

Choice of ceramic dielectric material

When choosing a filter, it is important to be aware of the different performance characteristics that may be available from different categories of ceramic materials employed in their capacitors. Generally, stability of dielectric constant (and therefore filter capacitance value), with respect to some operational and environmental parameters, deteriorates with increasing dielectric constant. Specific factors which affect dielectric constant are temperature, voltage, frequency and time (ageing).

The three main classifications of ceramic dielectric employed in the manufacture of EMI filters are generally referred to as ultra stable (COG/NP0), stable (X7R) and general purpose (Z5U, Y5V or X7W).

COG/NP0

Most parameters for materials in this dielectric classification remain unaffected by temperature, voltage, frequency or time. Stabilities are measured in terms of parts per million but dielectric constants are relatively low (10 to 100).

X7R

This is a classification for materials which are relatively stable with respect to temperature, voltage, frequency and time. Typical dielectric constants would be of the order 2,000 to 4,000, enabling the achievement of far higher capacitance values for a given size of capacitor than can be gained from COG/NP0 materials.

If the voltage coefficient (VC) is critical, Syfer are also able to offer parts with BX (2X1) and BZ (2C1) VC characteristics. Refer to the factory for further details.

Z5U/Y5V/X7W

These are classifications for materials which are severely restricted and performance under applied voltage may be seriously compromised.

A summary of the specifications of these materials follows. Please note that Syfer uses only the higher performance COG/NP0 and X7R in its standard ranges.

Summary of ceramic dielectric characteristics

	COG/NP0	X7R	Z5U	Y5V	X7W
EIA dielectric classification	Ultra stable	Stable	General purpose		
Rated temperature range	-55°C to +125°C	-55°C to +125°C	-10°C to +85°C	-30°C to +85°C	-55°C to +125°C
Maximum capacitance change over temperature range (no voltage applied)	0 ±30 ppm/°C	±15%	+22-56%	+22-56%	+40-90%
Ageing characteristics	Zero	<2% per time decade	6% per time decade	6% per time decade	6% per time decade

Spread of capacitance values

The capacitance of a ceramic capacitor can change as a result of a change in temperature, applied voltage and age. Please note that this potential change can lead to a significant drop in filtering performance.

Consider the typical performance of 5,000pF filter capacitors, offered in standard dielectric classifications, operating at a voltage of 100Vdc at 85°C, at an age of 10,000 hours. The final capacitance

value can fall within the range of values (see chart below), taking into account the ageing process and effects of temperature and voltage as shown in the chart above.

It is clear that the capacitance can change as a result of an increase (or decrease) in temperature, applied voltage and as a result of ageing. If the capacitance has reduced, so too will the insertion loss performance.

