

# INTEC

## VOLTAGE-TEMPERATURE CHARACTERISTICS

INTEC ceramic capacitors are offered in four of the most popular EIA (Electronics Industry Association) voltage-temperature characteristics: ultra-stable COG (NPO), X7R, (BX or BR), and general purpose Z5U Y5V.

### AGING

COG (NPO) dielectric is made from a non-ferroelectric ceramic material (Class I). This yields superior stability characteristics, but a low dielectric constant, and thus, low packaging efficiency. X7R, Z5U, and Y5V are made from ferroelectric materials (Class II and III), principally barium titanate. Ferroelectric dielectrics exhibit a time dependence of dielectric constant and capacitance loss known as *aging*. It is believed that this behavior is due to strain energy of the ferroelectric domains striving for orientation relative to one another after their formation. These domains appear in ferroelectrics of the barium titanate type after cooling past the Curie temperature. The Curie temperature is the point where the crystalline structure goes from a cubic to a tetragonal configuration. Thus, ferroelectric materials exhibit an aging of the dielectric constant after cooling past the Curie point, which is logarithmic with time.

The aging rate of capacitors is expressed in terms of decade hours. The predicted percent capacitance loss per decade hour (maximum) for each of the major dielectrics are as follows: COG (none), X7R (2%), Z5U (5%), and Y5V (7%).

The aging of high K dielectrics can be partially minimized by heating the capacitor to near the Curie temperature, with an applied DC bias. This voltage aging will accelerate the aging process by several decades of time depending on the dielectric and DC bias.

The aging process of ferroelectrics is reversible. Heating the material past the Curie point reverts the structure to its previous state and the aging pro-

cess starts anew. Users should be aware that certain capacitor attachment processes do exceed the Curie temperature of the dielectric and therefore a temporary increase in capacitance should be expected.

### VOLTAGE EFFECTS

Ferroelectric materials are also affected by applied voltage, both AC and DC. Voltages, which are low in relation to the rated voltage, produce a slight increase in capacitance and dissipation factor. As the voltage is increased towards the rated voltage, the capacitance will decrease. This decrease in capacitance is a function of dielectric thickness. High dielectric constant materials (Z5U, Y5V) could exhibit capacitance decreases as high as 50% due to a polarizing effect in the ferroelectric material. The voltage-capacitance characteristics for each dielectric material are shown on the applicable catalog page.

### ACCEPTANCE TESTING

Because of the effects of temperature and voltage on ferroelectric type materials (X7R and Z5U), the user must consider these effects when establishing acceptance test parameters. Both insulation resistance (IR) and dielectric strength tests require that high voltage be applied to the capacitor. These tests will therefore cause the capacitance to decrease. This decreased capacitance will persist for some time after the DC bias is removed. Therefore, it is recommended that capacitance be measured prior to performance of these tests.

### TERMINATIONS

The capacitor termination provides the electrical and mechanical connections to the outside world, regardless of whether the capacitor is attached to a ceramic substrate or printed circuit board. Therefore, the termination is a critical consideration. Characteristics that most affect the quality of the termination are described below:

### SOLDERABILITY:

The ability of the ceramic chip to accept solder, without preparations, except for the use of a flux material.