

# Non-Magnetic Capacitors - High Q, COG/NP0, X7R - 16V to 7.2kV



MLC capacitors with silver/palladium (Ag/Pd) terminations have often been used in medical applications where non-magnetic components are required, for example in MRI equipment - however, conventional nickel barrier terminations are not suitable due to their magnetic properties. In addition, RoHS requirement to use lead-free solders would cause an increase in soldering temperatures and cause solder leaching problems for the Ag/Pd termination. This has meant alternatives have had to be found and one solution is to use a copper barrier instead of a nickel barrier, with a tin finish on top. This non-magnetic termination is offered with selected non-magnetic COG/NP0, High Q and X7R dielectrics, providing a fully non-magnetic component ( $\mu_r = 1.0000$ ).

To meet high temperature 260°C soldering reflow profiles as detailed in J-STD-020, COG/NP0 dielectrics are supplied with FlexiCap™ or sintered termination whilst X7R dielectrics are supplied only with the FlexiCap™ termination.

Available in chip or ribbon led format for certain case sizes (consult sales office).



## High Q, COG/NP0 - minimum/maximum capacitance values

Chip Size	0402	0603	0505	0805	1206	1210	1808	1812	2220
<b>Min Cap</b>	0.1pF	0.1pF	0.2pF	0.2pF	0.5pF	0.3pF	1.0pF	1.0pF	2.0pF
<b>50V 63V</b>	22pF	100pF	220pF	470pF	1.5nF	-	-	-	-
<b>100V</b>	15pF	68pF	150pF	330pF	1.0nF	2.2nF	2.2nF	4.7nF	10nF
<b>150V</b>	10pF	47pF	100pF	220pF	680pF	1.5nF	1.5nF	3.3nF	6.8nF
<b>200V 250V</b>	6.8pF	33pF	56pF	150pF	470pF	1.0nF	1.0nF	2.2nF	4.7nF
<b>300V</b>	-	27pF	47pF	120pF	390pF	820pF	820pF	1.8nF	3.9nF
<b>500V</b>				68pF	270pF	680pF	680pF	1.5nF	3.3nF
<b>630V</b>				-	150pF	390pF	390pF	1.0nF	2.2nF
<b>1000V</b>				-	82pF	220pF	220pF	680pF	1.5nF
<b>2000V</b>				-	18pF	68pF	68pF	150pF	470pF
<b>3000V</b>				-	-	-	-	68pF	150pF

Min Capacitance Tolerance  
 $\pm 0.05\text{pF}$  ( $< 4.7\text{pF}$ )  
 $0.1\text{pF}$  ( $\geq 4.7\text{pF}$  &  $< 10\text{pF}$ )  
 $\pm 1\%$  ( $\geq 10\text{pF}$ )

## X7R - minimum/maximum capacitance values

Chip Size	0402	0603	0805	1206	1210	1808	1812	2220
<b>Min Cap</b>	47pF	100pF	330pF	680pF	1.5nF	2.2nF	3.3nF	6.8nF
<b>16V</b>	10nF	100nF	330nF	1.0 $\mu\text{F}$	1.5 $\mu\text{F}$	1.5 $\mu\text{F}$	3.3 $\mu\text{F}$	5.6 $\mu\text{F}$
<b>25V</b>	6.8nF	68nF	220nF	820nF	1.2 $\mu\text{F}$	1.2 $\mu\text{F}$	2.2 $\mu\text{F}$	4.7 $\mu\text{F}$
<b>50V 63V</b>	4.7nF	47nF	150nF	470nF	1.0 $\mu\text{F}$	680nF	1.5 $\mu\text{F}$	3.3 $\mu\text{F}$
<b>100V</b>	1.5nF	10nF	47nF	150nF	470nF	330nF	1.0 $\mu\text{F}$	1.5 $\mu\text{F}$
<b>200V 250V</b>	680pF	5.6nF	27nF	100nF	220nF	180nF	470nF	1.0 $\mu\text{F}$
<b>500V</b>	-	1.5nF	8.2nF	33nF	100nF	100nF	270nF	560nF
<b>630V</b>			4.7nF	10nF	27nF	33nF	150nF	330nF
<b>1000V</b>			3.3nF	4.7nF	15nF	18nF	56nF	120nF
<b>1200V</b>			-	3.3nF	10nF	10nF	33nF	82nF
<b>1500V</b>			-	2.7nF	6.8nF	6.8nF	22nF	47nF
<b>2000V</b>			-	2.2nF	4.7nF	4.7nF	10nF	27nF

Min Capacitance Tolerance  
 $\pm 5\%$

## High Q, COG/NP0 High Power RF capacitors - minimum/maximum capacitance values

A range of ultra-low loss High Q ceramic capacitors with COG/NP0 characteristics suitable for high power applications where minimal power loss and very low self heating is demanded.

Common applications include MRI body coils and wireless charging systems operating in the kHz and MHz frequencies.

Available in chip or ribbon led format.

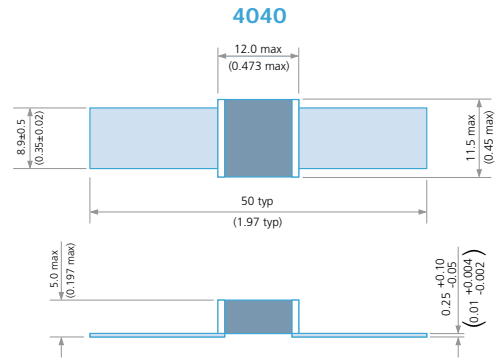
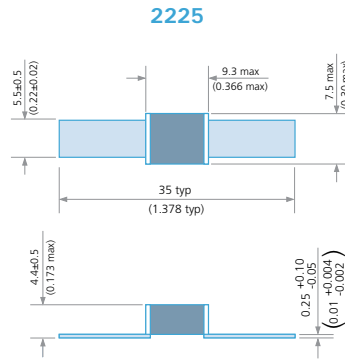
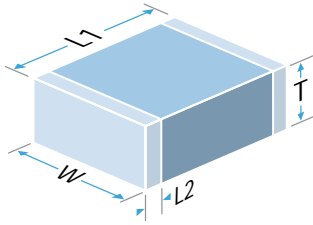
Chip size	Case size 11 - 1111		Case size 25 - 2225		Case size 40 - 4040	
	Min.	Max.	Min.	Max.	Min.	Max.
<b>100V</b>	1.8nF	2.2nF				
<b>150V</b>	1.2nF	1.5nF				
<b>200V</b>	5.7nF	10nF	6.2nF	10nF	16nF	27nF
<b>250V</b>	820pF	1.0nF				
<b>500V</b>	470pF	680pF	5.1nF	5.6nF	13nF	15nF
<b>630V</b>	270pF	390pF	3.6nF	4.7nF	11nF	12nF
<b>1kV</b>	82pF	220pF	1.1nF	3.3nF	5.6nF	10nF
<b>2kV</b>	0.3pF	68pF	510pF	1.0nF	1.6nF	5.1nF
<b>3kV</b>			110pF	470pF	910pF	1.5nF
<b>3.6kV</b>			1pF	47*/100pF	-	-
<b>4kV</b>					620pF	820pF
<b>5kV</b>					360pF	560pF
<b>6kV</b>					160pF	330pF
<b>7.0/7.2kV</b>					1pF	56**/150pF

\*47pF max. for dual rated @2.5kVac 30MHz  
 \*\*56pF max. for dual rated @5kVac 30MHz.

