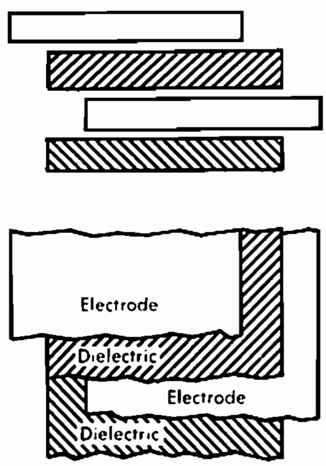
TECHNICAL BULLETIN NO. 09

CAPACITORS...THE METALLIZED DIELECTRIC FRIEND OR FOE?

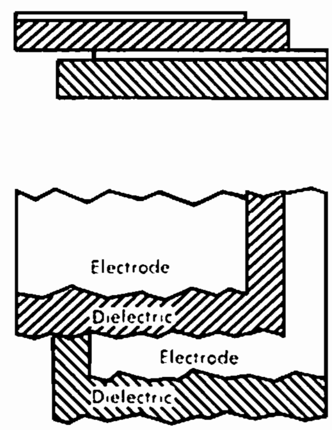
There is a great deal of confusion still existing in the minds of many engineers regarding metallized dielectric capacitors. This is unfortunate because this confusion has resulted in many cases in the exclusion of a most valuable tool from many circuit designs. These should not be, and there is nothing any more mysterious about the proper application of a metallized dielectric capacitor than there is in a non-metallized unit.

A close examination of the basic aspects of a metallized dielectric should help to clear up this unnecessary confusion.

Physical Construction



Non-Metallized
Capacitor
(Extended Foil)



Metallized
Capacitor
(Extended Foil)

The construction of a metallized dielectric capacitor is quite similar to that of a non-metallized design except for slight differences in electrodes and end terminations.

The electrodes in a non-metallized design are seperate sheets of metal foil wound with the sheets of dielectric. These electrode sheets extend alternately out each end of the roll beyond the dielectric and provide a mass of all metal material to which leads are then attached by soldering or welding.

The metal electrodes of the metallized design are deposited from a melted or liquified state directly onto the surface of the dielectric. Provisions are made to provide one end of each sheet with a margin. Two sheets of metallized dielectric are positioned properly relative to a right and left margin and wound into a roll. Because the dielectric material is also present at each end of the roll along with the metal electrode material, direct attachment of the leads is not generally done.

The end terminations of the metallized unit are accomplished by applying a finely divided molten metal spray to the capacitor roll ends to make initial contact with the electrode material. Leads are then attached to this metal spray.

Volumetric Efficiency

From the foregoing, the volumetric advantage of a metallized design is self-evident due to the physical reduction of total electrode material and air film. This advantage is more evident and becomes more pronounced as the capacitance rating increases.

At the smaller capacitance ratings, there is very little advantage evident because the end terminations, casings, and end seals form a disproportionate part of the total volume for a practical capacitor and are approximately the same for both types of units. For instance, the chart below compares the approximate volumetric ratio for various values of capacitance between the metallized and non-metallized designs. All units are wrap-and-fill style, 200 VDC rated, Mylar dielectric.

The volume of the metallized design is set as unity, and the volume of the non-metallized design is then expressed as an equivalent ratio.

It should be noted that contrary to the misconception held by some, the metallized unit is **not** vol-

2. The volumetric efficiency of a metallized unit is higher than its non-metallized equivalent unit. This size reduction is particularly effective with increasing microfarad ratings.
3. In direct proportion to the volumetric efficiency is the weight savings realized with a metallized unit.
4. The cost of a metallized unit in the higher microfarad ratings (above approximately .1 Mfd) is less than its non-metallized equivalent unit.

***The exact microfarad values where the cost of the metallized and non-metallized unit equates will vary with voltage, dielectric, and configuration.**

TECHNICAL BULLETIN NO. 10

CAPACITORS...DIELECTRIC ABSORPTION

"WARNING! — Do not remove wire from capacitor terminals until ready for use."

"Caution! — Removal of wire joining capacitor terminals except immediately prior to use or testing may result in severe electrical shock."

In spite of the above admonitions, usually in the form of tags affixed to most high voltage/high energy capacitors, many technicians, servicemen, and assembly workers are still electrically "shocked" each year; in some cases — severely enough to require hospitalization.

In one case, a manufacturer received a very bitter letter from one victim who threatened to sue for "gross negligence" in shipping a "charged" capacitor. And, if you'll pardon the unintentional pun — a very serious "charge" indeed!

Of course, no manufacturer of capacitors will deliberately ship a charged capacitor to a customer. On the contrary, very elaborate precautions are in effect to avoid this very circumstance from happening.

But — you might well question — if the manufacturer didn't "goof" and ship a "charged" capacitor — how come these people are getting shocked by so-called uncharged capacitors?

What we are seeing here is an extreme example of the result of a phenomenon found in all capacitors. This phenomenon has been given many names; such as, "dielectric soak", "voltage retention", "residual charge", "electric absorption", etc. In this article, we will refer to this phenomenon as "dielectric absorption", a term that has gained general acceptance in the industry.

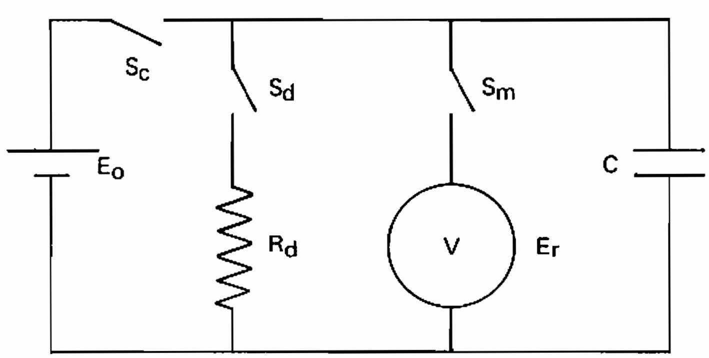
First let us demonstrate what this phenomenon is and how we observe and measure it.

Initial condition: All switches open.

Step 1: Close S_c -- charging capacitor C
Step 2: Open S_c -- removing charging voltage E_o
Step 3: Close S_d -- discharging capacitor C
Step 4: Open S_d -- removing discharge circuit
Step 5: Close S_m -- placing voltmeter V across C
Step 6: Read voltmeter for E_r (recovery voltage)

We now divide the recovery voltage (E_r) by the charging voltage (E_o), convert to a percent figure by multiplying by 100, and our result is a "percent dielectric absorption" (%DA) figure.

In basic terms then, we may now state that the phenomenon of dielectric absorption occurs because a capacitor, once charged, will not give up all



E_o = DC voltage source
S_c = Switch to charge C
S_d = Switch to discharge C
R_d = Discharge resistor
S_m = Meter switch
V = Voltmeter
C = Capacitor
E_r = Recovery voltage on C

Figure 1