LETDO Electronics
-Your Best Partner for Electronic Components

Power Capacitor for Electric Vehicles Application

LETDO
Industry Business Group
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Introduction

LETDO electronics has clearly incorporated the essence and idea of “let’s do it” in the name itself. We insist on the core idea of honesty, trust, specialty, vitality. Having established for 10 years, we gladly invite and enlist the services of top notch professionals in this arena.

In order to achieve a common goal in becoming the number one passive component distributor, we have fought to ensure fast, flexible services with large warehouses, customised services, VMI, FAE technical support, EDI and samples which are part of our commitment to our customers.

Over 10 years of development, LETDO currently has three Companies in Hong Kong, Suzhou and Xiamen, as well as four branch companies in Shenzhen, Beijing, Quanzhou and Shanghai with 5 offices in Hangzhou, Wuhan, Chengdu, Xi’an and Changsha. Through the integration of our warehouses in Hong Kong, Quanzhou ,Suzhou and Shenzhen, we are thus able to extend our service networks to many cities, ensuring that our consumers have the most convenient access.

Through our positive work attitude and professionalism, we have successfully been able to establish long term partnerships with over 1,100 companies in various industrial sectors, such as those from the communications, IT industry, consumer electronics, automotive electronics, medical equipment, industrial machinery, power supply, lighting, rail transportation, energy, environmental protection. This is why we have expanded from a single brand to encompass various complement product brands as well, to act as a one stop shop to cater to our clients’ needs. In 2009, we have also established the nation’s first service-oriented “LETDO Express” for Sample, to provide customers with a series of products and strive to deliver the products within 48 hours.

Dear friends, we hope to have your support as we work towards achieving our goals.

Overview

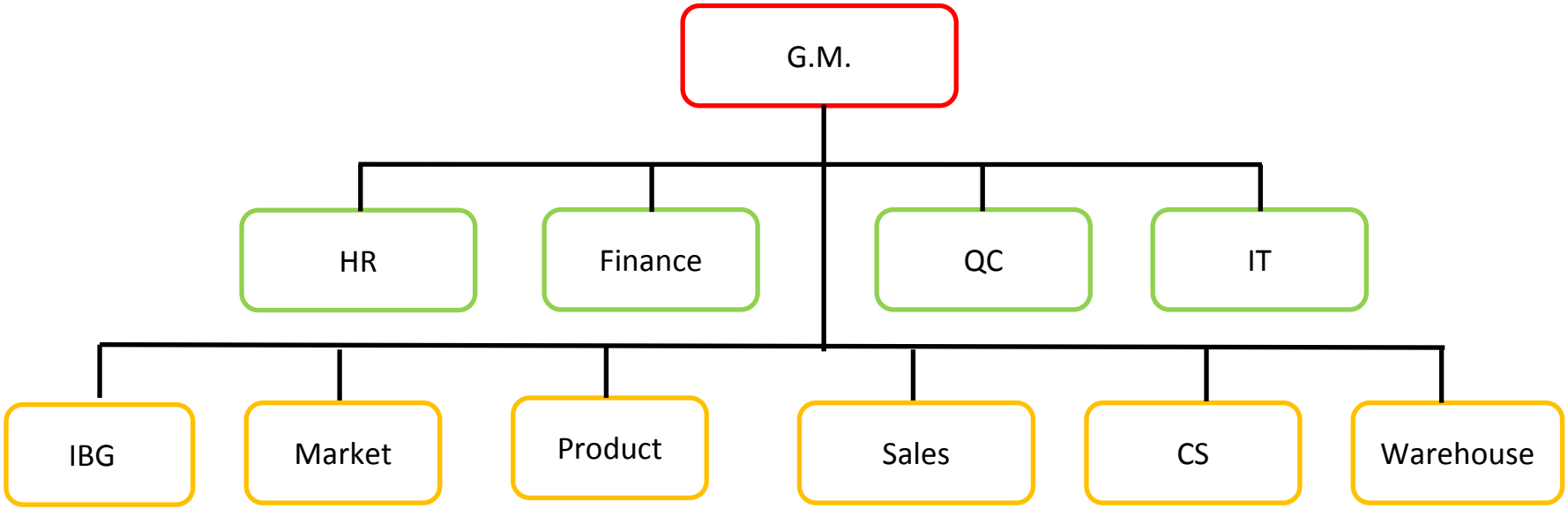
- More than 10 years experience in distribution business.
- Represent world's leading brands （AVX/Kyocera、TDK、KEMET 、TAIYO YUDEN 、 HDK、CMP 、 SI-EN）.
- Total 12 Branches and Offices
- More than 1,100 long-term customers.
- Major markets:

  communication, consumer, IT, automotive, medical, industrial, traffic and clean energy.

Milestones

- 1999 Q.Z TORCH International Limited in Hong Kong
- 2001 Shenzhen Office
- 2003 Suzhou LETDO Electronics Co.,Ltd
- 2004 Shanghai Office
- 2005 Beijing Office
- 2007 Xiamen LETDO Electronics Co.,Ltd(Headquarter)
- 2007 Quanzhou Branch
- 2007 Chengdu Office
- 2008 Wuhan Office
- 2008 Shenzhen Branch
- 2009 Hangzhou Office
- 2009 Xi'an Office
- 2009 Beijing Branch
- 2009 Changsha Office
- 2010 Shanghai Branch

Organization



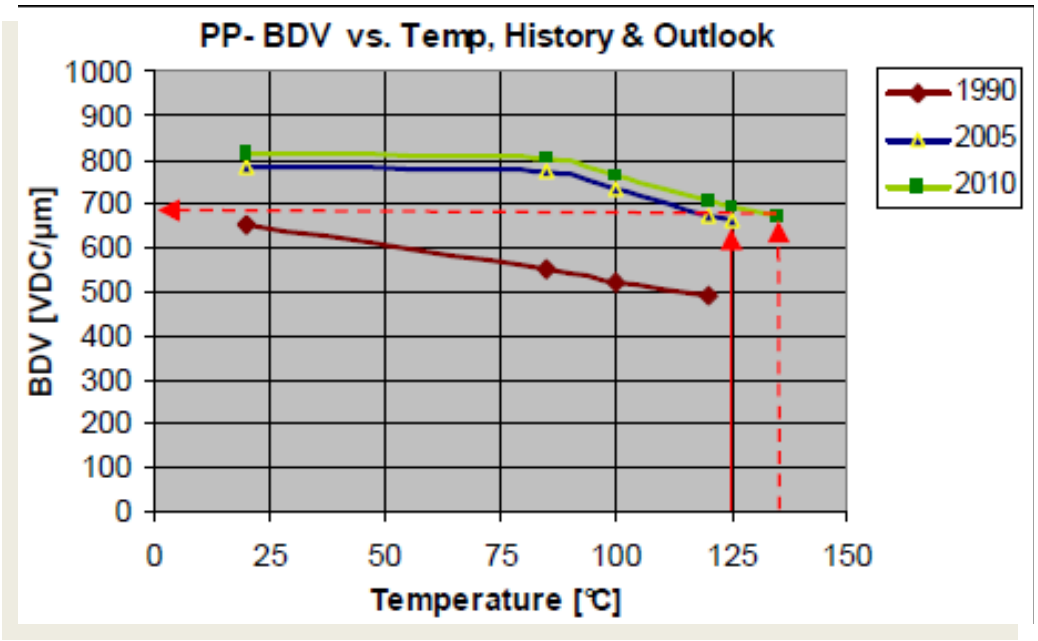
Customers

EMERSON Network Power
SANTAK An Eaton Brand
EATON Powering Business Worldwide
BIRD 波导
CSR 中国南车
CNR
alhua TECHNOLOGY
sim SIM Technology
BYD 比亚迪汽车
mindray 迈瑞
CHANGHONG 长虹
EVOC 研祥高科技控股集团 EVOC HI-TECH HOLDINGS GROUP
国家电网 STATE GRID
中国电力科学研究院 CHINA ELECTRIC POWER RESEARCH INSTITUTE
ZTE中兴

Dielectric Film Properties

Film	Costs	T_{melt}	T_{max} [°C]	ε_r [-]	$\tan\delta_{(1kHz)}$ [-]	U_{max} [ASTM D150-81]
Polypropylen [PP]	↓	160	100	2,2	1,5x E-4	450V/µm
Polyester [PETP]	→	260	125	3,2	40x E-4	280V/µm
Polyethylene Naphtalate [PEN]	↑	262	150	3,1	40x E-4	280V/µm
Polyphenylene Sulfid [PPS]	↑	285	170	3	6x E-4	320V/µm
Current Status						
High T Polypropylene [PHD]	↓	168	125	2,2	1,5x E-4	480V/µm
SMD PETP [CHT]	→	280	135	3,3	40x E-4	280V/µm
Potential for Development						
Coating of [PEN] and [PPS]	→	t. b. d.				

