-	-	15nF

Available capacitance values:
NP0: E6, E12, E24, E48, E96 (see page 14). Specific values upon request.
X7R: E6, E12, E24 (see page 14). Specific values upon request.

The above table defines the standard products, other components may be built upon request.
Other temperature coefficients, temperature characteristic 2B1 and Bismuth free dielectrics are available: contact your sales representative.

General Information NPO/COG (Class 1)

COMPOSITION

NPO capacitors are produced by using a dielectric made of titanium dioxide ($Ti\ O_2$) modified by magnesium oxide Mg O (white ceramics) or a rare earth oxide, e.g. $Nd_2\ O_3$ (other NPO ceramics).

As a consequence, these ceramics are non ferro-electric materials with a low dielectric constant ($\varepsilon r \leq 110$).

Other additives are used to dope the dielectric constant up to 300. Though derogating from CG class, doped dielectric constant features a linear temperature drift and a matchless stability compared with class 2 ceramics.

The wide range of possible NPO dielectric compositions enables to use the material best suited to the application :

- standard applications,
- high voltage,
- high temperature,
- microwave,
- power capacitors.

«Temperature coefficient» compositions are particularly suitable for impedance matching. These ceramics usually enable to achieve temperature coefficients from 0 to –1 000 ppm/°C. For specific requirements, other coefficients can be achieved (e.g. –3 300 ppm/°C).

STABILITY

As εr is low, these dielectrics are extremely stable with only minor changes under such stresses as :

- temperature,
- voltage,
- frequency.

In addition, they are not affected by piezo-electric phenomena and their dielectric absorption coefficients are low and even non measurable for dielectrics with the lowest constants.

MECHANICAL PROPERTIES

Class 1 ceramics are the perfect match for metallic electrodes made of Pd or Ag-Pd alloy and have a high hardness and mechanical toughness making them resistant to thermal shocks (wave soldering for instance) and to thermal cycling after mounting on substrates having an expansion coefficient close to the capacitor one.

Ceramic chips meet CECC 32100 and NF C 93133 standards.

CLIMATIC CATEGORIES

Climatic categories are identified by three-digit codes as per NF C 20700 standard. Coding method is described in table 6.

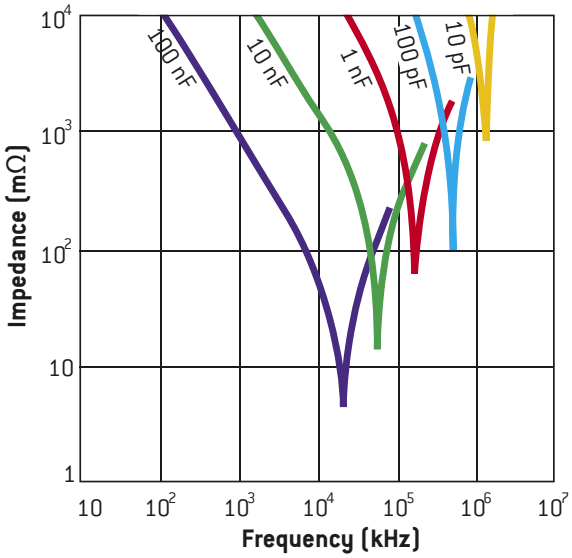
e.g. : – 55°C + 125°C / 56 days category is identified by code 434.

TEMPERATURE COEFFICIENT

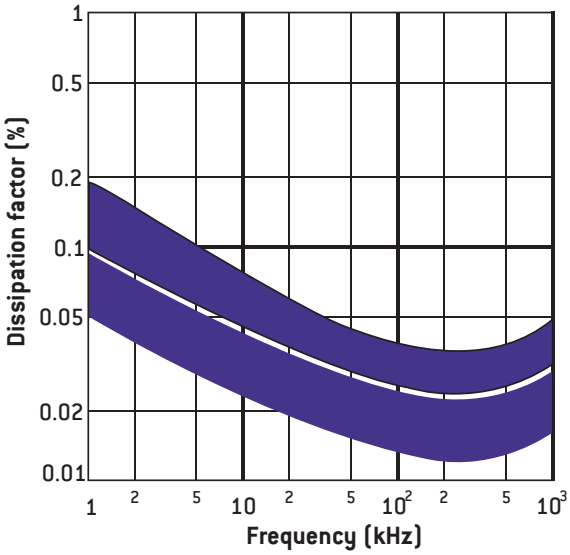
Temperature coefficient kθ(ppm/°C)		
kθ	Tolerances	Code letter
+ 100	± 30	AG
0	± 30	CG
– 33	± 30	HG
– 75	± 30	LG
– 150	± 30	PG
– 220	± 30	RG
– 330	± 60	SH
– 470	± 60	TH
– 750	± 120	UJ
– 1 000	± 250	QK

General Information NPO/COG (Class 1)

