DLI • Novacap • Syfer • Voltronics

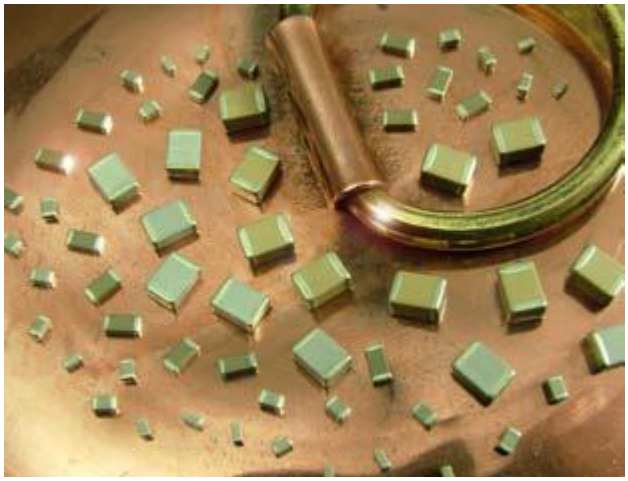
Syfer Technology Limited, Old Stoke Road,
Arminghall, Norwich, Norfolk, NR14 8SQ,
United Kingdom
Tel: +44 (0) 1603 723300
Tel. (Sales): 01603 723310
Fax: +44 (0) 1603 723301
Email: sales@syfer.co.uk
Web: www.knowlescapacitors.com

Magnetic Characteristics of Syfer Products

including Non Magnetic MLCC range

Introduction

All materials have electromagnetic properties, defined by their relative permeability μ_r, a ratio of permeability relative to that of free space μ_0. So a μ_r of 1.0000 is classed as totally non-magnetic. For capacitive electronic components, the magnetic characteristics can usually be ignored, but for some applications such as in MRI scanners, the magnetic characteristics must be considered.



Multilayer Ceramic Capacitor (MLCC) Construction

All ceramic MLCC based Syfer products consist of precious metal electrodes embedded in a dielectric material, externally terminated to provide electrical contact using a conductive metal ink and / or electroplated. The critical components we need to consider are the dielectric material and the termination materials employed.

Dielectric

First, it is important to remember that the familiar designations X7R and C0G/NP0 are not types of dielectric material, but simply define the characteristics of the material that is being used. Most manufacturers, including Syfer, will use several dielectric materials in each class for each designation. It is not therefore possible to simply discuss the magnetic properties of X7R or C0G. Most dielectric materials have little or no magnetic permeability, but there are some important exclusions. For example, certain C0G/NP0 types of dielectric contain Neodymium Titanate and have a degree of magnetic permeability.

Termination

The common termination for MLCCs is electroplated Tin over Nickel onto a fired silver base termination material. In this case the Nickel results in a significant degree of magnetism. Alternative termination materials have always been available, the most common for applications where the magnetism needs to be controlled being a precious metal based consisting of alloys of Palladium, Silver and Platinum. The poor solder leach resistance of these finishes resulted in a special solder alloy being developed especially to allow successful soldering to them – 62Sn36Pb2Ag being a development of the then popular 63Sn37Pb or 60Sn40Pb Tin-Lead solder alloys.

Unfortunately, the restrictions imposed by RoHS regulations on the use of Lead in solders have meant that these alloys are now banned in many applications and the replacements are almost universally high tin content alloys – SAC (96.5Sn3Ag0.5Cu or very similar) being the most popular. Palladium, Silver and Platinum alloys have poor solder leach resistance to Tin rich alloys such as SAC and it has been necessary to look for alternative solutions.

Syfer have developed an electroplated Copper undercoat alternative to replace the Nickel for magnetic critical applications. This Copper barrier layer allows for Lead free soldering with high temperature 260°C soldering profiles as demanded by J-STD-020, without the termination leaching associated with precious metal ink terminations. Copper barrier is available with sintered terminations on selected C0G/NP0 dielectrics and with Syfer's FlexiCap™ flexible polymer termination on X7R dielectrics.

