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C H A R G E

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A Technical News Journal from Deki Electronics Ltd

Editor's Desk

Dear Reader,

In this edition of ***Charge*** we talk about the effects of temperature and frequency on parameters like Capacitance Value, Insulation Resistance (IR), Loss Factor (Tan δ) for two different dielectric materials - Polyester and Polypropylene.

We also try to guide you regarding selection of an appropriate capacitor for high frequency applications, both, theoretically and practically. We hope you will find the information useful.

In case of any queries you can always contact me at bali@dekielectronics.com.

We look forward to your comments and suggestions.

Anil Bali

External Customer Satisfaction Survey

Readers may be aware that, at Deki, we conduct an external customer satisfaction survey every six months and the results of the last survey for the period July-December 2011 indicated an improvement over the score of the previous survey.

There was also an appreciable improvement in the parameters of product quality, delivery and technical support.

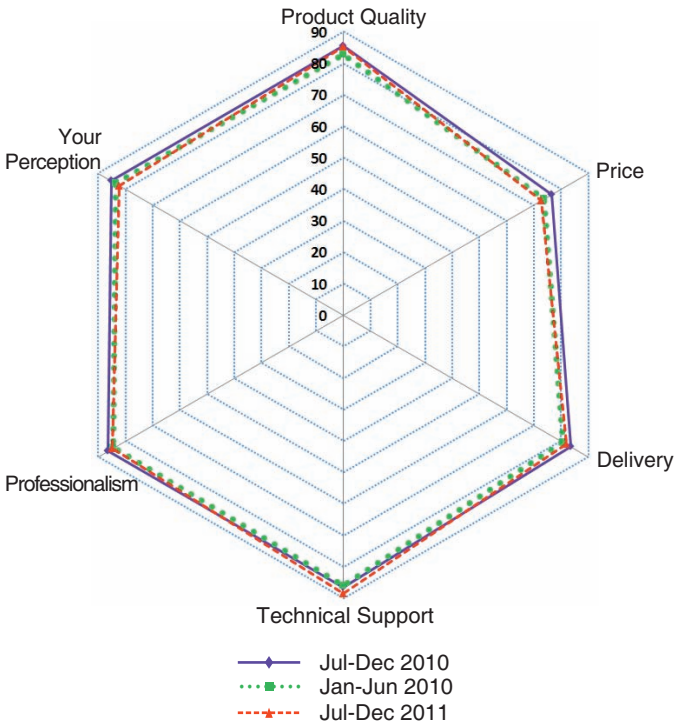
However, this improvement was tempered by the reduction in scores for price and the perception of Deki as a valuable supplier.

Deki's focus on the CTQ and the CTP parameters in the process helped us achieve a better score for quality. Our efforts towards reduction in process cycle time and daily monitoring of the production CLIP helped us improve our score in the area of delivery.

Our R&D team's interaction with our customers and the technical seminars that we host have been recognised by our customers while rating us in the area of technical support.

Cost reduction is accorded the highest priority at Deki and we always strive to offer our customers value for money. We recognise that we need to do more in this area especially when compared with our Chinese counterparts.

We will also redouble our efforts to further enhance your perception of Deki as a supplier who can add more value to your business.



External customer satisfaction survey results

Employee Motivation Survey

Deki's employee motivation survey, done every six months, generates important feedback from direct employees covering areas pertaining to work environment, salary, satisfaction level, growth opportunity, knowledge of targets, standard specifications, operating procedures, etc. The results of the current and previous survey are then discussed in an Open House session with our Managing Director, Mr Vinod Sharma.

The August 2011 survey, though showing a slight reduction, was still an impressive 86%. The main area of concern was "Improvement activities". We hope that this will be resolved with more participation in Six Sigma activities.

We also included all executives in the survey in August 2011 for the first time getting an average score of 80%. The main areas of concern were salary/benefits (no surprises!), growth opportunities and resource availability. Most of the executives felt that the scope for improvement lay in more training towards improving productivity, quality, yield, reduction in customer complaints and housekeeping.

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Guidelines to select a Film capacitor for High Frequency Applications

The performance of a capacitor changes with the frequency of operation. Therefore, the right capacitor has to be chosen to ensure stable capacitance and reliable operation. In this paper we discuss the selection of a film capacitor for high frequency applications such as CFL, HF ballast, etc.

Index terms: *Capacitance, Tan δ, ESR, IR, dv/dt, Power Dissipation, Self-healing.*

Theory

When a capacitor is used in AC application at high frequency, the internal heat generated by the capacitor is more. This is due to the current flowing through the internal resistance (ESR) of the capacitor.