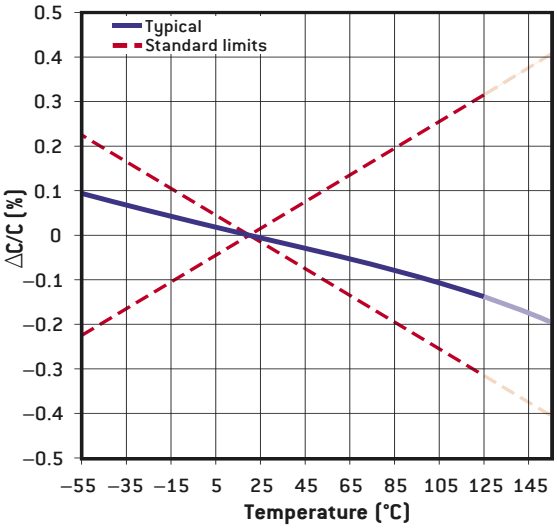
IMPEDANCE VERSUS FREQUENCY



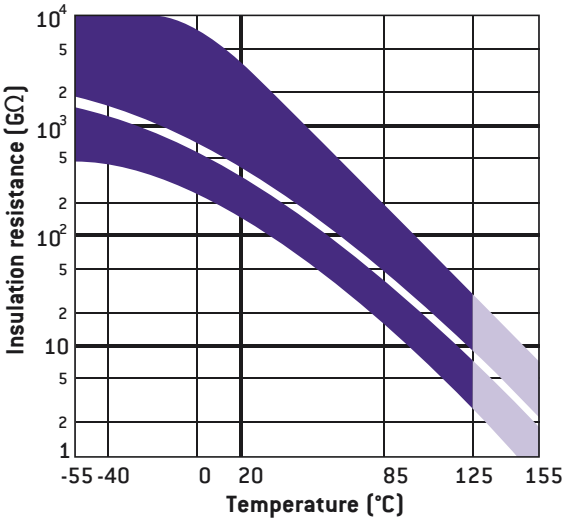
DISSIPATION FACTOR VERSUS FREQUENCY



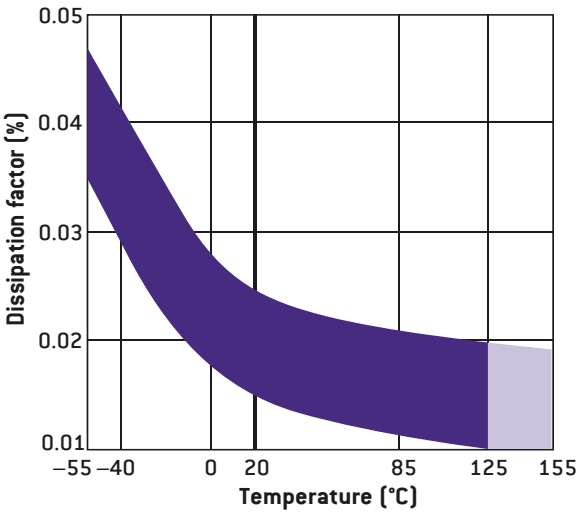
CAPACITANCE CHANGE VERSUS TEMPERATURE



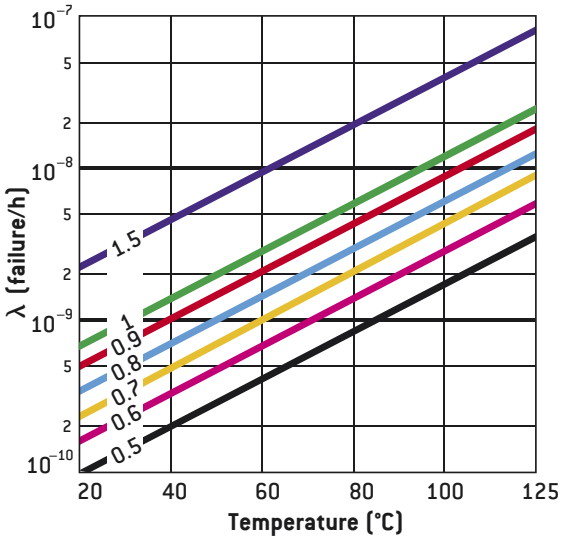
IR VERSUS TEMPERATURE



DISSIPATION FACTOR VERSUS TEMPERATURE



TYPICAL FAILURE RATE VERSUS TEMPERATURE



General Information X7R (Class 2)

COMPOSITION

Class 2 capacitors are produced by using a dielectric made of barium titanate ($Ba\ Ti\ O_3$). By nature, the dielectric is a ferroelectric compound with a high dielectric constant usually varying :

- from 1 000 to 5 000 - typical of capacitors meeting 2C1 type specifications (BX, X7R),
- from 5 000 to 15 000 - typical of capacitors meeting Z5U or Y5V type specifications.

Depending on whether the dielectric contains a flux additive, mainly bismuth or boron, electrodes are made of Ag-Pd alloys with high silver content or high palladium content, even pure palladium in some cases.

STABILITY

As the dielectric is a ferro-electric material, class 2 capacitors present significant variations under such stresses as :

- temperature,
- voltage,
- frequency.

In addition, the dielectric absorption coefficient can reach a few % and piezo-electric phenomena can affect the dielectric at critical frequencies (full information and specific documents available on request).