# Non-Magnetic Capacitors - High Q, C0G/NP0, X7R - 16V to 7.2kV

**Surface Mount** See page 20 for dimensions

**Ribbon Leaded** Silver plated copper ribbon attached with HMP solder - (MP greater than 260°C)



## Ordering information - Syfer Non-Magnetic capacitors

Chip size	Termination or Coating (Ribbon Leaded)	Voltage	Capacitance in picofarads (pF)	Capacitance tolerance	Dielectric	Packing	Lead Options	Suffix code
1206	2	500	0223	J	Q	T	-	-
4040	2	7K0	0470	G	Q	B	-	AF9
2225	B	3K0	6P80	G	Q	B	R	W221

Chip size	Termination or Coating (Ribbon Leaded)	Voltage	Capacitance in picofarads (pF)	Capacitance tolerance	Dielectric	Packing	Lead Options	Suffix code
0402*	2 = Sintered silver with copper barrier*	50 = 50V	<10pF Insert a P for the decimal point, eg 2P20 = 2.2pF.	<4.7pF H = ±0.05pF B = ±0.1pF C = ±0.25pF D = ±0.5pF	C = C0G/NP0 (1B) Q = High Q X = X7R (2R1)	T = 178mm (7") reel R = 330mm (13") reel B = Bulk pack - tubs or trays	R = Ribbon leaded Blank = SM chip	W221 = Leaded W211 = Leaded marked **AF9 = SM standard chip **AF9LM = SM marked standard chip
0603	3 = FlexiCap™ with copper barrier.	100 = 100V	>10pF. 1st digit is 0. 2nd and 3rd digits are significant figures of capacitance code. The 4th digit is number of 0's following	≥4.7pF ~ <10pF B = ±0.1pF C = ±0.25pF D = ±0.5pF				
0505	4 = Sintered silver with copper barrier*	1K0 = 1kV	eg. 0470 = 47pF 0512 = 5100pF	≥10pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%				
0805	5 = FlexiCap™ base with copper barrier.	2K0 = 2kV	Values <1pF in 0.1pF steps, above this values are E24 series					
1206	Ribbon Leaded	3K0 = 3kV						
1111	B = Uncoated	4K0 = 4kV						
1210	V = Coated with modified silicone laquer	5K0 = 5kV						
1808		6K0 = 6kV						
1812		7K0 = 7kV						
2220								
2225†								
4040†								

Note: \*0402 - C0G/NP0 and High Q only. †Ribbon Leads available. \*\*AF9 and AF9LM suffix code only available in 1111, 2225 and 4040 chip sizes.

## Ordering information - Voltronics Non-Magnetic capacitors

11	470	J	1000	W	F	R
Chip size	Capacitance	Tolerance	Voltage	Termination	Material	Lead/Packaging
4 0402*	OR1 0.1pF	A ±0.05pF	50 = 50V	W = Ag/Cu/Sn	Q = High Q	R = Ribbon
5 0505	100 10pF	B ±0.1pF	100 = 100V	S = Pd/Ag	0±30ppm/°C	T* = Tape & Reel
6 0603*	101 100pF	C ±0.25pF	1000 = 1000V	M = Poly/Cu/Sn	X = X7R (2R1)	B* = Bulk
8 0805*	102 1000pF	D ±0.5pF		2 = Ag/Cu/Sn - (Q dielectric only)		
11 1111†		F ±1%		3 = Poly/Cu/Sn - (X dielectric only)		
12 1206*		G ±2%		B = Silver - (Q ribbon only)		
13 1210*		J ±5%		V = Silver, laquer Coated - (Q ribbon only)		
18 1812*		K ±10%				
22 2220*		M ±20%				
25 2225†						
38 3838†						
40 4040†						

Note: \*Q and X dielectric only. †Ribbon Leads available.



# Non-Magnetic Capacitors, High Power RF - Porcelain High Q

Made from highly stable, low loss dielectric formulations, these traditional porcelain MLCs are known for their high RF power handling capability. Available in all industry common case sizes. The special silver-palladium termination and the proprietary ceramic formulations guarantee consistent non-magnetic performance. All MLCs in these series are RoHS compliant. Chips are available either with standard termination or can be fitted with ribbon leads, depending on your application.

## Description

- Porcelain Capacitors • Zero TC • Low Noise • Low ESR, High Q
- High Self-resonance • Established Reliability
- Capacitance range 0.1pF to 5.1nF

## Functional Applications

- Impedance Matching • DC Blocking • Bypass • Coupling
- Tuning and Feedback



## High Power RF capacitors - F & H materials - Minimum/maximum capacitance values - see ordering information

Chip Size	Case size 5 0505		Case size 11 1111		Case size 25 2225		Case size 38 3838	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
50V	-	-	680pF	1nF	-	-	-	-
100V	-	-	510pF	620pF	-	-	-	-
200V	36pF	100pF	220pF	470pF	-	-	-	-
250V	0.1pF	33pF	-	-	-	-	-	-
300V	-	-	-	-	2.2nF	2.7nF	-	-
500V	-	-	110pF	200pF	1.5nF	1.8nF	2.7nF	5.1nF
1kV	-	-	0.3pF	100pF	510pF	1.2nF	750pF	2.2nF
1.5kV	-	-	-	-	300pF	470pF	-	-
2kV	-	-	-	-	-	-	-	-
2.5kV	-	-	-	-	0.3pF	270pF	430pF	680pF
3.6kV	-	-	-	-	-	-	110pF	390pF
7.2kV	-	-	-	-	-	-	0.3pF	100pF

Note: Special capacitance values available upon request.

## Ordering information - Non-Magnetic capacitors

11	470	J	1000	W	F	R
Chip size	Capacitance	Tolerance	Voltage	Termination	Material	Lead
5 0505	OR1 0.1pF	A ±0.05pF	50 50V	W Ag/Cu/Sn	H AH +90±20ppm/°C	B = Chip
11 1111†	100 10pF	B ±0.1pF	100 100V	S Pd/Ag	F CF 0±15ppm/°C	R =Ribbon
25 2225†	101 100pF	C ±0.25pF	1000 1000V	M Poly/Cu/Sn		
38 3838†	102 1000pF	D ±0.5pF				
		F ±1%				
		G ±2%				
		J ±5%				
		K ±10%				

Note: †Available in chip or ribbon leaded format.