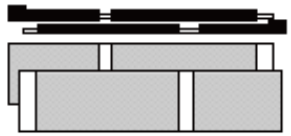
Breakdown Voltage Vs . Temperature

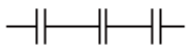


Polypropylen(PP) breakdwon voltage is about 600VDC/um .we designed our power film capacitor for 200V/um to 240V/um . If application condition is high temperature and high current ,we will reduce the breakdwon voltage .

Internal Series connection can raise the product voltage

Triple internal series connection



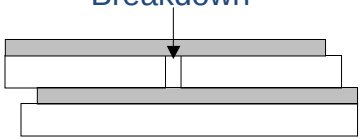


Self-healing property

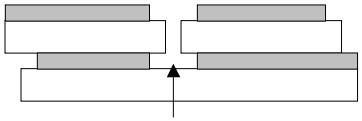
How it works: the metal layer is very thin and, in case of dielectric breakdown, the energy released by the arc discharge in the breakdown channel totally evaporates the thin metal coating layer near the channel. This results in a restored insulation and a small capacitance drop.

Metallized film capacitors

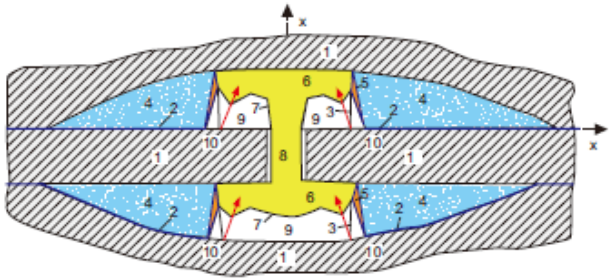
Breakdown

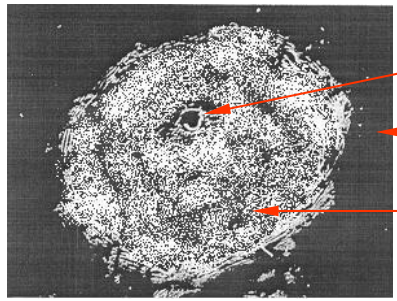


After the breakdown:



Metallization is evaporated (insulation is restored)





Breakdown channel

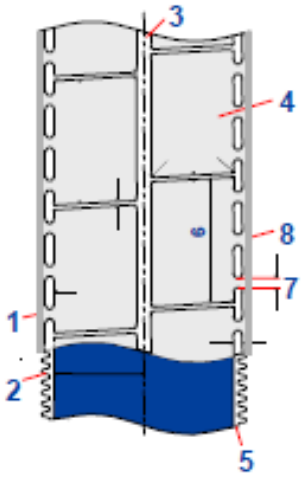
Metallized coating (black colour)

Metal is evaporated

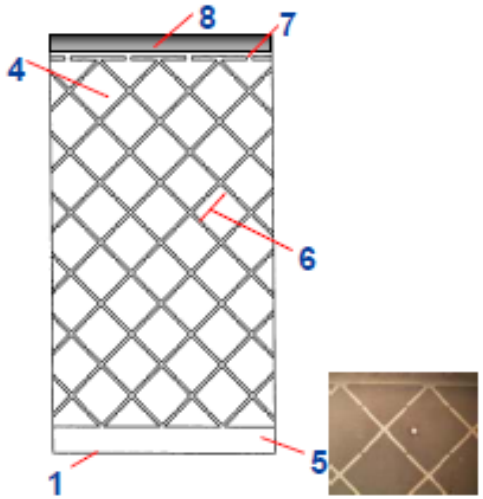
1 Organic dielectric
2 Metallized electrodes
3 Material displacing shock wave
4 Air gap
5,6 Plasma discharge zone
7 Boundary layer between plasma zone and dielectric
8 Breakdown channel
9 Dielectric in gas zone
10 Isolation area

Metalization TooL Box

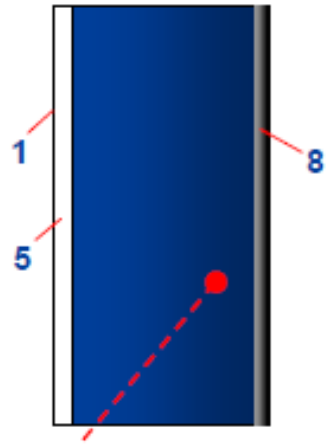
T - Segment



Patterned Electrode



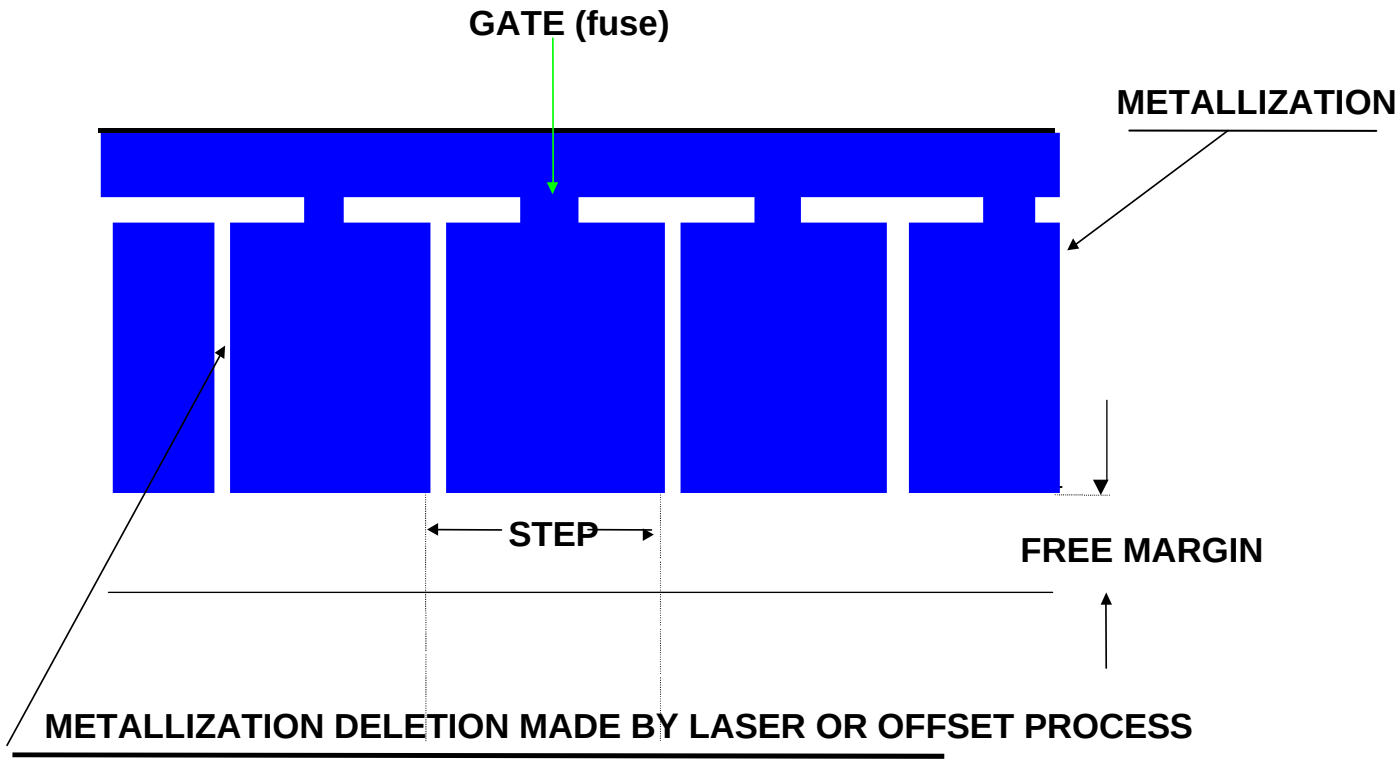
No - Segment



1. Smooth cut
2. Wavy cut
3. Free stripe
4. Partial capacitor
5. Free margin
6. Segment spacing
7. Protection fuse
8. Heavy edge electrode & CSP met. w / w. o. structure

