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Charge

A Technical News Journal from Deki Electronics Ltd

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Editor's Desk

Dear Reader,

Deki introduced Box type capacitors about one year ago. In this issue, we talk about the differences between Metallised & Film Foil capacitors and between Metallised Box type capacitors & Metallised Dip type capacitors. We also explain the process of "self healing" that is one of the characteristics of Metallised capacitors.

We, at Deki, have combined the technologies of, both, the Far East and the West to offer the most optimum Film Capacitor solution to customers. A small write up on the thinking that has gone behind this strategy is presented.

Do keep writing in with your suggestions. We look forward to them.

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 saw this early and decided to build its strategy around this interesting fact.

It was 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 impregnated.

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. 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 while 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 capacitor with an almost infinite dv/dt would be ideal and also cost may be just half.

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. Some of the high voltage requirements are met by high dv/dt constructions. 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.

The Deki Team Wishes Readers a Great New Year Ahead!

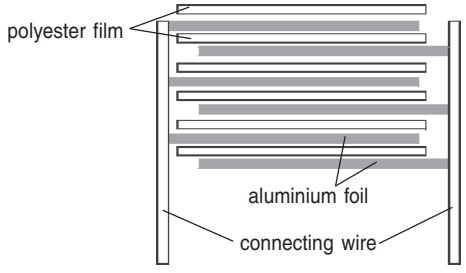
For your **FREE** subscription, please contact **Deki Electronics Ltd**, B-20 Sector 58, NOIDA 201 301. *Phone* (0120) 2585457, 2585458, *Fax* (0120) 2585289 *E-mail* bali@dekielectronics.com
www.dekielectronics.com

Self Healing Property

Capacitors with metallised film have one significant advantage over capacitors with film/foil design — they have a self-healing property.

Self-healing property of metallised film permits the designer to use the full dielectric strength of the dielectric material. In case of film/foil capacitors, however some safety margin for weak points in the dielectric needs to be incorporated.

Film/foil capacitor construction:



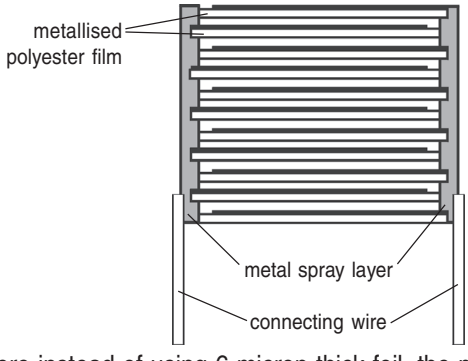
In film/foil capacitor metal foils of 5 to 6 micron thickness are used as metal electrodes.

Dielectric film is used in between the metal foils.

Most commonly used metal foils are aluminium and tin.

Self healing is not possible with 6 micron thick foil.

Metalised film capacitor construction:



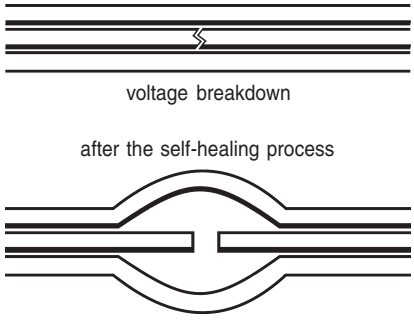
Here instead of using 6 micron thick foil, the plastic film (dielectric) is coated with either aluminium or zinc alloy material. Metal particles are vacuum deposited directly on to the plastic films. Thickness of the metallisation is approximately 30 nm. This drastic reduction in thickness of electrodes leads to the relatively smaller dimensions for metallised film capacitors.

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 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.

Tips for Design Engineers

Metallised capacitors always fail in the “Open mode”, which is really an advantage for certain applications.

Capacitor Encapsulations

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

- Environmental and 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 pros and cons.

Manufacturing process of most metallised 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 but the brominated flame retardant compounds are posing an environmental problem and are on the banned list effective 2005.

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

In **box encased capacitors**, welded elements are placed inside the cans followed by filling of flame retardant-grade liquid epoxy. The centering of the welded element into the can is ensured by either:

> Crimping the leads - so that they run along the insertion groove on the inside wall of the box or

> Using a solid epoxy resin to stick the element to the bottom of the box, before the potting resin is filled.

The resin filling is done in two shots to ensure no air bubbles are entrapped. It is also important to ensure that the resin is uniformly spread between the box and the element. An automatic assembly machine combines the processes of welding, box encasing, lead centering, epoxy filling and heat curing.

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 **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.

The most widely used capacitors are the dip coated and box encased.

Advantages of Box Encased Capacitors

Major advantages of box encased capacitors are:

1. No variations as far as dimensions are concerned (as compared to dip type capacitors). These are, hence, ideal where the dimensions are critical.
2. Perfect sitting on the PCB with more contact area on the PCB leading to better stability (as indicated in a vibration test) than compared to dip type capacitors.
3. Marking on the top leads to easier identification on a populated board.
4. Due to the pegs at the four corners, box capacitors leave a clear gap between the box and the PCB making cleaning more effective as compared to dip type capacitors.
5. Better dielectric strength (between termination and the capacitor body) because of uniform wall thickness of the capacitor can.
6. Discoloration of epoxy due to excessive temperature or exposure to UV light does not happen.
7. Possibilities for epoxy on lead wire is less as compared to dip type capacitor, which leads to better solderability.
8. Finally, a lot of designers find that the box capacitor has a good visual appeal.