## Reeled Quantities

Chip Size	0402	0505	0603	0805	1206	1111 1210	1808	1812	2220	2225
7" Reel	10000	2500	4000	3000	2500	1000/2000	1500	500	500	500
13" Reel	13" reel quantities available on request						6000	2000	2000	2000

Note: Other capacitance values may become available, please contact the Sales Office if you need values other than those shown in the above tables. For dimensions and soldering information, please go to our website [www.knowlescapacitors.com](http://www.knowlescapacitors.com).

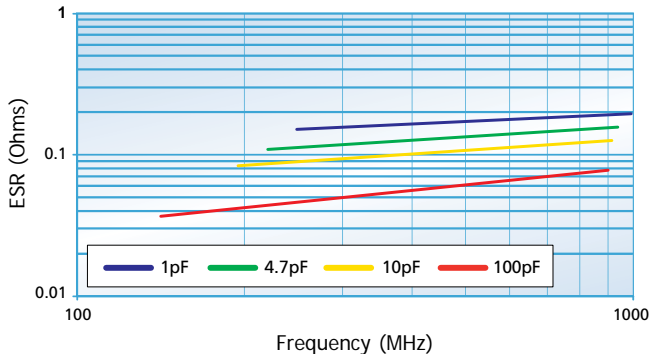
# Non-Magnetic Capacitors - High Q, X7R

Typical performance data - chip size 0805 High Q

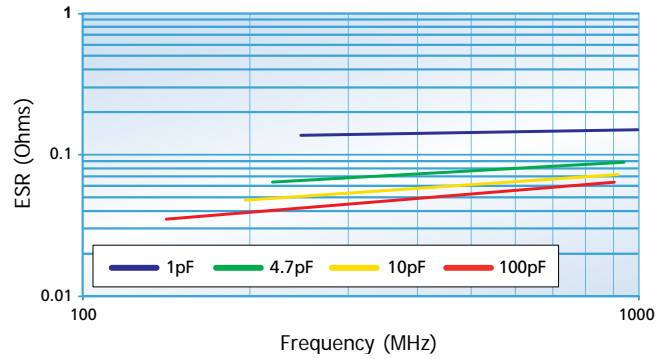
Typical performance data - chip size 1111 High Q



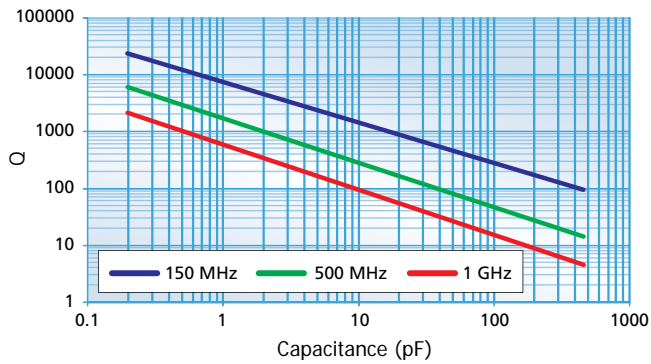
ESR vs Frequency



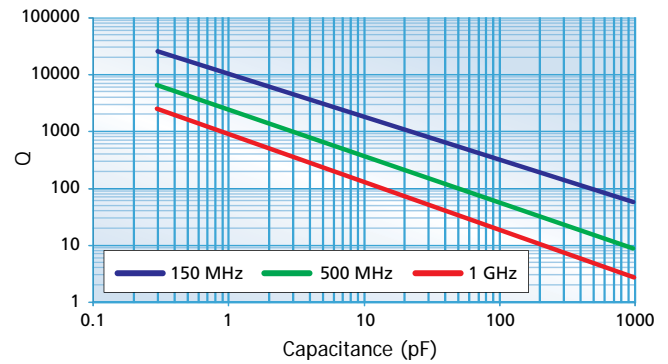
ESR vs Frequency



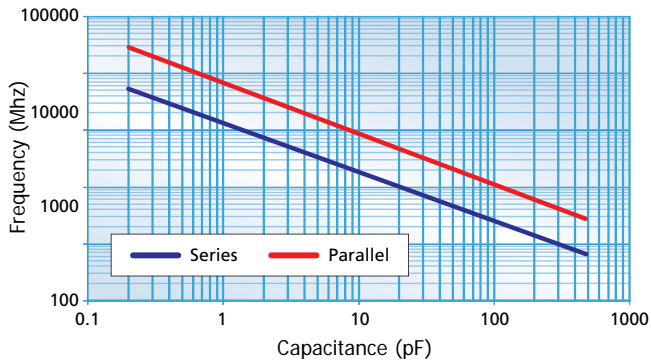
Q vs Capacitance



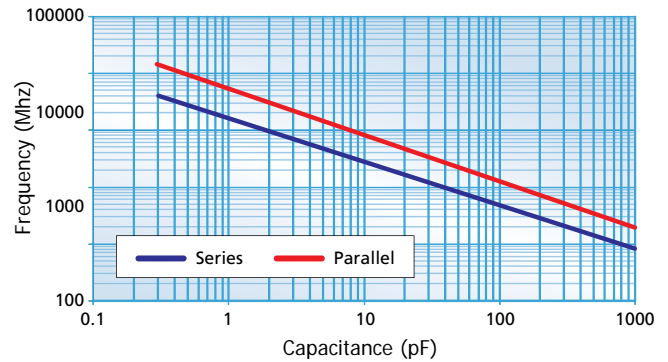
Q vs Capacitance



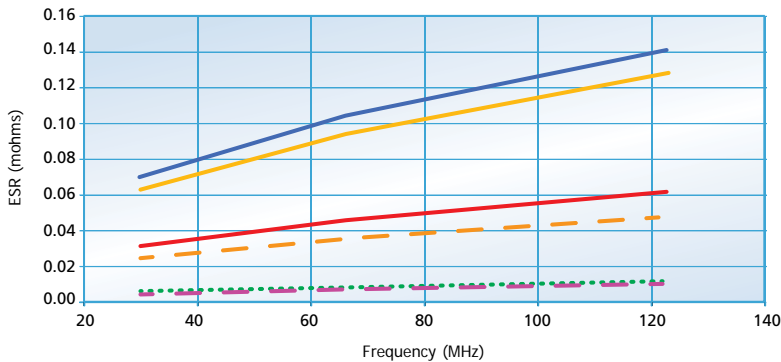
Resonant Frequency vs Capacitance



Resonant Frequency vs Capacitance



Typical ESR vs Frequency



- 4040 56pF
- 4040 18pF
- ... 2225 2.2nF
- 2225 39pF
- 2225 10pF
- - - 4040 5.1nF

**ESR Measurement**

All ESR figures are measured using a VNA and 2m copper resonant tube and extrapolating to 30MHz by ratio. Measured data can be supplied on request. Measurement of ESR can vary with test method and components should only be compared when tested back-to-back on the same equipment under controlled conditions.





# Non-magnetic Surface Mount Standard MLC Capacitors



## Non-magnetic MLCC Ranges

The use of a copper barrier instead of a nickel barrier, with a tin finish on top is the solution Syfer has developed for non-magnetic applications.

This Non-magnetic termination is offered with selected non-magnetic COG/NP0, High Q and X7R dielectrics, providing a fully non-magnetic component ( $\mu_r=1.0000$ ).