Metalization TooL Box

GATE SEGMENTATION

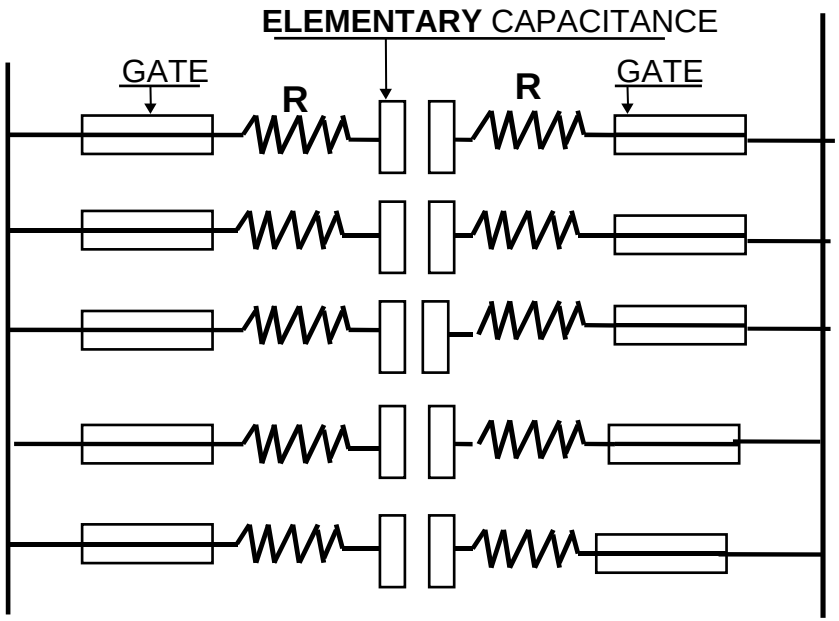


The Gate segmentation limits the self healing energy

Metalization TooL Box

GATE SEGMENTATION

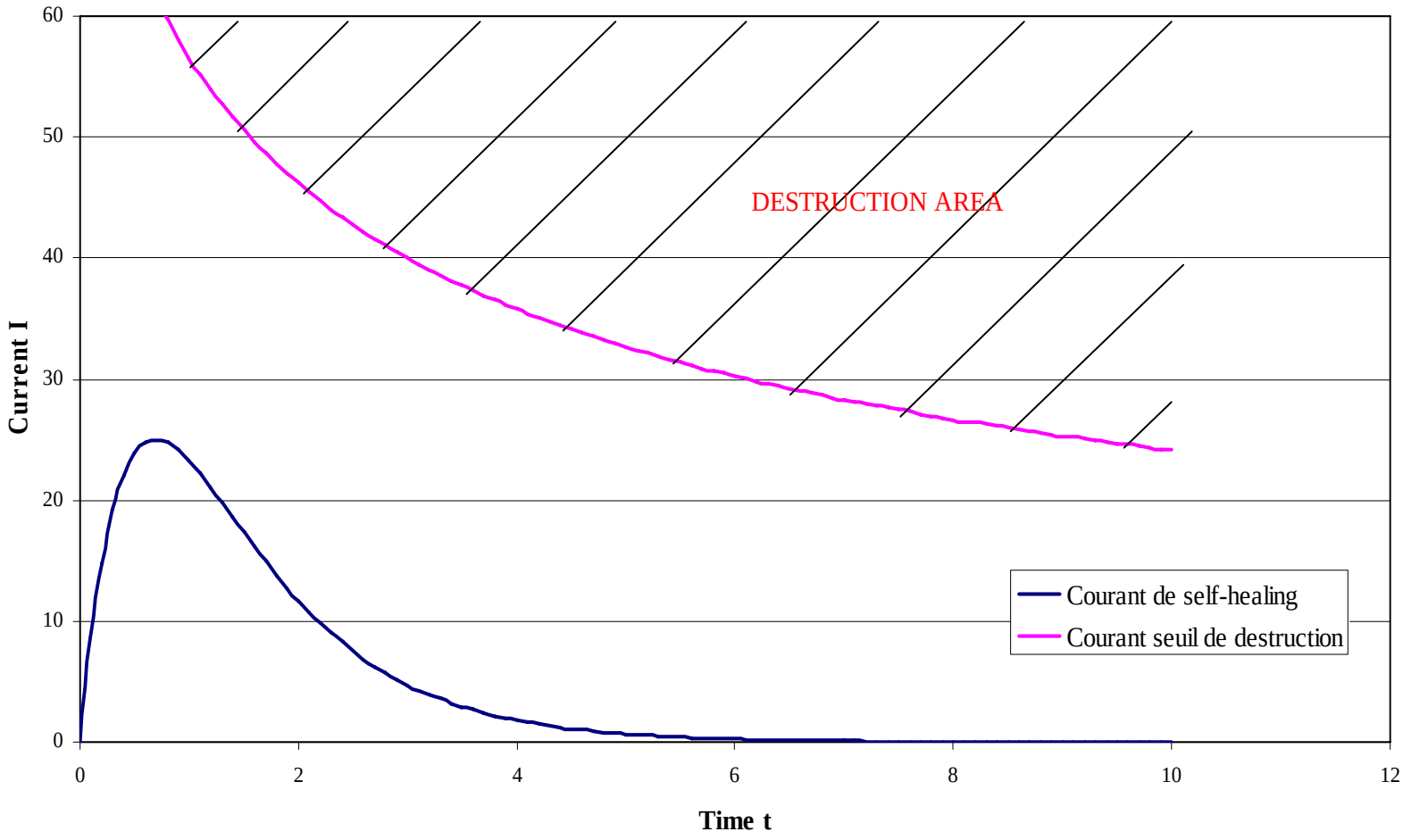
GATE SEGMENTATION LIMITS THE SELF HEALING ENERGY



IN ADDITION TO THE COMB EFFECT, THE GATE IS ACTING AS A FUSE

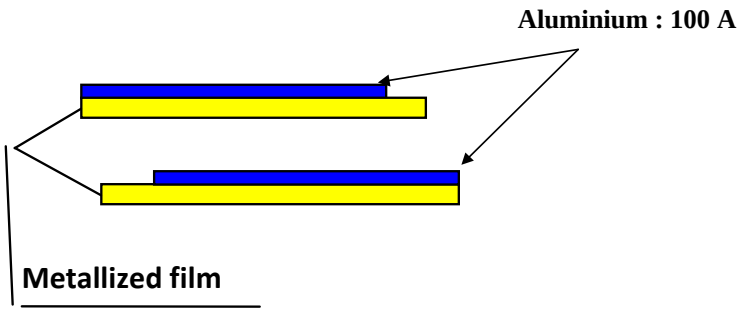
THE SELF HEALING CURRENT IS LIMITED BY THE RESISTIVITY OF THE FUSE

SELF-HEALING CURRENT

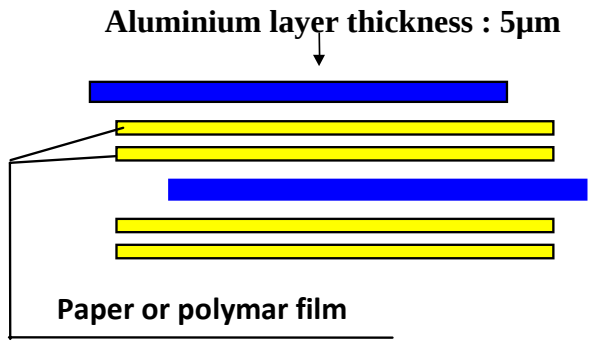


