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Reliable Testing of Capacitors

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Abstract*— A capacitor is an electronic device that consists of two conducting plates bearing opposite electronic charges, having dielectric (insulator) medium as their separator. Different capacitors may make use of different dielectric. Mostly include air, paper, and plastic, polyester and polystyrene. A potential difference across the conducting plates causes the formation of a static electric field in the dielectric. Capacitor stores energy between the two conductors where the electric field is present. Charging is the process allows the capacitor to store energy. The capacitor has a wide range of application in electronic circuits with the purpose of restricting direct current (DC) and allowing alternating current (AC) to pass through. The device is basically built for storing energy and for releasing all the energy at once. The capacity of this device to hold an electrical charge is termed as 'capacitance' and it is measured by Farads. For the measurement of electric charge between the two conducting plates is measured in the reliable methodology is described below.

***Index Terms*—Capacitance, Conducting Plates, Dielectric, Electric Field.**

I. INTRODUCTION

Capacitors may not be considered as the main component of electronic equipment, but more like the helpers and extras. However, they play a vital role wherever electrons are used in the components. A defective 2 cent capacitor in a TV or monitor can render it useless. This document describes techniques for the testing of capacitors using a multimeter without a capacitance test mode. Information on safe discharging of high value or voltage capacitors and a discharge circuit indicating visually charge and discharge values are also included. The general information is given on capacitors, capacitance and ESR meters, and other related topics.

II. CAPACITOR SAFETY CONSIDERATIONS

When there is an accidental contact with capacitors on a 3.3 V logic board isn't going to result in a shocking experience, this is not true of many common types of equipment including TVs, computer and other monitors, ; the switch mode power supplies in some VCRs; microwave ovens, laptops, camcorder battery chargers; electronic flash and other xenon strobes; laser power supplies, and many other industrial devices.

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Special precautions are required when equipment is AC line connected and uses high voltages both for personal safety and to prevent damage to circuitry from careless actions.
Safety Guidelines are required for High Voltage or Line Powered Equipment before attempting any testing or repairs to equipment for which this applies.

- **Precautions for capacitor testing**

Note1: make sure the capacitor is discharged! This is both for your safety and the continued health of your multimeter.

III. CAPACITORS TESTING USING MULTIMETER

Some DMMs have particular modes for capacitor testing. This is the best way to get μF rating. In most of the applications, they do not test for leakage or the normal working voltage. This type of testing requires disconnecting at least one lead of the suspect capacitor from the circuit to get an accurate reading or any other readings. Of course, all power in the capacitors should be discharged. This will generally work as long as the components attached to the capacitor are either semiconductors (which won't conduct with the low test voltage) or passive components with high impedance so that they do not load the tester too much. Sometimes good capacitors are referred as bad because of opposite sign shown in the multimeter.

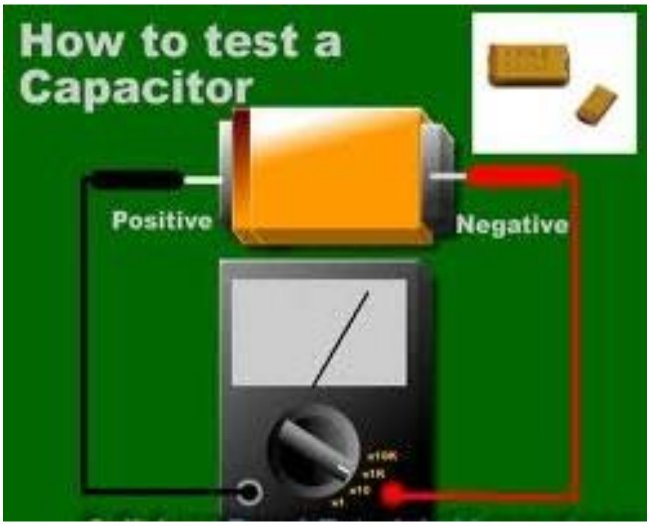

Fig1: capacitor testing using multimeter

Note2: Capacitor should be fully discharged while using in large capacitors, power supply, power amplifier, or similar circuits to avoid meter damage or destruction.