To meet high temperature 260°C soldering reflow profiles as detailed in J-STD-020, COG/NP0 dielectrics are supplied with FlexiCap™ or sintered termination and X7R dielectrics are supplied with Syfer's award winning FlexiCap™ termination. HighQ dielectrics are supplied with sintered termination.

Electrical Details		
Capacitance Range		0.1pF to 6.8µF
Temperature Coefficient of Capacitance (TCC)	COG/NP0 & HiQ	0 ± 30ppm/°C
	X7R	±15% from -55°C to +125°C
Dissipation Factor	COG/NP0 & HiQ	Cr > 50pF ≤ 0.0015 Cr ≤ 50pF = 0.0015(15±Cr+0.7)
	X7R	≤ 0.025
Insulation Resistance (IR)		100GΩ or 1000secs (whichever is the less)
Dielectric Withstand Voltage (DWV)		Voltage applied for 5 ± 1 seconds, 50mA charging current maximum
Ageing Rate	COG/NP0 & HiQ	Zero
	X7R	<2% per time decade

## Range Dimensions – Standard MLCC Ranges

Size	Length (L1) mm/inches	Width (W) mm/inches	Max. Thickness (T) mm/inches	Termination Band (L2) mm/inches	
				min	max
0402*	1.0 ± 0.10	0.5 ± 0.10	0.60	0.10	0.40
	0.04 ± 0.006	0.02 ± 0.003	0.024	0.004	0.015
0603	1.6 ± 0.2	0.8 ± 0.2	0.8	0.10	0.40
	0.063 ± 0.008	0.031 ± 0.008	0.031	0.004	0.015
0505	1.4 ± 0.38	1.4 ± 0.38	1.27	0.13	0.50
	0.055 ± 0.015	0.055 ± 0.015	0.050	0.005	0.020
0805	2.0 ± 0.3	1.25 ± 0.2	1.3	0.13	0.75
	0.08 ± 0.012	0.05 ± 0.008	0.051	0.005	0.03
1206	3.2 ± 0.3	1.6 ± 0.2	1.6	0.25	0.75
	0.126 ± 0.012	0.063 ± 0.008	0.063	0.01	0.03
1111	2.79 +0.51 -0.25	2.79 ± 0.38	2.54	0.13	0.63
	0.110 +0.020 -0.010	0.110 ± 0.015	0.100	0.005	0.025
1210	3.2 ± 0.3	2.5 ± 0.3	2.0	0.25	0.75
	0.126 ± 0.012	0.1 ± 0.012	0.08	0.01	0.03
1808	4.5 ± 0.35	2.0 ± 0.3	2.0	0.25	1.0
	0.18 ± 0.014	0.08 ± 0.012	0.08	0.01	0.04
1812	4.5 ± 0.35	3.2 ± 0.3	2.5	0.25	1.0
	0.18 ± 0.014	0.126 ± 0.012	0.1	0.01	0.04
2220	5.7 ± 0.4	5.0 ± 0.4	4.2	0.25	1.0
	0.225 ± 0.016	0.197 ± 0.016	0.16	0.01	0.04
2225	5.7 ± 0.4	6.3 ± 0.4	4.2	0.25	1.0
	0.225 ± 0.016	0.25 ± 0.016	0.16	0.01	0.04

## Ordering Information – Non-magnetic capacitors

1210	3	100	0103	J	X	T	□□□
Chip Size	Termination	Rated Voltage	Capacitance in Pico farads (pF)	Capacitance Tolerance	Dielectric Codes	Packaging	Suffix Code
0402*	<b>2</b> = Sintered silver base with copper barrier (100% matte tin plating). RoHS compliant. (Available on COG/NP0 & High Q only)  <b>3</b> = FlexiCap™ base with copper barrier (100% matte tin plating). RoHS compliant. (Available on COG/NP0 & X7R only)  <b>4</b> = Sintered silver base with copper barrier (tin/lead plating). Non RoHS compliant. (Available on COG/NP0 & High Q only)  <b>5</b> = FlexiCap™ base with copper barrier (tin/lead plating). Non RoHS compliant. (Available on COG/NP0 & X7R only)	<b>016</b> = 16V	<10pF	<4.7pF	<b>C</b> = COG/NP0 (1B)  <b>Q</b> = High Q <b>X</b> = X7R (2R1)	<b>T</b> = 178mm (7") reel  <b>R</b> = 330mm (13") reel  <b>B</b> = Bulk pack - tubs or trays	Used for specific customer requirements
0603		<b>025</b> = 25V	Insert a P for the decimal point as the second character.	<b>H</b> : ± 0.05pF			
0505		<b>050</b> = 50V	e.g., <b>P300</b> = 0.3pF	<b>B</b> : ± 0.10pF			
0805		<b>063</b> = 63V	<b>8P20</b> = 8.2pF	<b>C</b> : ± 0.25pF			
1206		<b>100</b> = 100V	≥10pF	<b>D</b> : ± 0.5pF			
1111		<b>150</b> = 150V	First digit is 0.	≥4.7pF <10pF			
1210		<b>200</b> = 200V	Second and third digits are significant figures of capacitance code.	<b>B</b> : ± 0.10pF			
1808		<b>250</b> = 250V	The fourth digit is the number of zeros following.	<b>C</b> : ± 0.25pF			
1812		<b>500</b> = 500V	e.g., <b>0103</b> = 10000 pF	<b>D</b> : ± 0.5pF			
2220		<b>630</b> = 630V	Values <1pF in 0.1pF steps, above this values are E24 series	≥10pF			
2225	<b>1K0</b> = 1kV		<b>F</b> : ± 1%				
	<b>1K2</b> = 1.2kV		<b>G</b> : ± 2%				
	<b>1K5</b> = 1.5kV		<b>J</b> : ± 5%				
	<b>2K0</b> = 2kV		<b>K</b> : ± 10%				
	<b>3K0</b> = 3kV						

\*0402 – please consult the sales office for availability



## COG/NPO & High Q - minimum/maximum capacitance values

Chip Size	0402*	0603	0505	0805	1206	1111/ 1210	1808	1812	2220	2225
Min Cap	0.1pF	0.1pF	0.2pF	0.2pF	0.5pF	0.3pF	1.0pF	1.0pF	2.0pF	2.0pF
Min Cap Tolerance	±0.05pF (<4.7pF), 0.1pF (≥4.7pF & <10pF) and ±1% (≥10pF)									
50V/63V	22pF	100pF	220pF	470pF	1.5nF	-	-	-	-	-
100V	15pF	68pF	150pF	330pF	1.0nF	2.2nF	2.2nF	4.7nF	10nF	15nF
150V	10pF	47pF	100pF	220pF	680pF	1.5nF	1.5nF	3.3nF	6.8nF	10nF
200V/250V	6.8pF	33pF	56pF	150pF	470pF	1.0nF	1.0nF	2.2nF	4.7nF	6.8nF
300V	-	27pF	47pF	120pF	390pF	820pF	820pF	1.8nF	3.9nF	5.6nF
500V	-	-	-	68pF	270pF	680pF	680pF	1.5nF	3.3nF	4.7nF
630V	-	-	-	-	150pF	390pF	390pF	1.0nF	2.2nF	3.3nF
1000V	-	-	-	-	82pF	220pF	220pF	680pF	1.5nF	2.2nF
2000V	-	-	-	-	18pF	68pF	68pF	150pF	470pF	560pF
3000V	-	-	-	-	-	-	-	68pF	150pF	220pF

For values < than 0.3pF please consult the Sales Office for availability.

