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Charge

A Technical News Journal from Deki Electronics Ltd

August 2005

Editor's Desk

Dear Reader,

Deki is India's largest manufacturer of Plastic Film capacitors with an installed capacity of 156 million pieces per annum. From August 1, 2005 the capacity has been nearly tripled to 460 million pieces per annum. With this we will be amongst the Top 5 Film Foil manufacturers in the world. The result of this expansion will be that customers will get single digit PPM capacitors at international prices and with very short lead times.

With technologies from both Europe and Japan/Korea, Deki is able to offer its customers the most optimum mix of capacitors. In this issue we will explain the advantages and disadvantages of Film/Foil vs. Metallised and Inductive vs. Non Inductive capacitors. The idea is to make it easier for the customer to choose the right capacitor.

As usual, we look forward to your comments and suggestions.

Anil Bali

East meets West: And you have a component buying solution!

We are all familiar with cultural differences, especially the ones between the eastern and western worlds and their implications for all of us in business.

Cultural differences influence the way we conduct business, communicate with associates, what we wear to a meeting and whether a gift is considered appropriate or not.

It may however surprise you that culture can even influence your buying preferences of electronic components.

Deki Electronics, a film capacitor manufacturer based in India saw this early and decided to build its strategy around this interesting fact.

They found that film capacitor technology in the East, earlier developed in Japan and later used in almost all capacitor manufacturing in Korea, Taiwan, Singapore, China and Malaysia was based on Film/ Foil winding and epoxy resin encapsulation. Later, vacuum impregnated capacitors began to find popularity.

In comparison, European technology preferred Metallised Paper and Film capacitors, oil impregnated and potted in boxes. To some extent these preferences were based on circuit design requirements and on manufacturing costs. An automated potting line was a capital intensive but low labour requiring process. The manufacturers were probably choosing between comparative capital and labour costs.

Each variant of technology has its own set of advantages and disadvantages. Surprisingly, designers are glossing over the advantages offered by components not belonging to their "territorial technology offerings".

The film/ foil version offers a high dv/dt at a low cost. The metallised capacitor has an edge when designers are integrating the inherent self healing property into their design. Similarly, a potted box with pegs offers additional mechanical stability which may also be accomplished by a low lying tape wrapped axial capacitor. Instances of usage of a tape wrapped capacitor or box capacitor in a circuit where almost no physical movement is envisaged are however plenty. It is also not uncommon to find a self healing metallised polypropylene capacitor being used in applications where a film/foil polypropylene with an almost infinite dv/dt would be ideal and also cost maybe just half the price.

Plotting a capacitance versus size and cost curve may illustrate the selection possibilities available to a designer. Low capacitance values are easily available in film/foil versions. Improved winding and welding technology has rendered imtermittency and high inductance in film/ foil capacitors a thing of the past.

A thorough understanding of the aspects offered by each technology is essential for arriving at optimal buying decisions.

Deki has done precisely that – the product range embraces both these technologies thus offering complementing advantages of superior design and good economics. The company is hence in a unique position to offer "the best of both worlds". This often translates into a cross functional buyer/ seller team working together to arrive at a capacitor design that serves to incorporate both the technical and commercial wish lists of the customer.

As an example, an effort at such an understanding and a close working relationship has recently accrued a 40% cost benefit to a European leader in the lighting industry. The initial circuit incorporated largely metallised polyester and metallised polypropylene capacitors in the potted box construction. Most of these have now been successfully replaced by dip coated film/ foil capacitors. More expensive mixed dielectric capacitors have given way to components using innovatively designed films and end terminations.

The possibilities are immense. The threat and pressures of finding an even lower price level, quarter after quarter may well be an opportunity for buyers and sellers to put their heads together and use the combined knowledge as a team.

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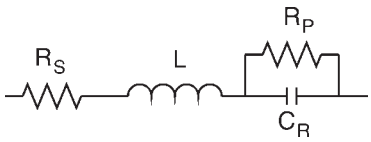
Capacitor Construction

Depending upon the type of dielectric the capacitors are classified into:

1) Film Capacitors
2) Electrolytic Capacitors
3) Mica capacitors
4) Ceramic Capacitors
5) Air Capacitors
6) Paper Capacitors

Practical Capacitor



L = inductance because of the lead length and the construction.