MECHANICAL PROPERTIES

Class 2 dielectrics are hard materials and are sensitive to thermo-mechanical stress. Stress should be limited when mounting and adequate substrates with an adapted expansion coefficient used.

BISMUTH OR BISMUTH FREE DIELECTRICS

Class 2 capacitors are made of ceramics capable to embed a flux element (e.g. bismuth or boron salt).Their eventual use will affect the choice of electrode alloys firing temperature used. Capacitor behavior under such constraints as temperature, voltage, frequency and even reliability, in some applications (further information available on request), is also different.

That is why French and European standard authorities have decided to differentiate bismuth from bismuth free ceramics by measuring tangent δ at –55°C. Tangent Tg δ (–55°C) 350.10^{-4} in flux free dielectrics.

Flux free dielectrics are identified by suffix «A» after capacitor type (e.g. CNC2A).

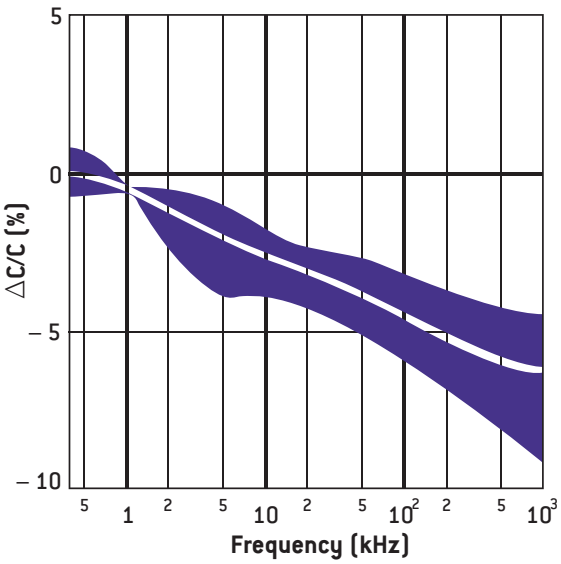
CAPACITANCE/TEMPERATURE RELATIONSHIP

Capacitance variations are defined within a specified temperature range, + 20°C being the reference temperature. This characteristic is expressed by associating the temperature range and capacitance stability.

Stability category Code letter	Max. capacitance variation (%) with reference to capacitance at 20°C	
	Without voltage	At rated DC voltage (U_{DC})
B	± 10	+ 10– 15
C	± 20	+ 20 – 30
D	+ 20 – 30	+ 20 – 40
E	+ 20 – 55	+ 20 – 65
R	+ 15 – 15	Not applicable
X	+ 15 – 15	+ 15 – 25

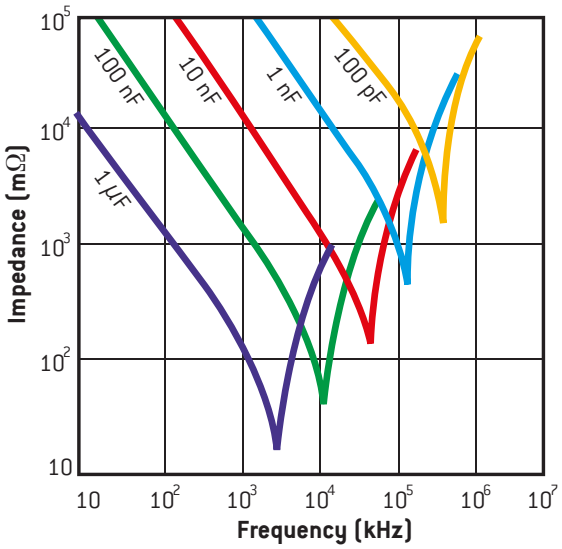
Temperature category	
Code	Temperature range
1	– 55°C +125°C
2	– 55°C + 85°C
4	– 25°C + 85°C

CAPACITANCE CHANGE VERSUS FREQUENCY

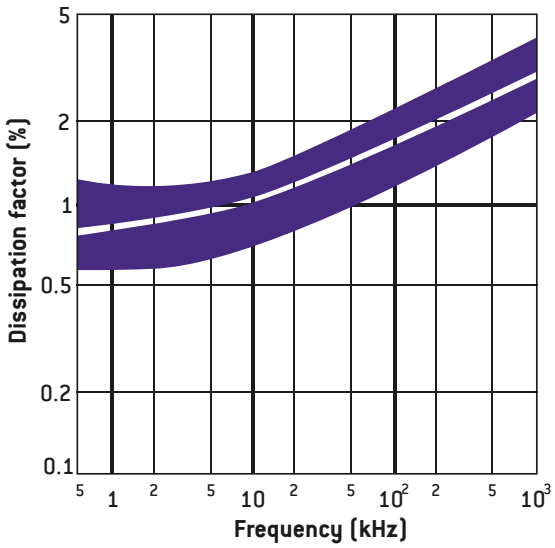


General Information X7R (Class 2)