COMPARISON METALLISED / FOIL TECHNOLOGY

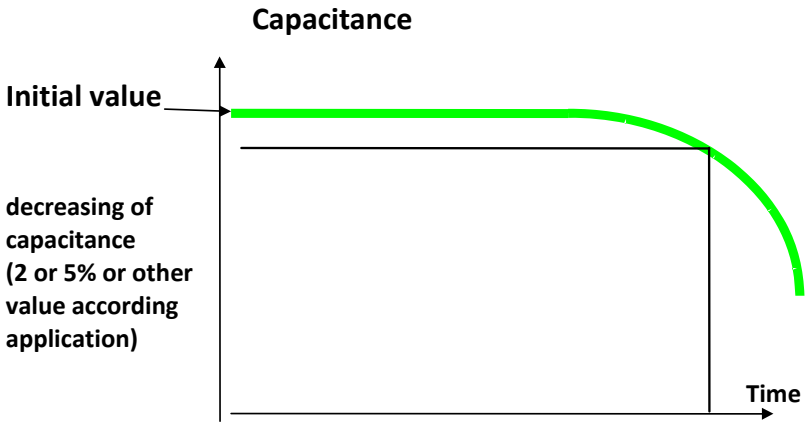
METALLIZED

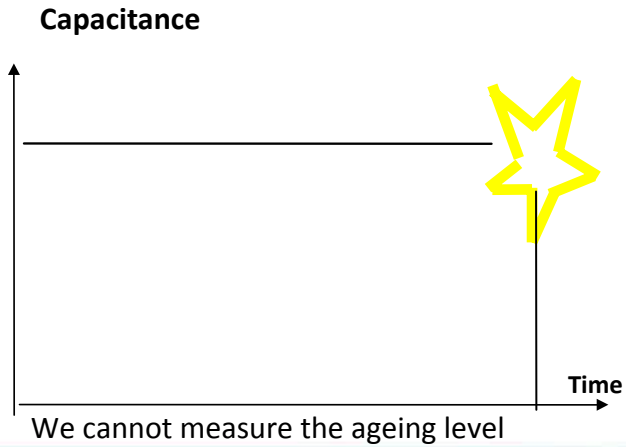


FOIL



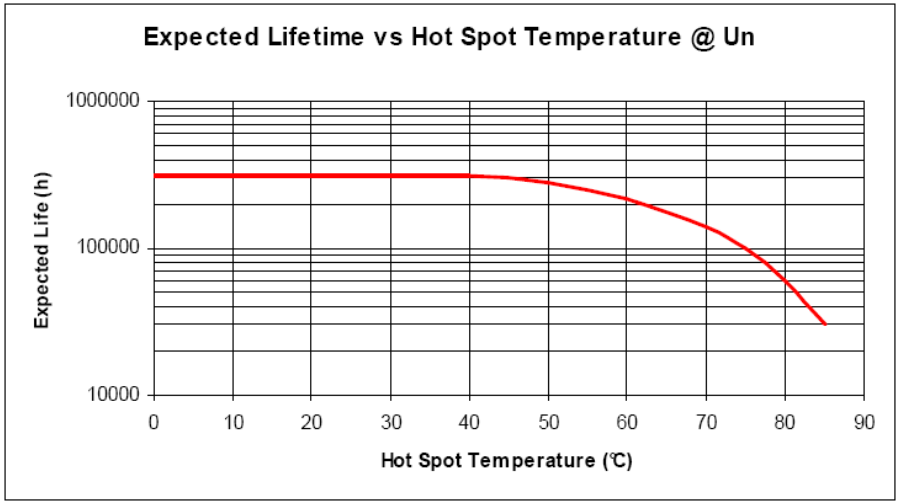
END OF LIFE

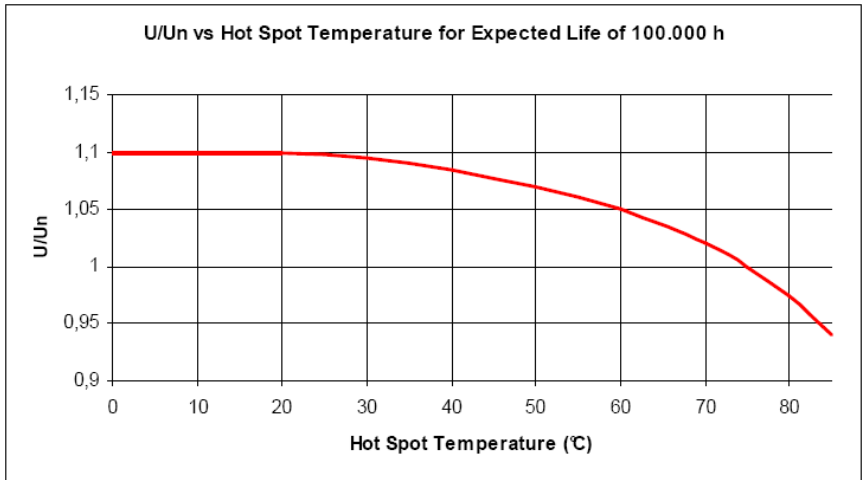




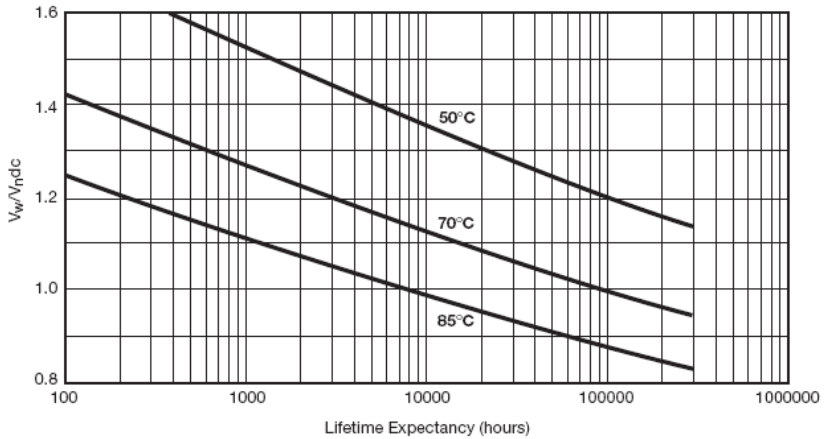
We cannot measure the ageing level

LIFE EXPECTANCY

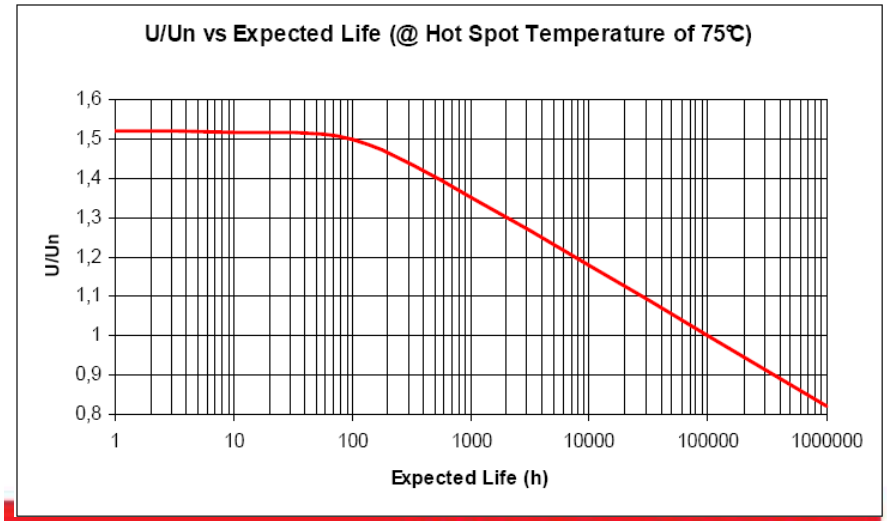




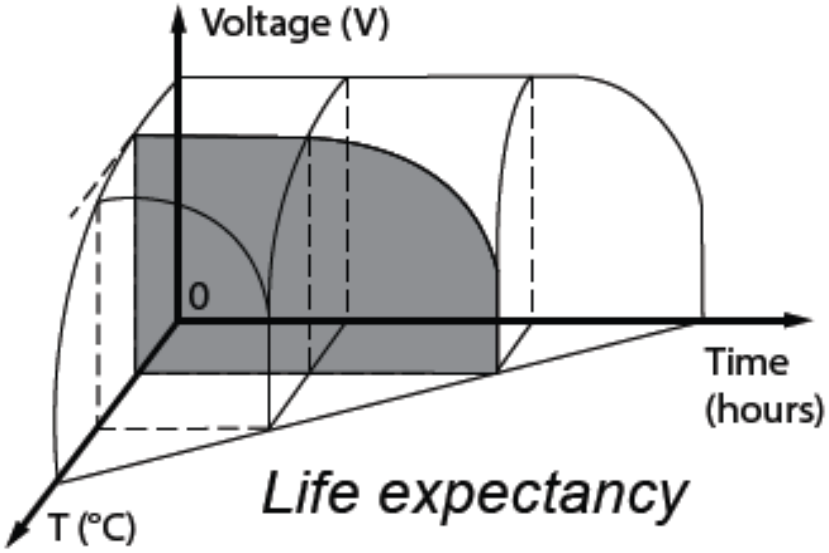
LIFETIME EXPECTANCY vs HOT SPOT TEMPERATURE AND VOLTAGE



Vw: permanent working or operating DC-voltage.



