

# CHARGE

May 2017

A Technical News Journal from Deki Electronics Ltd

## Editor's Desk

Dear Reader,

Deki has been a market leader in film capacitors used in lighting and industrial segments in India. To further our share in the industrial segment, at Deki, we have come out with IGBT snubber capacitor. In order to minimise the transient voltage, a snubber capacitor with low self-inductance is mounted as close to the IGBT terminal as possible. In this edition of Charge we talk about snubber capacitor in detail.

On a more worldly note, Deki has recently teamed with Goonj, a social enterprise working on ignored basic needs for village and slum India, to supply old clothes, books and stationery items for the needy. The two in-house campaigns conducted in December 2016 and again in April 2017, saw the whole-hearted participation of the entire Deki team.

As usual, do write in with your suggestions and comments on this issue of Charge.

*Anil Bali*

## External Customer Satisfaction Survey

Regular readers of Charge know that, at Deki, we conduct an external customer satisfaction survey every six months. The results of the most recent survey covering the July to December 2016 period was in line with the increasing satisfaction trend, coming in at 87.71%.

From the time we started this measurement in 2004 we have shown consistent growth from a level of 75% to the current rating. This upward trend is the result of the consistent action that Deki takes on the two most important aspects that our customers want us to focus on subsequent to each survey.

Our customer satisfaction rating target has now been revised to 90% and we hope to achieve it sooner than later!



## Health Awareness Session

Deki organised a special health session for its executives at the plant on 14 April 2017.

Dr Abhinav Tyagi, Senior Physiotherapist, Vikalp Physiotherapy Clinic shared information about good sitting postures, bed mattress, correct height of the pillow, light exercise and tips for the healthy life.

A representative from MedMap, a new mobile app that aims to connect patients with network of trusted care providers, made a presentation about the app's uses and its benefits.

An alternate medicine expert from Aarogyam Clinic, Vaishali, Ghaziabad gave a talk on the benefits of yoga and acupressure and demonstrated the use of a blood circulatory massager machine.

The session served as a timely reminder to the 35 participants about health awareness and simple measures that can ensure better health for them and their loved ones.



*Prevention is better than cure*



*Total attention*

## Deki's Tie Up with Goonj

With winter quite clearly a distant memory, at Deki we thought we could help ourselves by saving us the botheration of packing away all our winter clothes. We heard the resonance of the movement called Goonj and set out to make a pico farad of difference to society at large by giving away some clothing to those in need.

For those who may not be aware of Goonj, it is the first movement to highlight clothing as a basic but unaddressed need that deserves a place on the development agenda. At Deki, we had participated in the "Odha Do Zindagi" campaign of Goonj in December 2016 and collected 258 kg of clothes and other items.

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For your FREE subscription, please contact Deki Electronics Ltd,  
 B-20 Sector 58, NOIDA 201 301. Phone +91 120 2585457, 2585458  
 Fax +91 120 2585289 E-mail bali@dekielectronics.com  
 www.dekielectronics.com

## IGBT Snubber Capacitors

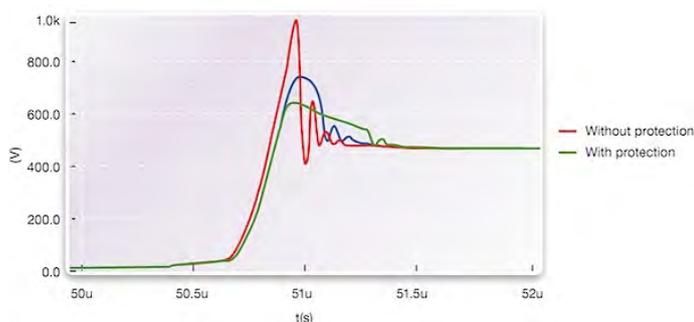
Important developments of IGBT's (Insulated Gate Bipolar Transistors) over the years have been focused on increasing power handling capability and increasing reliability. Snubber capacitors have also undergone changes in construction enabling increased power handling capability. This "charge" focuses on giving the reader a brief overview on the IGBT Snubber capacitor.

Power systems containing IGBTs must be designed so the transient voltage caused by the high  $di/dt$  that occurs at gate turn off is minimized. Left uncontrolled, this transient voltage can exceed the blocking voltage rating of the IGBT and cause it to fail. In order to minimize the transient voltage a wound construction polypropylene film capacitor mounted as close to the IGBT terminals as possible is usually recommended. (Refer to Image Below)



The acceptable amount of overshoot voltage is determined by the maximum DC voltage that an inverter power circuit is subject to and the IGBT voltage ratings. The peak current to turn off under a fault condition can be as high as 6 - 10 times the device current rating. This peak current under the fault condition will proportionally increase the overshoot voltage.