IV. DISCHARGE TOOL FOR CAPACITORS

The capacitor discharge tool has an indicator which provides visual display of polarity and charge (the discharge time constant is virtually instantaneous for CRT's and even with a multi-M ohm resistor).

Solder one end of the appropriate size resistor (for your application) along with the indicator circuit to a well-insulated clip lead about 2-3 feet long. For safety reasons, these connections must be properly soldered, not just wrapped.

Solder the other end of the resistor (and discharge circuit) to a well-insulated contact point which will act as an extension handle. By using some plastic electrical tape secure everything to the insulating rod. This discharge tool will keep you safely clear of the danger area. And always double check with a reliable voltmeter or by shorting with an insulated Screw driver.

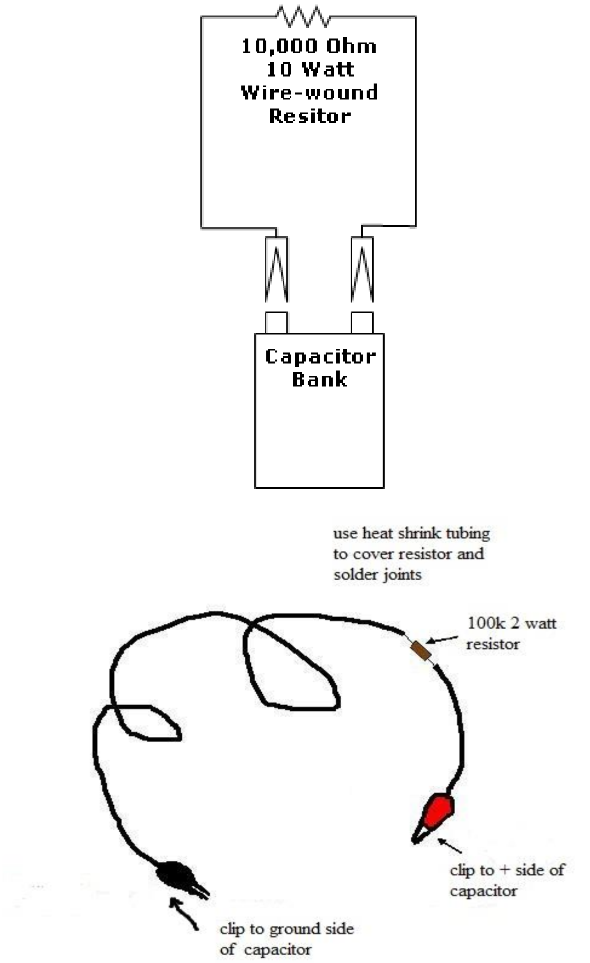

Fig2: discharging tool

V. INDICATOR CIRCUIT FOR CAPACITOR DISCHARGE

It is a suggested circuit which will discharge the high value main filter capacitors in TVs, video monitors, switch mode power supplies, microwave oven capacitors, and other similar devices quickly and safely. This circuit can be built into the discharge tool as described above (Note: different value resistors are needed for LV, HV, and EHV applications.)

A visual indication of polarity and charge is provided from maximum input down to a few volts. The total discharge time is approximately:

- LV: (TV and monitor power supplies, SMPSs, electronic flash units) - up to 1000 uF, 400 V. Discharge time of 1 second per 100 uF of capacitance (5RC with R = 2 K ohms).
- HV: (microwave oven HV capacitors) - up to5, 000 V, 2 uF. Discharge time of 0.5 second per 1 uF of capacitance (5RC with R = 100 K ohms)
- EHV: (CRT second anodes) - up to 50,000 V, 2 nF. Discharge time of 0.01 second per 1 nF of capacitance (5RC with R = 1 M ohm). Note: discharge time is so short that flash of LED may not be noticed.