Derating Formulas



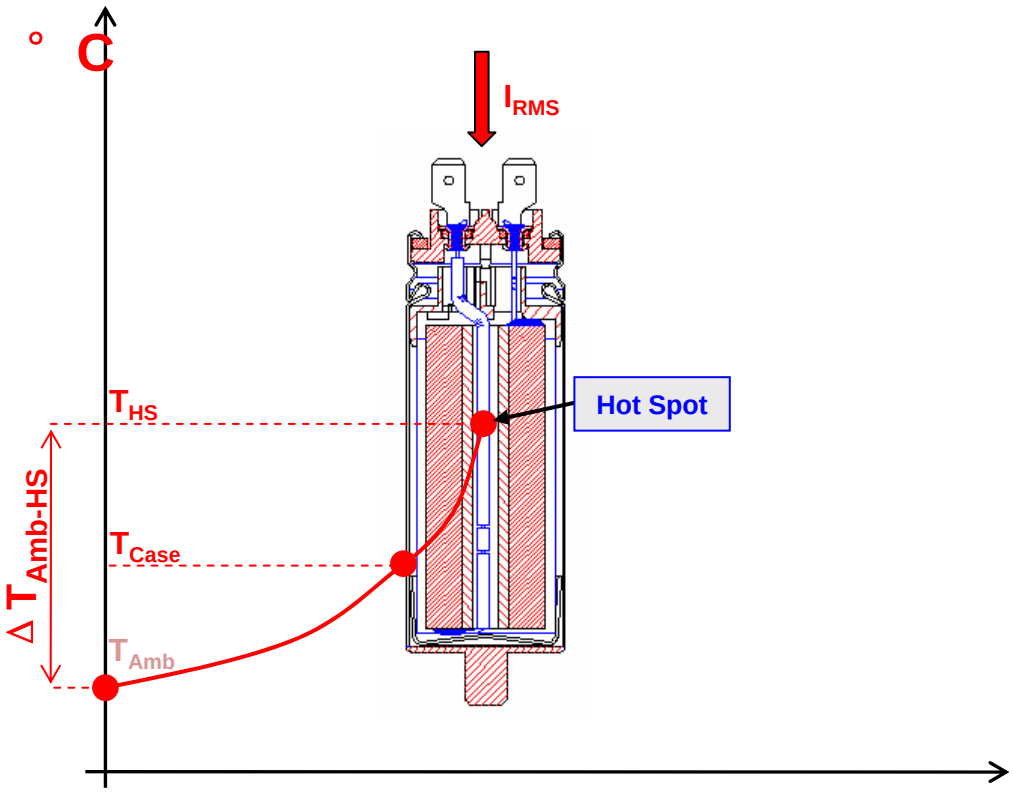
$$LE = LN \times (VN / V)^8$$

LE = Life expectancy at operating V
LN = Life expectancy at nominal voltage
VN = Nominal voltage Un (V)
V = Operating voltage (V)

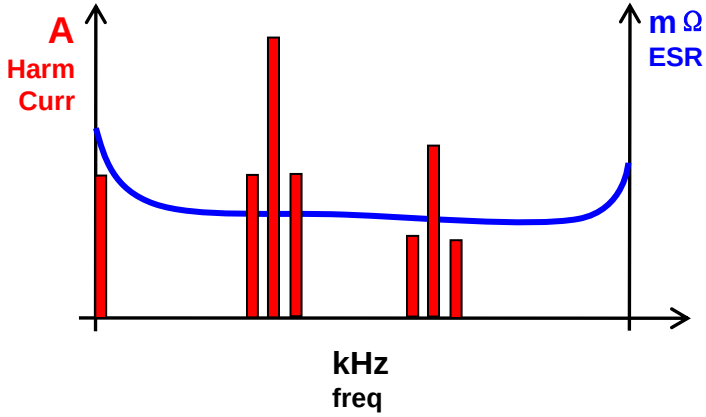
$$LE = LTd \times 2^{(Td - Ths) / 7}$$

LE = Life expectancy at operational Hot Spot temperature Ths
LTd = Designed Life expectancy at T hot spot = Td
Td = "Design" Hot Spot temperature
Ths = Operational Hot Spot
7= Arrhenius coefficient
Exampe: capacitor designed to live 100kh with an hot spot of 85° C – if the calculated operational hot spot temperature is different the formula should be applied

Hot Spot Definition



$$P_D[W] = \sum_{i=1}^{n} ESR(f_i) * I_i^2$$

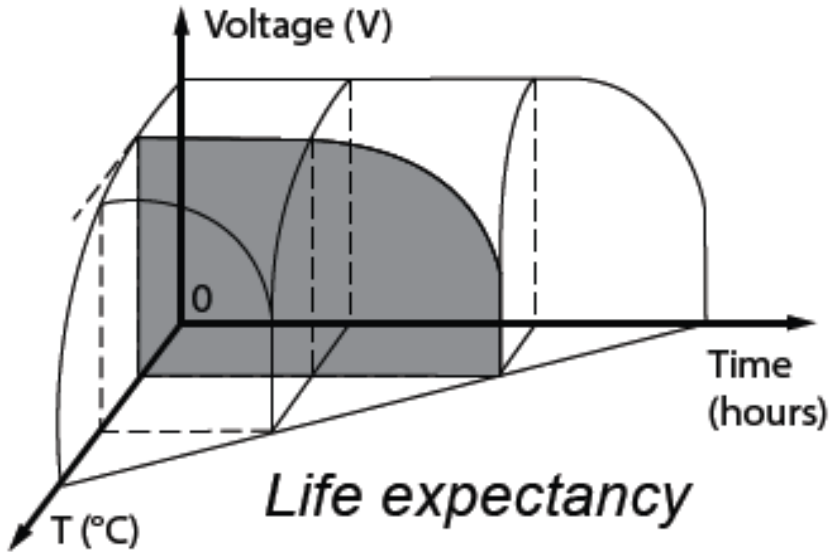


ΔTAmb-HS → Rth * PD

The hot spot is the internal point of the capacitor where the temperature reaches its maximum value. The hot spot temperature is always depending on the ambient temperature and on the internal overheating generated by the Irms

Usage Limitation for Derating Formulas

- **The hot spot temperature cannot anyway exceed the Max temperature that the base film is declared for**
- **The operating voltage cannot widely exceed the nominal voltage since a too high voltage would cause the dielectric break down**
- **The formulas can be applied only in case of limited variation from the rated values of Voltage and Temperature. A gap too big could not be verified with any reasonable accelerated test**



Example: if I get as a result an expected life of 1M h, with the typical endurance test I should put in test the capacitors for 100kh !!

