Innovative Service Around the Globe YAGEO

DATA SHEET

SURFACE-MOUNT CERAMIC MULTILAYER CAPACITORS

Introduction

YAGEO
Phycomp

Product Specification – Dec 06, 2010 V.11

GENERAL DATA

Ceramic capacitors are widely used in electronic circuitry for coupling, decoupling and in filters. These different functions require specific capacitor properties.

CERAMIC CAPACITORS CAN BE DIVIDED INTO TWO CLASSES:

- Class 1
  - In these capacitors dielectric materials are used which have a very high specific resistance, very good Q and linear temperature dependence (ε_r from 6 up to 550). They are used in such applications as oscillators and filters where low losses, capacitance drift compensation and high stability are required.
- Class 2
  - These capacitors have higher losses and have non-linear characteristics (ε_r > 250). They are used for coupling and decoupling.

CONSTRUCTION

The capacitance of a ceramic capacitor depends on the area of the electrodes (A), the thickness of the ceramic dielectric (t) and the dielectric constant of the ceramic material (ε_r); and on the number of dielectric layers (n) with multilayer ceramic capacitors:

$$C = \varepsilon_r \times \varepsilon_o \times \frac{A}{t} \times n$$

The rated voltage is dependent on the dielectric strength, which is mainly governed by the thickness of the dielectric layer and the ceramic structure. For this reason a reduction of the layer thickness is limited.

Construction of a multilayer capacitor shown on the following.

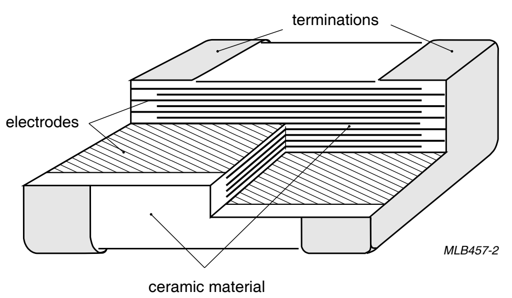

Fig. 1 Cross-section of a multilayer capacitor

ORDERING INFORMATION - GLOBAL PART NUMBER, CTC FOR NORTH AMERICA & 12NC

Capacitors are ordered in three ways. All ways give logistic and packing information.

- CTC: This unique number is an easily-readable code that is identified by the series, size, tolerance, TC material, packing style, voltage, process code, termination and capacitance value. Global part number is preferred.
  - 14~18 digits code (Global part number): Yageo/Phycomp branded products
  - 15 digits code (PHYCOMP CTC for North America): Phycomp branded products
- 12NC: In general, the carrier tape, voltage, size, tolerance, packing and capacitance code are integral parts of this number.
  - Phycomp branded product

Further information will be mentioned in the relevant data sheet.

MANUFACTURING OF CERAMIC CAPACITORS

The raw materials are finely milled and carefully mixed. Thereafter the powders are calcined at temperatures between 1,100 and 1,300 °C to achieve the required chemical composition. The resultant mass is reground and dopes and/or sintering means are added.

The finely ground material is mixed with a solvent and binding matter. Thin sheets are obtained by casting or rolling.

For multilayer capacitors , the electrode material is printed on the ceramic sheet , after stacking and pressing of sheets, it is sintered together with the ceramic material at temperature between 1,000 and 1,400 °C.

The totally enclosed electrodes of a multilayer capacitor guarantee good life test behaviour as well.

EQUIVALENT CIRCUIT FOR CERAMIC CAPACITORS

Definition of symbols (see fig. 2)

Symbol	Description
C	Capacitance between the two electrodes, plus the stray capacitance at the edges and between the leads.
R_p	Resistance of insulation and dielectric. Generally R_p is very high, and of decreasing importance with increasing frequency. R_p also represents the polarization losses of the material in an alternating electric field.
R_s	Losses in the leads, the electrodes and the contacts. Up to several hundreds of MHz the current penetration depth is greater than the conductor thickness so that no skin-effect occurs. For ceramic capacitors R_s is extremely low.
L	Inductance of the leads and the internal inductance of the capacitor; the latter, however, is almost negligible. The inductance is only important in high frequency applications, since the capacitor will act as an inductance when the frequency is higher than its resonance frequency.

