Box **Dielectric Absorption**

In essence two major dielectric characteristics exist - polar and non-polar. By polar I am not referring to an electrolytic capacitor, but the way a dielectric responds to voltage stress. This stress is the voltage gradient across the dielectric, and not simply the applied voltage. It is stress in volts per micron, which matters.

Vacuum and air, are little affected by voltage stress. Solid dielectric which behave in a similar fashion are termed 'non-polar'. Most solid dielectric and insulators are affected to some extent, increasing roughly in line with their dielectric constant or 'k' value. This 'k' value is the increase in capacitance when the dielectric is used to displace air.

When a dielectric is subject to voltage stress, electrons are attracted towards the positive electrode. The electron spin orbits become distorted creating stress and a so-called 'space charge' within the dielectric. This stress produces a heat rise in the dielectric, resulting in dielectric loss.

Non-polar dielectrics exhibit small losses but polar dielectrics are much more lossy. Having been charged to a voltage, it takes longer for the electron spin orbits in a polar dielectric to return to their original uncharged state. Thin polar dielectrics, produce large, easily measured 'dielectric absorption' effects.

Dielectric behaviour with voltage, depends on the voltage gradient, in volts/micron and the characteristics of the dielectric. It's effects are more readily apparent at low voltages with very thin dielectric. The dielectric used in low voltage electrolytics is exceptionally thin. Consequently we find increased effects from dielectric absorption when measuring these types.

Dielectric absorption is usually measured by fully charging the capacitor for several minutes, followed by a rapid discharge into a low value resistor for a few seconds. The capacitor is then left to rest for some time after which any 'recovered' voltage is measured. The ratio of recovered voltage to charge voltage, is called dielectric absorption.

So how might dielectric absorption affect the distortion produced by a capacitor? Many fanciful, even lurid descriptions can be found, describing smearing, time delays and signal compression. My capacitance and distortion measurements do not support these claims.

The main difference I found which clearly does relate to dielectric absorption, is the magnitude of the second harmonic. This increases with applied voltage, especially so with electrolytic capacitors.

My measurements indicate it is the level of third and odd harmonics generated by the capacitor which determine intermodulation products. These harmonics are little affected by DC bias on the capacitor. No doubt intermodulation distortions would contribute to a muddled or smeared background sound.

Third harmonic distortion depends on the peak voltage across the capacitor as well as capacitor through current. For a given signal level, voltage across the capacitor will be greatest at the lowest frequencies. Capacitor current increases as the voltage across the capacitor reduces at higher frequencies. A low frequency, large signal peak, can trigger intermodulation distortions, which affect higher frequencies. end of **Box**