Calculate Hot Spot

HOT SPOT CALCULATION

$$\theta_{hot\ spot} = \theta_{ambient} + (P_d + P_t) \times R_{th}$$

with P_d (Dielectric losses) $= Q \times tg\delta_0$

$$\Rightarrow [\ \tfrac{1}{2} \times C_n \times (V_{peak\ to\ peak})^2 \times f\ ] \times (2 \times 10^{-4})$$

P_t (Thermal losses) $= R_s \times (I_{rms})^2$

where C_n in Farad, I_{rms} in Ampere, f in Hertz
V in Volt, R_s in Ohm, θ in °C
R_{th} in °C/W

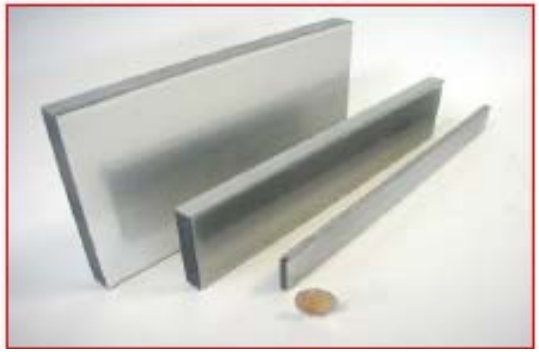
Winding Technology

Standard Round

Concentric Round

Customized Round

Standard Plat



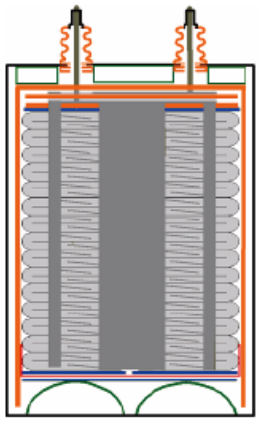
Standard Stack

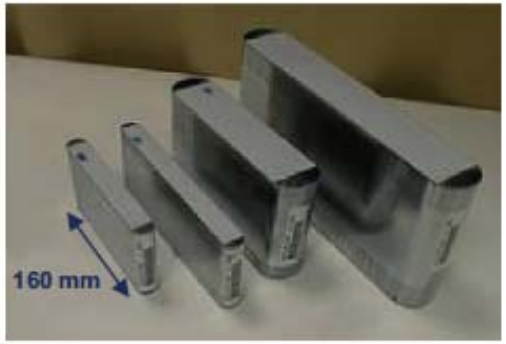
Customized Stack

Winding Technology

Plat Winding Technology Advantage

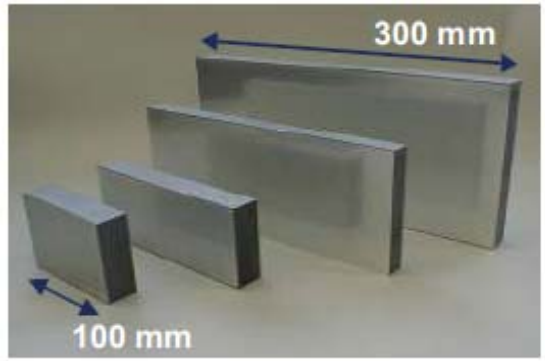
Diversification configuration
Good Self-healing property
Good volume Fill Factor
High Ripple Current
Low ESL
Impregnation Technology: Oil ; Protective Gas ; Resin





Stack Technology Advantage

Diversification configuration
Good Self-healing property
Good volume Fill Factor
Super Thin Film Technology
High Ripple Current
Low ESL



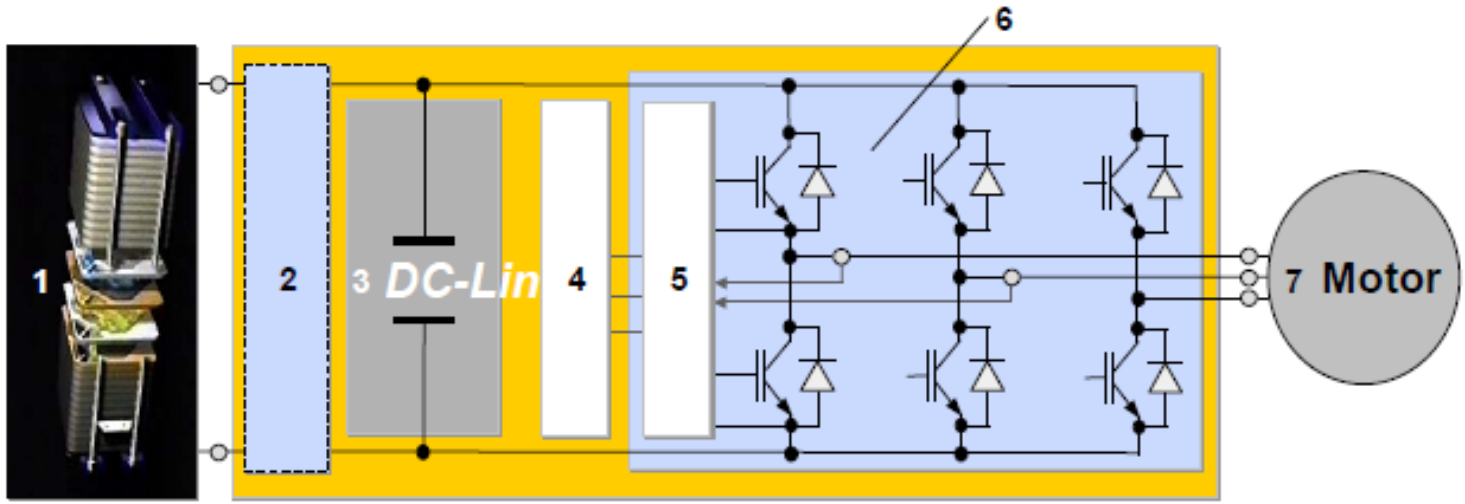
Impregnation Technology

Impregnation	Oil	Protective Gas	Resin
Product	DC-Link ; AC Filter	DC-Link	Snubber cap; DC-Link;AC filter
Voltage VDC	Typical＞1500	Typical＞1600	Typical＜1200
Weight	High	Low	Medium
Total Fire Load	Highest	Lowest	Medium
Cooling	Best	Normal	Good
Hotspot	10k Less than gas	Reference	Lower Compared to gas
Losses	Improved heat dissipation	Reference	Good heat dissipation
Lifetime	Longer at the same film thickness	Reference	Reference
△C/C %	Smaller,film protected from corona effect	Reference	Reference
Application	High absolute voltage and high AC Ripple load High ambient temperature and high currents	Mainly DC load, Low AC Rate,Low ambient Temperatre	Lower voltage

Impregnation Technology

Technical Characterisitics	Property
Resin Impregnated	High Capacitance
Gas impregnation	Low Weight, low risk of the fire
Oil impregnation	Heavy duty
Film metallization design	Very good self-healing capability
intergrated winding protection	Good overload capability
Custoized housing	Optimized mechanical adaptation
Stainless- steel casing	Pressure stable
Overpressure protection	Optional safety feature
Overpressure disconnector	Available upon request

Topology Of HEV Converter



- 1 Fuel Cell or HV-Battery
- 2 EMC Filter
- 3 DC-Link function with integrate bus bar
- 4 Drive control bus interface
- 5 Monitoring & Pretection gate driver
- 6 IGBT bridge with integrated cooling & sensors
- 7 Electric motor with high peak power