The switching capacity with shortest switching times which can be realized using IGBTs makes it necessary to use an extremely low-inductance circuit design. Even the low self-inductance of the power bus may induce dangerous voltage overshoots between collector and emitter which may result in the destruction of the valuable power semiconductors.



### Necessity of Using the Snubber Circuit

These are placed across the various switching devices like transistors, thyristors, etc. Switching from ON to OFF state results the impedance of the device suddenly changes to the high value. But this allows a small current to flow through the switching device. This induces a large voltage across the device. If this current reduced at faster rate more is the induced voltage across the device and also if the switching device is not capable of withstanding this voltage the device may burn out. So auxiliary path is needed to prevent this high induced

voltage.

Similarly when the transition is from OFF to ON state, due to uneven distribution of the current through the area of the switch overheating will takes place and eventually it will be burned. Here also snubber is necessary to reduce the current at starting by making an alternate path.

Snubbers in switching mode provides one or more of the following functions:

- Shape the load line of a bipolar switching transistor to keep it in its safe operating area.
- Reducing the transient voltages and currents during turn-ON and turn-OFF conditions.
- Removes transient energy from a switching device and dissipate the energy in a resistor to reduce junction temperature.
- Limiting the rate of change of voltage and currents during the transients.
- Reduce ringing to limit the peak voltage on a switching device and lowering their frequency.

Let us now understand the aspects which have to be considered when choosing the right snubber capacitor for the application:

#### 1. Capacitor DC-voltage class

The maximum continuously applied DC voltage can be the rated DC voltage of the capacitor in order to ensure longer life of the capacitor. Semiconductors with 1200V blocking voltage are used with up to 900V DC-link voltage. For these applications, capacitors with a rated voltage of 1000V are recommended. For 1700V semiconductors, 1250V or 1600V capacitors are recommended, depending on the DC-link voltage. The peak voltage also has to be in the admissible values because otherwise the plastic film could be damaged. Consider also that the applied DC voltage has to be derated when the capacitor is operating at higher temperatures than the rated temperature.

#### 2. Capacitance value and series inductance

The capacitance value has to be high enough to achieve sufficient voltage spike suppression during switching off. Typical values for these capacitors are from 0.1  $\mu\text{F}$  to 1.0  $\mu\text{F}$ . But not only is the capacitance value important for this. Also a low inductive design of the capacitor is important. The remaining inductance, caused by the loop between the terminals and the internal connections of the capacitors is responsible for a voltage spike/transient. A high capacitance value is no guarantee for a low voltage spike if the self-inductance remains. A low self-inductance can be achieved by using capacitors with wide flat terminals that can be screwed directly onto the IGBT module terminals. The capacitor should be designed so that the terminals encircle as small an area as possible and that they are directly connected to the capacitor coil without having internal wires between. Furthermore, metallized polypropylene foil capacitors should be used with plastic case according to UL94V-0.

#### 3. Pulse handling capability

The inner connections of the capacitor are capable of withstanding only a limited amount of energy at each switching

## IGBT Snubber Capacitors

event. The data sheets of the supplier specify limits for pulse operation. These values can be calculated from the oscillating current or voltage waveform of the capacitor. This calculation can easily be carried out using modern digital oscilloscopes. A capacitor failure can occur only because of very high peak currents, even when the involved voltages are lower than the specified ones. In this situation the critical thing is the involved energy and normally there will be a loss of connection between metal spray and film metallization. Because of the very high energy involved the film metallization will be vaporized on the connection area to the metal spray. This will lead the capacitor to a high loss factor or even to a capacitance loss. The maximum dv/dt values are less critical because of the damped sinusoidal waveform.

### 4. RMS voltage and RMS current

A damped oscillation occurs at each switching event (on or off = twice switching frequency of the IGBT) between the snubber capacitor and the bus bar capacitance. The RMS current leads to self-heating of the capacitor. The capacitor will stabilize at a certain temperature which also depends on the ambient temperature and on the mounting conditions (e.g. temperature of power module terminals). Data sheets give values for the permissible RMS current and RMS voltage depending on the frequency. The oscillating frequency depends on the DC-link stray inductance and the snubber capacitor value. Typical values are in the range of 100 kHz to 1 MHz. The permissible RMS current decreases with the frequency because the losses increase.