R_s = Series resistance which includes foil resistance and contact resistance.

R_p = Parallel resistance or insulation resistance.

Value of inductance, R_s and R_p is dependent on the type of construction.

Construction

There are two basic types of constructions:

- Film/foil construction.
  - Inductive Type
  - Non - Inductive Type
- Metalised construction
  - Non Inductive Construction

Film/foil capacitor construction

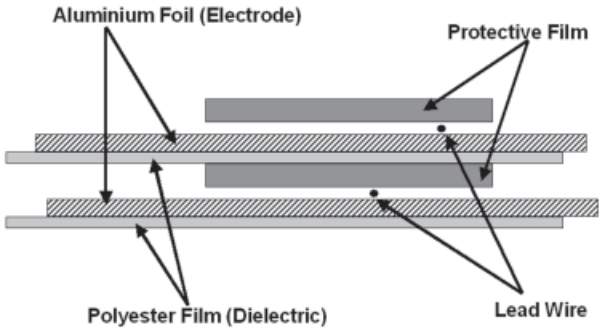
In film/foil capacitor, metal foils of 5 to 6 micron thickness are used as metal electrodes.

Dielectric film is used in between the metal foils.

Most commonly used metal foils are aluminium and tin. Use of 5-6 micron foil ensures a very high dv/dt.

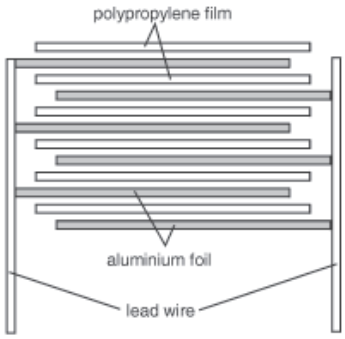
Self healing is not possible with 5 to 6 micron thick foil.

Inductive type construction (Film/Foil type)



Due to the basic wound construction there is an inductive effect but the effect of this inductance is significant only at higher working frequency range (Gigahertz range) and with higher capacitance values (Please see table 1).

Non–Inductive construction (Film/Foil type)



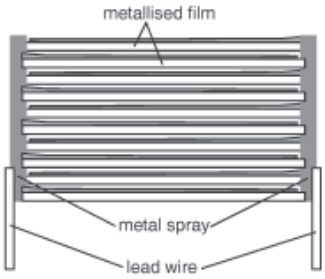
In the Non–Inductive film/foil construction aluminium foil is extended from the sides then all extended layers are short circuited by spray (or) Soldering operation. Due to this process the inductance value is less as compared to Inductive type capacitor for higher capacitace values and at higher frequencies.

Comparision between Film / Foil Inductive and Non–Inductive type Capacitors:

Typical inductance values @100Khz(in µH): table 1

Capacitance in µFd	PET Film / Foil Inductive	PET Film / Foil Non-inductive	MPET Metallised Non-inductive
0.0033/630V/±10%	-773	-875	-750
0.01/400V/±10%	-251	-240	-246
0.047/630V/±10%	-57	-55	-56
0.1/100V/±10%	-26	-25	-27
0.022/100V/±10%	-11	-10	-12
0.47/100V/±10%	-5	-5	-5

Non–Inductive construction (Metallised Construction)



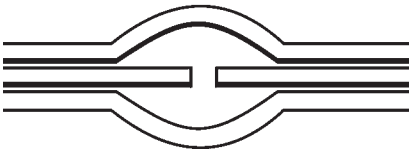
In the non-inductive metallised construction, metallised film is extended on either side. These extended layers are short circuited by metal spray operation.

Self Healing

As a natural phenomenon, all dielectric material are left with weak points and little bit of impurities during the manufacturing process. Dielectric breakdown occurs if the field strength is

exceeded locally at any of these weak points. During this dielectric break down, heavy current flows through the channel which is sufficient to totally evaporate the thin metal coating. This instant

voltage breakdown



after the self-healing process

vapourisation forms an insulated area around the faulty epicenter, thus isolating the affected area and permitting the capacitor to operate normally.