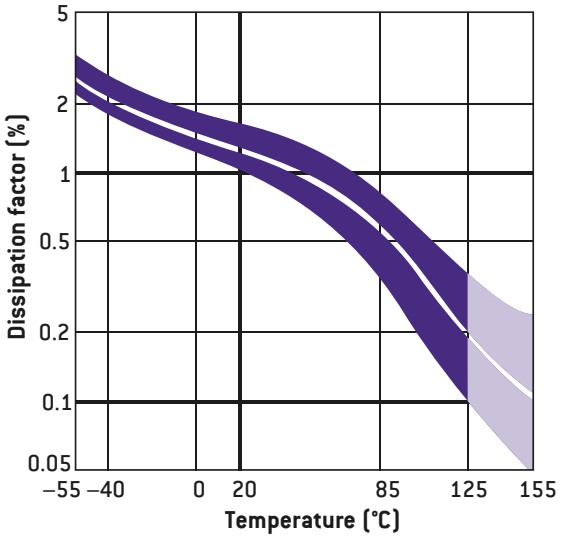
IMPEDANCE VERSUS FREQUENCY



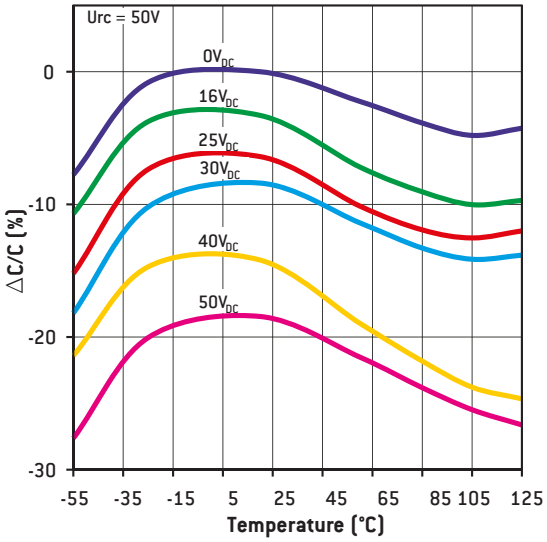
DISSIPATION FACTOR VERSUS FREQUENCY



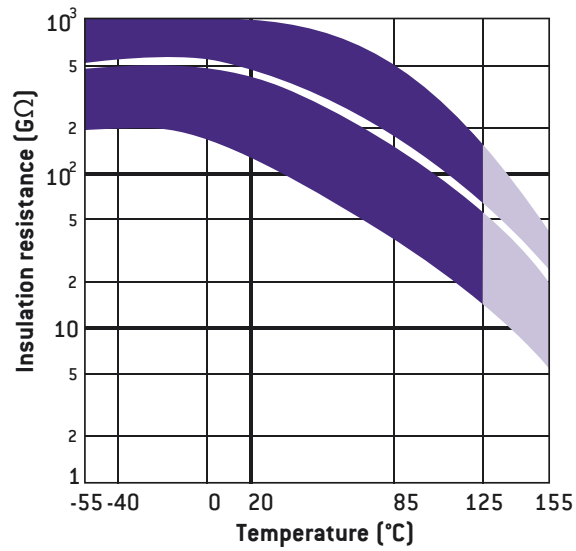
DISSIPATION FACTOR VERSUS TEMPERATURE



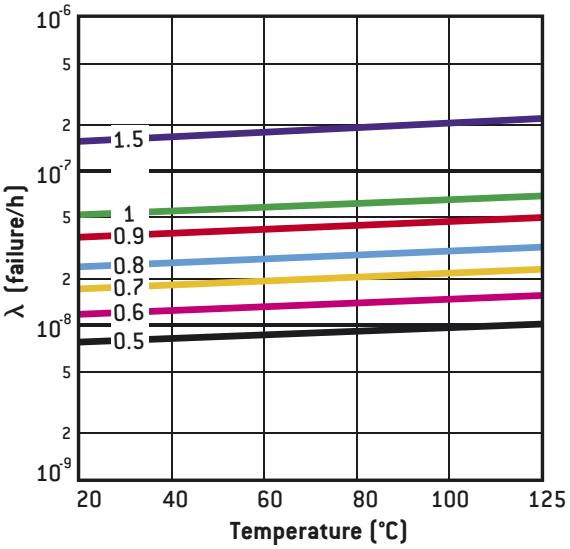
CAPACITANCE CHANGE VERSUS TEMPERATURE



IR VERSUS TEMPERATURE

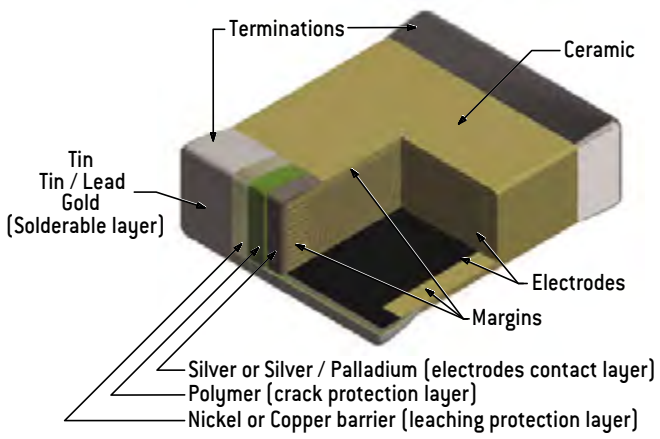


TYPICAL FAILURE RATE VERSUS TEMPERATURE



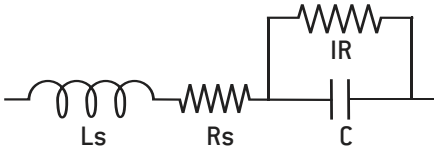
Ceramic Capacitors Technology

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 x IR) is often specified in Ω.F or MΩ.μF.