### 5. Lifetime

The capacitor lifetime and failure rate is mainly affected by the operating temperature and operating voltage.

The snubber circuit is formed using both R and C. Hence it is important to have the right selection of the Resistor also. It is important that R in the RC snubber, have low self-inductance. Inductance in R will increase the peak voltage and it will tend to defeat the purpose of the snubber.

Low inductance will also be desirable for R in snubber but it is not critical since the effect of a small amount of inductance is to slightly increase the recovery time of C and it will reduce the peak current in device during switching.

The normal choice of R is usually the carbon composition or metal film. Resistor dissipates the energy stored in the snubber capacitor in each transition. If we select the resistor as that the characteristic impedance, the ringing is well damped.

## IGBT Snubber Capacitor (121 Series)

### Construction

**Dielectric:** Polypropylene film

**Construction:** Extended foil electrodes with metallised polypropylene internal series connection

**Leads:** Tinned copper lugs

**Seal:** Plastic case with resin sealing. Flame retardant execution (UL94V-0).

### Highlights

- Self-healing
- High-frequency
- high peak current
- High DV/DT
- High peak and RMS current capability
- Low ESR



### Applications

IGBT snubber capacitors are used in high voltage, high current and high pulse applications such as:

- IGBT protection circuits
- Snubber network
- Protection circuits in SMPS
- Energy conversion and control in power electronics

### Electrical characteristics

**Working temperature:**  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$

**Capacitance:**  $0.047\ \mu\text{F}$  to  $5.6\ \mu\text{F}$

**Tolerance:**  $\pm 5\ \text{J}$ ,  $\pm 10\ \text{K}$

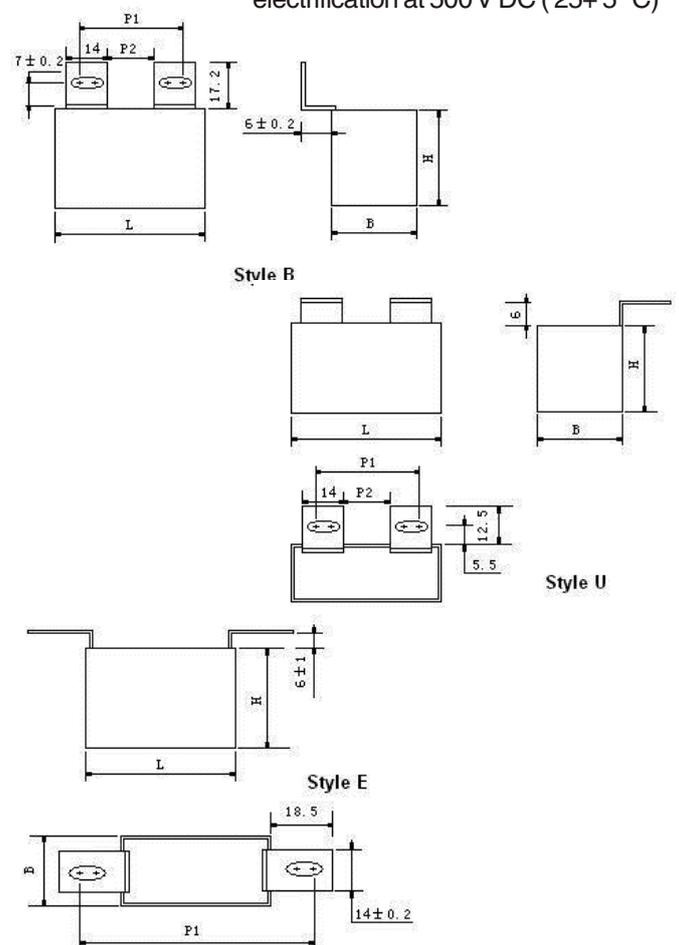
**Rated voltage:** 700~3000 V DC, 380~ 750 V AC

**Test voltage T-T:**  $1.6 \times$  rated voltage V DC for 2s. /  $25+5^{\circ}\text{C}$

**Test voltage T-C:** 3 kV AC at 50 Hz, 60 s

**Dissipation factor:**  $\leq 0.0005$  at 1 kHz  $25^{\circ}\text{C}$

**Insulation resistance:** For  $C \leq 0.33\ \mu\text{F}$  – 100000 M $\Omega$   
For  $C > 0.33\ \mu\text{F}$  3000s  
(not exceeding 30G), after 1 min of electrification at 500 V DC ( $25+5^{\circ}\text{C}$ )



## Deki's Tie Up with Goonj *(continued from page 1)*

We organised another collection camp at our office from 30 March to 15 April 2017 and were heartened by the response from Team Deki. We collected 207 kg of not just usable clothes but shoes, toys, school bags and stationary items like books, notebooks, geometry boxes, etc.