\*0402 - please consult the sales office for availability.

## X7R - minimum/maximum capacitance values

Chip Size	0402*	0603	0805	1206	1111/ 1210	1808	1812	2220	2225
MinCap	47pF	100pF	330pF	680pF	1.5nF	2.2nF	3.3nF	6.8nF	10nF
Min Cap Tolerance	±5%								
16V	10nF	100nF	330nF	1.0µF	1.5µF	1.5µF	3.3µF	5.6µF	6.8µF
25V	6.8nF	68nF	220nF	820nF	1.2µF	1.2µF	2.2µF	4.7µF	5.6µF
50V63V	4.7nF	47nF	150nF	470nF	1.0µF	680nF	1.5µF	3.3µF	3.3µF
100V	1.5nF	10nF	47nF	150nF	470nF	330nF	1.0µF	1.5µF	1.5µF
200V250V	680pF	5.6nF	27nF	100nF	220nF	180nF	470nF	1.0µF	1.0µF
500V	-	1.5nF	8.2nF	33nF	100nF	100nF	270nF	560nF	680nF
630V	-	-	4.7nF	10nF	27nF	33nF	150nF	330nF	390nF
1000V	-	-	3.3nF	4.7nF	15nF	18nF	56nF	120nF	150nF
1200V	-	-	-	3.3nF	10nF	10nF	33nF	82nF	100nF
1500V	-	-	-	2.7nF	6.8nF	6.8nF	22nF	47nF	68nF
2000V	-	-	-	2.2nF	4.7nF	4.7nF	10nF	27nF	33nF

\*0402 - please consult the sales office for availability.

## Reeled Quantities

Chip Size	0402*	0603	0505	0805	1206	11111210	1808	1812	2220	2225
7" Reel	5000	4000	2500	3000	2500	10002000	2000	500/1000	500/1000	500/1000
13" Reel	13" reel quantities available on request						8000	2000/4000	2000/4000	2000/4000

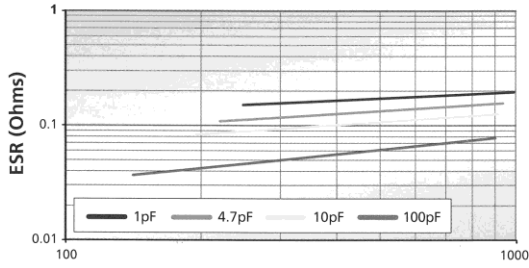
\*0402 - please consult the sales office for availability.

Note: Other capacitance values may become available, please contact our Sales Office if you need values other than those shown in the above tables.

For dimensions and soldering information, please go to our website ([www.syfer.com](http://www.syfer.com)) or see our MLC catalogue.

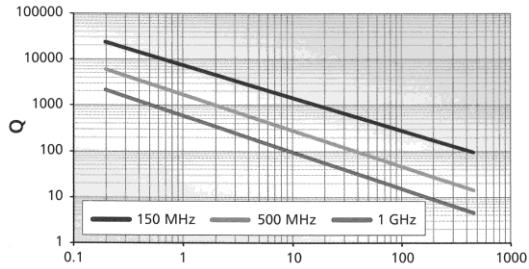
Typical performance data - 0805 chip size

ESR vs Frequency



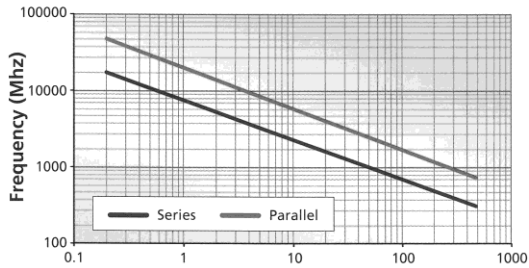
Frequency (MHz)

Q vs Capacitance



Capacitance (pF)

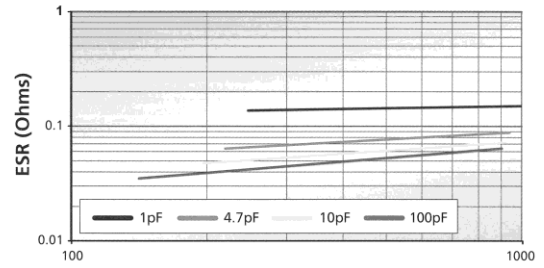
Resonant Frequency vs Capacitance



Capacitance (pF)

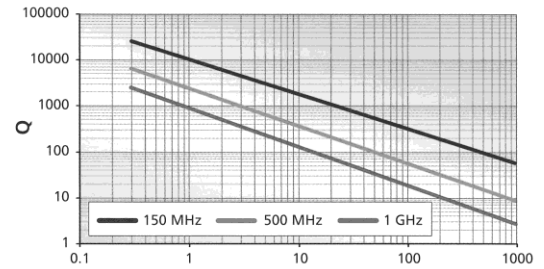
Typical performance data - 1111 chip size

ESR vs Frequency



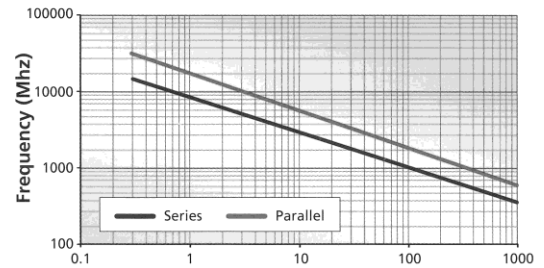
Frequency (MHz)

Q vs Capacitance



Capacitance (pF)

Resonant Frequency vs Capacitance



Capacitance (pF)

## Soldering Information

Syfer MLCCs are compatible with all recognised soldering/mounting methods for chip capacitors. A detailed application note is available at [syfer.com](http://syfer.com)

## Reflow Soldering

Syfer recommend reflow soldering as the preferred method for mounting MLCCs. Syfer MLCCs can be reflow soldered using a reflow profile generally defined in IPC/FEDEC J-STD-020. Sn plated termination chip capacitors are compatible with both conventional and lead free soldering with peak temperatures of 260° to 270°C acceptable.

The heating ramp rate should be such that components see a temperature rise of 1.5° to 4°C per second to maintain temperature uniformity through the MLCC.

The time for which the solder is molten should be maintained at a minimum, so as to prevent solder leaching. Extended times above 230°C can cause problems with oxidation of Sn plating. Use of an inert atmosphere can help if this problem is encountered. Palladium/Silver (Pd/Ag) terminations can be particularly susceptible to leaching with free lead, tin rich solders and trials are recommended for this combination.