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:

$P = 2\pi f C Vrms^2 DF$

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:

$Z = Rs + j (Ls.\omega - 1/(C.\omega))$ with $\omega = 2\pi f$

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

$Z = Rs$ and $LsC.\omega^2 = 1$

Above this frequency the capacitor behaves like an inductor.

	P100	NP0	N2200 (C4xx)	BX	2C1	X7R
Dielectric material	Porcelain	Magnesium titanate or Neodynium 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	+		+	++		

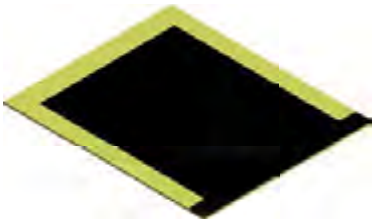
Ceramic Capacitors Technology

MANUFACTURING STEPS

SLIP CASTING

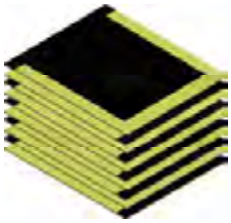
A slurry, a mix of ceramic powder, binder and solvents, is poured onto conveyor belt inside a drying oven, resulting in a dry ceramic sheet.

ELECTRODE SCREEN PRINTING



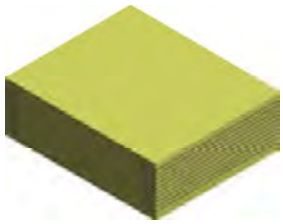
The electrode ink, made from a metal powder mixed with solvents, is printed onto the ceramic sheets using a screen printing process.

STACKING



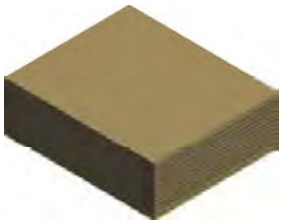
The sheets with electrode printed are stacked to create a multilayer structure.

PRESSING



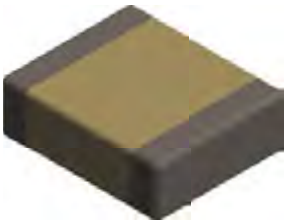
Pressure is applied to the stack to fuse all the separate layers, this created a monolithic structure.

SINTERING



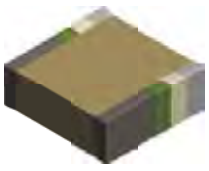
The parts are sintered in an oven with a precise temperature profile which is very important to the characteristics of the capacitors.

TERMINATIONS



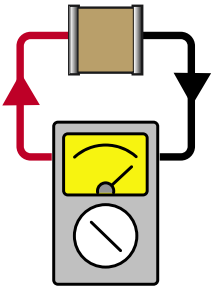
Each terminal of the capacitor is dipped in the termination ink, mix of metal powder, solvents and glass frit and the parts are fired in an oven.

TERMINATIONS PLATING



Stacking + leads soldering + encapsulation
(see pages 10-11)

FINAL TESTING



PACKAGING

User Guide

SMD TERMINATIONS

NON RoHS COMPLIANT	Code	RoHS COMPLIANT	Code	Magnetic	Recommended mounting process						Storage (months)*
					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.

User Guide

LEAD STYLES

SURFACE MOUNTING

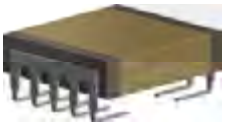
DIL LEADS

P style

PL style

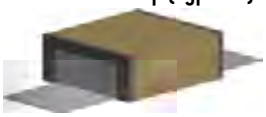
L style

J style

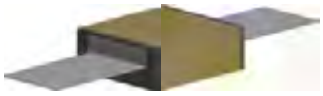


RIBBON LEADS

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



Axial (Type 2)

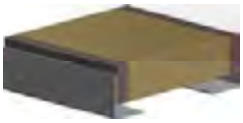


Radial (Type 3)

R style

RX style

RJ style



Please contact Exxelia sales for any lead configuration not shown.

