SIOV metal oxide varistors

Reliability tests

Date: January 2018

1 Reliability

1.1 Lifetime

The mean life (ML) of SIOV varistors as a function of

- voltage class (i.e. ceramic material),
- ambient temperature,
- applied voltage ratio (AVR)

can be derived from figure 1.

There is a marked difference between "low-voltage ceramics" ($\leq$K40) and "high-voltage ceramics" ($\geq$K50).

AVR is defined as the ratio between intended operating voltage and maximum permissible operating voltage.

$$AVR = \frac{v^*}{v_{max}} \qquad \text{(equ. 22)}$$

Reaching the maximum average power dissipation is defined as the end of useful life. But the varistor is still functional.
The increase in leakage current is, to a good approximation

$$i_L = A + k\sqrt{t} \qquad \text{(equ. 23)}$$

i_L = leakage current at constant voltage

A = factor, dependent on temperature, AVR, geometry, encapsulating material

k = slope coefficient of leakage current over $\sqrt{t}$

Investigations at different temperatures and AVRs show that the logarithm of lifetime is in a linear relation to reciprocal ambient temperature.The slope of this curve is virtually constant for zinc oxide. It can be attributed to activation energy.

The theoretical background of these relations is known as the Arrhenius model. Figures 1 and 2 show evaluation for SIOV varistors.

EPCOS lifetime tests extend over a period of several 10^4 hours. The higher lifetime figures are determined by extrapolation on the Arrhenius model.
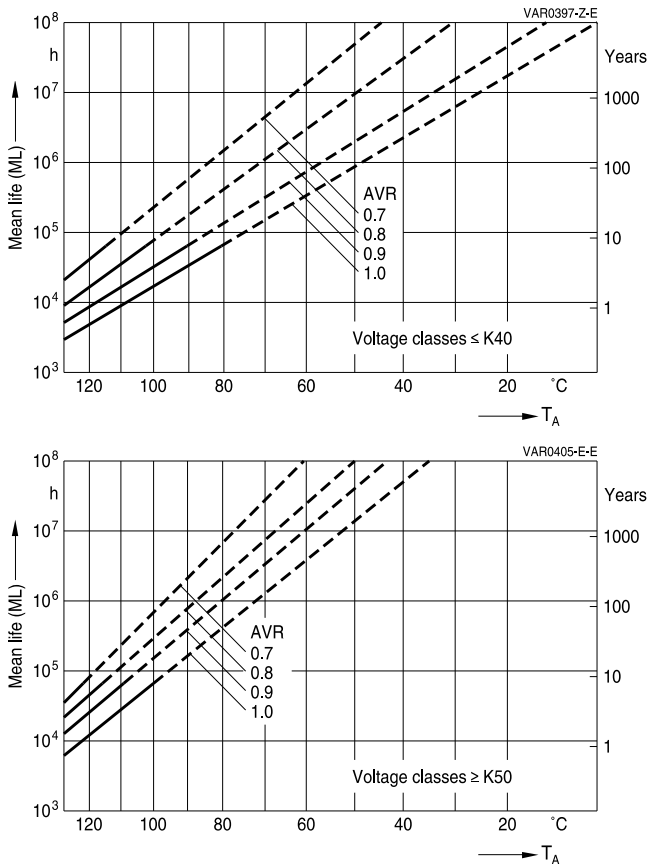
1.2 Failure rate

The failure rate λ is the reciprocal of mean life in hours, the unit being fit (**f**ailures **i**n **t**ime) = 10^{-9}/h.

$$\lambda[\text{fit}] = \frac{10^9}{ML[h]} \qquad \text{(equ. 24)}$$

Accordingly, the fit rate can also be derived from the Arrhenius model.

VAR0397-Z-E

VAR0405-E-E

Figure 1   Mean life on Arrhenius model
Applied voltage ratio (AVR) referred to maximum permissible operating voltage

Failure rate figures refer to the average production status and are therefore to be understood as mean values (statistical expectations) for a large number of delivery lots of identical varistors. These figures are based on application experience and on data obtained from preceding tests under normal conditions, or – for purposes of accelerated aging – more severe conditions.

1.3   Tests

SIOV varistors are tested periodically. The relevant characteristics and test methods are described under reliability data for each series. These reliability test data are available on request.