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Article

Variation in Capacitance of Ceramic Capacitors Due to Humidity

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ABSTRACT

In this paper the effect of humidity is considered on ceramic capacitors. The capacitance of ceramic capacitor varies due to the absorption of moisture. The dependence of the capacitance of a ceramic capacitor is determined under the effect of humidity. A decrease in capacitance of ceramic capacitor is observed.

Keywords: Relative Humidity, Capacitance, Ceramic Capacitor

Introduction

In daily life we come across many electronic elements and devices. These have become an especially important part of our life. These have some adverse effect of humidity or moisture on them. Electronic devices are exposed to varying and harsh environments and thus common reasons for failures in electronics are environmental contaminants and conditions such as temperature and humidity with other failures deriving, for example, from vibration, ripple voltage, overvoltage and corrosion. These all affect the reliability of electronic components. In this paper the effect of humidity is determined on active and passive electronic elements. These have an effect of corrosion also. This corrosion effect destroyed these elements in some time and then these elements are useless and can not be used further. The results of various other researchers for the same purpose show that combination of high humidity and high temperature did not possess a significant risk for these capacitors during their normal use. Very high humidity and radical temperature changes both affected the breakdown voltages of tantalum capacitors. Salt fog caused corrosion of these components and had a small effect on breakdown voltage but did not have an effect on capacitance or ESR.[1]

The electrical behavior of Multilayer Ceramic Capacitors (MLCs) in strict dynamic high temperature-humidity-DC bias voltage conditions were studied and it was found, if the environmental temperature and humidity rose too fast and the temperature of a MLC was lower than the dew point temperature of surrounding moist air, dewdrops would condense on the MLC surface.[2] It was shown that the characteristics can be strongly affected by the parasitic stray capacitances resulting from the humidity of the surrounding atmosphere and the condensed water on the outer walls of the sensor, particularly for the structure with a relatively low capacitance.[3] Ceramic chip capacitors can potentially crack due to thermal stresses in a surface mount assembly process. The electrical performance of the cracked capacitors will degrade with time and they will prematurely short.[4] A failure or fault is change of properties of system, in such a way that its functioning is seriously affected. Manufacturers often perform various experiments and tests before final release of product in the real market. By this method, a datasheet is prepared. But, when the product is launched for real time operation, it experiences variable operating conditions and environmental factors that deviate its lifetime from claimed lifetime.[5] Residual life of the electronic product is studied using experimental approach. An intelligent model is prepared which estimates the remaining life of ceramic capacitor. The residual life of ceramic capacitors depends on various environmental and electrical conditions. The accountable conditions are temperature, humidity and vibration. The critical electrical factors are operating voltage, ripple current and dissipation factor. Except these factors such as temperature i.e. ambient temperature is also effective to the working period of ceramic capacitors.[6] A capacitor is a device to store charge. There are various types of capacitors such as ceramic capacitor, electrolytic capacitor, paper capacitor, film capacitor etc. In a ceramic capacitor, the dielectric material is fixed ceramic. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes.[7] Effect of deterioration under various operating conditions on ceramic capacitor is discussed and advanced techniques are employed for health prognostics.[8]

Theory

The reliability of a capacitor is heavily influenced by humidity with various effects inside the capacitor. Moisture can penetrate the polymer encapsulating material and degrade the characteristics of the capacitor. These effects can later cause the capacitor to fail. A ceramic capacitor is a fixed capacitor with the ceramic material acting as the dielectric. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes. The composition of the ceramic material defines the electrical behavior and therefore the application of the capacitors.

Experimental Description

Preparation of Solution

Specific Gravity of H_2SO_4= 1.84 gm/ml

- For RH=60%, 38.35 gm percentage

i. e. 104.2 ml H_2SO_4+395.8ml distill water

- For RH=90%, 11 gm percentage

i. e. 29.9 ml H_2SO_4+470.1 ml distill water

We recorded the capacitance of ceramic capacitor using LCR Circuit Kit at relative humidities RH=60% and RH=90% for a few days. The variation of the capacitance is tabulated in tables (Table 1 and Table 2).

Table 1.Variation of capacitance of ceramic capacitor in parallel circuit vs Time at RH = 90%

Days	Capacitance (nf)
0	112.9
6	107
13	108.6
26	102.8
61	107.8

Table 2.Variation of capacitance of ceramic capacitor in series circuit vs Time at RH = 90%

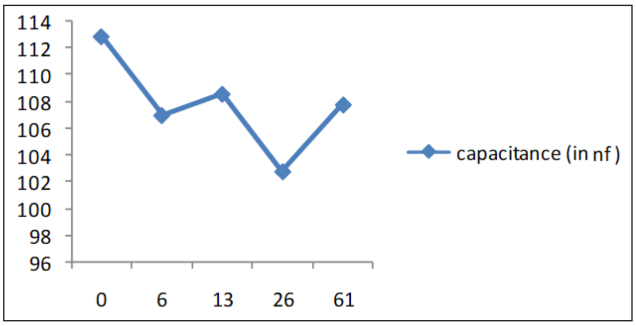
Days	Capacitance (nf)
0	112.7
6	107
13	109.1
26	102.5
61	107.9

Discussion of Results

The graphical variation of capacitance of ceramic capacitor Vs time (number of humid days):

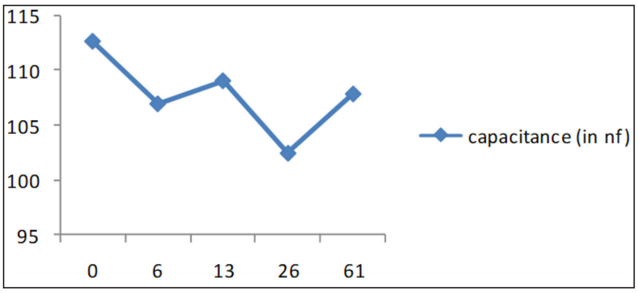
Graph 1

The graphical variation of capacitance of ceramic capacitor connected in parallel circuit vs time (number of humid days).



Graph 2

The graphical variation of capacitance of ceramic capacitor connected in series circuit vs time (number of humid days).



Conclusion

From the graph it is evident that the capacitance of the ceramic capacitor varies due to the absorption of moisture. This shows that the capacitance of a ceramic capacitor is dependent on humidity. This is due to the formation of a moisture absorbed layeron the surface of capacitor.

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