Cooling to ambient temperature should be allowed to occur naturally, particularly if larger chip sizes are being soldered. Natural cooling allows a gradual relaxation of thermal mismatch stresses in the solder joints. Forced cooling should be avoided as this can induce thermal breakage.

## Wave Soldering

Wave soldering is generally acceptable, but the thermal stresses caused by the wave have been shown to lead to potential problems with larger or thicker chips. Particular care should be taken when soldering SM chips larger than size 1210 and with a thickness greater than 1.0mm for this reason.

Maximum permissible wave temperature is 270°C for SM chips.

The total immersion time in solder should be kept to a minimum. It is strongly recommended that Sn/Ni plated terminations are specified for wave soldering applications.

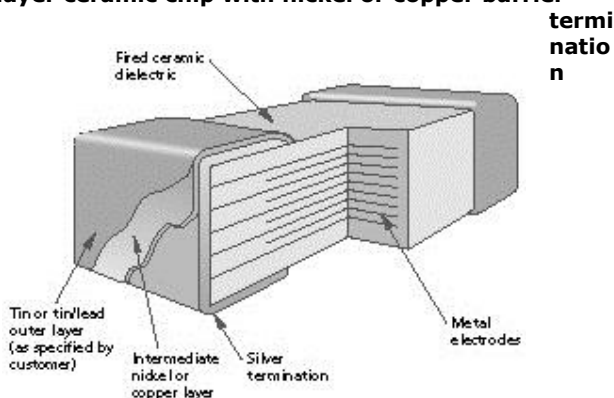
## Solder Leaching

Leaching is the term for the dissolution of silver into the solder causing a failure of the termination system which causes increased ESR, tan  $\delta$  and open circuit faults, including ultimately the possibility of the chip becoming detached.

Leaching occurs more readily with higher temperature solders and solders with a high tin content. Pb free solders can be very prone to leaching certain termination systems. To prevent leaching, exercise care when choosing solder allows and minimize both maximum temperature and dwell time with the molten solder.

Plated terminations with nickel or copper anti-leaching barrier layers are available in a range of top coat finishes to prevent leaching occurring. These finishes also include Syfer FlexiCap™ for improved stress resistance post soldering.

## Multilayer ceramic chip with nickel or copper barrier



## Rework of Chip Capacitors

Syfer recommend hot air/gas as the preferred method of applying heat for rework. Apply even heat surrounding the component to minimise internal thermal gradients. Soldering irons or other techniques that apply direct heat to the chip or surrounding area, should not be used as these can result in micro cracks being generated.

Minimise the rework heat duration and allow components to cool naturally after soldering.

## Use of Silver Loaded Epoxy Adhesives

Chip capacitors can be mounted to circuit boards using silver loaded adhesive provided the termination material of the capacitor is selected to be compatible with the adhesive. This is normally PdAg. Standard tin finishes are often not recommended for use with silver loaded epoxies as there can be electrical and mechanical issues with the joint integrity due to material mismatch.

## Handling & Storage

Components should never be handled with fingers; perspiration and skin oils can inhibit solderability and will aggravate cleaning.

Chip capacitors should never be handled with metallic instruments. Metal tweezers should never be used as these can chip the product and leave abraded metal tracks on the product surface. Plastic or plastic coated metal types are readily available and recommended – these should be used with an absolute minimum of applied pressure.

Incorrect storage can lead to problems for the user. Rapid tarnishing of the terminations, with an associated degradation of solderability, will occur if the product comes into contact with industrial gases such as sulphur dioxide and chlorine. Storage in free air, particularly moist or polluted air, can result in termination oxidation.

Packaging should not be opened until the MLCs are required for use. If opened, the pack should be re-sealed as soon as practicable. Alternatively, the contents could be kept in a sealed container with an environmental control agent.

Long term storage conditions, ideally, should be temperature controlled between -5° and +40°C and humidity controlled between 40 and 60% R.H.

Taped product should be stored out of direct sunlight, which might promote deterioration in tape or adhesive performance.

Product, store under the conditions recommended above, in its "as received" packaging, has a minimum shelf life of 2 years.

## SM Pad Design

Syfer conventional 2-terminal chip capacitors can generally be mounted using pad designs in accordance with IPC-7351, Generic Requirements for Surface Mount Design and Land Pattern Standards, but there are some other factors that have been shown to reduce mechanical stress, such as reducing the pad width to less than the chip width. In addition, the position of the chip on the board should also be considered.

3-terminal components are not specifically covered by IPC-7351, but recommended pad dimensions are included in the Syfer catalogue/website for these components.



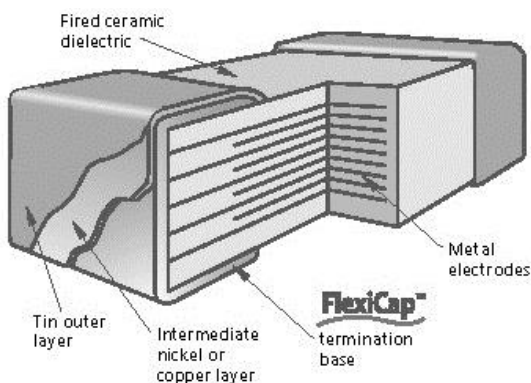
## FlexiCap™ Termination

FlexiCap™ has been developed as a result of listening to customer's 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.

All 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. Refer to Syfer application note reference AN0001. FlexiCap™ capacitors enable the board to be bent almost twice as much as before mechanical cracking occurs. Refer to application note AN0002.

FlexiCap™ is also suitable for space applications having passed thermal vacuum outgassing tests. Refer to Syfer application note reference AN0026.



FlexiCap™ MLCC cross section

Syfer 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 from -55° 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.

### 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 requirement to change the assembly process when converting to FlexiCap™.

Based upon the 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.

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

## REACH (Registration, Evaluation, Authorisation 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.

Syfer Technology Ltd maintains both ISO 14001, Environmental Management System and OHSAS 18001 Health & Safety Management System approvals that require and ensure compliance with corresponding legislation such as REACH.

For further information, please contact the sales office at [SyferSales@knowles.com](mailto:SyferSales@knowles.com)

## RoHS Compliance

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

All standard C0G/NPO, X7R, X5R and High Q Syfer MLCC products are compliant with the EU RoHS directive (see below for special exemptions) and those with plated terminations are suitable for soldering common lead free solder alloys (refer to 'Soldering Information' for more details on soldering limitations). Compliance with EU RoHS directive automatically signifies compliance with some other legislation (e.g., Korea RoHS). Please refer to the Sales Office for details of compliance with other materials legislation.

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

Most Syfer MLCC components are available with non-RoHS compliant tin/lead (SnPb) Solderable termination finish for exempt applications and where pure tin is not acceptable. Other tin free termination finishes may also be available – please refer to the Sales Office for further details.

X8R ranges <250Vdc are not RoHS 2011/65/EU compliant.