This dielectric puncture is in fact a momentary short-circuit (lasting a few microseconds) and hence the capacitor regains its full operation immediately. There is, however ,a slight drop in the capacitance value, on account of the isolated area.

Self-healing characteristics are influenced by the following parameters :

- Basic dielectric film itself
- Coating thickness of the metallised layer
- Manufacturing conditions.

The self-healing property ensures that failure mode for metallised capacitors is “open mode”.

Comparison between film/foil and metallised capacitors

FILM FOIL CAPACITORS

- Consists of two aluminum foil electrodes with plastic film material used as dielectric
- Higher Insulation Resistance
- Better Capacitance stability
- Good current Carrying Capability
- Failure mode: Short

METALLISED FILM CAPACITORS

- Electrodes consists of thin metal layer (0.003 Micron thickness approximately.
- Connection is accomplished by means of a metal spraying process
- Relatively small dimensions, a result of vacuum deposited electrodes.
- Self-healing property.
- Failure mode: Open

Capacitor encapsulations

Capacitors are available in several encapsulations. The basic purpose of any encapsulation is :

- Environmental & mechanical protection
- Improved breakdown voltage between body and terminals
- Improved handling and insertion

The widely used encapsulations are :

1. Dip lacquer coated
2. Box encased
3. Tape wrapped
4. Moulded

Each technology has its own advantages and disadvantages.

Manufacturing process of most metallised and film / foil capacitors is similar up to the welding operation. After welding, **Dip type capacitors** are coated with liquid epoxy resin (or) epoxy powder. This may be done as a single or multiple coats. The capacitors are normally vacuum impregnated in the case of liquid epoxy resins. Flame retardant epoxies are finding enhanced usage and the recent developments are without PBB/PBDE as a flame retarding agent.

Though an economic mass production method, the dip coating process has an inherent problem of dimensional variations.

In the **Box encased capacitors**, welded elements are placed inside the cans followed by filling of flame retardant grade liquid epoxy. These are then cured based on the potting tape of the epoxy used.

In **Tape wrapped capacitors**, the welded elements are wrapped with polyester tape, the width of the polyester tape being more than the length of the welded capacitor. These protruding flap sides of the capacitors are then filled with liquid epoxy resin. The resin is hence only at the edges and not around the entire body of the capacitor.

Advantage of the axial capacitors is the relatively low height as compared to other versions. This also offers good mechanical stability. The thickness of the polyester tape is critical as the tape is prone to mechanical damage during handling.

Axial capacitors are also available in **Tubular box construction** which is mainly used by Aerospace industry and is a more expensive alternative to tape wrapped capacitors.

In moulded capacitors, welded elements are moulded with the flame retardant epoxy resin . The advantage of the moulded capacitors is that the epoxy coating is very uniform around the capacitor body as compared to other versions. It is however more expensive and suitable only for a few special applications like aerospace and “Under the Hood” in auto.

Most widely used capacitors are the dip coated and box encased.

Advantages of Box Type Capacitor

No variations as far as dimensions are concerned as compared to dip type capacitors so it is ideal where the dimensions are very critical.

Disadvantage of Box Type Capacitor

The only disadvantage of Box type capacitor is it costs more especially for values less than 100 nano farad mainly due to high capital investment in the automatic assembly machines and the cost of the box.

Advantage of Dip Type Capacitor

Dip type capacitors are cost effective as compared to Box type capacitor.

Disadvantage of Dip Type capacitor

Dip type capacitor has some inherent varation in coating thickness the variation is about 0.5mm each side.

Deki New Introduction: Low Profile Capacitors

Film / Foil **Low Profile capacitors** in place of 5.0mm Pitch box type capacitors.

Why do you want to use 5.0mm box type capacitors ?

The answer is compact dimensions and 5.0mm pitch requirement as compared to film / foil capacitor. Deki has introduced a new series with compact dimensions and in 5.0mm pitch (straight lead) to replace 5.0 mm box type capacitors for the following values.