TROUGH-HOLE MOUNTING

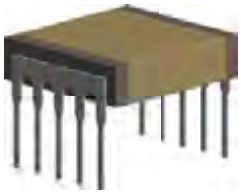
AXIAL AND RADIAL

Radial leads (Type 6)

Radial leads (4 leads)

Axial leads (Type 7)

DIL leads: N style



ENCAPSULATION STYLES

Ceramic encapsulation
(selfprotected)

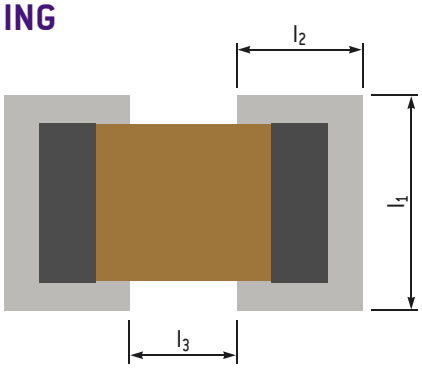
Varnish

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					
	I_1		I_2		I_3		I_1		I_2		I_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

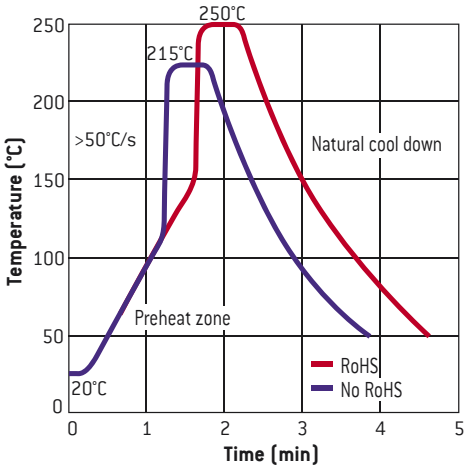
Ceramic is by nature a material which is sensitive both thermally and mechanically. Stresses caused by the physical and thermal properties of the capacitors, substrates and solders are attenuated by the leads.

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).

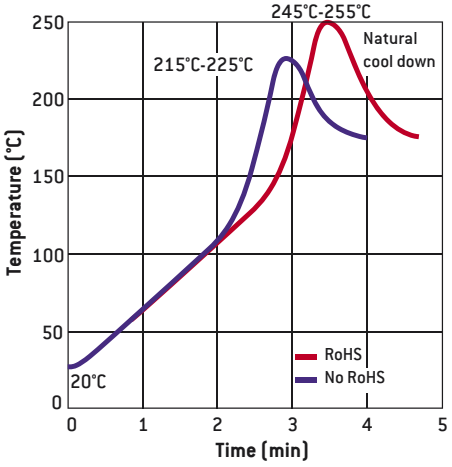
Infrared and vapor phase reflow, are preferred for high reliability applications as inherent thermo-mechanical strains are lower than those inherent to wave soldering.

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

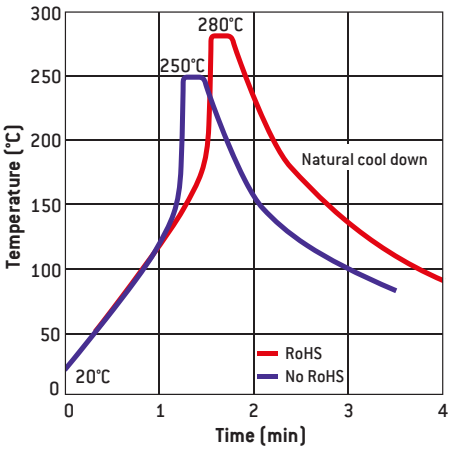
RECOMMENDED VAPOR PHASE REFLOW PROFILE



RECOMMENDED IR REFLOW PROFIL



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,

User Guide

- 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.

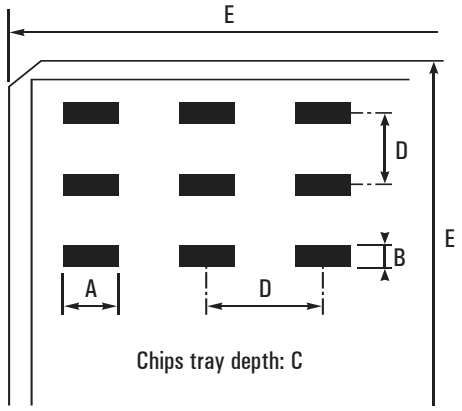
Maximum quantities per reel are as follows:

- 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.

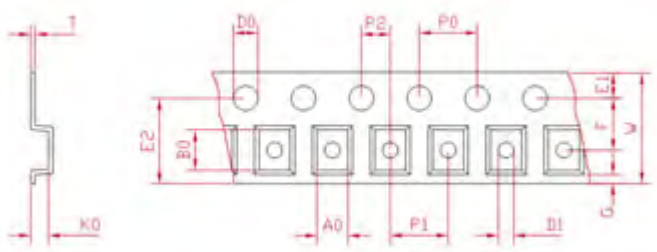
TRAY PACKAGES



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	Ø 0.112 (Ø 3.02)		0.065 (1.65)	0.167 (4.24)	2 (50.8)
0403	100	No	Ø 0.112 (Ø 3.02)		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)
	25	Yes	0.24 (6.1)	0.265 (6.73)	0.07 (1.78)	0.345 (8.76)	2 (50.8)
2220	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	12
		13
15	15	15
		16
	18	18
		20
22	22	22
		24
	27	27
		30
33	33	33
		36
	39	39
		43
47	47	47
		51
	56	56
		62
68	68	68
		75
	82	82
		91

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 VOLTAGE CODES

Use the following voltage code chart for part markings:

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

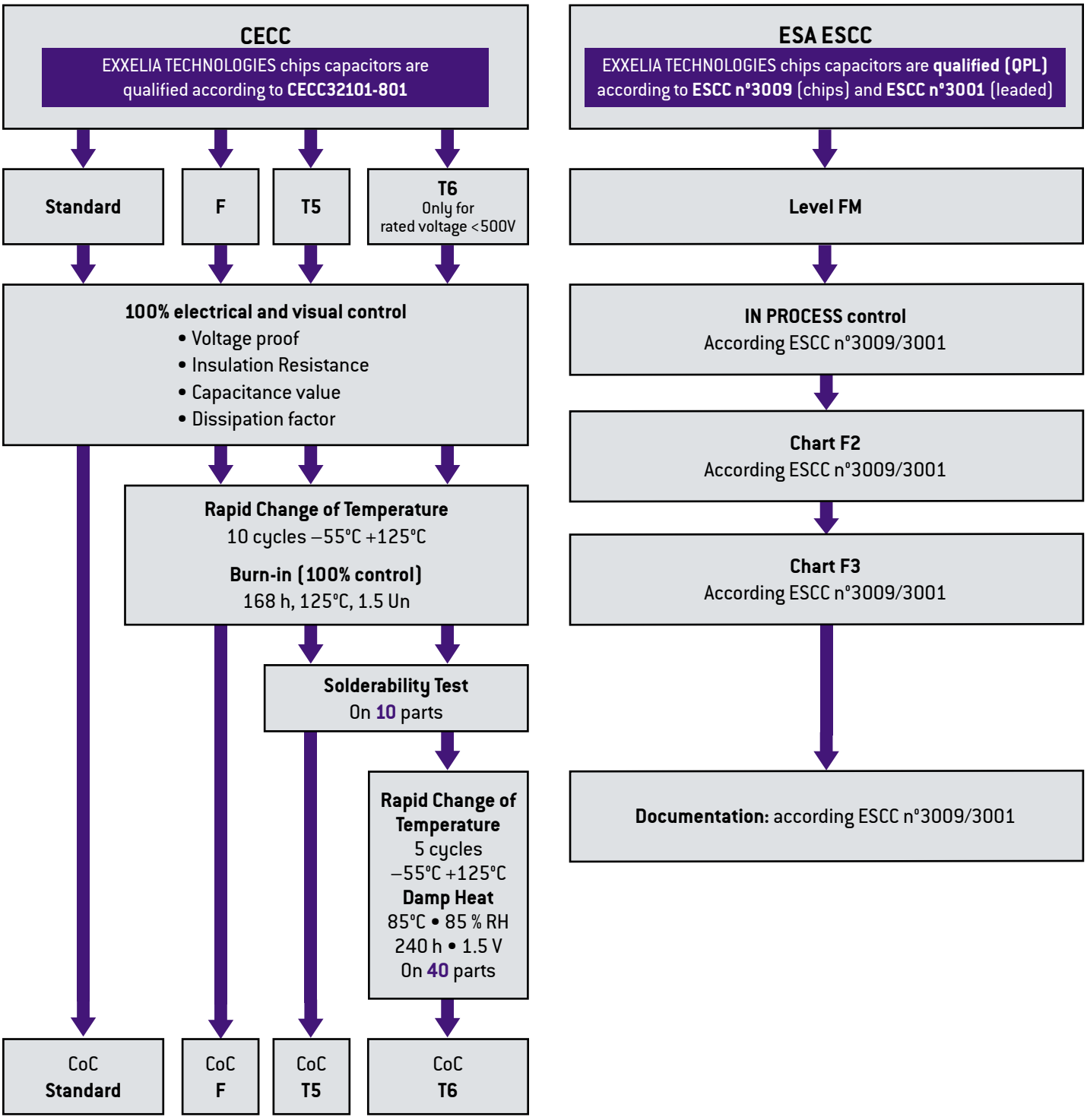
PART MARKING TOLERANCE CODES

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

RELIABILITY LEVELS

Exxelia proposes different reliability levels for the ceramic capacitors for both NP0 and X7R ceramics.



As the world's leading manufacturer of specific passive components, we stand apart through our ability to quickly evaluate the application specific engineering challenges and provide a cost-effective and efficient solutions.

For requirements that cannot be met by catalog products, we offer leading edge solutions in custom configuration: custom geometries, packaging, characteristics, all is possible thanks to our extensive experience and robust development process, while maintaining the highest level of reliability.

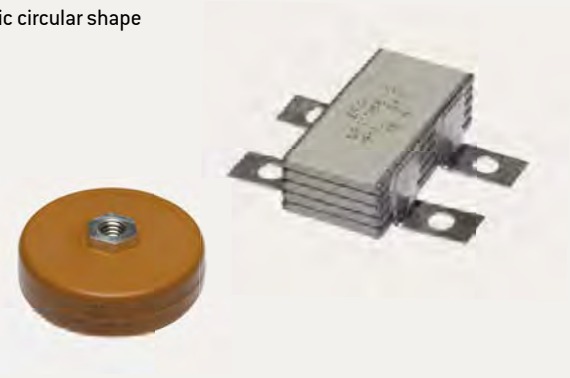
Where necessary, special testing is done to verify requirements, such as low dielectric absorption, ultra-high insulation resistance, low dissipation factor, stability under temperature cycling or under specified environmental conditions, etc.