Individual Product Details

Copper Barrier / Non-Magnetic

The Copper barrier / non-magnetic range detailed on the Syfer website and in the MLCC catalogue is a true non-magnetic range with a measured permeability μ_r of approximately 1.0000

This range covers C0G/NP0, Syfer High-Q and X7R dielectrics and uses defined dielectric materials in conjunction with copper barrier terminations to provide non-magnetic components with maximum solder leach resistance, suitable for use with Lead free solders and soldering processes. The termination system is also available with a SnPb plated finish for RoHS exempt applications

To identify the components from this range as non-magnetic, copper barrier, the termination code of the part number is changed as below:

Description of Termination	Dielectric Base Material	Termination Code
Sintered silver base with copper barrier (100% matte tin plating). RoHS compliant	C0G / NP0 & High Q	2
FlexiCap™ base with copper barrier (100% matte tin plating). RoHS compliant	C0G / NP0, High Q & X7R	3
Sintered silver base with copper barrier (tin/lead plating). Non RoHS compliant	C0G / NP0 & High Q	4
FlexiCap™ base with copper barrier (tin/lead plating). Non RoHS compliant.	C0G / NP0, High Q & X7R	5

Special requests for other MLCC's (e.g. Feedthrough chip filters) in non-magnetic dielectrics and with copper plating can be considered – please refer requests to the factory.

Other Multi Layer Chip Capacitors (including Feedthrough Filters & X2Y)

The standard plated termination systems all have electroplated Nickel undercoat plating applied for maximum soldering leach resistance. This imparts significant magnetism to the MLCC, with a typical relative permeability μ_r of 1.4000. This is irrespective of the dielectric material used.

Most Syfer MLCC's can be supplied with non-plated precious metal terminations to reduce the magnetic effect, however the dielectric material is not guaranteed to be non-magnetic for MLCC's selected from any range other than the specific non-magnetic range. In general, X7R dielectrics perform better than C0G/NP0 dielectrics, but relative permeabilities up to typically μ_r = 1.0005 can be expected from certain dielectrics when combined with non-magnetic terminations.

Radial Leaded Chip Capacitors

The lead material of radial sizes 8111 to 8141 inclusive is a steel base and obviously strongly magnetic. Radial sizes 8151, 8161, 8165 & 8171 have tin plated copper leads. In all cases the chip cannot be guaranteed to be non-magnetic. Nickel plated chips can be used in the assembly of all sizes of standard component and variation may occur on a batch to batch basis.

The coating material used includes an Iron Oxide pigment to allow for laser marking of the component. This has a minor magnetic effect – typical permeability of μ_r = 1.0040. This material is the most common coating material used for leaded devices and as such is known to be in use in magnetic sensitive applications, but it is the responsibility of the customer to determine if it is acceptable.

We can consider special requests for non-magnetic radial leaded components where the chip can be controlled and plated copper leads specified. However, the gold colour powder coating cannot easily be substituted. It has to remain the responsibility of the customer to confirm that the powder coating is sufficiently non-magnetic for application. We can support with samples if required.

Planar Arrays & Discoidal Capacitors

The same considerations for the dielectric material apply as for MLCCs above. In general C0G/NP0 dielectrics in planar and discoidal components are of the magnetic variety with permeabilities of typically $\mu_r =$ 1.0005.

The standard plating finish on these components is electroless plated Gold over electroless Nickel. Tests have shown this to have very little if any magnetic effect, but please refer to the factory for any non-magnetic application of these components.

EMI Filters

These are assembled using the above discoidal / planar capacitors soldered into plated brass bodies with plated brass through pins.

Although the capacitor element is typically low or non-magnetic, special non-magnetic brass is not used for standard components

Obviously the use of ferrite inductors in L-C, T & Pi filters infers considerable magnetism and cannot be considered for non-magnetic filters.

For further information or technical assistance please contact our Sales Department on:

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