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.

Deki Box Encased Capacitors

Deki has recently introduced miniature box type capacitors in both 5.0 and 7.5 mm pitch in a very pleasing green coloured box with light green epoxy resin.

The total capacity of the plant is 30 million pieces per annum. This totally automated plant is from Arcotronics, Italy, the leading manufacturer in the world.

Process Flow

Winding: Winding machines can handle 1.5 micron thickness film in 2.5 mm width.

Capacitors are cold pressed followed by masking and spray operation.

Sprayed elements are cleared before welding and box assembly process.

Materials

Capacitor Can:

PBT Material

UL – V0 Grade

Epoxy Resin:

UL –V2 Grade

Testing Operation

Capacitors are tested for all electrical parameters: cap value, Tan δ (both at 1 kHz and 100 kHz), charge–discharge test, H.V. test and insulation resistance test.

Packing

Capacitors are packed in both bulk and taped form. Ammo and reel taping are available.

Capacitors are supplied in cut lead form on special request. Standard cut lead length is 4.0 ± 0.5mm.

Approvals

Deki capacitors are tested at ERTL North as per IEC-384-2.

Deki capacitors are approved by CACT for telecom application.

Deki capacitors are approved CDOT for line exchanges.

Capacitor Range

5.0mm Pitch

50V DC: 0.1µf to 1.0µf
63V DC : 0.01µf to 1.0µf
100V DC: 0.001µf to 0.47µf
250V DC : 0.001µf to 0.22µf
400V DC : 0.00µf to 0.068µf

7.5mm Pitch

63V DC : 0.1µf to 1.0µf
100V DC: 0.033µf to 0.47µf
250V DC : 0.01µf to 0.22µf
400V DC : 0.001µf to 0.068µf
630 V DC : 0.001µf to 0.022µf

Tolerance

± 5% , ± 10%

Deki Capacity Enhancement

Another expansion is under way at Deki's plant at B-20 Sector 58, NOIDA. This project will result in a capacity increase of over 25 per cent. The enhanced annual installed capacity of 156 million capacitors includes 110 million pieces from the film/foil line and 46 million pieces from the metallised capacitor line. The metallised capacitors are manufactured on two lines – a 30 million p.a. box line for small pitch sizes (5 mm, 7.5 mm) and a 16 million p.a. line for larger pitch sizes in dip type.

Three taping machines make it possible to supply almost every thing on tape. Both, ammo packing and reel packing designs are available.

Steady Growth in Exports

Exports at Deki have been steadily growing with capacitors worth Rs 3.10 million being exported in November 2002. Exports touched 24% of turnover during April to November 2002, a shade higher than the target of 20%. The corresponding figure for the last year was 11% .

Colour Code System Implementation

The "Half Yearly Review System for Shop Floor Employees" was reviewed recently at Deki.

The intention was to make the review system more effective by making it extremely objective and transparent. It was also intended to include new areas such as "Suggestions" and "Participation in SGAs (small group activities)" in this review.

With these objectives, the review system was extensively brain stormed and examined over a period of three months. This effort has evolved into the "Colour Code System". The half-yearly review now evaluates team members on the following eight parameters :

1. ***Performance Level*** — Productivity and rejection level to be greater than 90% of target.
2. ***Attendance and Punctuality*** — Attendance above 92% and punctuality above 96%.
3. ***Discipline and Attitude*** — Positive attitude and no disciplinary case.
4. ***Written Knowledge Test and Practical Skill Test*** — Minimum 60% marks.
5. ***Multi-Skilling and Key Operations*** — Key operation is given additional weightage.
6. ***Accepted Suggestions*** — At least two suggestions in six months.
7. ***SGA Participation*** — At least 1 in a year.
8. ***Area Housekeeping*** — Minimum "adequate" evaluation by the audit team.

Each of these parameters is scored on a scale of 1 to 4.

The parameters are allocated weightage points based on their categorization as Essential, Necessary or Desirable. The total weighted score is then converted into a colour for easy reference. A score of 75% or more fetches a Green colour which indicates an Excellent rating whilst a score of below 35% fetches Black, indicating a Poor rating.

Each employee has been given a four page booklet for maintaining the Colour Coding score for 5 years along with salary details and annual increment record. All employees are being encouraged to draw an action plan for score improvement with advice from their executives.

As is the practice at Deki, this renewed scheme was presented and explained in detail to all employees by our Managing Director, Mr. Vinod Sharma. The system has been well received and is beginning to show results in terms of greater objective accountability and enthusiasm towards enrolling as volunteers for various SGAs.

Deki at Electronica 2002 in Munich

Deki was at Electronica 2002 fair in Munich, Germany between November 11-15, 2002 as a part of the ongoing programme of CBI, Netherlands for encouraging exports from developing countries. Part of the centrally located CBI section in Hall B5, the Deki stall (no. 325) attracted a lot of visitors who were drawn as much by the "Capacitor Bonsai" as by the full range of Plastic Film capacitors on offer. A total of forty two companies from India participated in this exhibition which was spread over twelve halls.

A number of manufacturers and distributors from Europe showed interest in Deki's capacitors. Samples have been sent to some customers and further communication is on with others.

End of a long innings!

Mr. Magru Verma retired from his assignment at Deki after an 18 year long innings. He was amongst the first few employees of Deki. His valuable contributions will be missed by all members of the team.