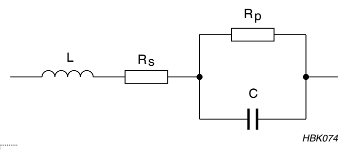

Fig. 2 Equivalent circuit

TANGENT OF THE LOSS ANGLE

The losses of a capacitor are expressed in terms of tan δ which is the relationship between the resistive and reactive parts of the impedance, specified as follows:

$$\tan\delta = \left|\frac{R}{X}\right| = \frac{R_p + R_s\{1+(\omega C R_p)^2\}}{(\omega C R_p)^2 - \omega L\{1+(\omega C R_p)^2\}}$$

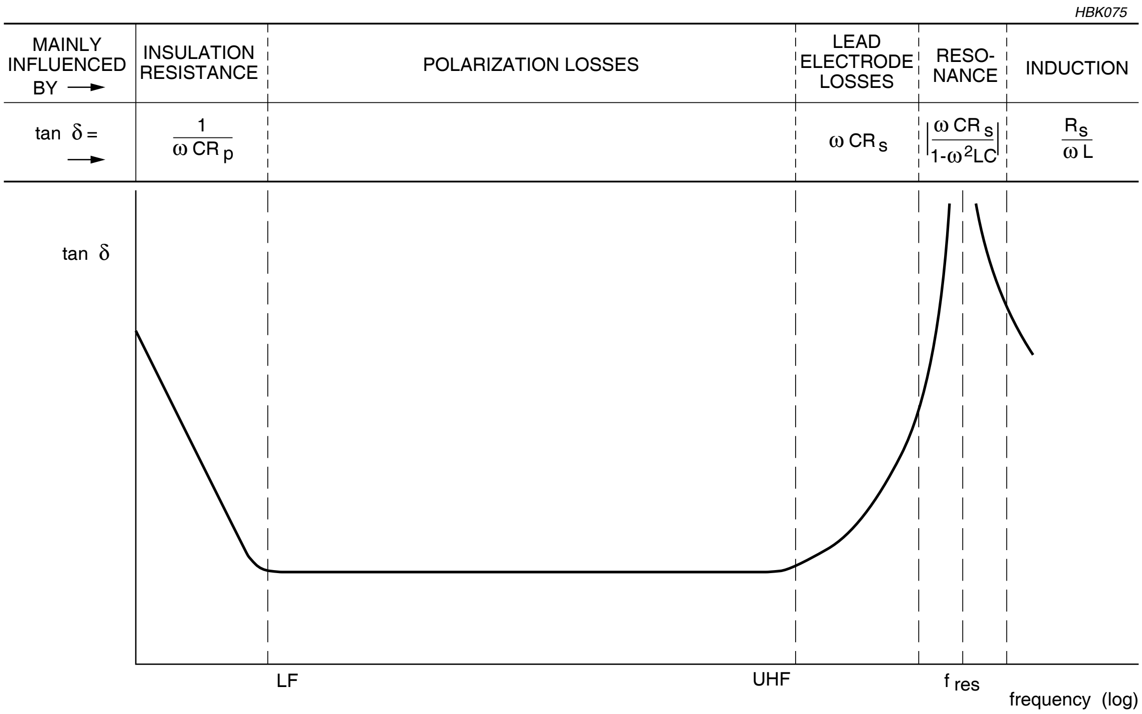

Fig. 3 Tan δ as a function of frequency

FAILURE IN TIME (FIT)

The failure rates shown in Table 1 have a confidence level of 60%. Failure rates are given under normalized conditions, i.e. (at 125 ℃ / 85 ℃, 2 times of rated voltage for 1,008 hours, *"IEC 60384-8 4.25.1"*).

Failures include capacitance, tan δ and insulation resistance values, which do not meet the requirements after endurance test.

The determination of failure rates is based on the rated conditions as stated in *"MIL-HDBK-217E"*. All the test results should be interpreted as results under rated conditions even if the temperature and voltage exceed the rated values.

Table 1 FIT of multilayer capacitor

TYPE	FIT (λ) (1)	MTTF (hours) (2)
NP0	336	2,973,600 (123,900 days)
X5R	1,901	525,913 (21,913 days)
X7R	323	3,098,504 (129,104 days)
Y5V	784	1,275,339 (53,139 days)

NOTE

1. FIT = failure rate within 10^9 component hours.
2. MTTF means " mean time to failure"
3. Data updated from 2008 1_{st} semi-annual report

REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 11	Dec 06, 2010	-	- 12NC ordering information updated
Version 10	Mar 05, 2009	-	- Change to dual brand datasheet - Failure in time (FIT) data modified
Version 9	Jul 15, 2003	-	- Cover page revised
Version 8	Jan 15, 2003	-	- Updated company logo - Updated FIT
Version 7	May 30, 2001	-	- Converted to Phycomp brand