DC Link & Filter Capacitors

Hybrid and Electric Vehicles

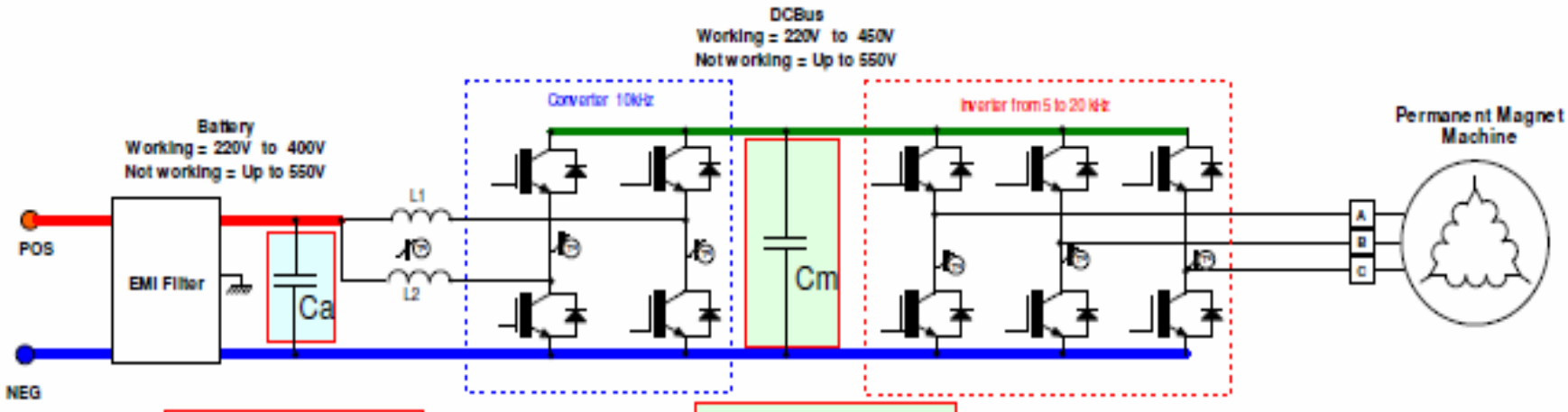
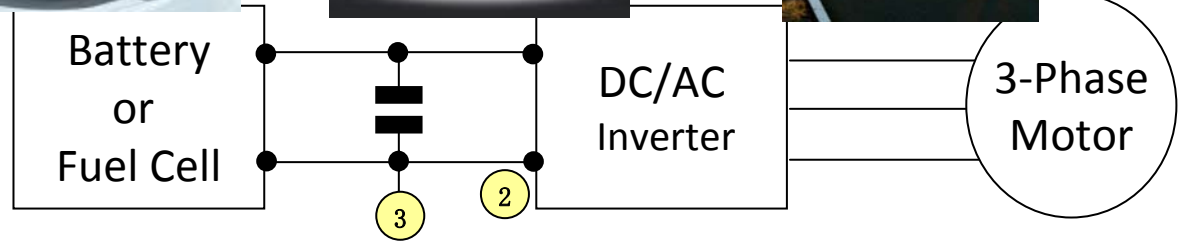


Figure 1 Overview on the application of the Double Bank Capacitor

LETDO ELECTRONICS
雷度电子

EV / HEV Power Train DC-Link Capacitors



Advantages:

- High ripple life 20 khours
- High voltage
- Large capacitance / Brick
- High operating temperature
- High switching frequencies
- Low ESR, Low ESL

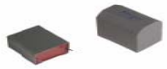
Typical Designs:

- Cap: 100 to 2000 uF
- Voltage: 450 to 1300Vdc

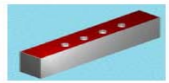
KEMET DC-Link :

Box Radial C4AE | Low ESL C4DE | Alu Can C44U | Brick C4E custom

AVX DC-Link :



