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Residual Capacitance Range VC1 Suffix

Introduction

MLCCs are split into 2 main groups, stable Class 2 which includes X7R, X5R and X8R dielectrics and ultra-stable Class 1 which includes C0G/NP0 dielectrics. Class 3 dielectrics types do exist but are rarely used. The common and useful factor of these dielectric types is that they have defined performance characteristics which enable the circuit designer to anticipate the performance under a given set of conditions.

EIA Code	Temperature Range	Capacitance Variation	ε_r	Tanδ	Class
C0G	-55°C to +125°C	30ppm/°C	10 – 100	<0.0015	1
X8R	-55°C to +150°C	±15%	~2000	<0.025	2
X7R	-55°C to +125°C	±15%	2000 – 4000	<0.025	2
X5R	-55°C to +85°C	±15%	2000 – 4000	<0.025	2
Y5V	-30°C to +85°C	+22% to -82%	~16000	<0.09	2
Z5U	+10°C to +85°C	+22% to -56%	~8000	<0.04	2

Red text indicate Syfer standard products

Generally speaking the more stable the dielectric the lower the available capacitance value, there is often a trade-off to be made with the most stable, lowest loss, zero ageing Class 1 materials only producing low capacitance values. In order to have parts with higher capacitance values Class 2 dielectrics are used, however these are less stable, as can be seen in the table above, and also have ageing effects and are more lossy.

Another property of Class 2 dielectrics that is rarely mentioned or defined is the Voltage Coefficient of Capacitance or VCC. This can often be very significant and have a serious impact on the performance of the circuit depending on the application requirements. Some dielectric materials and capacitor ranges are available which have improved VCC performance but these can be limited in their scope. Syfer's Residual Capacitance range aims to provide a broader range of options in this field.

Technical Information

Developments in materials and processing technology and increased understanding of capacitor design and failure modes over time has led to vast improvements in multilayer ceramic capacitor volumetric efficiency. For instance 10 years ago Syfer could offer an 1812 1kV 56nF, today that has increased to 180nF. An increase of 3 times seems, and is, significant but developments in BME and tape technology in low voltage components have far exceeded this statistic. The trade off is that, in some cases the actual capacitance remaining, the "residual capacitance" can be dramatically reduced by the conditions in which the capacitor operates.

VCC is related to the dielectric material and the voltage stress applied to said dielectric material. Increasing the dielectric strength of the material, by modification or improved quality, allows for a reduction in dielectric thickness which is where the large gains in volumetric efficiency are made. A halving of dielectric thickness can allow for a fourfold increase in available capacitance value as there can be twice the number of layers in a given thickness and they are half the distance apart, capacitance being proportional to total overlap area divided by plate separation.

This striving for reduction of dielectric thickness has resulted in a continuous worsening of VCC performance; it is not unheard of for capacitors to lose over 90% of their nominal capacitance value at rated voltage. Typically higher voltage components will perform worse than lower voltage due to relative processing safety margins. Despite this drawback these parts do deliver more capacitance and with many users derating from rated voltage the effect can be manageable. In some cases, where stability is more important, parts can be designed with this in mind as the VCC is fairly predictable.

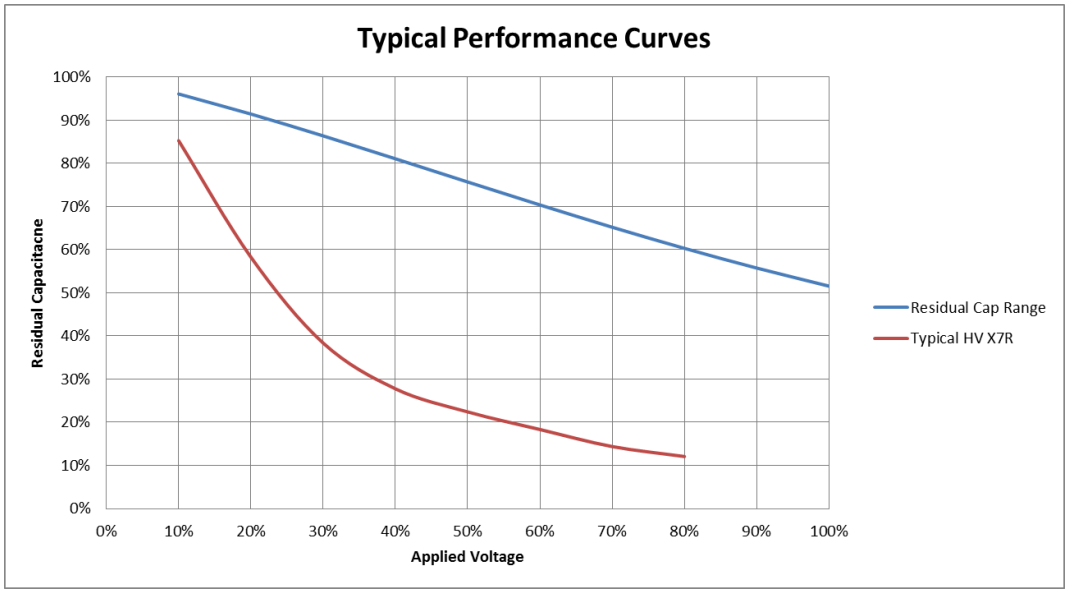
There are dielectric designations which address this requirement for stability, the MIL standard BZ and BX or IECQ-CECC 2C1 and 2X1 classifications are 2 examples:

Classification	Temperature Range	Capacitance Variation with Rated DC
2C1/BZ	-55°C to +125°C	+20%/-30%
2X1/BX	-55°C to +125°C	+15%/-25%

These parts do provide excellent stability but this comes at a cost, the ranges are extremely restricted in their scope as a result of the effective derating required to hold the VCC to the required level, Syfer's offering extends to 200V 2225 case size and 120nF in the 2C1(BZ) type. See 2C1(BZ) and 2X1(BX) ranges at www.syfer.com and at the end of this document.

There is a need to provide a balance between the headline capacitance values available in standard X7R and the the outright stability of MIL type dielectrics, there is also a requirement to offer improved voltage stability in larger case sizes and higher voltages, Syfer have evaluated the characteristics of our dielectric materials and fixed designs to provide reliable and consistent performance.

The Syfer residual capacitance range MLCCs are intended to provide a more stable capacitance value with voltage. They are designed so that, at room temperature, the capacitance should not drop below 50% of the 1Vrms 1kHz value all the way up to full rated DC voltage. The parts can be operated continuously at full rated voltage but if derated will maintain a larger percentage of their original capacitance value, if operated at 80% of rated voltage the capaciance drop will be approximately 40%. See graph below for capacitance variation with voltage:



Ranges and Ordering Information

This defined range is available and can be ordered by appending the suffix code VC1 to the standard Syfer part number within the range below. Syfer also has the data to provide bespoke parts with defined VCC behaviour. We have previously manufactured parts with defined characteristics up to 10kV DC. For additional queries and requirements please contact our Sales Department on:

+44 1603 723310 or by Email at sales@syfer.co.uk

Residual Capacitance Range VC1 Suffix							
Voltage	0805	1206	1210	1812	2220	2225	3640
250	12nF	39nF	82nF	220nF	680nF	1uF	1.8uF
500	2.2nF	6.8nF	15nF	56nF	150nF	220nF	560nF
630	1.5nF	4.7nF	8.2nF	39nF	100nF	120nF	470nF
1000	390pF	1.5nF	2.7nF	15nF	39nF	56nF	180nF
1200	-	1nF	2.2nF	10nF	27nF	39nF	120nF
1500	-	560pF	1.2nF	5.6nF	15nF	22nF	68nF
2000	-	270pF	560pF	3.3nF	10nF	12nF	39nF
2500	-	-	-	1.8nF	5.6nF	8.2nF	22nF
3000	-	-	-	-	3.9nF	5.6nF	12nF

Ordering Information Example:

Case Size	Termination	Voltage	Capacitance	Tolerance	Dielectric	Packaging	Suffix
1206	Y	1K0	0152	K	X	T	VC1

Part number: 1206Y1K00152KXTVC1 – Red characters are fixed.

Complementary Ranges

2C1 (BZ)								
Voltage	0603	0805	1206	1210	1808	1812	2220	2225
50	5.6nF	33nF	120nF	220nF	220nF	470nF	1.2µF*	1.5µF
100	1.5nF	12nF	39nF*	82nF*	100nF*	180nF	470nF*	560nF*
200	-	2.7nF	8.2nF	22nF*	22nF*	56nF*	82nF*	120nF

**Indicates that some values are not RoHS compliant, see www.syfer.com for details*

2X1 (BX)								
Voltage	0603	0805	1206	1210	1808	1812	2220	2225
50	4.7nF*	22nF	68nF	150nF	180nF*	390nF	820nF	1.0µF
100	1.2nF*	8.2nF	22nF	68nF*	68nF*	150nF*	330nF*	470nF*
200	-	1.5nF	5.6nF*	18nF*	18nF*	47nF*	82nF*	100nF*

**Indicates that some values are not RoHS compliant, see www.syfer.com for details*