

Electrolytic Capacitor Polarity Determination based on Electrical Measurements

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Abstract

Abstract— This paper presents a comparative study of several approaches for identification whether an electrolytic capacitor was mounted in correct polarity or not. An original method for the testing of electrolytic capacitors polarity determination developed by the authors, based on measurements is presented. The method uses simple charging-discharging techniques based on voltage measurements, is very fast and requires very low-cost electronic components. The method can be further extended for electrolytic capacitor on-assembly testing.

I. Studying AC parameters

- **B. Impedance analysis**
- RC 470µF/35V || 12Ω, 2V DC forward and reverse bias:



II. Studying Time-Domain behavior

A. Limited charging current study

 Higher voltage ratings require either higher charge voltages or longer charge times to make the oxidation effect visible:



Keywords—: Electrolytic capacitor, polarity, testing method, charging, discharging

Introduction

- Aluminum-based electrolytic capacitors: widely used for energy buffering in electronic power assemblies, especially in automotive industry.
- A reverse polarized electrolytic capacitor can lead to the destruction of the electronic circuit.
- The defects/ accidents can occur either at the testing phase, or during the operation phase.
- Therefore, a testing procedure to check if the electrolytic capacitors are correctly mounted, even before or as the first step of the electronic testing phase is compulsory.
- The authors studied several methods both from literature and own ones.
- The idea is to find easily measurable parameters

	10KH2 2018-0 100KH2
Cursor data:	
X2: 101.0 Hz A: -910.9 Hz X1: 1.012 kHz	
C forward: Z : 2.805 Ω Δ: 2.500 Ω Rs: 155.8 mΩ Δ:	66.13 mΩ Xs: -2.800 Ω
C reverse: Z: 2.116 Ω Δ: 1.860 Ω Rs: 182.5 mΩ Δ:	49.92 mΩ Xs: -2.108 Ω
C direct: Δ: -2.510 Ω θ: -86.80 ° Δ: -14.00 ° Cs	: 563.1 uF A: 21.28 uF

• Reverse biased capacitor: measured 32.8% larger than the nominal value

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Conclusion: AC measurements provide a reliable method to determine whether an electrolytic capacitor is direct or reverse biased, however the measurement device is rather expensive

II. Studying Time-Domain behavior

• Schematic:





B. Self-discharge study:

- Charge for 500ms, then leave it open:
- 1000µF/50V, I_{charge} = 100mA:



- and comfortable threshold between the direct and reverse polarized capacitor circuit measurements
- In a case of a testing equipment the measurement should clearly determine whether the capacitor is direct or reverse polarized

I. Studying AC parameters

A. Lowpass Bode Diagram

- RC 470µF/35V || 100Ω, 2V DC forward and reverse bias:
- Measuring device: Digilent Analog Discovery, 2V sine wave:



- A. Limited charging current study
- 470μF/35V, charging current limited to 100mA, 200ms pulse:



 All capacitors studied (5 different values from 470µF to 2200µF of which 1000µF with 3 nominal voltages) showed a similar behavior

Conclusions

- AC electrical parameters show over 30% difference between forward and reverse biased capacitor electrical behavior
- Both charging and self-discharging behavior study led to concluding results
- The study concludes to a simple and costeffective testing procedure

- Clear difference between forward and reverse biased capacitor behavior
- Parasitic effects of the reverse biased capacitor: Less visible
- After 100mS the effect of the oxidation process in the reverse charged capacitor becomes visible
- Easily measurable differences between forward and reverse charged capacitor
- During the 500ms charging test, no capacitor damage was observed. However, a deeper study has to be done on capacitor ageing

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