FFB
1,5 to 110 µF
75 to 1100 Vdc

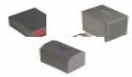


FFLC
1120µF to27mF
680 to 1900 Vdc

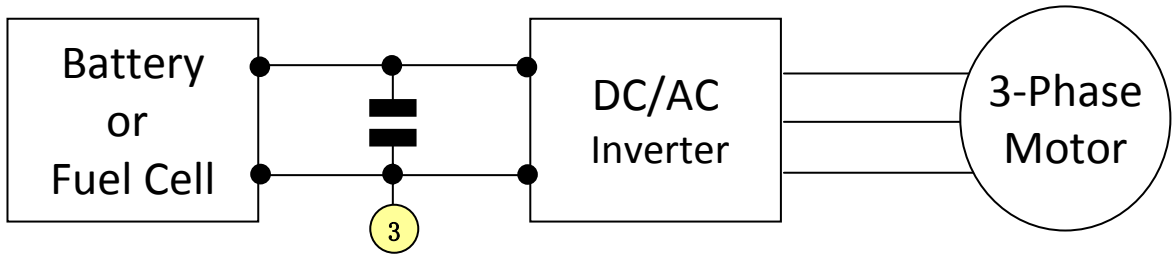
FFVE/FFVI
12 to 400 µF
300 to 1900 Vdc

FFLI/FFLB
58 to 800 µF
600 to 1900 Vdc

FFV3
6 to 160 µF
75 to 1100 Vdc



FSB
100nF to 3µF
850 to 2000 Vdc

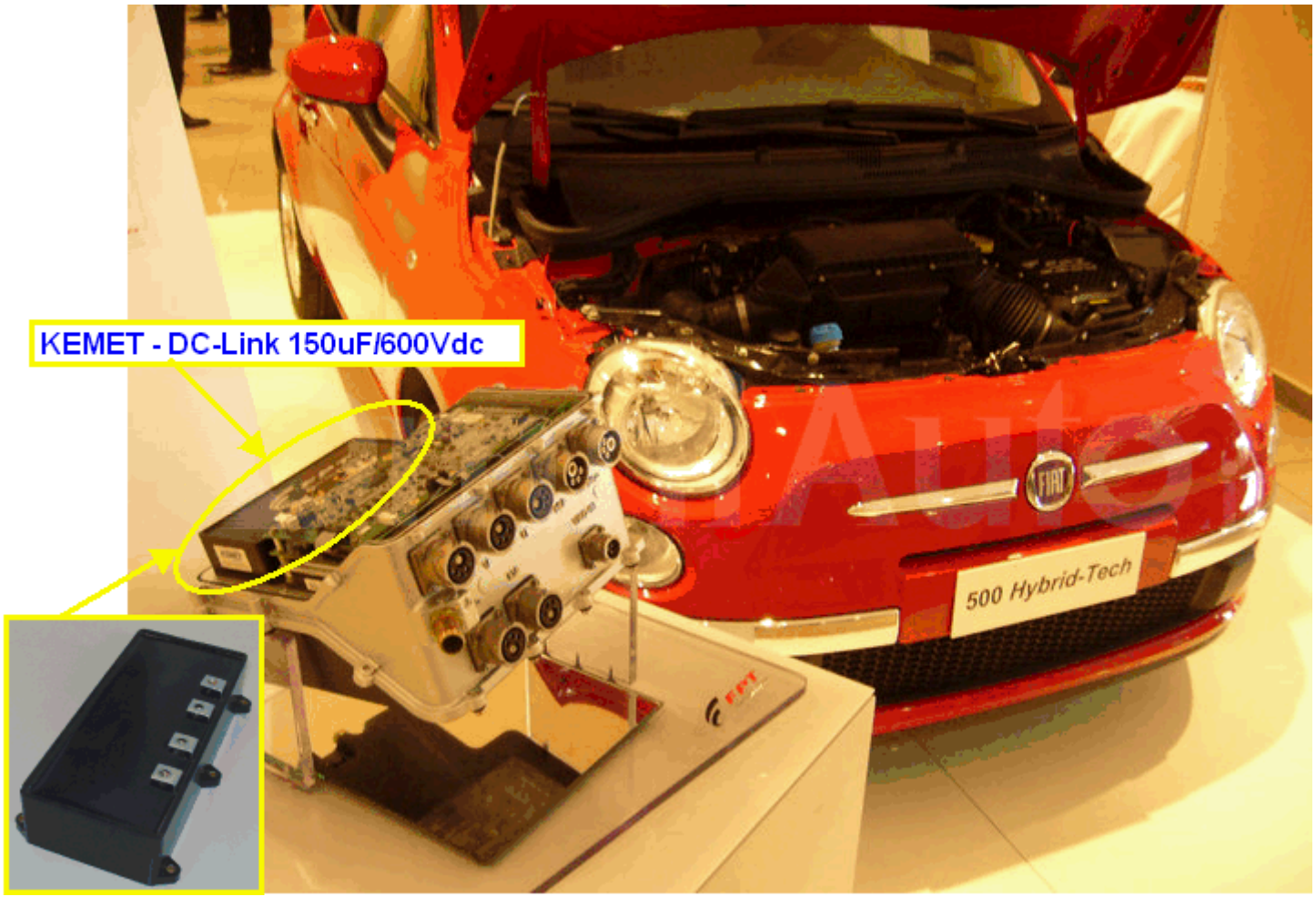


asynchronous
or synchronous

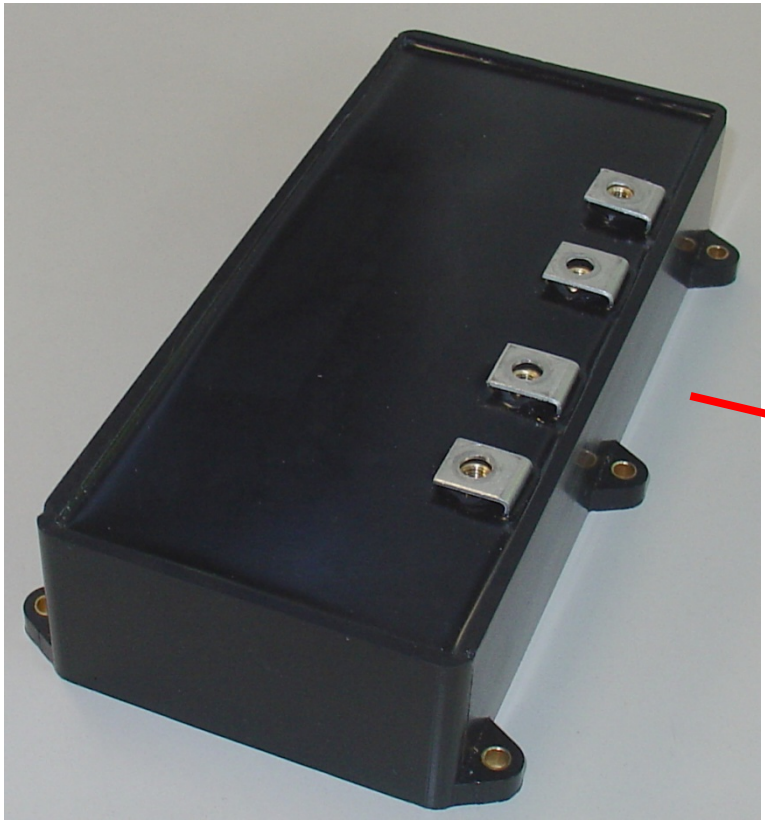
3-phase IGBT inverter
IGBT SKAI2
- 600 V up to 150 kVA
- 1200 V up to 230 kVA.
automotive qualification
EMI filters
Liquid cooling
DC link capacitor

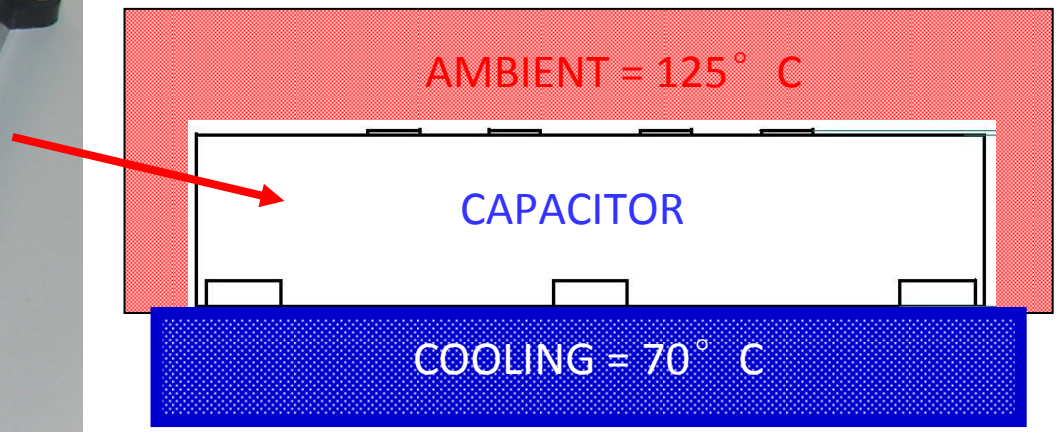
3 **Capacitor Solution: C4E Brick**
- Capacitance: 1000uF / 900V

HEV Automotive DC-Link Brick



Automotive DC-Link Capacitors
Heat Dissipators, Soft Winding

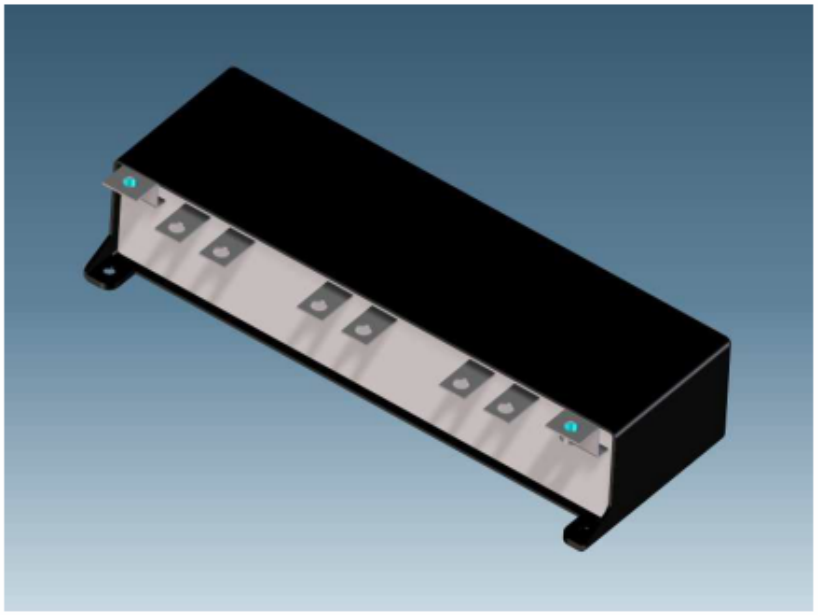




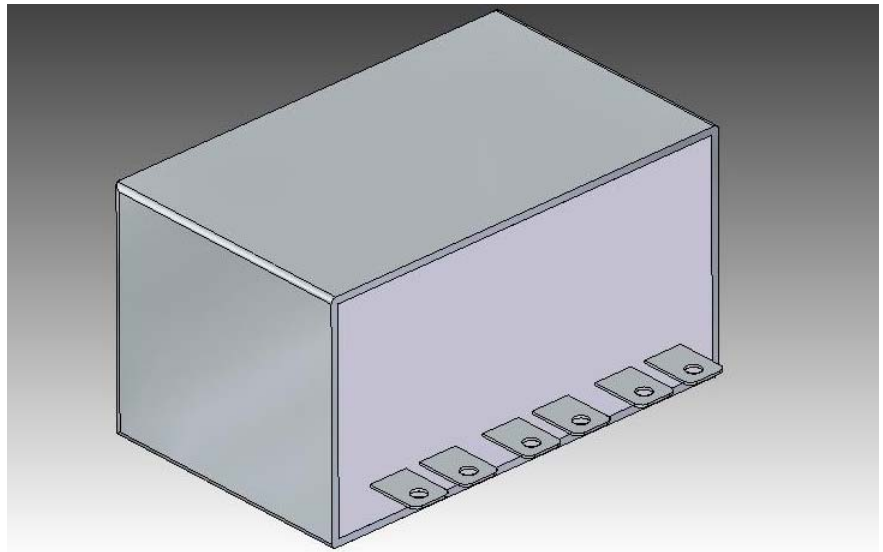
DC-Link Capacitor for Hybrid Vehicle

Standart Hybrid pack

Infineon HP2 module



Semikron SKAI2 module



Film or Electrolytic Power Solutions Design Parameter Information

Film:

- Capacitance & tolerance
- Voltages: nominal, peak, surge
- Operating ambient temperature range
- ESR, ESL
- Ripple current: continuous / max
- Peak current, dv/dt
- Life expectancy
- Thermal design: cooling/airflow/heatsink
- Mechanical design: size, terminations box, alu-can, brick
- Specification and / or competitor part number

Aluminum Electrolytic:

- Capacitance & tolerance
- Voltages: Operating, surge
- Operating ambient temperature range
- ESR
- Ripple current spectrum at associated frequencies
- Capacitor bank configuration (# in series by # in parallel)
- Life expectancy & end of life criteria
- Thermal design cooling, airflow, heatsink
- Mechanical design: size, terminations, plain / stud can, sleeving
- Specification and / or competitor part number

Thank you very much!

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