The power dissipation is given by,

$$P = V^2_{rms} \times 2\pi \times F \times C \times \tan \delta$$

Where P is the power dissipated in the capacitor in the form of heat,

V_{rms} is the rms voltage across the capacitor
F is the frequency of operation
C is the rated capacitance value
Tan δ is the loss factor

The power dissipated in the form of heat, is referred to as ***self-heating*** of the capacitor.

The temperature rise in the capacitor at high frequencies will lead to the disturbance of capacitor parameters, properties and performance.

The parameters affected are,

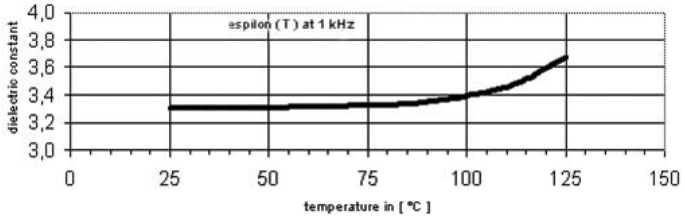
- Dielectric constant ε of the capacitor
- Loss factor (Tan δ) of the capacitor
- Insulation Resistance (IR) of the capacitor

Dielectric constant ε

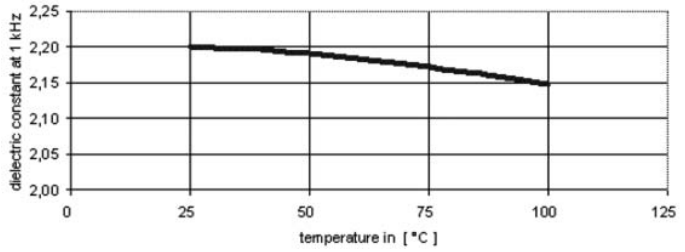
The dielectric constant is the inherent property of dielectric material. It differs with different dielectric materials.

For Polyester dielectric (PET), the increase in temperature will increase the dielectric constant where as In Polypropylene (PP) it will decrease with increase in temperature.

Polyester dielectric (PET)



Polypropylene dielectric (PP)



The increase/decrease in dielectric constant will change the capacitance since capacitance $C=\varepsilon_o\varepsilon_r \times A/d$

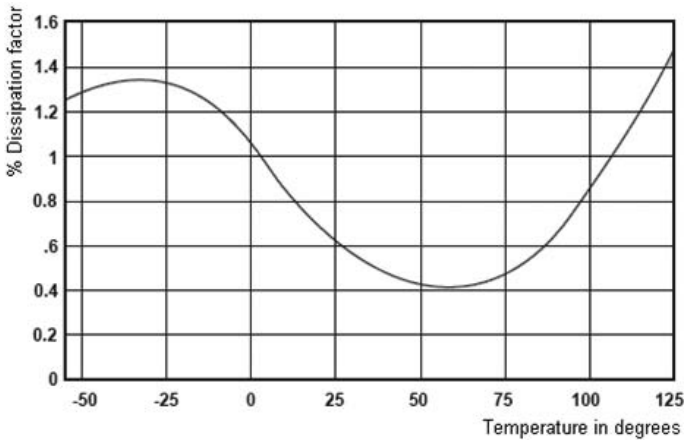
Where ε_o is the permittivity of free space, ε_r is the relative permittivity of dielectric material / dielectric constant
A is the area of the capacitor plates and d is the distance between the plates

Loss factor (Tan δ)

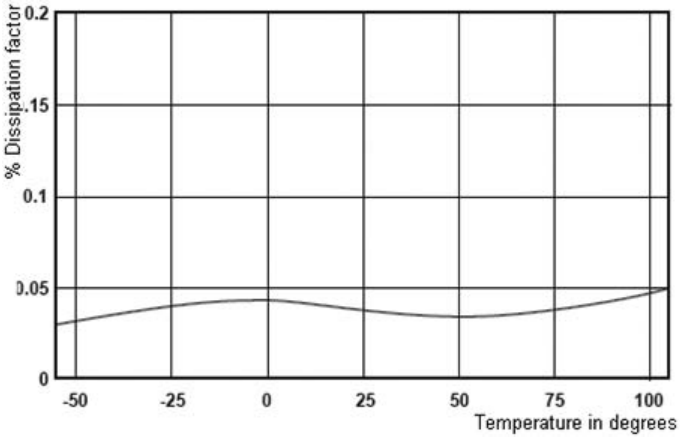
Tan δ is sensitive to both temperature and frequency and again it differs with different material.

The increase in tan δ will increase the Equivalent Series Resistance (ESR) of the capacitance since
tan δ = ESR × 2π × F × C.