HIGH CAPACITANCE

- High energy density
- Specific case sizes
- Specific shape of connections (high resistance to vibrations)

HIGH VOLTAGE

- Up to 50 kV
- Specific circular shape

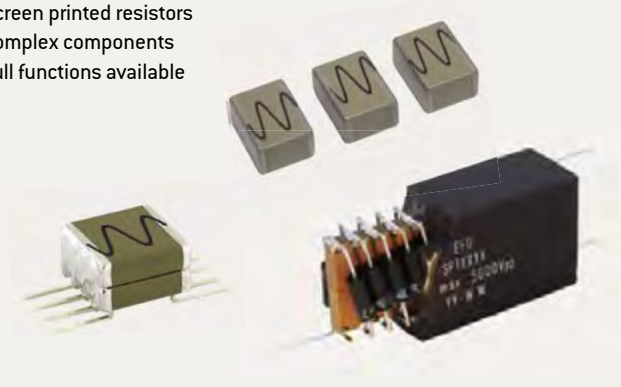


HIGH TEMPERATURE

- Up to 250°C
- Specific shape of connections
- 2,000 hours life time
- HMP soldering

OTHERS

- Screen printed resistors
- Complex components
- Full functions available



General Information

MATERIALS EXPERT

For 50 years and as a market leader, EXXELIA's comprehensive knowledge of the materials properties and performances have enabled us to design capacitors in Porcelain, NP0, BX, 2C1, BP, X7R and –2200ppm/°C ceramics.

CUSTOM DESIGNS

Our catalog products don't meet your application?

Based on the valuable experience accumulated over the design of 2,000+ specific ceramic capacitors, you can trust EXXELIA to define a qualitative custom solution in a time effective manner.

NO OBSOLESCENCE

Choosing a standard or custom EXXELIA product means you won't have to worry about obsolescence.

TYPICAL APPLICATIONS

- Aerospace & Defense: cockpit panels, flight control, radio systems, missile guidance systems…
- Space: military and commercial satellites, launcher…
- Medical: MRI, external defibrillators, implantable devices…
- Telecommunications: base stations…
- Oil and gas: drilling tools, MWD, LWD, wellheads…

ISO 9001 AND AS9100C

Quality is at the core of Exxelia's corporate culture. Each sites has its own certifications.

CERTIFICATIONS

Capacitors manufactured by EXXELIA comply with American and European standards and meet the requirements of many international standards.
For Space qualified parts (ESA QPL), please refer to our catalog «Ceramic capacitors for Space applications».

QUALITY & RELIABILITY

EXXELIA is committed to design and manufacture high quality and reliability products. The test cycles reproducing the most adverse operating conditions over extended periods (up to 10 000 hours) have logged to date well over 5.10^9 hours/°Component.
Failure rate data can be provided upon request.

CONFLICT MINERALS

EXXELIA is committed to an approach based on «Conflict Minerals Compliance». This US SEC rule demands complete traceability and a control mechanism for the mineral procurement chain, encouraging importers to buy only «certified» ore.
We have discontinued relations with suppliers that procure from the Democratic Republic of the Congo or an adjoining country.

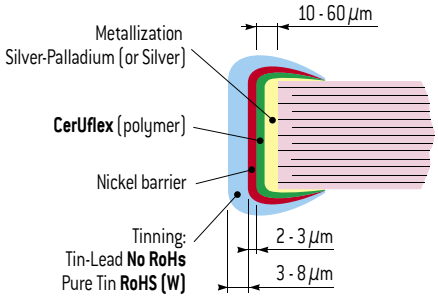
ENVIRONMENT

EXXELIA is committed to applying a robust environmental policy, from product design through to shipment. To control its environmental footprint and reconcile this with the company' functional imperatives, our environmental policy provides for the reduction or elimination of hazardous substances. We also focus on compliance with European Union directives and regulations, notably REACH and RoHS.

RoHS COMPLIANCY

SMD CAPACITORS

The capacitor terminations are generally protected by a nickel barrier formed by electrolytic deposit. This barrier gives chip capacitors leaching performance far exceeding the requirements of all applicable standards. The nickel barrier guarantees a minimum resistance to soldering heat for a period of 1 minute at 260°C in a tin-lead (60/40) or tin-lead-silver (62/36/2) bath without noticeable alteration to the solderability. It also allows repeated soldering-unsoldering and the longer soldering times required by reflow techniques.
However nickel barrier amplifies thermal shock and is not recommended for chip sizes equal or greater than CNC Y (30 30) - (C 282 to C 288 - CNC 80 to CNC 94).



LEADED COMPONENTS

As well as for SMD products, leaded capacitors ranges can also be RoHS. These products, which are characterized by the suffix «W» added to the commercial type, are naturally compatible with the soldering alloys used in RoHS mounting technology. The connections coating is generally an alloy SnAg (with a maximum of 4% Ag). However, on a few products that EXXELIA will precise on request, the coating is pure silver.