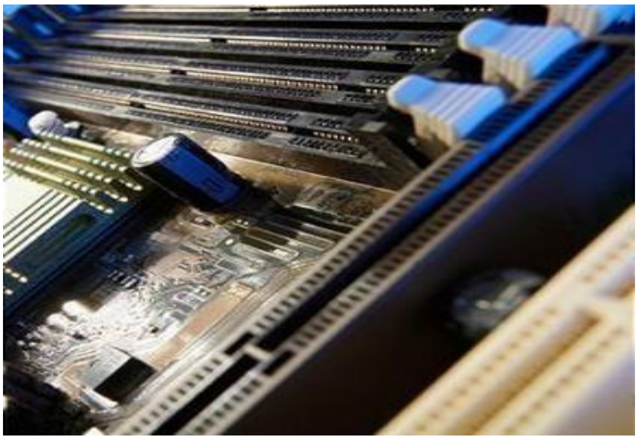

Fig3: capacitor testing circuit

VI. CAPACITOR DISCHARGE TECHNIQUE

The technique which is recommended is to use a high wattage resistor of about 5 to 50 ohms/V of the working voltage of the capacitor. The use of a current limiting resistor will prevent the arc-welding which is associated with screwdriver discharge but will have a short enough time constant so that the capacitor will drop to a low voltage in at most a few seconds (dependent of course on the RC time constant and its original voltage). Then check with a voltmeter to get the accurate reading. But then also monitor while discharging (monitoring is not needed for the CRT - discharge is nearly instantaneous even with multi-M ohm resistor).

VII. SAFE DISCHARGING OF CAPACITORS IN TV'S, VIDEO MONITORS AND MICROWAVE OVENS

It is essential - for everybody's safety and to prevent damage to the device under test and also prevent damage to the test equipment- that large or high voltage capacitors are to be fully discharged before measurements. Some of the large filter capacitors commonly found in line operated equipment store a potentially lethal charge.

This doesn't mean that every one of the 250 capacitors in your TV needs to be discharged every time you power off and want to make a measurement. However, the large main filter capacitors and other capacitors in the power supplies should be checked and discharged if any significant voltage is found before touching anything - some capacitors (like the high voltage of the CRT in a TV or video monitor) will retain a dangerous or at least painful charge for days or longer.

A working TV or monitor may discharge its caps fairly completely when it is shut off as there is a significant load on both the low and high voltage power supplies. However, a TV or monitor that appears dead may hold a charge on both the LV and HV supplies for quite a while - hours in the case of the LV, days or more in the case of the HV as there may be no load on these supplies.

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The main filter capacitors in the low voltage power supply should have bleeder resistors to drain their charge relatively quickly - but resistors can fail. Don't depend on them. There is no discharge path for the high voltage stored on the capacitance of the CRT other than the CRT beam current and reverse leakage through the high voltage rectifiers - which is quite small. In the case of old TV sets using vacuum tube HV rectifiers, the leakage was essentially zero. They would hold their charge almost indefinitely.

VIII. CONCLUSION

A capacitor discharges into whatever both of its leads touch, at the same time. This implies that if you happen to touch both the leads at the same time, the capacitor discharges into your body. Those with low value may not create any concern, but be careful with the large ones. They may seem harmless, but have the potential to do severe damage to the body. So before you know how to test a capacitor, you must know how to discharge it. To discharge a low capacitance capacitor, you need nothing more than a metal screwdriver. First you have to de-solder the device to be tested, from the unit, lest it may damage other components. Now short both the metal terminals of the capacitor with the metal end of the screwdriver. Ensure you do not touch any of the metal parts, so as to avoid getting an electric shock. In case you are working with a high-voltage capacitor, it is better to seek guidance from an expert.

To conclude, it is always safe to seek instructions about testing a capacitor in an AC unit or microwave, from a professional. This is because in such appliances, capacitors hold a high amount of charge within them and this might risk your safety, unless you are a professional yourself

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