The material was then sorted, packed and delivered to the Goonj Office in Sarita Vihar, New Delhi on 24 April 2017. We also contributed Rs 5000 from the company as monetary assistance for purchasing the essentials and logistics.

To be honest, while our effort is a tiny one, the happiness it has spread is immense and immeasurable. We hope to be able to replicate it, with greater gusto in the near future.

If we do not help our fellow citizens, who else will?



*Giving puts a smile on our faces*

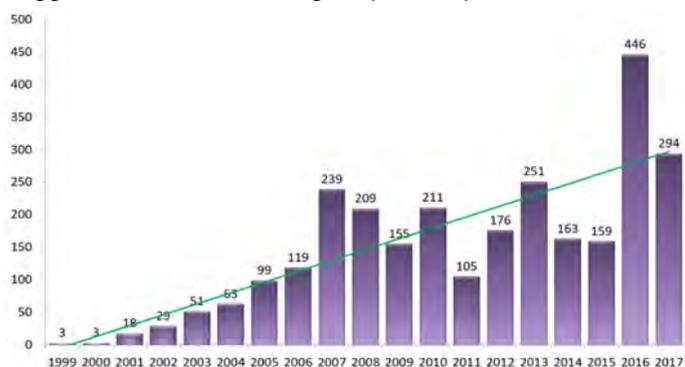


*Ready to roll with the contributions from Team Deki*

## Employee Suggestion Scheme

The employee suggestion scheme at Deki has seen consistent growth since inception in 1999 with 20,057 suggestions implemented till date.

The scheme is very simple with an employee filling a suggestion form mentioning the present process, the new or



*Average employee suggestions per month*

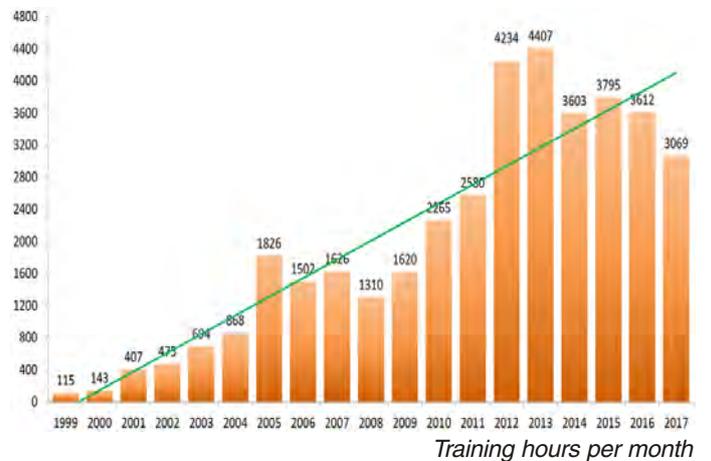
revised process proposed and the accruing savings /benefits from it. The suggestion reaches the suggestion committee with the remarks of the section-in-charge. The committee deliberates during a weekly meeting and selects suggestions that can be implemented. Accepted suggestion are rewarded every week.

In 2015-16 we received 5.38 suggestions per employee per annum and set a target of >10 suggestions per employee per annum for 2016-17. We have exceeded the target with 10.4 accepted suggestions per employee per annum.

At Deki, we believe that one of the indicators of a motivated work force is the number of suggestions received from employees. This, coupled with results of the Employee Satisfaction Survey, is ample indication of a highly motivated Deki work force.

## Training in Deki

As an integral part of continual skill enhancement, training at Deki has seen consistent growth with close to 3% of the time spent on it. Deki's training modules, recognised and serving as a benchmark for component manufacturers, cover detailed, stage wise training to impart knowledge of the process and the machines. This is followed by a written test in which employees have to score a minimum of 80% at critical stages to qualify to run machines.



*Training hours per month*

## Employee Motivation Survey

Deki conducts an employee satisfaction survey every six months in which employees are asked a set of fifteen questions pertaining to their:

- work environment,
- salary,
- satisfaction level,
- growth opportunity,
- knowledge of targets,
- standard specifications, and,
- operating procedures, etc.

The marks they give to each of the questions are consolidated and compared with the results of the most recent survey. The consolidated report along with the action points for improvement are discussed with all the employees in an "Open House" by our MD, Mr Vinod Sharma. The August 2016 survey showed a stable trend of 88-89%.