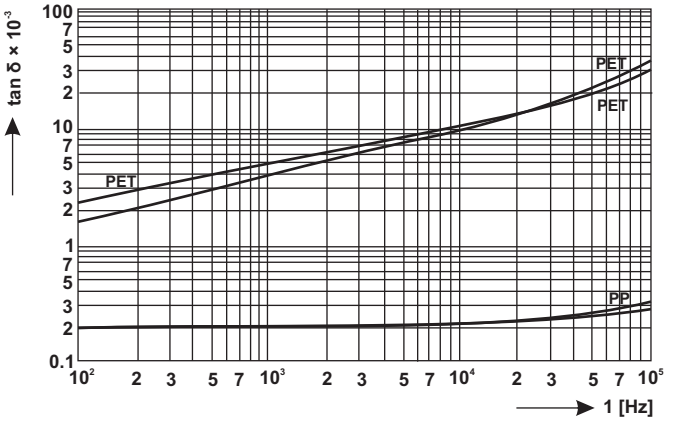
Polyester dielectric (PET)



Polypropylene dielectric (PP)



Frequency vs. Tan δ

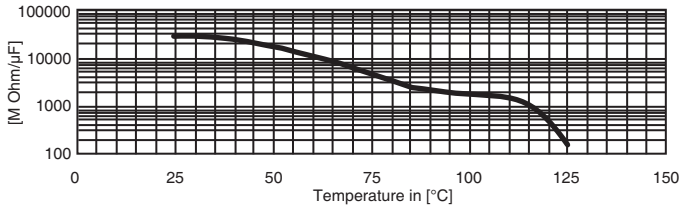


Hence for high frequency applications PP is ideal choice because of less tanδ change over frequency.

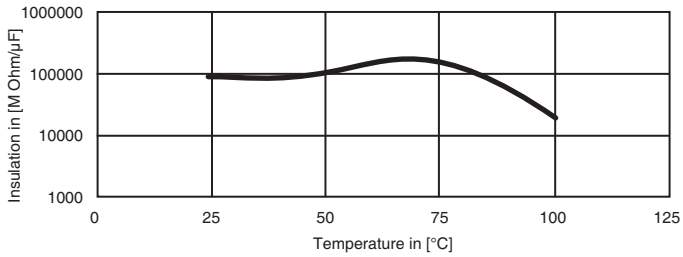
Insulation Resistance (IR)

The IR of the capacitance depends on the dielectric material. When the temperature increases, the IR decreases gradually.

Polyester dielectric (PET)



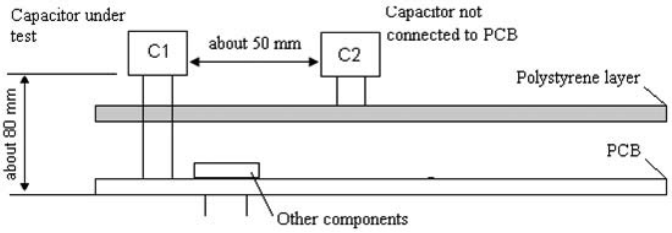
Polypropylene dielectric (PP)



Practical Measurement

Whenever a film capacitor is used in high frequency and pulse applications, an important parameter – surface temperature rise (ΔT) of the capacitor – is checked by artificially simulating real time application conditions like frequency, voltage spike, etc. The current flowing through the capacitor at high frequency will heat up the capacitor. The change in surface temperature is a good measure of the amount of stress that the capacitor is subjected to.

Test procedure for determining ΔT (Temp Rise)



The measurement must be made in free air convection, i.e., in a closed set up so as to measure the temperature rise accurately, without air flow from the outer atmosphere. The temperature is measured by a thermocouple through a hole of diameter of about 0.25~0.5mm.

C1 is the capacitor under test,
C2 is capacitor which has no connection (dummy capacitor to measure ambient temperature)

Distance between C1 and C2 should be about 50mm and 80-100mm from other components.

The capacitor under test is separated by polystyrene.

$\Delta T = T1 - T2$

Where T1 is the surface temperature of C1
T2 is the surface temperature of C2

Capacitor Selection

For the given high frequency application, the continuous application frequency and the continuous RMS voltage is applied to the capacitor from a high frequency power source. The surface temperature rise ΔT is measured.

The following general conditions are checked:

1. Temperature rise should be less than 10°C in the ΔT measurement
2. V_p should be less than DC rated voltage
3. V_{P-P} should be less than $2 \times 1.414 \times V_{RMS}$
4. dv/dt rating should be fulfilled from the voltage waveforms
5. Peak current should be less than C × (dv/dt)

After satisfying the above conditions, the two important characteristics, namely, dimensions of the capacitor and cost of the capacitor should be satisfied.

Dielectric materials and construction

Polypropylene dielectric capacitors are bigger than polyester dielectric capacitors in size for the same capacitance. In cost, metallised film capacitors (MMPP, MPP-MPP, PP-MPP, DPSH, DTSH) are more expensive than film/foil capacitors (PP, PET).

Metallised capacitor has the advantage of self-healing over the film/foil capacitors whereas in film/foil capacitor the failure mode of the capacitor is short circuit due to high voltage spikes.