Check the website, [www.knowlescapacitors.com/syfer](http://www.knowlescapacitors.com/syfer) for latest RoHS update.

## Export Controls and Dual-use Regulations

Certain Syfer catalogue components are defined as 'dual-use' items under international export controls – those that can be used for civil and military purposes which meet certain specified technical standards.

The defining criteria for a dual-use component with respect to Syfer products is one with a voltage rating of >750V and a capacitance value >250nF and a series inductance <10nH.

Components defined as 'dual-use' under the above criteria automatically require a licence for export outside the EU, and may require a licence for export with the EU.

The application for a licence is routine, but customers for these products will be asked to supply further information.

Please refer to the sales office if you require any further information on export restrictions.

Other special components may additionally need to comply with export regulations.

## Ageing of Ceramic Capacitors

Capacitor ageing is a term used to describe the negative, logarithmic capacitance change which takes place in ceramic capacitors with time. The crystalline structure for barium titanate based ceramics changes on passing through its Curie temperature (known as the Curie Point) at about 125°C. The domain structure relaxes with time and in doing so, the dielectric constant reduces logarithmically; this is known as the ageing mechanism of the dielectric constant. The more stable dielectrics have the lowest ageing rates.

The ageing process is reversible and repeatable. Whenever the capacitor is heated to a temperature above the Curie Point the ageing process starts again from zero.

The ageing constant, or ageing rate, is defined as the percentage loss of capacitance due to the ageing process of the dielectric which occurs during a decade of time (a tenfold increase in age) and is expressed as percent per logarithmic decade of hours. As the law of decrease of capacitance is logarithmic, this means that a capacitor with an ageing rate of 1% per decade of time, the capacitance will decrease at a rate of:

- 1% between 1 and 10 hours
- An additional 1% between the following 10 and 100 hours
- An additional 1% between the following 100 and 1000 hours
- An additional 1% between the following 1000 and 10000 hours
- The ageing rate continues in this manner throughout the capacitor's life.

Typical values of the ageing constant for our MLCCs are

Dielectric Class	Typical Values
Ultra Stable COG/NPO	Negligible capacitance loss through ageing
Stable X7R	<2% per decade of time

## Capacitance Measurements

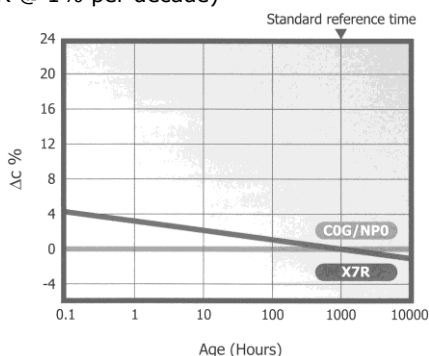
Because of ageing it is necessary to specify an age for reference measurements at which the capacitance shall be within the prescribed tolerance. This is fixed at 1000 hours, since for all practical purposes there is not much further loss of capacitance after this time.

All capacitors shipped are within their specified tolerance at the standard reference age of 1000 hours after having cooled through their Curie temperature.

The ageing curve for any ceramic dielectric is a straight line when plotted on semi-log paper.

## Capacitance vs Time

(Ageing X7R @ 1% per decade)



## Tight Tolerance

One of the advantages of Syfer's unique 'wet process' of manufacture is the ability to offer capacitors with exceptionally tight capacitance tolerances.

The accuracy of the printing screens used in the fully automated, computer controlled manufacturing process allows for tolerance as close as ± 1% on COG/NPO parts greater than or equal to 10pF. For capacitance value less than 4.7pF tolerances can be as tight as ± 0.05pF.

## Periodic Tests Conducted and Reliability Data

For standard surface mount capacitors components are randomly selected on a sample basis and the following routine tests conducted:

- Load Test. 1,000 hours @ 125°C (150oOC for X8R). Applied voltage depends on components tested
- Humidity Test. 168 hours @ 85°C/85%RH
- Board Deflection (bend test)

Test results are available on request.

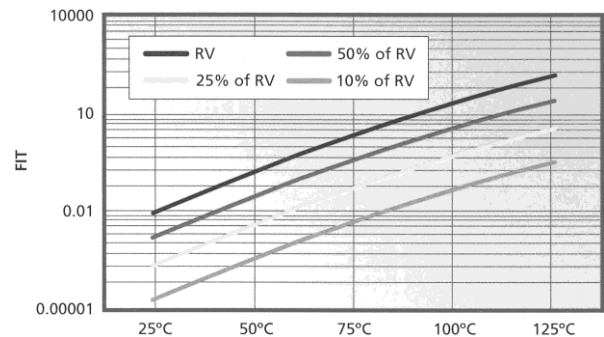
## Conversion Factors

From	To	Operation
FITs	MTBF (hours)	$10^9 \div \text{FITs}$
FITs	MTBF (years)	$10^9 \div (\text{FITs} \times 8760)$

FIT = Failures In Time. 1 FIT = 1 failure in  $10^9$  hours

MTBF = Mean Time Between Failure

## Example of FIT Data Available



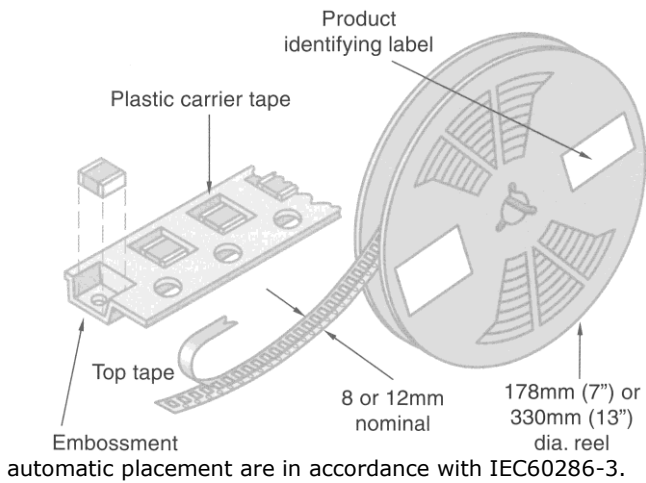
Component type: 0805 (COG/NPO and X7R)

Testing Location: Syfer reliability test department

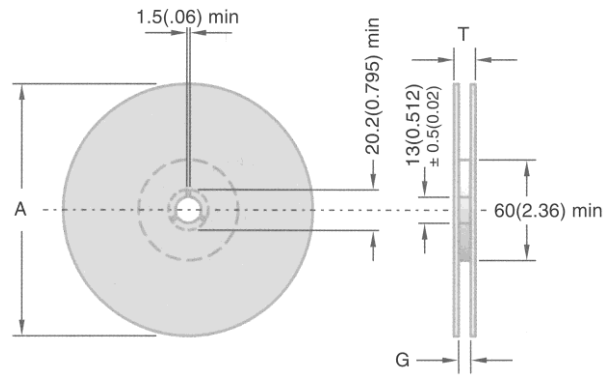
Results based on: 16,622,000 component test hours