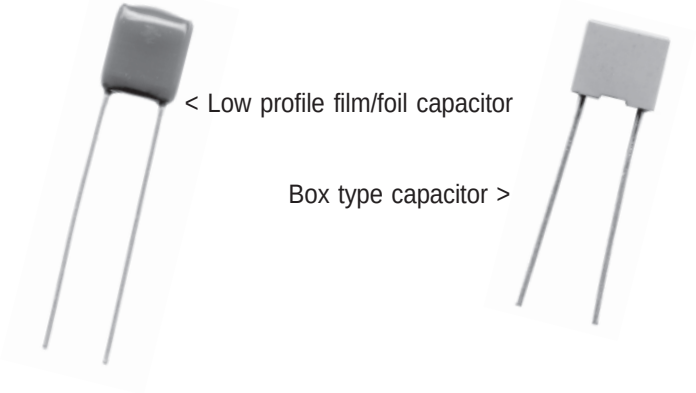
Capacitance value : 0.00068 Mfd to 0.047 Mfd.

Rated voltage : 50 V to 630 V

Technical Comparision

Parameter	Film/Foil Low profile	Metalised 5.0mm box
Cap Value	as specified	as specified
Tolerance	+/- 5.0%	+/- 5.0%
Tan δ At 100 kHhz	2.0 % (max)	3.0 % (max)
I_R at 50 Vdc	30G Ω	7.5 G Ω
H.V. Test	2.0 x V_r	1.6 x V_r
Pitch	5.0 mm	5.0 mm
Thickness	3.0 mm	2.5 mm
Height	8.2 mm	7.2 mm
Width	6.5 mm	6.5 mm
Applicable Spec	IEC-384 –11	IEC- 384 - 2

If low profile film/foil capacitor is able to meet your max dimensions specification and required pitch it is an ideal replacement for the box type capacitor which is 30 % costlier.



< Low profile film/foil capacitor

Box type capacitor >

Deki as a Bonsai

Deki Electronics is like a bonsai .Small yet complete.

Complete range of Plastic Film capacitors with a choice of Technologies.

Every branch and twig shaped or eliminated until the chosen image is achieved.

Clear focus on quality and providing solutions.

The image maintained and improved by constant pruning and trimming.

Commitment to training and knowledge enhancement.

PPM Activity at Deki

The PPM activity in Deki started in 2000.

The purpose of this activity was to set up a structured way for continuous improvement of quality levels of Deki capacitors based on the line rejections observed at the customer's end. The underlying assumption here is that the product quality has gone past the stage of % rejection (AQL) and is slowly moving towards zero defect.

A meeting is held in the 1st week of every month to review the performance of the previous month. This meeting is held alternately at Deki and at the Customers premises.

The meeting is attended by the QA managers of both Deki Electronics and the Customer and any other persons they would like to involve.

In this meeting a review is done of the minutes of the last meeting and actions taken by Deki for improving the quality of the product.

Rejected samples of the month just ended are handed over to Deki along with the data of the quantity consumed.

Deki QA manager analyzes the rejection and proposes an action plan for prevention within 7 days. A copy of the plan is sent to the customer.

A graphical plot of the quality level is maintained at both Deki and at the customer end.

When we started this activity in 2000 the PPM level was around 200. Today after 5 years we are at single digit level (below 10 PPM). This has been possible only with the active support of our Customers. The result has been that now Deki capacitors are not inspected but are shipped direct to line to most of our customers.

Deki Seminar on PEP Capacitors

Deki organized a Technical Seminar on “PEP Capacitors - A New Solution” on May 7, 2005 at Elcina House. This half day seminar was attended by a number of our customers and dealers.

After a short introduction by our MD, Mr Vinod Sharma, Mr Anil Bali, GM, spoke about Deki’s strategy and plans for the future, both, in terms of new products and capacity expansion. This was followed by a detailed technical presentation on PEP capacitors by Mr P. Sankar Raj. These PEP capacitors are a mixed dielectric capacitor and find use in high temperature/high frequency applications as a replacement for PP capacitors which are not able to withstand temperatures over 85°C.

⬆ Mr Anil Bali speaking about Deki’s strategy and future plans.

Technical presentation by Mr P. Sankar Raj ⬇