Recommended capacitor constructions for high frequency applications are:

MMPP > MPP-MPP > PP-MPP > DPSH > DTSH > PP > PET (arranged in decreasing dielectric strength)

Illustration

Let us take an example of HF ballast for lighting application. The requirements of a capacitor are as follows:

Capacitance: 3.2nF
Pulse rise time dv/dt: 1400 V/µS
V-I during 98% of operational life at 85°C: 701V_{rms}, 1990V_{pp}, 640mA_{pp}, 25 kHz.

Let us say MPP-MPP capacitor 3.2nf / 2000 V DC / 700 V AC as suggested.

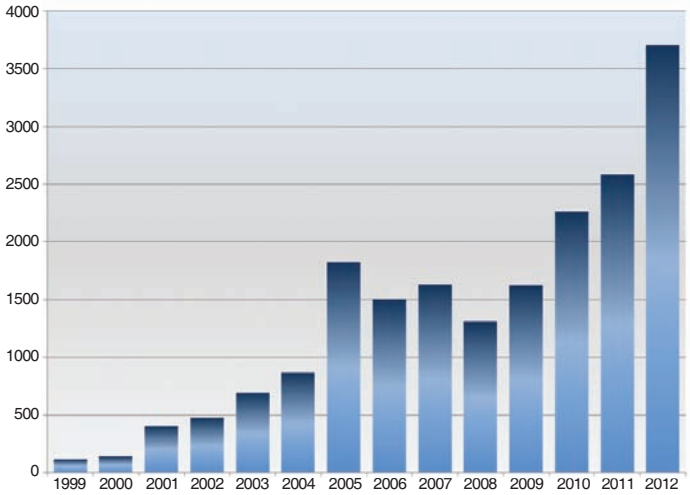
- Measure ΔT by applying 700Vac and 25kHz from a high frequency power source. Let us say ΔT < 10°C
- $V_p < U_r$
- $V_{P-P} < 2 \times 1.414 \times V_{rms}$ =1982 (almost equal)
- Dv/dt 1400 V/µS < 9500 V/µS (dv/dt for MPP-MPP 3.2nf)
- Peak current 1.1A < C × (dv/dt) (I_p = 30 A for MPP-MPP 3.2nf).

Dimension should also be acceptable.

Since all the necessary conditions are satisfied, the MPP-MPP 3.2nf/2000Vdc/700Vac is the right selection.

Training in Deki

Training in Deki has been growing consistently. During the year 2011 there was a 10% jump in training hours per month from 2265 to 2580. This comes to a very healthy five man hours per person per month. Detailed stage wise training is being conducted in which knowledge of the process and the machines is being imparted. This is followed by a written test. An employee has to score a minimum of 80% at critical stages to qualify to run the machine.



New Year Celebrations at Deki

Deki's New Year party and lunch on 1st January 2012 was a great success where all employees and their family members had a lot of fun. Employees from different departments shared their experiences with the company and wished for the well-being and growth of the organisation and all stakeholders.

Awards were given out to employees not only for best attendance and punctuality but also business activities like best small group activity and maximum number of suggestions. In addition, those who had submitted the three best suggestions in the year 2011 were given a special prize.

Various HoDs, Mr Anil Bali, Mr Vinod Sharma, MD and Jai Kumar, our Chairman wished all members of the Deki family a prosperous year ahead.

Deki launches CSR initiatives

At Deki, we have initiated our own Corporate Social Responsibility programme. CBI, the Netherlands (Centre for the Promotion of Imports from Developing Countries) is helping Deki in formulating this. With this initiative Deki is trying to contribute back to society and improve social welfare in its own small way.

Deki's Inductive Self Healing Capacitors

Deki has patented the Inductive Self Healing capacitor that has been well accepted by the Indian industry. Recently a legal notice had to be sent to a local competitor who was trying to infringe on Deki's patent. Our customers are fully aware that only Deki has the right to market this very innovative capacitor.

Deki's R&D is DSIR approved

We are proud to announce that Deki's R&D Laboratory has been approved by the Department of Scientific and Industrial Research. This is a big feather in the cap of the R&D Department which has been instrumental in churning out new products to ensure that they form nearly 30% of our product portfolio on an Y-o-Y basis for more than 10 years now.

3rd Indo German Manager Training Program

CII India and GIZ Germany conducted the Indo German Manager Training Programme, a result of bilateral economic relations between the two countries. CII picked twenty two managers from different SMEs for a four week training program in Germany.

Our Sr. Manager Marketing, Mohammad Shariq, joined the program on behalf of Deki.

Shariq enhanced his administrative, social, intercultural and professional competencies thanks to the programme. He also strengthened the foreign economic potential of Deki by establishing contacts with German enterprises.