## Packaging Information

Tape and reel packing of surface mounting chip capacitors for



## Reel Dimensions

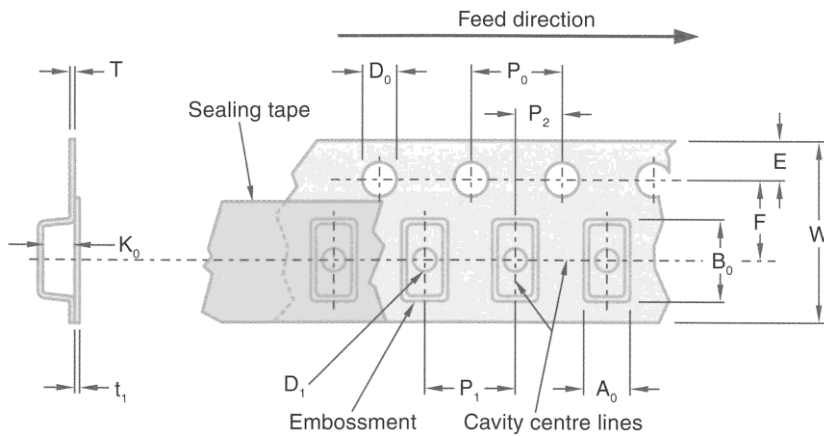


Symbol	Description	178mm Reel	330mm Reel
<b>A</b>	Reel diameter	178 (7)	330 (13)
<b>G</b>	Reel inside width	8.4 (0.33)	12.4 (0.49)
<b>T</b>	Reel outside width	14.4 (0.56) max	18.4 (0.72) max

## Peel Force

The peel force of the top sealing tape is between 0.2 and 1.0 Newton at 180°. The breaking force of the carrier and sealing tape in the direction of unreeling is greater than 10 Newtons.

## Tape Dimensions



Symbol	Description	Dimensions mm (inches)	
		8mm Tape	12mm Tape
A <sub>0</sub>	Width of cavity	Dependent on chip size to minimize rotation	
B <sub>0</sub>	Length of cavity		
K <sub>0</sub>	Depth of cavity		
W	Width of tape	8.0 (0.315)	12.0 (0.472)
F	Distance between drive hole centres and cavity centres	3.5 (0.138)	5.5 (0.213)
E	Distance between drive hole centres and tape edge	1.75 (0.069)	
P <sub>1</sub>	Distance between cavity centres	4.0 (0.156)	8.0 (0.315)
P <sub>2</sub>	Axial distance between drive hole centres and cavity centres	2.0 (0.079)	
P <sub>0</sub>	Axial distance between drive hole centres	4.0 (0.156)	
D <sub>0</sub>	Drive hole diameter	1.5 (0.059)	
D <sub>1</sub>	Diameter of cavity piercing	1.0 (0.039)	1.5 (0.059)
XT	Carrier tape thickness	0.3 (0.012) ± 0.1 (0.04)	0.4 (0.016) ± 0.1 (0.04)
Xt <sub>1</sub>	Top tape thickness	0.1 (0.004) max	

## Packing Information

### Missing Components

The number of missing components in the tape may not exceed 0.25% of the total quantity with not more than three consecutive components missing. This must be followed by at least six properly placed components

### Identification

Each reel is labelled with the following information: manufacturer, chip size, capacitance, tolerance, rated voltage, dielectric type, batch number, date code and quantity of components.

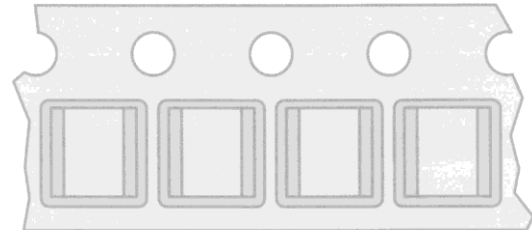
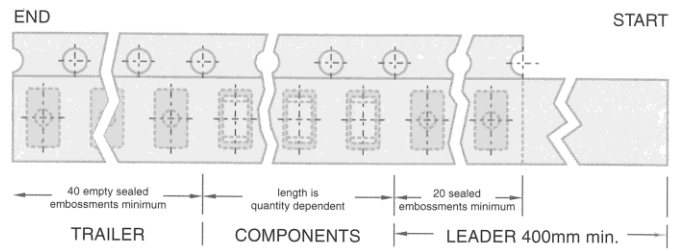
### Component Orientation

Tape and reeling is in accordance with IEC 60286 part 3, which defines the packaging specifications for leadless components on continuous tapes.

Notes: 1) IEC60286-3 states A0 <B0

- Regarding the orientation of 1825 and 2225 components, the termination bands are right to left, NOT front to back. Please see diagram.

## Leader Trailer

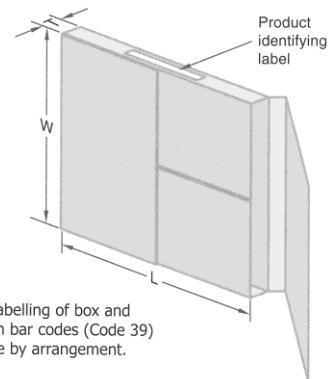


Orientation of 1825 & 2225 components

## Outer Packaging

Outer carton dimensions mm (inches) max

Reel Size	No. of Reels	L	W	T
178 (7)	1	185 (7.28)	185 (7.28)	25 (0.98)
178 (7)	4	190 (7.48)	195 (7.76)	75 (2.95)
330 (13)	1	335 (13.19)	335 (13.19)	25 (0.98)



Note: Labelling of box and reel with bar codes (Code 39) available by arrangement.

## Reel Quantities

Chip Size	0402	0505	0603	0805	1111	1206	1210	1410	1808	1812	1825	2211	2215	2220	2225
Max. Chip Thickness	0.5mm	1.3mm	0.8mm	1.3mm	2.0mm	1.6mm	2.0mm	2.0mm	2.0mm	2.5mm	2.5mm	2.5mm	2.5mm	2.5mm	2.5mm
	0.02"	0.05"	0.03"	0.05"	0.08"	0.06"	0.08"	0.08"	0.08"	0.1"	0.1"	0.1"	0.1"	0.1"	0.1"
Reel Quantities	178mm (7")	5000	2500	4000	3000	1000	2500	2000	2000	1500	500/1000	500	750	500	500/1000
	330mm (13")	-	-	16000	12000	-	10000	8000	8000	6000	2000/4000	2000	-	4000	2000/4000

### Notes:

- The above quantities per reel are for the maximum manufactured chip thickness. Thinner chips can be taped in larger quantities per reel.
- Where two different quantities are shown for the same case size, please contact the sales office to determine the exact quantity for any specific part number.

## Bulk Packing – Tubs

Chips are supplied in rigid re-sealable plastic tubs together with impact cushioning wadding. Tubs are labelled with the details: chip size, capacitance, tolerance, rated voltage, dielectric type, batch number, date code and quantity of components.

### Dimensions mm (inches)

H	60mm (2.36")
D	50mm (1.97")

